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) 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) $4q/\epsilon_0$

(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:

(a) 130^o

(b) 60^o

(c) 45^o

(d) 90^o

(iii) A beam of light is incident at the polarizing angle of 35^o on a certain glass plate. The refractive index of the glass plate is:

(a) $\sin 35^o$

(b) $\tan 35^o$

(c) $\tan 55^o$

(d) $\sin 55^o$

(iv) In a gamma ray emission from nucleus:

(a) only the number of protons change.

(b) the number of protons and neutrons, both change.

(c) there is no change in the number of protons and the number of neutrons.

(d) only the number of neutrons change.

(v) The energy associated with light of which of the following colours is minimum:

(a) violet

(b) red

(c) green

(d) yellow

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

(i) Define **equipotential** surface.

(ii) Calculate the net emf across A and B shown in ***Figure 1*** below:

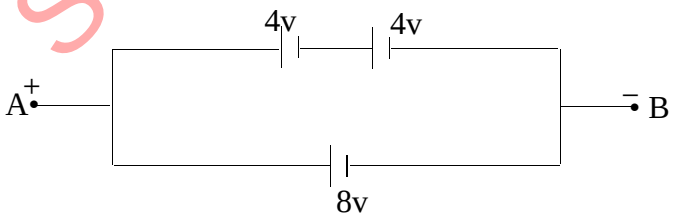

Figure 1

(iii) 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 2Ω 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 $5m^2$, 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^o. 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.

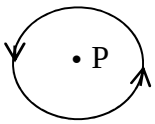

Figure 2(b)

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 $3{\cdot}75^{o}$, $3{\cdot}25^{o}$ and $2{\cdot}86^{o}$ 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 α-particles?

Question 10 **[2]**

Define the following with reference to photoelectric effect:

(a) Threshold frequency (f_o)

(b) Stopping potential (V_s)

Question 11 **[2]**

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

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:

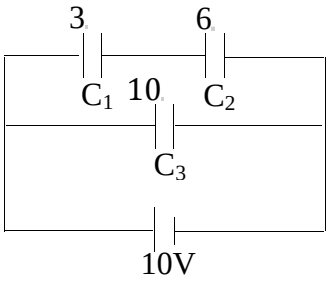

Figure 3

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:

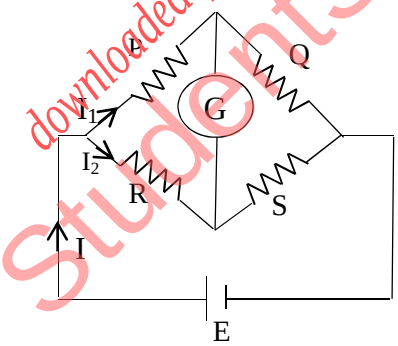

Figure 4

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^{o}. If the angle of emergence is 60^{o}, 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 10Ω 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 ($\mathbf{X_L}$) verses frequency ***(f)***.

OR

(b) (i) An a.c. source of emf $\varepsilon = 200 \sin \omega$ is connected to a resistor of 50Ω. Calculate:

(1) Average current ($\mathbf{I_{avg}}$).

(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 $\beta = \frac{\lambda}{a}$, 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)	$1{\cdot}6 \times 10^{-19}$ C
2.	Planck's constant	(h)	$= 6{\cdot}6 \times 10^{-34}$ Js
3.	Speed of light in vacuum	(c)	$= 3\times10^{8}$ ms^{-1}