

# PHYSICS

## PAPER – 1

### (THEORY)

(Maximum Marks: 70)

(Time allowed: Three hours)

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

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*All questions are compulsory.*

*This question paper is divided into 4 Sections, A, B, C and D as follows:*

#### **Section A**

*Question number 1 is of twelve marks. All parts of this question are compulsory.*

#### **Section B**

*Question numbers 2 to 12 carry 2 marks each with two questions having internal choice.*

#### **Section C**

*Question numbers 13 to 19 carry 3 marks each with two questions having internal choice.*

#### **Section D**

*Question numbers 20 to 22 are long-answer type questions and carry 5 marks each.  
Each question has an internal choice.*

*The intended marks for questions are given in brackets [ ].*

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

*Answers to sub parts of the same question must be given in one place only. A list of useful physical constants is given at the end of this paper.*

*A simple scientific calculator without a programmable memory may be used for calculations.*

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### **Section A**

*Answer all questions.*

#### **Question 1**

- (A) Choose the correct alternative (a), (b), (c) or (d) for each of the questions [5×1] given below:
- (i) A closed surface in vacuum encloses charges  $-q$  and  $+3q$ . The total electric flux emerging out of the surface is:
- (a) Zero
- (b)  $2q/\epsilon_0$
- (c)  $3q/\epsilon_0$
- (d)  $4q/\epsilon_0$
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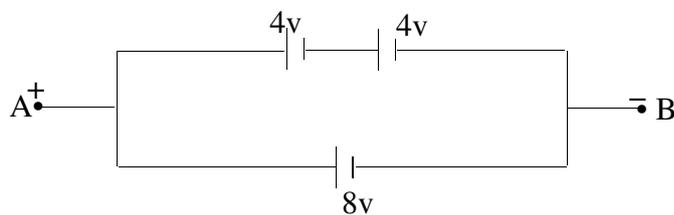
**This Paper consists of 7 printed pages and 1 blank page.**

- (ii) What is the angle of dip at a place where the horizontal component ( $B_H$ ) and vertical component ( $B_V$ ) of earth's magnetic field are equal:
- $130^\circ$
  - $60^\circ$
  - $45^\circ$
  - $90^\circ$
- (iii) A beam of light is incident at the polarizing angle of  $35^\circ$  on a certain glass plate. The refractive index of the glass plate is:
- $\sin 35^\circ$
  - $\tan 35^\circ$
  - $\tan 55^\circ$
  - $\sin 55^\circ$
- (iv) In a gamma ray emission from nucleus:
- only the number of protons change.
  - the number of protons and neutrons, both change.
  - there is no change in the number of protons and the number of neutrons.
  - only the number of neutrons change.
- (v) The energy associated with light of which of the following colours is minimum:
- violet
  - red
  - green
  - yellow

(B) Answer the following questions briefly and to the point.

[7×1]

- Define **equipotential** surface.
- Calculate the net emf across A and B shown in *Figure 1* below:



*Figure 1*

- Why are the pole pieces of a horseshoe magnet in a **moving coil galvanometer** made cylindrical in shape?

- (iv) What is the value of **power factor** for a pure resistor connected to an alternating current source?
- (v) What should be the path difference between two waves reaching a point for obtaining constructive interference in **Young's Double Slit** experiment?
- (vi) Define **critical angle** for a given medium.
- (vii) Name the series in the atomic spectra of the hydrogen atom that falls in the ultra violet region.

### Section B

*Answer all questions.*

#### Question 2

[2]

In a potentiometer experiment, the balancing length with a resistance of  $2\ \Omega$  is found to be 100 cm, while that of an unknown resistance is 500 cm. Calculate the value of the unknown resistance.

#### Question 3

[2]

A rectangular loop of area  $5\text{ m}^2$ , has 50 turns and carries a current of 1 A. It is held in a uniform magnetic field of 0.1T, at an angle of  $30^\circ$ . Calculate the torque experienced by the coil.

#### Question 4

[2]

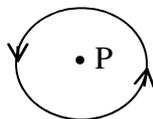
- (a) An electric current  $I$  flows through an infinitely long conductor as shown in **Figure 2(a)** below. Write an **expression** and **direction** for the magnetic field at point P.



**Figure 2(a)**

OR

- (b) An electric current  $I$  flows through a circular loop as shown in **Figure 2(b)** below. Write an **expression** and **direction** for the magnetic field at the centre of the loop at point P.



**Figure 2(b)**

#### Question 5

[2]

A transformer is used to step up an alternating emf of 200V to 440V. If the primary coil has 1000 turns, calculate the number of turns in the secondary coil.

**Question 6** [2]

State *any two* properties of **microwaves**.

**Question 7** [2]

Write *any one* use for each of the following mirrors:

- (a) Convex
- (b) Concave

**Question 8** [2]

The deviation produced for violet, yellow and red lights for crown glass are  $3.75^\circ$ ,  $3.25^\circ$  and  $2.86^\circ$  respectively. Calculate the dispersive power of the crown glass.

**Question 9** [2]

- (a) What is meant by **mass defect**?
- (b) What conclusion is drawn from **Rutherford's** scattering experiment of  $\alpha$ -particles?

**Question 10** [2]

Define the following with reference to photoelectric effect:

- (a) Threshold frequency ( $f_0$ )
- (b) Stopping potential ( $V_s$ )

**Question 11** [2]

- (a) The half-life of radium is 1550 years. Calculate its disintegration constant ( $\lambda$ ).

**OR**

- (b) Copy and complete the following table for a radioactive element whose half-life is 10 minutes. Assume that you have 30g of this element at  $t = 0$ .

t (minute)	0	20	30
Amount of radioactive element left in gm	30	--	--

**Question 12** [2]

Define **frequency modulation** and state *any one* advantage of frequency modulation (FM) over amplitude modulation (AM).

## Section C

*Answer all questions.*

### Question 13

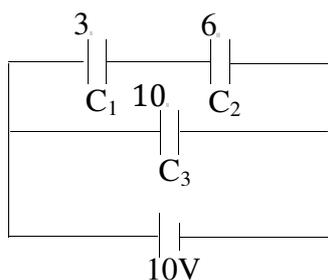
[3]

Obtain an expression for electric potential ' $V$ ' at a point in an **end-on position** i.e. axial position of an electric dipole.

### Question 14

[3]

Three capacitors of capacitance  $C_1 = 3\mu$ ,  $C_2 = 6\mu$  and  $C_3 = 10\mu$ , are connected to a 10V battery as shown in **Figure 3** below:



**Figure 3**

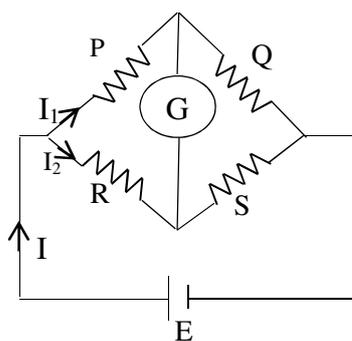
Calculate:

- (a) Equivalent capacitance.
- (b) Electrostatic potential energy stored in the system.

### Question 15

[3]

- (a) Obtain the balancing condition for the **Wheatstone bridge** arrangement as shown in **Figure 4** below:



**Figure 4**

**OR**

- (b) Draw a labelled circuit diagram of a **potentiometer** to measure the internal resistance ' $r$ ' of a cell. Write the working formula (*derivation is not required*).

**Question 16** [3]

- (a) A ray of light is incident on a prism whose refractive index is 1.52 at an angle of  $40^\circ$ . If the angle of emergence is  $60^\circ$ , calculate the angle of the prism.

**OR**

- (b) Calculate the focal length of a convex lens whose radii of curvature of two surfaces is 10 cm and 15 cm respectively and its refractive index is 1.5.

**Question 17** [3]

Derive the law of reflection using **Huygen's** Wave Theory.

**Question 18** [3]

State *any two* **Bohr's** postulates and write the **energy value** of the ground state of the hydrogen atom.

**Question 19** [3]

With reference to semi-conductors answer the following:

- (i) What is the change in the resistance of the semi-conductor with **increase** in temperature?
- (ii) Name the majority charge carriers in **n-type** semi-conductor.
- (iii) What is meant by **doping**?

**Section D**

*Answer all questions.*

**Question 20** [5]

- (a) (i) An alternating emf of 200V, 50Hz is applied to an **L-R** circuit, having a resistance **R** of 10  $\Omega$  and an inductance **L** of 0.05H connected in **series**. Calculate:
- (1) Impedance.
- (2) Current flowing in the circuit.
- (ii) Draw a labelled graph showing the variation of inductive reactance (**X<sub>L</sub>**) verses frequency (**f**).

**OR**

- (b) (i) An a.c. source of emf  $\mathcal{E} = 200 \sin \omega t$  is connected to a resistor of 50  $\Omega$ . Calculate:
- (1) Average current (**I<sub>avg</sub>**).
- (2) Root mean square (**rms**) value of emf.
- (ii) State *any two* characteristics of resonance in an LCR series circuit.

**Question 21****[5]**

- (a) Draw a neat labelled ray diagram showing the formation of an image at the **least distance of distinct vision D** by a **simple microscope**. When the final image is at D, derive an expression for its magnifying power at D.

**OR**

- (b) Draw a neat labelled diagram of **Young's Double Slit** experiment. Show that  $\beta = \frac{\lambda}{d}$ , where the terms have their usual meaning (*either for bright or dark fringe*).

**Question 22****[5]**

- (a) (i) Draw a labelled circuit diagram of a **half wave rectifier** and give its output waveform.  
(ii) Draw a symbol for **NOR** gate and write its truth table.

**OR**

- (b) (i) Draw a neat circuit diagram to study the input and output characteristics of a **common emitter** transistor.  
(ii) Draw the symbol for **AND** gate and write its truth table.

Useful Constants and Relations:

1.	Charge on electron	(e)	$1.6 \times 10^{-19} \text{C}$
2.	Planck's constant	(h)	$= 6.6 \times 10^{-34} \text{ Js}$
3.	Speed of light in vacuum	(c)	$= 3 \times 10^8 \text{ ms}^{-1}$