Subject: PHYSICS (042)
Marking Scheme
Class – XII
Academic Session 2026–27

Maximum Marks: 70 **Time Allowed: 3 hours**

Q. No	SECTION A	Marks
1.	C. remain the same According to Gauss's Law, electric flux, $$\Phi = \frac{Q}{\varepsilon_0}$$ Flux depends only on the enclosed charge, not on the shape or size of the Gaussian surface. Therefore, doubling the radius does not change the flux.	1
2.	C. 2000 W For a parallel combination , $P = P_1 + P_2$ $= 1000 + 1000 = 2000$ W	1
3.	C. No current will be induced As the cylinder is kept stationary and also the magnetic field is uniform. The flux linked with the cylinder is not changing, so no current is induced in the cylinder.	1
4.	A. $\hat{\imath}$ The direction of propagation of electromagnetic waves is given by –ω/k and is along x axis as equation of wave is a function of x	1
5.	D. Origin of spectra All three can be explained by Huygens' construction of wave front but Origin of spectra cannot.	1
6.	C. Plane As star will act as distance point source hence wavefront detected will be plane.	1
7.	B. They are the most tightly bound nuclei. A maximum in binding energy per nucleon means these nuclei are the most stable and most tightly bound. • They do not undergo spontaneous fission (that's typical for very heavy nuclei like uranium). • They are certainly not the least stable — in fact, they are the most stable. • They can still participate in nuclear reactions, but they are at the "energy valley," so both fusion (lighter nuclei) and fission (heavier nuclei) tend to release energy by moving toward iron.	1

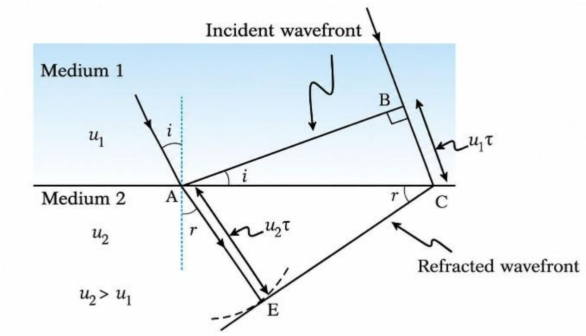
8.	D. Away from the bar magnet and opposite to that of bar magnet As the ball is dipped in liquid nitrogen, its temperature becomes less than the critical temperature and it becomes a superconductor. In this state, the ball becomes diamagnetic.	1
9.	B. 5 A The Wheatstone bridge is balanced, because $\frac{2\Omega}{4\Omega} = \frac{3\Omega}{6\Omega}$. The 5 Ω resistance is ineffective, we now have- (2 Ω + 4 Ω) and (3 Ω + 6 Ω) resistances in parallel. $R_{AB} = \frac{6 X 9}{6+9} = \frac{18}{5}\ \Omega$ Now, I= V/R Or, I= $\frac{18}{18/5}$A =5A **<u>For Visually Impaired Students only</u>** B. R In the balanced condition, the resistance R of the galvanometer is ineffective. We have (R+R) and (R+R) resistances in parallel. $R_{eq} = \frac{2R\ X\ 2R}{2R+2R} = R$	1
10.	A. 5:3 Here P_1=60 W , P_2=100 W $R_1 = \frac{V^2}{P_1}$ and $R_2 = \frac{V^2}{P_2}$ $\therefore \frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{100}{60} = 5:3$	1
11.	C. 22 km Typical **nuclear radius** ≈ 10^{-15}m (1 femtometer). Atom radius (electron orbit, roughly Bohr radius) ~ 10^{-10} m Ratio of atom size to nucleus size ~ 10^5. Football (nucleus) radius ~ 22 cm = 0.22 m. Multiply by 10^5 $0.22\text{m} \times 10^5 = 22{,}000\text{m} = 22\text{km}$.	1
12.	C. 5 π μ T **B** $= \frac{\mu_0 I}{4R} = \frac{4\pi \times 10^{-7} \times 5}{4 \times 0.10} T = 5\pi \times 10^{-6}\ T = 5\ \pi\ \mu\ T$	1

	For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. A. both Assertion and Reason are true and Reason is the correct explanation of Assertion. B. both Assertion and Reason are true but Reason is not the correct explanation of Assertion. C. Assertion is true but Reason is false. D. both Assertion and Reason are false.	
13.	B. both Assertion and Reason are true but Reason is not the correct explanation of Assertion. Explanation: Both are true; most of the space is empty (nucleus tiny), so alpha particles pass undeflected; electron mass has negligible deflecting effect on energetic alpha particles, as reason for statement is "most of the space is empty (nucleus tiny)"	1
14.	A. both Assertion and Reason are true and Reason is the correct explanation of Assertion. Explanation: Both true and R explains A; lens maker's formula uses relative index ($\frac{\mu_{lens}}{\mu_{medium}}$ - 1), so in water the relative refractive index decreases and f increases.	1
15.	C. Assertion is true but Reason is false Fringe width in YDSE is inversely proportional to the slit separation and directly proportional to the wavelength of light.	1
16.	D. both Assertion and Reason are false. Electrons in a conductor move freely. When an external field is applied, charges rearrange until the internal field they create exactly cancels the external field. This is the reason the net internal field becomes zero.	1
	SECTION B	
17.	I. Refractive index of medium (μ) = $\frac{c}{v_{medium}}$ C= 3×10^8m/s $V_{medium} = \frac{2\pi \times 10^{18}}{\pi \times 10^{10}}$ = 2×10^8 m/s μ = $\frac{3 \times 10^8}{2 \times 10^8}$ = 1.5 II. Angular frequency (ω)= $2\pi \times 10^{18}$ rad s^{-1}	½ ½ ½

	Or, $2\pi\nu = 2\pi \times 10^{18}$ rad s^{-1} Or, $\nu = 10^{18}$ s^{-1} - This frequency correspond to X Ray	½
18.	The nature of the path of free electrons in a conductor differs depending on whether an electric field is present or not: a. In the presence of an electric field • Free electrons experience a net force opposite to the direction of the electric field. • This causes them to drift slowly in the direction opposite to the field (since electrons are negatively charged). • Despite this drift, electrons still undergo frequent collisions with atoms in the conductor, resulting in a zigzag or random motion superimposed with a net drift. • This net movement of electrons constitutes an electric current. b. In the absence of an electric field • Electrons move randomly due to thermal energy. • There is no net movement of electrons in any particular direction. • The motion is random and chaotic, similar to the movement of gas molecules. • As a result, no electric current flows in the conductor.	1 1
19.	At the midpoint, distance from both charges is d/2 Potential due to one charge +q at the midpoint of the line: $V_1 = \frac{kq}{\frac{d}{2}} = \frac{2kq}{d}$ Potential due to both charges; $V = 2 \times \frac{2kq}{d} = \frac{4kq}{d}$ Work done by external gent : $W = qV = q\left(\frac{4kq}{d}\right) = 4kq^2/d$	½ ½ ½ ½
20(A)	Given: Relative magnetic permeability, μ_r=800 Since the relative permeability is much greater than 1, the material is a ferromagnetic material. Properties: 1. Ferromagnetic materials are strongly attracted by a magnetic field because they have a very high value of magnetic permeability. 2. They can retain magnetism even after the external magnetic field is removed, meaning they show hysteresis and can be made into permanent magnets.	1 ½ x2

20(B)	Gauss's law for magnetism states that the net magnetic flux through any closed surface is always zero: $\Phi_B = \oint \vec{B} \cdot d\vec{S} = 0$ This means that the magnetic field lines neither begin nor end at any point. Significance: • Magnetic monopoles do not exist • Magnetic field lines always form continuous loops	1 ½ x 2
21(A)	I. Hydrogen spectral lines are considered to be a fingerprint of the element because they represent the unique set of colored lines emitted when hydrogen atoms transit between energy levels. This phenomenon, known as the line spectrum, is a result of the quantized energy levels of electrons in the hydrogen atom. Each spectral line corresponds to a specific energy transition, and the distinct pattern of these lines allows for the identification of hydrogen in various environments. II. The minimum energy of a photon that can ionize an electron in a hydrogen atom is 13.6 eV. This is the ionization energy required to remove the electron from its ground considering all the energy is transferred to electron.	1
21(B)	Postulate: Bohr postulated that electrons revolve around the nucleus in certain discrete circular orbits without radiating energy. His quantization condition is: mvr = $\frac{nh}{2\pi}$ Where: • m = mass of the electron • v = velocity of the electron • r = radius of the orbit • n = principal quantum number Explanation of stationary orbits using de Broglie hypothesis: According to de Broglie, a moving electron behaves like a matter wave with wavelength: $\lambda = h/mv$ For an orbit to be stable (stationary), the electron wave must form a standing wave around the nucleus. This is possible only when the circumference of the orbit is an integral multiple of the wavelength: $2\pi r = n\lambda$ Substituting $\lambda = h/mv$	 1 1

	$2\pi r = nh/mv$ Or, $mvr = nh/2\pi$ This is exactly Bohr's quantization condition. Hence, de Broglie hypothesis explains Bohr's stationary orbits as those orbits in which the electron's matter wave forms a standing wave, leading to stable, non-radiating orbits.	
	SECTION C	
22.	Metals: Overlapping bands or partially filled conduction band; free electrons yield high conductivity. Insulators: Large band gap; negligible thermal excitation at room temperature; poor conductivity. Semiconductors: Moderate band gap; thermally/optically excited carriers; conductivity can be varied with doping. Diamond vs tin: Diamond (C): Strong network, large gap (~ 5.4 eV); insulator at room temperature. Tin (Sn): Metallic bonding with overlapping bands; conductor due to available states at Fermi level. Conclusion: Band gap magnitude controls room-temperature carrier availability and hence conductivity.	1 1 1
23.	I. The internal resistance of a car battery decreases with increase in temperature. Therefore, on a warm day a car battery gives large current which helps in starting the car engine. II. It is because our body is sensitive to minute currents even as low as a few mA. III. When the temperature of the heater becomes greater than the temperature of its surroundings, it begins to lose heat to surroundings. A stage is reached when the rate of production of heat becomes equal to the rate of loss of heat and the temperature becomes constant.	1 1 1
24.	Z= 8 protons, N= 8 neutrons. Sum of nucleon masses: $m_pZ + m_nN = 8(1.00727) + 8(1.00866)$ $=8.05816 + 8.06928 = 16.12744$ u Mass defect $\Delta m = 16.12744 - 15.99493 = 0.132514$ Binding energy $B = \Delta m \times 931.5 = 0.13251 \times 931.5 \approx 123.4$ MeV Binding energy per nucleon $\frac{B}{A} = \frac{123.4}{16} \approx 7.71$ MeV	1 1 1

25.	For diamond, refractive index μ=2.42 Critical angle $\Theta_c = \sin^{-1}\frac{1}{2.42}$ Or, $\Theta_c < 30^0$ I. Given incidence angle: 30^0. Since $30^0 > \Theta_c$, the ray exceeds the critical angle Hence, the ray will undergo Total Internal Reflection (TIR) inside the diamond. II. A well-cut diamond has facets (the flat faces) angled just right so that light hitting them reflects back inward (TIR) instead of leaking out the sides or bottom. So the light gets trapped inside the piece of diamond.	1 1
26.	Huygens' principle: Every point on a wavefront acts as a source of secondary wavelets, and the new wavefront at a later time is the common tangent (envelope) to these wavelets.  Consider a plane wavefront AB incident on the boundary between two media at an angle of incidence i. • Velocity of light in medium 1 = v_1 • Velocity of light in medium 2 = v_2 • Angle of refraction = r Let point A of the wavefront strike the boundary first. After time t: • Point B(still in medium 1) advances to C, where $BC = v_1 t$ • From point A, a secondary wavelet grows into medium 2 with radius $AE = v_2 t$ The refracted wavefront is the tangent CE drawn to the wavelet from A. From the geometry of the figure: Sin i $= \frac{BC}{AC}$; Sin r = $\frac{AE}{AC}$ Or, $\frac{Sin\ i}{Sin\ r} = \frac{BC}{AE} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2}$ But the refractive index n of a medium is defined as	 1 1

	$n = \frac{c}{v}$ hence, $\frac{v_1}{v_2} = \frac{n_1}{n_2}$ Therefore, $$n_1 \sin i = n_2 \sin r$$ This is Snell's law of refraction. Prediction of wave theory later experimentally verified The wave theory of light (from Huygens' construction) predicted that light travels more slowly in an optically denser medium than in a rarer medium: $$v \propto \frac{1}{n}$$ This prediction was experimentally verified by Foucault (and later Fizeau), who showed that the speed of light in water is less than its speed in air—contradicting the earlier corpuscular (Newtonian) theory.	1
27(A)	I. The original ammeter can be treated as the galvanometer. $S = \frac{I_g G}{I - I_g}$ $= \frac{100 X 13}{750-100}$ $= \frac{1300}{650} = 2\ \Omega$ II. To provide electromagnetic damping. The induced currents set up in the metal frame help to damp the oscillation of the coil in the magnetic field.	1 ½ ½ 1
	OR	
27(B)	I. Magnetic dipole moment SI unit: ampere metre^2 (Am^2) or joule per tesla (JT^{-1}) II. Pole strength, $q_m = \frac{m}{l}$ When the wire is bent into a semicircular arc, the separation between the poles changes from l to 2r, where r is the radius of the semicircular arc. $l = \pi r$ $r = \frac{l}{\pi}$ New magnetic moment = $q_m \times 2r$ $= \frac{m}{l} \times \frac{2l}{\pi}$ $= \frac{2m}{\pi}$	½ ½ ½ ½ ½ ½
28.	I. As the magnet falls, the magnetic flux linked with the copper ring increases. The current induced in the ring opposes the downward motion of the magnet. II. Self Inductance, $L \propto \frac{N^2 A}{l}$ Here $N \rightarrow 5N$ Area as square of linear dimension, $A \rightarrow 5^2 A = 25\ A$	1 ½

		Magnetic path Length, l →5l $\frac{L'}{L} = \frac{(5N)^2.25A/5l}{N^2A/l}$ $=\frac{25\ X\ 25}{5}$ =125 L' = 125 L	½ ½ ½
		SECTION D	
29.	I.	**C. Low power consumption and reliability** Wearable devices need to operate continuously with minimal energy usage and dependable performance, which semiconductors provide.	1
	II.	**B. Diamond's band gap is too large for thermal excitation at room temperature.** Because of its large band gap, diamond does not allow sufficient charge carriers to be generated at room temperature, making it unsuitable as a semiconductor	1
	III.	**C. Number of electrons equals number of holes.** In intrinsic semiconductors, electrons and holes are generated in pairs, so their numbers are equal.	1
	IV.	In polymer semiconductors, electrical conduction mainly occurs due to **majority carriers** (electrons in n-type or holes in p-type materials). By controlling the concentration and mobility of these carriers, polymer semiconductors can conduct electricity efficiently even when bent or stretched. Minority carriers play a role in recombination processes and stability. This balance allows polymer semiconductors to function reliably at low power, making them well-suited for flexible, lightweight, and wearable technologies such as smart clothing and medical patches.	1
30.	I.	The **work function (ϕ_0)** of a metal is the **minimum energy required to remove an electron from the surface of the metal** so that it just escapes with zero kinetic energy.	1
	II.	Increasing light intensity increases the **number of photons**, not the energy of each photon. Since the energy of a photon depends only on its **frequency**($E = h\nu$), the **maximum kinetic energy** of emitted electrons depends only on frequency, not intensity. Higher intensity only increases the number of emitted electrons (photoelectric current).	1
	III.	C. Electrons are emitted with maximum kinetic energy greater than 0 eV. Photon energy: $E = h\nu \approx 4.14 \times 10^{-15} \times 1.2 \times 10^{15} \approx 5$ eV Maximum kinetic energy: $K_{\max} = E - \phi_0 = 5 - 2 = 3$ Ev	1

	IV. D. (Both B and C) • B: Maximum kinetic energy depends only on frequency, not intensity • C: Electrons are emitted instantaneously Both observations cannot be explained by classical wave theory and support the particle nature of light	1
	SECTION E	
31(A)	I. An isolated conductor cannot have a large capacitance because its capacitance depends directly on its size (radius). For an isolated sphere: $C=4\pi\varepsilon_0 R$ Since ε_0 is a constant, the only way to increase capacitance is by increasing R (the radius). A very large capacitance would require an extremely large-sized conductor**,** which is not practically possible. Therefore, an isolated conductor always has a small capacitance**.** II. i. For minimum capacitance, the three capacitors must be connected in series, $\frac{1}{C_{min}} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18} = \frac{6}{18} = \frac{1}{3}$ $C_{min} = 3\ \mu F$ ii. For maximum capacitance, the three capacitors must be connected in parallel, $C_{max} = 6 + 9 + 18 = 33\ \mu F$ III. The other two factors on which capacitance of a parallel plate capacitor depends, are- i. Distance between the plates (C α 1/d) ii. Permittivity of the medium between the plates (C α ε)	½ ½ ½ ½ ½ ½ ½ ½ ½ x 2
	OR	

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<td>31(B)</td>
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I. Consider a small positive charge +q placed in an electric field $\vec{E}$. Suppose it is displaced through a very small distance *dx* in the direction of the field.

Force on the charge, $\vec{F}$ =q$\vec{E}$

Work done by the electric field in moving the charge through distance *dr,*

$$dW = \vec{F}.d\vec{r} = qE.dr \quad ......(1)$$

Here,the change in electric potential ,

$$dV = -\frac{dW}{q}$$

From (1)-

$$dV = -\frac{qE.dr}{q}$$

$$dV = -E.dr$$

$$\Rightarrow \quad E = -\frac{dV}{dr}$$

i.e. The electric field at any point is equal to the negative gradient of electric potential at that point.

II. Potential gradient, $\frac{dV}{dr}$ = 2.5 x 10^6 Vm^{-1}

$$dV = 2.5 \times 10^6 \, dr$$

$$V = 2.5 \times 10^6 \, r$$

$$r = \frac{V}{2.5 \times 10^6}$$

$$= \frac{5 \times 10^5}{2.5 \times 10^6}$$

$$r = 2 \times 10^{-1} = 0.2 \text{ m}$$

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<td>32(A)</td>
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I. Position of the image formed by the objective lens

Using the lens formula:

$$\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$$

$$\frac{1}{2} = \frac{1}{v_o} - \left(\frac{1}{-2.2}\right)$$

$$\frac{1}{v_o} = \frac{1}{2} - \frac{1}{2.2}$$

$$\frac{1}{v_o} = \frac{2.2 - 2}{4.4} = \frac{0.2}{4.4}$$

$$v_o = 22 \text{ cm}$$

Image formed by the objective lens is at 22 cm from it.

II. Magnifying power of the microscope (final image at infinity)

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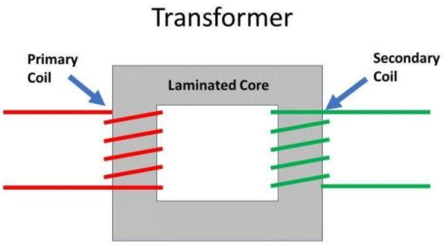
	Magnifying power of a compound microscope: $$M = \left(\frac{v_o}{u_o}\right)\left(\frac{D}{f_e}\right)$$ where $D = 25$ cm(least distance of distinct vision) $$M = \left(\frac{22}{2.2}\right)\left(\frac{25}{5}\right)$$ $$M = 10 \times 5 = 50$$ Magnifying power of the microscope = 50 III. A compound microscope provides much higher magnification than a simple magnifier because: A compound microscope uses two lenses: • The objective lens produces a highly magnified real image of a very small object. • The eyepiece lens further magnifies this image. Thus, the total magnification is the product of the magnifications of the objective and the eyepiece, making it much greater than that of a simple magnifier, which uses only a single lens.	
	OR	
32(B)	Given: Focal length of objective lens, $f_o = 100$ cm Focal length of eyepiece lens, $f_e = 5$ cm Least distance of distinct vision, $D = 25$ cm I. Magnifying power when final image is formed at infinity For an astronomical telescope (normal adjustment): $$M = \frac{f_o}{f_e}$$ $$M = \frac{100}{5} = 20$$ Magnifying power = 20 II. Magnifying power when final image is formed at the least distance of distinct vision $$M = \frac{f_o}{f_e}\left(1+\frac{f_e}{D}\right)$$ $$M = \frac{100}{5}\left(1+\frac{5}{25}\right)$$ $$M = 20(1+0.2) = 20 \times 1.2 = 24$$ Magnifying power = 24 III. Reason for design of objective and eyepiece in an astronomical telescope	2+2+1

	• The objective lens is made with a large focal length to produce a highly magnified real image of distant celestial objects and with a large aperture to collect more light, increasing brightness and resolution. • The eyepiece lens has a small focal length so that it can further magnify the image formed by the objective. This combination results in high magnifying power and a brighter, clearer image of distant astronomical objects.	
33(A)	I. Device: Step–up transformer  Principle – Mutual induction: When an alternating current flows in the primary coil, it produces a time-varying magnetic flux in the soft iron core. This changing flux links with the secondary coil and, by Faraday's law of electromagnetic induction, an emf is induced in the secondary. For an ideal transformer : $$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$ If $N_s > N_p$, then $V_s > V_p$: the transformer steps up the voltage. Because in an ideal transformer- $P_{in} = P_{out} \Rightarrow V_pI_p = V_sI_s$, The law of conservation of energy is not violated: when voltage increases, current decreases correspondingly. II. Working mechanism: • The primary coil is supplied with an alternating voltage. • This produces an alternating magnetic field in the core. • The changing magnetic flux linked with the secondary coil induces an alternating emf in it. • Thus energy is transferred from primary to secondary coil through the changing magnetic field in the core, without any electrical contact between the two windings.	1 ½ ½ 1 1

	Condition for proper functioning: The input must be alternating current (a.c.), not direct current (d.c.) With d.c. there is no change of flux, hence no induced emf in the secondary coil. III. Any one of the following : • Copper losses • Eddy current losses. • Hysteresis loss • Flux leakage Because of these losses, output power is less than input power, so efficiency is less than 100%.	1
	OR	
33(B)	I. Resonance condition in a series LCR circuit & resonant frequency A series LCR circuit has a resistor (R), inductor (L) and capacitor (C) all in series with an AC source. Resonance condition: The circuit is said to be in resonance when its inductive reactance equals its capacitive reactance: $X_L = X_C$ $\omega L = \frac{1}{\omega C}$ Where ω is the angular frequency of the a.c. supply. At resonance: • The net reactance $X = X_L - X_C = 0$ • The impedance Z=R (minimum) • The current in the circuit is maximum for the given applied voltage Hence the circuit behaves as a purely resistive circuit at resonance. The resonant frequency, $f_0 = \frac{\omega_0}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$ II. Use of a series resonant circuit in tuning a radio receiver A radio station transmits electromagnetic waves of a definite frequency. In a radio receiver, the input stage contains a tuneable series LCR circuit (or LC tank) whose resonance frequency can be changed. • The inductor (L) is usually fixed. • The capacitor (C) is made variable (variable capacitor).	1 ½ ½ 1 1

	By adjusting the variable capacitor **C**, the resonant frequency, $$f_0 = \frac{1}{2\pi\sqrt{LC}}$$ is changed until it becomes equal to the frequency of the desired radio station. At this condition: • The LCR circuit is at resonance with that station's frequency. • Its impedance is minimum, so the current (and hence signal voltage**)** is maximum for that particular station. • Signals of other frequencies (other stations) are not at resonance, so their currents are much smaller and get largely rejected. Thus, by using a series resonant circuit, the radio receiver can select (tune to) one particular station and reject others.	1