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 given below: **[5×1]**

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

(a) $24\times10^6\ \Omega \pm 5\%$

(b) $24\times10^6\ \Omega \pm 10\%$

(c) $34\times10^4\ \Omega \pm 10\%$

(d) $26\times10^4\ \Omega \pm 5\%$

(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:

(a) Double

(b) Half

(c) Four times

(d) 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:

(a) Virtual and magnified

(b) Virtual and diminished

(c) Real and magnified

(d) Real and diminished

(iv) **Einstein's** photoelectric equation is:

(a) $E_{max} = h\lambda - \varphi_0$

(b) $E_{max} = \frac{hc}{\lambda} - \varphi_0$

(c) $E_{max} = h\nu + \varphi_0$

(d) $E_{max} = \frac{hc}{\lambda} + \varphi_0$

(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:

(a) $\frac{r_0}{9}$

(b) r_0

(c) $3r_0$

(d) $9r_0$

(B) Answer the following questions briefly and to the point. **[7×1]**

(i) 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.)

(ii) How will you convert a moving coil galvanometer into a **voltmeter**?

(iii) 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**?

(iv) 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 $0{\cdot}025\ Nm^{-1}$ 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**.**

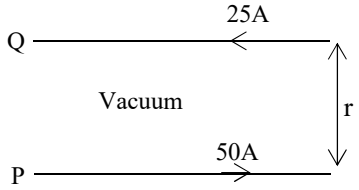


Figure 1

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)

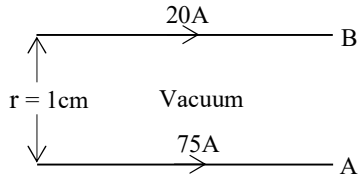


Figure 2

Question 4 **[2]**

(i) Explain **Curie's law** for a paramagnetic substance.

(ii) A rectangular coil having 60 turns and area of $0{\cdot}4m^2$ is held at right angles to a uniform magnetic field of flux density $5\times10^{-5}T$. 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 $1{\cdot}5$) 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.

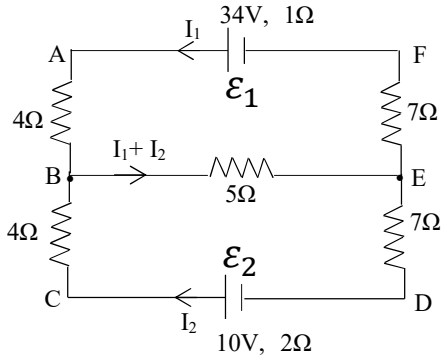


Figure 3

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:

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

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 16μF capacitor, 1H inductor and 100 Ω resistor. Calculate:

(i) Impedance of the circuit at the **given frequency**.

(ii) **Resonant** frequency f_o.

(iii) Power factor at **resonant** frequency f_o.

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:

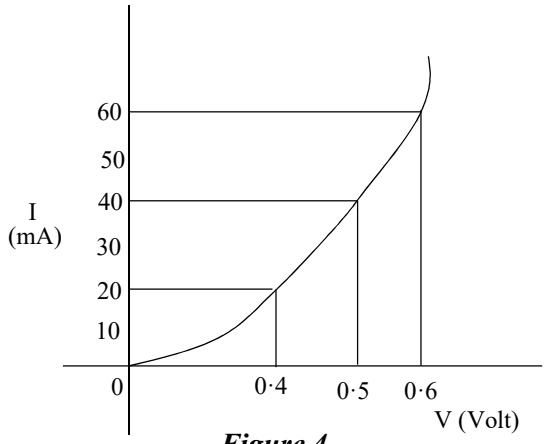


Figure 4

Calculate the resistance of the diode at:

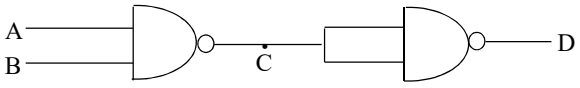
(1) V = 0·5 V

(2) I = 60 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_o)	= $\boldsymbol{4\pi \times 10^{-7} H\, m^{-1}}$
2.	Rydberg's constant	(R)	= 1·097 × $\boldsymbol{10^{7}\, m^{-1}}$