PHYSICS
PAPER – 1
(THEORY)

PART I (20 Marks)

*Answer **all** questions.*

Question 1

A. Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: **[5]**

(i) In ***Figure 1*** below, a charge Q is fixed. Another charge q is moved along a circular arc MN of radius r around it, from the point M to the point N such that the length of the arc MN $= l$. The work done in this process is:

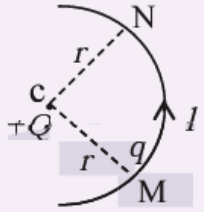


Figure 1

(a) zero

(b) $\frac{1}{4\pi\epsilon_0} \cdot \frac{Qq}{r^2}$ *l*

(c) $\frac{Qq}{2\epsilon_0 r^2}$ *l*

(d) $\frac{Qq}{2\pi\epsilon_0 r^2}$

(ii) A carbon resistor has coloured bands as shown in ***Figure 2*** below. The resistance of the resistor is:

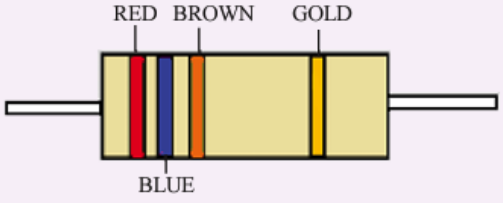


Figure 2

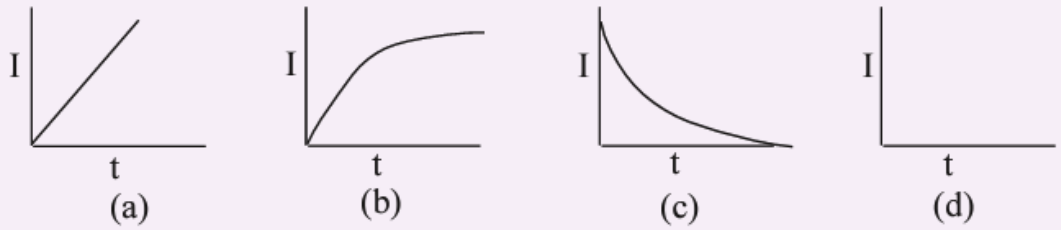
(a) 26Ω ± 10%

(b) 26Ω ± 5%

(c) 260Ω ± 5%

(d) 260Ω ± 10%

(iii) A solenoid L and a resistor R are connected in series to a battery, through a switch. When the switch is put on, current I flowing through it varies with time t as shown in which of the graphs given below:



(iv) Two thin lenses having optical powers of -10D and + 6D are placed in contact with each other. The focal length of the combination is:

(a) + 0·25 cm

(b) - 0·25 cm

(c) + 0·25 m

(d) - 0·25 m

(v) Total energy of an electron in the **ground state** of hydrogen atom is -13·6 eV. Its total energy, when hydrogen atom is in the **first excited state**, is:

(a) + 13·6 eV

(b) + 3·4 eV

(c) - 3·4 eV

(d) - 54·4 eV

B. Answer **all** questions given below **briefly** and to the point: **[15]**

(i) A charged oil drop weighing $1{\cdot}6 \times 10^{-15}$ N is found to remain suspended in a uniform electric field of intensity 2×10^{3} NC^{-1}. Find the **charge** on the drop.

(ii) For a metallic conductor, what is the relation between **current density** (J), **conductivity** (σ) and **electric field intensity** E?

(iii) In ***Figure 3*** given below, find the value of resistance x for which points A and B are at the same potential:

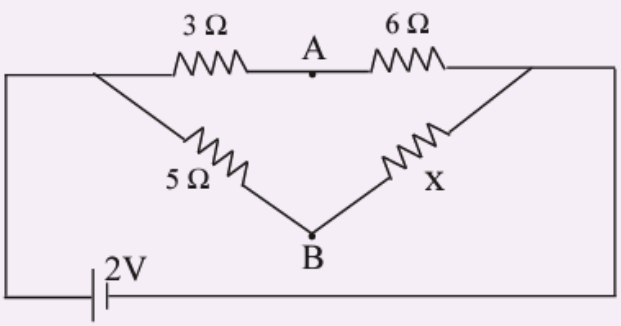


Figure 3

(iv) Write the expression for the **Lorentz force F** in vector form.

(v) A coil has a **self-inductance** of 0·05 Henry. Find magnitude of the emf induced in it when the current flowing through it is changing at the rate 100 As^{-1}.

(vi) To which regions of the **electromagnetic spectrum** do the following wavelengths belong:

(a) 250 nm

(b) 1500 nm

(vii) What is the difference between **polarised light** and **unpolarised light**?

(viii) Name the **principle** on the basis of which **optical fibres** work.

(ix) Calculate **dispersive power** of a transparent material given:

$$n_v = 1{\cdot}56\ ,\ n_r = 1{\cdot}54,\quad n_y = 1{\cdot}55.$$

(x) What is meant by **short-sightedness**?

(xi) Two metals A and B have work functions 4eV and 6eV respectively. Which metal has lower **threshold wavelength** for photoelectric effect?

(xii) Calculate **angular momentum** of an electron in the **third** Bohr orbit of hydrogen atom.

(xiii) In a nuclear reactor, what is the function of a **moderator**?

(xiv) In our Nature, where is the **nuclear fusion** reaction taking place continuously?

(xv) What is the use of a **Zener diode**?

PART II (50 Marks)

*Answer **ten** questions in this part, choosing **four** questions from Section **A**, **three** questions from Section **B** and **three** questions from Section **C**.*

SECTION A

*Answer any **four** questions.*

Question 2

(a) Two point charges $Q_1 = 400\mu C$ and $Q_2 = 100\mu C$ are kept fixed, 60 cm apart in vacuum. Find **intensity** of the electric field at **midpoint** of the line joining Q_1 and Q_2. **[3]**

(b) (i) State **Gauss' Law**. **[2]**

(ii) In an electric dipole, at which point is the **electric potential** zero?

Question 3

(a) Obtain an expression for **equivalent capacitance** when three capacitors C_1, C_2 and C_3 are connected in **series**. **[3]**

(b) A metallic wire has a resistance of $3 \cdot 0\Omega$ at 0^oC and $4 \cdot 8\Omega$ at 150^oC. Find the **temperature coefficient of resistance** of its material. **[2]**

Question 4

(a) In the circuit shown in ***Figure 4*** below, E_1 and E_2 are two cells having emfs 2V and 3V respectively, and negligible internal resistances. Applying **Kirchoff's laws** of electrical networks, find the values of currents I_1 and I_2. **[4]**

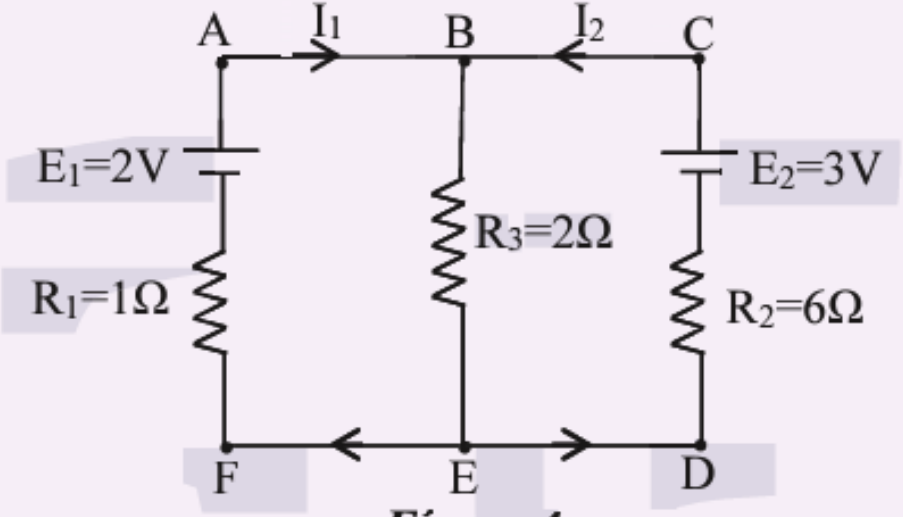


Figure 4

(b) State how a moving coil galvanometer can be converted into an ammeter. **[1]**

Question 5

(a) Draw a labelled circuit diagram of a **potentiometer** to measure **internal resistance** of a cell. Write the working formula. (*Derivation not required*). **[3]**

(b) (i) Define **Curie temperature**. **[2]**

(ii) If magnetic susceptibility of a certain magnetic material is 0·0001, find its **relative permeability**.

Question 6

(a) (i) Two infinitely long current carrying conductors X and Y are kept parallel to each other, 24 cm apart in vacuum. They carry currents of 5A and 7A respectively, in the **same** direction, as shown in ***Figure 5*** below. Find the position of a *neutral point*, i.e. a point where resultant magnetic flux density is zero. (*Ignore earth's magnetic field*). **[3]**

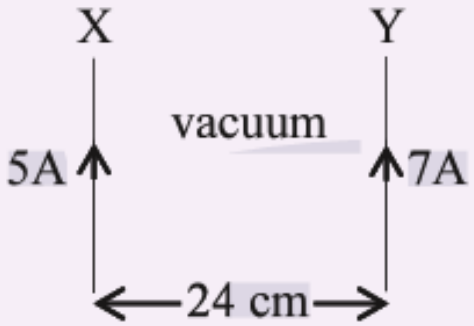


Figure 5

(ii) If current through the conductor Y is **reversed** in direction, will neutral point lie between X and Y, to the left of X or to the right of Y?

(b) (i) Define **Ampere** in terms of force between two current carrying conductors. **[2]**

(ii) What is an **ideal** transformer?

Question 7

(a) A coil having **self-inductance** of 0·7H and resistance of 165Ω is connected to an a.c. source of 275V, 50Hz. If $\pi = \frac{22}{7}$, **[3]**

Calculate:

(i) Reactance of the coil

(ii) Impedance of the coil

(iii) Current flowing through the coil

(b) Draw a labelled graph showing variation of **impedance** of a series LCR circuit with frequency of the a.c. supply. **[2]**

SECTION B

*Answer any **three** questions.*

Question 8

(a) Derive **Snell's law** of refraction using **Huygen's wave theory**. **[3]**

(b) Monochromatic light of wavelength 650nm falls normally on a slit of width $1{\cdot}3 \times 10^{-4}$ cm and the resulting **Fraunhofer diffraction** is obtained on a screen. Find the **angular width** of the central maxima. **[2]**

Question 9

(a) In **Young's double slit experiment**, show that: **[4]**

$$\beta = \frac{\lambda D}{d},$$

where the terms have their usual meaning.

(b) A ray of ordinary light is travelling in air. It is incident on air glass pair at a **polarising angle** of 56°. Find the angle of **refraction** in glass. **[1]**

Question 10

(a) Find the **angle of incidence** at which a ray of monochromatic light should be incident on the **first surface** AB of a **regular** glass prism ABC so that the emergent ray **grazes** the adjacent surface AC. (Refractive Index of glass = 1·56). **[3]**

(b) State how focal length of a glass lens (Refractive Index 1·5) changes when it is completely immersed in: **[2]**

(i) Water (Refractive Index 1·33)

(ii) A liquid (Refractive Index 1·65)

Question 11 sign convention was used by ma

(a) A convex lens of a focal length 5 cm is used as a **simple microscope**. Where should an object be placed so that the image formed by it lies at the least distance of distinct vision (D=25cm)? **[2]**

(b) Draw a labelled ray diagram showing the formation of an image by a refracting **telescope** when the final image lies at infinity. **[3]**

SECTION C

*Answer any **three** questions.*

Question 12

(a) Monochromatic light of wavelength 198 nm is incident on the surface of a metallic cathode whose work function is 2·5 eV. How much potential difference must be applied between the cathode and the anode of a photocell to **just stop** the photo current from flowing? **[3]**

(b) (i) What is **de Broglie** hypothesis? **[2]**

(ii) What conclusion can be drawn from **Davisson and Germer's** experiment?

Question 13

(a) (i) How are various lines of **Lyman series** formed? Explain on the basis of **Bohr's** theory. **[3]**

(ii) Calculate the **shortest** wavelength of electromagnetic radiation present in **Balmer** series of hydrogen spectrum.

(b) State the effect of the following changes on the X-rays emitted by Coolidge X-ray tube: **[2]**

(i) ***High voltage between cathode and anode is increased.***

(ii) Filament temperature is increased.

Question 14

(a) **Half life** of a certain **radioactive material** is 8 hours. **[3]**

(i) Find **disintegration constant** of this material.

(ii) If one starts with 600g of this substance, how much of it will **disintegrate** in one day?

(b) Sketch a graph showing the variation of **binding energy per nucleon** of a nucleus with its **mass number**. **[2]**

Question 15

(a) Draw a circuit diagram for the **common emitter transistor amplifier**. What is meant by **phase reversal**? **[3]**

(b) Write the **truth table** of the following circuit. Name the **gate** represented by this circuit. **[2]**