PHYSICS

Paper – 1

(THEORY)

Three hours and a quarter

(The first 15 minutes of the examination are for reading the paper only.

Candidates must NOT start writing during this time).

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*Answer **all** questions in Part I. From Part II, answer any four questions from Section A, any three questions from Section B and any two questions from Section C.*

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

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

A list of physical constants is given at the end of the question paper.

PART I (40 marks)
Answer **all** *questions.*

Question 1.

(a) Each question is followed by four possible choices of answers. Choose the correct answer and write it in your answer sheet. **[10]**

(i) A moving electric charge produces

A electric field only.

B magnetic field only.

C both electric field and magnetic field.

D neither of these two fields.

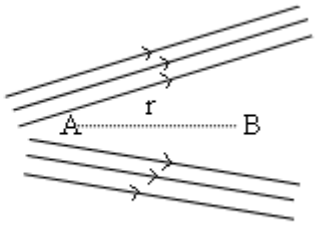
(ii) If the electric field at A and B are E_A and E_B and the distance between them is 'r' as shown in the figure given below, then

A $E_A > E_B$.

B $E_A < E_B$.

C $E_A = \frac{E_B}{r}$.

D $E_A = \frac{E_B}{r^2}$.



(iii) If an electric current of 2mA flows through a wire, then the number of free electrons passing a given point in a wire per second will be

A 1.25×10^{13}.

B 1.25×10^{16}.

C 1.25×10^{18}.

D 1.25×10^{21}.

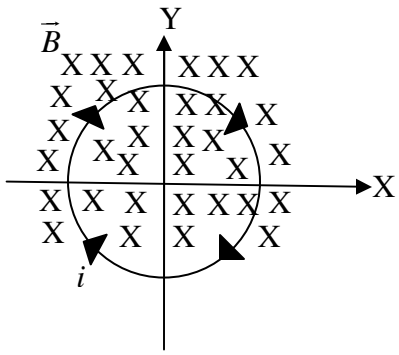
(iv) A conducting loop carrying a current '*i*' is placed in a uniform magnetic field $\vec{B}$ pointing into the plane of the paper as shown in the figure. The loop will have a tendency to

A expand.

B contract.

C move towards +ve x-axis.

D move towards –ve x-axis.



(v) The core of transformers are laminated because it

A increases the magnetic saturation level of the core.

B decreases the residual magnetism of the core.

C increases the strength of the magnetic field.

D decreases the eddy-current in the core.

(vi) All the following statements are true for electromagnetic waves *EXCEPT*

A travels with the same speed as light in free space.

B travels with the same speed in all media.

C produced by accelerating charges.

D are transverse in nature.

(vii) If an astronomical telescope has a magnifying power 10 and the focal length of the eye piece is 20 cm, then the focal length of the objective is

A $\frac{1}{200} cm$.

B $\frac{1}{2} cm$.

C $2cm$.

D $200cm$.

(viii) In the photoelectric effect on metals, an increase in the frequency of incident radiation increases

A rate of emission.

B threshold frequency.

C work function of the metal.

D velocity of emitted electrons.

(ix) In which region of the electromagnetic spectrum lies the Lyman series of hydrogen?

A ultraviolet

B infra-red

C visible

D X-ray

(x) The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately

A $3.10x10^{-7}\,nm$.

B $3.10x10^{-7}\,cm$.

C $310nm$.

D $310m$.

(b) Choose the correct word/s given in the brackets and write them in your answer sheets. **[6]**

(i) The phenomenon in which energy is converted into mass is called ……. and the phenomenon in which mass is converted into energy is called …….. (compton-effect, pair-production, photoelectric-effect, pair-annihilation)

(ii) The n-type semi-conductor is a ……. semiconductor obtained by adding a ……. impurity. (extrinsic, intrinsic, pentavalent, trivalent)

(iii) The electrolyte in a Lechlanche cell is ……. and its common name is ……. (manganese dioxide, ammonium chloride, secondary cell, dry cell)

(iv) A diamagnetic substance is ……. of temperature and its relative permeability is slightly ……. than unity. (dependent, independent, less, more)

(v) The device used to increase ac voltage is a ……. and ……. be used to step-up dc voltage. (step-up transformer, step-down transformer, can, cannot)

(vi) The ratio ……. is a time constant and its unit is ……. ($\frac{L}{R}$, $\frac{R}{L}$, $\frac{H}{\Omega}$, second)

(c) Match the items of column A with the items in column B. Rewrite the correct pairs in your answer sheet.

Column A	**Column B**
(i) Maxima	(a) varying fringe width
(ii) Interference	(b) infinite
(iii) Holes as majority charge carriers	(c) stationary orbit
(iv) Bohr's Theory	(d) X-ray
(v) Diffraction	(e) n-type semi-conductor
(vi) Resistance of a pure semiconductor	(f) zero
(vii) Minima	(g) same fringe width
(viii)Continuous spectrum	(h) p-type semi-conductor
	(i) even multiple of $\frac{\lambda}{2}$
	(j) odd multiple of $\frac{\lambda}{2}$

(d) Write True or False and give reasons for the false statements. **[4]**

(i) A reverse biased p-n junction diode acts as a low resistance instrument.

(ii) A beam of white light passing through a hollow prism gives no spectrum.

(iii) In a compound microscope, the aperture of the eye piece is smaller than that of the objective.

(iv) The depletion layer in the p-n junction is formed by drift of holes.

(e) Answer the following questions.

(i) The work function of photons for photoelectric emission from a metal is 0. 05 eV. Find the threshold frequency. **[2]**

(ii) With the help of a labelled diagram, show the formation of a rainbow. **[2]**

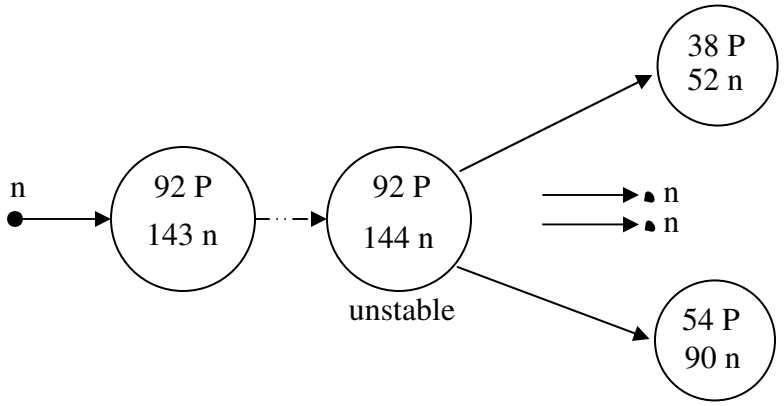
(iii) Establish a relation between half-life and decay constant. **[2]**

(iv) Obtain an expression for e/m of electron in terms of 'υ' and 'V' when an electron is accelerated from rest through a potential difference of 'V' volts and it acquires a final velocity 'υ' m/s. **[2]**

(v) For neutrino and antineutrino, mention *one* such property which is: **[2]**

1. common.
2. opposite.

(vi) The figure given below shows a fission reaction. Write an equation corresponding to this process. **[2]**



(vii) The electric field at a point due to a point charge is 20 N/C and the electric potential at that point is 10 V. Calculate the distance of the point from the charge and the magnitude of the charge. **[2]**

(viii) An air solenoid has 500 turns of wire in its 40 cm length. If the current in the wire is 1.0A, find the magnetic field at the axis inside the solenoid. **[2]**

PART II

SECTION A (28 marks)

Answer any **four** *questions.*

Question 2.

(a) The tyres of aircrafts are not made of ordinary rubber (which is an insulator) but of a special rubber which is slightly conducting. Why? **[1]**

(b) A regular pentagon of side 20 cm has a charge 5 μ C at each of its vertices. Calculate the electric potential at the centre of the pentagon. **[3]**

(c) Establish the formula $U = \frac{CV^2}{2}$, for the potential energy of a charged conductor of capacitance 'C' carrying a charge 'Q' at a potential 'V'. **[3]**

Question 3.

(a) A carbon resistor is marked in orange, green and red bands. What is its approximate resistance? **[1]**

(b) Two bulbs whose resistances are in the ratio 1:2 are connected in parallel to a source of constant voltage. **[2]**

(i) What will be the ratio of power dissipation in them?

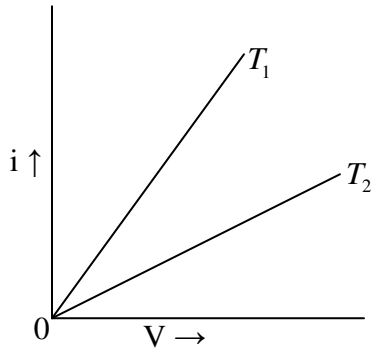
(ii) If connected in series, then?

(c) Derive an expression $\vec{\tau} = \overrightarrow{M}\ x\vec{B}$ for a rectangular coil of area A carrying a current '*i*' placed in a magnetic field. The angle between the direction of field and normal to the plane of coil is θ. **[4]**

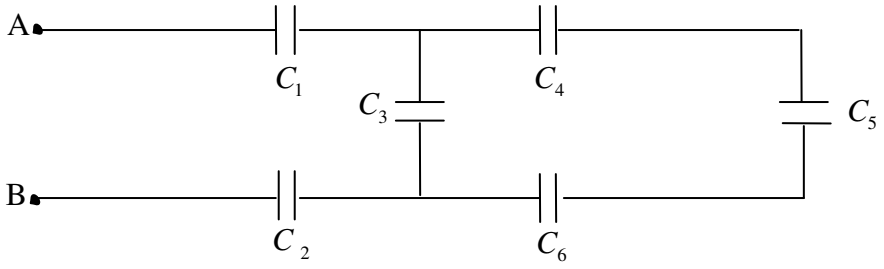
Question 4.

(a) How can a galvanometer be converted into an ammeter of desired range? Explain with the help of a diagram. **[2]**

(b) The diagram given below has $T_2 \rangle T_1$. Explain.



(c) Calculate the equivalent capacitance of the network shown below between the points 'A' and 'B', given $C_1 = C_2 = 12\mu F$, $C_3 = 7\mu F$, $C_4 = C_5 = C_6 = 15\mu F$. **[3]**



Question 5.

(a) Define internal resistance of a cell. A battery of emf 10V and internal resistance 3Ω is connected to a resistor. The current in the circuit is 0.5 A. What is the resistance of the resistor? **[3]**

(b) Derive the expression for comparison of the magnetic moments of two bar magnets of the same size and mass using a vibration magnetometer. **[3]**

(c) State the Curie Law. **[1]**

Question 6.

(a) Distinguish between diamagnetic, paramagnetic and ferromagnetic substances in terms of their relative permeability and susceptibility. **[3]**

(b) What is meant by eddy current? **[2]**

(c) Show the growth and decay of current in an L-R circuit with the help of a graph.

Question 7.

(a) Where is the power dissipation in an a.c circuit, in the resistance, inductance, capacitance or in all? **[1]**

(b) Why is the choke preferred to a rheostat in controlling the current in an a.c circuit? **[2]**

(c) An alternating emf of 100 V (rms), 50 Hz is applied across a capacitor of 10 μF and a resistor of 100 Ω in series. Calculate: **[4]**

(i) the reactance of the capacitor and

(ii) the impedance of the circuit.

SECTION B (18 marks)

Answer any **three** *questions.*

Question 8.

(a) If the two slits in Young's apparatus are illuminated by two identical but independent monochromatic light sources, will you observe interference pattern on the screen? Give a reason to support your answer. **[2]**

(b) Derive Snell's law of refraction for a parallel beam incident on the plane surface of a refracting medium using 'Huygen's Principle'. **[4]**

Question 9.

(a) Calculate the refractive index of the material of an equilateral prism for which the angle of minimum deviation is 60°. **[2]**

(b) With the help of a labelled diagram, derive the expression for the angular width of the central maximum of the diffraction pattern produced by a single slit illuminated with a monochromatic light. **[4]**

Question 10.

(a) Define dispersive power (for light) of a medium. **[1]**

(b) What are the necessary conditions for sustained interference? **[2]**

(c) Two thin lens of focal lengths, +10 cm and -5 cm are kept in contact. What is the focal length of the combination?

Question 11.

(a) Explain briefly how the illuminating powers of two sources of light are compared using Bunsen's grease spot photometer. **[3]**

(b) Explain the wave particle duality of radiation. **[3]**

SECTION C (14 marks)

Answer any **two** *questions.*

Question 12.

(a) Calculate the maximum frequency and corresponding wavelength of X-rays produced in a tube maintained at 13.26 KV. **[3]**

(b) Explain briefly why there is a maximum frequency for the X-rays produced by an X-ray tube operating at a certain voltage. **[2]**

(c) When ${}^{7}_{3}Li$ is bombarded with a certain particle, two alpha particles are produced. Identify the bombarding particle. **[2]**

Question 13.

(a) You are given two nucleides ${}_{3}X^{7}$ and ${}_{3}Y^{4}$. **[2]**

(i) Are they the isotope of the same element? Why?

(ii) Which one of the two is likely to be more stable? Why?

(b) In β-decay, a neutron is converted into a proton, so neutron-proton ratio decreases. Justify your answer for the equation of β-decay: ${}_{z}X^{A} \rightarrow {}_{Z+1}Y^{A} + {}_{-1}\beta^{0} + \bar{\gamma}$ **[2]**

(c) Neutrons can be slowed down even by ordinary water which has hydrogen nuclei (${}_{1}H^{1}$) having mass equal to almost that of neutron. Then why is heavy hydrogen used for this purpose in a reactor? **[3]**

Question 14.

(a) Draw a diagram of a p-n junction diode as a half-wave rectifier and explain its working briefly. **[3]**

(b) Explain briefly with reference to semiconductor physics: **[4]**

(i) Reverse biased p-n junction.

(ii) How are the radiations given out by light emitting diode (LED)?

[PHYSICAL CONSTANTS]

Planck's constant	$h = 6.63 \times 10^{-34}$ J.s
Electron charge	$e = 1.6 \times 10^{-19}$ C
	$K = \frac{1}{4\pi\varepsilon_0} = 9x10^9\ Nm^2 / c^2$
	$\mu_0 = 4\pi x10^{-7}\ TmA^{-1}$
	$C = 3x10^8\ m/s$
	$1\mu C = 1x10^{-6}\ C$
	$1pF = 1x10^{-12}\ F$