

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 **ten** questions from **Part II**, choosing **four** questions from **Section A**, **three** questions from **Section B** and **three** questions from **Section 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 (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) Two point charges $17.7 \mu\text{C}$ and $-17.7 \mu\text{C}$, separated by a very small distance, are kept inside a large hollow metallic sphere. Electric flux emanating through the sphere is:
- (a) $2 \times 10^6 \text{ Vm}$
 - (b) $-2 \times 10^6 \text{ Vm}$
 - (c) Zero
 - (d) $4 \times 10^6 \text{ Vm}$
- (ii) Ohm's law, in vector form is:
- (a) $\mathbf{J} = \rho \mathbf{E}$
 - (b) $\mathbf{J} = \sigma \mathbf{E}$
 - (c) $\mathbf{V} = \mathbf{I} \mathbf{R}$
 - (d) $\mathbf{E} = \sigma \mathbf{J}$
- (iii) If the current (I) flowing through a circular coil, its radius (R) and number of turns (N) in it are each doubled, magnetic flux density at its centre becomes:
- (a) Two times
 - (b) Four times
 - (c) Eight times
 - (d) Sixteen times

- (iv) A person is suffering from the defect of myopia. His far point will be:
- (a) Infinity
 - (b) 25 cm
 - (c) < 25 cm
 - (d) About a metre
- (v) Ratio of the radius of third Bohr orbit to the radius of second Bohr orbit in hydrogen atom is:
- (a) 2:3
 - (b) 4:9
 - (c) 9:4
 - (d) 3:2

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

[15]

- (i) A dielectric slab of relative permittivity (i.e. dielectric constant) 6 is introduced between the two plates of an $8\mu\text{F}$ air capacitor, in order to completely occupy the space between the two plates. Find the new capacitance of the capacitor.
- (ii) Show graphically how resistance of a piece of carbon varies with temperature.
- (iii) Current 'I' flowing through a metallic wire of area of cross-section 'a' is given by the equation $I = naev_d$. What is the meaning of the symbols 'n' and ' v_d '?
- (iv) You are provided with four identical cells each of emf 1.5V. How will you connect all of them to obtain a battery of emf 3V?
- (v) What is the value of magnetic field around a current carrying torroid?
- (vi) What type of wave front is associated with a line source of light?
- (vii) Calculate the polarizing angle for glass whose refractive index is 1.6.
- (viii) What is the optical power in diopetre of a concave lens of focal length 50 cm?
- (ix) What is meant by *resolving power* of a telescope?
- (x) What is the angle made by a refracted ray with the normal inside a regular (equilateral) prism, in minimum deviation case?
- (xi) Name the *series* of lines in the hydrogen spectrum which lie in the *infrared* region.
- (xii) What are *isotones*?
- (xiii) Explain the statement: *Half-life of polonium is 3.8 days.*
- (xiv) In a nuclear reactor, what is the function of graphite rods?
- (xv) What is *amplitude modulation*?

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) Obtain an expression for intensity of electric field at a point in axial position of an electric dipole. [3]
- (b) Calculate electrostatic potential energy stored in a system consisting of two point charges $100\mu\text{C}$ and $40\mu\text{C}$ separated by a distance of 9cm, in vacuum. [2]

Question 3

- (a) Two plates of a charged parallel plate capacitor are pulled apart with the help of insulating handles, till their separation is doubled. [3]
Compare the new electrostatic potential energy of the capacitor with the old.
- (b) Draw a labelled diagram of a potentiometer circuit used to measure internal resistance of a cell. [2]

Question 4

In **Figure 1** below, power developed in resistor R_1 is 120W. Find the power developed in resistor R_3 . [3]

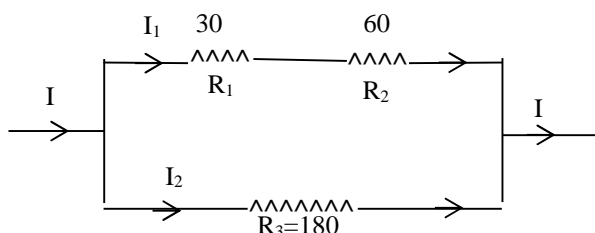


Figure 1

In a metre bridge experiment to determine unknown resistance of a coil, how is position of the null point affected if: [2]

- (i) Galvanometer and cell are interchanged?
- (ii) Known and unknown resistances are interchanged?

Question 5

- (a) Apply Kirchoff's Laws to calculate the currents I_1 and I_2 in the circuit shown in **Figure 2** below: [3]

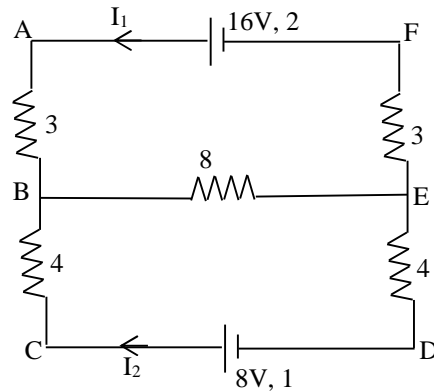


Figure 2

- (b) You are given a bar. How will you identify experimentally whether it is made of a ferro-magnetic, paramagnetic or a diamagnetic material? [2]

Question 6

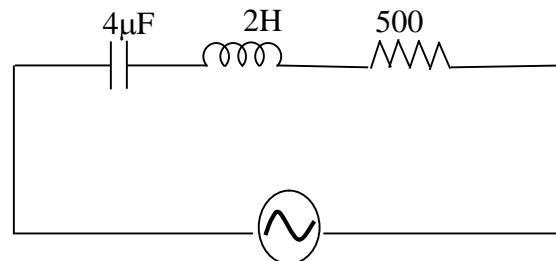
- (a) Using Ampere's Circuital Law and with the help of a labelled diagram, show that magnetic flux density 'B' at a distance r from a long straight conductor is given by: [3]

$$B = \frac{\mu_0 I}{2\pi r}, \text{ where the terms have their usual meaning.}$$

- (b) Define *time constant* of an RC circuit. What is its **SI** unit? [2]

Question 7

- (a) (i) In the circuit shown in **Figure 3** below, calculate phase difference between the current and the supply voltage: [4]



$$= 300 \sin(500t)$$

Figure 3

- (ii) State whether current is leading or lagging behind the supply voltage
- (b) What is meant by *quality factor* of an LCR circuit? [1]

SECTION B

Answer any *three* questions

Question 8

- (a) Prove the law of reflection of light on the basis of Huygens wave theory of light. [4]
- (b) Why can't two independent monochromatic sources of light emitting light of one and the same wavelength behave as coherent sources? [1]

Question 9

- (a) In Young's double slit experiment, using light of wavelength 600 nm, 10th bright fringe is obtained on a screen, 3mm from the centre of the pattern. If the screen is 120 cm away from the slits, calculate: [3]
- (i) Distance between the two slits;
- (ii) Fringe width, i.e. fringe separation.
- (b) Show graphically how intensity of light varies in Fraunhofer diffraction. [2]

Question 10

- (a) An optical system consists of a thin convex lens 'L' of focal length $f = 15$ cm and a convex mirror **M** having radius of curvature $R = 36$ cm, arranged co-axially, at a distance of 24 cm. (See **Figure 4** below). [3]

Where should an object **O** be kept so that its inverted image **I** formed by the lens mirror combination coincides with the object itself?

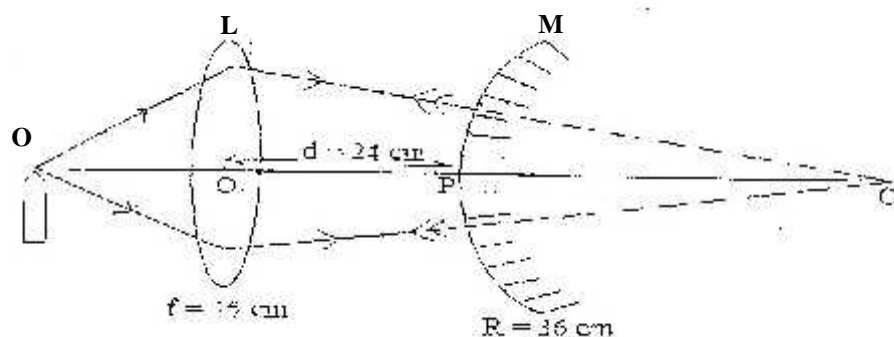


Figure 4

- (b) A narrow and parallel beam of white light is incident on a convex lens, parallel to its principal axis. Draw a labelled diagram to show how coloured images are formed by the lens. [2]

Question 11

- (a) Find the distance between the two lenses of a compound microscope if the final image formed by the microscope is virtual and lies at a distance of 25cm to the left of the eyepiece. Magnifying power of the microscope is 30 and focal lengths of objective and eyepiece are 2cm and 5cm, respectively. [4]
- (b) You are provided with two convex lenses having focal lengths 4cm and 80cm, respectively, to form an astronomical telescope. [1]
- Calculate its magnifying power for normal adjustment.

SECTION C

Answer any *three* questions.

Question 12

- (a) (i) Explain the statement: “Work function of a certain metal is 2.0 eV.” [3]
- (ii) Calculate the maximum wavelength of the electro-magnetic radiation which will cause emission of photoelectrons from this metal.
- (b) What is *de Broglie hypothesis*? What conclusion can be drawn from *Davisson and Germer’s* experiment? [2]

Question 13

- (a) **Figure 5** below shows a simple diagram of a modern X ray tube. (i.e. Coolidge tube). [3]

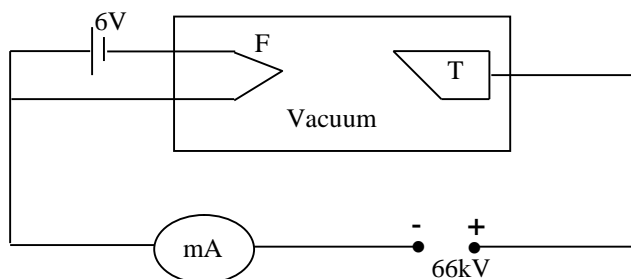


Figure 5

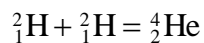
- (i) Find the *minimum* wavelength of the X rays emitted by the X ray tube.
- (ii) What will be the effect of replacing the 6V battery with a 9V battery on the emitted X rays?
- (b) What is meant by *mass defect* of a nucleus? How is it related to its binding energy? [2]

Question 14

- (a) Starting with the Law of Radioactive Disintegration, show that: [3]

$N = N_0 e^{-\lambda t}$, where the terms have their usual meaning.

- (b) Calculate the energy released in the following nuclear reaction: [2]



Mass of ${}^2_1\text{H} = 2.01419\text{u}$, Mass of ${}^4_2\text{He} = 4.00277\text{u}$

Question 15

- (a) Draw a labelled circuit diagram of a transistor as a switch and draw its input and output graphs. [3]

- (b) What is the symbol of a NOR gate? Write its truth table. [2]

Useful Constants and Relations:

1.	Planck's constant	(h)	$= 6.6 \times 10^{-34} \text{ Js}$
2.	Speed of Light in vacuum	(c)	$= 3.0 \times 10^8 \text{ ms}^{-1}$
3.	Charge of a proton	(e)	$= 1.6 \times 10^{-19} \text{ C}$
4.	Mass of an electron	m_e	$= 9.1 \times 10^{-31} \text{ kg}$
5.	Permittivity of free space	ϵ_0	$= 8.85 \times 10^{-12} \text{ Fm}^{-1}$
6.	Constant for Coulomb's Law	$\frac{1}{4\pi\epsilon_0}$	$= 9 \times 10^9 \text{ mF}^{-1}$
7.	One electron volt	1eV	$= 1.6 \times 10^{-19} \text{ J}$
8.	Unified atomic mass unit	1u	$= 931 \text{ MeV}$