PHYSICS

Paper – 1

(THEORY)

(Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper. They must NOT start writing during this time)*

Answer **all** *questions in* ***Part I*** *and* **six** *questions from* ***Part II****, choosing* **two** *questions from* ***each of*** *the Sections* ***A, B*** *and* ***C****.*

All working, including rough work, should be done on the same sheet as, and adjacent to, the rest of the answer.

The intended marks for questions or parts of questions are given in brackets [ ].

(Material to be supplied: Log tables including Trigonometric functions)

A list of useful physical constants is given at the end of this paper.

PART I

Answer **all** *questions*

Question 1

A Choose the correct alternative A, B, C or D for each of the questions given below: **[5]**

(i) Two point charges (+e) and (–e) are kept inside a large metallic cube without touching its sides. Electric flux emerging out of the cube is:

(A) $\frac{e}{\epsilon_o}$ (B) $\frac{-e}{\epsilon_o}$

(C) Zero (D) $\frac{2e}{\epsilon_o}$

(ii) In current electricity, Ohm's law is obeyed by all:

(A) solids

(B) metals

(C) liquids

(D) gases

(iii) When a charged particle is projected perpendicular to a uniform magnetic field, it describes a circular path in which:

(A) its speed remains constant.

(B) its velocity remains constant.

(C) its momentum remains constant.

(D) its kinetic energy increases.

(iv) Refractive index of a transparent material is:

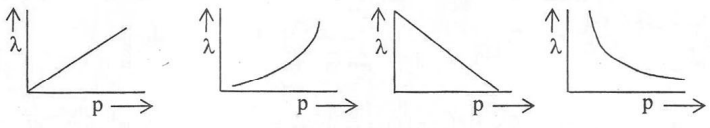
(A) same for all colours.

(B) maximum for violet colour.

(C) minimum for violet colour.

(D) maximum for red colour.

(v) Which one of the following graphs in ***Figure 1*** represents variation of **de Broglie** wavelength (λ) of a particle having linear momentum p:



(A) (B) (C) (D)

Figure 1

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

(i) How much work is done in taking an electron around a nucleus in a circular path?

(ii) A 10 m long potentiometer wire carries a steady current. A standard cell of emf 1.018 V is balanced against a length of 254.5 cm of the wire. What is the potential gradient across the potentiometer wire?

(iii) Name any **one** instrument which works on the principle of Tangent law in magnetism.

(iv) An inductor L and a resistor R are connected in series to a battery, through a key/switch. Show graphically, how current decreases with time when the key/switch is opened.

(v) An ideal inductor does not consume any power even though both V and I are non zero. Explain in brief.

(vi) In Fraunhofer's single slit diffraction experiment, how does semi-angular width θ of the central bright fringe depend on slit width 'a'?

(vii) State one use of a polaroid.

(viii) A ray of light LM incident **normally** on the surface AC of an isosceles right angled prism ABC (where AB = BC) emerges along PQ, parallel to LM, as shown in ***Figure 2*** below:

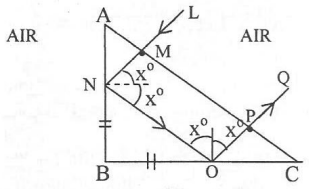


Figure 2

What can you say about refractive index μ of the material of the prism?

(ix) State one condition for obtaining a sustained interference of light.

(x) State any one postulate of **Huygen's** wave theory.

(xi) How can an **n** type semiconductor be obtained from a pure crystal of germanium?

(xii) In the following nuclear reaction

$$^{11}_{6}C \rightarrow {}^{11}_{5}B + {}^{0}_{1}e + X$$

what does X stand for?

(xiii) In photoelectric effect, what is meant by the term **'threshold frequency'**?

(xiv) Find angular momentum of an electron when it is in the second Bohr orbit of hydrogen atom.

(xv) What is the symbol of a **NOT** gate?

PART II

Answer **six** *questions in this part, choosing* **two** *questions*

from ***each*** *of the Sections* ***A, B*** *and* ***C.***

SECTION A

Answer any **two** *questions*

Question 2

(a) Obtain an expression for intensity of electric field in end on position, i.e. axial position of an electric dipole. **[4]**

(b) Three capacitors each of capacitance C are connected in series. Their equivalent capacitance is C_s . The same three capacitors are now connected in parallel. Their equivalent capacitance becomes C_p. Find the ratio $\left(\frac{C_p}{C_s}\right)$. ***(Working must be shown)*** **[3]**

(c) A galvanometer with a resistance of 75Ω produces a full scale deflection with a current of 5 mA. How can this galvanometer be converted into an ammeter which has a range of 0 – 5 A? **[2]**

Question 3

(a) In the circuit shown below in ***Figure 3,*** E_1 and E_2 are batteries having emfs 4.0 V and 3.5 V respectively and internal resistance 1 Ω and 2 Ω respectively. Using Kirchoff's laws, calculate currents: I_1, I_2 and I_3. **[4]**

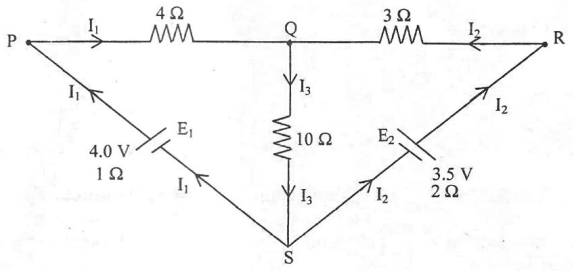


Figure 3

(b) Show, with the help of a labelled graph, how thermo emf 'e' developed by a thermocouple varies with θ, the temperature difference between the two junctions. On the graph, mark neutral temperature as θ_N and temperature of inversion as θ_I. **[2]**

(c) (i) What is meant by a **paramagnetic** substance? State **Curie's law.** **[3]**

(ii) What is the value of **magnetic susceptibility** of Aluminium if its relative permeability is 1.000022?

Question 4

(a) Using **Ampere's circuital law** or **Biot and Savart's law**, show that magnetic flux density 'B' at a point 'P' at a perpendicular distance 'a' from a long current carrying conductor is given by: [3]

$$B = \left(\frac{\mu_o}{4\pi}\right)\frac{2I}{a}$$

(Statement of the laws - not required)

(b) A current of 4A flows in a coil when it is connected to a 12V dc source. When the same coil is connected to an ac source (12 V, 8 Hz), a current of 2.4 A flows in the coil. Calculate coefficient of self inductance (**L**) of the coil. [4]

(c) How much force per unit length acts on a long current carrying conductor X due to a current flowing through another similar conductor Y, kept parallel to it in vacuum? [2]

Use this equation to define an **Ampere**, the fundamental unit of current.

SECTION B

Answer any **two** *questions*

Question 5

(a) (i) Arrange all the seven types of electro-magnetic radiations in increasing order of their frequencies. (You must begin with a radiation with lowest frequency and end with the one having the highest frequency.) [3]

(ii) State how electric vector $\overline{E}$, magnetic vector $\overline{B}$ and velocity vector $\overline{C}$ are oriented in an electromagnetic wave.

(b) In Young's double slit experiment, using monochromatic light L_1 of wavelength 700 nm, 10^{th} bright fringe was obtained at a certain point P on a screen. Which bright fringe will be obtained at the same point P if monochromatic light of wavelength 500 nm is used in place of L_1. (***No other alterations were made in the experimental set up.***) [3]

(c) A certain monochromatic light travelling in air is incident on a glass plate at a polarising angle. Angle of refraction in glass is found to be 32°. Calculate: [2]

(i) the polarising angle;

(ii) refractive index of glass.

Question 6

(a) Calculate angle of minimum deviation (δ_m) for a **regular** glass prism. (Refractive index of glass = 1.6) [2]

(b) Obtain an expression for refraction at a single convex spherical surface, i.e. the relation between μ_1 (rarer medium), μ_2 (denser medium), the object distance u, image distance v and radius of curvature R. [4]

(c) Where should an object be kept on the principal axis of a convex lens of focal length 20 cm, in order to get an image, which is double the size of the object? [2]

Question 7

(a) (i) What is the use of a spectrometer? [3]

(ii) In a spectrometer, what is the function of:

(1) Collimator?

(2) Telescope?

(b) Draw a labelled diagram of an image formed by a compound microscope with image at **least distance of distinct vision.** [3]

(c) An astronomical telescope consists of two thin convex lenses having focal lengths of 140 cm and 5 cm. The telescope is adjusted to be in **normal adjustment.** [2]

(i) What is the angular magnification, i.e. magnifying power of the telescope in this set up?

(ii) What is the distance between the two lenses equal to?

SECTION C

Answer any **two** *questions*

Question 8

(a) State two important conclusions that can be drawn from **Millikan's oil drop experiment** to determine the charge of an electron. [2]

(b) A monochromatic source of light emits light of wavelength 198 nm. Calculate: [3]

(i) energy of each photon;

(ii) Momentum of the photon.

(c) (i) Name a series of lines of hydrogen spectrum which lies in: [3]

(1) Visible region

(2) Ultra violet region

(ii) Write **Bohr's formula** to calculate wavelength (λ) of visible light, emitted by hydrogen, and explain the meaning of each and every symbol used.

Question 9

(a) Starting with the law of radioactive disintegration, show that: $N = N_o e^{-\lambda t}$, where the terms have their usual meaning. [3]

(b) What is meant by **Pair Production**? Explain with the help of an example and a balanced equation. [2]

(c) An X ray tube is operated at a tube potential of 40,000 V. Calculate: [3]

(i) Kinetic energy of an electron emitted by the filament when it reaches the target/anode.

(ii) Wavelengths of all the X rays emitted by the X ray tube.

Question 10

(a) (i) In the following nuclear reaction, calculate the energy released in MeV: [3]

$$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + ^{1}_{0}n$$

Given that:

Mass of $^{2}_{1}H$ = 2.015u

Mass of $^{3}_{2}He$ = 3.017u

Mass of $^{1}_{0}n$ = 1.009u

(ii) What is the name of this reaction?

(b) What is meant by the terms: [3]

(i) a full wave rectifier?

(ii) an amplifier?

(iii) an oscillator?

(c) Using several **NAND** gates, how can you obtain an **AND** gate? Draw a labelled diagram in support of your answer. [2]

Useful Constants and Relations:

1.	Speed of Light in vacuum	(c)	$= 3.0 \times 10^{8}$ ms^{-1}
2.	Planck's constant	(h)	$= 6.6 \times 10^{-34}$ Js
3.	Permeability of vacuum	(μ_o)	$= 4\pi \times 10^{-7}$ Hm^{-1}
4.	Charge of an electron	(-e)	$= -1.6 \times 10^{-19}$C
5.	Unified Atomic Mass Unit	(1*u*)	= 931 MeV
6.		(1nm)	$= 10^{-9}$m