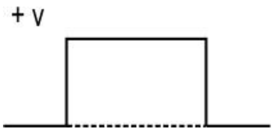
Practice Questions- Marking Scheme
SESSION: 2022-23
Class: XII
Subject: PHYSICS

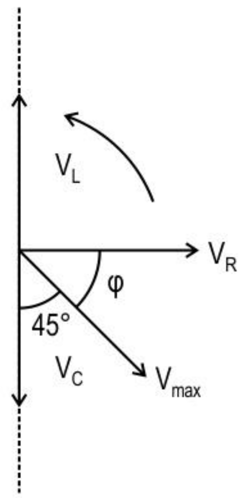
Q.No	Question	Marks
	SECTION A	
Q.1	C. The electric field in I is the same everywhere but the electric field in II becomes stronger as we move from left to right.	1
Q.2	C. The total charge on the capacitor increases.	1
Q.3	D. The electric field in the given region is non-uniform along x - axis.	1
Q.4	D. A is false and R is also false.	1
Q.5	A. one	1
Q.6	B. $\sqrt{2}$	1
Q.7	D. For I : $\mu_r < 1$, $\chi < 0$, For II : $\mu_r > 1$, $\chi > 0$	1
Q.8	D. R_1	1
Q.9	C. 2	1
Q.10	A. Input voltage V_o = 2 volt, I_o = 4 ampere and phase angle $\Phi = \pi/4$.	1
Q.11	A. perpendicular to E and B and out of the plane of the paper	1
Q.12	A. Both A and R are true and R is the correct explanation of A	1
Q.13	A. any two corners of the square	1
Q.14	D. Particle Q, because it has the smaller momentum	1
Q.15	C. infinitely large	1
Q.16	A. The angular momentum of the orbiting electron is $3h/\pi$.	1
Q.17	B. Both A and R are true and R is the correct explanation of A.	1
Q.18	C. 9.7 volt	1
	SECTION B	
Q.19	(a) As $\mathbf{E} = -\frac{\Delta V}{\Delta r}$ If E =0, at a given point, then $\frac{\Delta V}{\Delta r} = 0$ i.e., V = 0 or constant at that point. [1 mark for correct explanation] (b) At mid-point P in Fig I, E is zero, but V is non-zero.	2

	At mid-point P in Fig II, E is non-zero, but V adds up to zero. [0.5 mark for each point]	
Q.20	(a) orientation II Since $\vec{\tau} = \vec{m} \times \vec{B}$ = mB sinθ, torque is maximum when θ = 90°. (0.5 marks for correct identification and 0.5 marks for the correct reason.) (b) orientation I U = $-\vec{m} \cdot \vec{B}$ = -mB cosθ, potential energy in case of orientation I is positive. (0.5 marks for correct identification and 0.5 marks for the correct reason.)	2
Q.21	Displacement current through a capacitor connected to time varying current is given as, $i_d = \varepsilon_0 \frac{d\varphi_E}{dt}$ here Φ_E = E A = VA/d [1 mark for correct formula] Therefore, $i_d = \varepsilon_0 \frac{d\varphi_E}{dt} = \frac{\varepsilon_0 A}{d}\frac{dV}{dt} = 8.8 \times 10^{-12} \times \frac{0.001}{0.0001} \times 10^8 = 8.8 \times 10^{-3}$ A = 8.8 mA [1 mark for final result]	2
Q.22	(a) Correct. As the critical angle is sin $i_c = n_2/n_1$, where n_2 is the refractive index of the surrounding medium and n_1 is the absolute refractive index of the diamond. Now as n_2 for air < n_2 for water, sin i_c for the diamond in water will be more than sin i_c for the diamond in air. [0.5 mark for the correct answer] [0.5 mark for the correct explanation] (b) Incorrect. As the critical angle for the total internal reflection of diamond when surrounded by water is more than that when in air, the extent of total internal reflection that occurs in water is less than that occurs when in air. So the diamond sparkles more in air than when immersed in water. [0.5 mark for the correct answer] [0.5 mark for the correct explanation]	2
Q.23	As for dark fringes: sinθ = mλ/a	2

	For maximum value of $\sin\theta = 1$ [0.5 mark for the correct formula] [0.5 mark for the correct condition of maximum number of fringes] $m = a/\lambda = 5 \times 10^{-6} / 600 \times 10^{-9}$ m = 8.3 So 8 dark fringes will be seen on either side of the central maximum. [1 mark for the correct calculations and final answer]	
Q.24	Kinetic energy $K = \frac{1}{2} mv^2 = X/2n^2$ Potential energy $U = - X/n^2$ K in n = 1 is X/2 K in n = 3 is $\frac{1}{2x3^2} X = \frac{X}{18}$ Kinetic energy of the electron falls by a factor of 1/9. [1 mark for correct explanation and final answer] U in n = 1 is - X/1 U in n = 3 is $-X/3^2 = -X/9$ Potential energy of the electron rises by a factor of 1/9. [1 mark for correct explanation and final answer] **OR** (a) i. K = 1 ii. K < 1 [0.5 mark each] (b) Moderator molecules are smaller in size, so the neutrons undergo elastic collisions with these molecules and lose their energies effectively. On the other hand, when the fast moving neutrons collide with big molecules of ^{238}U, the nature of collisions is inelastic and the energy losses are not effective. [1 mark for the correct explanation]	2

Q.25	 [1 mark for the correct output waveform with the label of the voltage value] Since the P end of the PN diode is earthed, the PN diode will be forward biased and conduct only during the time the input wave form has voltage = – V. When the input waveform is +V, the diode will be reverse biased. Since the diode is ideal, during the forward bias, its resistance will be zero and hence no voltage drops across it. During reverse bias, its resistance will be infinite and hence the voltage drop will be +V, that is, same as the input. [1 mark for the correct explanation of the output waveform] **OR** (a) Forward bias. P side is at higher positive potential than the N side of the pn junction. (b) Reverse bias. P side is at zero potential (lower) and the N side is at positive potential (higher). (c) Forward bias. P side is at lower negative potential (higher) and the N side is at higher negative potential (lower). (d) Reverse bias. P is at lower (negative) potential and the N side is at zero potential (higher). [0.5 mark for each explanation and correct answer]	2
	SECTION C	
Q.26	(a) downwards in the plane of the paper (or) perpendicular to B and v, downwards (b) (i) proton moving with a velocity v No deviation (0.5 marks) $qE = qvB$ Force does not depend on mass and the charge cancels out. So the proton will also pass undeviated. (0.5 marks for correct explanation) (ii) electron moving with a velocity v/2 The electron will deviate upwards. (0.5 marks) Since velocity is halved, electric force > magnetic force. (0.5 marks for correct explanation)	2

Q.27	(a) As $e = L\, dI/dt$ $e_1/e_2 = L_1/L_2 = 3L/L = 3$ [1 mark for the correct ratio] (b) As power $P = eI$ $I_1/I_2 = P_1e_2/P_2e_1 = e_2/e_1 = 1/3$ [1 mark for the correct ratio] (c) Energy stored in a coil, $U = ½\, LI^2$ $U_1/U_2 = ½\, L_1I_1^2/½\, L_2I_2^2 = 3(1/3)^2 = 1/3$ [1 mark for the correct ratio]	3
Q.28	(a) In circuit (i): if ω is lowered, $X_c = 1/C\omega$ increases $I_{rms} = V_{rms}/\sqrt{R^2 + X_c^2}$ is lowered. Bulb glows dimmer. In circuit (ii): for lower ω, X_c is more, so very less current flows through the capacitor arm. But $X_L = L\omega$ is small, so most of the current flows through the inductor arm. The bulb in the inductor arm glows brighter. [0.5 mark for each conclusion on the blub glow] (b) In circuit (i): If ω increases, $X_c = 1/C\omega$ decreases. The current $I_{rms} = V_{rms}/\sqrt{R^2 + X_c^2}$ increases. The bulb glows brighter. In circuit (ii): If ω increases, the capacitive reactance decreases, and the inductive reactance increases. So more current flows through the capacitive arm than in the inductive arm. So the bulb glows dimmer. [0.5 mark for each conclusion on the blub glow] (c) If ω -> 0, the power supply is almost dc. In circuit (i): X_c -> Infinity , I_{rms} -> 0, Bulb doesn't glow at all. In circuit (ii): No current flows through the capacitive arm. Maximum current flows through the inductor arm. Bulb glows the brightest. [0.5 mark for each conclusion on the blub glow]	3

OR	a. The phasor diagram:  [1 mark for the correct phasor diagram and correct labels] b. Phase angle is 90 - 45 = 45 Since it is below the x axis, Φ = - 45 [0.5 mark for correct phase angle] c. As tan Φ = $(X_L - X_C)/R$ = (Lω - 1/Cω)/R and tanΦ = tan (- 45) = - tan45 = -1 So -1 = (Lω - 1/Cω)/R [1 mark for correct formulae] Transposing and substituting the values L = 97/9 = 10.7 H [0.5 mark for correct calculations]	3
Q.29	(a) Wave theory predicts that the photoelectric effect should occur at any frequency, provided the light intensity is high enough. But as observed in the photoelectric experiments, the light must have a sufficiently high frequency for the effect to occur irrespective of the intensity of the incident light. OR Wave theory predicts that all the electrons along the wavefront absorb energy continuously. Each electron takes time to pick up sufficient energy to overcome the work function and get ejected out of the metal. But as observed in the photoelectric experiments, the photoelectric emission is an instantaneous phenomenon.	3

	[1 mark for either of the correct statement] (b) As I = EN/A $I = hcN/\lambda\pi r^2$ $N = I\lambda\pi r^2 / hc$ $N = \dfrac{10^{-11} \times 600 \times \pi \times (8 \times 10^{-3})^2}{2 \times 10^{-16}}$ [1 mark for the correct formula] N = 6028 photons per second [1 mark for the correct calculations and final result] OR (a) The incident wavelength lower than the threshold value results in the emission of photoelectrons from the valence band. Once all the valence electrons in the valence band of the metal sphere are emitted, the photoemission stops as the incident radiations doesn't supply sufficient energy to eject the electrons from the inner shells of the metal atoms. [1 mark for the correct explanation] (b) i. The saturation value of the photo current remains constant. The rate at which the photoelectrons emitted per unit time remains unchanged. [1 mark for the correct explanation] ii. The kinetic energy of the photoelectrons increases due to electrostatic force experienced by the electric field applied in the direction opposite to their motion towards the collector plate. [1 mark for the correct explanation]	
Q.30	(a) As there are no electrons present in n = 2 or above in the ground state of hydrogen atom, the electron in the ground state gets excited only when it absorbs electromagnetic radiation of wavelength corresponding to Lyman series. The absorbed wavelengths will appear as absorption spectral lines in the exciting em radiation. [1 mark for the correct explanation] (b) i. When a photon is emitted with the shortest possible wavelength, it has the largest possible energy. The largest possible energy is released when the	3

	electron jumps from the initial state (n_i = 4) to the ground state (n_f = 1). So the final quantum number is n_f= 1 Energy of the photon emitted = $E_f - E_i = -13.6\left(\frac{1}{4^2} - \frac{1}{3^2}\right) = 12.75\text{ eV}$ [1 mark for the correct explanation and final answer] ii. When a photon is absorbed by the hydrogen atom, the electron jumps to a higher energy state. The photon has the longest possible wavelength when its energy is the smallest. The smallest possible energy change in the hydrogen atom arises when the electron jumps from the initial state n_i =4 to the immediate next possible higher state, that is, n_f =5. Energy of the photon absorbed = $E_f - E_i = -13.6\left(\frac{1}{5^2} - \frac{1}{4^2}\right) = 0.31\text{ eV}$ [1 mark for the correct explanation and final answer]	
	SECTION D	
Q.31	a. Position vectors $\vec{r}_1 = (2-0)\hat{i} + (1-0)\hat{j} + (2-0)\hat{k} = 2\hat{i} + 1\hat{j} + 2\hat{k}$ Here magnitude of $\vec{r}_1 = \sqrt{2^2 + 1^2 + 2^2} = 3$ $\vec{r}_2 = (2-1)\hat{i} + (1-0)\hat{j} + (2-0)\hat{k} = 1\hat{i} + 1\hat{j} + 2\hat{k}$ Here magnitude of $\vec{r}_2 = \sqrt{1^2 + 1^2 + 2^2} = \sqrt{6}$ [1 mark for writing correct vector form of position vectors]	5

$$\vec{E}_1 = k\frac{q}{3^3}.2\hat{i} + 1\hat{j} + 2\hat{k}$$

$$\vec{E}_2 = k\frac{10^{-9}}{6^{\frac{3}{2}}}.1\hat{i} + 1\hat{j} + 2\hat{k}$$

$$\vec{E} = \vec{E}_1 + \vec{E}_2 = k\left[\frac{2q}{3^3} + \frac{10^{-9}}{6^{\frac{3}{2}}}\right]\hat{i} + k\left[\frac{q}{3^3} + \frac{10^{-9}}{6^{\frac{3}{2}}}\right]\hat{j} + k\left[\frac{2q}{3^3} + \frac{2\times10^{-9}}{6^{\frac{3}{2}}}\right]\hat{k}$$

[1 mark for writing correct vector form of resultant electric field at point A]

Given in the problem is $E_x = 0$

So $k\left[\frac{2q}{3^3} + \frac{10^{-9}}{6^{\frac{3}{2}}}\right] = 0$

Solving for q,

$$\frac{2q}{3^3} = \frac{-10^{-9}}{6^{\frac{3}{2}}}$$

$q \approx -0.9 \times 10^{-9}$ C = -0.9 nC

[0.5 mark for putting correct condition of $E_x = 0$]

[1 mark for correct final answer]

b.
(i) At the center of the sphere.

[0.5 mark for the correct identification]

(ii) Potential is constant, same and maximum across the volume of the sphere of conducting material.

[0.5 mark for the correct answer]

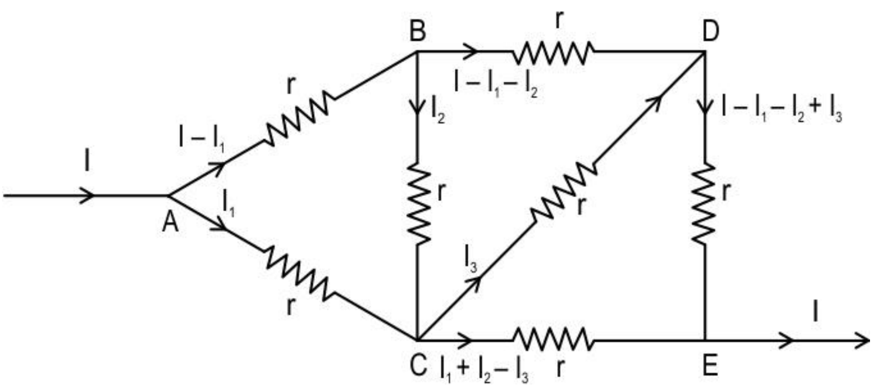
Charges are distributed only on the surface of the conducting sphere. The charge inside the surface of the conducting sphere is always zero.

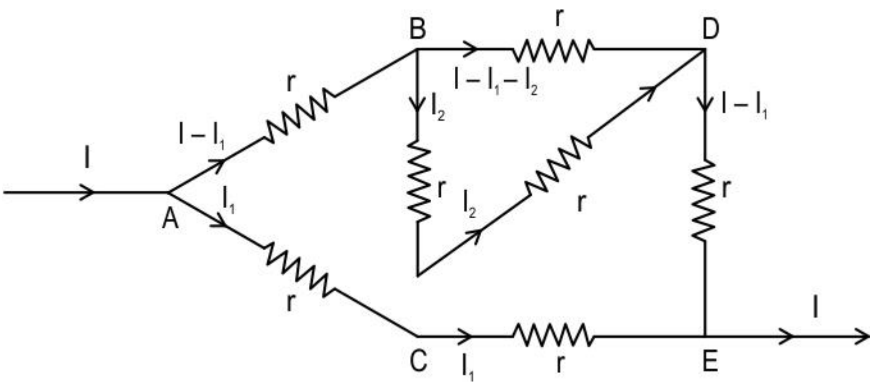
[0.5 mark for the correct statement]

OR

(a) Capacitance decreases.
Capacitance is inversely proportional to the distance of separation.

[0.5 mark for correct change] [0.5 mark for correct explanation]

	(b) Charge decreases. From Q=CV, C decreases and V remains the same, so Q decreases. [0.5 mark for correct change] [0.5 mark for correct explanation] (c) Potential difference remains the same. As the capacitor is connected to the battery, the potential V of the capacitor will remain the same as that of the battery. [0.5 mark for correct change] [0.5 mark for correct explanation] (d) Electric field decreases. E due to a plane sheet of charge = σ/ϵ_o is independent of the distance from the sheet. But charge density σ on the plate decreases, so E decreases. OR: Alternatively, As $E = V/d = Q/Cd = Q/\epsilon_o A$ Since Q decreases, E also decreases. [0.5 mark for correct change] [0.5 mark for correct explanation] (e) Energy stored in the capacitor decreases. Energy stored is proportional to both Q and V. Charge Q decreases but potential V is constant. [0.5 mark for correct change] [0.5 mark for correct explanation]	
Q.32	a. The current distribution through the given network can be:  [0.5 mark for the correct representation of the current in the network] Applying Kirchhoff's loop rules: Loop ABCA $-(I-I_1)r - I_2r + I_1r = 0$, that is, $2I_1 - I_2 = I$ .....1)	5

	Loop BDCB $-(I - I_1 - I_2)r + I_3r + I_2r = 0$, that is, $I_1 + 2I_2 + I_3 = I$ ---(2) Loop DECD $-(I-I_1-I_2+I_3)r + (I_1 + I_2 - I_3)r - I_3r = 0$, that is, $2I_1 + 2I_2 - 3I_3 = I$ ----(3) Solving the three equations, $I_1 = 4I/7$; $I_2 = I/7$; $I_3 = I/7$ [0.5 marks each for the three values of current] We see that $I_2 = I_3$, that is, the currents through the arm AC and CE are the same. [0.5 marks for the correct conclusion] The modified circuit diagram would be:  [0.5 mark for the correct representation of the currents in the network] b. Current through the circuit $I = 2E/(R+r_1+r_2)$ Potential drop V_1 across the first cell, $V_1 = E - Ir_1$ Potential drop V_2 across the first cell, $V_2 = E - Ir_2$ [1 mark for the correct equations of V1 and V2] For the potential drop V_1 across first cell to be zero, $V_1 = E - Ir_1 = 0$ $E = Ir_1$ $I = E/r_1$ $E/r_1 = 2E/(R+r_1+r_2)$	

	Transposing and solving, $R = r_1 - r_2$ So if $R = r_1 - r_2$, the potential drop across the cell E_1 with internal resistance r_1 will be zero. [1 mark for the correct formula relating R and internal resistances] **OR**	
	(a) The true voltage drop across the three resistors in series is divided in proportion their resistances. Voltage across 3000 ohm resistor V, $= \frac{3000}{1000 + 3000 + 1000} \times 50 = 30 \text{ volt}$ [1 mark for the voltage across the 3000 ohm resistor without voltmeter] When the voltmeter of resistance 6000 ohm is connected across 3000 ohm, the effective resistance of the 3000 ohm arm will be, $= \frac{6000 \times 3000}{6000 + 3000} = 2000 \text{ ohm}$ So the voltmeter reading will be: $V' = \frac{2000}{1000 + 2000 + 1000} \times 50 = \frac{2000}{4000} \times 50 \text{ volt} = 25 \text{ volt}$ [1.5 mark for the voltage across the 3000 ohm resistor with voltmeter] Percentage error $\frac{\Delta V}{V} \times 100 = \frac{V' - V}{V} \times 100 = \frac{25 - 30}{30} \times 100 = -16.6\%$ Voltmeter reading will be 16.6 % lesser than the true voltage across 3000 ohm resistor. [1 mark for the correct percentage difference in voltage the voltmeter] b. i. When the switch is open: $Power_1 = V^2/R_1 = V^2/r$ ii. When the switch is closed, $Power_2 = V^2/R_{eq} = 3V^2/2r$	5

	iii. When R_2 is heated, its value = 4r ohm $Power_3 = 5V^2/4r$ [0.5 mark for each correct power calculations]	
Q.33	a. Focal length of the lens is more in water than in the air, $f_{water} > f_{air}$ Image of the stone is visible from above, only if it is placed at distance less than focal length of the lens in the water. [0.5 mark for the correct reasoning] Since $f_{water} > f_{air}$, for the stone to be visible when seen from the above, if the distance $d < f_{water}$, and $d < f_{air}$. [1 mark for the correct conclusion] b. Given $A_o/A = 2$ and deviation produced by each prism $\delta = (\mu - 1)A$ $\delta_{net} = \delta - \delta_o + \delta = 2\delta - \delta_o$ [0.5 mark for the correct relation for δ_{net}] For $\delta_{net} = 0$, $2\delta = \delta_o$ $2(\mu-1)A = (\mu_o - 1)A_o$ As $A_o/A = 2$ So, $2(\mu-1) = (\mu_o - 1).2$ $(\mu-1) = (\mu_o - 1)$ $\mu = \mu_o$ [1 mark for the correct proof] c. For downward refraction as in P, the surrounding medium should have a refractive index less than that of the prism. So the medium surrounding the prism can be that of Benzene and Ethyl alcohol. And for the upward refraction as in Q, the surrounding medium should have a refractive index more than that of the prism. So the medium surrounding the prism can be that of Carbon disulphide and Aqueous sodium chloride.	5

[1 mark for the correct reasoning]

[1 mark for the correct choice of examples in each case]

OR

(a) (1) Waves on a string propagate in only one dimension while the light-wave interference pattern exists in three dimensions;
(2) The standing-wave pattern represents no net energy flow, while there is a net energy flow from the slits to the screen in an interference pattern.
(any one point)
[1 mark for the correct point of difference]

(b) i. S1 and λ2

Most spread-out fringes imply greater fringe width.
Since fringe width, $\beta = \lambda D/d$

For greater β , higher λ and small d is required.
So slits S1 and wavelength λ2 will produce fringe pattern that is most spread out.

[0.5 mark for correct answer and 0.5 mark for correct explanation]

ii. S2 and λ1
Least spread-out fringes imply smaller fringe width.
Since fringe width, $\beta = \lambda D/d$

For smaller β, lower λ and greater d is required.

So slits S2 and wavelength λ1 will produce a fringe pattern that is most spread out.

[0.5 mark for correct answer and 0.5 mark for correct explanation]

(c) The intensity of a given fringe where the phase difference between the two incoming waves r_1 and r_2 is Φ, is given as,
$I = 4I_o \cos^2\Phi/2$

Intensity at central maxima = maximum = $4\ I_o$
As given at P, Intensity = half of that at central maximum = $2\ I_o$
$2I_o = 4I_o \cos^2\Phi/2$

$1/2 = \cos^2\Phi/2$

Calculating, the phase difference, $\Phi = \pi/2$

[1 mark for the correct phase difference]

As we know the relation between path difference δ and the phase difference Φ,

	$\Phi = (2\pi/\lambda) \cdot \delta$ $\pi/2 = (2\pi/\lambda) \cdot \delta$ So path difference, $\delta = \lambda/4 = d\,y/D$ ….. from equation (3) So the intensity of the fringe at $y = \lambda D/4d$, will be half of that at the central maximum. [1 mark for the correct expression of y at which intensity is half that at the central maximum]	
	SECTION E	
Q.34	(a) $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ ....(1) for plane refracting surfaces, R -> Infinity, so substituting in the equation (1), the RHS -> 0 $\frac{n_2}{v} - \frac{n_1}{u} = 0$ So $\frac{n_2}{v} = \frac{n_1}{u}$ ....(2) [1 mark for the correct steps] (b) Apply equation (2) for bird – fish situation, $n_1 = 1$, $u = x$, $v = y$ $n_2/y = 1/x$ $x.n_2 = y$ Since $n_2 > 1$ $y > x$ [1 mark for the correct explanation] (c)	4

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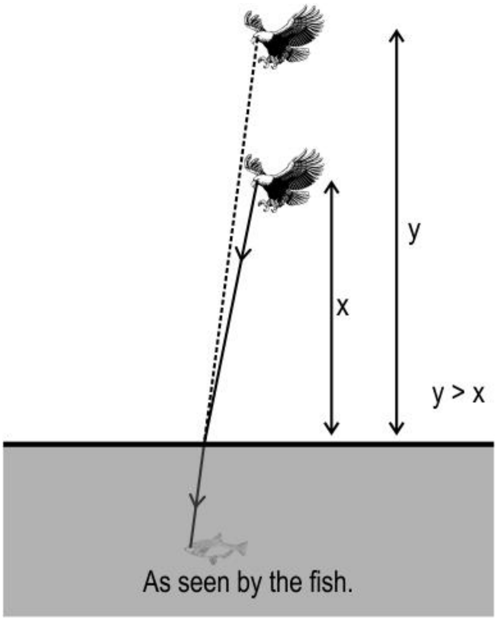
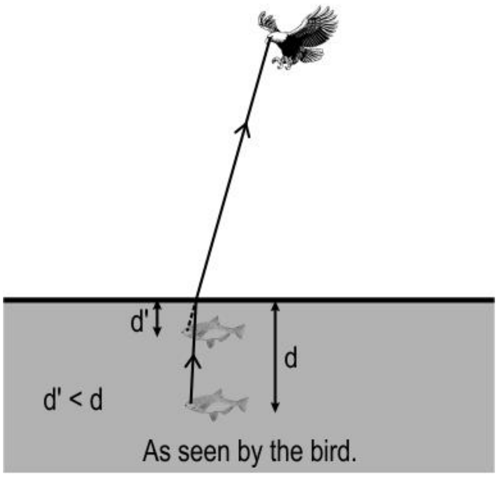


OR



The fish appears closer to the plane surface.

[1 mark for the correct representation of the refracting rays]

d. The fish sees the bird fall through a distance y in time t whereas the bird actually falls through x in the same time t.

Since y > x, the fish sees the bird flying downwards at a greater speed than the actual speed.

[1 mark for the correct explanation]
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<td>Q.35</td>
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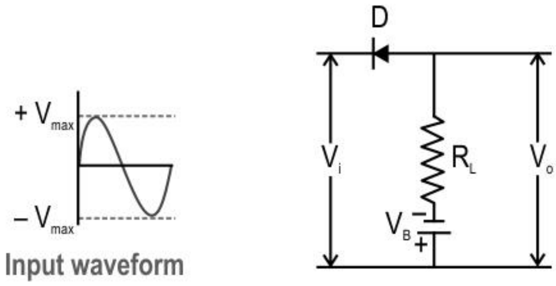
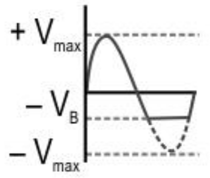


Series negative clipper with negative bias

[1.5 mark for the correct diagram and the labels of the + and - voltages]

(b) The negative cycle of the input signal gets clipped.

[0.5 mark for the correct identification of the cycle]



Output waveform

[0.5 mark for the correct output waveform]

(c) During the positive half cycle, the diode D is forward biased by both input supply voltage V_i and the battery voltage V_B.

[0.5 mark for the correct identification of the bias of the diode]

So it doesn't matter whether the input supply voltage is greater or less than battery voltage V_B, the diode always remains forward biased. Therefore, during the positive half cycle, the signal appears at the output.

[1 mark for the correct explanation of the output waveform]

OR

During the negative half cycle, the diode D is reverse biased by the input supply voltage V_i and forward biased by the battery voltage V_B.

[0.5 mark for the correct identification of the bias of the diode]

Initially, the input supply voltage V_i is less than the battery voltage V_B. So the diode is forward biased by the battery voltage V_B. As a result, the signal appears at the output. When the input supply voltage V_i becomes greater than the battery voltage V_B, the diode will become reverse biased. As a result, no signal appears at the output.

[1 mark for the correct explanation of the output waveform]