

PHYSICS
PAPER 1
(THEORY)
ANSWER KEY

(Equivalent answers are acceptable.)

SECTION A– 14 MARKS

Question 1

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

- (i) (c) $V_A < V_C < V_B$ [1]
- (ii) (d) Platinum [1]
- (iii) (d) $I = 8\text{A}$ towards C, with $r = 0.050\text{ m}$ [1]
- (iv) (a) 1-C, 2-D, 3-A, 4-B [1]
- (v) (a) Both (P) and (Q) [1]
- (vi) (b) Objective lens has greater focal length, and eyepiece lens has smaller focal length. [1]
- (vii) (d) Assertion is false and Reason is true. [1]

(B)

- (i) $Q_2 = -Q_1$ Or Q_1 and Q_2 form an electric dipole. [1]
- (ii) $R_v = \infty$ and $R_a = 0$ [1]
Voltmeter has a very high resistance while an ammeter has a very low resistance.
- (iii) The focal length of a convex lens can be measured using only a metre scale through the Distant Object Method. This method relies on focusing light rays from a very distant source onto a surface to find the lens's focal point. [1]
- (iv) When a photon collides with an electron, it loses either its **entire** energy or **none** at all, whereas a moving ball can lose **any fraction** of its energy. [1]
- (v) The gamma ray photon should have the minimum energy of $2(m_p)c^2$. [1]
Or
The gamma ray photon should have the Combined Minimum Energy
 $E = 938.3 + 938.3 = 1876.6\text{MeV}$.
- (vi) As temperature rises, large number of electrons break their covalent bonds and cross the forbidden band gap into the conduction band. Thus, there are large number of free electrons in the conduction band which result in reduction in resistance. [1]
- (vii) Frequency [1]

SECTION B – 14 MARKS

Question 2

[2]

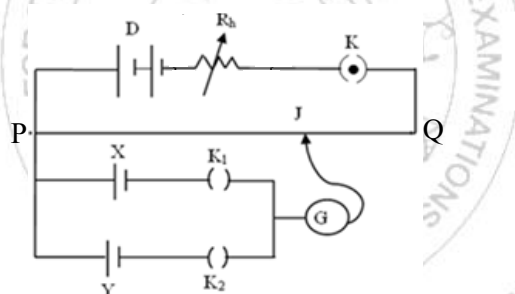
$$\begin{aligned}
 \text{(i)} \quad C &= \frac{\epsilon_0 A}{d} \\
 &= \frac{8.85 \times 10^{-12} \times 4.5 \times 10^8}{4425} \\
 &= 0.009 \times 10^{-4} \\
 &= 9 \times 10^{-7} \text{F}
 \end{aligned}$$

OR

$$\begin{aligned}
 \text{(ii)} \quad qE &= mg \\
 q \frac{\sigma}{2\epsilon_0} &= mg \\
 \sigma &= \frac{2mg\epsilon_0}{q} \\
 &= \frac{2 \times 50 \times 10^{-3} \times 9.8 \times 8.85 \times 10^{-12}}{8 \times 10^{-17}} \\
 &= 10.8 \times 10^4 \text{Vm}^{-1}
 \end{aligned}$$

Question 3

[2]



Question 4

[2]

- (i) No, resistance R of a conductor is constant. Its value does not depend on V or I .

OR

- (ii) $P \propto \frac{1}{R}$ when V is constant i.e. when resistors are connected in parallel.
 $P \propto R$ when I is constant i.e., when resistors are connected in series.

Question 5

[2]

This is due to a large induced emf which produces an electric discharge through air. Ionised air molecules emit light when they return to ground state from their excited states.

Question 6**[2]**

The correct arrangement of the seven electromagnetic waves in increasing order of their frequencies (from lowest to highest frequency) is:

1. Radio Waves (Lowest frequency)
2. Microwaves
3. Infrared Waves
4. Visible Light
5. Ultraviolet (UV) Rays
6. X-rays
7. Gamma Rays (Highest frequency)

Question 7**[2]**

- (i) The current flowing through the diode during reverse bias is extremely small because it is entirely due to minority charge carriers, which are much smaller in number (in comparison with number of majority carriers).
- (ii) Extrinsic semiconductors are highly useful because their electrical conductivity can be precisely controlled, tuned, and manipulated by altering the concentration of dopant atoms (impurities) added to the crystal.

Or

Electronic devices like diodes, transistors, solar cells etc. can be made out of extrinsic semiconductors, which have many applications in electronic gadgets.

Question 8**[2]**

$$\frac{(KE)_A}{(KE)_B} = \frac{\frac{h^2}{2m_A\lambda_A^2}}{\frac{h^2}{2m_B\lambda_B^2}}$$

$$\frac{(KE)_A}{(KE)_B} = \frac{m_B\lambda_B^2}{m_A\lambda_A^2}$$

$$\text{Given: } \lambda_A = 2\lambda_B$$

Now,

$$\frac{(KE)_A}{(KE)_B} = \frac{m_B\lambda_B^2}{m_A(2\lambda_B)^2}$$

$$\frac{(KE)_A}{(KE)_B} = \frac{m_B}{m_A \times 4}$$

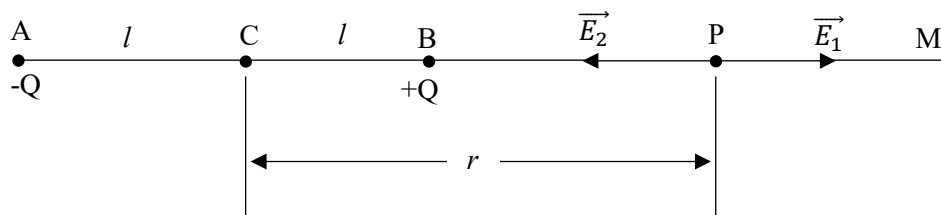
$$(KE)_A : (KE)_B = m_B : 4m_A$$

SECTION C – 27 MARKS

Question 9

[3]

(i)



$$E_1 = K \cdot \frac{Q}{(r-l)^2}$$

$$E_2 = K \cdot \frac{Q}{(r+l)^2}$$

$$E = E_1 - E_2$$

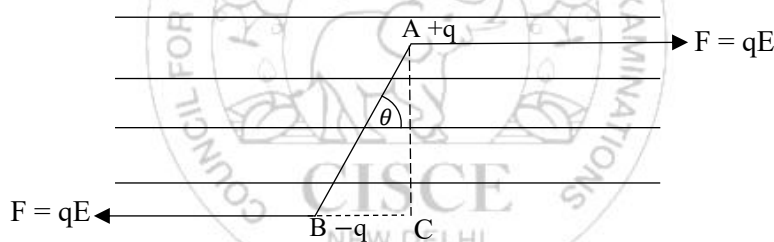
$$= K Q \left[\frac{1}{(r-l)^2} - \frac{1}{(r+l)^2} \right]$$

$$E = K \cdot \frac{2pr}{(r^2-l^2)^2}$$

This is the required expression.

OR

(ii)



$$\tau = \text{Force} \times \text{distance}$$

$$= qE \times AC$$

$$= qE \times \left(\frac{AC}{AB} \right) \times AB$$

$$= qE \sin \theta \times L$$

$$\tau = pE \sin \theta \text{ (where, } p = qL \text{)}$$

This is the required expression.

Question 10

[3]

(i) R_4 , R_5 and R_2 are in parallel.

Their equivalent resistance R_6 is given by

$$\frac{1}{R_6} = \frac{1}{30} + \frac{1}{40} + \frac{1}{120}$$

$$\therefore R_6 = 15\Omega$$

Now, R_1 , R_6 and R_3 are in series.

$$\therefore R = 10 + 15 + 14 = 39\Omega$$

Current I delivered by the battery is given by

$$I = \frac{E_{\text{Total}}}{R+r} = \frac{4.5}{39+6}$$

$$= 0.1\text{A}$$

Reading of ammeter = 0.1A

OR

- (ii) R_2 and R_3 are in parallel.

Their equivalent resistance R_4 is given by

$$\frac{1}{R_4} = \frac{1}{12} + \frac{1}{24}$$

$$\therefore R_4 = \frac{24}{3} = 8\Omega$$

It's a balanced Wheatstone bridge

So,

$$\frac{R_1}{R_4} = \frac{l}{(100-l)}$$

$$\frac{R_1}{8} = \frac{60}{40}$$

$$\therefore R_1 = \frac{60 \times 8}{40} = 12\Omega$$

Question 11

[3]

- (i) $\vec{E}$ should be in the plane of the paper, pointing vertically downwards.

- (ii) Since alpha particles travel undeviated;

$$F_m = F_e$$

$$Bqv = qe$$

$$\therefore v = \frac{E}{B}$$

Since protons also obey the abovesaid relation (same v , same E and same B), they will also travel undeviated.

Question 12

[3]

- (i) Magnetic field inside a solenoid is **uniform** whereas magnetic field along the axis of a circular coil is **non uniform**.
- (ii) In anticlockwise direction (according to Lenz's law)
- (iii) It has a large coercive force i.e. it is more difficult to demagnetise steel than iron.

Question 13

[3]

- (i) Incorrect, bright fringe (since path difference = 2λ)
- (ii) Incorrect, because the slit separation should have been decreased.
- (iii) Incorrect, diffraction pattern is seen on the screen.

Question 14**[3]**

- (i)
$$n = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60+34}{2}\right)}{\sin\left(\frac{60}{2}\right)} = 1.47$$
- (ii) The student's statement is not always correct. A larger minimum deviation indicates a higher mean refractive index, whereas dispersive power depends on the difference in refractive indices for violet and red light.

Question 15**[3]**

- (i) The nature, size, and position of the image will not change at all, but the brightness (intensity) of the image will be reduced to half because there is no change in focal length and same object and image distances.
- (ii) Magnifying power increases when the focal length is decreased.

Question 16**[3]**

- (i) No photoelectrons are emitted because the energy of the incident photons is less than the work function of the material. For photoelectric emission to take place, the incident photon energy must be greater than or equal to the threshold work function.
- (ii) C
- (iii) Using Einstein's photoelectric equation:
 $K_{\max} = E - \phi$
 $K_{\max} = 2.8 - 2.3 = 0.5 \text{ eV}$
The maximum kinetic energy of the emitted photoelectrons in image B is 0.5 eV.

Question 17**[3]**

- (i) A solar cell (also known as a photovoltaic cell) is a semiconductor p-n junction diode that directly converts solar energy (light energy) into electrical energy.
- (ii) The incoming photons break covalent bonds near the junction, generating free electron-hole pairs. This build-up of charges creates a voltage difference (electromotive force). When an external load or circuit is connected, a direct electric current begins to flow.
- (iii) Metal

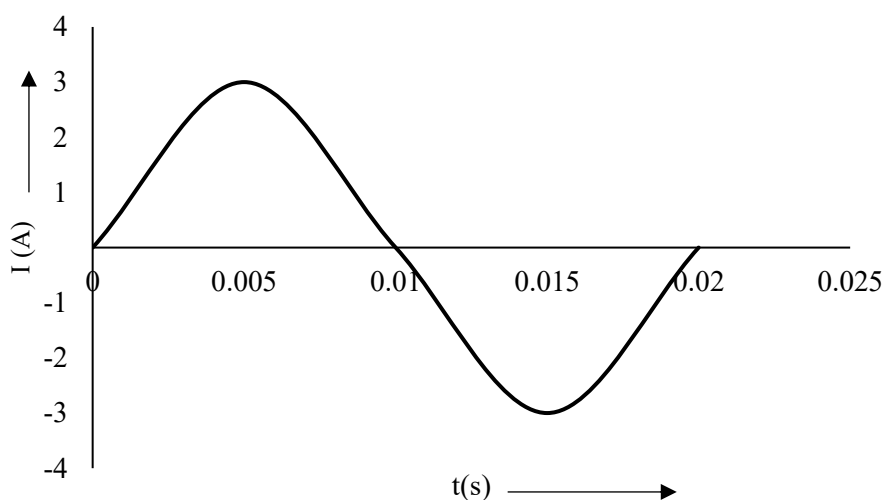
SECTION D – 15 MARKS**Question 18****[5]**

- (i) (a) (1) Capacitor (current is leading over applied emf by 90°)
- (2) $f = \frac{1}{T} = \frac{1}{80 \times 10^{-3}} = 12.5 \text{ Hz}$
- (3) $X_c = \frac{e_0}{i_0} = \frac{240}{6} = 40 \Omega$

(b) $x = 3t^2 + 6$
 $\therefore \frac{dx}{dt} = 6t$
 $\therefore v = 6t$
 After 10s, $v = 6 \times 10 = 60\text{ms}^{-1}$
 $E = BLv$
 $= 2 \times 10^{-5} \times 1.2 \times 60$
 $= 1.44 \times 10^{-3} \text{ V}$

OR

(ii) (a) $i_0 = \frac{e_0}{R} = \frac{300}{100} = 3.00\text{A},$
 $2\pi f = 100\pi$
 $f = 50 \text{ Hz}$
 $T = \frac{1}{f} = \frac{1}{50} = 0.02\text{Hz}$



(b) $\langle P \rangle = \frac{I_0^2 R}{2}$
 $= \frac{9 \times 100}{2}$
 $= 450\text{W}$

- (c) Because ac can be stepped up or down with the help of a transformer whereas dc cannot be stepped up or down.
 (d) The former is a step up transformer whereas the latter is a step down transformer.

Question 19

[5]

(i) (a) $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{(Ze)(e)}{r^2}$
 $mvr = n \frac{h}{2\pi}$
 $mv^2 = \frac{Ze^2}{4\pi\epsilon_0} \frac{(2\pi mv)}{nh}$
 $\therefore v = \frac{Ze^2}{2\epsilon_0 nh}$

(b) $1u = 1.66 \times 10^{-27} \text{ kg}$

$$\begin{aligned}
 c &= 3 \times 10^8 \text{ m/s} \\
 E &= mc^2 \\
 E &= 1.66 \times 10^{-27} \times (3 \times 10^8)^2 \\
 &= 14.929 \times 10^{-11} \text{ J} \\
 E &= \frac{14.929 \times 10^{-11}}{1.6 \times 10^{-19}} = 9.315 \times 10^8 \text{ eV} \\
 &= 931.5 \text{ MeV}
 \end{aligned}$$

OR

- (ii) (a) $R = R_0 A^{1/3}$
 where,
 $R_0 = \text{constant}$
 $A = \text{mass number of the nucleus}$
 Nuclear matter density, $\rho = \frac{\text{mass of the nucleus}}{\text{volume of the nucleus}}$
 Let m be the average mass of the nucleon.
 Hence, mass of the nucleus = mA
 $\therefore \rho = \frac{mA}{\frac{4}{3}\pi R^3}$
 $= \frac{3mA}{4\pi \left(R_0 A^{1/3}\right)^3}$
 $= \frac{3mA}{4\pi R_0^3 A} = \frac{3m}{4\pi R_0^3}$
- (b) Isotones are atoms or nuclei that have the same number of neutrons (N) but different numbers of protons (Z)
- (c) (1) Balmer series lies in the visible region.
 (2) The Lyman series lies in the ultraviolet (UV) region.

Question 20

[5]

- (i) The refractive power of the lens will decrease (focal length will increase).
- (ii) $\frac{1.5}{v} - \frac{1}{-60} = \frac{1.5-1}{20}$ solving this $v = +180 \text{ cm}$
 The image is formed at a distance of 180cm inside the denser medium (glass), measured from the pole of the refracting surface.
- (iii) Objective: The concave spherical mirror must act as the objective.
 Eyepiece: The thin biconvex lens must act as the eyepiece.
- (iv) A parabolic mirror