055/1/2

COMMON PREBOARD EXAMINATION - 2023

PHYSICS THEORY (042)
ANSWER KEY

MAX.MARKS: 70 **CLASS: XII** **TIME: 3Hours**

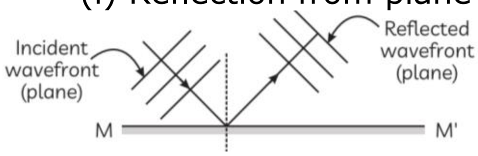
SECTION A

1	(c) decreases because the charge moves along the electric field.	1
2	(a) A is +ve and B is –ve and |A|>|B|	1
3	(b) v/2	1
4	(a) shape of the loop	1
5	(a) 14/11	1
6	(b) $\sqrt{2}$	1
7	(b) D2 is forward biased and D1 is reverse biased and hence no current flows from B to A and vice versa.	1
8	(b) 0.3 mm	1
9	(b) $A^{1/3}$	1
10	(a) their momenta are the same	1
11	(b) 1026 Å	1
12	(c) wavelength is halved and frequency remains unchanged	1
13	(d) angle between can have any value other than zero and 180°	1
14	(d) 10	1
15	(b)	1
16	(d) A is false and R is also false	1
17	(a) Both A and R are true and R is the correct explanation of A	1
18	(a) Both A and R are true and R is the correct explanation of A	1

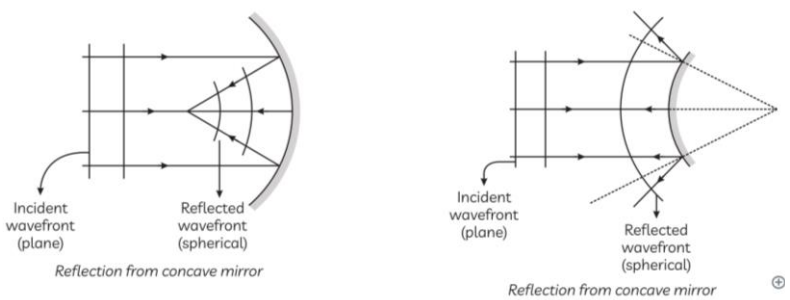
SECTION B

19 (a) From a point source, the wave front is diverging spherical wave front and from a distant light source, the wave front is plane front. 2

(b) (i) Reflection from plane mirror:



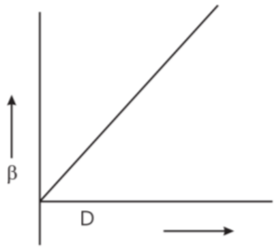
(ii) Reflection from curved mirror



OR

The fringe width in Young's double slit experiment is given by $\beta = \lambda D/d$

D = distance between slit and screen, d = distance between slits



So, $\beta \propto D$ It is linear graph with slope λ/d. So, the fringe width to vary linearly with distance of screen from the slits, the ratio of wavelength to distance between the slits should remain constant. Therefore, it is advised to take wavelength of incident light nearly equal to the width of the slit.

20 (i) Since the charge inside the Gaussian surface remains the same, the electric flux through it remains unchanged. 2

(ii) Since the net charge inside the surface is zero, the electric flux passing through the surface also becomes zero

21 When a bar magnet of magnetic moment (M=mx2l) is cut into two equal pieces transverse to its length, 2

(i) the pole strength remains unchanged (since pole strength depends on number of atoms in cross-sectional area).

(ii) the magnetic moment is reduced to half (since $M \propto$ length and here length is halved).

22 (a) A brief description of diffusion and drift. 2

(b) From the given curve, voltage,

$V = 0.7$ V for current

$I = 15$ mA for voltage

$$\text{Resistance} = \frac{V}{I} = \frac{0.7}{15 \times 10^{-3}}$$

$$= 46.66\ \Omega$$

(ii) For $V = -10$ V,

we have $I = -1\ \mu A$

$= -1 \times 10^{-6}$A

$$R = \frac{10}{1 \times 10^{-6}}$$

$$= 1.0 \times 10^{7}\ \Omega$$

OR

B : Reverse biased

Justification: When an external voltage V is applied across the semiconductor diode such that n-side is positive and p-side is negative, the direction of applied voltage is same as the direction of barrier potential. As a result, the barrier height increases and the depletion region widens due to the change in the electric field. The effective barrier height under reverse bias is (V_0+V).

C : Forward biased

Justification: When an external voltage V is applied across a diode such that p-side is positive and n-side is negative, the direction of applied voltage (V) is opposite to the barrier potential (V_0). As a result, the depletion layer width decreases and the barrier height is reduced. The effective barrier height under forward bias is (V_0 – V).

23 $$\Delta E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{102.7 \times 10^{-9}} \text{J}$$ 2

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{102.7 \times 10^{-9} \times 1.6 \times 10^{-19}} \text{eV}$$

$$= \frac{66 \times 3000}{1027 \times 16} = 12.04 \text{ eV}$$

Now, $\Delta E = |-13.6 - (-1.50)|$

$= \mathbf{12.1\ eV}$

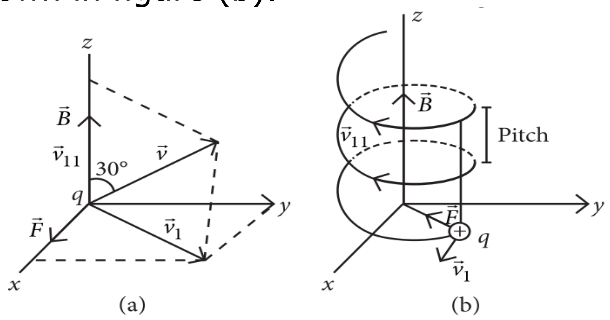
24 (i) Microwave, 2

(ii) Infrared,

(iii) X-rays

Microwave are produced by special vacuum tubes, like klystrons, magnetrons and gunn diodes. Infrared are produced by the vibrating molecules and atoms in hot bodies. X-rays are produced by the bombardment of high energy electrons on a metal target of high atomic weight (like tungsten)

25 When a charged particle moving in a uniform magnetic field has two concurrent motions. A linear motion in the direction of **B** (along z-axis) as shown in figure (a) and a circular motion in a plane perpendicular to **B** (in XY-plane). Hence the resultant path of the charged particle will be a helix, with its axis along the direction of **B**, as shown in figure (b). 2



SECTION C

26 (i) Saturation or short range nature of nuclear forces. 3

(ii)

$_7N^{14}$ nucleus contains 7 protons and 7 neutrons.

Mass of 7-protons = $7m_H$ = 7 × 1.00783 u = 7.05481 u

Mass of 7-neutrons = $7m_n$ = 7 × 1.00867 u = 7.06069 u

∴ Mass of nucleons in $^{14}_{7}N = 7.05481 + 7.06069 = 14.11550$ u

Mass of nucleus $^{14}_{7}N = m_N = 14.00307$ u

∴ Mass defect = mass of nucleons – mass of nucleus

= 14.11550 – 14.00307 = 0.11243 u

Total Binding energy = 0.11243 × 931 MeV = **104.67 MeV**

Binding energy per nucleon $= \frac{104.67}{14}$ = **7.47 MeV/nucleon**

27 3

$$\varepsilon = \frac{-d\varphi}{dt} = \frac{-d(BA)}{dt} = A\frac{dB}{dt}$$

$$I = \frac{\varepsilon}{R} = \frac{-A\left(\frac{dB}{dt}\right)}{R}$$

For 0< t< 2

$$= \frac{-3.14(0.12)^2 ?1}{2 ?8.5} = 0.0026\ A$$

For 0< t< 2

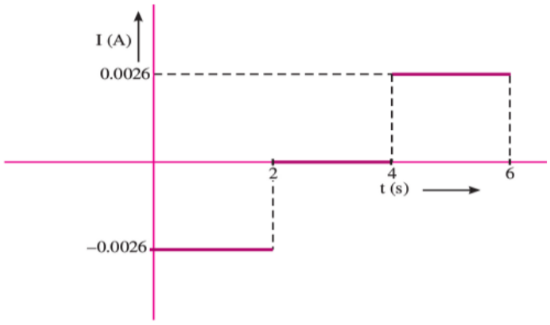
$$= \frac{-3.14(0.12)^2 ?1}{2 ?8.5} = 0.0026\ A$$

For, 2 < t < 4

$$\frac{dB}{dt} = 0 \Rightarrow I = 0$$

For, 4 < t < 6

$I = +0.0026$



OR

Ans. (i) Induced voltage (emf) in the coil,

$$\varepsilon = -L\frac{dI}{dt}$$

$$\therefore \quad \frac{\varepsilon_1}{\varepsilon_2} = \frac{-L_1\frac{dI}{dt}}{-L_2\frac{dI}{dt}} = \frac{L_1}{L_2} = \frac{16\,mH}{12\,mH} = \frac{4}{3}$$

(ii) Power supplied, P= εI

Since power is same for both the coils

$$\therefore\ \varepsilon_1 I_1 = \varepsilon_2 I_2 = \frac{I_1}{I_2} = \frac{\varepsilon_2}{\varepsilon_1} = \frac{3}{4}$$

(iii) Energy stored in the coil is given by

$$U = \frac{1}{2}LI^2$$

$$\therefore\ \frac{U_1}{U_2} = \frac{\frac{1}{2}L_1 I_1^2}{\frac{1}{2}L_2 I_2^2} = \frac{L_1}{L_2} \times \left(\frac{I_1}{I_2}\right)^2 = \frac{4}{3} \times \left(\frac{3}{4}\right)^2 = \frac{3}{4}$$

28 3

Capacitance, $C = \frac{1}{L\omega^2}$

$$= \frac{1}{\frac{4}{\pi^2}(2\pi \times 50)^2}F = \frac{1}{40000}F = 2.5 \times 10^{-5}F$$

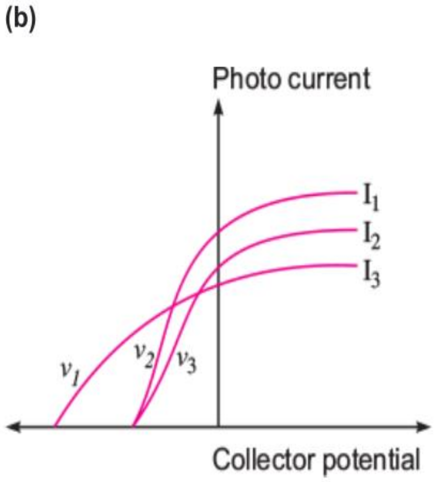
Since V and I are in same phase

Impedance = Resistance = 100Ω

Power dissipated $= \frac{E_{rms}^2}{2} = \frac{(200)^2}{100}W = 400W$

29 (a) The amount of light energy or photon energy incident per metre square per second is called intensity of radiation. 3

(b)

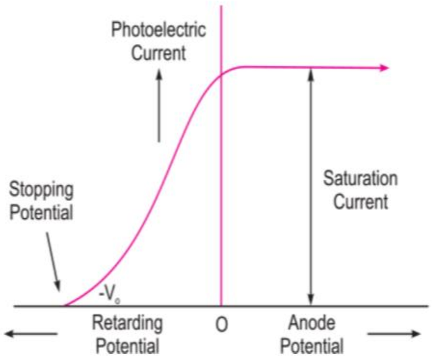


(c) As per Einstein's equation,

(i) The stopping potential is same for I_1 and I_2 as they have the same frequency.

(ii) The saturation currents are as shown in figure because $I_1 > I_2 > I_3$.

OR



Intercept of the graph with potential axis gives the stopping potential.

(ii) We have

$$h\nu_{in} = eV$$

$$\Rightarrow \quad \Delta V = \frac{h(\nu_1 - \nu_2)}{e}$$

$$= \frac{6.62\times10^{-15}\times(8\times10^{15} - 4\times10^{15})}{1.6\times10^{-19}}$$

$$= \frac{6.62\times4\times10^{15}\times10^{-34}}{1.6\times10^{19}} V$$

$$= \mathbf{16.55V}$$

30 Let I_g be the current through galvanometer at full deflection 3

To measure V volts, $V = I_g(G + R_1)$

$\frac{V}{2}$ volts, $\frac{V}{2} = I_g(G + R_2)$

2 V volts, $2\text{ V} = I_g(G + R_3)$

To measure for conversion of range dividing (*i*) by (*ii*),

$$2 = \frac{G + R_1}{G + R_2} \Rightarrow G = R_1 - 2R_2$$

Putting the value of G in (*i*), we have

$$I_g = \frac{V}{R_1 - 2R_2 + R_1} \Rightarrow I_g = \frac{V}{2R_1 - 2R_2}$$

Substituting the value of G and I_g in equation (*iii*), we have

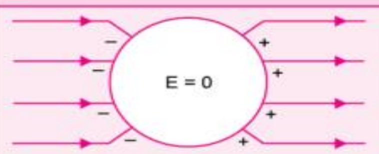
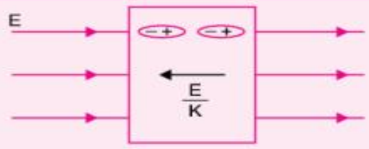
$$2V = \frac{V}{2R_1 - 2R_2}(R_1 - 2R_2 + R_3)$$

$$4R_1 - 4R_2 = R_1 - 2R_2 + R_3$$

$$R_3 = 3R_1 - 2R_2$$

SECTION D

31 5

	Conductor		Dielectric
			 where K is dielectric constant
1.	No electric field lines travel inside conductor.	1.	Alignment of atoms takes place due to electric field.
2.	Electric field inside a conductor is zero.	2.	This results in a small electric field inside dielectric in opposite direction. Net field inside the dielectric is $\frac{E}{K}$.

Induced electric field, due to polarisation of dielectric, is in opposite direction to the applied field.

$E_{net} = E_o - E_p$

(ii) (a) Charge remains same, as after disconnecting capacitor no transfer of charge take place.

(b) Electric field, $E = \frac{\sigma}{\varepsilon_o} = \frac{q}{\varepsilon_o A}$ remain same, as there is no change in charge.

$$\text{Energy stored} = \frac{q^2}{2C} = \frac{q^2}{2\left(\frac{\varepsilon_o A}{d}\right)} = \frac{q^2 d}{2\varepsilon_o A}$$

(c)

Energy will be doubled as separation between the plates (d) is doubled.

OR

Capacitance with dielectric of thickness 't'

$$C = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}} \qquad \text{Put } t = \frac{d}{2}$$

$$C = \frac{\varepsilon_0}{d - \frac{d}{2} + \frac{d}{2K}} = \frac{\varepsilon_0 A}{\frac{d}{2} + \frac{d}{2K}} \quad \Rightarrow \quad \frac{\varepsilon_0 A}{\frac{d}{2}\left(1 + \frac{1}{K}\right)} = \frac{2\varepsilon_0 AK}{d(K+1)}$$

Two capacitors are connected in parallel. Hence, the potential on each of them remains the same. So, the charge on each capacitor is

$Q_A = Q_B = CV$

Formula for energy stored = $\frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$

Net capacitance with switch S closed = C + C = 2C

$\therefore$ Energy stored = $\frac{1}{2} \times 2C \times V^2 = CV^2$

After the switch S is opened, capacitance of each capacitor = KC

In this case, voltage only across A remains the same.

32 The optical instrument is therefore a compound microscope. 5

Ray diagram

When the final image is formed at infinity, the magnification of a compound microscope equals

L=25cm D=25cm

f_0=1 cm

f_e=2cm

$$m = \left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right) = (25/1)(25/2) = 312.5$$

OR

Snell's law says $\mu_1 \text{Sin}(i) = \mu_2 \text{Sin}(r)$

$\mu_{\text{Prism}} = \sqrt{3}$

$\mu_{\text{Prism}} = (30^\circ) = \sin(e)$

$\sqrt{3} \times \frac{1}{2} = \sin(e)$

$e = 60^\circ$

Now when the external medium is changed to liquid of $\mu_L = 1.3$ then,

$\mu_{\text{prism}} \ \text{Sin}(30) = \mu_L \sin(e)$

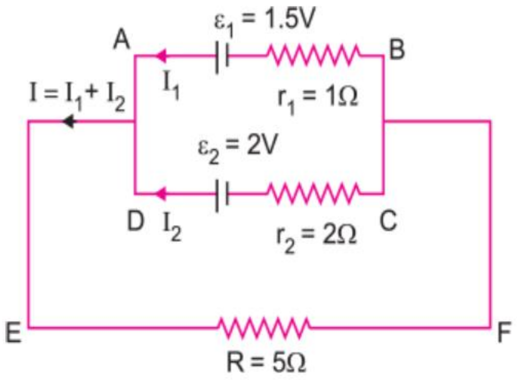
$\sqrt{3}\,\text{Sin}(30^\circ) = 1.3\,\text{Sin}(e)$

$e = \text{Sin}^{-1}\left(\frac{\sqrt{3}}{2 \times 1.3}\right) = 41.83^\circ$

Hence the angle of emergence reduces to 41.83° from 60°.

(i) L_1 Objective
L_2 Eyepiece
Necessary reason (any two)

33 5



Ans. (i) The circuit is shown in figure.

(ii) Suppose I_1 are I_2 current drawn from cells ε1 and ε2 respectively, then according to Kirchhoff's junction law, current in $R = 5\Omega$ $I = I_1 + I_2$.

Applying Kirchhoff's second law to mesh ABFEA

$1 \times I_1 + 1.5 - 5(I_1 + I_2) = 0$

⇒ $6I_1 + 5I_2 = 1.5$ ...(i)

Applying Kirchhoff's second law to mesh CDEFC

$-2I_2 + 2 - 5(I_1 + I_2) = 0$

⇒ $5I_1 + 7I_2 = 2$ ...(ii)

Solving equation (i) and (ii), we get

$$I_1 = \tfrac{1}{34}A,\ I_2 = \tfrac{9}{34}A$$

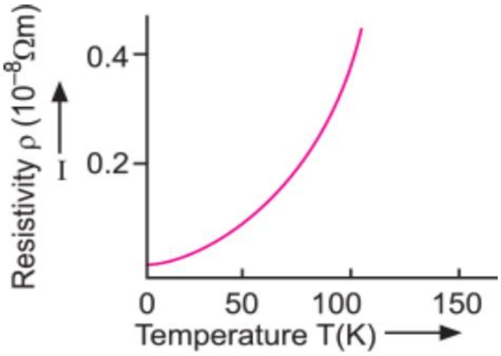
$$I = I_1 + I_2 = \tfrac{1}{34} + \tfrac{9}{34} = \tfrac{10}{34}A$$

Potential difference across R=5Ω resistor

$$(I_1 + I_2)\,R = \tfrac{10}{34} \times 5 = \tfrac{25}{17}\ \text{volt}$$

OR

$\rho = \frac{m}{ne^2\tau}$



(a) With rise of temperature, the collision of electrons with fixed lattice ions/atoms increases so that relaxation time (τ) decreases. Consequently, the conductivity of metals decreases with rise of temperature.

(b) Conductivity of ionic conductor increases with increase of temperature because with increase of temperature, the ionic bonds break releasing positive and negative ions which are charge carriers in ionic conductors.

(c) In the case of a semiconductors, when temperature increases, covalent bonds break and charge carriers (electrons and holes) become free i.e., n increases, so conductivity increases with rise of temperature.

SECTION E

34 4

(i) $V_0/\sqrt{2}$

Full wave rectified.

(ii) As a detector.

OR

81.2%

35 (i) 4

Here n = 1.5 ; R_1 = – 30 cm ; R_2 = 30 cm

Using len's maker's formula,

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$= (1.5-1)\left[\frac{1}{-30} - \frac{1}{30}\right] = 0.5 \times \left(\frac{-2}{30}\right)$$

$$\frac{1}{f} = \frac{1}{30}$$

f = -30

(ii)

Given R_1 =10cm, R_2 = -15cm, f =12cm

Refractive index n =?

Lens-maker's formula is

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \quad \frac{1}{12} = (n-1)\left(\frac{1}{10} + \frac{1}{15}\right)$$

$$= (n-1) \times \frac{5}{30}$$

$$\Rightarrow \quad n-1 = \frac{30}{5} \times \frac{1}{12} \quad \text{or} \quad n = 1 + \frac{30}{60} \quad \Rightarrow \quad n = 1 + 0\cdot5 = 1\cdot5$$

(iii) The eye lens is surrounded by a different medium than air. This will change the focal length of the eyes lens. The eye cannot accommodate all images as it would do in air.

OR

If the refractive index of the body becomes equal to surrounding liquid, there will not be any deviation in the direction of light neither will any light get reflected from its surface. So, the object becomes invisible.