Physics 12th Class Model Paper

Section A

Q#1: Multiple Choice Questions (MCQs)

i. The electrostatic force between two-point charges is ***F*** when they are a distance "d" apart. If the distance between them is halved and the magnitude of only one charge is tripled, what will be the new force between them?

a) (3/4)F

b) (3/2)F

c) 3F

d) **12F**

ii. The electric flux through a surface is zero. This necessarily means:

a) The electric field is zero everywhere on the surface.

b) The surface is small in area.

c) **The number of electric field lines entering the surface equals the number leaving it.**

d) The surface is parallel to the electric field lines.

iii. What is the electric potential at a point 0.2 m from a 4μC point charge in a vacuum?

a) 0.9×10^5 V

b) **1.8×10^5 V**

c) 3.6×10^4 V

d) 7.2×10^4 V

iv. Ohm's law establishes a relationship among which three fundamental electrical quantities?

a) Charge, Time, and Current

b) **Voltage, Current, and Resistance**

c) Power, Energy, and Time

d) EMF, Internal Resistance, and Terminal Voltage

v. A battery with an emf of 12V and an internal resistance of 1Ω is connected to a 5Ω resistor. What is the terminal potential difference across the battery?

a) 14.0 V

b) 12.0 V

c) **10.0 V**

d) 8.0 V

vi. A conductor of length L, carrying current I, lies entirely within a uniform magnetic field B. Which of the following actions would NOT change the force??

a) Double both I and B

b) Rotate it about an axis parallel to field lines

c) Replace with same length conductor of different material (same I)

d) Double L, but keep only half inside the field

vii. The phenomenon of self-inductance occurs when:

a) The current in a nearby coil changes.

b) The magnetic field around a coil remains constant.

c) The current in the coil itself changes.

d) A conductor moves through a magnetic field.

viii. A pure inductor is connected to an AC source. The instantaneous voltage is given by $V=V_m\sin(\omega t)$. The equation for the instantaneous current is:

a) $I=I_m\sin(\omega t)$

b) $I=I_m\sin(\omega t+\pi/2)$

c) **$I=I_m\sin(\omega t-\pi/2)$**

d) $I=I_m\cos(\omega t)$

ix. The relationship between the peak voltage (V_m) and the root mean square voltage (V_{rms}) of a sinusoidal AC supply is:

a) $V_{rms} = V_m$

b) $V_{rms} = V_m/2$

c) **$V_{rms} = V_m/\sqrt{2}$**

d) $V_{rms} = \pi V_m$

x. A student is given three samples: a quartz, a piece of copper metal, and a glass pane. Based on their atomic structure, how should they be classified?

a) Quartz - Polycrystalline, Copper - Amorphous, Glass - Crystalline

b) **Quartz - Crystalline, Copper - Polycrystalline, Glass - Amorphous**

c) Quartz - Amorphous, Copper - Crystalline, Glass - Polycrystalline

d) Quartz - Crystalline, Copper - Amorphous, Glass - Polycrystalline

xi. Which of the following formulas correctly defines Bulk Modulus (B)?

a) $B = (\Delta V/V)/ \Delta P$

b) $B = (F/A) / (\Delta L/L)$

c) **$B = -\Delta P / (\Delta V/V)$**

d) $B = (F/A) / (\Delta x/y)$

xii. According to the modern view of magnetism, what is primarily responsible for the magnetic properties of a substance?

a) The orbital motion of electrons only.

b) The presence of iron atoms in the material.

c) **The spin motion of electrons.**

d) The random orientation of molecular magnets.

xiii. A silicon crystal is doped with a trivalent impurity atom such as Boron. What is the primary characteristic of the resulting semiconductor?

a) It has an excess of free electrons and is called an N-type semiconductor.

b) **It has an excess of holes and is called a P-type semiconductor.**

c) Its conductivity decreases because the impurity atoms disrupt the crystal lattice.

d) It remains an intrinsic semiconductor as the impurity concentration is low.

xiv. According to the special theory of relativity, which of the following quantities is *absolute* (i.e., remains the same for all inertial observers)?

a) The simultaneity of two events

b) The length of a moving object

c) The time interval between two events

d) **The speed of light in a vacuum**

xv. A high-energy photon disappears near a heavy nucleus and two particles, each with rest mass, are created. This event illustrates which principle?

a) Wave-particle duality of light

b) Conversion of energy into mass

c) Quantization of energy levels

d) Wave nature of electron

xvi. According to Bohr's model of the hydrogen atom, the energy of an electron in the nth orbit is given by:

a) $E_n = -13.6/n$ eV

b) **$E_n = -13.6/n^2$ eV**

c) $E_n = -13.6/n^3$ eV

d) $E_n = -13.6 \times n^2$ eV

xvii. In a laser, which process starts the emission of light without needing an external photon?

a) Stimulated emission

b) Induced absorption

c) **Spontaneous emission**

d) Population inversion

xviii. In nuclear physics, the mass defect is primarily used to calculate which of the following?

a) The atomic number

b) **The binding energy**

c) The half-life

d) The decay constant

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Section B

Q#2: Attempt any TEN of the following questions. Each question carries 4 marks

i. Define electrical resistivity. Explain how the resistivity of a copper wire changes as its temperature increases.

ii. Briefly explain how the thermoelectric emf varies with temperature in a thermocouple. Define neutral temperature and inversion temperature.

iii. State the mathematical expression of Faraday's law of electromagnetic induction. Explain the significance of the negative sign in the expression.

iv. The magnetic flux through a single loop of wire changes from 0.02 Wb to 0.11 Wb in a time of 0.3 seconds. Calculate the induced EMF in the loop

v. Identify the four main components of a simple AC generator and explain the function of the component that ensures the output current is alternating.

vi. State the modern view of what causes magnetism in materials. Define a magnetic domain, and explain the domain arrangement in unmagnetized iron and its change under a strong external magnetic field.

vii. Define an intrinsic semiconductor; state the purpose of doping a pure semiconductor, name the two types of impurities used; and identify the type of semiconductor created by adding a pentavalent impurity.

viii. The α of a transistor changes from 0.98 to 0.995. What is the corresponding change in its β value?

ix. The hydrogen spectrum consists of several series of spectral lines. Name any two series of the hydrogen spectrum and state the region of the electromagnetic spectrum in which each series lies.

x. Define the following terms essential for laser operation: (a) Population inversion (b) Meta-stable state.

xi. An atom is represented by the symbol ${}^{A}_{Z}X$. (a) Identify what the letters A and Z represent. (b) Based on this symbol, state how one can determine the number of neutrons in its nucleus**.**

xii. Define isotopes. Explain why isotopes of the same element have identical chemical properties but may have different physical properties.

xiii. The mass defect (Δm) for a particular nucleus is found to be 0.5 u. (a) Calculate the binding energy of this nucleus in MeV. (b) State what this binding energy represents. (Use: 1 u = 931 MeV)

Section C

NOTE: Attempt any THREE Questions. All Question carry equal marks.

Q.3. **(a)** Prove that the energy U stored in a capacitor can be expressed by the three formulae: $U = \frac{1}{2}QV, U = \frac{1}{2}CV^2, and\ U = \frac{1}{2}\frac{Q^2}{C}$.

(b) Three capacitors of 2 μF, 3 μF, and 6 μF are connected first in series and then in parallel

to a 12 V battery. Calculate the equivalent capacitance and the total energy stored in each combination.

Q.4. **(a)** Define magnetic flux. Write its mathematical formula and explain the condition for which it is (i) maximum and (ii) zero.

(b) A straight wire 0.5 m long carries a current of 3 A. It is placed in a uniform magnetic field of 0.2 T. Calculate the force on the wire when it is placed: (i) Perpendicular to the field. (ii) At an angle of 30° to the field.

Q.5. **(a)** Explain the behavior of a pure capacitor in an AC circuit with reference to: (i) phase relation between current and voltage, (ii) capacitive reactance X_C (formula and frequency dependence), and (iii) a labeled phasor diagram.

(b) Define the term 'impedance' in an AC circuit. How is it different from resistance? Derive the expression for the impedance of a series RL circuit, $Z = \sqrt{(R^2 + X_L^2)}$, using the concept of phasor diagram.

Q.6. **(a)** State five key experimental observations of the photoelectric effect that were in direct contradiction with the predictions of the classical wave theory of light.

(b) Explain how Einstein's photon theory of light successfully resolved these contradictions.