



PHYSICS

PAPER 1

(THEORY)

ANSWER KEY

SECTION A– 14 MARKS

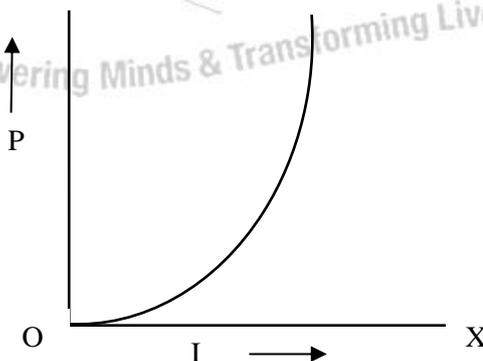
Question 1

(A) In answering Multiple Choice Questions, candidates have to write either the correct option number or the explanation against it. Please note that only ONE correct answer should be written.

- (i) (d) A shows deflection but G does not. [1]
- (ii) (d) B/4 [1]
- (iii) (b) is not affected by the change in its temperature. [1]
- (iv) (b) circumference of the first orbit. [1]
- (v) (c) zero resistance in forward, but infinite resistance in reverse bias. [1]
- (vi) (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion. [1]
- (vii) (c) Assertion is false and Reason is true. [1]

(B) Answer the following questions briefly:

- (i) [1]



- (ii) to reduce the loss of power/energy due to **eddy currents** [1]
- (iii) since it forms diminished images of objects behind and hence provides a wide field of view. [1]
- (iv) diagram showing **diverging spherical wavefront** [1]
- (v) Matter exhibits both particle and wave nature. [1]
- (vi) They annihilate each other producing gamma ray photons. [1]
- (vii) Solar/ light energy to electrical energy

SECTION B – 14 MARKS

Question 2 [2]

(i) (a) Using $t = d/2$ [1]

Substituting in the given formula and calculating,

$$C = \frac{\epsilon_0 A}{\left[\left(d - \frac{d}{2} \right) + \frac{d}{2K} \right]}$$

$$C = \frac{2\epsilon_0 AK}{[d(K+1)]}$$

(b) The whole space between the plates is filled with the dielectric implies, [1]
 $t = d$, so,

$$C = \frac{K\epsilon_0 A}{d}$$

OR

(ii) (a) For the I-V graph, the slope of the I-V graph gives the conductance [1]

$$R = \frac{V}{I} = \frac{1}{\tan\theta}$$

Since $\theta_1 > \theta_2$

$$\tan\theta_1 > \tan\theta_2$$

So Resistance at $T_1 <$ Resistance at T_2 .

(b) Since the resistance of a conductor rises with temperature and 'R' at T_2 is [1]
 higher than 'R' at T_1 , so $T_2 > T_1$.

Question 3 [2]

$$P_1 = P_2 = e \times l$$

$$P = 2p \cos \alpha = 2 e \times l \cos (\theta/2)$$

Question 4 [2]

(i) (a) $I_1 + I_2 = I$
 $2 + I_2 = 5$
 $I_2 = 5 - 2 = 3A$

(b) $I_1 \times 4 + I_3 \times 7 = I_2 \times 5$
 $2 \times 4 + I_3 \times 7 = 3 \times 5$
 $7I_3 = 15 - 8 = 7$
 So, $I_3 = 1A$

OR

(ii) $r = R (I_1 / I_2 - 1)$
 $= 10 (110 / 100 - 1)$
 $= 1 \Omega$

Question 5

[2]

- (i) It will move towards I_1 .
(Two linear parallel conductors carrying currents in the same direction attract each other.)
- (ii) It will move away from I_1 .
(Two linear parallel conductors carrying currents in the opposite direction repel each other.)

Question 6

[2]

- (i) $1/f = (n-1) (1/r_1 + 1/r_2)$
 $1/f = (n-1) (1/f + 1/f)$
 $(n-1) = 1/2$
So, $n = 1.5$
- (ii) It is that prism whose refracting angle is small i.e., less than 4°

Question 7

[2]

- (i) X rays
(ii) Greater than 1m.

Question 8

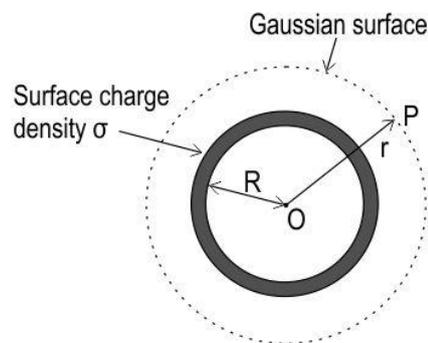
[2]

- (i) The stopping potential is independent of the intensity of the incident photon.
(ii) The stopping potential will change with the frequency of the incident photon.

SECTION C – 27 MARKS**Question 9**

[3]

A shell of radius R is carrying uniformly distributed charge of charge density σ .



Electric field E at point P at a distance r from the centre of a uniformly charged spherical shell:

Consider a Gaussian surface to be a sphere of radius $r > R$ and with centre O, passing through P.

Using the principles of spherical symmetry, E and area vector ΔS at every point are parallel, flux through each of the area element.

$$\Delta\Phi = E \cdot \Delta S$$

Summing over all ΔS ,

$$\Phi = E \times 4 \pi R^2.$$

The charge enclosed is $\sigma \times 4 \pi R^2$.

By Gauss' law,

$$E \times 4 \pi r^2 = \frac{q}{\epsilon_0} = \frac{\sigma \times 4 \pi R^2}{\epsilon_0}$$

$$E = \frac{\sigma R^2}{\epsilon_0 r^2} = \frac{q}{4 \pi \epsilon_0 r^2}$$

This formula is exactly similar to the field produced by a point charge q placed at the centre O, that is, as per Coulomb's law.

Question 10

[3]

- (i) Current I in load resistance R is given by the formula $I = E/(R+r)$; where E is the emf of the cell, r is the internal resistance of the cell

In circuit 1, the cells are in series.

Therefore, $E_{eq} = 2E$ and $r_{eq} = 2r$

Current through R in circuit 1, $I = 2E/(R+2r)$

In circuit 2, the cells are in parallel.

Therefore, $E_{eq} = E$ and $r_{eq} = r/2$

Current through R in circuit 2, $I = E/(R+r/2)$

Since the current is the same in both circuits,

$$2E/(R+2r) = E/(R+r/2)$$

Solving, we get $r = R$

OR

(ii)

- (a) As the potential difference across the conductor is increased, the electric field set-up inside the conductor increases. Since $v_d \propto E$, drift velocity also increases with an increase in potential difference.

- (b) Given $v_d \propto E$

but $E = V/l$

Therefore $v_d \propto (1/l)$

As length increases to $4l$, drift velocity becomes $(1/4)$ th of the original value.

Question 11**[3]**

- (i) Given
- $G = 100 \Omega$
- ;
- $I = 200 \text{ mA}$
- ;

$$V_g = 200 \text{ mV};$$

Resistance to be connected to the galvanometer to convert to an ammeter:

$$S = I_g G / (I - I_g)$$

$$\text{Here } I_g = V_g / G = 200 \text{ mV} / 100 \Omega = 2 \text{ mA}$$

$$S = 2 \times 10^{-3} \times 100 / (0.2 - 0.002)$$

$$S = 1.01 \Omega$$

- (ii)
- $1/R = 1/100 + 1/1.01$

$$R = 0.999 \Omega$$

Question 12**[3]**

- (i) The expression for
- B
- at an axial point of a circular coil carrying current is,

$$B = \frac{\mu_0 2NI(\pi a^2)}{4\pi r^3}, \text{ for } N \text{ turns}$$

$$B = \frac{\mu_0 2I(\pi a^2)}{4\pi r^3}, \text{ for } N = 1 \text{ turn}$$

$$\text{At the center, } x = 0: = \frac{\mu_0 I}{2a}$$

$$\text{At } x = a: = \frac{B_0}{2\sqrt{2}}$$

$$\text{At } x = 2a: = \frac{B_0}{5\sqrt{5}}$$

$$\text{At } x = 3a: = \frac{B_0}{10\sqrt{10}}$$

OR

- (ii)

- (a) Because force exerted by the magnetic field is always perpendicular to its velocity. So, it provides the necessary centripetal force to the electron.

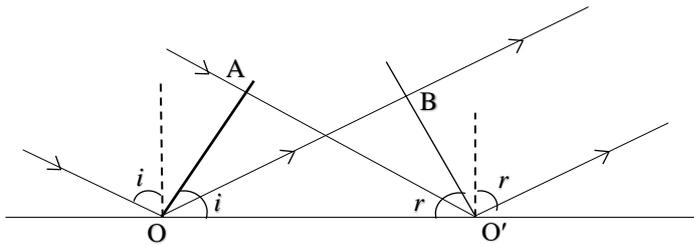
$$(b) \frac{e}{m} = \frac{v}{Br}$$

$$\frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}} = \frac{8 \times 10 \times 7}{1.3 \times 10^{-3} \times r}$$

$$\text{So, } r = 0.35 \text{ m}$$

Question 13

[3]



Correct diagram [$\angle i$ and $\angle r$ at one place, atleast one arrow marked and wavefront nearly perpendicular or shown with arc drawn

In triangles AOO' & BOO'

OO' is common.

$AO' = O'B = ct$ or vt

$\angle OAO' = \angle OBO' = 90^\circ$

Hence, the two triangles are equal/ congruent in all respects

$\angle AOO' = \angle BO'O$

$\therefore (\angle i = \angle r)$ only accepted if shown correctly in the diagram.

(Any other equivalent derivation may be accepted)

Question 14

[3]

(i) $1/f = (\eta - 1) (2/R)$

(ii) $1/f_1 = (\eta - 1) (1/R)$

$F_1 = 2f$

$1/f_2 = (\eta - 1) (2/R)$

$F_2 = f$

Question 15

[3]

(i) Fringe width (separation) increases.

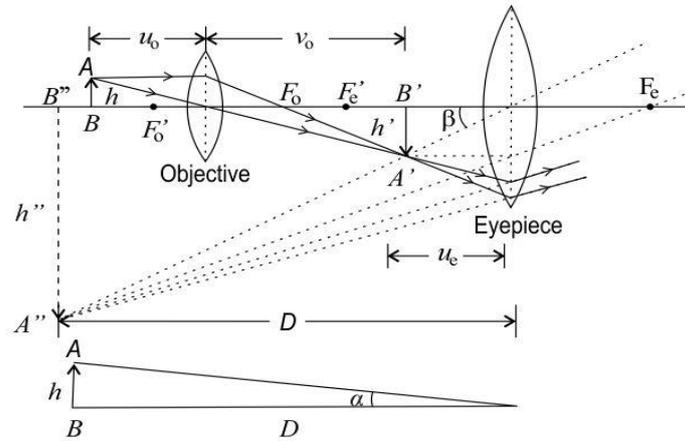
(ii) Fringe width (separation) decreases.

(iii) Fringe width (separation) decreases.

Question 16

[3]

- (i) Compound microscope.
 (ii)



Question 17

[3]

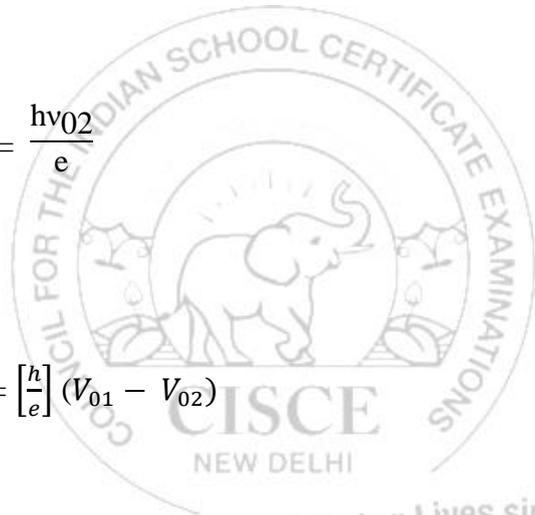
$$W_{01} = \frac{hv_{01}}{e} \text{ and } W_{02} = \frac{hv_{02}}{e}$$

$$V_1 = \left[\frac{h}{e} \right] v - \left[\frac{h}{e} \right] V_{01}$$

$$V_2 = \left[\frac{h}{e} \right] v - \left[\frac{h}{e} \right] V_{02}$$

$$\therefore V_1 - V_2 = \left[\frac{h}{e} \right] (V_{01} - V_{02})$$

$$\left[\frac{h}{e} \right] = \frac{V_1 - V_2}{V_{01} - V_{02}}$$



SECTION D – 15 MARKS

Question 18

[5]

(i) (a)
$$e = - \frac{d\phi}{dt} = - \frac{dNAB \cos \theta}{dt}$$

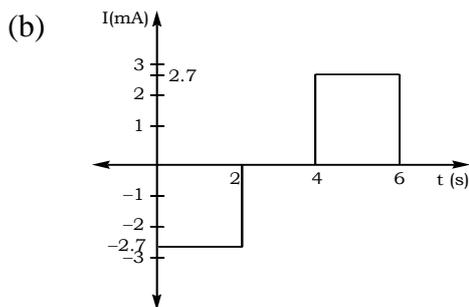
$$e = - 0.023 \text{ volt}$$

$$i = \frac{e}{R} = - \frac{0.023}{8.5} = - 2.7 \times 10^{-3} \text{ A}$$

t : 0 – 2.0 sec : i = - 2.7 x 10⁻³ A

t : 2.0 sec – 4.0 sec : i = 0

t : 4.0 sec – 6.0 sec : i = + 2.7 x 10⁻³ A



OR

- (ii) (a) Resistance used by X is the least and resistance used by Z is the maximum.
- (b) Q maximum for X
- (c) at resonance impedance is equal to ohmic resistance.
- (d) In a capacitor the current is dependent directly on frequency

$$\frac{I_1}{I_2} = \frac{1}{2}$$

Question 19

[5]

- (i) (a) mass of protons (m_p) = $92 \times 1.0073 \text{ u} = 92.6716 \text{ u}$
 mass of neutrons (m_n) = $143 \times 1.0087 \text{ u} = 144.2441 \text{ u}$
 Total mass ($m_p + m_n$) = 236.9157 u
 mass defect = $\Delta m = 236.9157 \text{ u} - 235.0439 \text{ u} = 1.8718 \text{ u}$
 Binding energy = $\Delta m \times 931.5 \text{ MeV} = 1.8718 \times 931.5 \text{ MeV} = 1743.6 \text{ MeV}$
 Binding energy per nucleon = $1743.6 \text{ MeV} / 235 = 7.42 \text{ MeV}$
- (b) Mass of reactants = $235.0439 + 1.0087 = 236.0526 \text{ u}$
 Mass of products = $89.9195 + 142.9206 + 3(1.0087) = 235.8662 \text{ u}$
 change in mass = $\Delta m = 236.0526 - 235.8662 = 0.1864 \text{ u}$
 $Q = \Delta m \times 931.5 \text{ MeV} = 0.1864 \times 931.5 \text{ MeV} = 173.63$
- (c) entire +ve charge in the atom is concentrated at its centre, which he called as nucleus

OR

- (ii) (a) $1/12^{\text{th}}$ of the mass of an atom of ${}^6\text{C}^{12}$ isotope.
- (b) The value of E to be calculated in MeV using
 $\Delta m \times c^2 = E = 931.5 \text{ MeV}$

- (c) (1) To start the laser, the molecule will have to be excited from E_1 to E_3 . The wavelength required is

$$\begin{aligned}\lambda &= hc/\Delta E \\ &= 1.24 \times 10^{-6}/2.95 \\ &= 420.3 \text{ nm}\end{aligned}$$

Laser transition takes place between E_1 and E_2 . So the wavelength of the beam of laser-produced will be

$$\begin{aligned}\lambda &= hc / \Delta E \\ &= 1.24 \times 10^{-6}/ 1.78 \\ &= 696.6 \text{ nm}\end{aligned}$$

- (2) energy of photon = 1.78 eV
 $= 1.78 \times 1.602 \times 10^{-19} \text{ J} = 2.8516 \times 10^{-19} \text{ J}$
photons emitted per second = power (energy emitted per second) / energy of each photon = $100 \text{ W} / 2.8516 \times 10^{-19} \text{ J}$
 $= 3.506 \times 10^{20}$

Question 20

[5]

- (i) D_2 is forward biased.
(ii) It is that current which remains constant even on increasing the p.d.
(iii) Due to potential barrier or barrier p.d.
(iv) Ignoring D_2 as it is reverse biased and offers infinite resistance,
By Ohm' law,

$$I = \frac{E}{(R^* + R^*)} = 6/(50+150+100) = 6/300 = 0.02 \text{ A}$$