

# 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).*

-----

*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 useful physical constants is given at the end of the question paper.*

-----

#### **PART I (40 marks)**

*Answer **all** questions.*

#### **Question 1.**

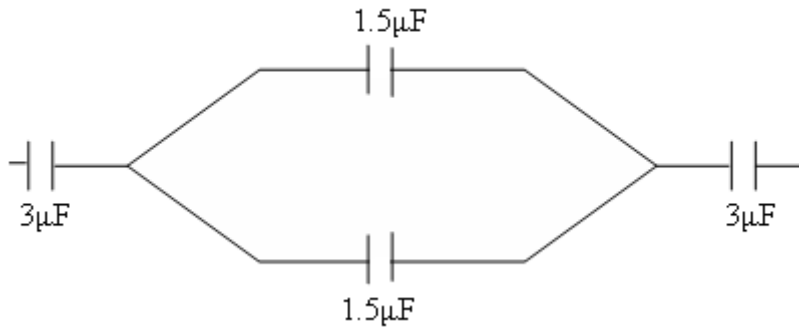
(a) *Each question is followed by four possible choices of answers. Choose the correct answer and write it in your answer sheet.*

**[10]**

(i) Kirchhoff's first law deals with the conservation of

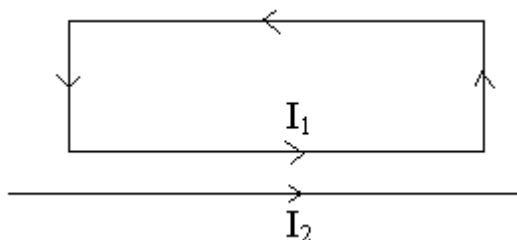
- A charge.
- B energy.
- C momentum.
- D angular momentum.

- (ii) When light travels from one medium to another the characteristic which does not change is the
- A wavelength.
  - B amplitude.
  - C frequency.
  - D velocity.
- (iii) In forward bias, the width of depletion layer in a p-n junction
- A increases.
  - B decreases.
  - C remains unchanged.
  - D first decreases and then increases.
- (iv) What is the equivalent capacitance of the following circuit?



- A  $3\mu\text{F}$
- B  $2\mu\text{F}$
- C  $1.5\mu\text{F}$
- D  $1\mu\text{F}$

- (v) The magnetic field lines
- A cannot intersect at all.
  - B intersect at the neutral point.
  - C intersect near the north and south poles.
  - D depend upon the position of the magnet.
- (vi) A rectangular loop carrying a current  $I_1$  is placed near a long straight wire as shown in the figure.



- If the wire carries a current  $I_2$  and is parallel to one of the sides of the loop, then the loop will
- A rotate about the axis parallel to the wire.
  - B move away from the wire.
  - C move towards the wire.
  - D remain stationary.
- (vii) A single slit diffraction pattern is obtained using a beam of red light. What will happen if the red light is replaced by blue light?
- A Diffraction fringes become narrow and crowded together.
  - B Diffraction fringes become broad and farther apart.
  - C There is no change in diffraction pattern.
  - D Diffraction pattern disappears.

(viii) If  $c$  is the velocity of light then momentum of photon of frequency  $f$  is

A  $hf^2/c$ .

B  $hf/c$ .

C  $f/c$ .

D  $hfc^2$ .

(ix) The energy of an electron in the first orbit of an atom is  $-27.2$  eV. What will be the energy in the third orbit?

A  $3.02eV$

B  $1.51eV$

C  $-3.02eV$

D  $-1.51eV$

(x) The critical mass of a fission reaction is the

A size of the reactor core.

B minimum mass for a chain reaction.

C maximum mass for a chain reaction.

D size of the fuel and the size of the moderator.

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

(i) The ..... of the material of a prism for any two colours may be defined as the ratio of angular dispersion for these two colours to the ..... suffered by the mean light. (chromatic aberration / dispersive power / deviation / dispersion)

(ii) The path difference for maxima is ..... and for minima is .....

$$(n\lambda / 2n\lambda / (2n+1)\frac{\lambda}{2} / (3n+1)\frac{\lambda}{2})$$

(iii) The base of a transistor is always ..... and ..... doped compared to the emitter and collector. (thicker / thinner / lightly / heavily)

- (iv) In photoelectric effect, stopping potential depends on ..... of light  
photoelectric current depends on ..... of light. (frequency / velocity / intensity / amplitude)
- (v) Beta rays are same as ..... and gamma rays are same as .....  
(anode rays / cathode rays / sound wave / light wave)
- (vi) The depolarizer used in a Leclanche cell is ..... while ..... is used in a Daniel cell. (NH<sub>4</sub>Cl / MnO<sub>2</sub> / CuSO<sub>4</sub> / H<sub>2</sub>SO<sub>4</sub>)

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

[4]

Column A	Column B
(i) Parallel plate capacitor	(a) longitudinal wave
(ii) Bohr	(b) energy to mass
(iii) Binding energy	(c) $f_0 < f_e$
(iv) Pair production	(d) transverse wave
(v) Polarization	(e) $f_0 > f_e$
(vi) Infrared radiation	(f) $\Delta mc^2$
(vii) Telescope	(g) $C = \frac{\epsilon_0 A}{d}$
(viii) Compound microscope	(h) stationary orbit
	(i) heat wave
	(j) $C = 4\pi\epsilon_0 r$

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

[4]

- (i) In LED, the junction diode is reverse biased.
- (ii) Compton shift depends on scattering angle  $\theta$  of recoil electron.
- (iii) Neutral temperature changes with change in temperature of cold junction of the same thermocouple.
- (iv) Dielectric substance placed between two plates of a capacitor increases the potential energy of the plates.

(e) Answer the following questions.

- (i) When a current of 2mA flows through a coil, a magnetic flux of  $6\mu\text{Wb}$  is produced. What is the self inductance of the coil? [2]
- (ii) Derive the relation between the energy and the momentum of a photon. [2]
- (iii) Deduce the magnetic field 'B' due to a long straight conductor carrying current  $I$  using Ampere circuital law. [2]
- (iv) Write the truth table for the combination of the gates shown in the figure. [2]



- (v) Complete the following nuclear reactions. [2]
  - 1.  ${}_{13}\text{A}^{27} + {}_0\text{n}^1 \rightarrow {}_{11}\text{Na}^{24} + \dots\dots\dots$
  - 2.  ${}_1\text{H}^1 + {}_1\text{H}^1 \rightarrow {}_1\text{H}^2 + \dots\dots\dots$
- (vi) 1. Write down the relationship between relative permeability and magnetic susceptibility. [1]
- 2. The decay constant of the radioactive element radium is  $4.28 \times 10^{-4} \text{ year}^{-1}$ . What will be its half-life? [1]
- (vii) Write any *two* conclusions drawn from Rutherford scattering experiment. [2]
- (viii) 1. In Young's double slit experiment, the separation between the slits is halved. What happens to the fringe width? [1]
- 2. Write down the relationship between angle of polarization and refractive index of the medium. [1]

**PART II****SECTION A (28 marks)**

Answer any **four** questions.

**Question 2.**

- (a) Name the factors on which capacitance of a parallel plate capacitor depends.  
Give the corresponding relation. [2]
- (b) An  $\alpha$ -particle is accelerated to a potential  $10^6$  volt from the position of rest.  
Calculate its energy in electron volt. [2]
- (c) Write any **three** differences between Joule's heating effect and Peltiers' effect. [3]

**Question 3.**

- (a) State Kirchoff's laws for electrical circuit. [2]
- (b) A power line of resistance  $0.4\Omega$  carries a constant current of 90A. How much energy is lost per day in the form of heat in the line? [2]
- (c) Distinguish between paramagnetic and diamagnetic substances. [3]

**Question 4.**

- (a) Obtain an expression for potential energy of a system of three charges. [3]
- (b) An electric charge is uniformly distributed on the surface of a hollow sphere.  
State how the values of electric intensity E and potential V vary: [2]
- (i) inside the sphere and
- (ii) outside the sphere.
- (c) Mention any **two** special properties of an LCR circuit at resonance. [2]

**Question 5.**

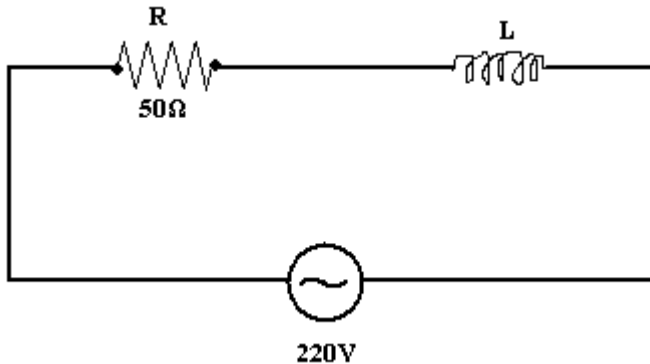
- (a) What is the nature of a magnetic field in a moving coil galvanometer? State its importance and briefly explain how it can be achieved. [3]
- (b) Give **two** advantages of a moving coil galvanometer over a tangent galvanometer. [2]
- (c) An induced current has no direction of its own. Explain. [2]

**Question 6.**

- (a) What is magnetic Lorentz force?
- (b) The magnetic induction (B) and magnetizing field (H) in a sample of magnetic material are 1.2T and  $2000 \text{ Am}^{-1}$  respectively. Find the: [3]
  - (i) magnetic permeability ( $\mu$ ),
  - (ii) relative magnetic permeability ( $\mu_r$ ) and
  - (iii) magnetic susceptibility ( $\chi_m$ ).
- (c) Derive the expression for force per unit length between two long parallel current carrying wires. [3]

**Question 7.**

- (a) Explain with the help of a circuit diagram, how potentiometer is used to compare the emfs of the cells. [3]
- (b) In the circuit diagram given below, the current is found to lag behind the voltage by an angle  $60^\circ$ .



- Calculate the: [3]
- (i) inductive reactance,
  - (ii) impedance of the circuit and
  - (iii) current flowing in the circuit.
- (c) Write down the definition of an ampere based on the force between two current carrying wires. [1]



**SECTION B (18 marks)**

Answer any **three** questions.

**Question 8.**

- (a) Define luminous intensity. State its S.I unit. [2]
- (b) Explain the formation of rainbow with the help of a sketch diagram. [2]
- (c) Obtain an expression for the diffraction of the first minima in the diffraction pattern. [2]

**Question 9.**

- (a) State the necessary conditions for sustained interference pattern. [3]
- (b) A ray of light passes through an equilateral glass prism such that the angle of incidence is equal to the angle of emergence. If the angle of emergence is  $\frac{4}{5}$  times the angle of the prism, calculate the refractive index of the glass prism. [3]

**Question 10.**

- (a) A blue light of wavelength  $4000 \text{ \AA}$  from a narrow slit is incident on a double slit. The distance of the 10<sup>th</sup> fringe from the centre is 2 cm and a screen is placed 200 cm away from the slits. Find the slit separation. [2]
- (b) Can a converging lens in one medium behave as a diverging lens in some other medium? Support your answer. [2]
- (c) Why is a reflecting telescope preferred in astronomy? [2]

**Question 11.**

- (a) Diffraction is common in sound but not common in light waves. Why? [3]
- (b) Derive the expression for the magnifying power of a simple microscope in normal adjustment. [3]

**SECTION C (14 marks)**

Answer any **two** questions.

**Question 12.**

- (a) With the help of a diagram, describe G.P Thomson's experiment to prove wave nature of electrons. [3]
- (b) An X-ray tube is operated at 18 kV. Calculate the maximum velocity of the striking electrons and the minimum wavelength of the X-ray produced. [3]
- (c) Define threshold frequency. [1]

**Question 13.**

- (a) How is the intensity of X-rays increased in an X-ray tube? [1]
- (b) (i) What is the depletion layer in a p-n junction diode? [1]
- (ii) Draw a labelled circuit diagram of a transistor oscillator. [2]
- (iii) Why does a p-n junction diode offer low resistance in forward bias and a high resistance in reverse bias? [2]
- (iv) Is it possible to measure the potential barrier of a p-n junction by using a sensitive voltmeter across its terminal? Support your answer. [1]

**Question 14.**

- (a) Distinguish between the following pairs. [3]
- (i) pair production and nuclear annihilation,
- (ii) nuclear fusion and nuclear fission reactions
- (iii) free neutron and bound neutron.
- (b) Deduce the relation  $N = N_0 e^{-\lambda t}$ . [3]
- (c) What is meant by binding energy of the nucleus? [1]

## [PHYSICAL CONSTANTS]

Permittivity of free space

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$$

Planck's constant

$$h = 6.63 \times 10^{-34} \text{ J.s}$$

Electron charge

$$e = 1.6 \times 10^{-19} \text{ C}$$

1 electron volt

$$1\text{eV} = 1.6 \times 10^{-19} \text{ J}$$

Speed of electromagnetic wave

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

Energy equivalent of

$$1\text{u} = 931 \text{ MeV}$$

Mass of an electron

$$M_e = 9.1 \times 10^{-31} \text{ kg}$$

Absolute magnetic permeability

$$\mu_0 = 4\pi \times 10^{-7} \text{ SI unit}$$

