

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.)

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.*

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) The order of coloured rings in a carbon resistor is red, yellow, blue and
silver. The resistance of the carbon resistor is:

- (a) $24 \times 10^6 \Omega \pm 5\%$
 - (b) $24 \times 10^6 \Omega \pm 10\%$
 - (c) $34 \times 10^4 \Omega \pm 10\%$
 - (d) $26 \times 10^4 \Omega \pm 5\%$
-

This Paper consists of 8 printed pages.

- (ii) A circular coil carrying a current I has radius R and number of turns N . If **all** the three, i.e. the current I , radius R and number of turns N are doubled, then, **magnetic field** at its centre becomes:
- Double
 - Half
 - Four times
 - One fourth
- (iii) An object is kept on the principal axis of a **concave mirror** of focal length 10 cm, at a distance of 15 cm from its pole. The image formed by the mirror is:
- Virtual and magnified
 - Virtual and diminished
 - Real and magnified
 - Real and diminished
- (iv) **Einstein's** photoelectric equation is:
- $E_{\max} = h\lambda - \phi_0$
 - $E_{\max} = \frac{hc}{\lambda} - \phi_0$
 - $E_{\max} = h\nu + \phi_0$
 - $E_{\max} = \frac{hc}{\lambda} + \phi_0$
- (v) In **Bohr's** model of hydrogen atom, radius of the first orbit of an electron is r_0 . Then, radius of the **third** orbit is:
- $\frac{r_0}{9}$
 - r_0
 - $3r_0$
 - $9r_0$

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

[7×1]

- In a **potentiometer** experiment, balancing length is found to be 120 cm for a cell E_1 of emf 2V. What will be the balancing length for another cell E_2 of emf 1.5V? (No other changes are made in the experiment.)
- How will you convert a moving coil galvanometer into a **voltmeter**?
- A moving charged particle **q** travelling along the positive x-axis enters a uniform magnetic field **B**. When will the **force** acting on **q** be **maximum**?
- Why is the core of a transformer **laminated**?

- (v) Ordinary (i.e. unpolarised) light is incident on the surface of a transparent material at the **polarising angle**. If it is partly reflected and partly refracted, what is the angle between the reflected and the refracted rays?
- (vi) Define **coherent** sources of light.
- (vii) Name a **material** which is used in making **control rods** in a nuclear reactor.

Section B

Answer all questions.

Question 2

[2]

Define **current density**. Write an expression which connects **current density** with **drift speed**.

Question 3

[2]

- (a) A long horizontal wire P carries a current of 50A. It is rigidly fixed. Another wire Q is placed directly above and parallel to P, as shown in **Figure 1** below. The weight per unit length of the wire Q is 0.025 Nm^{-1} and it carries a current of 25A. Find the distance ' r ' of the wire Q from the wire P so that the wire Q remains at rest.

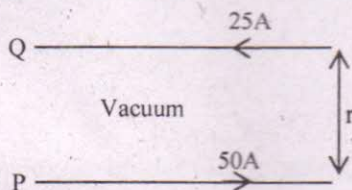


Figure 1

OR

- (b) Calculate **force per unit length** acting on the wire B due to the current flowing in the wire A. (See **Figure 2** below)

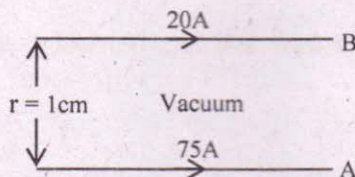


Figure 2

Question 4**[2]**

- (i) Explain **Curie's law** for a paramagnetic substance.
- (ii) A rectangular coil having 60 turns and area of 0.4m^2 is held at right angles to a uniform magnetic field of flux density $5 \times 10^{-5}\text{T}$. Calculate the **magnetic flux** passing through it.

Question 5**[2]**

What is **motional emf** ? State **any two** factors on which it depends.

Question 6**[2]**

- (i) What is the **ratio** of the speed of gamma rays to that of radio waves in vacuum?
- (ii) Name an electromagnetic wave which is used in the **radar** system used in aircraft navigation.

Question 7**[2]**

A biconvex lens made of glass (refractive index 1.5) has two spherical surfaces having radii 20 cm and 30 cm. Calculate its **focal length**.

Question 8**[2]**

State **any two** differences between **primary** rainbow and **secondary** rainbow.

Question 9**[2]**

- (i) State **de Broglie** hypothesis.
- (ii) With reference to **photoelectric** effect, define **threshold wavelength**.

Question 10**[2]**

Calculate the **minimum** wavelength of the spectral line present in **Balmer** series of hydrogen.

Question 11**[2]**

- (a) What is meant by **pair annihilation**? Write a **balanced** equation for the same.

OR

- (b) What is meant by the terms **half-life** of a radioactive substance and **binding energy** of a nucleus?

Question 12**[2]**

In a **communication** system, what is meant by **modulation**? State **any two** types of modulation.

Section C

Answer all questions.

Question 13

[3]

Obtain an expression for intensity of electric field at a point in **end on** position, i.e. **axial** position of an electric dipole.

Question 14

[3]

Deduce an expression for **equivalent** capacitance C when three capacitors C_1 , C_2 and C_3 are connected in **parallel**.

Question 15

[3]

- (a) $\mathcal{E}_1$ and $\mathcal{E}_2$ are two batteries having emf of 34V and 10V respectively and internal resistance of 1Ω and 2Ω respectively. They are connected as shown in **Figure 3** below. Using **Kirchhoff's' Laws** of electrical networks, calculate the currents I_1 and I_2 .

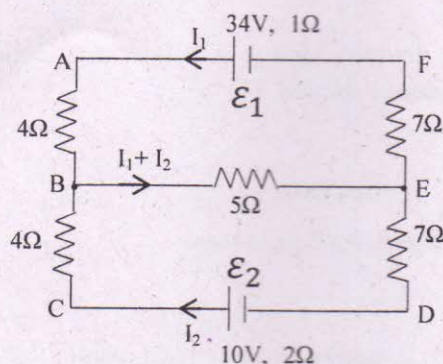


Figure 3

OR

- (b) An electric bulb is marked 200V, 100W. Calculate **electrical resistance** of its filament. If **five** such bulbs are connected in **series** to a 200V supply, how much **current** will flow through them?

Question 16

[3]

- (a) For any prism, prove that:

$$'n' \text{ or } \mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

where the terms have their usual meaning.

OR

- (b) When two **thin** lenses are kept in **contact**, prove that their **combined** or **effective** focal length F is given by:

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

where the terms have their usual meaning.

Question 17**[3]**

- (i) In **Young's** double slit experiment, show graphically how intensity of light varies with distance.
- (ii) In **Fraunhofer** diffraction, how is the angular width of the central bright fringe affected when slit separation is increased?

Question 18**[3]**

Write one **balanced equation** each to show:

- (i) Nuclear fission
- (ii) Nuclear fusion
- (iii) Emission of β^- (i.e. a negative beta particle)

Question 19**[3]**

With reference to semiconductor devices, define a **p-type** semiconductor and a **Zener** diode. What is the use of a **Zener** diode?

Section D

Answer all questions.

Question 20**[5]**

- (a) An alternating emf of 220V is applied to a circuit containing a resistor R having resistance of 160Ω and a capacitor 'C' in **series**. The current is found to lead the supply voltage by an angle $\theta = \tan^{-1} (3/4)$.
 - (i) Calculate: (1) The capacitive reactance (2) Impedance of the circuit (3) Current flowing in the circuit
 - (ii) If the frequency of the applied emf is 50 Hz, what is the value of the capacitance of the capacitor 'C'?

OR

- (b) An A.C. generator generating an emf of $\varepsilon = 300 \sin (100\pi t) V$ is connected to a **series** combination of $16\mu F$ capacitor, 1H inductor and 100Ω resistor. Calculate:
 - (i) Impedance of the circuit at the **given frequency**.
 - (ii) **Resonant** frequency f_0 .
 - (iii) Power factor at **resonant** frequency f_0 .

Question 21

[5]

- (a) Draw a labelled ray diagram of an image formed by a **refracting telescope** with final image formed at **infinity**. Derive an expression for its magnifying power with the final image at infinity.

OR

- (b) (i) Using **Huygen's** wave theory, derive **Snell's** law of refraction.
(ii) With the help of an **experiment**, state how will you identify whether a given beam of light is polarised or unpolarised.

Question 22

[5]

- (a) (i) The forward characteristic curve of a junction diode is shown in **Figure 4** below:

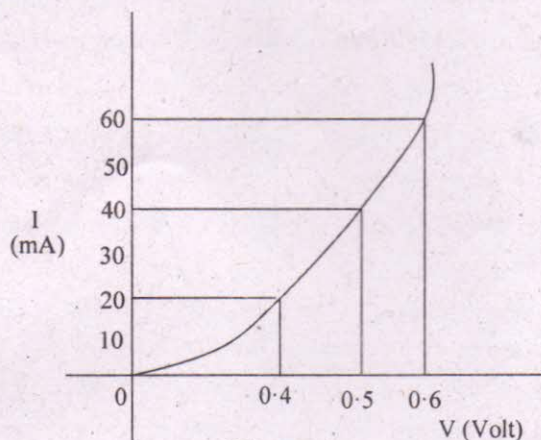


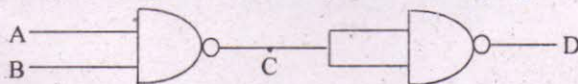
Figure 4

Calculate the resistance of the diode at:

- (1) $V = 0.5 \text{ V}$
(2) $I = 60 \text{ mA}$
(ii) Draw **separate** energy band diagrams for conductors, semi-conductors and insulators and label each of them.

OR

- (b) (i) The arrangement given below represents a logic gate:



Copy the following truth table in your answer booklet and complete it showing outputs at C and D.

A	B	C	D
0	0		
1	0		
0	1		
1	1		

- (ii) Draw a labelled diagram of a **common emitter** amplifier, showing waveforms of **signal** voltage and **output** voltage.

Useful Constants and Relations:

1.	Permeability of vacuum	(μ_0)	$= 4\pi \times 10^{-7} H m^{-1}$
2.	Rydberg's constant	(R)	$= 1.097 \times 10^7 m^{-1}$