Central Board of Secondary Education

UNDERSTANDING COMPETENCY BASED LEARNING FOR SCIENTIFIC LITERACY

Sri Aurobindo Society
Creating the Next Future

ACER

Foreword

The Government of India unveiled the National Education Policy 2020 with a vision to transform school education for equipping students with 21st century skills. The focus is to move from rote learning to Competency Based Learning. The Central Board of Secondary Education (CBSE), working towards this vision, has taken several steps. Aligned to its commitment of making education meaningful for learners, CBSE entered into an MOU with Sri Aurobindo Society in November, 2019. As a part of this initiative, Sri Aurobindo Society has collaborated with Australian Council for Educational Research (ACER) as its knowledge partner.

Through this collaborative effort, resource books have been prepared for English Reading, Scientific and Mathematical literacies. Each one is aligned to the broad competencies identified by the Organisation for Economic Co-operation and Development (OECD) for the Programe for International Student Assessment (PISA) frameworks. The documents introduce the concept of competency based education, PISA framework for the respective subject and strategies to foster and assess these in the classroom. Besides this, the mapping of the NCERT Learning Outcomes to the content areas (as defined in CBSE-TERM document) and the PISA competencies have been included. Practical examples for teaching and assessing across various content area and competencies are further inbuilt to enrich the teacher's repertoire for classroom transactions.

This document, *Understanding Competency Based Learning for Mathematical Literacy* prepared by Sri Aurobindo Society in collaboration with ACER for CBSE is a rich resource that can be used by schools and teachers for supporting students to acquire mathematical literacy and problem solving competencies. The resource samples the teaching pedagogy aligned with educational content that would benefit practioners in the field.

About CBSE

The Central Board of Secondary Education (CBSE) is a national Board under the Ministry of Education, Govt. of India. The Board has more than 25,000 schools affiliated to it in India and overseas, in 25 countries. These include the Kendriya Vidyalayas, the Jawahar Navodaya Vidyalayas, Central Tibetian Schools, Schools run/aided by the State Governments and Private Schools. The Board's main objective is to encourage quality education focussed on holistic development of learners. It motivates schools and teachers to adopt learner centric enquiry based pedagogies and use innovative methods to achieve academic excellence. The Board is committed to providing a stress-free learning environment that will develop competent, confident and enterprising citizens who will promote harmony and peace in the world.

About SAS

Sri Aurobindo Society (SAS) is an international, spiritual, and cultural, not-for-profit NGO. SAS has been recognised by the Government of India as a Charitable Organisation, a Research Institute and an Institute of National Importance. Sri Aurobindo Society has more than 300 centres and branches across the country, with its head office in Puducherry. SAS is setting up models, centers of excellence and training institutions that are Sustainable, Scalable and Replicable in the country. Rupantar, a dynamic and multidimensional program of Sri Aurobindo Society is dedicated to transform education in schools by harnessing the power of existing resources.

About ACER

Australian Council for Educational Research (ACER) is a leading and pioneer international organization working in the field of Competency Based Learning and has led a consortium of international organizations for the implementation of the PISA (Programme for International Students Assessment) survey in 2000, 2003, 2006, 2009 and 2012.

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ABBREVIATIONS AND ACRONYMS

ACER	Australian Council for Educational Research
CBSE	Central Board of Secondary Education
ICT	Information and Communication Technology
IEA	International Energy Agency
MHRD	Ministry of Human Resource and Development
NEP	National Educational Policy
NEQMAP	The Network on Education Quality Monitoring in the Asia-Pacific
NGSS	United States Next Generation Science Standards
NRC	National Research Council
OECD	Organization for Economic Cooperation and Development
PIAAC	Programme for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
TIMSS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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EXECUTIVE SUMMARY

Fuelled by advances in technologies, especially education technologies, competency-based education has gained popularity from the education community across the world. It emphasises personalised learning of students following a well-designed learning pathway at their own pace. It is more important for students to demonstrate proficiency by applying their knowledge and skills to solve real-world problems than to spend specific amounts of time receiving instruction in a course. This learning framework is an effort to introduce competency-based learning to classroom teaching and learning in India in order to prepare Indian students for the rapidly changing future.

This framework spans the entire spectrum of the teaching learning process. Initially, science domain is defined and the competencies that comprise the domain are presented. Then, practical techniques of teaching learning and methods of implementation are discussed. For a competency-based learning system to be effective, an effective system of assessment that is integral to the teaching-learning process must be adopted. Traditional approaches to assessment, with their emphasis on marks or grades, are not effective at describing student proficiency levels substantively. Therefore, a new approach to assessment that makes use of learning progressions that contain descriptions of proficiency levels at various stages is recommended in the framework.

A chapter-wise summary is provided below.

Chapter 1 introduces competency-based education in the 21st century. Its importance is established with reference to research that provides evidence of its effectiveness. As a best practice example of competency-based assessment, the chapter introduces the Programme for International Student Assessment (PISA) of OECD. PISA is different from other large-scale learning assessments in that it measures knowledge and skills of 15-year olds and monitors trends in student performances in three main cognitive domains every three years. India's decision to participate in PISA 2021 is a big step forward toward promoting competency-based learning and to shift the focus of education from rote learning in order to prepare the new generation of learners for the rapidly changing future.

Chapter 2 analyses the importance of scientific literacy and what the characteristics of a scientifically literate person are in society. It outlines how the objectives of science education will change with the implementation of the National Educational Policy 2020 in India. It introduces the concept of scientific literacy and how the definitions have evolved over the years. Students are being expected to become scientifically literate enough to make conscious decisions that are supported by scientific rationales. The definition of scientific literacy as defined by the Program for International Student Assessment (PISA, 2018) has been introduced. The definition emphasizes students' ability to engage in reasoned discourse about science and technology in a range of contexts and how scientifically literate individuals will contribute to sustainable development of society as global citizens. The chapter concludes with a close examination of the importance of reforms in curriculum and teaching and the usefulness of scientific literacy in initiating a paradigm shift in pedagogical interventions in Indian classrooms.

Chapter 3 tries to give more insight into the competencies assessed by the PISA science assessment. PISA assesses three key scientific competencies – explaining phenomena scientifically, evaluating and designing scientific enquiries and interpreting data and evidence scientifically. The PISA science competencies are embedded in real-life contexts and based on an individual's ability to use knowledge of the natural world and technological artefacts (content knowledge), knowledge of practices and concepts on which empirical enquiry is based (procedural knowledge) and understanding of the underlying rationale of the procedures with justification for their use (epistemic knowledge).

Chapter 4 constitutes the core of the document. It emphasizes the need to improvise teaching strategies in order to encourage students in making decisions on their own, think critically, and

determine questions that can be investigated. There are many widely approved teaching strategies being followed globally to promote inquiry-based learning in the classroom. The chapter describes some of the teaching strategies that promote competency-based education. Professionally trained teachers with the right support and resources need to identify the strategies that are most appropriate for their context and can be adapted to develop the science competencies in students.

Chapter 5 gives further insight into scientific proficiency with the help of PISA *proficiency levels*. Description of the skills are mentioned for each level in terms of what the students are likely to know and perform at that specific level. A discussion on the scientific literacy scale is provided where the proficiency levels are mapped to the three competencies defined by PISA. This chapter also includes PISA sample items for scientific literacy along with some additional competency-based sample items aligned to the NCERT learning outcomes.

Chapter 6 emphasises robust assessment and the need for monitoring students' learning progress over time. One of the key recommendations is to use learning progressions to bridge the gap between student knowledge and curriculum expectations. Learning progressions map curriculum with development in students' learnings that help in integrating learning outcomes, curriculum and proficiency based assessments. It suggests that teachers use learning rubrics to collect information on students' knowledge and skills. The chapter also includes guidelines on developing such rubrics. One of the key points discussed in this chapter is the usefulness of providing feedback to students, an important part of the assessment process. Rubrics can provide feedback on instructional practices implemented in the classroom. It is suggested that teachers develop rubrics based on learning outcomes rather than specific tasks as it will help them to synchronize the teaching-learning process and assessments with the desired outcomes.

Chapter 7 provides the linkage between NCERT textbooks from grade 6 to 10 and PISA competencies at a granular level. Subtopics in each chapter is aligned with the learning outcomes, measurable learning outcomes, learning objectives and PISA competencies. In addition some exemplar teaching strategies are mentioned if applicable.

1. INTRODUCTION

We are living in a highly technology-driven world in which both promises and challenges coexist. It is estimated that around 50 percent of current work activities are technically automatable (McKinsey Global Institute, 2017). There have been discussions on changes in employment types due to automation. Experts expect that workforce transformation is inevitable and will take place in two ways (World Economic Forum, 2018):

- Large-scale decline in some roles as tasks within roles become automated or redundant;
- Large-scale growth in new products and services – and associated new tasks and jobs – generated by the adoption of new technologies and other socio-economic developments.

Most of the new tasks and jobs in demand due to these changes are different from traditional ones, including Social Media Specialists, Innovation Managers, AI and Machine Learning Specialists, Human-Machine Interaction Designers, and so on. This rapid transformation in workforce calls for prompt changes in the way we teach students and help ready them for the future. This is more important for India whose youth population is the world's largest (United Nations Population Fund, 2014).

In this challenging world, it is inevitable that our expectation from education and the way we prepare students for the future change. The international education community is moving toward preparing the new generation of learners for the era of technology when critical thinking, practical application of principles, problem solving, and creativity are more crucial than rote learning. In this regard, it is a promising move that India recognizes quality education for all and has introduced competency-based learning in its National Education Policy 2020 (MHRD, 2020).

Competency-based learning, unlike curriculum-based learning, emphasizes a student-centred approach to education. It is heavily driven by experience and discovery rather than lecture and memorization. The focus of competency-based learning is on what students understand and how they apply what they learn in real-life situations rather than what they remember. This learning framework is an effort to introduce competency-based learning to classroom teaching and learning in India in order to prepare Indian students for the rapidly changing future.

The Australian Council for Educational Research (ACER) has been a long-time proponent of competency-based education. The framework will be a meaningful contribution of ACER (India), partnering with Sri Aurobindo Society, to Indian education to promote competency-based teaching, learning, and assessment in classrooms.

1.1. Competency-based teaching and learning

Competency-based education initially gained popularity among researchers in the 1970s spurred by Benjamin Bloom's research (Steele et al., 2014). His approach to education focuses on attention to individual students, student-centred instruction and flexible pacing in teaching and learning. Bloom (1956) contributed to the body of educational research by defining the hierarchy of cognitive processes, which places learner's ability to apply, analyse, evaluate, and synthesise, higher than that of remembering and comprehending. However, this approach was not an entirely new idea. John Dewey's experiential learning emphasised that students constructed their own learning through real-world experience and engagement (Steele et al., 2014). Competency-based learning has regained its popularity recently with information technology supporting learners for self-motivated and personalised learning.

Traditional teacher-centric approach to education assumes that an educated man is equivalent to a competent man. In this approach, students are expected to acquire the knowledge and skills by

receiving lectures and learning the curriculum. On the contrary, competency-based education recognises that real learning does not take place automatically by taking lectures and memorising a body of facts. In a competency-based system, it is believed that mastery in learning comes from application of knowledge and skills in real-world situations. In this sense, competency-based learning is similar to experiential learning, proficiency learning, project-based learning, and flipped learning.

Competency is a general term that describes the desired knowledge, skills, and behaviours of a student graduating from a programme (or completing a course), whereas a learning outcome is more granular and specific. Competencies are commonly defined as the applied skills and knowledge that enable people to successfully perform in professional, educational, and other life contexts.

Competency-based education is in favour of reducing disparities in students' performance outcomes and bridging achievement gaps. It allows students to build academic foundations by mastering the current concepts or skills before they move on to new ones. In order to achieve success in competency-based teaching and learning, it requires unique features (Steele et al., 2014):

- Defined progression toward mastery – this means that learning progressions are clearly defined and students see a clear learning pathway for improvement.
- Flexible pacing – this means that each student progresses through content at his or her own pace, and potentially at different paces in different content areas. It is more important to set a student's starting point at the current level of competency in learning progression rather than his or her placement in an age-based grade level.
- Personalised learning – it is important to recognise that learners learn differently, have different skill levels, and encounter different opportunities to learn outside of school. As students mature, competency-based education provides opportunities to make more choices regarding how to acquire skills and knowledge, as well as how to provide evidence. This personalisation can lead to increased engagement.
- Anytime/anywhere learning – this means that access to out-of-school learning opportunities. This is catalysed by the advances in educational technology, enabling instructional system that incorporates both online and teacher-led instruction.
- Credit for mastery – students demonstrate proficiency and earn credit by applying knowledge and skills. Academic credit is based on evidence of learning, not only completion of a certain number of days or hours of instruction in a course.

1.2. Competency-based assessment

Assessment plays a critical role in competency-based learning. The fundamental purpose of assessment in education is to establish and understand where learners are in an aspect of their learning at the time of assessment. This usually means establishing what they know, understand, and can do. The traditional approach of curriculum-based assessment focuses on whether the skills have been attained and the content has been learned. On the other hand, competency-based assessment focuses on whether the learner can apply the skills and concepts that he or she has acquired and learned. In competency-based assessment, it is important to build a system of capturing the student's competencies such as knowledge, skills and attitudes in an area and their application to real-world problems.

Competency-based assessment focuses on students' mastery of skills, feedback to students, and improvement in performance rather than test scores or grades. Thus, an assessment is carried

out as a process in order to collect evidence about the performance and knowledge in a competency standard. A few assessment methods are emphasised in competency-based education, including performance-based, portfolio-based, and rubric-based evaluation (Steele et al., 2014). Evaluation against well-designed rubrics provides students with an indication of how well they performed on a task. At the same time, it guides students on what they need to do to improve and master the skill required. Therefore, development of well-defined learning outcomes and objectives aligned with a pathway demonstrating progression in student learning is a must in implementing a competency-based assessment. This allows students to expect what they should know and be able to do at each level of proficiency.

Many international learning assessments have established well-specified learning standards along with the hierarchy of proficiencies or benchmarks in core test domains, while developing tests designed to measure students' mastery of related knowledge and skills. Numerous governments around the world have adopted or have been setting quantifiable standards for successful learning. It is, however, more important for schools and teachers to wisely adopt the learning standards for classroom teaching to evaluate students' mastery by applying competency-based education pedagogy.

Competency-based assessment has gained recognition by the international education community. The Organisation for Economic Co-operation and Development (OECD) has long been supporting the competency-based approach. This is well reflected in its large scale educational assessments such as the Programme for International Student Assessment and the Programme for the International Assessment of Adult Competencies (PIAAC). As is expressed in the NEQMAP Strategy 2020-2024, the United Nations Educational, Scientific and Cultural Organization (UNESCO) adopts and recommends competency-based approach for educational assessments (NEQMAP, 2020).

1.3. PISA – an international competency-based assessment

Large-scale educational assessments are becoming more and more popular in the world, including OECD's Programme for International Student Assessment (PISA), IEA's Trends in International Mathematics and Science Study (TIMSS), Progress in International Reading Literacy Study (PIRLS), and India's National Achievement Survey. International large-scale assessments allow comparison of the strengths and weaknesses of different education systems and learning from other education systems around the world. The findings of the scientific educational assessments are an important indicator of the quality of the education systems in participating countries and economies. The assessments enable governments to effectively monitor their education systems and design policy interventions for improvement and reform.

Among the various international educational assessments, PISA is unique in that it assesses knowledge and skills of 15-year-olds and monitors trends in student performances in three cognitive domains. PISA is designed to gauge what is important for citizens to know and be able to do. In order to achieve this, PISA takes the approach of competency-based assessment rather than a curriculum-based one. It measures students' capacity to apply knowledge and skills, and to analyse, reason and communicate effectively as they identify, interpret and solve problems in real-life situations (OECD, 2019). This approach reflects the fact that modern economies reward individuals not for what they know, but for what they can do with what they know. Thus, the focus of PISA is on students' mastery and readiness to apply knowledge gained from school to real-life situations.

In addition, PISA tests 15-year-olds in a country or economy rather than students at a specific academic grade level unlike other international assessments. This is to assess future

preparedness of 15-year-old youths who are nearing the end of their compulsory education in most countries and economies. On the contrary, most of the other large-scale learning assessments assess students studying at particular grade level(s) in order to measure the effectiveness of their schooling. For example, TIMSS and PIRLS survey students in Grade 4 and Grade 8.

Lastly, PISA is the world's largest international learning assessment thanks to the high degree of validity and reliability gained from the above mentioned points. In PISA 2018, a total of 79 countries and economies participated, including all 37 OECD countries and 42 partner countries and economies. A total of 87 countries and economies have signed up to participate in PISA 2021, which is delayed to 2022 due to the COVID-19 pandemic crisis, in order to gain important data on learning outcomes of their youths.

The advanced techniques applied to PISA to make the tests valid and reliable are based on rigorous scientific research from various disciplines including psychology, statistics, psychometrics, and education. OECD maintains strict implementation rules for all participating countries and economies in order to ensure comparability of the assessment results of the countries and economies. Thus, PISA results help governments around the world understand the strengths and weaknesses of their education system and to use them for evidence-based policy making.

It is promising that India recognises high quality education for all by adopting the National Educational Policy 2020 and has re-joined the next cycle of PISA 2021 to monitor its education system. Promotion of competency-based learning and assessment through PISA will facilitate improvement of the quality of education in India and preparation of the new generation of learners for the era of technology when practical application of principles, problem solving, and creativity are more critical than rote learning. This learning framework aims to help teachers understand competency-based education and apply its various pedagogical strategies to implement competency-based teaching in the classroom.

1.4. Prerequisites for competency-based learning

It is to be noted that competency-based education is for all levels of education – from early childhood education to higher and adult education. The key belief in a competency-based system is that students learn more effectively when they progress at their own pace through a series of personalized learning experiences. Therefore, not all students are expected to achieve the same level of proficiency at the same time. In this sense, it is immensely important for teachers to ensure and support students build foundational skills from an early stage of their education, since students who are weak in foundational skills have great difficulty in coping with the next level of proficiency in learning.

It is praiseworthy that the Government of India recognized the importance of early childhood education as the foundation of learning in the National Education Policy 2020. Competency-based education can be applied to earlier stages of education as effectively as to later stages of education in order to ensure students' development of foundational skills. It is not recommended to suddenly introduce the competency-based learning approach to students at any one stage of education. It is ideal to adopt the competency-based education for all levels of education.

This learning framework is developed to target teaching students in secondary education, from Class 6 to Class 10. The pedagogical strategies mentioned and examples shared in the framework are to help secondary education teachers and students. These may not be directly related to building foundational skills. Therefore, the framework is developed, assuming that students at

the secondary level must have acquired knowledge and skills expected at early learning and primary education levels.

In the following chapters, the details of competency-based learning will be discussed. In chapter 2, the subject domain is defined. It introduces the concept of the literacy approach and domain literacy and highlights importance of the domain. Chapter 3 is the introduction to domain competencies based on the PISA competencies. There will be a discussion on various pedagogical strategies in chapter 4 to promote competency-based learning in classroom teaching. Chapter 5 and chapter 6 are about how to assess the competencies. The key components of competency-based assessment, including the proficiency levels defined by PISA, are introduced in Chapter 5. In chapter 6, the discussion on how to link assessment to teaching is elaborated. Chapter 7 maps the NCERT learning outcomes and the CBSE defined learning objectives with the PISA competencies by grade and chapter of the NCERT textbooks.

2. DEFINING SCIENTIFIC LITERACY

2.1. Introduction to scientific literacy

The term "scientific literacy" indicates the broad goals of science education. Science education in today's context is not just about curriculum involving content and relevant skills, it encompasses a wide range of abilities that can enable students to engage with their environment and with the society; economically, socially and politically in a range of contexts. Science education has always been popular among Indian students. In this context, a career in engineering or medical science is considered to be rewarding in terms of advancement and better chances of economic prosperity leading to tough competition amongst students. This has resulted in teachers teaching to tests, a culture that encourages mindless rote learning rather than fostering actual curiosity and the zeal to understand scientific concerns. The aim of teaching and learning science appears to be preparing students for examinations, thus defeating the overall goal of science education. The objective of science education is not just to prepare students for specific careers in science but to raise individuals who are literate enough to understand scientific problems that might impact their lives in future.

There are two different terms – 'science literacy' and 'scientific literacy' defined in different ways by different researchers. Science literacy provides a context for addressing societal problems, helping people make intelligent and informed decisions that will affect the quality of their lives and those of their children (E-an Zen, 1990). Science literacy is useful in daily lives, particularly the way a science literate person solves his day to day problems in a meaningful way and makes informed decisions, sometimes called public engagement with science (Feinstein, 2010). While science literacy focuses on gaining specific facts and skills that make individuals productive members of the society, scientific literacy is the scientific ways of knowing and thinking critically and creatively about the natural world (Maienschein, 1998). In the present context, scientific literacy has gained more popularity because it emphasises not just on acquiring knowledge of science but also the common procedures and practices associated with scientific enquiry. Science process skills used for investigation and exploration can play an essential role in developing 21st century skills in students (Turiman et al., 2012). Undoubtedly, the nature of the problems in future are expected to be different than they were in the past and therefore the scientific approaches to deal with these problems will need to be different. It is believed that a scientifically literate person will responsibly and rationally deal with problems facing humanity in the 21st century. The United States Next Generation Science Standards (NGSS, 2013) for K-12 presents a new vision of science education with greater emphasis on linking content with science practices. The performance expectations are expected to better prepare students for college, career, and citizenship with development of skills such as critical thinking and inquiry-based problem solving.

International large-scale assessments such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are increasingly becoming popular due to their focus on competencies relevant to today's world. While TIMSS is content centred, PISA is content free. PISA is significantly different from state or national level assessments in a way that it focuses on how well-prepared 15-year-old students are for the future challenges in life, their ability to analyse, reason and communicate effectively and their capacity to continue lifelong learning (Sadler and Zeidler 2009). Comparison of students' performance across countries have prompted policy-makers to adopt a series of reforms in science education in order to make students scientifically literate. In this context, it becomes imperative to define scientific literacy in a way that is aligned with best standards and competencies.

2.2. Definition of scientific literacy

Scientific literacy was first described by Paul DeHart Hurd in 1958. Since then different researchers and reformists have defined scientific literacy in various ways and there is not one common definition of scientific literacy. George DeBoer (2000) presented a historical review of the term scientific literacy suggesting there were different goals of science education and hence different meanings of scientific literacy. However, most definitions broadly encapsulate the functional understanding of science useful in day-to-day life and not the preparation for a scientific or technical career. Despite the revisions in definitions by different scholars and organisations from time to time, it is noteworthy that the objective of defining the goals of science education have always been aligned towards raising scientifically literate students who are not just aware of the natural world around them but also capable of understanding the causes and effects of natural phenomenon, finding possible solutions to problems related to the changing environment and communicating the same to the wider world.

The question therefore is how scientific literacy should be appropriately defined. Roberts (2007), in the Handbook of Research on Science Education (Abell and Lederman 2007), presents two perspectives of how science literacy can be defined - Vision I and Vision II. Vision I is curriculum centric with a focus on what science literate individuals should know or be able to do in terms of knowledge that they possess while Vision II is focussed on how individuals use the acquired scientific knowledge in different real-life contexts that they come across their lives as citizens. Importantly, Vision II implies knowledge, understanding and application of science across a range of contexts. It is evident from the review that the definition of scientific literacy has evolved over time in response to the changing socio-economic and environmental issues.

The Program for International Student Assessment (PISA) focusses primarily on the concept of Vision II as is evident in the competencies that the programme aims to assess across a range of personal, local, national and global contexts. PISA 2018 defines scientific literacy as:

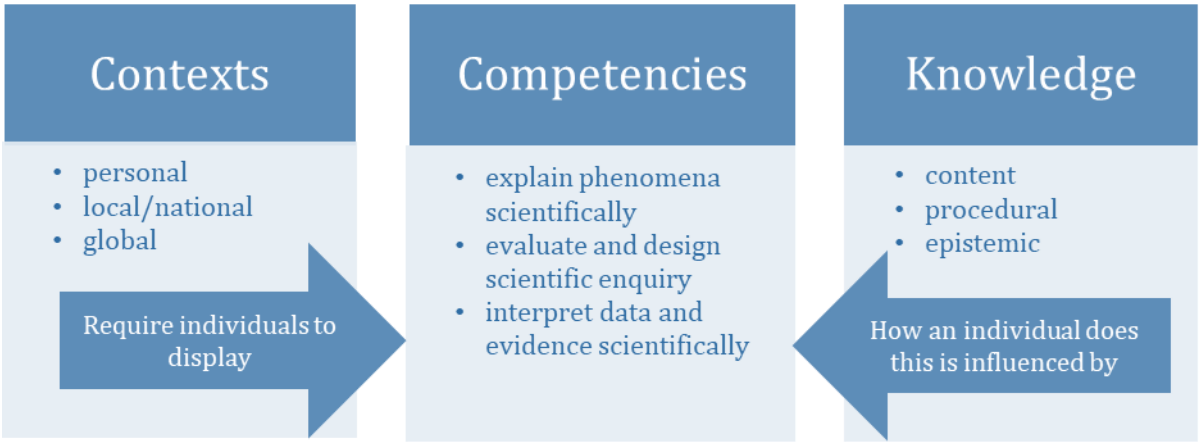
"Scientific literacy is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person, therefore, is willing to engage in reasoned discourse about science and technology which requires the competencies of:

- *Explaining phenomena scientifically: Recognising, offering and evaluating explanations for a range of natural and technological phenomena.*
- *Evaluating and designing scientific enquiry: Describing and appraising scientific investigations and proposing ways of addressing questions scientifically.*
- *Interpreting data and evidence scientifically: Analysing and evaluating data, claims and arguments in a variety of representations and drawing appropriate scientific conclusions."* (OECD, 2019, PISA 2018 Assessment and Analytical framework, pp. 100-101)

Scientific literacy described in PISA 2018 includes three interrelated aspects: contexts, knowledge of science, and competencies.

A scientific literacy assessment instrument is characterised by the competencies at its core with the other elements (knowledge of science and contexts) linked to it.

Figure 2.1: Aspects of scientific literacy in PISA 2018 Assessment and Analytical framework.



Exhibiting the three PISA scientific competencies require knowledge. *Content Knowledge* is described as a knowledge of the content of science to explain various scientific phenomena – a criterion for demonstrating the first PISA competency. The second and third competencies, however, require more than just content knowledge. They demand an understanding of how scientific knowledge is utilized and the degree of confidence with which it is applied. Understanding the features that characterise scientific enquiry requires a knowledge of the standard procedures that underlines the diverse methods and practices used to establish scientific knowledge – termed as *procedural knowledge*. These competencies, at times, also demand an understanding of the rationale for the common practices of scientific enquiry and the importance of the components of scientific enquiry including hypothesis, observation and data – termed as *epistemic knowledge*.

PISA focuses not only on the evaluation of students' content knowledge in science but also their ability to apply the knowledge to different types of contexts. The contexts are generally set in the areas of concerns, such as health and disease, natural resources, environmental quality, hazards, and the frontiers of science and technology.

• *Personal context* includes situations and tasks that arise in students', their peers' and families' daily lives, such as handling of personal hygiene.

• *Local context* is related with issues around community and the nation where people live, such as deforestation, soil erosion, loss of biodiversity, etc.

• *Global context* is applicable to all the problems and tasks related to global issues, such as global warming, ozone depletion in atmosphere, etc.

2.3. Importance of the domain

In contemporary societies, including India, there is an increasing emphasis on the importance of helping students to enhance '21st century' skills during their school and higher education. While most education systems across the world are curricula based and teachers impart knowledge to students via traditional teacher centric method (Schleicher, 2012), much reference is made to incorporating skills such as problem solving, teamwork, creativity, communications and critical thinking into subject domains.

According to data published by Global Business Coalition for Education, the Education Commission and UNICEF, over half of Indian students will leave school without the necessary skills to get 21st century jobs by 2030. This would inevitably result in loss of future talent that could otherwise drive Indian economy to become more productive and vibrant. This points to the urgent need of reforming education system in India with more focus on achieving relevant skills rather than just possessing knowledge of a defined content area.

India's National Education Policy (MHRD, 2020) lays emphasis on a holistic education aligned with the key 21st century skills. NEP also recognises that with the rapidly changing global ecosystem and the emerging crisis of resources such as energy, water, and food, a new skilled workforce will be needed. It focusses on multidisciplinary learning along with a collaborative approach to deal with growing problems in the world. In the context of diseases and their management, the world is facing important health issues. For example, antimicrobial resistance is a rapidly emerging global health crisis in the world and studies indicate 75% of the Indian population are not scientifically literate to understand that cold or flu (viral infections) cannot be treated with antibiotics (WHO, 2016). Evidently, the aspirations of India's National Education Policy will mean significant changes in the way science is taught in classrooms in order to raise students who are scientifically literate in a meaningful way.

Pedagogical techniques including problem-based learning, can help students analyse, reflect, evaluate and think innovatively (Hmelo-Silver, 2004). Science education in post-independent India requires both pedagogical innovations and reforms in science curriculum to instil scientific temper and the ability to apply knowledge to several aspects of life (Kumar and Singh, 2017). It is obvious that competency- based education with the right reforms in curriculum, teaching methodologies and assessments can fulfil the long term goal of scientific literacy.

3. COMPETENCIES IN SCIENTIFIC LITERACY

3.1. Introduction

Educational systems across the world are shifting to competency-based education where the focus is gradually shifting from teachers to the students. Competencies are a combination of knowledge, skills and attitude needed to perform a task when posed with a problem in real life. They include not just skills and knowledge acquired but also the scientific attitude to apply knowledge and skills contributing towards solving problems by engaging with the society. Competencies related to science process skills such as observing, classifying, measuring, predicting, communicating, interpreting data, and experimenting play key roles in fostering 21st century skills (Turiman et al., 2012). Foundational literacies including scientific literacy should equip students with core skills and competencies like collaboration, creativity, and problem-solving needed to thrive in today's innovation-driven economy (World Economic Forum, 2015).

A scientifically literate individual is expected to make informed decisions as a citizen evaluating circumstances or situations based on valid and reliable evidence. Very often, these decisions related to science and technology are influenced by social, economic, political and cultural contexts familiar to an individual. Socio-scientific issues are problems influenced by various social factors and incorporating such science based social issues in teaching and learning will build competency to engage in democratic discourse and processes (Sadler, 2011). Science pedagogy using an inquiry-based teaching and learning strategies integrate problem-based approach and promote critical thinking- an important dimension of science education (Bailin, 2002). In order to engage in socio-scientific issues one must develop critical thinking so as to make informed judgements (Yacoubian, 2015). Therefore, developing critical thinking mind set is a key competency to achieving scientific literacy.

India's National Education Policy (MHRD, 2020), emphasises on reducing curriculum content to make space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning with more focus on application and problem solving. The National Curriculum Framework (2005) expects students to develop investigative skills in order to promote innovation and creativity. A constructivist approach adopting an inquiry-based teaching develops skills of reflecting, analysing and interpreting. Based on these ideas, NEP suggests aligning the National Curriculum Framework towards promoting these competencies from early years of teaching and learning.

Scientific inquiry includes key science practices such as asking questions based on evidence, generating evidence, working with data, answering research questions and making arguments from evidence are practices that need to be assessed in the context of science domain (TIMSS Assessment Framework, 2019). Therefore, these competencies cannot be taught or tested in isolation and need to be embedded in the pedagogical and assessment approaches.

3.2. PISA Competencies

The PISA 2018 Assessment and Analytical Framework defines three key competencies that are essential for a scientifically literate person (OECD, 2019). The competencies reflect social and epistemic practices and hence framed as actions, conveying what the scientifically literate person both understands and is capable of doing. These competencies are:

1. **Explaining phenomena scientifically**

This competency requires students to recall the appropriate content knowledge in a given situation and use it to interpret and provide an explanation for the observed phenomenon. In addition, it may involve recognising or identifying appropriate descriptions, explanations, and predictions. The content knowledge can be derived from the major sub-domains such as physics, chemistry, biology and earth and space sciences. The content knowledge is age-appropriate, authentic and based on real-life contexts that the students may have seen or heard in their lives or are likely to encounter in the future.

2. **Evaluating and designing scientific enquiry**

This competency requires students to identify problems that can be investigated scientifically. It also requires students to evaluate reports of scientific findings and investigations, critically, which in turn is dependent on the knowledge of key aspects of scientific investigation such as the role of various measurements, the different variables involved in an experiment and the reliability of data collected. This is particularly important for students in the context of reading and comprehending news from the outside world related to scientific issues. Students should be able to distinguish between facts and fiction, between biased and unbiased reports and most importantly should be able to reflect on the validity and reliability of media reports. This competency requires students to possess procedural and epistemic knowledge or may also require students to use their knowledge of content of science.

3. **Interpreting data and evidence scientifically**

This competency requires students to assess and evaluate scientific information and conclusions in the light of scientific evidence. The competency also includes taking into account the assumptions made in deriving those conclusions. Besides, students should be able to disseminate their data using appropriate tools and summarise their findings to a larger audience.

Table 3-1 provides details of tasks that make up each of the three competencies comprising scientific literacy. The competencies are framed as actions, conveying what the scientifically literate person both understands and is capable of doing.

Table 3-1: PISA 2018 Scientific competencies

Competency 1: Explaining phenomena scientifically
Recognising, offering and evaluating explanations for a range of natural and technological phenomena through: • Recalling and applying appropriate scientific knowledge; • Identifying, using and generating explanatory models and representations; • Making and justifying appropriate predictions; • Offering explanatory hypotheses; • Explaining the potential implications of scientific knowledge for society

Competency 2: Evaluating and designing scientific enquiry
Describing and appraising scientific investigations and proposing ways of addressing questions scientifically through: • Identifying the question explored in a given scientific study; • Distinguishing questions that are possible to investigate scientifically; • Proposing a way of exploring a given question scientifically; • Evaluating ways of exploring a given question scientifically; • Describing and evaluating a range of ways that scientists use to ensure the reliability of data and the objectivity and generalisability of explanations.
Competency 3: Interpreting data and evidence scientifically
Analysing and evaluating scientific data, claims and arguments in a variety of representations and drawing appropriate conclusions through: • Transforming data from one representation to another; • Analysing and interpreting data and drawing appropriate conclusions; • Identifying the assumptions, evidence and reasoning in science-related texts; • Distinguishing between arguments that are based on scientific evidence and theory and those based on other considerations; • Evaluating scientific arguments and evidence from different sources (e.g. newspaper, Internet, journals).

The PISA scientific competencies are embedded in real-life contexts and based on an individual's ability to use knowledge of natural world and technological artefacts (content knowledge), knowledge of practices and concepts on which empirical enquiry is based (procedural knowledge) and understanding of the underlying rationale of the procedures with justification for their use (epistemic knowledge).

An important question is how to develop scientific competencies in students. Various teaching strategies have been proposed by different reformers for effectively teaching and assessing the competencies. Teachers play the most important role in the educational system and therefore much depends on how teachers adopt new pedagogical approaches in an effort to build these competencies in students (Mathelitsch, 2013). It is noteworthy that there is no standard pedagogical approach to build a specific competency in students and different approaches may need to be adapted to local contexts, availability of resources and the flexibility offered by the curriculum.

4. APPLYING THE COMPETENCIES IN TEACHING

4.1. Why teach these competencies

The world is getting more interconnected and interdependent on the economic, cultural, technological, environmental, and political aspects of civilization than ever before. Responding to the emerging demands, societies desire for students and future leaders who can participate simultaneously in local, national, and global issues concerning scientific understanding. In other words, it should be the universal aim that schools prepare today's students to be scientifically literate.

According to OECD (2019), "scientific literacy is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person, therefore, is willing to engage in reasoned discourse about science and technology which requires the competencies of:

- Explaining phenomena scientifically,
- Evaluating and designing scientific enquiry, and
- Interpreting data and evidence scientifically."

All three competencies require scientific knowledge. **Explaining phenomena scientifically** demands a knowledge of the content of science as a domain, i.e. *content knowledge*. However, the other two competencies require some additional elements along with content knowledge. **Interpreting data and evidence scientifically** requires understanding of how to apply scientific knowledge in real-world situations, i.e. *procedural knowledge*. **Evaluating and designing scientific enquiry** requires an understanding of how to generate and address a scientific inquiry or how to make decisions that are scientifically valid, i.e. *epistemic knowledge*.

According to Villalba-Condori et al. (2019), a scientifically competent student can operate not only in school environments, but also in various real-life situations, thereby showcasing a variety of competencies as defined by the PISA skills. These competencies are based on contexts, like personal, local and global as outlined in the PISA framework. However, teaching students with an emphasis on contexts and content does not mean that classroom instruction should not focus on imparting measurable scientific skills. Actually, teaching the competencies for scientific literacy involves a broad view that encompasses various factors like creativity, critical thinking, values and emotions in addition to domain-specific skills.

All the three competencies are important to the practice of science and are closely related to the key cognitive skills such as investigation and reasoning, critical thinking, decision-making, analysis and exploration of information (e.g. creating tables or graphs out of raw data), and designing of models for application in scientific discussions.

4.2 How to foster these competencies in classroom

Competencies for scientific literacy cannot be taught in vacuum or separately from the competencies for science as a subject. A learner first needs to develop a solid understanding of the content before expanding his/her learning ability in the domain of higher level competencies. A concrete foundation in domain content is an absolute requirement for the effective scaffolding of higher level competencies. Critical thinking and creativity would manifest as extensions of content mastery in a seamless manner. Therefore, the process of developing competencies among

learners should start from elementary grades rather than waiting for students to reach higher grades.

According to the Teachers' Handbook (Volume 2: Scientific Literacy) by the Central Board of Secondary Education, contemporary views on pedagogy suggest that teaching science in classrooms should be based on the principle of practicing **Science in Action**. To achieve this objective, the following methods are prescribed by CBSE:

- Teaching scientific ways of thinking
- Actively involving students in their learning
- Helping students to develop a conceptual framework as well as to develop problem-solving skills
- Promoting student discussions and group activities
- Helping students experience science in varied, interesting, and enjoyable ways
- Assessing student understanding at frequent intervals throughout the learning process

Aksela et al. (2010) explained how inquiry-based education can enhance scientific competencies among students, particularly elements like decision making, critical thinking, hypothesizing, etc. This new method of teaching should be in sync with the teacher's role as the instructor so that an appropriate harmony is maintained between the two. The transition from old tradition to new pedagogy requires a scale of difference between the two methods. Franklin (2002) elaborates the two methods as below.

Characteristics	Inquiry-based	Traditional
Principle learning theory	constructivism	behaviourism
Student participation	active	passive
Student role in outcome	increased responsibility	decreased responsibility
Student role	problem solver	direction follower
Curriculum goals	process oriented	product oriented
Teacher's role	guide/ facilitator	director/ instructor

The next section describes some of the widely approved teaching strategies that encourage and elevate the competencies relevant to scientific literacy among learners.

4.2.1. Pedagogical approaches for developing PISA competencies

1. Spiral Learning

Spiral learning is an interactive teaching method consisting of multiple steps and goals. The strategy is to probe students' thought processes through multi-layered challenges, to stimulate them to ask questions, and then find answers to those.

According to the findings of a research study by Veladat & Mohammadi (2011, p. 1122), spiral learning resulted in a significant increase in the students' learning outcomes and durability of learning. Spiral model of learning is an option for teachers and educators to improve students' learning as an investment for future.

Example

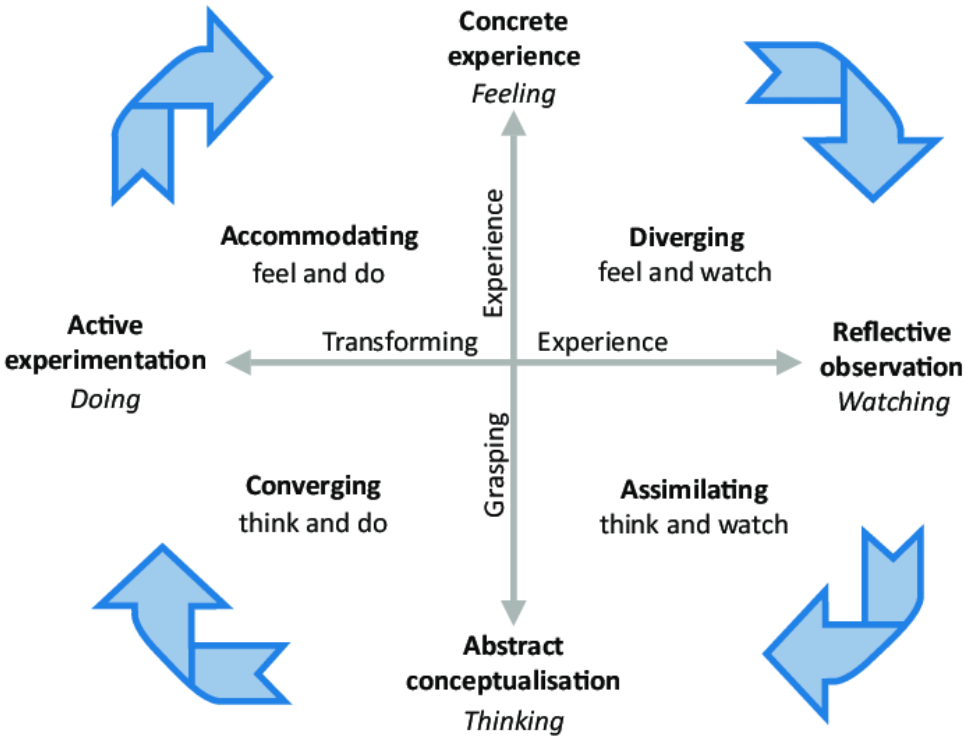
Finding examples of spiral learning in science is comparatively more difficult than other subjects. However, there are certain content areas where spiral learning model can be implemented. Plant biology, for instance, is a suitable subject-area for spiral learning methods to be put into action. A lesson in second grade might focus on what plants need to grow, including sunlight. In fifth grade, students will learn about photosynthesis, which explains why plants need sunlight to grow. In eighth grade, students will learn about the cellular structure of plants, which will give them a more complex picture of plant biology. Finally, students in high school will learn about organic chemistry in plants, completing the picture.[1]

2. Experiential Learning

Experiential learning is the process of learning by doing. By engaging students in hands-on experiences and reflections, they are better able to connect the theories and the content knowledge learned in classrooms to real-world situations.

Kolb's Experiential Learning Theory (Kolb, 1984) defines experiential learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience."

Figure 4.1: Experiential Learning Cycle (Kolb, 1984)



[1] Source: http://198.12.96.119/academy/lesson/spiral-curriculum-definition-example.html

Kolb's experiential learning theory presents a cycle of four elements:

- Concrete Experience
- Reflective Observation
- Abstract Conceptualization
- Active Experimentation

The cycle begins with an experience that the student had followed an opportunity to reflect on that experience. Then students may conceptualize and draw a conclusion about what they experienced and observed, leading to future actions in which the students experiment with different behaviours. This begins the cycle anew as students have new experiences based on their experimentation (Oxendine, Robinson and Willson, 2004). Although this continuum is presented as a cycle, the steps may occur in nearly any order. This learning cycle involves both concrete components (steps 1 and 4) and conceptual components (steps 2 and 3), which require a variety of cognitive and affective behaviours.

Example

Objective: Understanding that light is refracted when it travels from one medium to another, understanding that light can be reflected from and transmitted through an interface.

Activity: Students fill a plastic lunch box with water and add salt or milk until the water appears cloudy. The students begin by shining laser pointers from air into the water and investigating how the path of light alters as they change the angle.

Next they investigate how the path of light changes if they shine the laser pointer through the side of the lunch box, through the water, and into the air. They should also draw diagrams to illustrate what they observe.

The teacher should then use a green or blue pointer side-by-side with a red pointer to illustrate that light of different colours will refract by different amounts.[2]

3. Cooperative Learning

Cooperative learning involves structuring classes around small groups that work together in such a way that each group member's success is dependent on the group's success.

Cooperative learning can also be contrasted with what it is not. Cooperation is not having students sit side-by-side at the same table to talk with each other as they do their individual assignments. Cooperation is not assigning a report to a group of students where one student does all the work and the others put their names on the product as well. Cooperation involves much more than being physically near other students, discussing material, helping, or sharing material with other students. There is a crucial difference between simply putting students into groups to learn and structuring cooperative interdependence among students.

[2] Source: https://www.stem.org.uk/best-evidence-science-teaching

Irrespective of the setting, the design and implementation of cooperative learning involves five key steps:

- Pre-Instructional Planning
- Introducing the Activity to the Students
- Monitoring and Intervention
- Assessment
- Process

Cooperative learning techniques can be loosely categorized by the skill that each enhances (Barkley, Cross and Major, 2005). The categories include: *discussion, reciprocal teaching, graphic organizers, writing* and *problem solving*. Each category includes a number of potential structures to guide the development of a cooperative learning exercise.

Example

Jigsaw groups are an informal cooperative learning group structure that can be used in both laboratory investigations and the discussion of scientific readings. The explicit goal of the jigsaw discussion is for students to share their expertise and to gather information from peers who have completed a different task. For example, students may be asked to read different informative materials like textbooks, magazines and also watch educational videos regarding life processes. As opposed to having all students read the same source of information on different life processes, each student would be assigned readings highlighting the details of one particular process, such as circulation, digestion, excretion, etc. After completing the reading, students would be assigned to jigsaw groups that would bring together four students, each of whom had completed readings on one life process, with the requirement that each student report to the others in an effort to identify common or related organs.

This type of jigsaw approach has been successfully used to introduce students to literature of biology and provide peer support in understanding the complexities of language in written scientific communications (Fortner, 1999). A similar approach can be taken in laboratory courses in which different groups of students have pursued different investigations on a related topic. In addition, students learning laboratory techniques can hone their expertise on a single methodology in one learning group, and then jigsaw with two or three students who have developed expertise in other techniques, thus promoting mutual teaching and learning among students (Colosi, 1998).[3]

4. Experimentation

This pedagogical method is built on research of learning that shows that most students do not respond best to pure "chalk and talk," but rather to "active learning" environments. Classroom experiments keep learners active in a number of ways depending on the nature of the particular experiment. While doing experiments:

[3] Source: https://www.lifescied.org/doi/full/10.1187/cbe.03-03-0010

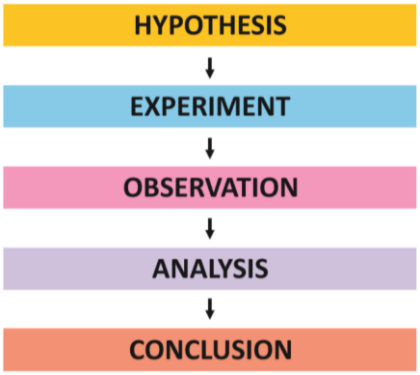
- Students generate data or behavioural observations
- Students analyse data, examples or models
- Students answer leading questions posed by the instructor and compare their answers with those of other students
- Students work together in groups to solve problems, devise strategies or understand class concepts
- Students predict how changing the experiment will change the outcomes
- Students compare experimental results to classroom theories and use them to confirm or critique the theories

Why use Experiments?

Teachers can use experiments to introduce new ideas or clarify puzzling aspects of topics with which students typically struggle. If the result of an experiment is surprising yet convincing, students are in a position to build ownership of the new idea and use it to scaffold learning. The post-experiment assignments can push students to describe a follow-up experiment or to extend their conceptual understanding to another application.

According to the Teachers' Handbook (Volume 2: Scientific Literacy) by the Central Board of Secondary Education (India), the process consists of the following steps.

Figure 4.2: Steps involved in Experimental learning

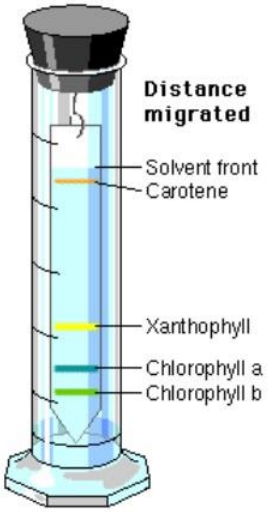


Source 4-1: Retrieved from Teachers' Handbook (Volume 2: Scientific Literacy) by CBSE

Example

Objective: Understand the structure and function of chloroplast

Activity: Students conduct the experiment using paper chromatography technique in order to separate plant pigment substances in a mixture based on the movement of the different substances up a piece of paper by capillary action. Beta carotene is carried the furthest because it is highly soluble in the solvent and because it forms no hydrogen bonds with the chromatography paper fibres. Xanthophyll contains oxygen and does not travel quite as far with the solvent because it is less soluble than beta carotene and forms some hydrogen bonds with the paper. Chlorophylls are bound more tightly to the paper than the other two, so they travel the shortest distance. Spinach leaves are given only as an example. As a solvent, the mixture of acetone and ethanol (1:1) or petroleum ether and acetone (92:8) is used.[4]

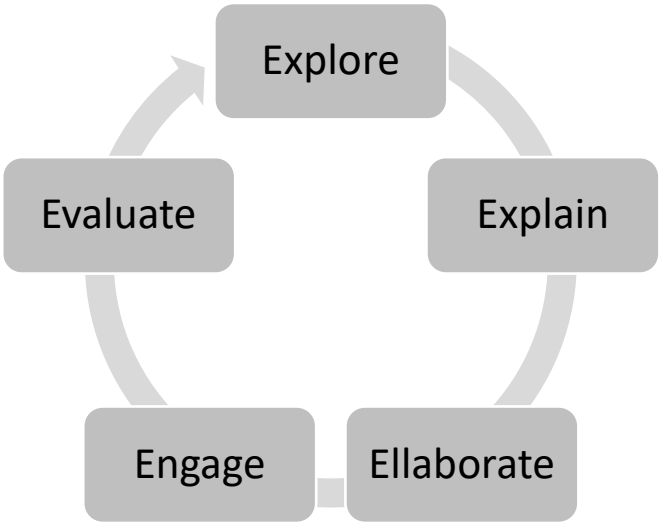


5. Inquiry-based Learning

According to Gillies (2020), when science is taught through inquiry-based learning, it takes an investigative approach to teaching and learning where students investigate a problem, search for possible solutions, make observations, ask questions, test out ideas, and think creatively and use their intuition. Therefore, in inquiry-based science teaching students are provided with opportunities of doing science where they can explore possible solutions, develop explanations for the phenomena under investigation, elaborate on concepts and processes, and evaluate or assess their understanding in the light of available evidence.

The most widely accepted model of inquiry-based learning is the *5E model of teaching*.

Figure 4.3: Key steps of the 5E Model of teaching (Bybee & Landes, 1990)



[4] Source: http://www.establish-fp7.eu/resources/units/photosynthesis.html

Engagement

This is the first phase of the cycle where the teacher assesses students' prior knowledge and/or identify possible misconceptions. This student-centred phase should be a motivational period that can create a desire to learn more about the upcoming topic.

Exploration

This phase provides the students with a common, concrete learning experience. This phase is also student-centred and incorporates active exploration. Students are encouraged to apply process skills such as observing, questioning, investigating, testing predictions, hypothesizing, and communicating, in collaboration with peers.

Explanation

This phase enables students to describe their understanding and pose questions about the concepts they have been exploring. This is a more teacher-directed phase and is guided by students' experience during the exploration phase.

Elaboration

The fourth phase encourages students to apply their new understanding of concepts, while reinforcing new skills. Students are encouraged to check for understanding with their peers, or to design new experiments or models based on the new skills or concepts they have acquired. The objective here is to help develop deeper and broader understanding of the learned concepts.

Evaluation

In an inquiry-based classroom teaching, the use of assessments should be viewed as an ongoing process, with teachers making observations of their students as they apply new concepts and skills and looking for evidence that the students have changed or modified their thinking. Students may also have the opportunity to conduct self-assessment or peer-assessment.

Example

Students are taught about the chemical bonds (covalent and hydrogen) that hold water molecules together. Teacher explains how the bonds stretch out when water freezes so that ice becomes less dense than liquid water. Now, the students are given an opportunity to come up with ways they can watch this property of water in action. The ideas include:

- Pour water into a plastic bottle and then place it in the freezer. Compare the volume of the liquid and solid water after freezing.
- Make a pitcher of ice water. Mark the water level before the ice melts. Allow the ice to melt into the water and mark the new water level. Compare the two.[5]

[5] Source: https://wabisabilearning.com/blogs/inquiry/inquiry-based-learning-science-activities

6. Information and Communication Technology (ICT)

ICT can remove problems concerning space and time. Students can contact the teacher and exchange information anywhere and anytime. In principle, students can draw on a global pool of knowledge. ICT makes serving and sharing knowledge easier. Students can individually and /or together create records, notes and presentations and thus, register their progress as well as share it with their peers.

7. Differentiation into Groups

Differentiated instruction is not a one-size-fits-all approach, but can be customized to meet the needs of individual students. This does not mean that teachers have to customize instruction for each and every student. Rather, they differentiate the instruction for groups of students.

What makes this challenging for teachers is that students' needs vary:

- across content areas (for example, some students excel at biology but struggle with physics)
- within content areas (e.g., some students excel at cell structure and function but struggle with cellular processes)
- across the school year (e.g., at the beginning of the year, some students struggle with inquiry-based science assessments but improve greatly due to effective instruction)

Because students' needs change frequently, teachers should be familiar with two general principles or strategies of differentiated instruction: *ongoing assessment* and *flexible grouping*.

Teachers design lessons to address the needs of groups of students. Before teachers can do this, however, they must first get to know their students in terms of:

- Readiness - student's knowledge and skill level regarding given content.
- Interest - topics, skills, or activities that pique a student's curiosity or inspire him or her.
- Learning profile - student's preferred method of learning new information or skills (e.g., visually, hands-on, through deductive means) and environmental factors that influence a student's learning (e.g., small group, bright lights, no distractions).

Example

This is an example of a learning centre based on readiness level (struggling students, red folders; average students, orange folders; advanced students, green folders).

Theme: Metamorphosis

Unit of Study: Insects

Materials: Plastic models of each stage of a butterfly's life cycle, pictures of all stages of the life cycle, posters of different caterpillars and the corresponding butterflies, books about a butterfly's life cycle, a bug box containing several caterpillars.

Activity: Using the table provided, describe each stage of the life cycle (what it looks like, what butterflies eat during each, number of days in stage).

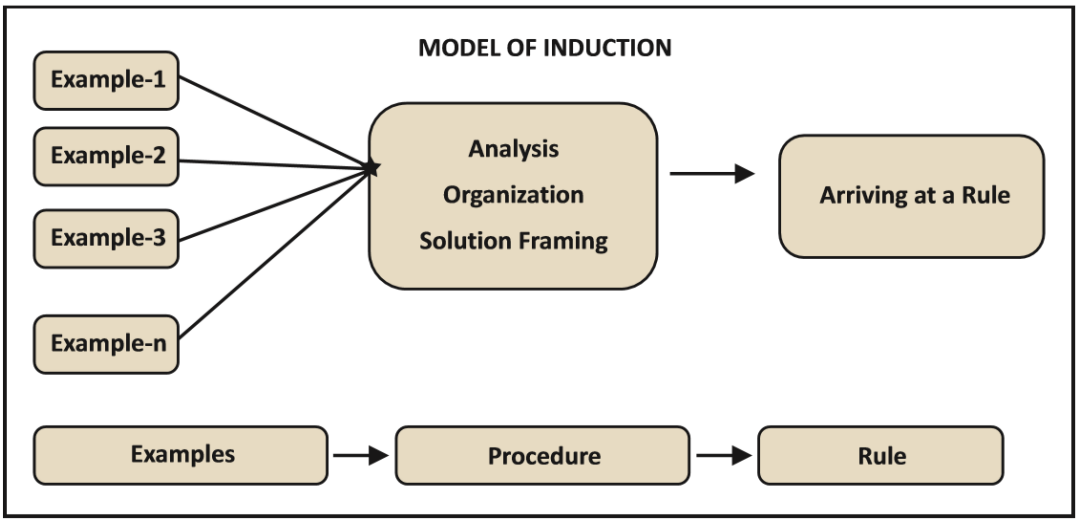
Activity: Create a table and record three characteristics for each stage of a butterfly's life cycle.

Activity: Create a table and record five characteristics for each stage of a butterfly's life cycle. In addition, do this for the life cycle of a frog. Compare and contrast.[6]

8. Inductive Approach

According to Chiappetta (n.d.), the inductive approach is grounded on the principle of catering students with learning situations in which they can discover a scientific concept or principle. In this method, the learner first encounters the attributes and examples of an idea and then describes and explains the idea. This strategy provides the students a complete experience where they observe and analyse data from real-life situations or objects. In the process, the student can experience certain stimuli and may be in a better position to interpret a situation than if he or she had received abstract information about the particular concept solely from classroom facilitation. Experimentally obtained information can be acted upon cognitively by the student and organized in the mind, where elements may be discovered that are meaningful to the learner. This is how a concept, that is later put forth to describe and explain a phenomenon, is originally induced or discovered.

Figure 4.4: Model of Inductive Approach



Source 4-2: Retrieved from Teachers' Handbook (Volume 2: Scientific Literacy) by CBSE

[6] Source: https://iris.peabody.vanderbilt.edu/module/di/cresource/q2/p06/#content

Example

Objective: Students get to look at various pictures of real-life things and draw a general conclusion based off of the observations they make.

Materials: Pictures of various animals, plants, scenery, etc.

Procedure:

- Students work individually or with a partner.
- Students make observations based on the pictures they see to come to a general conclusion.

Observation: The cat is orange. The cat is about to pounce on the rodent.

Conclusion:

1. All orange cats pounce on rodents.

Guide students through the first few examples. Then, allow them to make their own observations and conclusions.

Observe students as they are completing this activity. Provide scaffolding as needed to help children collect observations and make a general conclusion.

Share observations and conclusions as a class.[7]

Multidisciplinary learning competencies enable students to transfer knowledge to successfully meet the changing demands of new settings. However, mastery over such competencies require focused training and practice. Over the years, educational institutions across nations have been teaching their students to develop rich content knowledge, and use that knowledge to think critically and solve problems, communicate in a variety of ways, collaborate with peers, reflect on their own learning, and develop appropriate academic mind sets. In this chapter we have discussed why scientific literacy competencies are important for making students ready for their global role. Additionally, the chapter elaborates various widely practised teaching strategies that are effective in building inquiry-based learning for science. The next chapter will discuss the details of proficiencies in scientific literacy and how they can be arranged in a learning scale.

[7] Source: https://study.com/academy/lesson/inductive-reasoning-activities-for-kids.html

5. ASSESSING THE COMPETENCIES

This chapter describes the process of assessing proficiency in the scientific literacy domain through a competency-based system. To begin with, traditional systems of performance based grading are examined and the challenges they pose for a competency-based system are detailed. The importance of assessing proficiencies are discussed and their connection to the teaching learning process established. An example of a learning progression for scientific literacy used for reporting purposes is the PISA proficiency scale. The PISA 2018 Scientific literacy proficiency scale (OECD, 2019) is provided and discussed in this chapter, along with sample items to exemplify descriptions in the proficiency scale.

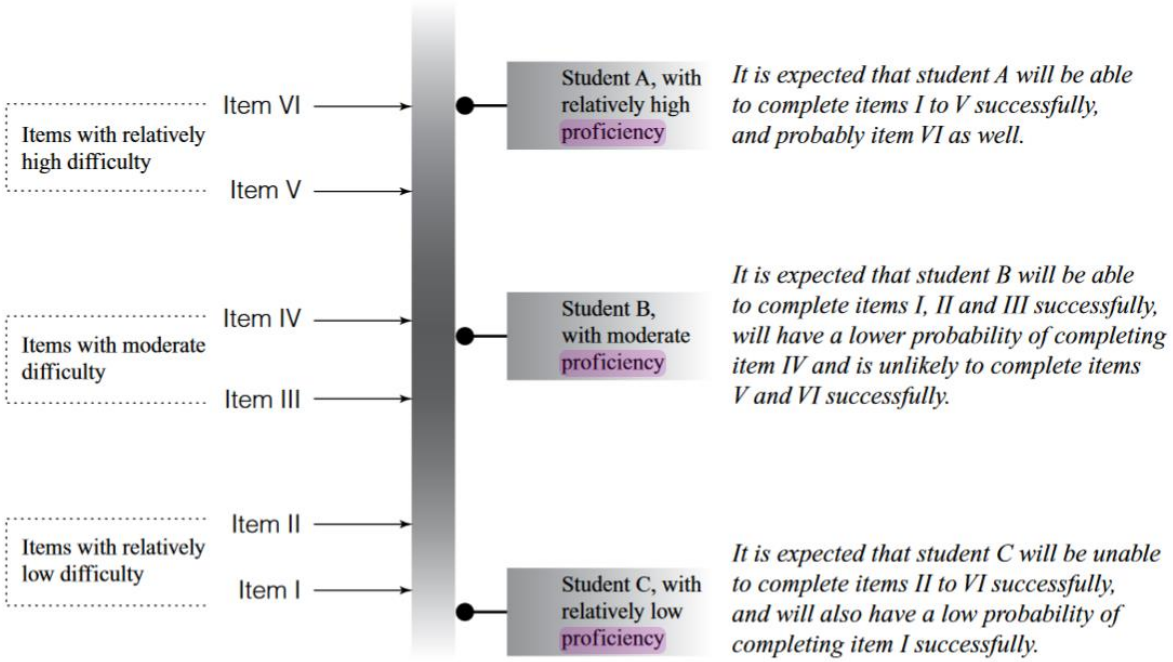
5.1. Introduction to proficiency - How do we know students achieved competencies?

In a competency-based learning system, a learner is expected to become proficient in a domain. Therefore, a clear understanding of what proficiency in a domain looks like is crucial. Proficient learners are expected to demonstrate certain skills, knowledge and understanding that they can use in real-life scenarios. In other words, scenarios that are likely to be encountered in situations outside the classroom. Hence, the first step is to define proficiency in the domain. So, the skills, knowledge and understanding that will be demonstrated by students graduating from a system must be clearly defined and communicated to teachers, students and other stakeholders.

PISA measures proficiency in scientific literacy with a *subject or domain specific scale*, constructed using Item Response Theory, where the items are arranged in order of difficulty and linked to student proficiency. PISA assessment framework 2018 refers to the reporting scales as "*proficiency scales*" rather than "performance scales" because they describe what students typically know and can do at given levels of proficiency, rather than how students actually performed on a single test . In each cycle, PISA is administered to a representative sample and is designed to report at the population level. It is to be noted that results are not reported at the individual student level.

PISA analyses the outcomes of the assessment to evaluate students' proficiencies, in terms of competencies and content knowledge as it pertains to scientific literacy. The PISA scientific literacy scale has multiple levels or bands ranging from lower levels of proficiency to higher levels of proficiency. Each level of student proficiency reflects the specific set of tasks students would be expected to successfully complete. According to the PISA science thematic report by Thomson, Hillman, and Bortoli (2013), the position of a student on the PISA scientific literacy scale is based on his/her ability to perform the set the tasks mentioned for that level or below the position. The probability for the student to successfully complete the tasks located below the position increases progressively. However, the student has a progressively lower chance of completing the tasks located above the position on the scale.

Figure 5.1: PISA Scientific literacy scale



Source 5-1: Retrieved from PISA 2015 technical report

In addition to defining the numerical range of the proficiency scale, PISA also defines the competencies of students located at particular points along the scale. These definitions give a clear description of competencies at each proficiency level of the scientific literacy scale.

Defining the levels of scientific literacy

According to the PISA 2015 technical report, OECD has designed the scientific literacy scale based on the definition of a number of levels of proficiency. For each proficiency level, typical description of student performance was developed. The levels represent what the student population at each level is likely to perform. They are used to compare performances among groups of students across countries.

Student raw scores were transformed to the domain or subject specific scale, with a mean of 500 and a standard deviation of 100, and levels of proficiency were mapped to the scale scores.

Figure 5.2: Scientific literacy performance band definitions on the PISA scale

Level	Score points on the PISA scale
6	Higher than 707.93
5	Higher than 633.33 and less than or equal to 707.93
4	Higher than 558.73 and less than or equal to 633.33
3	Higher than 484.14 and less than or equal to 558.73
2	Higher than 409.54 and less than or equal to 484.14
1a	Higher than 334.94 and less than or equal to 409.54
1b	260.54 to less than or equal to 334.94

Source 5-2: Retrieved from PISA 2015 technical report

The following section will elaborate the description of each proficiency level in the scientific literacy scale as well as the mapping of the competencies to the proficiency levels.

5.2. Learning progression and PISA proficiency levels (unpacking of PISA proficiencies)

Description of the items in each proficiency level are used to develop a summary description of the kinds of scientific literacy associated with the particular level of proficiency. Each proficiency level has a unique description of competencies and it shows a clear progression in terms of scientific literacy when compared to the previous level of proficiency. **Error! Reference source not found.**

Table 5-1 shows the summarized described proficiency levels in scientific literacy as per the PISA 2015 technical report.

Level	Characteristics of tasks
6	At Level 6, students can draw on a range of inter-related scientific ideas and concepts from the physical, life and earth and space sciences and use content, procedural and epistemic knowledge in order to offer explanatory hypotheses of novel scientific phenomena, events and processes or to make predictions. In interpreting data and evidence, they are able to discriminate between relevant and irrelevant information and can draw on knowledge external to the normal school curriculum. They can distinguish between arguments that are based on scientific evidence and theory and those based on other considerations. Level 6 students can evaluate competing designs of complex experiments, field studies or simulations and justify their choices.
5	At Level 5, students can use abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. They are able to apply more sophisticated epistemic knowledge to evaluate alternative experimental designs and justify their choices and use theoretical knowledge to interpret information or make predictions. Level 5 students can evaluate ways of exploring a given question scientifically and identify limitations in interpretations of data sets including sources and the effects of uncertainty in scientific data.
4	At Level 4, students can use more complex or more abstract content knowledge, which is either provided or recalled, to construct explanations of more complex or less familiar events and processes. They can conduct experiments involving two or more independent variables in a constrained context. They are able to justify an experimental design, drawing on elements of procedural and epistemic knowledge. Level 4 students can interpret data drawn from a moderately complex data set or less familiar context, draw appropriate conclusions that go beyond the data and provide justifications for their choices.
3	At Level 3, students can draw upon moderately complex content knowledge to identify or construct explanations of familiar phenomena. In less familiar or more complex situations, they can construct explanations with relevant cueing or support. They can draw on elements of procedural or epistemic knowledge to carry out a simple experiment in a constrained context. Level 3 students are able to distinguish between scientific and non-scientific issues and identify the evidence supporting a scientific claim.
2	At Level 2, students are able to draw on everyday content knowledge and basic procedural knowledge to identify an appropriate scientific explanation, interpret data, and identify the question being addressed in a simple experimental design. They can use basic or everyday scientific knowledge to identify a valid conclusion from a simple data set. Level 2 students demonstrate basic epistemic knowledge by being able to identify questions that could be investigated scientifically.
1a	At Level 1a, students are able to use basic or everyday content and procedural knowledge to recognise or identify explanations of simple scientific phenomenon. With support, they can undertake structured scientific enquiries with no more than two variables. They are able to identify simple causal or correlational relationships and interpret graphical and visual data that require a low level of cognitive demand. Level 1a students can select the best scientific explanation for given data in familiar personal, local and global contexts.
1b	At Level 1b, students can use basic or everyday scientific knowledge to recognise aspects of familiar or simple phenomenon. They are able to identify simple patterns in data, recognise basic scientific terms and follow explicit instructions to carry out a scientific procedure.
1c	At Level 1c, students can use an element of basic or everyday scientific fact to identify a correct scientific explanation.

Table 5-1: Summary descriptions of the seven proficiency levels on the scientific literacy scale

Level	Characteristics of tasks
6	At Level 6, students can draw on a range of inter-related scientific ideas and concepts from the physical, life and earth and space sciences and use content, procedural and epistemic knowledge in order to offer explanatory hypotheses of novel scientific phenomena, events and processes or to make predictions. In interpreting data and evidence, they are able to discriminate between relevant and irrelevant information and can draw on knowledge external to the normal school curriculum. They can distinguish between arguments that are based on scientific evidence and theory and those based on other considerations. Level 6 students can evaluate competing designs of complex experiments, field studies or simulations and justify their choices.
5	At Level 5, students can use abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. They are able to apply more sophisticated epistemic knowledge to evaluate alternative experimental designs and justify their choices and use theoretical knowledge to interpret information or make predictions. Level 5 students can evaluate ways of exploring a given question scientifically and identify limitations in interpretations of data sets including sources and the effects of uncertainty in scientific data.
4	At Level 4, students can use more complex or more abstract content knowledge, which is either provided or recalled, to construct explanations of more complex or less familiar events and processes. They can conduct experiments involving two or more independent variables in a constrained context. They are able to justify an experimental design, drawing on elements of procedural and epistemic knowledge. Level 4 students can interpret data drawn from a moderately complex data set or less familiar context, draw appropriate conclusions that go beyond the data and provide justifications for their choices.
3	At Level 3, students can draw upon moderately complex content knowledge to identify or construct explanations of familiar phenomena. In less familiar or more complex situations, they can construct explanations with relevant cueing or support. They can draw on elements of procedural or epistemic knowledge to carry out a simple experiment in a constrained context. Level 3 students are able to distinguish between scientific and non-scientific issues and identify the evidence supporting a scientific claim.
2	At Level 2, students are able to draw on everyday content knowledge and basic procedural knowledge to identify an appropriate scientific explanation, interpret data, and identify the question being addressed in a simple experimental design. They can use basic or everyday scientific knowledge to identify a valid conclusion from a simple data set. Level 2 students demonstrate basic epistemic knowledge by being able to identify questions that could be investigated scientifically.
1a	At Level 1a, students are able to use basic or everyday content and procedural knowledge to recognise or identify explanations of simple scientific phenomenon. With support, they can undertake structured scientific enquiries with no more than two variables. They are able to identify simple causal or correlational relationships and interpret graphical and visual data that require a low level of cognitive demand. Level 1a students can select the best scientific explanation for given data in familiar personal, local and global contexts.
1b	At Level 1b, students can use basic or everyday scientific knowledge to recognise aspects of familiar or simple phenomenon. They are able to identify simple patterns in data, recognise basic scientific terms and follow explicit instructions to carry out a scientific procedure.
1c	At Level 1c, students can use an element of basic or everyday scientific fact to identify a correct scientific explanation.

Source 5-3: Retrieved from PISA D 2018 assessment framework

According to the PISA 2015 technical report, the described proficiency scale can be further sub-divided according to the different competencies assessed by the assessment instrument. Table 5-2, Table 5-3 and Table 5-4 represent the knowledge and skills required to complete tasks aligned with the defined proficiency bands for the three competency subscales.

Table 5-2: Summary descriptions of the proficiency levels on the scientific literacy subscale: Explain phenomena scientifically

Level	General proficiencies students should have at each level	Tasks a student should be able to do
6	At Level 6, students can draw on a range of inter-related scientific ideas and concepts from life, physical or Earth and space sciences to make predictions or to construct explanations of novel and unfamiliar phenomena, events and processes that may involve several steps. They can demonstrate the use of knowledge beyond standard science curricula and use procedural and epistemic knowledge appropriately.	▪ Construct acceptable scientific explanations, using a broad range of knowledge, ideas and concepts. ▪ Recognise when data/information in the text does not answer the question. ▪ Use given scientific knowledge and recall additional relevant scientific knowledge to explain an unfamiliar phenomenon. ▪ Construct and run a mental model to offer an explanation or make a prediction in an unfamiliar situation. ▪ Comment on the appropriate use of scientific models and their limitations.
5	Students at this level can use abstract scientific ideas or concepts to explain more complex phenomena, events and processes, which may be unfamiliar.	▪ Select an appropriate scientific explanation of an unfamiliar event, phenomenon or process. ▪ Construct an appropriate explanation drawing upon abstract scientific ideas and constructs. ▪ Apply theoretical scientific knowledge to interpret given information, develop an explanation or make a prediction.
4	At Level 4, students can recall or use given scientific ideas to construct explanations of relatively complex or less familiar events and processes, or to make simple predictions.	▪ Identify or construct an appropriate causal explanation for a more complex or less familiar phenomenon, event or process. ▪ Identify the relationship between simple physical quantities and use this to explain a phenomenon. ▪ Predict how one quantity will change when other quantities change. ▪ Use scientific knowledge to evaluate a claim or to interpret an unfamiliar phenomenon. ▪ Recognise relationships between physical quantities.
3	Students at this level can draw upon moderately complex scientific facts and ideas to identify or construct appropriate simple explanations of familiar phenomena. In less familiar or more complex situations, they can construct an explanation with relevant cueing or support.	▪ Construct simple explanations of familiar phenomena drawing on knowledge from life, physical or Earth and space sciences. ▪ Identify a conclusion consistent with given information in an unfamiliar context. ▪ Select from multiple components and place them in a logical order to construct simple explanations. ▪ Identify causal factors which explain a phenomenon.
2	At Level 2, students can recall and apply simple scientific facts and ideas, or select a simple scientific explanation, given relevant cues and support.	▪ Use familiar and simple scientific knowledge to draw an appropriate conclusion. ▪ Select the correct explanation of a relatively familiar scientific situation. ▪ Choose appropriate alternatives to complete an explanation. ▪ Use simple scientific knowledge to identify causal relationships. ▪ Reconstruct a temporal sequence for a familiar scientific phenomenon.
1a	Students at this level can select an appropriate example of a given simple scientific concept or identify an appropriate scientific explanation for a familiar event or process that is consistent with given information.	▪ Use familiar content and procedural knowledge to recognise or identify explanations. ▪ Select the best scientific explanation from a list for given data in familiar contexts.
1b	Students at this level can recognise scientific terms and use single scientific facts close to their personal experience to recognise very simple cause and effect relationships.	▪ Recognise simple scientific language or scientific conventions used in everyday life situations. ▪ Use familiar content knowledge to recognise scientific aspects of simple phenomena in tasks that require a low level of cognitive demand.

Source 5-4: Retrieved from PISA 2015 technical report

Table 5-3: Summary descriptions of the proficiency levels on the scientific literacy subscale: Interpret data and evidence scientifically

Level	General proficiencies students should have at each level	Tasks a student should be able to do
6	At Level 6, students can evaluate the strength of support provided by data for competing hypotheses and construct and justify a conclusion using abstract science concepts. They can also discriminate between relevant and irrelevant information, and draw on outside knowledge to construct an explanation.	▪ Evaluate a complex set of data to determine whether each piece of data supports one, both or neither of two or more competing hypotheses. ▪ Provide a reason for their choice using abstract science concepts and applying procedural or epistemic knowledge.
5	Students at this level can interpret a moderately complex data set to construct and justify a conclusion using abstract science concepts. They can also identify sources and effects of uncertainty in scientific data.	▪ Analyse complex data to identify which of several inferences is correct. ▪ Generate a set of data from a simulation by manipulating a single variable to identify the correct outcome from a number of possibilities.
4	At Level 4, students can interpret and manipulate a moderately complex data set expressed in a number of formats to select or justify appropriate conclusions. They can also distinguish between scientific and social or personal issues when interpreting data.	▪ Analyse moderately complex data to identify which of several inferences is correct. ▪ Analyse more complex data to identify the appropriate conclusion of an experiment using controls and provide a reason that justifies their choice.
3	Students at this level can interpret and transform data to support a claim or conclusion. They can identify the evidence supporting a scientific claim.	▪ Analyse a data table to identify which of several inferences is correct. ▪ Use data to identify the appropriate conclusion from an experiment using controls or a set of data and provide a reason that justifies their choice.
2	Students at this level can identify data that support a claim or conclusion and interpret data to select relevant explanations.	▪ Analyse tabular or graphic data to identify which of several hypotheses or claims are supported by the data. ▪ Identify the pattern in a data set such as a graph or table.
1a	Students at this level can identify whether simple data support a claim or conclusion. They can make straightforward interpretations of simple data sets presented in different formats.	▪ Identify the trend in simple data set. ▪ Transform simple data representations between pictorial, graphical, tabular and text. ▪ Use a simple data set to Identify data that support a conclusion.
1b	Students at this level can identify simple patterns in data.	▪ In response to a specific question showing a simple pictorial representation of objects, make comparisons and judgments about the differences observed.

Source 5-5: Retrieved from PISA 2015 technical report

Table 5-4: Summary descriptions of the proficiency levels on the scientific literacy subscale: Evaluate and design scientific enquiry

Level	General proficiencies students should have at each level	Tasks a student should be able to do
6	At Level 6, students can evaluate competing designs of complex experiments, field studies or simulations and justify their choices.	▪ Evaluate an investigation involving multiple variables requiring the identification of the independent or dependent variable. ▪ Justify choices and the range of data to be collected drawing on relevant epistemic and/or procedural knowledge. ▪ Evaluate and comment on the model inherent to experimental designs.
5	Students at this level can evaluate alternative experimental designs or data interpretations and justify their choices. They can identify limitations of the interpretations of data sets.	▪ Evaluate whether an empirical question can be answered scientifically or not. ▪ Justify a more detailed feature of an experimental design. ▪ Provide a procedural justification for the inadequacy of a set of data. ▪ Choose between two experimental designs and justify the choice drawing on procedural, epistemic or content knowledge. ▪ Justify a data collection procedure in a context involving several independent variables.
4	At Level 4, students can conduct experiments involving two or more independent variables in a constrained context and justify aspects of their experimental design, drawing on procedural and epistemic knowledge. They can interpret data drawn from more complex or less familiar contexts and draw appropriate conclusions that go beyond the data. They can use data from less familiar contexts to identify trends and make predictions.	▪ Carry out and interpret a simple experiment involving the manipulation of more than one independent variable. ▪ Follow instructions to identify the outcome of several variable choices. ▪ Manipulate variables to answer a scientific question, identify a trend, interpolate between, or extrapolate beyond, the data. ▪ Justify the conclusions of an experimental design drawing on procedural or epistemic knowledge. ▪ Identify the question of an investigation of a more complex or less familiar experimental design.
3	Students at this level can draw on procedural or epistemic knowledge to design, and justify aspects of the design of, a simple experiment in a constrained context. They can distinguish between scientific, technological and non-scientific issues.	▪ Identify which variable to control in a two variable experiment. ▪ Drawing on epistemic or procedural knowledge, provide a justification for aspects of a simple experimental design. ▪ Identify the role of simulations in scientific enquiry. ▪ Discriminate between issue that can be solved by science or other means. ▪ Within a constrained context, identify a set of data that could answer a specified question about a phenomenon.
2	Students at Level 2 are able to draw on procedural and basic content knowledge to identify the question being addressed in a simple experimental design. They can collect and interpret data to answer questions that require only simple or everyday content knowledge. They can distinguish between a non-scientific and scientific question.	▪ Given a simple experimental design, identify the question being addressed. ▪ Distinguish between simple scientific and simple non-scientific questions. ▪ Interpret simple data sets and draw an appropriate conclusion using everyday knowledge. ▪ Carry out a straightforward procedure to collect a data set to answer a simple question. ▪ Identify the aspects of a simple model and the external features they represent.
1a	Students at this level can, with support, carry out a simple experiment involving one independent and one dependent variable to generate data to answer a question.	▪ Identify the independent variable in a given situation. ▪ Follow instructions to carry out a simple experiment to investigate how an outcome changes when one independent variable is changed.
1b	At this level, students typically are able to follow simple instructions to carry out a scientific procedure.	▪ Run a simulation to extract a single data point.

Source 5-6: Retrieved from PISA 2015 technical report

5.3. Sample items based on PISA scientific competencies

The following section of this chapter discusses some sample items that are based on the scientific competencies mentioned in the PISA assessment framework 2018.

5.3.1. Sample tasks (PISA sample items)

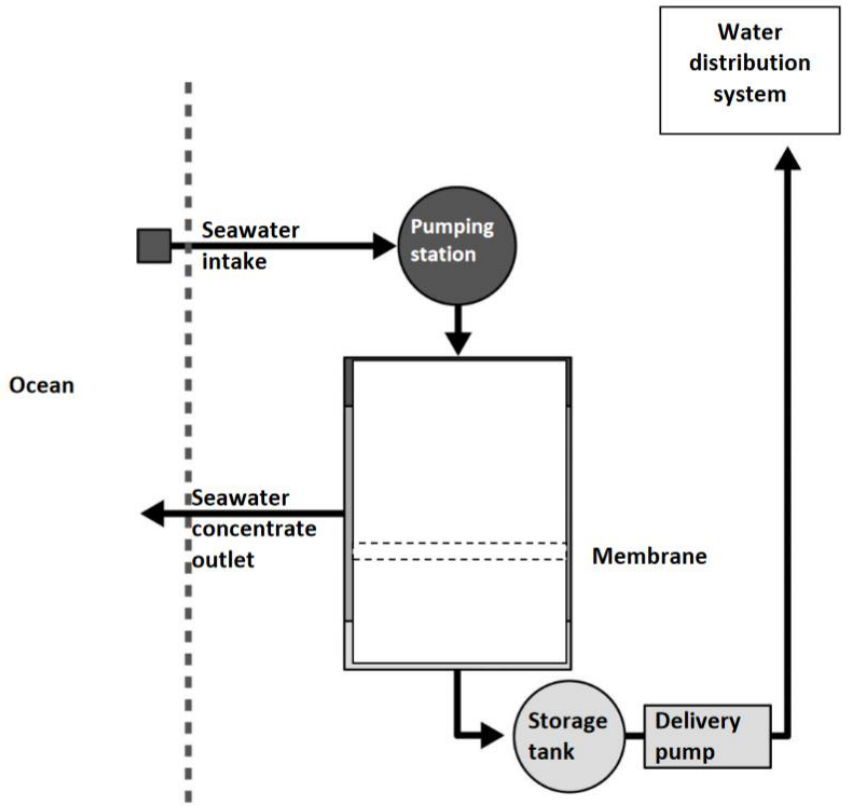
The following section discusses several PISA sample items released by OECD, listed in accordance with the competencies and content knowledge assessed. Each item is mapped to the respective proficiency based on the competency and the content or strand. The following sample tasks are sourced from PISA-based Test for Schools Sample Test Items (OECD, n.d.)

Sample 1

One way of producing drinking water from seawater is by reverse osmosis.

Reverse osmosis is a type of filtration. Seawater is pushed through a semi-permeable membrane. Pressure is applied to the seawater. Semi-permeable means salt is trapped on one side of the membrane, but water can pass through.

The trapped salts form a 'seawater concentrate' on one side of the membrane.



Seawater reverse osmosis desalination process

QUESTION

Where do the trapped salts go?

A. ocean

B. storage tank

C. delivery pipeline

D. water distribution system

Meta-data for sample 1

***Question level*:** At Level 1, students have limited scientific knowledge that applies to a few, familiar situations. They can present scientific explanations that are obvious and follow explicitly from given evidence.

***Nature of the task*:** Access scientific information and produce a conclusion based on scientific evidence. The setting is *social*. The question belongs to the knowledge about science – *scientific explanations* knowledge category.

***Science competency*:** The competency is *interpret data and evidence scientifically* because the individual has to access scientific information and produce arguments and conclusions based on scientific evidence. The required response can involve knowledge about science or knowledge of science or both.

***Scoring*:**

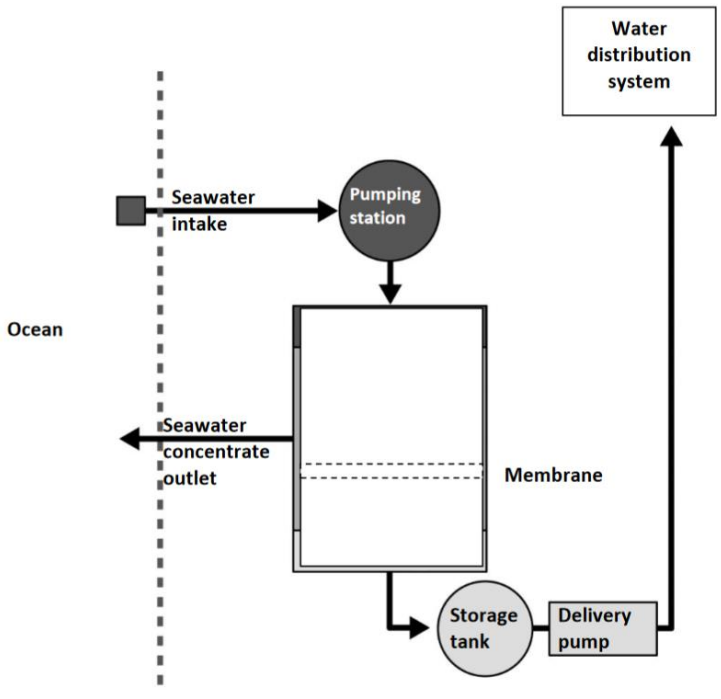
Full credit: A. ocean

No credit: Other responses or missing.

Sample 2

One way of producing drinking water from seawater is by reverse osmosis.

Reverse osmosis is a type of filtration. Seawater is pushed through a semi-permeable membrane. Pressure is applied to the seawater. Semi-permeable means salt is trapped on one side of the membrane, but water can pass through. The trapped salts form a 'seawater concentrate' on one side of the membrane.



Seawater reverse osmosis desalination process

QUESTION

What will determine whether a particle is able to pass through the membrane?

A. particle size
B. particle mass
C. number of particles
D. charge on the particle

Meta-data for sample 2

***Question level*:** At Level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving.

***Nature of the task*:** Use knowledge of science where a correct response requires an explanation of an observed scientific phenomenon. The situation is *social*. The question belongs to the knowledge of science –*physical systems* knowledge category

***Science competency*:** The competency is *explaining phenomena scientifically* because it requires the reader to apply appropriate knowledge of science in a given situation. The competency includes describing or interpreting phenomena and predicting changes, and may involve recognizing or identifying appropriate descriptions, explanations, and predictions.

Scoring:

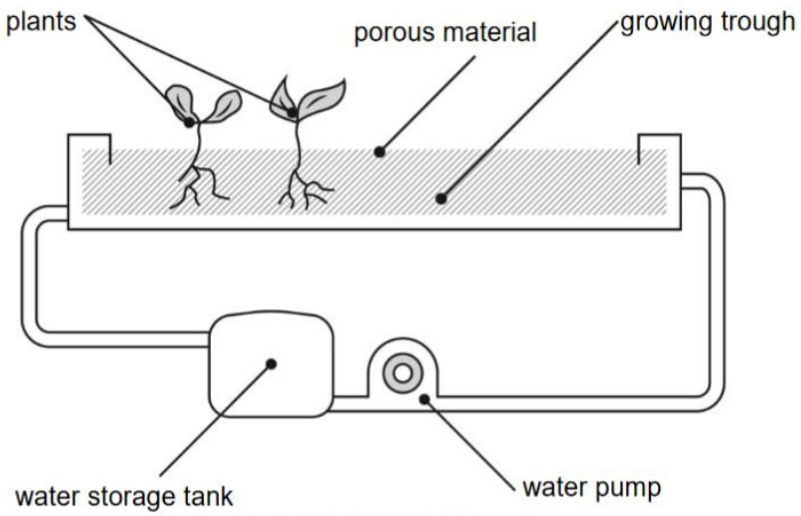
Full credit: A. particle size

No credit: Other responses or missing.

Sample 3

Hydroponics is a way of growing plants without soil. The plants grow in an insoluble porous material, for example sand, which is regularly soaked with water.

A simple hydroponics system is shown below.



Simple HYDROPONICS system

Water is pumped though the system four to six times a day depending on plant type. Once the pumping stops, any excess water drains away and collects in the water storage tank.

QUESTION

Studies have shown that plants grown hydroponically use less water than plants grown in soil.

A key reason for this lies in the design of hydroponics systems.

What feature of the hydroponics system saves water compared to plants grown in soil?

A. The porous material holds the water in the growing trough.
B. Because water is not present all the time there is less evaporation.
C. Plants watered at regular intervals absorb less water.
D. Water flow over the roots cools the plant, so the plant uses less water.

Meta-data for sample 3

***Question level*:** At Level 4, students can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence.

***Nature of the task*:** Access scientific information and produce a conclusion based on scientific evidence.

The situation is *social*. The question belongs to the knowledge about science –*scientific explanations* knowledge category.

***Science competency*:** The competency is *interpret data and evidence scientifically* because the individual has to access scientific information and produce arguments and conclusions based on scientific evidence. The required response can involve knowledge about science or knowledge of science or both.

***Scoring*:**

Full credit: B. Because water is not present all the time there is less evaporation.

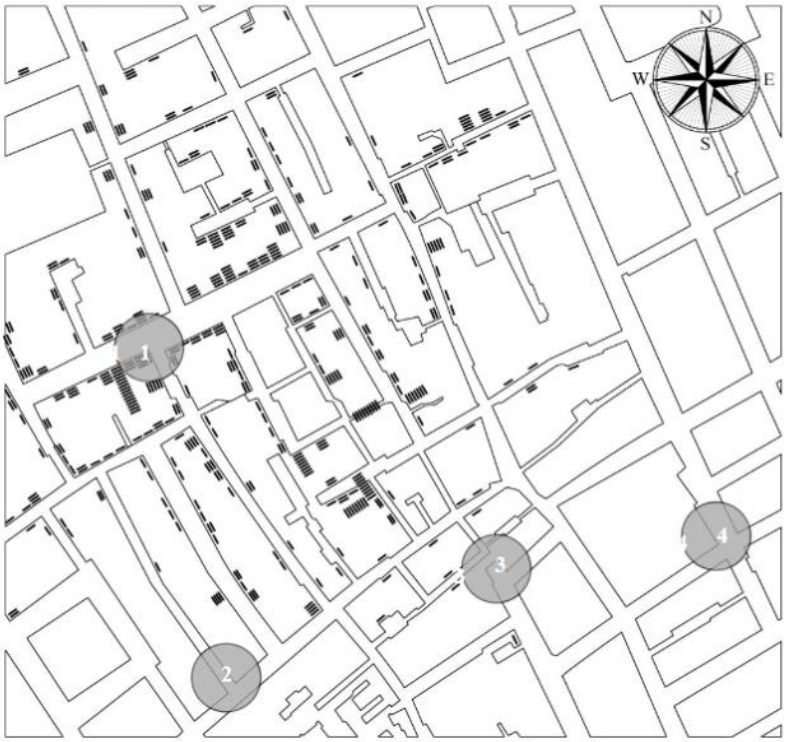
No credit: Other responses or missing.

Sample 4

Cholera is a disease caused by bacteria. The symptoms are severe diarrhoea and vomiting.

In August of 1854, there was a cholera epidemic in London. At the time it was assumed that cholera was airborne and caused by 'bad air'. John Snow, a British doctor didn't believe this theory.

Snow studied the pattern of deaths from the disease. He plotted a map of the affected area, marking the location of every person that died from cholera.



John Snow's map of London 1854 showing water pumps and places where people died of cholera.

KEY

Water Pump

Deceased person

QUESTION

What further research could John Snow have done to help find out how cholera spread?

Click "Yes" or "No" for the statements about further research.

Would this research have helped John Snow find out how cholera spread?	Yes or No?
Ask relatives of those that died which pump they collected their water from.	Yes / No
Find out who the cholera victims came into contact with just before they became ill.	Yes / No
Find out the direction the wind was blowing before the cholera outbreak.	Yes / No

Meta-data for sample 4

***Question level*:** At Level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge.

***Nature of the task*:** Recognise questions that can be investigated scientifically. The situation is *personal*. The question belongs to the knowledge about science –*scientific enquiry* knowledge category.

***Science competency*:** The competency is *evaluate and design scientific enquiry* because the reader has to recognise questions that can be investigated scientifically in a given situation and identify keywords to search for scientific information on a given topic.

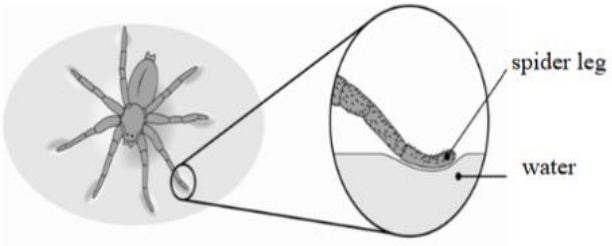
Scoring:

Full credit: All three correct: Yes, Yes, Yes in that order.

Partial credit: Any two of the three correct.

No credit: Other responses or missing.

Sample 5



Spider or insect walking on water

Metal paperclip floating on water in a glass

QUESTION

Look at the pictures of the spider and the metal paper clip.

What is the reason that both the spider and the paper clip can stay on top of the water?

Type your answer here:

Meta-data for sample 5

***Question level*:** At Level 5, students can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.

***Nature of the task*:** Use knowledge of science where a correct response requires an explanation of an observed scientific phenomenon. The situation is *personal.* The question belongs to the knowledge of science –*physical systems* knowledge category.

***Science competency*:** The competency is *explaining phenomena scientifically* because it requires the reader to apply appropriate knowledge of science in a given situation. The competency includes describing or interpreting phenomena and predicting changes, and may involve recognising or identifying appropriate descriptions, explanations, and predictions.

***Scoring*:**

Full credit: Mentions the surface tension of the water and/or expresses the idea of the weight of the object being spread over a large area.

No credit: Responses that do not meet the "full credit" criteria or missing

The sample items are intended to provide an insight into the thought processes behind each item to interested academicians. They showcase the proficiencies that students at each level are expected to exhibit in order to receive credits for their responses.

5.3.2. Sample items (NCERT Curriculum-based competency items)

This section includes sample items that represent competency-based items aligned to scientific literacy. The items are aligned to the NCERT learning outcomes and the concepts are covered in the NCERT textbooks.

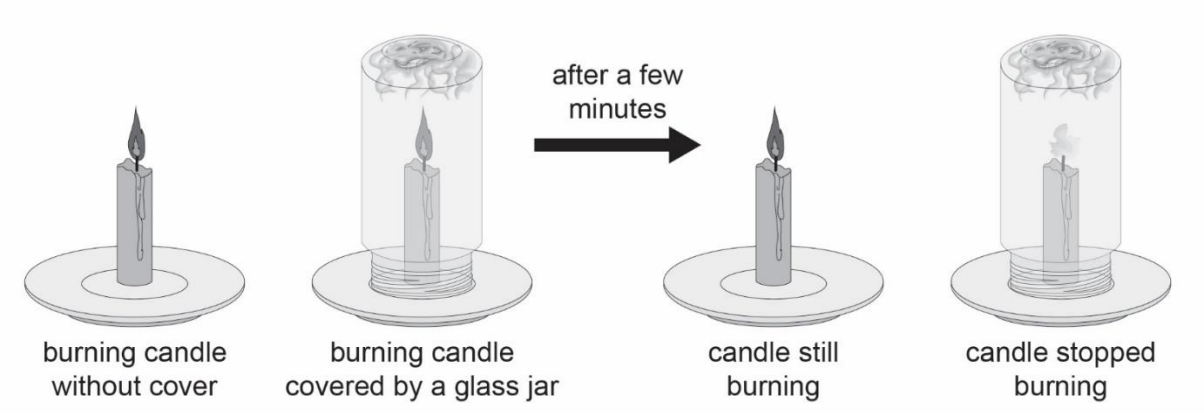
Burning candle

This unit is based on the importance of oxygen required for combustion, introduced in the NCERT curriculum at grade 6, chapter 15. The stimulus includes a short text and images showing the changes in two burning candles (one uncovered and the other covered) over a few minutes.

Raju lighted two candles.

He covered one candle with a glass jar and left the other candle uncovered.

The picture shows Raju's findings after a few minutes.



Q1. Why did the candle covered by the glass jar stop burning?

_____

_____

Q1 requires students to provide a scientifically valid explanation for an observation. The PISA competency for this item is **explaining phenomena scientifically** as the students are asked to produce a valid explanation for a given observation.

Competency: Explaining phenomena scientifically

Learning outcome: Relate processes and phenomenon with causes

Item format: Constructed response task

Key: Mentions the response

- The burning candle consumed all the oxygen trapped inside the glass jar.

OR

- Oxygen inside the glass jar was used up by the burning candle.

Q2. A book caught fire accidentally.

Which of the following actions is/are likely to put out the fire?

Will this help to put out the fire?	**Select Yes or No**
blowing air over the fire	Yes / No
covering the book with a plastic net	Yes / No
wrapping a wet cloth over the book	Yes / No

Q2 requires students to analyse an observation and draw a conclusion from it. The PISA competency for this item is **interpreting data and evidence scientifically** as the students are asked to analyse the outcome of an experiment and then draw an appropriate conclusion.

Competency: Interpreting data and evidence scientifically

Learning outcome: Applies learning of scientific concepts in day-to-day life

Item format: Complex multiple-choice question

Key: No/ No/ Yes

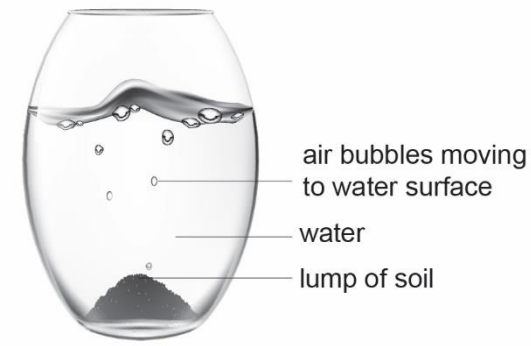
Air in soil

This unit is based on the presence of air in soil introduced in the NCERT curriculum at grade 6, chapter 15. The stimulus includes a short text, and an image showing air bubbles coming out of a lump of soil placed in water (to show that soil contains air).

Madhavi wanted to find out if soil contains air.

She placed a lump of soil in a jar of water.

Madhavi saw air bubbles moving to the water surface.



Q3. Madhavi was not sure if the bubbles were coming out of the soil.

Which extra jar will help her decide?

A an empty jar

B a jar with only water

C a jar with only a lump of soil

D another jar with both water and a lump of soil

Q3 requires students to analyse an experiment and then suggest an appropriate improvement in the experiment to prove a hypothesis. The PISA competency for this item is **evaluating and designing scientific enquiry** as the students are asked to analyse an experiment and then evaluate a range of ways to identify the improvement that would make the experiment reliable.

Competency: Evaluating and designing scientific enquiry

Learning outcome: Conducts simple investigations to seek answers to queries

Item format: Multiple-choice question

Key: B. a jar with only water

Insulating material

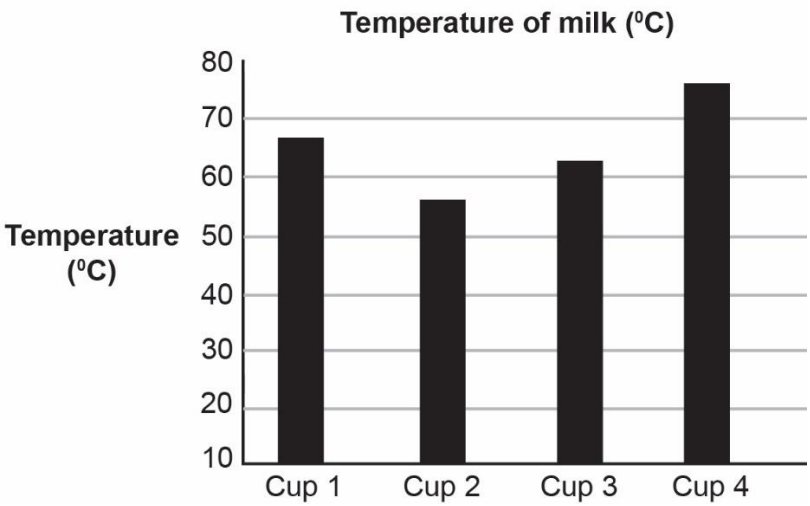
This unit is based on heat conductors and insulators introduced in the NCERT curriculum at grade 7, chapter 4. The stimulus includes a short text, images of cups made of different materials and a bar graph to show how the cups lose heat after a hot drink is poured in them.

Anu pours hot milk into four different cups at the same time.

The cups are similar in shape and size but made of different materials.

Anu measures the temperature of the milk in each cup after 5 minutes.

She draws a graph to show the temperatures she recorded.



Q4. Which cup lost maximum amount of heat in 5 minutes?

A. Cup 1

B. Cup 2

C. Cup 3

D. Cup 4

Q4 requires students to analyse and interpret data shown in a bar graph. The competency for this item is **interpreting data and evidence scientifically** as the students are asked to read the graph and interpret data recorded in the graph based on the given stimulus. The use of words 'conductors' and 'insulators' is deliberately avoided in order to avoid dependency on the direct recall of knowledge about conductors and insulators.

Competency: Interpreting data and evidence scientifically

Learning outcome: Plots and interprets graphs

Item format: Multiple-choice question

Key: B. Cup 2

Q5. Anu kept the initial temperature of the milk same for the four cups.

What else should Anu keep the same to make her experiment reliable?

_____

Q5 requires students to ensure the reliability of an experiment. The competency for this item is **evaluating and designing scientific enquiry** as the students are asked to think about the various dependent and independent variables involved in the experiment.

Competency: Evaluating and designing scientific enquiry

Learning outcome: Conducts simple investigations to seek answers to queries

Item format: Constructed response task

Key: The amount of milk in each cup

Q6. What is likely to happen if the cups are covered with a lid?

A. The cups will lose heat equally.

B. The cups will not lose heat at all.

C. The cups will lose heat more quickly.

D. The cups will lose heat in the same way.

Q6 requires students to make a prediction. The competency for this item is **explaining phenomena scientifically** as the students are asked to predict a scientifically valid outcome for the variations introduced in an experiment.

Competency: Explaining phenomena scientifically

Learning outcome: Explains processes and phenomena

Item format: Multiple-choice question

Key: D. The cups will lose heat in the same way.

5.4. Distribution of items in PISA Scientific Literacy test

In a balanced assessment like PISA, the weightage of scientific competencies are shown in the table below.

Table 5-5: Distribution of scientific competencies in PISA

Competency	Percentage of items in PISA
Explaining phenomena scientifically	40 – 50
Evaluating and designing scientific enquiry	20 – 30
Interpreting data and evidence scientifically	30 – 40

Source 5-7: OECD (2018). PISA Science Framework. OECD (2018). https://www.oecd-ilibrary.org/docserver/f30da688-en.pdf?expires=1608718326&id=id&accname=guest&checksum=B84138984C868FF77A2C193B21FBADE6

The science content areas of Life Systems and Physical Systems are given equal weightage in PISA whereas the third content area - Earth and Space Systems is given comparatively lesser weightage. Table 5.6 shows the content-wise distribution of items.

Table 5-6: Distribution of science content areas in PISA

Content	Percentage of items in PISA
Life Systems	36
Physical Systems	36
Earth and Space Systems	28

Source 5-8: OECD (2018). PISA Science Framework. OECD (2018). https://www.oecd-ilibrary.org/docserver/f30da688-en.pdf?expires=1608718326&id=id&accname=guest&checksum=B84138984C868FF77A2C193B21FBADE6

While it is important for a competency-based test to include items testing a range of competencies, however, the proportion of items for each competency is decided considering the target cohort and the overall objective of the assessment.

For grades 6-8, considering that competency-based tests are being gradually introduced in Indian classrooms, it is suggested that the weightage of the lowest order scientific competency is slightly increased and that of the highest order scientific competency is slightly decreased. Table 5.7 shows the distribution of competencies for grades 6-8.

Table 5-7: Suggested distribution range of scientific competencies for grades 6-8

Competency	Distribution range of competencies for grades 6-8 (in percentages)
Explaining phenomena scientifically	50 – 60
Evaluating and designing scientific enquiry	20 – 30
Interpreting data and evidence scientifically	20 – 30

Three types of item formats are used to assess scientific literacy in PISA.

- Open constructed-response
- Closed constructed-response
- Selected-response (multiple-choice) items

A PISA test contains an approximately equal distribution of item format.

6. USING ASSESSMENT IN THE TEACHING LEARNING PROCESS

6.1. Introduction

Assessment is an integral part of competency-based education. Competency-based education focuses on learning outcomes with instructions and assessments designed in a way to evaluate students learning and mastery of key skills and behaviours (Gervais, 2016). It is a way to assess a combination of knowledge, skills, attitude and judgement against defined standards that students are expected to achieve as scientifically literate individuals. The assessment could involve a wide range of methods and tools to assess students' performance in the classroom.

A competency-based assessment involves designing suitable assessments aligned to pre-determined core competencies followed by collection of evidence about what students know and can actually do in a range of real life contexts. The range of assessment tools and tasks help teachers identify students who are proficient enough to take a performance-based summative assessment. Students who achieve the first level of competency move on to more advanced challenging work while those who need additional support receive targeted instruction until they are ready to retake the test (Pace, 2013). In short, competency-based assessments are tailored towards the needs of individual students.

According to the National Education Policy (MHRD, 2020 p. 12):

> "To close the gap in achievement of learning outcomes, classroom transactions will shift, towards competency-based learning and education. The assessment tools (including assessment "as", "of", and "for" learning) will also be aligned with the learning outcomes, capabilities, and dispositions as specified for each subject of a given class."

NEP also mentions placing more emphasis on regular formative assessments rather than summative assessments, in order to track the learning progress of students. In this chapter, we seek to link competency-based assessment to classroom teaching. The focus of the discussion in this chapter is on the introduction and development of assessment rubrics based on the concept of learning progressions.

6.2. Developing a learning roadmap

According to Brookhart (1999), "assessment refers to assignments and tasks that provide information, and evaluation refers to judgements based on that information." Before developing any assessment, a teacher needs to reflect on the purpose of the assessment, the method of evaluation to be adopted and the kind of feedback that the teacher plans to provide.

Developing a robust assessment to assess specific scientific competencies could be a challenging task as it requires teachers to develop tasks or tools that precisely map with the measurable attributes of the competency. Often, the tasks are arbitrarily mapped to learning outcomes with no clear indications of what skills the tasks intend to assess. In the absence of clear guidelines, teachers often find it difficult to follow a consistent method of providing instructions and at the same time, observing and marking students in a uniform and fair manner. This results in a lack of understanding with respect to where the students stand in their learning path and what progression from less advanced skills to more advanced skills actually looks like. Therefore, there seems to be a requirement for an effective coherent conceptual learning pathway indicating a continuum of learning or a learning progression capable of guiding personalised learning of individual students.

Learning progressions are based on the performance standards as described in learning outcomes. The challenge lies in describing the path of progression. In a research study, teachers found that a learning progression map helped them develop assessments with better focus and clarity and that the assessment data helped them in targeting instructions (Hess, 2012). Evidently, a framework showing the learning continuum serves as a guide to teachers not just in assessing students based on learning outcomes but also as a guide for imparting instructions.

The learning progressions can be best implemented when coupled with appropriate instructional practices. Instructional practices aimed at building understanding by incorporating a variety of practices, including gathering data through observations or experiments, representing data, reasoning—with oneself and others—about what data mean, and applying key ideas to new situations can be effective in fostering appropriate competencies (National Research Council, 2007).

Different types of assessments and assessment tasks can be used to allow students to demonstrate their knowledge and skills. Assessment tasks can be mapped to a rubric with a scoring guide to precisely portray a picture of students' achievements. However, it is important that the learning tasks match with the competencies to ensure validity of the assessment.

Table 6-1 and Table 6-2 provide representative sample rubrics for scoring students' performances as well as guiding teachers' instructions for effectively integrating teaching and learning with assessments.

Table 6-1 shows a science continuum intended for teachers and administrators to use in **guiding and evaluating student performance** in some of the science practices. Understanding of a scientific concept can be built around the levels that reflect increasingly sophisticated engagement in practice.

Table 6-1: Science Practices Continuum – Students' Performance.

	Level 1	**Level 2**	**Level 3**	**Level 4**
Asking questions	Students do not ask questions.	Students ask questions. Students' questions are both *scientific and non-scientific* (i.e., not answerable through the gathering of evidence or about the natural world).	Students ask questions. Students' questions are typically *scientific* (i.e. answerable through gathering evidence about the natural world). Students do not *evaluate the merits* and limitations of the questions.	Students ask questions. Students' questions are typically scientific (i.e. answerable through gathering evidence about the natural world). Students *do evaluate the merits and limitations* of the questions.
Planning and carrying out investigations	Students do not design or conduct investigations.	Students conduct investigations, but these opportunities are typically *teacher-driven*. Students do not make decisions about experimental variables or investigational methods (e.g. number of trials).	Students *design or conduct* investigations to gather data. Students make decisions about experimental variables, controls or investigational methods (e.g. number of trials).	Students *design and conduct investigations* to gather data. *Students make decisions* about experimental variables, controls and investigational methods (e.g. number of trials).
Analysing and interpreting data	Students may record data, but do not analyse data.	Students work with data to organize or group the data in a table or graph. However, students *do not recognize patterns or relationships* in the natural world.	Students work with data to organize or group the data in a table or graph. Students make sense of data by *recognizing patterns or relationships* in the natural world.	Students *make decisions* about how to analyse data (e.g. table or graph) and work with the data to create the representation. Students make *sense of data by recognizing patterns or relationships* in the natural world.

Source 6-1: Adapted from "Science Practices Continuum" - Instructional Leadership for Science Practices. Retrieved from https://www.sciencepracticesleadership.com/continuum.html

Table 6-2 shows a science continuum intended for teachers and administrators to use in **guiding and monitoring instructions** in some of the science practices. The levels reflect increasingly sophisticated instruction of the practices and can be taught in developmentally appropriate ways at any of these levels.

Table 6-2: Science Practices Continuum – Supervision.

	Level 1	**Level 2**	**Level 3**	**Level 4**
Asking questions	Teacher does not provide opportunities for students to ask questions.	Teacher provides opportunities for students to ask questions. Students' questions are both *scientific and non-scientific* questions (i.e., not answerable through the gathering of evidence or about the natural world).	Teacher provides opportunities for students to ask questions. Students' questions are *typically scientific* (i.e. answerable through gathering evidence about the natural world). Students do not evaluate the merits and limitations of the questions.	Teacher provides opportunities for students to ask questions. Students' questions are typically *scientific* (i.e. answerable through gathering evidence about the natural world). Students do *evaluate* the merits and limitations of the questions.
Planning and carrying out investigations	Teacher does not provide opportunities for students to design or conduct investigations.	Teacher provides opportunities for students to conduct investigations, but these opportunities are typically *teacher-driven*. Students do not make decisions about experimental variables or investigational methods (e.g. number of trials).	Teacher provides opportunities for students to *design or conduct* investigations to gather data. These opportunities enable students to make decisions about experimental variables, controls and investigational methods (e.g. number of trials).	Teacher provides opportunities for students to *design and conduct* investigations to gather data. These opportunities enable *students to make decisions* about experimental variables, controls and investigational methods (e.g. number of trials).
Analysing and interpreting data	Teacher does not provide opportunities for students to analyse data. Students may record data, but do not analyse it	Teacher provides opportunities for students to work with data, which could include organizing or grouping the data. However, these opportunities *do not* support students in *recognizing patterns or relationships* in the natural world.	Teacher provides opportunities for students to work with data to organize or group the data in a table or graph. These opportunities support students in making sense of data by *recognizing patterns or relationships* in the natural world.	Teacher provides opportunities for students to *make decisions* about how to analyse data (e.g. table or graph) and work with the data to create the representation. Students make sense of data by *recognizing patterns or relationships* in the natural world.

Source 6-2: Adapted from "Science Practices Continuum" - Instructional Leadership for Science Practices. Retrieved from https://www.sciencepracticesleadership.com/continuum.html

6.3. Developing a learning rubric

Finland has been one of PISA's highest performing countries. According to Bristow and Patrick (2014), teachers in Finland assess students' extensively through performance-based assessments and evaluate students using rubrics based on national core curriculum guidelines. The key idea of competency-based assessment is utilising rubrics for assessments. Rubrics indicate what is expected from students, what are they required to do, and how they will be graded. If this is communicated to students, they can participate actively in the assessment. They become aware of the critical elements being assessed and are able to demonstrate their achievements and learning productively. Developing a robust rubric requires teachers, education reformers and researchers to collaborate in order to validate the learning progressions aligned with the performance standards. According to Velasco-Martínez and Tójar-Hurtado (2018), "As for the competency-based approach, a rubric is an evaluation scale that is preferentially used by teachers (by students in self-assessment and peer-assessment tasks) in order to assess competence descriptors."

Involving students in the development of rubrics enables them to take responsibility for their learning by ensuring that all requirements for the assignment are met. Rubrics can serve as a tool to promote student accountability for their learning. When rubrics are used only for giving grades in the assessment, it deprives students the opportunity for self-learning as they become mere recipients rather than active partners in the assessment.

Research confirms that rubrics can be used for evaluation as well as teaching. Teachers who use assessment as a tool of instruction, and provide corrective feedback help students learn better. Teachers can explicitly list the assessment criteria to enhance the alignment of learning, instruction, and assessment (Andrade, 2005). When student performances best indicate the intended learning outcomes—things students would do, make, say, or write, then rubrics are the best way to assess them (Brookhart, 2013). Rubrics can be defined for processes like scientific communication, reasoning, problem-solving as well as a product like scientific models. For example, in a collaborative task, a rubric can be used to provide consistency and description of the performance. The results can be used to provide feedback for teachers and students.

The quality of an assessment heavily depends upon the tool used for it. A robust assessment tool, coupled with a well-defined rubric, can provide precise information about the learning level of students. Rubrics, when used accurately, can serve as a link between assessment and learning.

6.4. Types of rubrics

Effective rubrics are useful for both students and teachers, and they can be customised to serve specific purposes. Rubrics, which provide information about single criteria or multiple criteria at a time, can be general or task-specific. Each composition serves both summative and formative purposes. In a holistic rubric, a task is described in terms of the overall quality. They are often used to describe the overall performance of a student (Whittaker et al., 2001). When a task is broken into subparts or components of performance and includes the various levels of each subpart or component, the rubric used is called an analytic rubric. Both holistic and analytic rubrics can be task-specific or general.

Rubrics to measure student progress in learning and inform teaching are often used for formative assessment. Rubrics with marking schemes can be used in awarding grades in summative assessment (Jackson & Larkin, 2002). Some researchers (Brookhart, 2013) argue that focusing on the criteria one at a time provides accurate feedback for teachers and students. But developing extensive rubric for each criteria is time-consuming and impractical for classroom assessments.

Holistic rubrics, reporting the overall performance of student in a task, are useful when an assessment is administered over a large group, and faster results are required.

A task-specific rubric is more useful when scoring is required. It helps in maintaining consistency in grading assignments. A task is divided into various components, and a qualitative description of the performance for each component is provided. General rubrics use criteria and descriptions of performance appropriate for different tasks related to the same competencies, for example, scientific problem-solving. The criteria point to different subcomponents of a competency not related to one specific task.

6.4.1. Steps for constructing a learning rubric

Rubrics have the potential to guide the teaching-learning process, provided specific criteria are kept in mind while developing them. Rubrics which are not aligned to competencies required for a task may create confusion among students; they become unsure of expectations from a given task. Sometimes, it may lead to students' development of dependence on rubrics rather than developing the art of learning from it (Glasgow & Hicks, 2003).

Focus of writing or selecting rubrics should be on learning rather than the way a topic is taught, or how a specific task can be done. Since rubric creation is a time-consuming activity, it is recommended that most rubrics be designed for repeated use on several tasks. The criteria and performance-level descriptions in rubrics should indicate the desired performance and what can be the next step to enhance the quality of performance (Brookhart, 2013).

Each evaluative criterion of a rubric must represent a key attribute of the skill being assessed. Rubrics that are aligned with learning outcomes provide a useful way to measure progress toward the standards. However, teachers may find it beneficial to develop additional rubrics for specific purposes.

Before starting a rubric development for a task the following questions should be considered
• What is the desired outcome of the task? • What is the best possible performance on the task? • How to decide what is the best performance on the task? • What contributes to it being the best?

Source 6-3: Adapted from 'Developing and Using Instructional Rubrics' Educational Research Service. Arlington, VA 22201-2908.

There are no hard and fast rules for designing a rubric; however, the steps provided below can act as general guidelines. (https://champlain.instructure.com/courses/200147/pages/rubric).

- Determine the elements or criteria used to evaluate the work. (Performance Elements)
- List all of the criteria or traits that must be present in the student's work to ensure that it is high in quality.
- Identify the difference between good work and weaker work. (Performance Levels)
- Use three to five levels (Beginning, Fundamental, Practicing, Inspiring; Unacceptable, Developing, Acceptable, Exemplary; Novice, Developing, Proficient, Expert)
- Describe the procedures used for making judgments (or assigning scores). (level descriptions)

- Write clear descriptions of the types of work assigned to each category or level of achievement. These descriptions will help users apply the rubric consistently over time, increasing the reliability and perceived fairness of the evaluation process.

6.4.2. Constructing rubric: example

Learning outcomes indicate what the students know and are capable of doing after the completion of a learning task. Table 6-3 shows how a rubric following a learning progression can be created based on NCERT learning outcomes for the content area "food."

The content based on learning outcomes is mapped against the PISA 2018 competencies.

Table 6-3: A rubric for students' evaluation of the content area "Food" for grade 6

	Explain phenomena scientifically	**Evaluate and design scientific enquiry**	**Interpret data and evidence scientifically**
Grade 6 Learning outcomes - Sub-domain **Food**	**Recognising, offering and evaluating explanations for a range of natural and technological phenomena**	**Describing and appraising scientific investigations and proposing ways of addressing questions scientifically**	**Analysing and evaluating scientific data, claims and arguments in a variety of representations and drawing appropriate conclusions**
LO 1: conducts simple investigations to seek answers to queries; **LO 2:** relates processes and phenomenon with causes, e.g., deficiency diseases with diet; **LO 3:** applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet	• Understand/ explain why living things need food • Identify different food habits • Recall a variety of food items • Identify the different sources of food • Recall the main nutrients in food • Understand the role of different nutrients in our body • Identify the deficiency diseases and their symptoms	• Relate processes and phenomenon with causes, e.g., deficiency diseases with diet • Sets up an experiment with little help. • Employ the right procedure to test different nutrients in food • Make correct observations in an experiment • Describe different variables involved in an experiment	• Develop valid explanation for selecting food items for a balanced diet • Record data • Present data/ observations systematically • Communicate findings effectively with appropriate tools

The PISA competencies in the top row progressively advance from left to right, with 'explaining phenomenon scientifically' being the lowest competency and 'interpreting data and evidence scientifically' the highest. The skills in a column under a specific competency progressively advance from top to bottom. For example, under the competency - explaining phenomenon scientifically:

At level 1: Students will be able to

- Understand/ explain why living things need food
- Identify different food habits
- Recall a variety of food items
- Identify the different sources of food

At level 2: Students will be able to

- Recall the main nutrients in food
- Understand the role of different nutrients in our body

At level 3: Students will be able to

- Identify the deficiency diseases and their symptoms.

In this way, a progressive learning map can be created to assess student competencies. Assessment items or tasks are mapped to the learning progression to investigate students' described levels of competencies. However, as mentioned earlier, any learning rubric needs validation and consolidation to establish what value the learning progression adds to aid teaching and learning in classroom. Often classroom observations and teachers' rich experiences are used to validate the framework with actual student abilities that they come across in classroom settings. Last but not the least, teachers need to use assessment data to reflect on the success of the learning rubric and make subsequent revisions in order to use it to improve learning.

In this chapter, rubrics are projected as a bridge between assessment and the teaching-learning process. When students are provided with a rubric at the beginning of a unit of instruction or task, they can work accordingly. It helps them receive feedback, practice, revise or do another task till they complete the unit or receive a grade, resulting in complete alignment of learning outcomes, the teaching-learning process, and assessment.

7. Chapter-wise mapping of NCERT learning outcomes toward PISA competencies

7.1. Grade 6

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
1	Food: Where does it come from?	Life Sciences	Food variety, Food materials and sources	Identifies materials and organisms, such as, plant fibres, flowers, on the basis of observable features, i.e., appearance, texture, function, aroma, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S06.01.LS.01	Analyze the food items in order to Identify the ingredients used in different food items.	S06.01.LS.01.1	Yes			Inductive Approach/ Cooperative Learning
							Identify the sources of ingredients which are used to prepare food items.	S06.01.LS.01.2	Yes			
			Plant parts and animal products as food	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment	S06.01.LS.02	Observe different food ingredients in order to recognize if their origin is from the part of the plant and recognize the respective part	S06.01.LS.02.1	Yes			Inductive Approach/ Inquiry-based learning
							List the animal products in order to understand how we depend on them for our food.	S06.01.LS.02.2	Yes			Inductive Approach
			What do animals eat?	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can	Uses observable properties, in order to classify materials, organisms and processes	S06.01.LS.03	Categorize organisms into Herbivores, carnivores & omnivores based on their food habits or nutrition.	S06.01.LS.03.1	Yes			ICT

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.								
2	Components of food	Life Sciences	What do different food items contain? Deficiency diseases	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.02.LS.01	Improvise an activity to test the nutrients present in the given food items &critique their utility in adequate, inadequate & excess proportions.	S06.02.LS.01.1		Yes		Experiential Learning/ Experimentation
			What do various nutrients do for our body? Deficiency diseases	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.02.LS.02	Explain the function of each nutrients in order to discuss the importance of nutrients in good health.	S06.02.LS.02.1	Yes			
							Hypothesize consequences of eliminating any one major nutrients in order to make a healthy food choice.	S06.02.LS.02.2	Yes			Inquiry-based learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Balanced diet	Applies learning of scientific concepts in day-to- day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.02.LS.03	Design a balance diet plan in order to provide body sufficient nutrients it need to function properly.	S06.02.LS.03.1	Yes			Cooperative Learning/ Differentiation into Groups
			What do different food Items contain? What do various nutrients do for our body? Deficiency diseases	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment:	S06.02.LS.04	Improvise an activity to test the nutrients present in the given food items & critique their utility in adequate, inadequate & excess proportions.	S06.02.LS.04.1		Yes		Experimentation
3	Fibre to Fabric	Physical Sciences	Variety in fabrics	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties,	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.03.PS.01	Examine various fabrics in order to predict what they are made up of.	S06.03.PS.01.1	Yes			Inductive Approach/ Cooperative Learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				structure and functions								
			Fibres, Some plant fibres	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	Uses observable properties, in order to classify materials, organisms and processes	S06.03.PS.02	Classify the given fabrics as Natural or Synthetic based on their source.	S06.03.PS.02.1	Yes			
							Describe the processing of cotton and jute fibres into yarn in order to conclude the required conditions to grow them.	S06.03.PS.02.2	Yes			
			Spinning cotton yarn, Yarn to fabric	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.03.PS.03	Explain the various processes of making yarn from fibres in order to create the fabric.	S06.03.PS.03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				vermicompost, etc.								
			History of clothing materials	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.03.PS.04	Outline the history of textile industry in our country	S06.03.PS.04.1	Yes			
4	Sorting materials into groups	Physical Sciences	Properties of materials	Identifies materials and organisms, such as, plant fibres, flowers, on the basis of observable features, i.e., appearance, texture, function, aroma, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S06.04.PS.01	List the objects around us in order to analyse the materials they are made up of.	S06.04.PS.01.1	Yes			Experiential Learning
			Properties of materials	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.04.PS.02	Observe the appearance of the materials in order to differentiate them as lustre and non-lustre material.	S06.04.PS.02.1	Yes			Inquiry-based learning
							Plan and conduct an investigation in order to classify different kinds of materials by their observable properties.	S06.04.PS.02.2		Yes		Experiential Learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				their properties, structure and functions								
			Properties of materials	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	Uses observable properties, in order to classify materials, organisms and processes	S06.04.PS.03	Examine the materials by compressing or scratching them in order to categorize them as hard and soft material.	S06.04.PS.03.1	Yes			
							Observe the change in the shape of object added to water in order to categorize them as soluble and insoluble materials.	S06.04.PS.03.2	Yes			Inquiry-based learning
							Plan and conduct an investigation for various objects to classify them based on whether the object sink or float in water	S06.04.PS.03.3		Yes		Experimentation
							See through the objects in order to classify them into opaque, transparent and translucent.	S06.04.PS.03.4	Yes			Inductive Approach
			Properties of materials	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.04.PS.04	Plan and conduct an investigation in order to classify different kinds of materials by their observable properties.	S06.04.PS.04.1		Yes		
							Plan and conduct an investigation for various objects to classify them based on whether the object sink or float in water	S06.04.PS.04.2		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
5	Separation of substances	Physical Sciences	Methods of separation	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	Uses observable properties, in order to classify materials, organisms and processes	S06.05.PS.01	Identify properties of given items and select a property that would help them easily separate the items from each other.	S06.05.PS.01.1	Yes			
							Arrives at logical conclusion that certain specific methods can be employed to separate solid mixtures based on the size, colour or weight of the components	S06.05.PS.01.2			Yes	Experiential learning
			Methods of separation	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.05.PS.02	Examine the solubility of salt in water in certain conditions in order differentiate the solution as saturated and unsaturated.	S06.05.PS.02.1		Yes		
			Methods of separation	Explains processes and phenomenon, e.g., processing of plant fibres;	Explains processes and phenomena in order to relate to science behind the	S06.05.PS.03	Outlines methods that can be adapted in everyday life situations such as separation of husk from grains, separation of fine sand from coarse sand	S06.05.PS.03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	phenomena /processes and develop scientific thinking skills.		Carries out some of the improvised procedures of separation of insoluble solids from liquids in a given situation	S06.05.PS.03.2		Yes		Experiential learning
							Explains how multiple processes can be employed when the mixture has a soluble and insoluble component	S06.05.PS.03.3	Yes			
			Methods of separation	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.05.PS.04	Outlines methods that can be adapted in everyday life situations such as separation of husk from grains, separation of fine sand from coarse sand	S06.05.PS.04.1	Yes			
							Arrives at logical conclusion that certain specific methods can be employed to separate solid mixtures based on the size, colour or weight of the components	S06.05.PS.04.2			Yes	
6	Changes around us	Physical Sciences	Can all changes be reversed?	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be	Uses observable properties, in order to classify materials, organisms and processes	S06.06.PS.01	Classifies these changes based on interpretations into reversible and irreversible changes	S06.06.PS.01.1	Yes			
							Organizes the observation to make generalizations about various changes	S06.06.PS.01.2			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.								
			Can all changes be reversed? Could there be other ways to bring a change?	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.06.PS.02	Illustrates with examples of changes to find out the factors that can bring about specific changes	S06.06.PS.02.1	Yes			
							Checks the effect of various factors on materials with the help of simple activities	S06.06.PS.02.2		Yes		
7	Getting to know plants	Life Sciences	Herbs, Shrubs and Trees	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.07.LS.01	Compare the roots of different plants in order to classify them into tap roots and fibrous roots.	S06.07.LS.01.1	Yes			
			Herbs, Shrubs and Trees Root Leaf	Classifies materials, organisms and processes based on	Uses observable properties, in order to classify	S06.07.LS.02	Compare the features of Herbs, Shrubs & Trees in order to classify them considering their physical features / appearance	S06.07.LS.02.1	Yes			Inductive Approach/ Cooperative Learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	materials, organisms and processes		Analyze the parts of a plant and their function to in order to classify them into root and shoot system	S06.07.LS.02.2	Yes			ICT/ Differentiation into Groups
							List the characteristics of plants with weak stems in order to classify them into creepers and climbers.	S06.07.LS.02.3	Yes			Cooperative Learning
							Recognize patterns on leaves of different plants in order to classify them into reticulate venation and parallel venation	S06.07.LS.02.4	Yes			
							Compare the roots of different plants in order to classify them into tap roots and fibrous roots.	S06.07.LS.02.5	Yes			
			Stem, root Leaf	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.07.LS.03	Examine the stems of different plants and design an activity to demonstrate water conduction through stem (from roots).	S06.07.LS.03.1		Yes		
							Deduce the relation between leaf venation and the types of roots in a plant in order to identify the types of roots without pulling it out.	S06.07.LS.03.2			Yes	Inquiry based learning
			Stem, root, leaf	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals;	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop	S06.07.LS.04	Examine the stems of different plants and design an activity to demonstrate water conduction through stem (from roots).	S06.07.LS.04.1		Yes		Experimentation
							Demonstrate the process of transpiration in order to describe the functions of the leaf.	S06.07.LS.04.2		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	scientific thinking skills.		Explain the process of photosynthesis in order to describe the functions of the leaf.	S06.07.LS.04.3	Yes			
							Outline / list the functions of root in the plant with the help activities.	S06.07.LS.04.4	Yes			
			Stem, root, leaf, Flower	Draws labelled diagrams / flow charts of organisms and processes, e.g., parts of flowers; joints; filtration; water cycle, etc.	Draws labelled diagrams /flow charts of organisms and processes in order to demonstrate knowledge of structure /processes /relationships.	S06.07.LS.05	Apply knowledge of parts of plants to decipher features of plants / specimens provided	S06.07.LS.05.1	Yes			
							Identify the different parts of the leaf in order to draw a labelled diagram.	S06.07.LS.05.2	Yes			
							Recognize patterns on leaves of different plants in order to classify them into reticulate venation and parallel venation.	S06.07.LS.05.3	Yes			
							Compare the roots of different plants in order to classify them into tap roots and fibrous roots.	S06.07.LS.05.4	Yes			
							Illustrate the structure of a (typical) flower with at least 6 labelling & elaborate on each (Labelling)	S06.07.LS.05.5	Yes			
			Stem, root, leaf	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.07.LS.06	Examine the stems of different plants and design an activity to demonstrate water conduction through stem (from roots).	S06.07.LS.06.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Stem, root, leaf, flower	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.07.LS.07	Apply knowledge of parts of plants to decipher features of plants / specimens provided	S06.07.LS.07.1	Yes			
							Outline / list the functions of root in the plant with the help activities.	S06.07.LS.07.2	Yes			
8	Body Movements	Life Sciences	Human body and its movements	Identifies materials and organisms, such as, plant fibres, flowers, on the basis of observable features, i.e., appearance, texture, function, aroma, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S06.08.LS.01	Identify the type of joints in human body & their extent of movement /motion	S06.08.LS.01.1	Yes			
			Human body and its movements	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as	Uses observable properties, in order to classify materials, organisms and processes	S06.08.LS.02	Predict the classes that different organisms belong based on their movement	S06.08.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.								
			Gait of animals	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.08.LS.03	Compare the characteristics features of body movements of various organisms	S06.08.LS.02.2	Yes			
							Predict the possible reasons for animals showing different gaits	S06.08.LS.03.1	Yes			
			Human body and its movements	Draws labelled diagrams / flow charts of organisms and processes, e.g., parts of flowers; joints; filtration; water cycle, etc.	Draws labelled diagrams /flow charts of organisms and processes in order to demonstrate knowledge of structure /processes /relationships.	S06.08.LS.04	Compare and contrast between bones in different parts of human body	S06.08.LS.03.2	Yes			
							Identify the structure and function of skeletal system.	S06.08.LS.04.1	Yes			
			Human body and its movements, Gait of animals	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.08.LS.05	Demonstrate how muscles work in order to explain its functions,	S06.08.LS.04.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
9	The living organisms- Characteristics and habitats	Life Sciences	Organisms and the surrounding where they live	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.09.LS.01	Differentiate between the terrestrial & aquatic habitats based on their abiotic factors.	S06.09.LS.01.1	Yes			
			Habitat and adaptation	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	Uses observable properties, in order to classify materials, organisms and processes	S06.09.LS.02	Summarize the key features of living organisms that contribute to their survival in their habitats	S06.09.LS.02.1	Yes			
			A journey through different habitats	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal	Conducts simple investigations on his /her own in order to seek answers to queries	S06.09.LS.03	Devise an experiment to show the importance of abiotic factors for the growth & sustenance of life on earth.	S06.09.LS.03.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?								
			A journey through different habitats, Characteristics of organisms	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.09.LS.04	Summarize the key features of living organisms that contribute to their survival in their habitats	S06.09.LS.04.1	Yes			
							Infer reasons for effects produced on inhabitants, as an extension of their features meant for survival in their habitats	S06.09.LS.04.2			Yes	
							Critique the idea that the absence of any one feature characteristic of a habitat, might not affect the balance of the habitat	S06.09.LS.04.3			Yes	
			Habitat and adaptation A journey through different habitats	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.09.LS.05	Structure evidence of features contributing towards diversity of life within a single habitat, into one note, taking into consideration specific habitats	S06.09.LS.05.1			Yes	
			Characteristics of organisms, A journey through different habitats	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials;	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions	S06.09.LS.06	Apply knowledge of life processes in studying a specimen for signs of life	S06.09.LS.06.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	/take preventive measures /etc.							
10	Motion and measurement of distances	Physical Sciences	Some measurements, Moving things around us	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.10.PS.01	Compare the measurement of length for an object using a scientific instrument and an unscientific instrument in order to differentiate between standard and non-standard units of measurement	S06.10.PS.01.1	Yes			
							Distinguish between rest and motion in order to classify objects as in motion or at rest.	S06.10.PS.01.2	Yes			
			Moving things around us	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as	Uses observable properties, in order to classify materials, organisms and processes	S06.10.PS.02	Distinguish between rest and motion in order to classify objects as in motion or at rest.	S06.10.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				rectilinear, circular, periodic etc.								
			Standard units of measurement, Correct measurements of length	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.10.PS.03	Check out the procedures to find the errors associated with finding measurements using standard measurement devices	S06.10.PS.03.1		Yes		
			Standard units of measurement, Types of Motion	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.10.PS.04	Hypothesize reasons for utilisation /usage of Standard units of measurement	S06.10.PS.04.1	Yes			
							Explain the distortion in the size of continents when represented on a world map in order to explain the effect of projection from a 3D shape to a 2D plane	S06.10.PS.04.2	Yes			
							Find out the similarities and differences between the two objects based on the types of motion	S06.10.PS.04.3	Yes			
			Some measurements, Correct measurement of length, Measurement of curved line	Measures physical quantities and expresses in SI units, e.g., length	Measures physical quantities in order to express the measurement in SI units,	S06.10.PS.05	Construct a device by choosing appropriate materials in-order to measure length of given objects	S06.10.PS.05.1		Yes		
							Summarize the rules associated with the measurement of length.	S06.10.PS.05.2	Yes			
							Check out the procedures to find the errors associated with finding measurements using standard measurement devices	S06.10.PS.05.3		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Compare the measurement of length for an object using a scientific instrument and an unscientific instrument in order to differentiate between standard and non-standard units of measurement	S06.10.PS.05.4	Yes			
							Apply scientific inquiry to measure the length of an object in order to approximate the length of a curved line	S06.10.PS.05.5		Yes		
			Story of Transport	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.10.PS.06	Sequence different modes of transport from earliest to the most recent in order to suggest possible modification required in current scenario.	S06.10.PS.06.1	Yes			
			Story of Transport	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment	S06.10.PS.07	Sequence different modes of transport from earliest to the most recent in order to suggest possible modification required in current scenario.	S06.10.PS.07.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
11	Light, shadows and reflections	Physical Sciences	Transparent, opaque and translucent objects, what exactly are shadows?	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.11.PS.01	Distinguishes objects based on the following features- emission of light by them and visibility through them.	S06.11.PS.01.1	Yes			
							Distinguish between shadows & reflections.	S06.11.PS.01.2	Yes			
			What exactly are shadows? Pinhole camera, mirrors and reflections	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.11.PS.02	Concludes that there should be a source of light, opaque object and a surface for shadows to form.	S06.11.PS.02.1			Yes	
							Summarizes the characteristics of image formed by a pinhole camera	S06.11.PS.02.2			Yes	
							Makes conclusion about the nature of reflection shown by a plane mirror.	S06.11.PS.02.3			Yes	
			Pinhole camera, what exactly are shadows?	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.11.PS.03	Represents working of a pinhole camera diagrammatically	S06.11.PS.03.1	Yes			
							Makes conclusion about the nature of reflection shown by a plane mirror.	S06.11.PS.03.2			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			What exactly are shadows?	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought,	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.11.PS.04	Evaluates criteria for formation of shadows and makes judgment about situations like, shadow of an airplane flying at a higher altitude and shadow of a bird flying nearer to the ground,	S06.11.PS.04.1			Yes	
12	Electricity and circuits	Physical Sciences	An electric circuit	Differentiates materials andorganisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.12.PS.01	Distinguish between complete and incomplete circuit with a well labelled figure	S06.12.PS.01.1	Yes			
			Electric conductors and insulators	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be	Uses observable properties, in order to classify materials, organisms and processes	S06.12.PS.02	Test items to classify them as conductor and insulator in order to examine the role of conductors and insulators in day-to-day life.	S06.12.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.								
			A bulb connected to an electric cell, electric conductors and insulators	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.12.PS.03	Analyze the flow of current in a simple electric circuit with battery, bulb and wires to identify necessary condition to ensure flow of current.	S06.12.PS.03.1			Yes	
			An electric cell	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.12.PS.04	Describe the structure and function of the electric cell	S06.12.PS.04.1	Yes			

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			An electric circuit	Draws labelled diagrams / flow charts of organisms and processes, e.g., parts of flowers; joints; filtration; water cycle, etc.	Draws labelled diagrams /flow charts of organisms and processes in order to demonstrate knowledge of structure /processes /relationships.	S06.12.PS.05	Distinguish between complete and incomplete circuit with a well labelled figure	S06.12.PS.05.1	Yes			
			A bulb connected to an electric cell, electric switch	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.12.PS.06	Analyze the flow of current in a simple electric circuit with battery, bulb and wires to identify necessary condition to ensure flow of current.	S06.12.PS.06.1			Yes	
							Make a simple working model of an electric switch with easily available materials	S06.12.PS.06.2		Yes		
			Electric conductors and insulators	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.12.PS.07	Infer why metals like copper and aluminium are used for making wires for domestic & industrial purposes	S06.12.PS.07.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Electric conductors and insulators	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment	S06.12.PS.08	Infer why metals like copper and aluminium are used for making wires for domestic & industrial purposes	S06.12.PS.08.1+J103	Yes			
13	Fun with magnets	Physical Sciences	Magnetic and non-magnetic materials	Classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular, periodic etc.	Uses observable properties, in order to classify materials, organisms and processes	S06.13.PS.01	Classify the given substances as magnetic & nonmagnetic based on their ability to be attracted by magnets along with examples.	S06.13.PS.01.1	Yes			
			How magnets were discovered poles of magnet, attraction and repulsion between magnets	Conducts simple investigations to seek answers to queries, e.g., what are the	Conducts simple investigations on his /her own in order to seek	S06.13.PS.02	Outline the events responsible for the discovery of natural magnets.	S06.13.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	answers to queries		Suggest an activity to determine the poles of a magnet	S06.13.PS.02.2		Yes		
							Analyze what happens when two magnets are placed together in order to conclude the property of magnet.	S06.13.PS.02.3			Yes	
			Finding directions, make your own magnet	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.13.PS.03	Create a direction finder in order to find the direction.	S06.13.PS.03.1	Yes			
							Make a magnet in order to demonstrate how artificial magnets can be created.	S06.13.PS.03.2	Yes			
			Finding directions, make your own magnet	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.13.PS.04	Create a direction finder in order to find the direction.	S06.13.PS.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
14	Water	Earth Sciences	Where do we get water from?	Identifies materials and organisms, such as, plant fibres, flowers, on the basis of observable features, i.e., appearance, texture, function, aroma, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S06.14.ES.01	List down all the sources of water in order to conclude the major source of water.	S06.14.ES.01.1	Yes			
			What happens if it does not rain for a long period?	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.14.ES.02	Attribute the natural calamities like drought & floods to disturbance in water cycle	S06.14.ES.02.1	Yes			
							Predict what will happen if rain doesn't happen in order to explain the significance of rain.	S06.14.ES.02.2	Yes			
			Water cycle	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.14.ES.03	Argue the important role played by trees /plants in water cycle	S06.14.ES.03.1			Yes	
			Water cycle, back to the oceans	Draws labelled diagrams / flow charts of organisms and processes, e.g., parts of flowers; joints; filtration;	Draws labelled diagrams /flow charts of organisms and processes in order to demonstrate	S06.14.ES.04	Create a model of the water cycle in order to explain the processes that take place during water cycle.	S06.14.ES.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				water cycle, etc.	knowledge of structure /processes /relationships.							
			Water cycle, back to the oceans	Constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S06.14.ES.05	Create a model of the water cycle in order to explain the processes that take place during water cycle.	S06.14.ES.05.1	Yes			
			How much water do we use? What if it rains heavily? What happens if it does not rain for a long period?	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.14.ES.06	Compute the amount of water required per person annually	S06.14.ES.06.1			Yes	
							Attribute the natural calamities like drought & floods to disturbance in water cycle	S06.14.ES.06.2	Yes			
							Infer the problems may arise due to heavy rainfall in order to suggest possible measures that can be taken.	S06.14.ES.06.3	Yes			
							Predict what will happen if rain doesn't happen in order to explain the significance of rain.	S06.14.ES.06.4	Yes			
							Evaluate the consequences of mismanagement of water or excessive usage of ground water.	S06.14.ES.06.5			Yes	
			What if it rains heavily? How can we conserve water? Rainwater harvesting	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste;	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to	S06.14.ES.07	Infer the problems may arise due to heavy rainfall in order to suggest possible measures that can be taken.	S06.14.ES.07.1	Yes			
							Evaluate the consequences of mismanagement of water or excessive usage of ground water.	S06.14.ES.07.2			Yes	
							Devise the possible strategies for individual /	S06.14.ES.07.3		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				spreading awareness to adopt rain water harvesting; care for plants, etc.	the protection of the environment		community level Rain water Harvesting techniques.					
15	Air around us	Earth Sciences	Is air present everywhere around us? What is air made up of?	Conducts simple investigations to seek answers to queries, e.g., what are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction?	Conducts simple investigations on his /her own in order to seek answers to queries	S06.15.ES.01	Conduct experiments in order to prove the presence of air around us.	S06.15.ES.01.1		Yes		
							Execute an improvised plan to test the presence of CO2, oxygen, water vapour, nitrogen, dust and smoke in air.	S06.15.ES.01.2		Yes		
							Prove the presence of air in water and soil in order to explain how oxygen becomes available to animals and plants.	S06.15.ES.01.3		Yes		
			How is the oxygen in the atmosphere replaced?	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.15.ES.02	Outline the causes & effects of Air pollution	S06.15.ES.02.1	Yes			
			How does oxygen become available to animals and plants living in water and soil?	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror;	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S06.15.ES.03	Prove the presence of air in water and soil in order to explain how oxygen becomes available to animals and plants.	S06.15.ES.03.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				variations in composition of air; preparation of vermicompost, etc.								
			What is air made up of? How is the oxygen in the atmosphere replaced?	Draws labelled diagrams / flow charts of organisms and processes, e.g., parts of flowers; joints; filtration; water cycle, etc.	Draws labelled diagrams /flow charts of organisms and processes in order to demonstrate knowledge of structure /processes /relationships.	S06.15.ES.04	Depict the composition of air using pie chart	S06.15.ES.04.1			Yes	
							Illustrate Oxygen cycle using well labelled figure	S06.15.ES.04.2	Yes			
			How does oxygen become available to animals and plants living in water and soil?	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.15.ES.05	Critique the importance of air for the sustenance of life on earth	S06.15.ES.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			How does oxygen become available to animals and plants living in water and soil?	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment	S06.15.ES.06	Critique the importance of air for the sustenance of life on earth	S06.15.ES.06.1	Yes			
16	Garbage in, Garbage out	Earth Sciences	Dealing with garbage	Differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S06.16.ES.01	Compare distinguishing features between compostable waste and non-compostable waste, in connection with properties of the end product	S06.16.ES.01.1	Yes			
			Dealing with garbage, vermicomposting	Relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S06.16.ES.02	Hypothesize on the reasons for layering the composting pit with different types of materials	S06.16.ES.02.1	Yes			
							Infer reasons for success or failure of vermicomposting, considering steps involved and resultant products, etc.	S06.16.ES.02.2			Yes	
			Vermicomposting	Explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and	Explains processes and phenomena in order to relate to science behind the phenomena /processes	S06.16.ES.03	Infer reasons for success or failure of vermicomposting, considering steps involved and resultant products, etc.	S06.16.ES.03.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermicompost, etc.	and develop scientific thinking skills.							
			Dealing with garbage	Applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain / drought, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S06.16.ES.04	Discuss the waste management system in your community in order to explain the process of garbage disposal by 'SafaiKaramcharis'.	S06.16.ES.04.1	Yes			
			Think and throw,	Makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment	S06.16.ES.05	Investigate their own trash consumption in order to formulate alternatives to offset trash production in their household.	S06.16.ES.05.1	Yes			
							Design a method to ensure effective disposal of garbage, in connection with knowledge of different types of wastes, their properties, etc.	S06.16.ES.05.2		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Recycling of paper, plastics – boon or a curse?	Exhibits creativity in designing, planning, making use of available resources, etc.	Designs, plans, makes use of available resources, etc. in order to exhibit creativity.	S06.16.ES.06	Outline possible means of dealing with a specific type of waste (Plastics), in connection with composting, reuse, recycle, reduce etc.	S06.16.ES.06.1	Yes			

7.2. Grade 7

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
1	Nutrition in Plants	Life Sciences	Mode of nutrition in plants	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.01.LS.01	Examine different methods of nutrition in order to differentiate between autotrophic and heterotrophic nutrition	S07.01.LS.01.1	Yes			Cooperative learning/ Experiential learning
			Mode of nutrition in plants, other modes of nutrition in plants	Classifies materials and organisms based on properties/characteristics, e.g., plant and animal fibres; physical and chemical changes /characteristics, e.g., plant and animal fibres; physical and chemical changes	Explains properties /characteristics of materials and organisms in order to classify them	S07.01.LS.02	Evaluate other plants in their surroundings & classify them as autotrophs, heterotrophs, saprotrophs, parasitic or symbiotic based on their nutritional requirements	S07.01.LS.02.1			Yes	Experiential learning
			Saprotrophs	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.01.LS.03	Categorize features of insectivores, saprophytes and symbionts, based on their similarities.	S07.01.LS.03.1	Yes			Inductive Approach/ ICT
			Photosynthesis — food making process in plants	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.01.LS.04	Evaluate if leaves that are red, purple/colours other than green might show lesser photosynthetic activity than green leaves	S07.01.LS.04.1		Yes		Inquiry-based learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			How nutrients are replenished in the soil	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.01.LS.05	Construct the cause & effect model of plant rotation done by farmers	S07.01.LS .05.1	Yes			
			Mode of nutrition in plants, photosynthesis	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.01.LS.06	Recall details/definitions specific to autotrophic mode of nutrition in plants / photosynthesis / detection of photosynthetic activity of plants/nutrients other than carbohydrates, in plants	S07.01.LS .06.1	Yes			
							Define Nutrition & its importance to living organisms	S07.01.LS .06.2	Yes			
							Elaborate the photosynthetic process in plants	S07.01.LS .06.3	Yes			
							List the nutrients and sunlight requirements in plants in order to explain how these are fulfilled through enquiry activity	S07.01.LS .06.4	Yes			
							Relate the nutritional requirements of different organisms (plants & animals) to the environment or surroundings for survival	S07.01.LS .06.5	Yes			
			Photosynthesis — food making process in plants	Writes word equation for chemical reactions, e.g., acid-base reactions; corrosion; photosynthesis; respiration, etc.	Writes word equation in order to express chemical reactions	S07.01.LS.07	Describe the process of photosynthesis with the help of word/chemical equation	S07.01.LS .07.1	Yes			
			Photosynthesis — food making process in plants	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate	S07.01.LS.08	Draw a schematic diagram of a section through a leaf in order to pictorially represent photosynthesis	S07.01.LS .08.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
					knowledge of structure /processes /relationships							
			How nutrients are replenished in the soil	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.01.LS.09	Establish the relationship between Rhizobium bacteria & leguminous plants	S07.01.LS.09.1	Yes			
2	Nutrition in animals	Life Sciences	Digestion in human	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.02.LS.01	Illustrate human digestive system with the help of a well labelled diagram & elaborate the process & function of each part	S07.02.LS.01.1	Yes			
			Digestion in grass-eating animals	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.02.LS.02	Compare & contrast the features of digestive system of grass-eating animals with those of humans.	S07.02.LS.02.1	Yes			
			Different ways of taking food	Classifies materials and organisms based on properties /characteristics, e.g., plant and animal fibres; physical and chemical changes	Explains properties /characteristics of materials and organisms in order to classify them	S07.02.LS.03	Classifies animals based on their modes of feeding.	S07.02.LS.03.1	Yes			
			Digestion in human	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.02.LS.04	Perform the starch test on raw and chewed food in order to infer the role of saliva.	S07.02.LS.04.1		Yes		Experimentation

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Different ways of taking food	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.02.LS.05	Recall details pertaining different modes of acquiring food.	S07.02.LS .05.1	Yes			
			Digestion in human, Feeding and digestion in Amoeba	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.02.LS.06	Summarize the functions of Human digestive system.	S07.02.LS .06.1	Yes			
							Recall details pertaining to nutrition in amoeba	S07.02.LS .06.2	Yes			
							Illustrate human digestive system with the help of a well labelled diagram & elaborate the process & function of each part	S07.02.LS .06.3	Yes			ICT/ Cooperative learning
3	Fibre to Fabric	Physical Sciences	Wool	Classifies materials and organisms based on properties /characteristics, e.g., plant and animal fibres; physical and chemical changes	Explains properties /characteristics of materials and organisms in order to classify them	S07.03.PS.01	Examine selective breeding process for obtaining special characters in the offspring, e.g. soft under hair in sheep	S07.03.PS .01.1			Yes	
							Compare coarse beard hair & soft under hair of animals based on their utility	S07.03.PS .01.2	Yes			
			Wool	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.03.PS.02	Examine selective breeding process for obtaining special characters in the offspring, e.g. soft under hair in sheep	S07.03.PS .02.1			Yes	
			Wool, silk	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.03.PS.03	Outline the steps involved in processing of fibres into wool	S07.03.PS .03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				magnetic effects of electric current, etc.			Outline the steps involved in obtaining silk from cocoon	S07.03.PS.03.2	Yes			
			Silk	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.03.PS.04	Describe and illustrate diagrammatically the life cycle of silk moth	S07.03.PS.04.1	Yes			
			Wool, silk	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.03.PS.05	Critique the risk factors associated with wool industry & appreciate the efforts of people involved in it	S07.03.PS.05.1			Yes	
							Explain the significance of silk in textile industry	S07.03.PS.05.2	Yes			
							Evaluate the contribution of silk in Indian Economy and appreciate our weavers for the intricate & dedicated efforts	S07.03.PS.05.3			Yes	
4	Heat	Physical Sciences	Measuring temperature	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.04.PS.01	Distinguish the Clinical thermometer from Laboratory thermometer (range, least count, units of measurement)	S07.04.PS.01.1	Yes			Experiential learning/ Inductive Approach
			Measuring temperature, laboratory thermometer, transfer of heat, kinds of clothes	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other	Conducts simple investigations on his /her own in order to seek answers to queries	S07.04.PS.02	List precautions while using a clinical and laboratory thermometer in order to identify the role of a kink.	S07.04.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			we wear in summer and winter	than green also carry out photosynthesis? Is white light composed of many colours?			Devise an activity or elaborate a situation to show the rate of thermal conduction, convection & radiation	S07.04.PS.02.2		Yes		Experimentation
							Devise an activity to show that woollen clothes are insulators/ poor conductors of heat	S07.04.PS.02.3		Yes		
			Laboratory thermometer, transfer of heat	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.04.PS.03	Critique the need for Laboratory thermometer while doing experiments in the laboratories	S07.04.PS.03.1			Yes	
							Explain why a substance remains in the same temperature in a Thermos flask or vacuum bottle	S07.04.PS.03.2	Yes			Inquiry-based learning
							Corelate the modes of transfer of heat to the usage of different clothes in different parts of the world (Polar, temperature, tropical, etc.)	S07.04.PS.03.3	Yes			
			Transfer of heat	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.04.PS.04	Observe the heating and cooling of objects in order to describe conduction	S07.04.PS.04.1	Yes			
							Apply the concept of convection to heating of land and water in order to predict the description of land and sea breeze	S07.04.PS.04.2	Yes			Inductive approach
			Hot and cold, measuring temperature	Measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc.	Measures and calculates in order to demonstrate understanding of measurability of various scientific processes /phenomena	S07.04.PS.05	Categorize a given substance as hot & cold by a reliable measure (using temperature without touching)	S07.04.PS.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Distinguish the Clinical thermometer from Laboratory thermometer (range, least count, units of measurement)	S07.04.PS.05.2	Yes			
5	Acids, Bases and Salts	Physical Sciences	Acids and bases, natural indicators around us	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.05.PS.01	Examine the common substance used at home based on taste and touch and classify them as acidic or basic	S07.05.PS.01.1		Yes		Experiential learning
							Summarizes observations with respect to behavior of indicators in acidic and basic solutions	S07.05.PS.01.2	Yes			
			Neutralisation,	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.05.PS.02	Identify neutralization reactions and its characteristics	S07.05.PS.02.1	Yes			
							Summarizes observations with respect to behavior of indicators in acidic and basic solutions	S07.05.PS.02.2	Yes			
			Neutralisation in everyday life	Writes word equation for chemical reactions, e.g., acid-base reactions; corrosion; photosynthesis; respiration, etc.	Writes word equation in order to express chemical reactions	S07.05.PS.03	Identify neutralization reactions and its characteristics	S07.05.PS.03.1	Yes			
							Illustrates neutralization reactions seen in everyday life	S07.05.PS.03.2	Yes			
			Neutralisation in everyday life	Applies learning of scientific concepts in day-to- day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc	S07.05.PS.04	Evaluate the effectiveness of certain neutralization reactions employed in everyday life, based on observed data	S07.05.PS.04.1			Yes	Inquiry-based learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				during and after disasters; suggesting methods for treatment of polluted water for								
6	Physical and chemical changes	Physical Sciences	Physical changes, chemical change, rusting of iron	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.06.PS.01	Infer the effects which help you to identify a physical change	S07.06.PS.01.1			Yes	
							Summarize various features accompanying chemical change	S07.06.PS.01.2	Yes			
							Evaluate a given set of changes (in everyday life) on attributes of physical or chemical changes to distinguish between them	S07.06.PS.01.3			Yes	
							Defend why rusting of iron is a chemical change	S07.06.PS.01.4	Yes			
			Physical changes	Classifies materials and organisms based on properties /characteristics, e.g., plant and animal fibres; physical and chemical changes	Explains properties /characteristics of materials and organisms in order to classify them	S07.06.PS.02	Differentiates physical changes from other changes (periodic changes etc.) in order to characterize the common feature of physical changes	S07.06.PS.02.1	Yes			
			Rusting of iron, crystallisation	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.06.PS.03	Design an experiment to prevent rusting by eliminating/ controlling a particular condition for rusting	S07.06.PS.03.1		Yes		

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							Illustrate the usage of crystallization in purification of various salts	S07.06.PS .03.2	Yes			
			Crystallisation	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.06.PS.04	Judge why better crystallization occurs at lower temperatures	S07.06.PS .04.1	Yes			
			Chemical change	Writes word equation for chemical reactions, e.g., acid-base reactions; corrosion; photosynthesis; respiration, etc.	Writes word equation in order to express chemical reactions	S07.06.PS.05	Elaborate the understanding of Chemical Reaction & Chemical Bonding by word equation	S07.06.PS .05.1	Yes			
							Illustrates chemical change with specific examples	S07.06.PS .05.2	Yes			
7	Weather, Climate and Adaptations of Animals to Climate	Earth Sciences , Life Sciences	Weather, Climate	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.07.ES.01	Demonstrate an experiment in order to conclude the weather of a day, like maximum and minimum temperature and amount of rainfall.	S07.07.ES .01.1		Yes		
							Examine the extended weather pattern of place to decide the climate	S07.07.ES .06.01.2		Yes		
			Weather, Climate, Climate and adaptation	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc	Examines and explains processes and phenomenon in order to relate them with causes	S07.07.ES.02	List the factors the influence the weather of a place	S07.07.ES .02.1	Yes			
							Describe the impact of various types of weather on humans	S07.07.ES .02.2	Yes			

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							Categorize the different types of climates based on set criteria	S07.07.ES .02.3			Yes	
							Explain how different organisms adapt to survive in extreme climates	S07.07.ES .02.4	Yes			
			Weather, Climate and adaptation	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.07.ES.03	Explains how the weather of a place depends on the Sun	S07.07.ES .03.1	Yes			
							Describe how migration helps certain organisms to survive	S07.07.ES .03.2	Yes			
			Weather, Climate	Measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc.	Measures and calculates in order to demonstrate understanding of measurability of various scientific processes /phenomena	S07.07.ES.04	Examine a weather report and calculate the maximum and/or minimum temperature of the day	S07.07.ES .04.1			Yes	
							Analyse a climate report and determine the duration of seasons for the place	S07.07.ES .04.2			Yes	
			Weather, Climate	Plots and interprets graphs e.g., distance- time graph	Plots graphs on the basis of given data, in order to interpret it	S07.07.ES.05	Record data of the weather and use the data to construct a graph	S07.07.ES .05.1			Yes	
							Construct a graph using the data from a climate report	S07.07.ES .05.2			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Weather, Climate	Applies learning of scientific concepts in day-to- day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc	S07.07.ES.06	Apply the understanding of impact on weather on human beings in a real-life situation	S07.07.ES.06.1	Yes			
							Predict the weather pattern based on available data	S07.07.ES.06.2			Yes	
							Examine a weather pattern and relate it to the factors influencing it	S07.07.ES.06.3	Yes			
							Determine the type of habitat based on the climate of a place	S07.07.ES.06.4	Yes			
							Predict the habitat of an organism based on its adaptive features	S07.07.ES.06.5	Yes			
			Climate and adaptation	Makes efforts to protect environment, e.g., following good practices for sanitation at public places; minimising generation of pollutants; planting trees to avoid soil erosion; sensitising others with the consequences of excessive consumption of natural resources, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S07.07.ES.07	Describe how conservation of habitats helps migratory organisms	S07.07.ES.07.1	Yes			
							Describe how the climate of rainforests helps in sustaining large biodiversity	S07.07.ES.07.2	Yes			
8	Winds, storms and cyclones	Earth Sciences	High speed winds are accompanied by reduced air pressure, air expands on heating	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.08.ES.01	Demonstrate an experiment in order to conclude that high speed winds are accompanied by low air pressure by the method of scientific inquiry.	S07.08.ES.01.1		Yes		

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							Demonstrate an experiment in order to conclude that air moves from a region of high pressure to a region of low pressure.	S07.08.ES.01.2		Yes		
							Demonstrate an experiment in order to conclude that air expands on heating.	S07.08.ES.01.3		Yes		
			Air exerts pressure, wind currents are generated due to uneven heating on the earth, thunderstorms and cyclones, destruction caused by cyclones	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.08.ES.02	Apply the knowledge that air exerts pressure in order to explain phenomenon of cyclones.	S07.08.ES.02.1	Yes			
							Attribute the direction of movement of wind currents to the uneven heating of atmosphere at various regions of earth & rotation of earth.	S07.08.ES.02.2	Yes			
							Recall the concept of land breeze and sea breeze in order to describe monsoon winds.	S07.08.ES.02.3	Yes			
							Suggest the possible reasons for absence of cyclones/thunderstorms in certain areas where as their abundance in others.	S07.08.ES.02.4	Yes			
							Describe the structure of a cyclone in order to list factors that contribute to its development and explain the damage it causes.	S07.08.ES.02.5	Yes			
			Air exerts pressure	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.08.ES.03	Recall details pertaining to air & effects of air pressure.	S07.08.ES.03.1	Yes			

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			Effective safety measures, advanced technology has helped	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.08.ES.04	Recall details about safety measure & precautions against Cyclones, Thunderstorms & Tornadoes	S07.08.ES .04.1	Yes			
							Implement knowledge of storms/cyclones/tornados and safety measure and precautions against them in order to devise new safety measures and precautions.	S07.08.ES .04.2	Yes			
							Summarize the consequences of absence of precautionary measures against storms/cyclones/tornado, etc.	S07.08.ES .04.3	Yes			
9	Soil	Earth Sciences	Soil types, properties of soil, moisture in soil, absorption of water by soil	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.09.ES.01	Compare different types of soils in connections with properties shared along with contrasting features.	S07.09.ES .01.1	Yes			
							Determine the percolation of given soil using the time of percolation.	S07.09.ES .01.2			Yes	
							Examine different soil samples in order to infer that moisture is contained in soil.	S07.09.ES .01.3			Yes	
							Examine different soil samples in order to calculate the percentage of water absorbed and assess moisture absorbing property of soil	S07.09.ES .01.4			Yes	
			Soil profile	Classifies materials and organisms based on properties /characteristics, e.g., plant and animal fibres; physical and chemical changes	Explains properties /characteristics of materials and organisms in order to classify them	S07.09.ES.02	Classify soil into different categories based on its properties.	S07.09.ES .02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Describe all the layers in the soil profile in order to classify them into A-, B-, C-horizon and bedrock.	S07.09.ES.02.2	Yes			
			Properties of soil, moisture in soil, absorption of water by soil	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.09.ES.03	Determine the percolation of given soil using the time of percolation.	S07.09.ES.03.1			Yes	
							Examine different soil samples in order to infer that moisture is contained in soil.	S07.09.ES.03.2			Yes	
							Examine different soil samples in order to calculate the percentage of water absorbed and assess moisture absorbing property of soil	S07.09.ES.03.3			Yes	
			Soil and crops, soil teeming with life	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.09.ES.04	Evaluate the characteristics of soil that will support a particular type of crop with reasons	S07.09.ES.04.1			Yes	
							Construct a cause & effect model of effects of soil pollution on life on earth.	S07.09.ES.04.2		Yes		
			Soil teeming with life	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.09.ES.05	Predict the consequences of absence of soil on life on earth.	S07.09.ES.05.1	Yes			
							Construct a cause & effect model of effects of soil pollution on life on earth.	S07.09.ES.05.2		Yes		
			Soil and crops	Applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S07.09.ES.06	Construct a cause & effect model of effects of soil pollution on life on earth.	S07.09.ES.06.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc.								
10	Respiration in organism	Life Sciences	Why do we respire?	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.10.LS.01	Define cellular respiration in order to differentiate between aerobic and anaerobic respiration.	S07.10.LS.01.1	Yes			
			Breathing, what do we breathe out?	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.10.LS.02	Examine inhalation, exhalation and breathing rate in own body in order to analyse the effect of various activities on breathing rate.	S07.10.LS.02.1			Yes	
							Observe the reaction of exhaled air with lime water in order to infer the gas exhaled.	S07.10.LS.02.2			Yes	
			Breathing, breathing in other animals, breathing under water, do plants also respire?	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.10.LS.03	Examine inhalation, exhalation and breathing rate in own body in order to analyse the effect of various activities on breathing rate	S07.10.LS.03.1			Yes	
							Construct a cause and effect model of respiratory processes in animals and plants, as an extension of available resources and respiratory organs/features.	S07.10.LS.03.2		Yes		
			Why do we respire? How do we breathe? Breathing in other animals,	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.10.LS.04	List the functions performed by a cell in order to infer the need of energy for various processes	S07.10.LS.04.1	Yes			

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			breathing under water, do plants also respire?	magnetic effects of electric current, etc.			Recall details/definitions of terminology related to respiration in humans.	S07.10.LS .04.2	Yes			
							Describe the process of breathing in humans in order to explain the role of nostrils (hair and mucus), trachea, lungs, ribs and diaphragm.	S07.10.LS .04.3	Yes			
							Describe the process of respiration in cockroach, earthworm, fish and plants in order to predict consequences of absence of respiratory organs/features, in animals or plants.	S07.10.LS .04.4	Yes			
							Select distinguishing features and categorize them as belonging to respiratory systems in plants and human beings (stomata & lungs).	S07.10.LS .04.5	Yes			
			Why do we respire?	Writes word equation for chemical reactions, e.g., acid-base reactions; corrosion; photosynthesis; respiration, etc.	Writes word equation in order to express chemical reactions	S07.10.LS.05	Define cellular respiration in order to differentiate between aerobic and anaerobic respiration.	S07.10.LS .05.1	Yes			
			Breathing	Measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc.	Measures and calculates in order to demonstrate understanding of measurability of various scientific processes /phenomena	S07.10.LS.06	Examine inhalation, exhalation and breathing rate in own body in order to analyse the effect of various activities on breathing rate.	S07.10.LS .06.1			Yes	
			How do we breathe?	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.10.LS.07	Describe the process of breathing in humans in order to explain the role of nostrils (hair and mucus), trachea, lungs, ribs and diaphragm.	S07.10.LS .07.1	Yes			

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11	Transportation in Animals and Plants	Life Sciences	Circulatory system	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.11.LS.01	Draw a contrast between the functions of arteries and veins, in the functioning of the circulatory system.	S07.11.LS.01.1	Yes			
			Circulatory system, excretion in animals, transport of substances in plants	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.11.LS.02	Analyse the implications of intermixing of oxygenated and deoxygenated blood in order to explain the existence of four chambers in the heart.	S07.11.LS.02.1	Yes			
							Interpret reasons for discrepancies in the process of urine formation and expulsion.	S07.11.LS.02.2	Yes			
							Predict reasons for decreased absorption of water by plants.	S07.11.LS.02.3	Yes			
			Circulatory system, excretion in animals, transport of substances in plants	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.11.LS.03	Outline functions carried out by parts of the circulatory system as being contributory to proper circulation of oxygen.	S07.11.LS.03.1	Yes			
							Describe the function of blood and its constituents.	S07.11.LS.03.2	Yes			
							Describe the location and function of the heart.	S07.11.LS.03.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Recall details/functions of parts of the excretory system	S07.11.LS.03.4	Yes			
							Explain the process of transport of water, minerals and food in plants in order to differentiate between xylem and phloem.	S07.11.LS.03.5	Yes			
							Explain the process of transpiration in order to infer its advantages.	S07.11.LS.03.6	Yes			
							Study excretion in other organisms.	S07.11.LS.03.7	Yes			
			Circulatory system,	Measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc.	Measures and calculates in order to demonstrate understanding of measurability of various scientific processes /phenomena	S07.11.LS.04	Examine own pulse in order to infer the pulse rate and define it.	S07.11.LS.04.1			Yes	
							Define heartbeat in order to design a model of a stethoscope to measure it.	S07.11.LS.04.2	Yes			
							Observe own heartbeat and pulse rate after different activities in order to draw a relationship between them.	S07.11.LS.04.3			Yes	Experimentation
			Circulatory system	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.11.LS.05	Describe the location and function of the heart.	S07.11.LS.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Circulatory system, excretion in animals	Constructs models using materials from surroundings and explains their working, e.g., stethoscope; anemometer; electromagnets; newton's colour disc ,etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S07.11.LS.06	Recall details/functions of parts of the excretory system	S07.11.LS.06.1	Yes			
							Define heartbeat in order to design a model of a stethoscope to measure it.	S07.11.LS.06.2	Yes			
			Excretion in animals, transport of substances in plants, circulatory system	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.11.LS.07	Compare situations of effective and ineffective functioning of the excretory system, in connection with functions of the parts of the system	S07.11.LS.07.1	Yes			
							Attribute reasons for ineffective transportation of materials in plants, to functions of their parts.	S07.11.LS.07.2	Yes			
							Explain the importance and need for blood donations.	S07.11.LS.07.3	Yes			
							Analyse the condition of kidney failure in order to explain the process of dialysis.	S07.11.LS.07.4	Yes			
12	Reproduction in plants	Life Sciences	Modes of reproduction	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.12.LS.01	Infer the mode of reproduction from the features of a plant	S07.12.LS.01.1			Yes	
			Modes of reproduction, sexual reproduction, fruits and seed formation	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic,	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.12.LS.02	Observe and recall how different types of plants grow new ones in order to differentiate between asexual and sexual modes of reproduction	S07.12.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function			Distinguish between any two modes of asexual reproduction, in connection with parts involved, etc.	S07.12.LS .02.2	Yes			
							Compare the outcomes of sexual reproduction in unisexual plants with those in bisexual plants	S07.12.LS .02.3	Yes			
			Modes of reproduction	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.12.LS.03	Define reproduction in order to identify its need	S07.12.LS .03.1	Yes			
			Sexual reproduction, fruits and seed formation	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms/ structures/processes in order to demonstrate knowledge of structure /processes /relationships	S07.12.LS.04	Recall details/definitions pertaining to sexual mode of reproduction in plants	S07.12.LS .04.1	Yes			
			Seed dispersal, modes of reproduction	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.12.LS.05	Critique the idea that any one of the categories of seeds might disperse better than another category, in connection with reference to their features	S07.12.LS .05.1			Yes	Inquiry-based learning
							Draw a contrast between any two modes of asexual reproduction, in connection with parts involved, etc.	S07.12.LS .05.2	Yes			
13	Motion and time	Physical Sciences	Measurement of time	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.13.PS.01	Paraphrase the to and from motion of simple pendulum/metallic bob suspended by a string is known as oscillatory motion	S07.13.PS .01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Slow or fast, measurement of time	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.13.PS.02	Recall change in position of the body with respect to surroundings as motion.	S07.13.PS.02.1	Yes			
							Identify repetition of natural events at definite/regular intervals of time/fraction of second in order to describe periodicity.	S07.13.PS.02.2	Yes			
							Infer from the given data that time taken to complete one oscillation as time period of simple pendulum.	S07.13.PS.02.3			Yes	
							Paraphrase the to and from motion of simple pendulum/metallic bob suspended by a string is known as oscillatory motion	S07.13.PS.02.4	Yes			ICT
			Speed, measurement of speed	Measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc.	Measures and calculates in order to demonstrate understanding of measurability of various scientific processes /phenomena	S07.13.PS.03	Recall the definition of speed (average speed) as distance covered in unit time.	S07.13.PS.03.1	Yes			
							Recall the instrument used to measure speed.	S07.13.PS.03.2	Yes			
							Derive the mathematical formula to calculate speed in order to compare the speeds of various moving objects (uniform and non-uniform motion).	S07.13.PS.03.3			Yes	
							Calculate speed or distance or time taken if any two of these three are quantitates are provided	S07.13.PS.03.4			Yes	
							Utilize data given in odometer to measure distance travelled, average speed for a given time.	S07.13.PS.03.5			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Distance-time graph	Plots and interprets graphs e.g., distance- time graph	Plots graphs on the basis of given data, in order to interpret it	S07.13.PS.04	Record data for distance covered in fixed intervals of time for a moving object in order to plot a distance-time graph and interpret the shape.	S07.13.PS.04.1			Yes	Inductive approach
14	Electric current and its effects	Physical Sciences	Magnetic effect of electric current, electromagnet, electric bell	Explains processes and phenomena, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills	S07.14.PS.01	Examine how that an electric current can be used as a magnet in order to list its uses.	S07.14.PS.01.1	Yes			
							Outline the construction and uses of electromagnets and electric bell.	S07.14.PS.01.2	Yes			
			Symbols of electric components	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.14.PS.02	Translate a circuit with actual components into a circuit diagram.	S07.14.PS.02.1	Yes			
			Heating effect of electric current, magnetic effect of electric current	Constructs models using materials from surroundings and explains their working, e.g., stethoscope; anemometer; electromagnets; newton's colour disc ,etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S07.14.PS.03	Observe heating effect of current in order to enlist its uses and compare it for conductors of different material, length and thickness.	S07.14.PS.03.1	Yes			Experiential learning
							Perform a simple activity to demonstrate the magnetic effect of an electric current.	S07.14.PS.03.2		Yes		
			Heating effect of electric current	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.14.PS.04	Recall the precautions to be observed while working with electricity.	S07.14.PS.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Summarize the benefits of using CFLs over ordinary electric bulbs.	S07.14.PS .04.2	Yes			
							Evaluate the role of a fuse wire and MCBs provide for electrical safety in a circuit.	S07.14.PS .04.3	Yes			
15	Light	Physical Sciences	Right or left!, playing with spherical mirrors,	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.15.PS.01	Recall reflection as change in direction of light by polished surfaces/mirrors.	S07.15.PS .01.1	Yes			
							Observe and describe image formed by a plane mirror in order to enlist its uses. (image/object, erect/inverted, virtual/real, distance from the mirror)	S07.15.PS .01.2	Yes			
							Conclude from observations that concave mirror forms real, inverted image at all places except when the object is too close whereas convex mirror is erect, virtual & smaller size than the object.	S07.15.PS .01.3			Yes	
			Images formed by lenses	Differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure and function	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them	S07.15.PS.02	Differentiate between convex and concave lenses based on the image formed when object is placed at different positions.	S07.15.PS .02.1			Yes	
			Sunlight — white or coloured?	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out	Conducts simple investigations on his /her own in order to seek answers to queries	S07.15.PS.03	Explain the formation of a rainbow.	S07.15.PS .03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				photosynthesis? Is white light composed of many colours?								
			Reflection of light	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.15.PS.04	Analyse why virtual image cannot be obtained on the screen but still can be photographed.	S07.15.PS.04.1	Yes			
			Sunlight — white or coloured?	Constructs models using materials from surroundings and explains their working, e.g., stethoscope; anemometer; electromagnets; newton's colour disc ,etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works	S07.15.PS.05	Explain the formation of a rainbow.	S07.15.PS.05.1	Yes			
			Right or left!, playing with spherical mirrors, images formed by lenses	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.15.PS.06	Analyze the reason behind 'AMBULANCE' written as its mirror image on the hospital vehicles/ambulances.	S07.15.PS.06.1	Yes			
							Attribute to the type of image formed by convex mirror for its utility as rear-view mirror in the vehicles	S07.15.PS.06.2	Yes			
							Outline the important uses of spherical mirrors & lenses.	S07.15.PS.06.3	Yes			
16	Water: A precious resource	Earth Sciences	Water management	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.16.ES.01	Recall process that generate waste water that goes down the drains from sinks, showers, toilets, laundries etc.	S07.16.ES.01.1	Yes			
			Water management	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white	Conducts simple investigations on his /her own in order to seek answers to queries	S07.16.ES.02	Examine the role of plants in water management	S07.16.ES.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				light composed of many colours?								
			Groundwater as an important source of water, distribution of water, water management	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.16.ES.03	List the means of access to water in order to trace their origin to the water cycle.	S07.16.ES.03.1	Yes			
							Describe infiltration i.e. seepage of water into the ground in order to define the water table and aquifer	S07.16.ES.03.2	Yes			
							Construct a cause & effect model of depletion of ground water table.	S07.16.ES.03.3	Yes			Cooperative learning
							Analyse the rainfall map of India in order to attribute reasons and factors leading to shortage and excess of water in major areas.	S07.16.ES.03.4			Yes	
			Forms of water,	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.16.ES.04	Recall the water cycle in order to describe the processes encompassed by it	S07.16.ES.04.1	Yes			
			What role you can play, water management	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S07.16.ES.05	Suggest some (of his/her own) methods for recharging ground water table	S07.16.ES.05.1	Yes			
							Suggest the steps for efficient water management at individual/community level.	S07.16.ES.05.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Elaborate the steps to be taken by the public/private authorities for improved water supply	S07.16.ES.05.3	Yes			
			How much water is available, depletion of water table	Applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S07.16.ES.06	Visualize the percentage of freshwater available on the Earth in order to conclude the need for water conservation.	S07.16.ES.06.1	Yes			
							Suggest some (of his/her own) methods for recharging ground water table	S07.16.ES.06.2	Yes			
							Suggest the steps for efficient water management at individual/community level.	S07.16.ES.06.3	Yes			
							Elaborate the steps to be taken by the public/private authorities for improved water supply/debate on steps taken/to be taken by the Government for the supply of clean drinking water to people	S07.16.ES.06.4	Yes			
17	Forests: Our Lifeline	Earth Sciences	Visit to a forest	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.17.ES.01	Infer reasons for the aerial appearance of forests (as shown in the chapter), in connection with types of trees/shapes of trees.	S07.17.ES.01.1	Yes			
			Visit to a forest	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.17.ES.02	Create a flowchart of the food web, taking into consideration some examples of living beings, used in the chapter	S07.17.ES.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Visit to a forest	Applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S07.17.ES.03	Outline features of forests that are responsible for sustenance of life.	S07.17.ES .03.1	Yes			
							Design a forest ecosystem by considering a few plants and animals and explaining how they support one another.	S07.17.ES .03.2	Yes			
18	Wastewater story	Earth Sciences	Water freshens up — an eventful journey	Identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc.	Examines observable features, i.e., appearance, texture, function, aroma, etc. in order to identify materials and organisms	S07.18.ES.01	Recall the journey of used water as waste water/ water that goes down the drains from sinks, showers, toilets, laundries	S07.18.ES .01.1	Yes			
			Wastewater treatment plant	Conducts simple investigations to seek answers to queries, e.g., can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours?	Conducts simple investigations on his /her own in order to seek answers to queries	S07.18.ES.02	Perform various processes related to treatment of wastewater in order to describe processes inside a Wastewater Treatment Plant	S07.18.ES .02.1	Yes			
			What is sewage? Water freshens up — an eventful journey	Relates processes and phenomena with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc.	Examines and explains processes and phenomenon in order to relate them with causes	S07.18.ES.03	List the uses of water in everyday life in order to identify various source of contamination	S07.18.ES .03.1	Yes			
							Define sewage and list its components in order to identify their points of origin	S07.18.ES .03.2	Yes			
			Wastewater treatment plant	Draws labelled diagrams / flow charts e.g., organ systems in human and plants; electric circuits; experimental set ups; life cycle of silk moth, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships	S07.18.ES.04	Make a flow chart/line diagram of sewage route from all the various sources of generation to the treatment plant	S07.18.ES .04.1	Yes			ICT

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Sanitation and disease	Applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures/ etc.	S07.18.ES.05	Outline factors responsible for scarcity of clean water and list some waterborne diseases in order to suggest methods of their prevention	S07.18.ES .05.1	Yes			
			Alternative arrangement for sewage disposal, sanitation at public places	Makes efforts to protect environment, e.g., following good practices for sanitation at public places; minimising generation of pollutants; planting trees to avoid soil erosion; sensitising others with the consequences of excessive consumption of natural resources, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S07.18.ES.06	Conduct a water contamination survey in order to devise a plan for good sanitation practices and avoidance of contagious diseases	S07.18.ES .06.1		Yes		
							Devise and execute a step wise plan for treatment of waste water	S07.18.ES .06.2		Yes		

7.3. Grade 8

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
1	Crop Production & Management	Life Sciences	Basic Practices of Crop Production, Preparation of soil, Sowing, Adding manure and fertilisers, Protecting from weeds, Harvesting, Food from Animal	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.01.LS.01	Compare the advantages of three major tools used for tilling and ploughing to justify the variety of agricultural practices	S08.01.LS.01.1	Yes			Cooperative learning
							Analyse the quality of seeds with respect to their germinability	S08.01.LS.01.2			Yes	Experimentation
							Compare the advantages of two major tools used for sowing to justify the variety of agricultural practices used in the country	S08.01.LS.01.3	Yes			
							Distinguish between manure and fertilisers to identify ways in which nutrients in soil is replenished	S08.01.LS.01.4	Yes			Experiential learning
							Evaluate how weeds adversely affects the growth of the plants in order to justify their removal and control	S08.01.LS.01.5			Yes	Experiential learning
							Identify commonly known food items based on their sources to define animal husbandry	S08.01.LS.01.6	Yes			
			Agricultural Practices, Basic Practices of Crop Production	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops;	Explains properties /characteristics of materials and organisms in order to classify them.	S08.01.LS.02	Classify the major crops based on the time they are sown in the field to explain the months Kharif and Rabi crops are cultivated	S08.01.LS.02.1	Yes			Inductive Approach

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.			Sequence the tasks involved in cultivating the crop to list major steps of agricultural practices	S08.01.LS.02.2	Yes			Inquiry-based learning
							Describe the process of crop rotation to explain ways in which nutrients in soil is replenished	S08.01.LS.02.3	Yes			
			Preparation of soil , Harvesting, Storage	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.01.LS.03	Explain why it is important to loosen the soil before sowing in order to elaborate the effect of loose soil in plant's growth	S08.01.LS.03.1	Yes			Experimentation
							Elaborate the process of harvesting to justify the reasons for employing combine and winnowing machine in the process of agriculture	S08.01.LS.03.2	Yes			
							Distinguish between the practices of large scale and small- scale storage of food in order to conclude that stored grains need protection from pests and microorganisms	S08.01.LS.03.3	Yes			
			Irrigation, Adding Manure and Fertilisers	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with environmental hazards, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S08.01.LS.04	Compare and analyse the traditional and modern methods of irrigation based on cost and efficiency in order to predict suitable irrigation method in real life situations	S08.01.LS.04.1	Yes			
							Describe the process of crop rotation to explain ways in which nutrients in soil is replenished	S08.01.LS.04.2	Yes			
2	Microorganisms- Friend and foe	Life Sciences	Microorganisms	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals,	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.02.LS.01	Differentiate between microorganisms and viruses to establish that viruses reproduce only in the host body	S08.02.LS.01.1	Yes			Cooperative learning/ ICT

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				on the basis of their properties, structure and functions.								
			Microorganisms, Harmful microorganisms	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.	Explains properties /characteristics of materials and organisms in order to classify them.	S08.02.LS.02	Recall four major categories of microorganisms (bacteria, fungi, protozoa, algae)	S08.02.LS.02.1	Yes			
							Define pathogens to list the class of harmful microorganisms	S08.02.LS.02.2	Yes			
			Microorganisms and Us, Harmful microorganisms	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.02.LS.03	Elucidate the reason for increasing volume when yeast is added to dough in baking industry to explain fermentation	S08.02.LS.03.1	Yes			Inquiry-based learning
							Describe how mosquitoes spread malaria and dengue to explain the role of carriers in spreading communicable disease	S08.02.LS.03.2	Yes			
			Harmful microorganisms	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.02.LS.04	List examples of diseases in humans, plants and animal caused by microorganisms in order to explain the harmful effects of microorganisms	S08.02.LS.04.1	Yes			Inductive approach/ Cooperative learning
			Microorganisms and Us,	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.02.LS.05	Explain the role of antibiotics in order to demonstrate the medicinal uses of microorganisms	S08.02.LS.05.1	Yes			
							Explain the role of vaccinations in fighting with diseases in order to appreciate the medicinal uses of microorganisms	S08.02.LS.05.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Explain microorganisms role in decomposing to describe importance	S08.02.LS.05.3	Yes			
			Nitrogen Fixation, Nitrogen cycle	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.02.LS.06	Explain how microorganism help in increasing the nitrogen in soil to the agricultural uses of microorganisms	S08.02.LS.06.1	Yes			
							Illustrate the process of fixing the nitrogen back in the soil to explain the role of microorganisms in increasing the fertility of soil	S08.02.LS.06.2	Yes			
			Food preservation	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.02.LS.07	List various methods of preserving food in order to demonstrate the restriction of growth of microorganism	S08.02.LS.07.1	Yes			
3	Synthetic fibres and plastics	Physical Sciences	What are Synthetic Fibres? Plastics as Materials of Choice, Plastics and the Environment	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.03.PS.01	Distinguish between Synthetic & Natural fibres based on their properties	S08.03.PS.01.1	Yes			
							List characteristics of plastic's ability to bend to differentiate between thermoplastics and thermosetting plastics	S08.03.PS.01.2	Yes			
							Differentiate between plastics based on their ability to decompose in order to explain why plastics are a threat to the environment.	S08.03.PS.01.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Types of Synthetic Fibres	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.03.PS.02	Enlist different types of synthetic fibres and their characteristics in order to explain their specific uses	S08.03.PS.02.1	Yes			
							Examine suggest the characteristics of plastic to explain its suitability in a variety of applications.	S08.03.PS.02.2	Yes			
			Characteristics of Synthetic Fibres	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S08.03.PS.03	Distinguish between Synthetic & Natural fibres based on their properties	S08.03.PS.03.1	Yes			
							Enlist different types of synthetic fibres and their characteristics in order to explain their specific uses	S08.03.PS.03.2	Yes			
			Plastics and the Environment	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with environmental hazards, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S08.03.PS.04	Differentiate between plastics based on their ability to decompose in order to explain why plastics are a threat to the environment	S08.03.PS.04.1	Yes			
4	Materials : Metals and Non- metals	Physical Sciences	Physical Properties of Metals and Non-metals, Chemical Properties of Metals and Non-metals	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.04.PS.01	Elaborate the chemical reactions of metals and non-metals with oxygen, water, acids and bases in order to distinguish between them.	S08.04.PS.01.1	Yes			
							Differentiate between the commonly known materials based on their ability to be bent and formed into sheets, be drawn into wires, ability to produce ringing sound, ability to conduct electricity, ability to conduct heat in order to define various properties of metal	S08.04.PS.01.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Physical Properties of Metals and Non-metals	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.	Explains properties /characteristics of materials and organisms in order to classify them.	S08.04.PS.02	Categorize the commonly known materials as Metals & Non- metals in order to explain their physical properties.	S08.04.PS.02.1	Yes			Inductive Approach
			Chemical Properties of Metals and Non-metals	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.04.PS.03	Apply the concept of reactivity of a metal to predict if a given metal will displace other metal or not in a displacement reaction	S08.04.PS.03.1			Yes	Experimentation
			Chemical Properties of Metals and Non-metals	Writes word equation for chemical reactions, e.g., reactions of metals and non-metals with air, water and acids, etc.	Writes word equation in order to express chemical reactions.	S08.04.PS.04	Elaborate the chemical reactions of metals and non-metals with oxygen, water, acids and bases in order to distinguish between them.	S08.04.PS.04.1	Yes			
							Apply the concept of reactivity of a metal to predict if a given metal will displace other metal or not in a displacement reaction	S08.04.PS.04.2			Yes	
			Chemical Properties of Metals and Non-metals, Uses of Metals and Non-metals	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.04.PS.05	Apply the concept of reactivity of a metal to predict if a given metal will displace another metal in a displacement reaction	S08.04.PS.05.1			Yes	
							Predict the utility of a given material for a specific task to reinforce the physical and chemical properties of metals and non-metals	S08.04.PS.05.2	Yes			Inquiry-based learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
5	Coal and petroleum	Earth Sciences	Natural resources	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.05.ES.01	Classify natural resources based on their ability to replenish in order to distinguish between inexhaustible and exhaustible natural resources	S08.05.ES.01.1	Yes			Cooperative learning/ Inductive approach
			Natural resources, petroleum	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.	Explains properties /characteristics of materials and organisms in order to classify them.	S08.05.ES.02	Classify natural resources based on their ability to replenish in order to distinguish between inexhaustible and exhaustible natural resources	S08.05.ES.02.1	Yes			
							Classify different constituents of petroleum according to their use in daily life in order to observe various by products	S08.05.ES.02.2	Yes			
			Petroleum, natural gas	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.05.ES.03	Infer why gas, oil and water found in this particular sequence in location where petroleum is found in order to explain that gas, oil their densities and ability to mix with each other	S08.05.ES.03.1		Yes		
			Coal	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.05.ES.04	Discuss the process of formation of coal to explain why coal is an exhaustible natural resource	S08.05.ES.04.1	Yes			ICT/ Inquiry-based learning
			Coal	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of	S08.05.ES.05	List the useful by products after processing coal to explain that natural resources can be used to obtain useful products other than fuel	S08.05.ES.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				environmental hazards, etc.	the environment.							
6	Combustion and flame	Physical Sciences	Types of Combustion	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.06.PS.01	Differentiate between the type of combustion taking place in gas stove, burning of phosphorus and bursting of firecrackers to assess rapid combustion, spontaneous combustion and explosion	S08.06.PS.01.1	Yes			
			How Do We Control Fire? What is Combustion?	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.06.PS.02	Compile and list the commonly known inflammable substances to explain that certain substance catch fire than others.	S08.06.PS.02.1	Yes			
							Explain the process of combustion in order to describe the role of fuel and oxygen in the process as necessary conditions for combustion to take place	S08.06.PS.02.2	Yes			
			Fuel efficiency	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.06.PS.03	List harmful by-products of burning fuel to be aware of its harmful effects on individuals and environment such as global warming and acid rains	S08.06.PS.03.1	Yes			
							Compare the calorific value of commonly used fuel to examine fuel efficiency	S08.06.PS.03.2			Yes	
			What is Combustion? Structure of a Flame,	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects	Explains processes and phenomena in order to relate to science behind the phenomena /processes and	S08.06.PS.04	Define ignition temperature to explain why minimum temperature is required for a substance to catch fire.	S08.06.PS.04.1	Yes			

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			Structure of a flame, What is a fuel?	of electric current; formation of multiple images; structure of flame, etc.	develop scientific thinking skills.		Explain the different parts of flame in order to explain why goldsmiths blow the outermost zone of a flame to melt gold and silver	S08.06.PS.04.2	Yes			
			How do we control fire?	Constructs models using materials from surroundings and explains their working, e.g., ektara, electroscope, fire extinguisher, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works.	S08.06.PS.05	List the conditions necessary for producing fire to discover how combustible materials can be prevented from catching the fire.	S08.06.PS.05.1	Yes			
7	Conservation of plants and animals	Life Sciences	Deforestation and Its Causes , Consequences of Deforestation, Red Data Book	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.07.LS.01	List causes of deforestation to reflect on its rampant existence despite forest being essential to life	S08.07.LS.01.1	Yes			
							Describe how droughts are caused to elaborate the consequence of deforestation	S08.07.LS.01.2	Yes			
							Describe the process of desertification to explain the consequence of deforestation	S08.07.LS.01.3	Yes			
							Interpret the importance of Red Data Book to explain why keeping a track of endangered species is important	S08.07.LS.01.4	Yes			
			Flora and Fauna, Endemic Species	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing /	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.07.LS.02	List the flora and fauna in surroundings to establish the term used for locally found plants and animals	S08.07.LS.02.1	Yes			
							List the flora and fauna exclusive to a particular region to describe the term endemic species	S08.07.LS.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				reducing friction; challenging myths and taboos regarding adolescence, etc.								
			Biosphere reserve, wildlife sanctuary, National Park, reforestation	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with environmental hazards, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S08.07.LS.03	List some famous biosphere and wildlife sanctuaries to describe different mechanisms through which governments protect and conserve forest and wildlife	S08.07.LS.03.1	Yes			
							List famous animal reserve e.g.Satpura Tiger Reserve to describe measures taken by government in protecting endangered animals	S08.07.LS.03.2	Yes			
							Explain reforestation to describe ways to reduce it	S08.07.LS.03.3	Yes			
			Recycling of Paper	Exhibits creativity in designing, planning, making use of available resources, etc.	Designs, plans, makes use of available resources, etc.in order to exhibit creativity.	S08.07.LS.04	Explain recycling to describe ways to reduce deforestation	S08.07.LS.04.1	Yes			
8	Cell - structure and functions	Life Sciences	Organisms show Variety in Cell Number, Shape and Size	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources	Explains properties /characteristics of materials and organisms in order to classify them.	S08.08.LS.01	Classify animals based on their cell number, shape and size in order to describe unicellular and multicellular animals	S08.08.LS.01.1	Yes			
			Cell Structure and Function, Comparison of Plant and Animal Cells	Prepares slides of microorganisms; onion peel, human cheek cells, etc., and describes their microscopic features	Prepares slides of microorganisms and describes their microscopic features.	S08.08.LS.02	List the different parts and functions of a typical cell in order to appreciate the unit structure in an organism	S08.08.LS.02.1	Yes			

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							Distinguish between plant and animal cells to explain the function of cell wall	S08.08.LS.02.2	Yes			
			Parts of the Cell Comparison of Plant and Animal Cells	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.08.LS.03	List the different parts and functions of a typical cell in order to appreciate the unit structure in an organism	S08.08.LS.03.1	Yes			
							Distinguish between plant and animal cells to explain the function of cell wall	S08.08.LS.03.2	Yes			
9	Reproduction in animals	Life Sciences	Sexual reproduction, asexual reproduction	Differentiates materials and organisms, such as, natural and human made fibres; contact and non- contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.09.LS.01	Differentiate between asexual and sexual reproduction in order to list two modes of reproduction	S08.09.LS.01.1	Yes			
							Differentiate between sex cells corresponding to parent in order to explain male and female gamete	S08.09.LS.01.2	Yes			
							Differentiate between internal and external fertilization in order to describe two modes of fertilization in animals	S08.09.LS.01.3	Yes			
							Classify animals based on their ability to give birth or lay eggs to differentiate between viviparous and oviparous animals	S08.09.LS.01.4	Yes			
			Sexual reproduction	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial	Explains properties /characteristics of materials and organisms in order to classify them.	S08.09.LS.02	Classify animals based on their ability to give birth or lay eggs to differentiate between viviparous and oviparous animals	S08.09.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				objects; exhaustible and inexhaustible natural resources, etc.								
			Sexual reproduction, asexual reproduction	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.09.LS.03	Describe the process of fertilization in order to explain zygote formation	S08.09.LS.03.1	Yes			
							Describe the process of embryo and foetus formation to explain how an individual is formed inside mother's womb	S08.09.LS.03.2	Yes			
							Describe the life cycle of frogs from eggs to adult frogs in order to explain metamorphosis	S08.09.LS.03.3	Yes			
							Describe the process of reproduction in hydra in order to explain the process of asexual reproduction	S08.09.LS.03.4	Yes			
			Sexual reproduction, asexual reproduction	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental setups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.09.LS.04	Differentiate between asexual and sexual reproduction in order to describe two modes of reproduction in animals	S08.09.LS.04.1	Yes			
10	Reaching the age of adolescence	Life Sciences	Reproductive health	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.10.LS.01	Identify the consequences of taking drugs in order to explain why drugs are not a solution to confused and insecure feeling during adolescent	S08.10.LS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Changes at Puberty, Secondary Sexual Characters	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.10.LS.02	Enumerate different variations that take place in body at puberty to explain the effect of adolescence on changing human body	S08.10.LS.02.1	Yes			
							Summarize the functions of sex and other hormones to establish their role secondary sexual characteristics	S08.10.LS.02.2	Yes			
			Adolescence and Puberty, Changes at Puberty, Secondary Sexual Characters, Role of Hormones in Initiating Reproductive Function, Reproductive Phase of Life in Humans, How is the Sex of the Baby Determined?, Hormones other than Sex Hormones, Reproductive Health	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.10.LS.03	Define adolescence and adolescent age in order to explain changes at puberty	S08.10.LS.03.1	Yes			
							Enumerate different variations that take place in body at puberty to explain the effect of adolescence on changing human body	S08.10.LS.03.2	Yes			
							Explain the effects of hormones in the development of secondary sexual characteristics in order to illustrate growth during puberty	S08.10.LS.03.3	Yes			
							Elaborate the functions of hormones secreted by endocrine glands in order to explain the growth in male and female body at puberty	S08.10.LS.03.4	Yes			
							Describe mensuration , menarche and menopause to explain the reproductive phases of life in humans	S08.10.LS.03.5	Yes			
							Illustrate the procedure for the determining the sex of a baby in order to establish that the gender of the child is decided by the chromosome from male sperm	S08.10.LS.03.6			Yes	

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							Elucidate the need for a balanced diet in order to explain the nutritional needs of adolescents	S08.10.LS.03.7	Yes			
							Identify the harmful consequences of taking drugs in order to explain why drugs are not solution to confused and insecure feeling during adolescence	S08.10.LS.03.8	Yes			
11	Force and pressure	Physical Sciences	Force – A Push or a Pull	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.	Explains properties /characteristics of materials and organisms in order to classify them.	S08.11.PS.01	Classify common actions involving motion of object as push or pull in order to define the term force	S08.11.PS.01.1	Yes			
			Forces are due to an Interaction, Exploring Forces, Pressure Exerted by Liquids and Gases, Atmospheric Pressure	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.11.PS.02	Provide examples where force is being applied in order to explain that two objects must interact for a force to come into play	S08.11.PS.02.1	Yes			
							Analyse motion of an object when force is applied in the same and opposite direction in order to conclude that forces in same direction add while forces in opposite directions subtract	S08.11.PS.02.2			Yes	
							Discover the direction of pressure applied by liquid when put in a container to conclude that liquids exert pressure on the walls of the container	S08.11.PS.02.3		Yes		
							Demonstrate and calculate the atmospheric pressure exerted due to the air column above a given area in order to establish that great atmospheric pressure is exerted without us realizing it	S08.11.PS.02.4		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Pressure	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.11.PS.03	Derive the formula and calculate pressure for given force applied on a given area in order to explain common daily phenomenon requirement of sharp knife etc.	S08.11.PS.03.1			Yes	
			A Force can Change the State of Motion, Force can Change the Shape of an Object, Contact Force, Non-contact Force	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.11.PS.04	Predict the motion of an object when force is applied viz-a- viz force is not applied in order to explain that a force may bring a change in the state of motion of an object	S08.11.PS.04.1	Yes			
							Predict the changes when force is applied to a body that is not free to move in order to explain that force can cause change in shape of objects	S08.11.PS.04.2	Yes			
							Cite examples from daily life where an action causes change in movement or shape due to the contact between two objects in order to define contact forces	S08.11.PS.04.3			Yes	
							Illustrate with examples from daily life an action that causes change in movement or shape without contact between two objects in order to define non-contact forces.	S08.11.PS.04.4			Yes	
12	Friction	Physical Sciences	Wheels Reduce Friction, Force of Friction,	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.12.PS.01	Differentiate between rolling friction and sliding friction in order to explain why ball bearings are employed in machines e.g. bicycle wheels	S08.12.PS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Force of Friction, Factors affecting Friction	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.12.PS.02	Analyse situations where resistance is felt while applying force to move a body in order to explain friction force where acts in opposite direction	S08.12.PS.02.1			Yes	
							Analyse and identify number of bodies interacting when friction force is felt in order to establish that friction is a contact force.	S08.12.PS.02.2			Yes	
			Factors affecting Friction, Friction : A Necessary Evil, Wheels Reduce Friction, Fluid Friction,	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.12.PS.03	Discover the factors that cause friction when two bodies moving relatively in order to explain why it is easier to move an object on a smooth surface compared to a rough surface	S08.12.PS.03.1	Yes			
							Provide advantages and disadvantages of friction in order to justify friction as necessary evil	S08.12.PS.03.2	Yes			
							Differentiate between rolling friction and sliding friction in order to explain the use of different friction reducing strategies	S08.12.PS.03.3	Yes			
							Explain why the engine of an airplane is needed when flying in order to explain drag caused by air	S08.12.PS.03.4	Yes			
			Increasing and Reducing Friction,	Exhibits creativity in designing, planning, making use of available resources, etc.	Designs, plans, makes use of available resources, etc.in order to exhibit creativity.	S08.12.PS.04	Identify factors causing friction in order to come up with formulate strategies to reduce	S08.12.PS.04.1			Yes	
13	Sound	Physical Sciences	Amplitude, Time Period and Frequency of a Vibration	Differentiates materials and organisms, such as, natural and human made fibres; contact and non- contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.13.PS.01	Differentiate between frequency and amplitude in order to describe factors responsible for loudness and pitch of the sound	S08.13.PS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				and oviparous animals, on the basis of their properties, structure and functions.								
			Sound Needs a Medium for Propagation	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.13.PS.02	Provide examples where sound travels from one point to another in order to establish that sound needs a medium to propagate	S08.13.PS.02.1	Yes			
			Sound is Produced by a Vibrating Body, Sound Needs a Medium for Propagation, Audible and Inaudible Sounds	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.13.PS.03	List examples of body moving in to and fro motion in order to explain vibration	S08.13.PS.03.1	Yes			
							Provide examples where sound travels from one point to another in order to establish that sound needs a medium to propagate	S08.13.PS.03.2	Yes			
							Recall the audible range of sound for humans in order to explain why certain sounds cannot be heard by humans	S08.13.PS.03.3	Yes			
			We Hear Sound through Our Ears	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.13.PS.04	Describe the structure and function of an eardrum in order to explain how humans hear sound	S08.13.PS.04.1	Yes			
			Sound is Produced by a Vibrating Body	Constructs models using materials from surroundings and explains their working, e.g., ektara, electroscope, fire extinguisher, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works.	S08.13.PS.05	List commonly known musical instrument and identify parts that vibrate in order to explain that vibration produces sound	S08.13.PS.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Sound Produced by Humans	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.13.PS.06	List commonly known musical instrument and identify parts that vibrate in order to explain that vibration produces sound	S08.13.PS.06.1	Yes			
							List and identify functions of parts of human body that produces sound in order to explain the process of sound production	S08.13.PS.06.2	Yes			
			Noise pollution	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with environmental hazards, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S08.13.PS.07	List the harmful effects of noise pollution in order to mitigate it	S08.13.PS.07.1	Yes			
14	Chemical effects of electric current	Physical Sciences	Do liquids conduct electricity?	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.14.PS.01	Distinguish between good and poor conductors of electricity in order to explain that various materials can conduct electricity under certain conditions	S08.14.PS.01.1	Yes			
			Chemical Effects of Electric Current	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.14.PS.02	List commonly known chemical effects of electricity in order to establish that electricity causes chemical reactions	S08.14.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Chemical Effects of Electric Current	Constructs models using materials from surroundings and explains their working, e.g., ektara, electroscope, fire extinguisher, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works.	S08.14.PS.03	Describe the process of electroplating in order to explain the application of chemical effects of electricity on metals	S08.14.PS.03.1	Yes			
			Chemical Effects of Electric Current	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.14.PS.04	Describe the process of electroplating in order to explain the application of chemical effects of electricity on metals	S08.14.PS.04.1	Yes			
15	Some natural phenomenon	Physical Sciences	Earthquakes	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.15.PS.01	Identify and explain seismic zones around earth to explain why some areas are more affected by earthquakes than others	S08.15.PS.01.1	Yes			
			Lightning, Types of Charges and Their Interaction, The Story of Lightning, Earthquakes	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.15.PS.02	Analyse if two charged objects attract or repel each other in order to establish that similar charge repel each other while opposite charge attract each other	S08.15.PS.02.1			Yes	
							Examine the sequence of lightening occurring in clouds in order to explain the process of electric discharge in nature	S08.15.PS.02.2	Yes			
							Justify the phenomenon of earthquake in order to explain that the ground beneath us is not static	S08.15.PS.02.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Earthquakes	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.15.PS.03	Illustrate with a diagram the movement of earth in order to explain how earthquakes cause tsunami	S08.15.PS.03.1	Yes			
			Transfer of Charge	Constructs models using materials from surroundings and explains their working, e.g., ektara, electroscope, fire extinguisher, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works.	S08.15.PS.04	Examine the working of electroscope to detect if an object is charged or not in order to apply the concept of similar charge objects repel each other	S08.15.PS.04.1			Yes	
			Transfer of Charge, The Story of Lightning, Lightning Safety	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.15.PS.05	Recall examples of visible sparks in order to explain the phenomenon of lightning	S08.15.PS.05.1	Yes			
							Investigate the process of earthing in order to assess the process of transferring charge from a charged object to earth in order to explain the advantages of earthing of electric circuits in households	S08.15.PS.05.2			Yes	
							Predict how lightning travels from the cloud to the ground in order to describe the measures that must be taken during lightning	S08.15.PS.05.3	Yes			
			The Story of Lightning	Discusses and appreciates stories of scientific discoveries	Discusses stories of scientific discoveries /inventions, both orally and in writing, in order to critically appreciate them.	S08.15.PS.06	Examine the sequence of lightening occurring in clouds in order to explain the process of electric discharge in nature	S08.15.PS.06.1	Yes			
16	Light	Physical Sciences	Regular and Diffused Reflection	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical	Examines and explains properties, structure and functions of materials and	S08.16.PS.01	Distinguish between reflection from a rough and a smooth reflecting surface in order to differentiate between diffused and regular reflection	S08.16.PS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	organisms, in order to differentiate them.							
			What is inside Our Eyes?	Conducts simple investigations to seek answers to queries, e.g., what are the conditions required for combustion? Why do we add salt and sugar in pickles and murabbas? Do liquids exert equal pressure at the same depth?	Conducts simple investigations on his /her own in order to seek answers to queries.	S08.16.PS.02	Compare and contrast between blind spot and field of view in order to explain how humans see object in the presence of light	S08.16.PS.02.1	Yes			
			Laws of Reflection	Explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop scientific thinking skills.	S08.16.PS.03	Conclude the law of reflection and represent it by drawing a ray diagram identifying incident ray, reflected ray and the normal	S08.16.PS.03.1	Yes			
			Laws of Reflection,	Measures angles of incidence and reflection, etc.	Measures angles of incidence and reflection, etc.	S08.16.PS.04	Identify and calculate the angles of incidence and reflection of a ray of light to illustrate the laws of reflection in real life.	S08.16.PS.04.1			Yes	
							Conclude the law of reflection and represent it by drawing a ray diagram identifying incident ray, reflected ray and the normal	S08.16.PS.04.2	Yes			
			Laws of Reflection, What is inside Our Eyes?	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.16.PS.05	Illustrate with a line diagram how images invert when reflecting from a mirror in order to see the applications of the laws of reflection	S08.16.PS.05.1	Yes			
							Describe various parts of human eye and identify their functions in order to explain how humans see object in presence of light	S08.16.PS.05.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Multiple images	Constructs models using materials from surroundings and explains their working, e.g., ektara, electroscope, fire extinguisher, etc.	Constructs models using materials from surroundings and explains their working in order to demonstrate scientific knowledge and understanding of how it works.	S08.16.PS.06	Establish that light can reflect multiple time with a set of mirrors by constructing a kaleidoscope	S08.16.PS.06.1		Yes		
			Care of the Eyes, Visually Impaired Persons Can Read and Write, What is the Braille System?	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.16.PS.07	Recommend different measures for protecting eyes when a problem is felt in order to establish the importance of eye care	S08.16.PS.07.1	Yes			
							Describe the braille system in order to explain how people with visual impairment manage to read and write	S08.16.PS.07.2	Yes			
17	Stars and the solar system	Earth Sciences	Some Other Members of the Solar System	Differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.	Examines and explains properties, structure and functions of materials and organisms, in order to differentiate them.	S08.17.ES.01	Differentiate between asteroids, comet and meteor in order identify the celestial body.	S08.17.ES.01.1	Yes			
			The Solar system, Constellations	Classifies materials and organisms based on properties / characteristics, e.g., metals and non-metals; kharif and rabi crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.	Explains properties /characteristics of materials and organisms in order to classify them.	S08.17.ES.02	List commonly seen objects in the sky as celestial objects are	S08.17.ES.02.1	Yes			
							Categorize the name of commonly known group of stars in order to explain that constellations are a group of stars with recognisable shape	S08.17.ES.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Moon, Stars, The Solar system, Constellations	Draws labelled diagram / flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.	Draws labelled diagrams /flow charts of organisms /structures /processes in order to demonstrate knowledge of structure /processes /relationships.	S08.17.ES.03	Explain with diagram the different phases of moon in order to explain that moon rotates around earth	S08.17.ES.03.1	Yes			
							Categorize the name of commonly known group of stars in order to explain that constellations are a group of stars with recognisable shape	S08.17.ES.03.2	Yes			
							Outline and illustrate the planets of the solar system in order to correctly identify them	S08.17.ES.03.3	Yes			
							Identify the name of different celestial bodies in the solar system in order to explain the constituting bodies of a solar system	S08.17.ES.03.4	Yes			
			Some Other Members of the Solar System	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.17.ES.04	Describe artificial satellites in order correctly classify them as man-made celestial body	S08.17.ES.04.1	Yes			
18	Pollution of air and water	Earth Sciences	Air Pollution, How does Air Get Polluted?, Case Study— The Taj Mahal, Greenhouse Effect, Water Pollution	Relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.	Examines and explains processes and phenomenon in order to relate them with causes.	S08.18.ES.01	Analyse the problem of air pollution in order to explain why it is a threat to human beings.	S08.18.ES.01.1	Yes			
							Elaborate the formation and effects of acid rain in order to explain the reasons for discolouration of the marble of monuments (Taj Mahal)	S08.18.ES.01.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Explain the effect of greenhouse gases on the planet in order to explain potential reason for rising temperature of the planet.	S08.18.ES.01.3	Yes			
							Describe water pollution in order to assess it as a threat to human beings.	S08.18.ES.01.4	Yes			
			Case study— the Taj Mahal,	Writes word equation for chemical reactions, e.g., reactions of metals and non-metals with air, water and acids, etc.	Writes word equation in order to express chemical reactions.	S08.18.ES.02	Elaborate the formation and effects of acid rain in order to explain the reasons for discolouration of the marble of monuments (Taj Mahal)	S08.18.ES.02.1	Yes			
			What is Potable Water and How is Water Purified?	Applies learning of scientific concepts in day- to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for various purposes; increasing / reducing friction; challenging myths and taboos regarding adolescence, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S08.18.ES.03	Enumerate steps that can be taken to clean water for drinking in order to explain how water can be made safe for drinking i.e. potable water	S08.18.ES.03.1	Yes			
							Explain how reducing, reusing and recycling industrial waste helps in reducing the water pollutants in order to explore measures for dealing with water pollution	S08.18.ES.03.2	Yes			
			How does Air Get Polluted? What can be Done?	Makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilisers and pesticides; suggesting ways to cope with environmental hazards, etc.	Makes efforts to apply to daily life the understanding of environment and steps to conserve it, in order to contribute to the protection of the environment.	S08.18.ES.04	Identify commonly known air pollutants in order to examine their harmful effects	S08.18.ES.04.1	Yes			
							Suggest alternate mechanism to lower carbon emission in order to suggest steps to curb the air pollution.	S08.18.ES.04.2	Yes			
							Cite steps taken to prevent water pollution in major river(s) in order to explain measures to deal with water pollutants	S08.18.ES.04.3	Yes			

7.4. Grade 9

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
1	Matter in our surroundings	Physical Sciences	Physical nature of matter	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.01.PS.01	Describe the physical properties of solids and illustrate their molecular arrangements	S09.01.PS.01.1	Yes			Cooperative learning / Inductive approach
							Identify the distinguishing characteristics of liquids.	S09.01.PS.01.2	Yes			
			Characteristics of particles of matter, States of matter, Can Matter Change its State?	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas) and composition (element / compound / mixture), etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.01.PS.02	Classify matter into solids, liquids and gases based on characteristic properties of the particles in them.	S09.01.PS.02.1	Yes			Inductive approach / ICT
							Identify the various processes during change of substances from one physical state to another and classify substances on this basis.	S09.01.PS.02.2	Yes			
			Matter is made up of particles, Effect of change of temperature	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.01.PS.03	Demonstrate that matter is made up of tiny particles.	S09.01.PS.03.1	Yes			ICT
							Conclude that particles of matter continuously move during interaction between various forms and change in temperature changes the kinetic energy of particles.	S09.01.PS.03.2			Yes	Inquiry-based learning
							Identify the characteristic features of gases and compare the three states of matter.	S09.01.PS.03.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Describe the effect of change in temperature on the state of matter to explain why ice melts when heated	S09.01.PS.03.4	Yes			
							Make inferences about the effect of temperature on the states of matter.	S09.01.PS.03.5			Yes	Experiential learning
							Postulate the reason for constancy of temperature during the change in states of matter.	S09.01.PS.03.6	Yes			
							Provide explanation for life situations that demonstrate effects of evaporation.	S09.01.PS.03.7	Yes			Experiential learning
			Characteristics of Particles of Matter	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.01.PS.04	Infer that intermolecular space between particles of solids makes diffusion possible between matters.	S09.01.PS.04.1			Yes	Inquiry-based learning
			States of Matter, Evaporation	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.01.PS.05	Provide scientific explanation for diffusion in examples of gases and liquids witnessed in real life.	S09.01.PS.05.1	Yes			
							Explain situations that demonstrate factors affecting evaporation.	S09.01.PS.05.2	Yes			
			Effect of change of Temperature, Effect of change of Pressure	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in	S09.01.PS.06	Explain the effect of change in temperature on states of matter.	S09.01.PS.06.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	order to verify the principles /phenomena, or in order to seek answers to queries.		Relate the effect of pressure on different states of matter and its applications.	S09.01.PS.06.2	Yes			
			Particles of matter attract each other	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.01.PS.07	Conclude that particles of mater attract each other and depict the molecular arrangement of particles in the three states of matter, i.e., solids, liquids and gases.	S09.01.PS.07.1			Yes	
			Effect of change of temperature	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.01.PS.08	Hypothesize why the temperature remains same during the change in state	S09.01.PS.08.1	Yes			
2	Is Matter around Us Pure?	Physical Sciences	What is a Mixture? Types of mixtures, What is a Solution? What are the Types of Pure Substances? Separating the Components of a Mixture	Differentiates materials / objects / organisms / phenomena /processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.02.PS.01	Differentiate between homogeneous and heterogeneous mixtures to classify types of mixtures based on their properties	S09.02.PS.01.1	Yes			
							Classify homogenous and heterogeneous mixtures into solutions, suspensions and colloids.	S09.02.PS.01.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Classify substances into elements and compounds.	S09.02.PS.01.3	Yes			
							Differentiate between distillation and fractional distillation procedures.	S09.02.PS.01.4	Yes			
							Differentiate between elements and compounds to classify different materials based on their physical and chemical properties.	S09.02.PS.01.5	Yes			
			Types of mixtures	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas) and composition (element / compound / mixture), etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.02.PS.02	Differentiate between homogeneous and heterogeneous mixtures.	S09.02.PS.02.1	Yes			
							Classify different substances based on their physical properties as metals, non-metals and metalloids.	S09.02.PS.02.2	Yes			
			Concentration of a solution	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.02.PS.03	Determine the effect of concentration of solution on its physical properties.	S09.02.PS.03.1		Yes		Experimentation

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Separating the Components of a Mixture	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.02.PS.04	Identify different processes to separate mixtures and apply them to separate various mixtures.	S09.02.PS.04.1	Yes			
							Examine the process of crystallization to separate (explain how) mixtures of solid and liquid	S09.02.PS.04.2		Yes		
			What is a Mixture? Types of mixture	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.02.PS.05	Identify mixtures from your surroundings based on their characteristic properties.	S09.02.PS.05.1	Yes			
							Identify the processes to separate various mixtures	S09.02.PS.05.2	Yes			
							State the underlying principle behind centrifugation process and locate its use.	S09.02.PS.05.3	Yes			
							Deduce the process of chromatography and identify mixtures that can be separated by the use of this procedure.	S09.02.PS.05.4			Yes	Experimentation / Cooperative learning
							Explain the principle of chromatography and identify mixtures that can be separated through this process.	S09.02.PS.05.5	Yes			
							Elaborate the technique of fractional distillation to separate homogeneous (or miscible) liquids.	S09.02.PS.05.6	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Explain the basis for use of separating funnel to separate miscible liquids.	S09.02.PS.05.7	Yes			
							Describe the process of using fractional distillation to explain its use in separating gases from the air.	S09.02.PS.05.8	Yes			
			Concentration of a solution	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.02.PS.06	Deduce/ determine the concentration of solution to predict the colour of the solution formed by colouring substance and the solvent	S09.02.PS.06.1			Yes	Experimentation / Inquiry-based learning
			Separating the Components of a Mixture	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.02.PS.07	Recognize the basis of distillation and identify mixtures that can be separated through this.	S09.02.PS.07.1	Yes			
							Elaborate the technique of fractional distillation to explain the process of separation of homogeneous (or miscible) liquid solution	S09.02.PS.07.2	Yes			Inductive approach
							Explain the basis for use of separating funnel to separate miscible liquids.	S09.02.PS.07.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Describe the process of using fractional distillation to explain its use in separating gases from the air.	S09.02.PS.07.4	Yes			
			How can we obtain pure copper sulphate from an impure sample? How can we separate a mixture of two miscible liquids	Analyses and interprets graphs / figures etc., such as distance- time and velocity-time graphs, computing distance / speed / acceleration of objects in motion, properties of components of a mixture to identify the appropriate method of separation, crop yield after application of fertilizers, etc.	Analyses graphs /figures /etc. in order to interpret them.	S09.02.PS.08	Explain the process of crystallization	S09.02.PS.08.1	Yes			
							Recognize the basis of distillation and identify mixtures that can be separated through this.	S09.02.PS.08.2	Yes			
			Separating the Components of a Mixture	Applies scientific concepts in daily life and solving problems, such as separation of mixtures, uses safety belts in automobiles, covers walls of large rooms with sound absorbent materials, follows intercropping and crop rotation, takes preventive measures to control disease causing agents, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S09.02.PS.09	Become conversant with the basis for separation and suggest procedures to separate mixtures of solids in real life situations.	S09.02.PS.09.1	Yes			Cooperative learning / Inquiry-based learning
							Suggest procedures to separate mixtures of solids and liquids.	S09.02.PS.09.2	Yes			
							Identify situations where basic principle of evaporation is used to separate solids from liquids.	S09.02.PS.09.3	Yes			
							Identify suitable processes of separation to separate mixtures in real life situations.	S09.02.PS.09.4	Yes			
			What are the Types of Pure Substances? Elements, Compounds	Draws conclusion, such as classification of life forms is related to evolution, deficiency of nutrients affects physiological processes in plants, matter is made up of particles, elements combine chemically in a fixed ratio to form compounds, action	Analyses interdependencies in order to draw conclusions.	S09.02.PS.10	Differentiate between elements and compounds to classify different materials based on their physical and chemical properties.	S09.02.PS.10.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				and reaction act on two different bodies, etc.								
			How can we separate a mixture of two miscible liquids	Designs models using eco-friendly resources, such as 3-d model of a cell, water purification system, stethoscope, etc.	Uses eco-friendly resources in order to design models.	S09.02.PS.11	Elaborate the technique of fractional distillation to separate homogeneous (or miscible) liquids.	S09.02.PS.11.1	Yes			Experiential learning
3	Atoms and Molecules	Physical Sciences	What is an ion?	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.03.PS.01	Identify ionic compounds whose formula unit mass can be calculated.	S09.03.PS.03.1	Yes			
			Law of conservation of mass, Law of constant proportions	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.03.PS.02	Apply the Law of Conservation of Mass to determine the mass of elements in a mixture.	S09.03.PS.02.1			Yes	
							Calculate the mass ratio of atoms in a molecule to validate law of constant proportions	S09.03.PS.02.2			Yes	Differentiation into groups
			How big are atoms?	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.03.PS.03	Correlate the fact of invisibility of atoms to the size of atoms.	S09.03.PS.03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Molecules of elements, Law of constant proportions, Molecular mass and mole concept	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.03.PS.04	Determine the number of atoms present in an element on the basis of their atomicity.	S09.03.PS.04.1	Yes			
							Apply the law of constant proportions to calculate the mass ratio of atoms in a molecule.	S09.03.PS.04.2			Yes	
							Calculate the relative molecular mass of commonly known chemical compounds.	S09.03.PS.04.3			Yes	
							Calculate the number of moles, mass, atoms and molecules using Avogadro's number.	S09.03.PS.04.4			Yes	
			What are the modern day symbols of atoms of different elements? Atomic mass, Writing Chemical Formulae	Uses scientific conventions / symbols / equations to represent various quantities / elements /units, such as SI units, symbols of elements, formulae of simple compounds, chemical equations, etc.	Uses scientific conventions /symbols /equations in order to represent various quantities /elements /units.	S09.03.PS.05	List atomic symbols of commonly known elements as per IUPAC	S09.03.PS.05.1	Yes			
							Recognise that different elements have different atomic mass.	S09.03.PS.05.2	Yes			
							Write chemical formulae using symbols & valences.	S09.03.PS.05.3	Yes			
			Laws of Conservation of mass	Derives formulae / equations / laws, such as mathematical expression for second law of motion, law of conservation of momentum, expression for force of gravity, equations of motion from velocity-time graphs, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking and understanding of scientific laws /concepts.	S09.03.PS.06	Apply the Law of Conservation of Mass to determine the mass of elements in a mixture.	S09.03.PS.06.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Law of constant proportions	Describes scientific discoveries / inventions, such as discovery of various atomic models, discovery of cell with invention of microscope, experiments of Lavoisier and Priestley, beliefs regarding motion, discovery of real cause for peptic ulcers, Archimedes principle, classification of living things, etc.	Describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S09.03.PS.07	Apply the Law of Constant Proportions to estimate the amount of elements required in a chemical substance and identify postulates of Dalton's atomic theory.	S09.03.PS.07.1			Yes	Inquiry-based learning
							Recall atomic masses of a few elements to reinforce the idea of different atomic mass for different elements	S09.03.PS.07.2	Yes			
4	Structure of the Atom	Physical Sciences	Charged Particles in Matter	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.04.PS.01	Know the different constituents of an atom and differentiate between electrons and protons.	S09.04.PS.01.1	Yes			
			Isobars	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.04.PS.02	Identify isobars on the basis of scientific notation of their atoms.	S09.04.PS.02.1	Yes			
			Valency, How are Electrons Distributed in Different Orbits (Shells)? Isotopes	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.04.PS.03	Find the valency of elements on the basis of their electronic configuration and relate inertness and reactivity of elements.	S09.04.PS.03.1			Yes	
							Calculate the number of electrons distributed in different orbits (shells) according to Bohr and Bury rules and find out valence	S09.04.PS.03.2			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				object, boiling points of liquids to predict the order of their separation from the mixture, etc.			electrons for different elements.					
							Postulate the reason for different atomic numbers for isotopes of an element.	S09.04.PS.03.3	Yes			
			Bohr's Model Of Atom	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.04.PS.04	Enlist Bohr & Bury's rules for electronic configuration to show the distribution of electrons in elements from atomic number 1 to 20	S09.04.PS.04.1	Yes			
			Atomic Number and Mass Number	Uses scientific conventions /symbols / equations to represent various quantities / elements /units, such as SI units, symbols of elements, formulae of simple compounds, chemical equations, etc.	Uses scientific conventions / symbols /equations in order to represent various quantities /elements /units.	S09.04.PS.05	Write the scientific notations of atoms of commonly known elements and calculate their atomic mass and atomic number.	S09.04.PS.05.1			Yes	
			The Structure of an Atom	Describes scientific discoveries / inventions, such as discovery of various atomic models, discovery of cell with invention of microscope, experiments of Lavoisier and Priestley, beliefs regarding motion, discovery of real cause for peptic ulcers, Archimedes principle, classification of living things, etc.	Describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S09.04.PS.06	Explain Thomson's model of an atom and its incoherent features with the results of other experiments.	S09.04.PS.06.1	Yes			
							Draw logical conclusions from Rutherford's experiment to understand the structure of an atom.	S09.04.PS.06.2			Yes	
							Compare Rutherford's model with Thomson's atomic model and state their relative advantages and limitations	S09.04.PS.06.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Highlight the limitations of Rutherford's model	S09.04.PS.06.4	Yes			
							State the postulates of Neil Bohr's model of an atom and their significance.	S09.04.PS.06.5	Yes			
							Get conversant with the Bohr and Bury rules for distribution of electrons into different orbits.	S09.04.PS.06.6	Yes			
5	The Fundamental Unit of Life	Life Sciences	What is a Cell Made Up of? What is the Structural Organisation of a Cell?	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.05.LS.01	Compare a Prokaryotic and an Eukaryotic cell	S09.05.LS.01.1	Yes			
							Demonstrate the difference between animal and plant cells with appropriate experiments.	S09.05.LS.01.2	Yes			
			What is a Cell Made Up of? What is the Structural Organisation of a Cell? Cell wall, Plastids	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.05.LS.02	Demonstrate the difference between animal and plant cells with appropriate experiments.	S09.05.LS.02.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			What is a Cell Made Up of? What is the Structural Organisation of a Cell?	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.05.LS.03	Compare a Prokaryotic and an Eukaryotic cell	S09.05.LS.03.1	Yes			
			Cell organelles, Endoplasmic reticulum (ER)	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.05.LS.04	Differentiate between types of endoplasmic reticulum and identify their functions.	S09.05.LS.04.1	Yes			
							Name the cell organelle responsible for storage, modification and packaging of products in a cell	S09.05.LS.04.2	Yes			
							Explain the functioning of Mitochondria in a cell.	S09.05.LS.04.3	Yes			
							Relate the functions of Lysosomes in a cell	S09.05.LS.04.4	Yes			
							Locate the cell organelle that helps cells prepare their food	S09.05.LS.04.5	Yes			
							Elaborate the role of chromosomes during cell division.	S09.05.LS.04.6	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Relate the role of vacuoles in a cell.	S09.05.LS.04.7	Yes			
			What are these structures?	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.05.LS.05	Cognize the variety in shape and size of cells in different organisms and infer that cells are functionally similar despite structural differences.	S09.05.LS.05.1	Yes			
							Locate different cell organelles in a plant cell and state their functions.	S09.05.LS.05.2	Yes			
			What are these structures?	Describes scientific discoveries / inventions, such as discovery of various atomic models, discovery of cell with invention of microscope, experiments of Lavoisier and Priestley, beliefs regarding motion, discovery of real cause for peptic ulcers, Archimedes principle, classification of living things, etc.	Describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S09.05.LS.06	Cognize the variety in shape and size of cells in different organisms and infer that cells are functionally similar despite structural differences.	S09.05.LS.06.1	Yes			
							Compare a Prokaryotic and an Eukaryotic cell	S09.05.LS.06.2	Yes			
6	Tissues	Life Sciences	Plant Tissues, Animal Tissues	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas) and composition (element / compound / mixture), etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.06.LS.01	Classify the meristematic tissue based on their location in the plant body.	S09.06.LS.01.1	Yes			
							Classify different animal tissues based on their functions in the body	S09.06.LS.01.2	Yes			
			Meristematic tissue	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.06.LS.02	Describe the locations and function of meristematic tissue plants.	S09.06.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?								
			Meristematic tissue	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.06.LS.03	Describe the locations and function of meristematic tissue plants.	S09.06.LS.03.1	Yes			
			Permanent tissue, Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.06.LS.04	Identify the type of simple permanent tissues and their functions in a plant.	S09.06.LS.04.1	Yes			
							Identify the type of complex permanent and their role in a plant.	S09.06.LS.04.2	Yes			
							Corelate the structure of epithelial tissues to their functions in an organism.	S09.06.LS.04.3	Yes			
							Describe different types of connective tissues and relate their structure to specific functions.	S09.06.LS.04.4	Yes			
							Compare the structure of different types of muscular tissues and relate it to their functions.	S09.06.LS.04.5	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Describe the structure of a neuron and explain the functioning of nervous tissue.	S09.06.LS.04.6	Yes			
			Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.06.LS.05	Correlate the structure of epithelial tissues to their functions in an organism.	S09.06.LS.05.1	Yes			
							Describe different types of connective tissues and relate their structure to specific functions.	S09.06.LS.05.2	Yes			
							Compare the structure of different types of muscular tissues and relate it to their functions.	S09.06.LS.05.3	Yes			
							Describe the structure of a neuron and explain the functioning of nervous tissue.	S09.06.LS.05.4	Yes			
7	Diversity in Living Organisms	Life Sciences	Animalia	Differentiates materials / objects / organisms / phenomena /processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.07.LS.01	Identify the characteristic features of different animal groups and distinguish between them. (cyclostomata, pisces, amphibia, reptilia, aves and mammalia)	S09.07.LS.01.1	Yes			
			The Hierarchy of classification groups	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas)	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.07.LS.02	Examine the characteristic criterion between the five kingdoms (monera, protista, fungi, plantae and animalia) and categorise species into a particular kingdom on this basis.	S09.07.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				and composition (element / compound / mixture), etc.			Identify the characteristic differences in order to categorise living organisms into two biggest kingdoms, i.e., plantae and animalia kingdom.	S09.07.LS.02.2	Yes			
							Acquire the skill of classifying a plant species into different groups on the basis of their characteristic features.	S09.07.LS.02.3	Yes			
							Classify plants into different groups based on characteristic features of body design and presence of vascular tissues.	S09.07.LS.02.4	Yes			
							Classify plants into different groups based on their ability to bear seed and the nature of seeds.	S09.07.LS.02.5	Yes			
							Acquire the skill of classifying animals into different groups on the basis of their body design.	S09.07.LS.02.6	Yes			
			Classification and Evolution	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.07.LS.03	Identify the characteristic difference between earlier evolved and later evolved living beings.	S09.07.LS.03.1	Yes			
			The Hierarchy of classification groups	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts/concept map /graphs to demonstrate knowledge of how the process /structure/relationship works and also to demonstrate the	S09.07.LS.04	Examine the characteristic criterion between the five kingdoms (monera, protista, fungi, plantae and animalia) and categorise species	S09.07.LS.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
					application of different forms of illustrations.		into a particular kingdom on this basis.					
							Identify the characteristic differences in order to categorise living organisms into two biggest kingdoms, i.e., plantae and animalia kingdom.	S09.07.LS.04.2	Yes			
			What is the Basis of Classification?	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas) and composition (element / compound / mixture), etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.07.LS.05	Identify the basis for classification of organisms into kingdoms and name the various levels in a kingdom.	S09.07.LS.05.1	Yes			
			Classification and Evolution	Draws conclusion, such as classification of life forms is related to evolution, deficiency of nutrients affects physiological processes in plants, matter is made up of particles, elements combine chemically in a fixed ratio to form compounds, action and reaction act on two different bodies, etc.	Analyses interdependencies in order to draw conclusions.	S09.07.LS.06	Identify the characteristic difference between earlier evolved and later evolved living beings.	S09.07.LS.06.1	Yes			
							Identify the characteristic differences in order to categorise living organisms into two biggest kingdoms, i.e., plantae and animalia kingdom.	S09.07.LS.06.2	Yes			
			The Hierarchy of Classification Groups	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas)	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes	S09.07.LS.07	Examine the characteristic criterion between the five kingdoms (monera, protista, fungi, plantae and animalia) and categorise species into a particular kingdom on this basis.	S09.07.LS.07.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				and composition (element / compound / mixture), etc.								
8	Motion	Physical Sciences	Describing motion, Uniform motion and Non-uniform motion, Measuring the Rate of Motion	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.08.PS.01	Differentiate between the distance and displacement and calculate them in real situations.	S09.08.PS.01.1	Yes			
							Calculate and compare speed of an object at different intervals of time and differentiate between uniform and non-uniform motion.	S09.08.PS.01.2			Yes	
							Calculate average speed of an object.	S09.08.PS.01.3			Yes	
			Measuring the Rate of Motion, Uniform motion and non-uniform motion, Speed with direction	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.08.PS.02	Calculate and compare speed of an object at different intervals of time and differentiate between uniform and non-uniform motion.	S09.08.PS.02.1			Yes	
							Calculate average speed of an object.	S09.08.PS.02.2			Yes	
							Distinguish between speed and velocity and calculate average velocity.	S09.08.PS.02.3	Yes			
							Define accelerated motion and compute the change in velocity of a moving object in a non-uniform motion.	S09.08.PS.02.4	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Graphical representation of motion	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.08.PS.03	Plot distance-time graph for a moving object and determine its speed, velocity, acceleration.	S09.08.PS.03.1			Yes	
							Construct velocity-time graphs and interpret them to determine speed, velocity, acceleration.	S09.08.PS.03.2			Yes	
			Graphical representation of motion	Analyses and interprets graphs / figures etc., such as distance- time and velocity-time graphs, computing distance / speed / acceleration of objects in motion, properties of components of a mixture to identify the appropriate method of separation, crop yield after application of fertilizers, etc.	Analyses graphs /figures /etc. in order to interpret them.	S09.08.PS.04	Plot distance-time graph for a moving object and determine its speed, velocity, acceleration.	S09.08.PS.04.1			Yes	
							Construct velocity-time graphs and interpret them to determine speed, velocity, acceleration.	S09.08.PS.04.2			Yes	
							Extrapolate velocity-time graphs to derive velocity-time, position-time & position-velocity relations.	S09.08.PS.04.3			Yes	
			Velocity-time graph	Derives formulae / equations / laws, such as mathematical expression for second law of motion, law of conservation of momentum, expression for force of gravity, equations of motion from velocity-time graphs, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking and understanding of scientific laws /concepts.	S09.08.PS.05	Extrapolate velocity-time graphs to derive velocity-time, position-time & position-velocity relations.	S09.08.PS.05.1			Yes	
							Calculate speed of an object traveling in a uniform circular motion.	S09.08.PS.05.2			Yes	
9	Force and Laws of motion	Physical Sciences	Uniform and non-uniform motion	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture,	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.09.PS.01	Interpret data to identify uniform and non-uniform motion of an object.	S09.09.PS.01.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				solution, suspension and colloid, isobars and isotopes, etc.								
			Balanced and unbalanced forces, First Law of Motion, Second Law of Motion, Third Law of Motion	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.09.PS.02	Examine forces acting on a body in order to determine change in body's motion as a consequence of resultant force	S09.09.PS.01.2			Yes	
							Determine the impact of frictional force on the motion of an object.	S09.09.PS.02.1	Yes			
							Identify examples and situations that illustrate the use of Newton's first Law of motion and Inertia.	S09.09.PS.02.2	Yes			
							Illustrate Newton's Third Law of Motion.	S09.09.PS.02.3	Yes			
			Second Law of Motion	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.09.PS.03	Calculate the momentum of objects when two bodies collide.	S09.09.PS.03.1			Yes	
							Calculate momentum of bodies before and after a collision (when no external force is applied), and thus apply and derive law of conservation of momentum	S09.09.PS.03.2			Yes	
			Second Law of Motion, Conservation of Momentum	Analyses and interprets graphs / figures etc., such as distance- time and velocity-time graphs, computing distance / speed / acceleration of objects in motion, properties of components of a	Analyses graphs /figures /etc. in order to interpret them.	S09.09.PS.04	Calculate the momentum of objects when two bodies collide.	S09.09.PS.04.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				mixture to identify the appropriate method of separation, crop yield after application of fertilizers, etc.								
			Mathematical Formulation Of Second Law Of Motion	Uses scientific conventions /symbols / equations to represent various quantities / elements /units, such as SI units, symbols of elements, formulae of simple compounds, chemical equations, etc.	Uses scientific conventions / symbols /equations in order to represent various quantities /elements /units.	S09.09.PS.05	Interpret SI unit of force and use formulas to calculate mass of an object.	S09.09.PS.05.1			Yes	
			Second Law of Motion, Newton's third law of motion	Applies scientific concepts in daily life and solving problems, such as separation of mixtures, uses safety belts in automobiles, covers walls of large rooms with sound absorbent materials, follows intercropping and crop rotation, takes preventive measures to control disease causing agents, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S09.09.PS.06	Apply Newton's Second Law of Motion and calculate rate of change of momentum in objects.	S09.09.PS.06.1			Yes	
							Identify situations that demonstrate the application of Newton's third Law of Motion.	S09.09.PS.06.2	Yes			
			Mathematical Formulation Of Second Law Of Motion	Derives formulae / equations / laws, such as mathematical expression for second law of motion, law of conservation of momentum, expression for force of gravity, equations of motion from velocity-time graphs, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking and understanding of scientific laws /concepts.	S09.09.PS.07	Interpret SI unit of force and use formulas to calculate mass of an object.	S09.09.PS.07.1			Yes	
							Calculate momentum of bodies before and after a collision (when no external force is applied), and thus apply and derive law of conservation of momentum	S09.09.PS.07.2			Yes	
10	Gravitation	Physical Sciences	Thrust and Pressure	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects/organisms /phenomena /processes	S09.10.PS.01	Differentiate between thrust and pressure.	S09.10.PS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Buoyancy	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.10.PS.02	Examine the impact of buoyant force to determine if an object will sink or float in water.	S09.10.PS.02.1			Yes	
			Gravitation, Universal Law Of Gravitation	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.10.PS.03	Explain the role of centripetal force in life situations.	S09.10.PS.03.1	Yes			
							Relate Newton's third law of motion and gravitational force to explain the motion of bodies.	S09.10.PS.03.2	Yes			
			Free Fall, To calculate the value of g	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.10.PS.04	Calculate gravitational force and its impact on objects.	S09.10.PS.04.1			Yes	
							Estimate the acceleration due to gravity acting on a body.	S09.10.PS.04.2	Yes			
							Calculate buoyant force acting on a body and determine its impact.	S09.10.PS.04.3			Yes	
			Universal Law Of Gravitation, Mass, Weight	Applies learning to hypothetical situations, such as weight of an object at moon, weight of an object at equator and poles, life on other planets, etc.	Applies learning to given hypothetical situations in order to solve problems /give possible solutions.	S09.10.PS.05	Relate change in acceleration due to gravity to Earth's shape and weight of objects.	S09.10.PS.05.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Assess the force of gravitation exerted and compute mass of an object on earth and moon.	S09.10.PS.05.2			Yes	
			Motion Of Objects Under The Influence Of Gravitational Force Of The Earth	Derives formulae / equations / laws, such as mathematical expression for second law of motion, law of conservation of momentum, expression for force of gravity, equations of motion from velocity-time graphs, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking and understanding of scientific laws /concepts.	S09.10.PS.06	Calculate the magnitude of acceleration at different points on the path when the object is in motion.	S09.10.PS.06.1			Yes	
							Interpret the relation between universal constant and acceleration due to gravity.	S09.10.PS.06.2			Yes	
			Gravitation, Universal Law Of Gravitation	Describes scientific discoveries / inventions, such as discovery of various atomic models, discovery of cell with invention of microscope, experiments of Lavoisier and Priestley, beliefs regarding motion, discovery of real cause for peptic ulcers, Archimedes principle, classification of living things, etc.	Describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S09.10.PS.07	Demonstrate a clear understanding of gravitational force.	S09.10.PS.07.1	Yes			
11	Work and energy	Physical Sciences	Work, Law of conservation of energy, Rate of Doing Work, Commercial unit of energy	Calculates using the data given, such as distance, velocity, speed, frequency, work done, number of moles in a given mass of substance, concentration of solution in terms of mass by mass percentage of substances, conversion of Celsius scale to kelvin scale and vice versa, number of neutrons in an atom from atomic number and mass number, speed of sound, kinetic and potential energies of an object, boiling points of liquids to predict the order of their separation from the mixture, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S09.11.PS.01	Calculate the total work done on an object when force is applied in varied directions and determine its nature	S09.11.PS.01.1			Yes	
							Generalise the law of conservation of energy to situations of energy transfer and calculate the total energy of an object	S09.11.PS.01.2			Yes	
							Calculate power and assess the efficiency of work done	S09.11.PS.01.3			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Get conversant with commercial unit of energy	S09.11.PS.01.4	Yes			
							Calculate total energy consumption and determine total cost in households and industries	S09.11.PS.01.5			Yes	
							Comprehend energy and calculate the amount of work an object is capable of doing	S09.11.PS.01.6			Yes	
			Rate of Doing Work, Commercial unit of energy	Uses scientific conventions /symbols / equations to represent various quantities / elements /units, such as SI units, symbols of elements, formulae of simple compounds, chemical equations, etc.	Uses scientific conventions / symbols /equations in order to represent various quantities /elements /units.	S09.11.PS.02	Calculate power and assess the efficiency of work done	S09.11.PS.02.1			Yes	
							Get conversant with commercial unit of energy	S09.11.PS.02.2	Yes			
			Potential energy, Kinetic energy	Derives formulae / equations / laws, such as mathematical expression for second law of motion, law of conservation of momentum, expression for force of gravity, equations of motion from velocity-time graphs, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking and understanding of scientific laws /concepts.	S09.11.PS.03	Relate potential energy to position and calculate potential energy possessed by the objects	S09.11.PS.03.1			Yes	
							Comprehend energy transfer and write an expression for the kinetic energy of an object	S09.11.PS.03.2	Yes			
			Work, Kinetic energy, Potential energy	Draws conclusion, such as classification of life forms is related to evolution, deficiency of nutrients affects physiological processes in plants, matter is made up of particles, elements	Analyses interdependencies in order to draw conclusions.	S09.11.PS.04	Judge situations to identify where work is done according to scientific conception and calculate the magnitude of work	S09.11.PS.04.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				combine chemically in a fixed ratio to form compounds, action and reaction act on two different bodies, etc.			Comprehend energy and calculate the amount of work an object is capable of doing	S09.11.PS.04.2			Yes	
							Relate kinetic energy to motion and calculate kinetic energy possessed by the objects	S09.11.PS.04.3			Yes	
							Relate potential energy to position and calculate potential energy possessed by the objects	S09.11.PS.04.4			Yes	
12	Sound	Physical Sciences	Propagation of Sound	Differentiates materials / objects / organisms / phenomena / processes, based on such as prokaryote and eukaryote, plant cell and animal cell, diffusion and osmosis, simple and complex tissues, distance and displacement, speed and velocity, balanced and unbalanced forces, element, compound and mixture, solution, suspension and colloid, isobars and isotopes, etc.	Explains properties /characteristics in order to differentiate materials /objects /organisms /phenomena /processes	S09.12.PS.01	Generalise that sound travels as successive compressions and rarefactions in the medium.	S09.12.PS.01.1	Yes			
			Reflection of sound	Plans and conducts investigations / experiments to arrive at and verify the facts / principles / phenomena or to seek answers to queries on their own, such as how does speed of an object change? How objects float / sink when placed on surface of liquid? Is there any change in mass when chemical reaction takes place? What is the effect of heat on state of substances? What is the effect of compression on different states of matter? Where are stomata present in different types of leaves? Where are growing tissues present in plants?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S09.12.PS.02	Examine the paths of reflection of sound on different surfaces.	S09.12.PS.02.1	Yes			
			Production of Sound, Characteristics of a sound wave,	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.12.PS.03	Infer and demonstrate that sound is produced due to vibration of different objects.	S09.12.PS.03.1		Yes		

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Propagation of Sound	with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.			Relate frequency, amplitude and speed of a sound wave to determine its loudness and frequency.	S09.12.PS.03.2	Yes			
							Relate properties of the medium through which sound travels to its speed.	S09.12.PS.03.3	Yes			
							Explain propagation of sound in a medium based on their knowledge of echo and reverberation.	S09.12.PS.03.4	Yes			
			Range of hearing, Structure Of Human Ear	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.12.PS.04	Classify audible range of sounds of different organisms into ultra and infra sounds.	S09.12.PS.04.1	Yes			
							Explain the process of hearing in human beings.	S09.12.PS.04.2	Yes			
			Structure Of Human Ear	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.12.PS.05	Explain the process of hearing in human beings.	S09.12.PS.05.1	Yes			
			Characteristics Of A Sound Wave	Analyses and interprets graphs / figures etc., such as distance- time and velocity-time graphs, computing distance / speed / acceleration of objects in motion, properties of components of a mixture to identify the appropriate method of separation, crop yield after application of fertilizers, etc.	Analyses graphs /figures /etc. in order to interpret them.	S09.12.PS.06	Interpret the graphical representation of sound waves to determine its frequency, amplitude, and speed.	S09.12.PS.06.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
13	Why do we fall ill?	Life Sciences	Applications of ultrasound, Echo, Reverberation	Applies scientific concepts in daily life and solving problems, such as separation of mixtures, uses safety belts in automobiles, covers walls of large rooms with sound absorbent materials, follows intercropping and crop rotation, takes preventive measures to control disease causing agents, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S09.12.PS.07	Demonstrate an understanding of application of ultrasound waves in medical, defence and other fields.	S09.12.PS.07.1	Yes			
							Explain propagation of sound in a medium based on their knowledge of echo and reverberation.	S09.12.PS.07.2	Yes			
			Health And Its Failure, Diseases and its causes	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.13.LS.01	Understand the requirements for being 'healthy', and thus differentiate between healthy, unhealthy & disease-free human body	S09.13.LS.01.1	Yes			
							Infer 'symptoms' and 'signs' of falling ill, in order to identify a disease	S09.13.LS.01.2			Yes	
							Identify acute and chronic diseases, in order to develop a better plan for recovery	S09.13.LS.01.3	Yes			
							Identify different causes/ agents for the diseases in order to prevent & cure them	S09.13.LS.01.4	Yes			
			Infectious diseases	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.13.LS.02	Predict how a disease (communicable) spreads in order to prevent it from affecting others	S09.13.LS.02.1	Yes			
							Identify causes of a disease, and use adequate medicines for cure	S09.13.LS.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Tabulate different ways of prevent diseases, in order to stay healthy	S09.13.LS.02.3	Yes			
			Infectious agent	Applies scientific concepts in daily life and solving problems, such as separation of mixtures, uses safety belts in automobiles, covers walls of large rooms with sound absorbent materials, follows intercropping and crop rotation, takes preventive measures to control disease causing agents, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S09.13.LS.03	Identify different causes/ agents for the diseases in order to prevent & cure them	S09.13.LS.03.1	Yes			
			Infectious agent, Principles of treatment	Describes scientific discoveries / inventions, such as discovery of various atomic models, discovery of cell with invention of microscope, experiments of Lavoisier and Priestley, beliefs regarding motion, discovery of real cause for peptic ulcers, Archimedes principle, classification of living things, etc.	Describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S09.13.LS.04	Identify causes of a disease, and use adequate medicines for cure	S09.13.LS.04.1	Yes			
14	Natural Resources	Earth Sciences	What are these resources on the Earth?	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as classification of plants, animals under various hierarchical sub-groups, natural resources, classification of matter based on their states (solid / liquid / gas) and composition (element / compound / mixture), etc.	Describes and interprets properties /characteristics in order to classify materials /objects/organisms/ phenomena/ processes	S09.14.ES.01	Understand and Classify the resources present on Earth and ways to save them in order to protect our planet	S09.14.ES.01.1	Yes			
			The water cycle, Air pollution, Mineral riches in the soil, Ozone layer	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.14.ES.02	Describe movement of water particles and heating of land & water in order to explain process of raining	S09.14.ES.02.1	Yes			
							Enlist reasons for air pollution in order to prevent them and keep air clean	S09.14.ES.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Explain ways of soil formation in order to understand diversity of life	S09.14.ES.02.3	Yes			
							Explore reasons for soil erosion, in order to prevent them and thus improve flora	S09.14.ES.02.4	Yes			
							Elaborate the importance of ozone layer and draw conclusions on causes for its depletion, and measures to prevent its depletion	S09.14.ES.02.5	Yes			
			The Breath of Life: Air, Water: a wonder liquid, Water Pollution, Mineral riches in the soil	Explains processes and phenomena, such as function of different organelles, spread of diseases and their prevention, effect of force on the state of motion of objects, action and reaction, revolution of planets and satellites, conservation laws, principle of separation of different gases from air, melting / boiling / freezing, how bats use ultrasound to catch prey, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S09.14.ES.03	Tabulate the composition of air around us & their role, in order to understand role of atmosphere in climate control	S09.14.ES.03.1	Yes			
							Comprehend how air moves, in order to explain winds	S09.14.ES.03.2	Yes			
							List down uses & distribution of water, in order to efficiently use it around the world	S09.14.ES.03.3	Yes			
							List down reasons for water pollution in order to prevent them and keep air clean	S09.14.ES.03.4	Yes			
							Elaborate components of soil and their significance in order to improve biodiversity of an area	S09.14.ES.03.5	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Water cycle, Nitrogen cycle, Carbon cycle, Oxygen cycle	Draws labelled diagrams / flow charts / concept map /graphs, such as biogeochemical cycles, cell organelles and tissues, human ear, distance-time and speed-time graphs, distribution of electrons in different orbits, process of distillation / sublimation, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S09.14.ES.04	Describe & draw water cycle, and thus explain how water replenishes	S09.14.ES.04.1	Yes			
							Describe & draw nitrogen cycle, in order to realize presence of different forms of nitrogen in our surroundings	S09.14.ES.04.2	Yes			
							Describe & draw carbon cycle, in order to realize presence of different forms of carbon in our surroundings and reduce greenhouse effect	S09.14.ES.04.3	Yes			
							Describe & draw oxygen cycle, in order to realize presence of different forms of oxygen in our surroundings	S09.14.ES.04.4	Yes			
			Ozone layer	Applies learning to hypothetical situations, such as weight of an object at moon, weight of an object at equator and poles, life on other planets, etc.	Applies learning to given hypothetical situations in order to solve problems /give possible solutions.	S09.14.ES.05	Elaborate the importance of ozone layer and draw conclusions on causes for its depletion, and measures to prevent its depletion	S09.14.ES.05.1	Yes			
15	Improvement in Food Resources	Life Sciences	Improvement in crop yields, Cropping patterns, Storage of grains	Relates processes and phenomena with causes / effects, such as symptoms with diseases / causal agents, tissues with their functions, production with use of fertilizers, process of evaporation with cooling effect, various processes of separation with the physical and chemical properties of the substances, production of sound with vibrations of source, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S09.15.LS.01	Recognize growth needs of different crops like temperature, in order to produce them effectively	S09.15.LS.01.1	Yes			
							Analyse ways/ combinations of growing crops in order to maximize yield	S09.15.LS.01.2	Yes			
							Develop better storage strategies for crops, in order to minimize storage losses	S09.15.LS.01.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Crop variety improvement, Nutrition management, Irrigation, Animal Husbandry	Applies scientific concepts in daily life and solving problems, such as separation of mixtures, uses safety belts in automobiles, covers walls of large rooms with sound absorbent materials, follows intercropping and crop rotation, takes preventive measure to control disease causing agents, etc.	Applies learning of scientific concepts in daily life /real life situations in order to solve problems /give solutions /take preventive measures /etc.	S09.15.LS.02	Discover ways of breeding a better variety of seeds, in order to improve quality of crops	S09.15.LS.02.1	Yes			
							Enlist various ways of enriching the soil in order to increase crop yield	S09.15.LS.02.2	Yes			
							List down ways of irrigating a piece of land, in order to provide adequate water to all crops	S09.15.LS.02.3	Yes			
							List down some characteristics local and Foreign breeds of cattle, in order to develop cattle with desired qualities	S09.15.LS.02.4	Yes			
							Outline food requirements and common diseases of cattle, in order to protect them better	S09.15.LS.02.5	Yes			
							Analyse desirable traits in poultry in order to maximize egg production and chicken meat	S09.15.LS.02.6			Yes	
							Identify housing, nutritional & environmental requirements of poultry in order to prevent and control diseases	S09.15.LS.02.7	Yes			
							Analyse the process of catching fish from seawater and fresh water, in order to maximize yield	S09.15.LS.02.8			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Name different varieties of bees and examine their traits, in order to maximize output	S09.15.LS.02.9	Yes			
			Animal Husbandry	Draws conclusion, such as classification of life forms is related to evolution, deficiency of nutrients affects physiological processes in plants, matter is made up of particles, elements combine chemically in a fixed ratio to form compounds, action and reaction act on two different bodies, etc.	Analyses interdependencies in order to draw conclusions.	S09.15.LS.03	List down some characteristics local and Foreign breeds of cattle, in order to develop cattle with desired qualities	S09.15.LS.03.1	Yes			
							Outline food requirements and common diseases of cattle, in order to protect them better	S09.15.LS.03.2	Yes			
							Analyse desirable traits in poultry in order to maximize egg production and chicken meat	S09.15.LS.03.3			Yes	
							Identify housing, nutritional & environmental requirements of poultry in order to prevent and control diseases	S09.15.LS.03.4	Yes			
							Analyse the process of catching fish from seawater and fresh water, in order to maximize yield	S09.15.LS.03.5			Yes	
							Name different varieties of bees and examine their traits, in order to maximize output	S09.15.LS.03.6	Yes			
			Crop protection management	Applies the interdependency and interrelationship in the biotic and abiotic factors of environment to promote conservation of environment, such as organic farming, waste management, etc.	Applies the interdependency and interrelationship in the biotic and abiotic factors of environment in order to promote conservation of environment.	S09.15.LS.04	Describe ways/ organisms by which crops get affected, in order to develop a solution to prevent them from attacking crops	S09.15.LS.04.1	Yes			

7.5. Grade 10

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
1	Chemical Reactions and Equations	Physical Sciences	Characteristics of Chemical reactions	Draws conclusion, such as traits / features are inherited through genes present on chromosomes, a new species originates through evolutionary processes, water is made up of hydrogen and oxygen, properties of elements vary periodically along the groups and periods in periodic table, potential difference across a metal conductor is proportional to the electric current through it, etc.	Analyses interdependencies in order to draw conclusions.	S10.01.PS.01	Compare the characteristics of initial & final substances in order to check whether the change is physical or chemical.	S10.01.PS.01.1	Yes			Inductive approach/ Experiential learning
			Chemical Equations	Uses scientific conventions to represent units of various quantities / symbols / formulae / equations, such as balanced chemical equation by using symbols and physical states of substances, sign convention in optics, SI units, etc.	Uses scientific conventions in order to represent units of various quantities / symbols /formulae /equations.	S10.01.PS.02	Relate the substances taking part in the chemical reaction & substances formed in the chemical reaction in order to classify them as reactants & products.	S10.01.PS.02.1	Yes			
			Writing a chemical equation, Balanced chemical equations	Calculates using the data given, such as number of atoms in reactants and products to balance a chemical equation, resistance of a system of resistors, power of a lens, electric power, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S10.01.PS.03	Use chemical symbols & chemical formulae correctly in order to acquire the skill of writing chemical equations.	S10.01.PS.03.1	Yes			
							Apply Law of Conservation of Mass in order to balance chemical equations.	S10.01.PS.03.2	Yes			Cooperative learning / ICT

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Types of chemical reactions, Oxidation and Reduction	Differentiates materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as autotrophic and heterotrophic nutrition, biodegradable and non- biodegradable substances, various types of reactions, strong and weak acids and bases, acidic, basic and neutral salts, real and virtual images, etc.	Explains properties /characteristics in order to differentiate materials / objects /organisms /phenomena /processes.	S10.01.PS.04	Categorize the given reactions as (combination / decomposition) based on the reactants & products of a chemical reaction.	S10.01.PS.04.1	Yes			
							Classify the given reaction as displacement or double displacement based on the type of reactants used & products formed.	S10.01.PS.04.2	Yes			Cooperative learning / Inquiry-based learning
							Predict the reaction as Oxidation or Reduction based on the addition/ removal of oxygen/ hydrogen/ electrons to the reactants to form products.	S10.01.PS.04.3	Yes			
			Have you Observed the Effect of Oxidation Reactions in everyday life	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion, applies concept of decomposition reaction of baking soda to make spongy cakes, etc.	Applies learning of scientific concepts in daily life in order to solve problems.	S10.01.PS.05	Observe colour change in iron, copper and silver articles over time in order to outline the effects of corrosion in our surroundings (real life situations, stating any two).	S10.01.PS.05.1	Yes			
							Detect changes in smell, colour, taste of food items overtime, in order to explain effects of oxidation on food items	S10.01.PS.05.2	Yes			Experimentation

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
2	Acids, Bases and Salts	Physical Sciences	What do all acids and all bases have in common? How strong are acid or base solutions?	Differentiates materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as autotrophic and heterotrophic nutrition, biodegradable and non- biodegradable substances, various types of reactions, strong and weak acids and bases, acidic, basic and neutral salts, real and virtual images, etc.	Explains properties /characteristics in order to differentiate materials / objects	S10.02.PS.01	Write down the ions present in aqueous solution of an acid or a base, in order to explain why aqueous acid/ base conduct electricity	S10.02.PS.01.1	Yes			
							Identify the positive and negative radicals present in a salt, in order to predict a salt's family and pH range	S10.02.PS.01.2	Yes			
			Importance of pH in Everyday Life	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as metals and non-metals on the basis of their physical and chemical properties, acids and bases on the basis of their chemical properties, etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes.	S10.02.PS.02	Recall the tastes of acids and bases in order to point out if given food items contain an acid or a base.	S10.02.PS.02.1	Yes			Inductive approach
			How strong are acid or base solutions? Understanding the Chemical Properties of Acids and Bases	Plans and conducts investigations / experiments to arrive at and verify the facts, principles, phenomena or to seek answers to queries on their own, such as investigates conditions necessary for rusting, tests the conductivity of various solutions, compares the foaming capacity of different types of	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S10.02.PS.03	Observe the action of given substances with various indicators, in order to categorize them as acids or bases	S10.02.PS.03.1	Yes			
							Detect the formation of hydrogen gas when a metal reacts with an acid or a base, in order to confirm the presence of an acid/ base given an unknown compound	S10.02.PS.03.2	Yes			Inquiry-based learning / Experimentation

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				soap samples, verifies laws of reflection and refraction of light, ohm's law, do variegated leaves perform photosynthesis? Which gas is evolved during fermentation? Why plants shoot moves towards light?			Detect the formation of carbon dioxide when a metal carbonate/ bicarbonate reacts with acid, in order to detect the presence of acid given an unknown compound	S10.02.PS.03.3	Yes			
							Demonstrate the activity of heating copper sulphate crystals and change in colour, in order to detect the presence of water of crystallisation	S10.02.PS.03.4	Yes			Experimentation
			Importance of pH in everyday life	Relates processes and phenomena with causes / effects, such as hormones with their functions, tooth decay with pH of saliva, growth of plants with pH of the soil, survival of aquatic life with pH of water, blue colour of sky with scattering of light, deflection of compass needle due to magnetic effect of electric current, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S10.02.PS.04	Explain the effect of pH change in animals, plants and environment in order to learn suitable pH range for survival	S10.02.PS.04.1	Yes			
			Chemicals from Common Salt	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.02.PS.05	Outline the process of formation of sodium hydroxide in order to explain its manufacture using common salt	S10.02.PS.05.1	Yes			ICT
							List the properties & explain the preparation/ manufacture some important compounds of Sodium. (bleaching powder, baking soda and washing soda) in order to explain their	S10.02.PS.05.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.			manufacture using common salt					
			How strong are acid or base solutions?	Analyses and interprets data / graph / figure, such as melting and boiling points of substances to differentiate between covalent and ionic compounds, pH of solutions to predict the nature of substances, v-i graphs, ray diagrams, etc.	Analyses data /graph /figures in order to interpret them.	S10.02.PS.06	Detect the strength of given substances based on their position in the pH scale.	S10.02.PS.06.1	Yes			
			How do Acids and Bases React with Metals?	Measures physical quantities using appropriate apparatus / instruments /devices, such as ph of substances using different indicators, electric current and potential difference using ammeter and voltmeter, etc.	Selects and uses appropriate apparatus /instruments / devices in order to measure physical quantities.	S10.02.PS.07	Analyse the reaction taking place between an acid and a base (alkalis, metal oxides) using an indicator.	S10.02.PS.07.1			Yes	Experiential learning
3	Metals and Non-metals	Physical Sciences	Physical properties of metals and non-metals, Chemical properties of metals	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as metals and non-metals on the basis of their physical and chemical properties, acids and bases on the basis of their chemical properties, etc.	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes.	S10.03.PS.01	Observe various substances and their physical properties in order to classify them as metals or non-metals	S10.03.PS.01.1	Yes			
							Predict the products when metals & non-metals react with oxygen, water, dilute acids in order to write a balanced chemical equation.	S10.03.PS.01.2		Yes		Cooperative learning / Inductive approach

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			The Reactivity Series, Occurrence of metals, Prevention of Corrosion	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.03.PS.02	Identify the product formed when a metal reacts with a metal salt, in order to list the metals in order of their reactivity	S10.03.PS.02.1	Yes			
							Analyse the process of getting metals from their oxides, sulphides, carbonates in order to extract them from their ores	S10.03.PS.02.2			Yes	
							Explain the process of electrolytic refining in order to assess how to obtain pure metals from impure samples	S10.03.PS.02.3	Yes			
							Observe corrosion in metal articles & its process in order to develop ways to prevent corrosion by forming alloys, painting, galvanising	S10.03.PS.02.4	Yes			
			How do metals and non-metals react? Extraction of Metals	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.03.PS.03	Discuss the process of how metals react with non-metals, in order to explain formation & properties of ionic compounds	S10.03.PS.03.1	Yes			
							Analyse the process of getting metals from their oxides, sulphides, carbonates in order to extract them from their ores	S10.03.PS.03.2			Yes	
			How do metals and non-metals react?	Analyses and interprets data / graph / figure, such as melting and boiling points of substances to differentiate between	Analyses data /graph /figures in order to interpret them.	S10.03.PS.04	Discuss the process of how metals react with non-metals, in order to explain formation & properties of ionic compounds	S10.03.PS.04.1	Yes			Inquiry-based learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				covalent and ionic compounds, pH of solutions to predict the nature of substances, v-i graphs, ray diagrams, etc.								
4	Carbon and its Compounds	Physical Sciences	Chemical properties of carbon compounds	Differentiates materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as autotrophic and heterotrophic nutrition, biodegradable and non- biodegradable substances, various types of reactions, strong and weak acids and bases, acidic, basic and neutral salts, real and virtual images, etc.	Explains properties /characteristics in order to differentiate materials / objects	S10.04.PS.01	Illustrate the chemical properties of carbon compounds (like combustion, oxidation, addition & substitution) along with balanced chemical reaction.	S10.04.PS.01.1	Yes			
							Identify how carbon compounds react with hydrogen in the presence of nickel catalyst, in order to write a balanced chemical reaction	S10.04.PS.01.2	Yes			
							Identify how carbon compounds react with chlorine in the presence of sunlight, in order to write a balanced chemical reaction	S10.04.PS.01.3	Yes			
			Combustion, Some important carbon compounds – ethanol and ethanoic acid, Soaps and Detergents	Plans and conducts investigations / experiments to arrive at and verify the facts, principles, phenomena or to seek answers to queries on their own, such as investigates conditions necessary for rusting, tests the conductivity of various solutions, compares the foaming capacity of different types of	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S10.04.PS.02	Observe how carbon compounds burn in oxygen, in order to classify them as saturated or unsaturated	S10.04.PS.02.1	Yes			Experimentation / Cooperative learning
							Perform physical and chemical tests in order to distinguish between Ethanol & Ethanoic acid based on their properties (reaction with other substances)	S10.04.PS.02.2		Yes		Experimentation / Cooperative learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				soap samples, verifies laws of reflection and refraction of light, ohm's law, do variegated leaves perform photosynthesis? Which gas is evolved during fermentation? Why plants shoot moves towards light?			Describe the process of micelle formation in order to understand how soaps work	S10.04.PS.02.3	Yes			ICT
			Chains, Branches and Rings, Bonding in carbon – the covalent bond, Saturated and Unsaturated Carbon Compounds	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.04.PS.03	Draw structures of carbon compounds and show types of bonds (single/ double/ triple) in order to classify them as alkanes/ alkenes/ alkynes	S10.04.PS.03.1	Yes			
							Draw structures of carbon compounds with functional groups, in order to predict their properties due to functional groups and type of bonding present	S10.04.PS.03.2	Yes			
							Write down electron shell configuration of carbon in order to predict formulae of carbon compounds and illustrate the structure of molecules of carbon compounds with chain, branched & ring structure.	S10.04.PS.03.3	Yes			
							Draw structures of carbon compounds in order to classify them as saturated or unsaturated	S10.04.PS.03.4	Yes			
			Functional groups in carbon compounds	Uses scientific conventions to represent units of various quantities / symbols / formulae / equations, such as	Uses scientific conventions in order to represent units of various quantities /	S10.04.PS.04	Identify the functional group, type of bonding, number of C atoms present in a carbon compound, in	S10.04.PS.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				balanced chemical equation by using symbols and physical states of substances, sign convention in optics, SI units, etc.	symbols /formulae /equations.		order to correctly name them					
5	Periodic Classification of Elements	Physical Sciences	Making order out of chaos – Mendeleev's Periodic Table	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.05.PS.01	Interpret the arrangement of elements in the MPT.	S10.05.PS.01.1			Yes	
							Analyse the usefulness of MPT in studying the chemical behaviour of elements.	S10.05.PS.01.2			Yes	
			Making order out of chaos –The Modern Periodic Table	Draws conclusion, such as traits / features are inherited through genes present on chromosomes, a new species originates through evolutionary processes, water is made up of hydrogen and oxygen, properties of elements vary periodically along the groups and periods in periodic table, potential difference across a metal conductor is proportional to the electric current through it, etc.	Analyses interdependencies in order to draw conclusions.	S10.05.PS.02	Arrange the elements on the basis of their properties like oxides and hydrides, in order to form Mendeleev's Periodic Table	S10.05.PS.02.1	Yes			
							Compute the group and period number of an element given its atomic number, in order to determine its place in MPT	S10.05.PS.02.2			Yes	
							Compute the number of shells & valence electrons of an element given its position in MPT, in order to determine its properties	S10.05.PS.02.3			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Predict the position of elements in the MPT in order to explain the trends in groups and periods.	S10.05.PS.02.4	Yes			
							Predict the trend of atomic size across the period and down the group, in order to explain arrangement of elements in MPT	S10.05.PS.02.5	Yes			
			Döbereiner's Triads, Newlands' Law of Octaves, Achievements and limitations of Mendeléev's Classification	Takes initiative to know about scientific discoveries / inventions, such as Mendel's contribution in understanding the concept of inheritance, Dobereiner for discovering triads of elements, Mendeleev for the development of the periodic table of elements, Oersted discovery that electricity and magnetism are related, discovery of relation between potential difference across a metal conductor and the electric current through it by ohm, etc.	Takes initiative to know about and describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S10.05.PS.03	Calculate the average atomic mass given masses of different elements, in order to identify Dobereiner's Triads	S10.05.PS.03.1			Yes	
							Arrange elements in order of increasing atomic masses, in order to form Newlands' Octaves	S10.05.PS.03.2	Yes			
							Identify the achievements and limitations in Mendeleev's periodic table with respect to arrangement of elements.	S10.05.PS.03.3	Yes			
6	Life Processes	Life Sciences	Heterotrophic Nutrition, Autotrophic Nutrition,	Differentiates materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as autotrophic and heterotrophic nutrition, biodegradable and non- biodegradable substances, various	Explains properties /characteristics in order to differentiate materials / objects	S10.06.LS.01	List and explain the strategies employed by heterotrophs to take up food, in order to understand how heterotrophs obtain nutrition and differentiate it from autotrophic nutrition.	S10.06.LS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				types of reactions, strong and weak acids and bases, acidic, basic and neutral salts, real and virtual								
			Autotrophic Nutrition	Plans and conducts investigations / experiments to arrive at and verify the facts, principles, phenomena or to seek answers to queries on their own, such as investigates conditions necessary for rusting, tests the conductivity of various solutions, compares the foaming capacity of different types of soap samples, verifies laws of reflection and refraction of light, ohm's law, do variegated leaves perform photosynthesis? Which gas is evolved during fermentation? Why plants shoot moves towards light?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S10.06.LS.02	Explain the process of absorption of CO2 & H2O, in order to understand how autotrophs obtain substances necessary for nutrition	S10.06.LS.02.1	Yes			
			Autotrophic Nutrition, Nutrition in Human Beings, Respiration, Transportation, Excretion	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.06.LS.03	Explain the process of conversion of CO2 & H2O into carbohydrates, in order to understand how autotrophs obtain nutrition	S10.06.LS.03.1	Yes			
							Illustrate the process involved in human digestive system, in order to explain how humans obtain nutrients from food	S10.06.LS.03.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.			List the enzymes & their functions involved in human digestive system, in order to understand breakdown of food in humans	S10.06.LS.03.3	Yes			
							Outline and explain the ways of breakdown of glucose by various pathways, in order to explain how energy is obtained in organisms	S10.06.LS.03.4	Yes			
							Illustrate the process involved in human respiratory system, in order to explain how humans take in oxygen and expel CO2	S10.06.LS.03.5	Yes			ICT / Inductive approach
							Illustrate the process of transport of oxygenated & de-oxygenated blood by human heart, in order to explain how oxygen is transported to cells	S10.06.LS.03.6	Yes			
							Outline the process of double circulation of blood in fishes, in order to explain how oxygenated & deoxygenated blood is compartmentalized	S10.06.LS.03.7	Yes			ICT / Inductive approach
							Describe the function of blood vessels, arteries, platelets & lymph in human body, in order to understand how human transportation system works	S10.06.LS.03.8	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Explain the function of xylem (vessels and tracheids) in plants, in order to explain how plants take up water forms soil	S10.06.LS.03.9	Yes			
							Explain the function of transpiration in order to explain how water travels up in plants	S10.06.LS.03.10	Yes			
							Explain the function of phloem & ATP, in order to explain how food is transported in plants	S10.06.LS.03.11	Yes			
							Illustrate the process involved in human excretory system, in order to explain how waste is transported out of humans' body	S10.06.LS.03.12	Yes			
							Describe transpiration and other ways in which plants shed extra wastes, in order to explain excretion in plants	S10.06.LS.03.13	Yes			
			Heterotrophic Nutrition, Nutrition in Human Beings, Respiration, Transportation, Excretion	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.06.LS.04	List and explain the strategies employed by heterotrophs to take up food, in order to understand how heterotrophs obtain nutrition and differentiate it from autotrophic nutrition.	S10.06.LS.04.1	Yes			
							Illustrate the process involved in human digestive system, in order to explain how humans obtain	S10.06.LS.04.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							nutrients from food					
							Illustrate the process involved in human respiratory system, in order to explain how humans take in oxygen and expel CO2	S10.06.LS.04.3	Yes			
							Illustrate the process of transport of oxygenated & de-oxygenated blood by human heart, in order to explain how oxygen is transported to cells	S10.06.LS.04.4	Yes			
							Illustrate the process involved in human excretory system, in order to explain how waste is transported out of humans' body	S10.06.LS.04.5	Yes			
			Nutrition in Human Beings, Respiration, Transportation, Excretion	Exhibits creativity in designing models using eco-friendly resources, such as working model of respiratory, digestive and excretory systems, soda acid fire extinguisher, periodic table, micelles formation, diamond / graphite / Buckminster fullerene, human eye, electric motor and generator, etc.	Designs models using eco-friendly resources in order to exhibit creativity.	S10.06.LS.05	Illustrate the process involved in human digestive system, in order to explain how humans obtain nutrients from food	S10.06.LS.05.1	Yes			
							Illustrate the process involved in human respiratory system, in order to explain how humans take in oxygen and expel CO2	S10.06.LS.05.2	Yes			
							Illustrate the process of transport of oxygenated & de-oxygenated blood by human heart, in order to explain	S10.06.LS.05.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							how oxygen is transported to cells					
							Illustrate the process involved in human excretory system, in order to explain how waste is transported out of humans' body	S10.06.LS.05.4	Yes			
7	Control and Coordination	Life Sciences	What happens in Reflex Actions? Coordination in plants, Hormones in animals	Relates processes and phenomena with causes / effects, such as hormones with their functions, tooth decay with pH of saliva, growth of plants with pH of the soil, survival of aquatic life with pH of water, blue colour of sky with scattering of light, deflection of compass needle due to magnetic effect of electric current, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S10.07.LS.01	Outline the working of a reflex arc, in order to explain how reflex actions take place in humans	S10.07.LS.01.1	Yes			
							Examine tropic movements in plants, in order to understand how plants respond to environmental triggers like light, gravity, water	S10.07.LS.01.2	Yes			
							Discuss limitations of electrical impulses, in order to outline the importance and use of hormones	S10.07.LS.01.3	Yes			
							Illustrate the function of endocrine glands in human body, in order to understand functioning of hormones	S10.07.LS.01.4	Yes			
			Animals- Nervous System	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals,	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a	S10.07.LS.02	Draw the structure & explain the functioning of a neuron, in order to explain how electrical signals travel in human body	S10.07.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				extraction of metals from ores, placement of elements in modern periodic table, displacement of meta ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	keen interest in the science in daily life.		Illustrate the location and functions of different parts of human brain, in order to understand working of human brain	S10.07.LS.02.2	Yes			
			Animals- Nervous System	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.07.LS.03	Draw the structure & explain the functioning of a neuron, in order to explain how electrical signals travel in human body	S10.07.LS.03.1	Yes			
							Outline the working of a reflex arc, in order to explain how reflex actions take place in humans	S10.07.LS.03.2	Yes			
8	Reproduction in Human Being	Life Sciences	Reproduction in Human Beings	Relates processes and phenomena with causes / effects, such as hormones with their functions, tooth decay with pH of saliva, growth of plants with pH of the soil, survival of aquatic life with pH of water, blue colour of sky with scattering of light, deflection of compass needle due to magnetic effect of electric current, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S10.08.LS.01	Describe the changes taking place in female body after/ without fertilization, in order to understand human reproduction	S10.08.LS.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Modes Of Reproduction Used By Single Organisms, Vegetative propagation, Sexual Reproduction	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.08.LS.02	Illustrate the process of fission in amoeba, leishmania & plasmodium, in order to understand how unicellular organisms divide	S10.08.LS.02.1	Yes			
							Illustrate the process of fragmentation in Spirogyra & spore formation in Rhizopus, in order to understand how multicellular organisms with simple body design divide	S10.08.LS.02.2	Yes			
							Illustrate the process of regeneration in Planaria, in order to understand how fully differentiated multicellular organisms divide	S10.08.LS.02.3	Yes			
							Illustrate the process of budding in Hydra, in order to understand how fully differentiated multi- cellular organisms use regenerative cells to divide	S10.08.LS.02.4	Yes			
							Illustrate the process of vegetative propagation in plants like sugarcane, roses, grapes in order to understand how plants reproduce without seeds	S10.08.LS.02.5	Yes			
							Label the different parts of a flower and explain their functions, in order to understand how	S10.08.LS.02.6	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							flowers reproduce to form fruit					
							List down the changes occurring in male and female body in teenage years, in order to understand effects of puberty	S10.08.LS.02.7	Yes			
							Illustrate the male reproductive system, in order to understand its function in reproduction	S10.08.LS.02.8	Yes			
							Illustrate the female reproductive system, in order to understand its function in reproduction	S10.08.LS.02.9	Yes			
			Modes Of Reproduction Used By Single Organisms, Vegetative propagation, Sexual Reproduction	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.08.LS.03	Illustrate the process of fission in amoeba, leishmania & plasmodium, in order to understand how unicellular organisms divide	S10.08.LS.03.1	Yes			
							Illustrate the process of fragmentation in Spirogyra & spore formation in Rhizopus, in order to understand how multicellular organisms with simple body design divide	S10.08.LS.03.2	Yes			
							Illustrate the process of regeneration in Planaria, in order to understand how fully differentiated multicellular organisms divide	S10.08.LS.03.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Illustrate the process of budding in Hydra, in order to understand how fully differentiated multi- cellular organisms use regenerative cells to divide	S10.08.LS.03.4	Yes			
							Illustrate the process of vegetative propagation in plants like sugarcane, roses, grapes in order to understand how plants reproduce without seeds	S10.08.LS.03.5	Yes			
							Illustrate the male reproductive system, in order to understand its function in reproduction	S10.08.LS.03.6	Yes			
							Illustrate the female reproductive system, in order to understand its function in reproduction	S10.08.LS.03.7	Yes			
			Reproductive Health	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion,	Applies learning of scientific concepts in daily life in order to solve problems.	S10.08.LS.04	List down the ways to avoid fertilization, in order to avoid pregnancy and maintain reproductive health	S10.08.LS.04.1	Yes			

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				applies concept of decomposition reaction of baking soda to make spongy cakes, etc.								
9	Heredity and Evolution	Life Sciences	Accumulation of variation during reproduction	Draws conclusion, such as traits / features are inherited through genes present on chromosomes, a new species originates through evolutionary processes, water is made up of hydrogen and oxygen, properties of elements vary periodically along the groups and periods in periodic table, potential difference across a metal conductor is proportional to the electric current through it, etc.	Analyses interdependencies in order to draw conclusions.	S10.09.LS.01	List down the reasons for changes in DNA copying and their effect on ecosystem, in order to understand importance of variations	S10.09.LS.01.1	Yes			
			Sex determination	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.09.LS.02	Explain the combination of sex chromosomes, in order to understand how sex is determined in humans	S10.09.LS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Heredity, Rules for the Inheritance of Traits -Mendel's Contributions, Sex determination	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.09.LS.03	Explain the combination of sex chromosomes, in order to understand how sex is determined in humans	S10.09.LS.03.1	Yes			
							State and explain Mendel's traits of inheritance, in order to understand how traits are inherited from one generation to next	S10.09.LS.03.2	Yes			
							Classify the given traits as inherited or acquired, in order to understand which traits cause a change in genes.	S10.09.LS.03.3	Yes			Cooperative learning / Inquiry-based learning
			Speciation, Evolution and Classification	Draws conclusion, such as traits / features are inherited through genes present on chromosomes, a new species originates through evolutionary processes, water is made up of hydrogen and oxygen, properties of elements vary periodically along the groups and periods in periodic table, potential difference across a metal conductor is proportional to the electric current through it, etc.	Analyses interdependencies in order to draw conclusions.	S10.09.LS.04	Explain how changes in DNA can lead to stronger/ better species, or formation of new species altogether, in order to understand natural selection & speciation	S10.09.LS.04.1	Yes			
							Identify if a given pair of organs is analogous or homologous, in order to find relationship between species	S10.09.LS.04.2	Yes			
							Observe different fossils and identify the differences and similarities, in order to understand the timeline of evolution	S10.09.LS.04.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							State and explain Mendel's traits of inheritance, in order to understand how traits are inherited from one generation to next	S10.09.LS.04.4	Yes			
			Rules for the Inheritance of Traits -Mendel's Contributions	Takes initiative to know about scientific discoveries / inventions, such as Mendel's contribution in understanding the concept of inheritance, Dobereiner for discovering triads of elements, Mendeleev for the development of the periodic table of elements, Oersted discovery that electricity and magnetism are related, discovery of relation between potential difference across a metal conductor and the electric current through it by ohm, etc.	Takes initiative to know about and describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S10.09.LS.05	State and explain Mendel's traits of inheritance, in order to understand how traits are inherited from one generation to next	S10.09.LS.05.1	Yes			
10	Light – Reflection and Rarefaction	Physical Sciences	Refraction of Light	Plans and conducts investigations / experiments to arrive at and verify the facts, principles, phenomena or to seek answers to queries on their own, such as investigates conditions necessary for rusting, tests the conductivity of various solutions, compares the foaming capacity of different types of soap samples, verifies laws of reflection and	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S10.10.PS.01	Demonstrate the path of light when it travels through a rectangular glass slab, in order to formulate laws of refraction of light.	S10.10.PS.01.1		Yes		
							Outline the rule of image formation by spherical mirrors in order to complete the ray diagrams by	S10.10.PS.01.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				refraction of light, ohm's law, do variegated leaves perform photosynthesis? Which gas is evolved during fermentation? Why plants shoot moves towards light?			drawing reflected rays.					
							Represent the path of incident & reflected light rays from a concave lens, in order decipher the position and nature of image formed.	S10.10.PS.01.3	Yes			
			Refractive index	Relates processes and phenomena with causes / effects, such as hormones with their functions, tooth decay with pH of saliva, growth of plants with pH of the soil, survival of aquatic life with pH of water, blue colour of sky with scattering of light, deflection of compass needle due to magnetic effect of electric current, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S10.10.PS.02	Compare speed of light in one medium with another in order to calculate refractive index.	S10.10.PS.02.1			Yes	
			Reflection of Light, Image Formation by Spherical Mirrors	Explains processes and phenomena in order to relate to science behind the phenomena/ processes and develop a keen interest in the science in daily life: such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.10.PS.03	State the laws of reflection of light, in order to understand how light travels in a medium when it encounters another object	S10.10.PS.03.1	Yes			
							Represent the path of incident ray and reflected ray in order to decipher the position and nature of image formed.	S10.10.PS.03.2	Yes			Experimentation
							Illustrate the path of incident & reflected light rays from a convex lens, in order decipher the position and	S10.10.PS.03.3	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.)			nature of image formed.					
			Image Formation by Spherical Mirror, Representation of Images Formed in Lenses Using Ray Diagrams	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray diagrams, magnetic field lines, etc.	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.10.PS.04	Outline the rule of image formation by spherical mirrors in order to complete the ray diagrams by drawing reflected rays.	S10.10.PS.04.1	Yes			
							Represent the path of incident ray and reflected ray in order to decipher the position and nature of image formed.	S10.10.PS.04.2	Yes			
							Demonstrate the path of light when it travels through a rectangular glass slab, in order to formulate laws of refraction of light.	S10.10.PS.04.3		Yes		
							Represent the path of incident & reflected light rays from a concave lens, in order decipher the position and nature of image	S10.10.PS.04.4	Yes			
							Illustrate the path of incident & reflected light rays from a convex lens, in order decipher the position and nature of image formed.	S10.10.PS.04.5	Yes			
			Image Formation by Spherical Mirrors, Representation of Images	Analyses and interprets data / graph / figure, such as melting and boiling points of substances to	Analyses data /graph /figures in order to interpret them.	S10.10.PS.05	Outline the rule of image formation by spherical mirrors in order to complete the ray diagrams by	S10.10.PS.05.1	Yes			ICT / Inductive approach

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Formed in Lenses Using Ray Diagrams	differentiate between covalent and ionic compounds, pH of solutions to predict the nature of substances, v-i graphs, ray diagrams, etc.			drawing reflected rays.					
							Represent the path of incident & reflected light rays from a concave lens, in order decipher the position and nature of image formed.	S10.10.PS.05.2	Yes			
			Mirror Formula and Magnification, Lens Formula and Magnification	Calculates using the data given, such as number of atoms in reactants and products to balance a chemical equation, resistance of a system of resistors, power of a lens, electric power, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S10.10.PS.06	Express u, v, f in the mirror formula in order to apply sign convention in solving word problems to find the unknown variable.	S10.10.PS.06.1		Yes		
							Deduce the nature and size of image by magnification in order to relate height of object with height of image.	S10.10.PS.06.2			Yes	
							Compare speed of light in one medium with another in order to calculate refractive index.	S10.10.PS.06.3			Yes	
							Construct the lens formula for a lens relating v, u, f; in order to find an unknown variable given the other two.	S10.10.PS.06.4		Yes		
							State the magnification for a lens, in order to relate height of object with height of image	S10.10.PS.06.5	Yes			
							Calculate the power of a lens, in order to determine its power to converge or diverge	S10.10.PS.06.6			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
11	Human Eye and the Colourful World	Life Sciences	Mirror Formula and Magnification, Lens Formula and Magnification	Uses scientific conventions to represent units of various quantities / symbols / formulae / equations, such as balanced chemical equation by using symbols and physical states of substances, sign convention in optics, SI units, etc.	Uses scientific conventions in order to represent units of various quantities / symbols /formulae /equations.	S10.10.PS.07	Express u, v, f in the mirror formula in order to apply sign convention in solving word problems to find the unknown variable.	S10.10.PS.07.1	Yes			
							Construct the lens formula for a lens relating v, u, f; in order to find an unknown variable given the other two.	S10.10.PS.07.2		Yes		
			Defects of vision and their correction	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.11.PS.01	Relate changes in focal length of eye lens to vision of distant and nearby objects	S10.11.PS.01.1	Yes			
			Defects of vision and their correction, The human eye	Draws labelled diagrams / flow charts / concept map /graphs, such as digestive, respiratory, circulatory, excretory and reproductive systems, electrolysis of water, electron dot structure of atoms and molecules, flow chart for extraction of metals from ores, ray	Draws labelled diagrams /flow charts /concept map /graphs to demonstrate knowledge of how the process /structure /relationship works and also to demonstrate the application of different forms of illustrations.	S10.11.LS.02	Relate changes in focal length of eye lens to vision of distant and nearby objects	S10.11.LS.02.1	Yes			
							Describe the structure of an eye and functions of various parts that help humans to see.	S10.11.LS.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				diagrams, magnetic field lines, etc.								
			Defects of vision and their correction, the human eye, Refraction Of Light Through A Prism, Dispersion of white light by a glass prism, Atmospheric refraction	Draws conclusion, such as traits / features are inherited through genes present on chromosomes, a new species originates through evolutionary processes, water is made up of hydrogen and oxygen, properties of elements vary periodically along the groups and periods in periodic table, potential difference across a metal conductor is proportional to the electric current through it, etc.	Analyses interdependencies in order to draw conclusions.	S10.11.LS.03	Identify the causes of defects of vision in human eye and suggest correction procedures.	S10.11.LS.03.1	Yes			
							Examine the path of light rays through a prism and identify various rays and angles formed	S10.11.LS.03.2	Yes			
							Demonstrate that white light is dispersed into seven colours by a prism and explain the reasons for the same.	S10.11.LS.03.3		Yes		
							Provide scientific explanation for twinkling of stars, advanced sunrise and delayed sunset.	S10.11.LS.03.4	Yes			
							Describe the structure of an eye and functions of various parts that help humans to see.	S10.11.LS.03.5	Yes			
			The human eye, Scattering of light	Takes initiative to know about scientific discoveries / inventions, such as Mendel's contribution in understanding the concept of inheritance, Dobereiner for discovering triads of elements, Mendeleev for the development of the periodic table of elements, Oersted	Takes initiative to know about and describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S10.11.LS.04	Describe the structure of an eye and functions of various parts that help humans to see.	S10.11.LS.04.1	Yes			
							Relate scattering of light to Tyndall effect, blue colour of sky and red colour of sun at sunrise and sunset.	S10.11.LS.04.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				discovery that electricity and magnetism are related, discovery of relation between potential difference across a metal conductor and the electric current through it by ohm, etc.								
12	Electricity	Physical Sciences	Ohm's Law	Plans and conducts investigations / experiments to arrive at and verify the facts, principles, phenomena or to seek answers to queries on their own, such as investigates conditions necessary for rusting, tests the conductivity of various solutions, compares the foaming capacity of different types of soap samples, verifies laws of reflection and refraction of light, ohm's law, do variegated leaves perform photosynthesis? Which gas is evolved during fermentation? Why plants shoot moves towards light?	Plans and conducts investigations /experiments on their own, in order to arrive at facts and in order to verify the principles /phenomena, or in order to seek answers to queries.	S10.12.PS.01	Plot a graph between voltage and current, in order to prove ohm's law & find resistance	S10.12.PS.01.1			Yes	
			Factors on which the resistance of a conductor depends, Practical Applications Of Heating Effect Of Electric Current	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.12.PS.02	Define resistivity and its range for different materials, in order to classify substances as conductors, alloys and insulators	S10.12.PS.02.1	Yes			
							Explain and calculate the heating effect of electric current, in order to learn working of appliances like	S10.12.PS.02.2	Yes			Experiential learning

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.			heater, iron and fuse.					
			Electric Current and Circuit, Electric Potential and Potential Difference, Electric power	Calculates using the data given, such as number of atoms in reactants and products to balance a chemical equation, resistance of a system of resistors, power of a lens, electric power, etc.	Calculates using the data given, in order to show measurability of scientific postulates and applications of scientific measurement units.	S10.12.PS.03	Evaluate the charge flowing through a conductor in a given time, in order to calculate current flowing through it	S10.12.PS.03.1			Yes	
							Determine work done in moving a charge across two points, in order to calculate potential difference between two points	S10.12.PS.03.2			Yes	
							Calculate power, in order to represent electric consumption in domestic circuits	S10.12.PS.03.3			Yes	
			Electric Current and Circuit, Electric Potential and Potential Difference, Electric power, Ohm's Law	Uses scientific conventions to represent units of various quantities / symbols / formulae / equations, such as balanced chemical equation by using symbols and physical states of substances, sign convention in optics, SI units, etc.	Uses scientific conventions in order to represent units of various quantities / symbols /formulae /equations.	S10.12.PS.04	Evaluate the charge flowing through a conductor in a given time, in order to calculate current flowing through it	S10.12.PS.04.1			Yes	
							Determine work done in moving a charge across two points, in order to calculate potential difference between two points	S10.12.PS.04.2			Yes	
							Plot a graph between voltage and current, in order to prove ohm's law & find resistance	S10.12.PS.04.3			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							Calculate power, in order to represent electric consumption in domestic circuits	S10.12.PS.04.4			Yes	
			Electric Current and Circuit	Measures physical quantities using appropriate apparatus / instruments /devices, such as ph of substances using different indicators, electric current and potential difference using ammeter and voltmeter, etc.	Selects and uses appropriate apparatus /instruments / devices in order to measure physical quantities.	S10.12.PS.05	Identify the electrical components and their functions, in order to build a functioning circuit	S10.12.PS.05.1	Yes			
			Practical Applications Of Heating Effect Of Electric Current	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion, applies concept of decomposition reaction of baking soda to make spongy cakes, etc.	Applies learning of scientific concepts in daily life in order to solve problems.	S10.12.PS.06	Explain and calculate the heating effect of electric current, in order to learn working of appliances like heater, iron and fuse.	S10.12.PS.06.1	Yes			
			Resistance of a system of resistors	Derives formulae / equations / laws, such as equivalent resistance of resistors in series and parallel, etc.	Derives formulae /equations /laws in order to demonstrate mathematical thinking skills and understanding of scientific laws /concepts.	S10.12.PS.07	Determine the resultant resistance in a series and a parallel combination, in order to identify the suitable	S10.12.PS.07.1			Yes	

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
							combination like house, etc					
13	Magnetic Effects of Electric Current	Physical Sciences	Magnetic field and field lines, Magnetic field due to a Current carrying conductor, Electromagnetic Induction	Relates processes and phenomena with causes / effects, such as hormones with their functions, tooth decay with pH of saliva, growth of plants with pH of the soil, survival of aquatic life with pH of water, blue colour of sky with scattering of light, deflection of compass needle due to magnetic effect of electric current, etc.	Examines and explains processes and phenomena in order to relate them with causes and effects.	S10.13.PS.01	Draw magnetic field lines for a bar magnet, in order to identify the magnetic field strength at different points around a magnet	S10.13.PS.01.1	Yes			
							Represent magnetic field lines for a straight current carrying conductor, in order to identify the magnetic field strength at different points around it.	S10.13.PS.01.2	Yes			
							Draw magnetic field lines for at current carrying circular loop, in order to identify the magnetic field strength at different points around it	S10.13.PS.01.3	Yes			
							Outline magnetic field lines for at current carrying solenoid, in order to identify the magnetic field strength at different points around it.	S10.13.PS.01.4	Yes			
							Discuss electromagnetic induction, in order to understand how a moving magnet can be used to generate electric currents.	S10.13.PS.01.5	Yes			
			Force on a current-carrying conductor in a Magnetic field,	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants,	Explains processes and phenomena in order to relate to science behind the phenomena /processes and	S10.13.PS.02	State Fleming's Left-Hand rule, in order to understand the working of an electric motor	S10.13.PS.02.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Electric Generator	transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.	develop a keen interest in the science in daily life.		Explain Fleming's right hand rule, in order to understand the working of an electric generator	S10.13.PS.02.2	Yes			
			Domestic Electric Circuits	Uses scientific conventions to represent units of various quantities / symbols / formulae / equations, such as balanced chemical equation by using symbols and physical states of substances, sign convention in optics, SI units, etc.	Uses scientific conventions in order to represent units of various quantities / symbols /formulae /equations.	S10.13.PS.03	Analyse the significance of neutral, earth and live wire, in order to understand formation of a domestic electrical circuit	S10.13.PS.03.1			Yes	
			Magnetic Field due to a Current through a Straight Conductor	Takes initiative to know about scientific discoveries / inventions, such as Mendel's contribution in understanding the concept of inheritance, Dobereiner for discovering triads of elements, Mendeleev for the development of the periodic table of elements, Oersted discovery that electricity and magnetism are related, discovery of relation between potential difference across a metal conductor and the electric current	Takes initiative to know about and describes scientific discoveries /inventions in order to compare, contrast, and evaluate their usefulness, particularly in context of the age in which it was discovered /invented and its relevance today.	S10.13.PS.04	Represent magnetic field lines for a straight current carrying conductor, in order to identify the magnetic field strength at different points around it.	S10.13.PS.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				through it by ohm, etc.								
			Force on a current-carrying conductor in a Magnetic field, Electric Generator	Exhibits creativity in designing models using eco-friendly resources, such as working model of respiratory, digestive and excretory systems, soda acid fire extinguisher, periodic table, micelles formation, diamond / graphite / Buckminster fullerene, human eye, electric motor and generator, etc.	Designs models using eco-friendly resources in order to exhibit creativity.	S10.13.PS.05	State Fleming's Left-Hand rule, in order to understand the working of an electric motor	S10.13.PS.05.1	Yes			
							Explain Fleming's right hand rule, in order to understand the working of an electric generator	S10.13.PS.05.2	Yes			
14	Sources of Energy	Earth Sciences	What is a Good source of Energy	Classifies materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as metals and non-metals on the basis of their physical and chemical properties, acids and bases on the basis of their chemical properties, etc	Describes and interprets properties /characteristics in order to classify materials /objects /organisms / phenomena / processes.	S10.14.PS.01	Classify difference sources of energy on the basis of accessibility, cost, transportation and storage, in order to identify a 'good' source of energy	S10.14.PS.01.1	Yes			
			Conventional sources of energy, Alternative or Non-conventional sources of Energy, Improvements in the technology for using Conventional sources of Energy	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.14.ES.02	Understand the process of extracting energy from fossil fuels, in order to develop its efficiency	S10.14.ES.02.1	Yes			
							Compare the process of energy consumption through thermal and hydro power plants, in order to classify them as 'good' or 'bad' sources of energy.	S10.14.ES.02.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				basis of reactivity series, working of electric motor and generator, twinkling of stars, advance sunrise and delayed sunset, formation of rainbow, etc.			Explain the formation of biomass, in order to classify it as 'good' or 'bad' sources of energy	S10.14.ES.02.3	Yes			
							Outline the process of extracting energy from wind, in order to assess it as a conventional source of energy	S10.14.ES.02.4	Yes			
							Describe the process of extracting energy from sun's rays, in order to assess it as a non-conventional source of energy	S10.14.ES.02.5	Yes			
							Infer the process of extracting energy from the sea (tidal, wave, ocean thermal), in order to assess it as a non-conventional source of energy	S10.14.ES.02.6			Yes	
							Elaborate the process of extracting geothermal and nuclear energy, in order to assess it as a non-conventional source of energy	S10.14.ES.02.7	Yes			
			Fossil fuels	Applies learning to hypothetical situations, such as what happens if all herbivores removed from an ecosystem? What will happen if all non-renewable sources of energy are exhausted?	Applies learning to given hypothetical situations in order to solve problems /give possible solutions.	S10.14.ES.03	Understand the process of extracting energy from fossil fuels, in order to develop its efficiency	S10.14.ES.03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
			Alternative or Non-conventional sources of Energy	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion, applies concept of decomposition reaction of baking soda to make spongy cakes, etc.	Applies learning of scientific concepts in daily life in order to solve problems.	S10.14.ES.04	Describe the process of extracting energy from sun's rays, in order to assess it as a non-conventional source of energy	S10.14.ES.04.1	Yes			
							Infer the process of extracting energy from the sea (tidal, wave, ocean thermal), in order to assess it as a non-conventional source of energy	S10.14.ES.04.2			Yes	
							Elaborate the process of extracting geothermal and nuclear energy, in order to assess it as a non-conventional source of energy	S10.14.ES.04.3	Yes			
			What is a Good source of Energy, Fossil Fuels	Makes efforts to conserve environment realizing the inter-dependency and interrelationship in the biotic and abiotic factors of environment, such as appreciates and promotes segregation of biodegradable and non - biodegradable wastes, takes steps to promote sustainable management of resources in day to day life, advocates use of fuels which produces less pollutants, uses energy efficient electric devices, uses fossil fuels judiciously, etc.	Realises the interdependency and interrelationship in the biotic and abiotic factors of environment and applies it in order to make efforts to promote conservation of environment.	S10.14.ES.05	Classify difference sources of energy on the basis of accessibility, cost, transportation and storage, in order to identify a 'good' source of energy	S10.14.ES.05.1	Yes			
							Understand the process of extracting energy from fossil fuels, in order to develop its efficiency	S10.14.ES.05.2	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
15	Our Environment	Earth Sciences	Managing the Garbage we Produce	Differentiates materials / objects / organisms / phenomena / processes, based on, properties / characteristics, such as autotrophic and heterotrophic nutrition, biodegradable and non- biodegradable substances, various types of reactions, strong and weak acids and bases, acidic, basic and neutral salts, real and virtual images, etc.	Explains properties /characteristics in order to differentiate materials / objects	S10.15.ES.01	Classify different waste products as biodegradable or non-biodegradable, in order to assess their effect on environment	S10.15.ES.01.1	Yes			
			Food Chains and Webs	Applies learning to hypothetical situations, such as what happens if all herbivores removed from an ecosystem? What will happen if all non-renewable sources of energy are exhausted?	Applies learning to given hypothetical situations in order to solve problems /give possible solutions.	S10.15.ES.02	Tabulate the organisms feeding on one another (producers, consumers, decomposers) and energy transfer between them, in order to form a food chain or a food web	S10.15.ES.02.1			Yes	
			Ozone Layer and how it is getting depleted	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion, applies concept of decomposition	Applies learning of scientific concepts in daily life in order to solve problems.	S10.15.ES.03	Describe the formation & properties of ozone, in order to identify ways to protect it from depletion	S10.15.ES.03.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				reaction of baking soda to make spongy cakes, etc.								
			Ecosystem - What are its components? Food Chains and Webs	Makes efforts to conserve environment realizing the inter-dependency and interrelationship in the biotic and abiotic factors of environment, such as appreciates and promotes segregation of biodegradable and non - biodegradable wastes, takes steps to promote sustainable management of resources in day to day life, advocates use of fuels which produces less pollutants, uses energy efficient electric devices, uses fossil fuels judiciously, etc.	Realises the interdependency and interrelationship in the biotic and abiotic factors of environment and applies it in order to make efforts to promote conservation of environment.	S10.15.ES.04	Classify biotic and abiotic components and their interaction with each other, in order to describe an ecosystem	S10.15.ES.04.1	Yes			
							Tabulate the organisms feeding on one another (producers, consumers, decomposers) and energy transfer between them, in order to form a food chain or a food web	S10.15.ES.04.2			Yes	
16	Sustainable Management of Natural Resources	Earth Sciences	Water for all	Explains processes and phenomena, such as nutrition in human beings and plants, transportation in plants and plants, transportation in plants and animals, extraction of metals from ores, placement of elements in modern periodic table, displacement of metals from their salt solutions on the basis of reactivity series, working of electric motor and generator, twinkling	Explains processes and phenomena in order to relate to science behind the phenomena /processes and develop a keen interest in the science in daily life.	S10.16.ES.01	Explain the construction and use of dams and water harvesting, in order to devise an efficient plan to conserve water	S10.16.ES.01.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				of stars, advance sunrise and delayed sunset, formation of rainbow, etc.								
			Why Do We Need To Manage Our Resources? Coal and petroleum	Applies learning to hypothetical situations, such as what happens if all herbivores removed from an ecosystem? What will happen if all non-renewable sources of energy are exhausted?	Applies learning to given hypothetical situations in order to solve problems /give possible solutions.	S10.16.ES.02	Explain sustainable development, in order to conserve natural resources for future generations	S10.16.ES.02.1	Yes			
							List down the disadvantages of using coal and petroleum as energy sources, in order to develop a better plan of generating energy	S10.16.ES.02.2	Yes			
			The five R's	Applies scientific concepts in daily life and solving problems, such as takes precautions to prevent sexually transmitted infections, uses appropriate electrical plugs (5 /15a) for different electrical devices, uses vegetative propagation to develop saplings in gardening, performs exercise to keep in good health, avoids using appliances responsible for ozone layer depletion, applies concept of decomposition reaction of baking soda to make spongy cakes, etc.	Applies learning of scientific concepts in daily life in order to solve problems.	S10.16.ES.03	Identify the 5 R's (refuse, reduce, reuse, repurpose, recycle), in order to employ one of these methods to make environment-friendly choices	S10.16.ES.03.1	Yes			
			Forests and Wildlife	Makes efforts to conserve environment realizing the inter-dependency and interrelationship in the biotic and abiotic	Realises the interdependency and interrelationship in the biotic and abiotic factors of environment and	S10.16.ES.04	Identify different stakeholders involved in a forest, in order to prepare a conservation plan for forests	S10.16.ES.04.1	Yes			

Chapter No.	Chapter Name	Strand	Concept/ topic	Learning Outcomes	Measuring the Learning Outcomes	Code	Learning Objectives	Learning Outcome code	Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically	Suggestive example of pedagogical strategies
				factors of environment, such as appreciates and promotes segregation of biodegradable and non - biodegradable wastes, takes steps to promote sustainable management of resources in day to day life, advocates use of fuels which produces less pollutants, uses energy efficient electric devices, uses fossil fuels judiciously, etc.	applies it in order to make efforts to promote conservation of environment.							

8. CONCLUSION

This learning framework contributes to Indian education by introducing and unpacking competency-based education which is a valid approach to prepare students for the rapidly changing future.

8.1. Summary

Chapter 1 introduces competency-based teaching and learning. It outlines how technological advancement has drastically altered the landscape of education. The focus of education is gradually shifting from rote learning and acquisition of skills to problem solving rooted in critical thinking and creativity. Competency-based teaching and learning, with its student-centric paradigm, is identified as a useful alternative to the traditional curriculum-based pedagogy in helping students to navigate the dynamic challenges that they are expected to encounter in a technology-driven world. PISA is introduced as an internationally accepted best practice in competency-based assessment. Participation in PISA, with its strong foundation in competency-based learning framework, is identified as a useful starting point for India to embark on competency-based pedagogic practices in its classrooms.

Chapter 2 discusses science education as an integral part of school education. With the onset of the 21st century, people across the world recognise the need to change how science education is imparted to future generations. Teaching and learning science is no longer considered as mere acquisition of knowledge and scientific principles or a way to prepare students for a career in science. Often a lack of motivation has been observed among students to study science mainly due to the way science teaching and learning happen in the classroom with more focus on rote learning of principles and theories rather than application of the knowledge acquired. The objective of science education in the present context is to raise scientifically literate students who can gain an understanding of the natural world around them, be able to engage with society in decision making matters and voice their opinions and concerns with respect to matters that impact their lives. It therefore becomes imperative to define the competencies of science education for a common understanding of all stakeholders in order to facilitate science teaching and learning in a way envisioned in the educational policies.

Chapter 3 explains that as much as defining scientific literacy is important, equally important is to understand the key skills and competencies essential to raise scientifically literate individuals. The attributes of science like critical thinking and problem solving are the key skills that equip students to deal with the challenges facing mankind in areas of maintenance and sustainability of the environment, health issues, and shortage of essential resources. PISA describes key competencies and sub-skills that a scientifically literate person would need to perform successfully in today's world. Therefore, these competencies have been adopted in this framework for designing competency-based learning in Science. India's National Education policy 2020 also emphasises a shift from traditional content learning to instilling skills and attitudes that encourage students to think innovatively, explore, seek explanation and make decisions in the light of available evidence.

Chapter 4 describes why scientific competencies are important to raise globally competent individuals. Students of today should progress beyond the conventional competencies required to progress academically. They should be literate enough to make conscious decisions that are scientifically valid and acceptable to the global community. Keeping this in mind, PISA tries to assess the students across nations in terms of their key cognitive skills such as investigation and reasoning, critical thinking, decision-making, analysis and exploration of information. The three scientific competencies designed by PISA to measure the discussed skills are based on the understanding that true scientific education has creativity, critical thinking, values and emotions at its core.

Education systems across the world emphasise a shift from the traditional methods of classroom teaching to the modern inquiry-based education where the focus is on elements like decision making, critical thinking, hypothesizing, etc. Different researchers and education reformers have proposed different teaching strategies for encouraging inquiry-based learning in the classroom. Teachers with the right professional training, support and resources can find the best strategies for their context. The objective is to adopt strategies that can stimulate scientific literacy among the students within a classroom environment.

Chapter 5 explains why PISA describes *proficiency levels* for measuring scientific literacy. The proficiency levels are preferred for assessing students' scientific ability rather than performance levels since they describe what students typically know and can do at given levels of proficiency, rather than how the students actually perform on a single test administration. A scientific literacy scale is provided and the different proficiency levels are defined statistically within the scientific literacy scale. This chapter also includes PISA sample items for scientific literacy along with some additional competency-based sample items aligned to the NCERT learning outcomes.

Chapter 6 discusses the use of assessment in the teaching-learning process. Assessment is a key component of any educational programme. Regular assessments are important to understand students' achievements and monitor their educational path over time. Assessments also play an important role in providing feedback to students in order to help them achieve the desired goals of learning. For this, assessment tools or tasks need to be tailored or designed according to the purpose of the assessment so as to provide a true picture of what the students know and can do. This becomes more relevant if the purpose of the assessment is to assess key competencies in students. A collaborative research oriented approach among teachers can help them create valid, reliable and robust assessments. A clear road map explicitly describing the competencies aligned with the learning progressions can serve as an effective tool to help teachers assess and evaluate students in a comprehensive manner.

Chapter 7 maps the NCERT learning outcomes, the measurable learning outcomes and the CBSE defined learning objectives with the PISA scientific competencies. It also contains the suggested examples of some pedagogical strategies that are described in detail within chapter 4 if relevant to the learning objectives.

8.2. Suggestions for teaching Science

Traditional practices in science teaching focus on the mastery of scientific concepts, definitions, and explanations of phenomena. The improvisation of this approach, with the help of competency-based learning suggested in this framework, can help prepare young learners for future needs. Throughout the framework, stress is on helping students to attain scientific competencies. In chapters 4, 5 and 6, strategies to prepare a scientifically literate generation are suggested. **Inquiry-based teaching models** form the core of the teaching strategies suggested in the framework.

It is recommended that teachers activate inquiry skills in students. Studies have shown that inquiry-based science education results in triggering the scientific competencies within the students. Inquiry-based teaching enables learners to think critically, resulting in better control of their learning. They help students' master science by connecting scientific facts, procedures, and phenomena. They focus on the method of problem-solving rather than on finding the correct answer. One of the results of activation of inquiry skills in science is the enhancement of the capability of a student to ask questions and to design investigative methods to find the answer.

Reasoning is considered as a core skill in being scientifically literate. The framework contains specific strategies to enhance scientific reasoning in students. Reasoning skills can be activated through teaching strategies like using experiments, inductive learning of the concepts and establishing an in-depth understanding. It is not only important for students to be able to perform

an experiment, what is more important is how carefully a student makes observations, inspects different variables, records data, makes conclusions in the light of evidence and is able to communicate the results effectively. Key skills picked up in each task are more important than the final result of the experiment.

A competency-based assessment is focussed on getting information about young learners' preparedness to solve real-life problems. By allowing opportunities to students to ask questions, set up experiments on their own, collect data and make conclusions, and above allowing opportunities to make mistakes could go a long way in instilling scientific temper and a natural inquisitiveness in students. One of the key recommendations of the framework is to use learning progressions to bridge the gap between student knowledge and curriculum expectations. Learning progressions help teachers to see the bigger picture of science education and guide students throughout their developmental process. It is recommended that teachers use rubrics to collect evidence of student progress as well as receive feedback on instructional practices implemented in the classroom. It is suggested that teachers develop rubrics based on learning outcomes rather than specific tasks as it will help them to synchronise teaching-learning and assessment with the desired outcomes. A well-defined rubric should have criteria linked with the proficiency required to complete the task and non-overlapping performance levels indicating the progress of capabilities.

It is clear that society needs to educate the new generation of learners in a different way to prepare for the great uncertainty they will face in a technology-driven world. We hope that the details of competency-based education unpacked in this learning framework will help India achieve this objective.

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ANNEXURE

Brief suggestions for teaching

In this section we will discuss how specific learning outcomes for Grades 6 to 10 can be taught in classrooms using the teaching strategies outlined in Chapter 4. While the inquiry-based models of teaching can be used to teach the strategies in classrooms, specific methods can be used during the practice of each strategy. While these have already been described in Chapter 4, this section seeks to demonstrate the methods in detail using specific sample items as examples.

One learning outcome is chosen for each grade to demonstrate a strategy and its implementation. Most learning outcomes encompass a variety of PISA competencies and can be taught using a combination of these strategies. However, in order to demonstrate the application of each strategy, certain aspects of the learning outcomes are focused on and appropriate strategies or methods that are found most suitable for teaching those are elaborated.

Grade 6 – Life Science

NCERT Learning outcome:

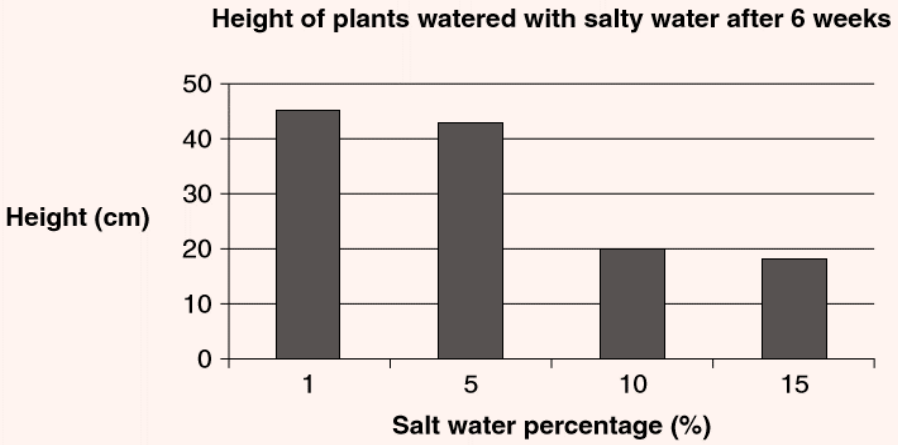
Relates processes and phenomenon with causes.

PISA Competency:

- Explain phenomena scientifically
- Interpret data and evidence scientifically

Sample Item:

Ahmed watered four plants of the same type with salty water.
Each plant received a different amount of salt in the water.
He measured how tall the plants grew.
Ahmed graphed his results after 6 weeks.



14 Which is the best conclusion Ahmed can make from his graph?

A Salt water always stops the plants from growing.
B The plants watered with more than 5% salt do not grow.
C The plants grow best with a small amount of salt.
D More than 15% salt in the water would kill the plants.

Source 0-1: Copyright © 2012 Australian Council for Educational Research

The sample item assesses whether students can analyse data from a graph for a given experiment and then derive an appropriate conclusion from the data.

Suggested Teaching Strategy:

1. *Experimentation* where students are engaged in activity based learning emphasizing on the various steps of an experiment, i.e. hypothesis, experiment, observation, analysis and conclusion.
2. *Inquiry-based learning* where students have opportunities to explore possible solutions, develop explanations for the phenomena under investigation, elaborate concepts and processes, and evaluate or assess their understandings in the light of available evidence.
3. *Inductive approach* where students first encounter the attributes and examples of an idea and then describe and explain the idea.

Grade 7 – Physical Science

NCERT Learning outcome:

Explains processes and phenomena.

PISA Competency:

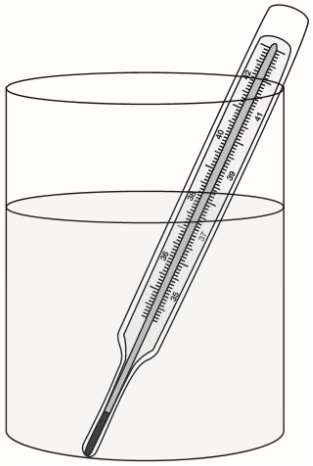
- Explain phenomena scientifically

Sample Item:

A thermometer sits in a glass of hot water.

Why does the liquid inside the thermometer rise?

A Gravity pushes it up.
B Air bubbles are released.
C Heat from the water makes it expand.
D Air pressure above the water pulls it up.



Source 0-2: Copyright © 2012 Australian Council for Educational Research

The sample item assesses whether students understand that liquids expand on heating.

Suggested Teaching Strategy:

1. *Experiential learning* where students are engaged in hands-on experiences and reflections that, in turn, help them to connect theories and knowledge learned in the classroom to real-world situations.
2. *Inductive approach* where students first encounter the attributes and examples of an idea and then describe and explain the idea.
3. *Spiral learning* where students are encouraged to process thoughts through multi-layered challenges, stimulate them to ask questions, and then find answers to those.

Grade 8 – Physical Science

NCERT Learning outcome:

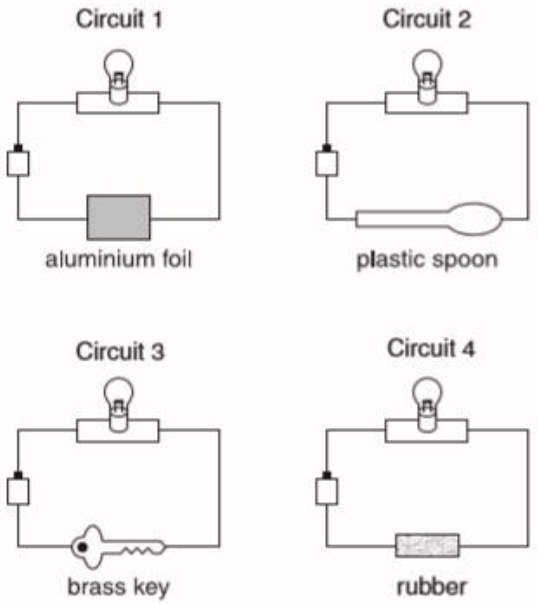
Differentiates materials on the basis of their properties, structure and functions.

PISA Competency:

- Explain phenomena scientifically

Sample Item:

The circuit diagrams show a battery and a bulb connected by wires to various materials.



3 In which circuit(s) will the bulbs light?

A Circuit 1 only
B Circuits 1 and 2 only
C Circuits 1and 3 only
D Circuits 1 and 4 only

Source 0-3: Copyright © 2012 Australian Council for Educational Research

The sample item assesses whether the students can identify and differentiate between electrical conductors and insulators and then predict an outcome based on the role of a conductor in an electrical circuit.

Suggested Teaching Strategy:

1. *Experiential learning* where students are engaged in hands-on experiences and reflections that, in turn, help them to connect theories and knowledge learned in the classroom to real-world situations.
2. *Spiral learning* where students are encouraged to process thoughts through multi-layered challenges, stimulate them to ask questions and then find answers to those.
3. *Differentiated instruction* where students are divided into groups on the basis of their level of understanding of a particular concept and then taught about the concept in accordance with their level.

Grade 9 – Life Science

NCERT Learning outcome:

Analyses and interprets graphs/ figures etc.

PISA Competency:

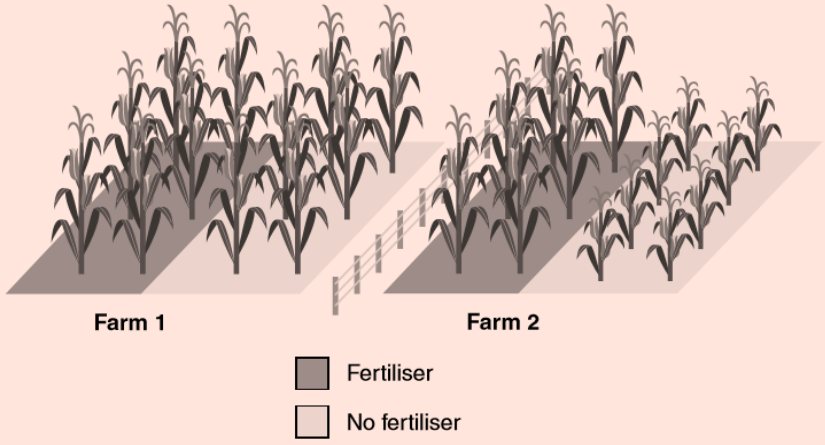
- Interpret data and evidence scientifically

Sample Item:

Two farmers each used fertiliser on **half** of their field. Both farmers planted corn on their **whole** field.

On Farm 1 all the corn grew tall.

On Farm 2 only the fertilised corn grew tall.



39 What is the most likely reason for the differing results on Farm 1 and Farm 2?

A Farm 2 did not get the same amount of sunlight.
B The soil on Farm 1 did not need the fertiliser.
C Farm 1 got more water than Farm 2.
D Farm 1 did not get as much fertiliser as Farm 2.

Source 0-4: Copyright © 2012 Australian Council for Educational Research

The sample item assesses whether the students can analyse data from a diagram for a given experiment and then derive an appropriate conclusion from the data.

Suggested Teaching Strategy:

1. *Experimentation* where students are engaged in activity based learning emphasizing on the various steps of an experiment, i.e. hypothesis, experiment, observation, analysis and conclusion.
2. *Inquiry-based learning* where students have opportunities to explore possible solutions, develop explanations for the phenomena under investigation, elaborate concepts and processes, and evaluate or assess their understanding in the light of available evidence.
3. *Differentiated instruction* where students are divided into groups on the basis of their level of understanding of a particular concept and then taught about the concept in accordance with their level.

Grade 10 – Life Science

NCERT Learning outcome:

Exhibits values of honesty/ objectivity/ rational thinking/ freedom from myth/ superstitious beliefs while taking decisions, respect for life.

PISA Competency:

- Evaluate and design scientific enquiry

Sample Item:

S423: Mousepox

There are many types of pox viruses that cause pox diseases in animals. Each type of virus usually infects only one animal species. A magazine has reported that a scientist has used genetic engineering to modify the DNA of mousepox. The altered virus kills all the mice it infects.

The scientist says research on modifying viruses is necessary in order to control pests that damage human food. Critics of the research say viruses could escape from laboratories and infect other animals. They are also worried that a modified pox virus for one species could infect other species, especially humans.

Humans are infected with a pox virus called smallpox. Smallpox kills most people it infects. While it is thought that this disease has been eliminated from the general population, smallpox virus samples are kept in laboratories around the world.

Question 3: MOUSEPOX *S423Q03*

One company is trying to develop a virus that will make mice sterile (i.e., unable to have babies). Such a virus could help control the number of mice.

Suppose the company is successful. Should the following questions be answered by research before releasing the virus? Circle "Yes" or "No" in each case.

Should this question be answered before releasing the virus?	Yes or No?
What is the best method for spreading the virus?	Yes / No
How soon will mice develop immunity to the virus?	Yes / No
Will the virus affect other animal species?	Yes / No

Source 0-5: Copyright © 2006 PISA sample items, OECD

The sample item assesses whether the students can evaluate and then identify the scientific information required for addressing the basic safety parameters of a vaccine before its release in the society.

Suggested Teaching Strategy:

1. *Inductive approach* where students first encounter the attributes and examples of an idea and then describe and explain the idea.
2. *Cooperative learning* where students sit in small groups that work together in such a way that each group member's success is dependent on the group's success.
3. *Inquiry-based learning* where students have opportunities to explore possible solutions, develop explanations for the phenomena under investigation, elaborate concepts and processes, and evaluate or assess their understanding in the light of available evidence.