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 in 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) Ohm‟s law in **vector** form is:

(a) V = I.R

(b) $\vec{J} = \sigma\vec{E}$

(c) $\vec{J} = \rho\vec{E}$

(d) $\vec{E} = \sigma\vec{J}$

(ii) Current flowing through a long solenoid is varied. Then, magnetic flux density of the magnetic field inside it varies:

(a) inversely with I

(b) inversely with I^2

(c) directly with I

(d) directly with I^2

(iii) A convex lens, made of glass, is immersed in water. As a result, its focal length will:

(a) increase

(b) decrease

(c) double

(d) remain same

(iv) de Broglie wavelength of a moving particle is λ. Its momentum is given by:

(a) $\frac{h\lambda}{c}$

(b) $\frac{h}{\lambda}$

(c) $\frac{hc}{\lambda}$

(d) Zero

(v) Half Life of a certain radioactive substance is 69·3 days. Its disintegration constant is:

(a) 0.010 day^{-1}

(b) 0.100 day^{-1}

(c) 0.001 day^{-1}

(d) 1.00 day^{-1}

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

(i) How will the **sensitivity** of a potentiometer change with increase in current flowing through its wire?

(ii) Which of the two; an ammeter or a voltmeter, has a greater resistance?

(iii) Why is soft iron preferred to steel in making the **core** of a transformer?

(iv) When would a moving charged particle travel undeviated in a uniform magnetic field?

(v) Complete the ray diagram shown in ***Figure 1*****,** given that the critical angle for air-glass pair is $i_c=42^o$.

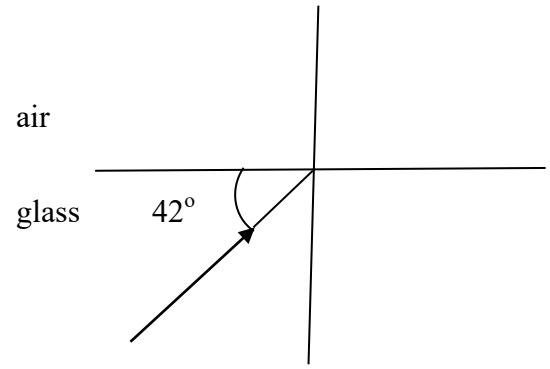

Figure 1

(vi) State the Law of Malus.

(vii) Name *any one* material used as a moderator in a nuclear reactor.

Section B

*Answer **all** questions.*

Question 2 **[2]**

Define **drift velocity** and **relaxation time,** with reference to the free electron theory of conductors.

Question 3 **[2]**

A long straight wire is bent as shown in ***Figure 2*** below. Find the resultant magnetic field „B" at the centre C of the circular path of radius 2 cm if a current I of 5 A is passed through the wire as shown:

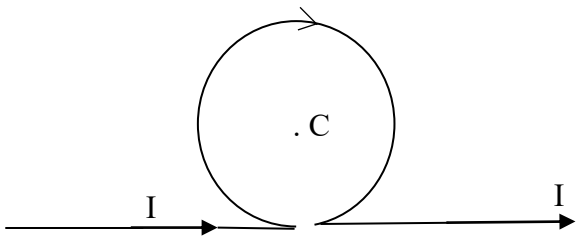

Figure 2

Question 4 **[2]**

(i) Explain the meaning of the statement:

"Angle of dip at a certain place on earth is 60^o."

(ii) If the horizontal component of earth"s magnetic field at this place is 3×10^{-5} T, calculate the earth"s **total** magnetic field at that place.

Question 5 **[2]**

(a) Briefly explain the following terms:

(i) Curie temperature

(ii) Self-induction

OR

(b) Name *any two* types of energy losses in a transformer. State how *any one* of them can be minimized.

Question 6 **[2]**

(i) What is **displacement current?**

(ii) Which electromagnetic radiation is used to study the crystal structure?

Question 7 **[2]**

A thin convex lens of focal length 20 cm is kept in contact with a thin concave lens of focal length 15 cm. Find the focal length and the nature of the combination.

Question 8 **[2]**

What is meant by **dispersive power**? Write an expression of dispersive power in terms of refractive indices.

Question 9

(a) For *each* of the following, state *one* phenomenon in which: **[2]**

(i) particles behave like waves.

(ii) waves behave like particles.

OR

(b) Plot a labelled graph of maximum kinetic energy of photo electrons versus frequency of incident radiation. State how you will obtain the value of Planck‟s constant „h‟ from the graph. **[2]**

Question 10

Draw energy level diagram for Hydrogen atom showing at least four lowest energy levels. Show the transitions responsible for emission of **Balmer series**.

Question 11 **[2]**

What is meant by **‘binding energy per nucleon’** of a nucleus? State its physical significance.

Question 12 **[2]**

Name essential components of a communication system. Draw its block diagram.

Section C

*Answer **all** questions.*

Question 13 **[3]**

Using **Gauss' theorem**, obtain an expression for **intensity of electric field 'E'** at a point, which is at a distance „r" (r > R) from the centre „C" of a thin spherical shell (of radius R) carrying charge „Q".

Question 14 **[3]**

(a) Obtain an expression for **electric potential 'V'** due to a point charge **'Q'** at a distance ***r.***

OR

(b) A parallel plate capacitor is charged by a battery; which is then disconnected. A dielectric slab is now introduced between the two plates to occupy the space completely. State the effect on the following:

(i) the capacitance of the capacitor.

(ii) potential difference between the plates.

(iii) the energy stored in the capacitor.

Question 15 **[3]**

Using **Kirchhoff's laws** of electrical networks, calculate the currents I_1, I_2 and I_3 in the circuit shown below (***Figure 3***).

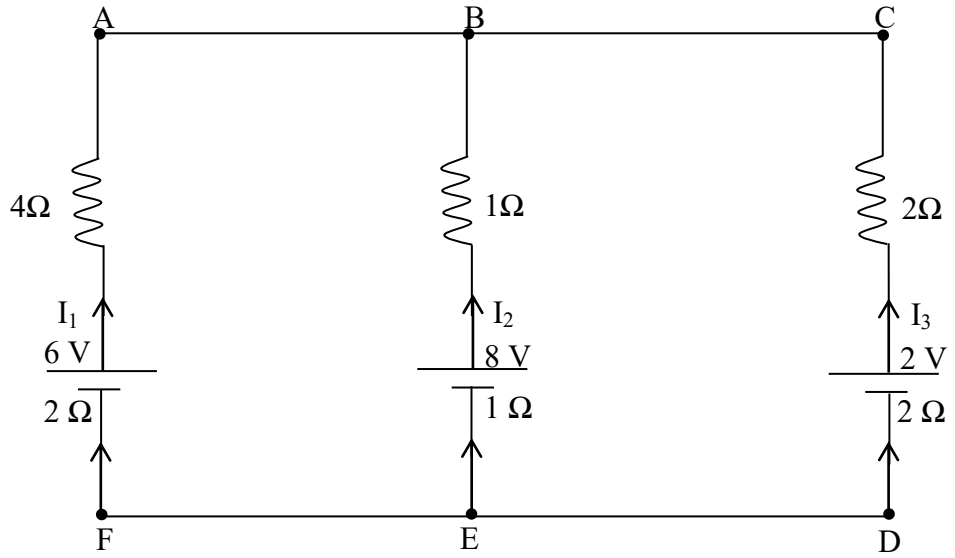

Figure 3

Question 16 **[3]**

(a) Obtain an expression for refraction at a single convex spherical surface separating the two media having refractive indices „n_1" (rarer medium) and „n_2" (denser medium) i.e. a relation between u, v, n_1, n_2 and R.

OR

(b) Derive R = 2f for a spherical mirror, where the symbols have their usual meaning.

Question 17 **[3]**

When a ray of ordinary light is incident on the surface of separation of two media at **polarizing angle**, show with the help of a **labelled diagram** that reflected ray and the refracted ray are mutually perpendicular to each other.

Question 18 **[3]**

For **radioactive disintegration** of a radioactive substance, show that

$$N = N_0 e^{-\lambda t}$$

where the terms have their usual meaning.

Question 19 **[3]**

With reference to a semiconductor diode, define the terms **'depletion region'** and **'potential barrier'**. How will the width of depletion region change during reverse biasing?

Section D

*Answer **all** questions.*

Question 20 **[5]**

(a) An 8 H inductor, a 2 μF capacitor and a 100 Ω resistor are connected in **series** to an A.C. supply of 220 V and 50 Hz. Calculate:

(i) Impedance of the circuit.

(ii) Current flowing through the circuit.

(iii) Phase difference between the current and the supply voltage.

(iv) Average power consumed by the circuit.

OR

(b) An A.C. generator generating an emf „E' given by $\boldsymbol{E = 311 \sin(10\ t)}$ is connected to a 44 Ω resistor. Calculate:

(i) rms value of A.C. flowing through the resistor.

(ii) frequency of the current.

(iii) mean value of emf generated by the generator in time interval 0.06s to 0.08s.

Question 21 **[5]**

(a) Draw a labelled ray diagram of an image formed by a **compound microscope** with final image formed at the least distance of distinct vision (D). **Derive** an expression for its magnifying power (in terms of V_o, U_o, f_e and D).

OR

(b) Draw a neat and labelled diagram of an experimental setup of **Young's double slit experiment** to study the interference of light and show that:

$$\beta = \frac{\lambda D}{d}$$

where the terms have their usual meaning. Show intensity variation in the interference

pattern graphically.

Question 22 **[5]**

(a) (i) For a transistor in a **common emitter** mode, draw labelled graph to show:

(1) Input characteristic curve.

(2) Output characteristic curve.

(3) Transfer characteristic curve.

(*Circuit diagram of the arrangement is **not** required.)*

(ii) The characteristic curve of a silicon diode is shown in ***Figure 5*** below:

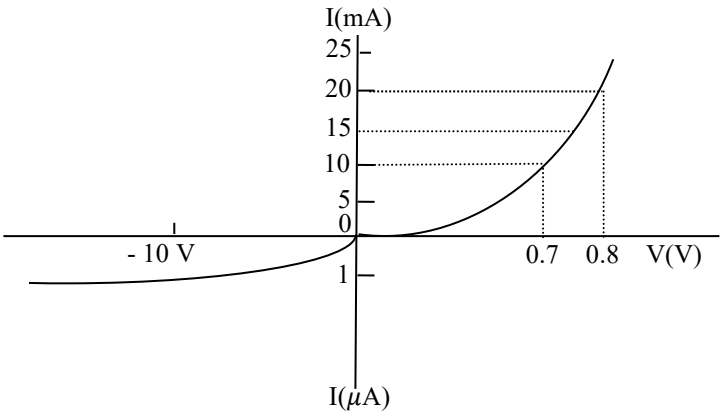

Figure 5

Calculate the resistance of the diode at:

(1) I= 15 mA and

(2) V= -10 V

OR

(b) (i) Show how you will obtain an **AND** gate using only **NOR** gates. Draw the **truth table** for this arrangement of gates.

(ii) For a **common emitter transistor amplifier,** the audio signal voltage across the collector resistance (r_c) of 2 kΩ is 2 V. If the current amplification factor (β) of the transistor is 100, calculate the input signal voltage (V_{BE}) and base current (I_B) for base resistance of 1 kΩ.

Useful Constants and Relations:

1.	Permeability of vacuum	(μ_o)	= $4\pi \times 10^{-7} H\, m^{-1}$
2.		ln2	=0.693