MARKING SCHEME PHYSICS MODEL PAPER CLASS XII

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, the new force between them will be:
   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 between 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 action would *not* change the force on it?
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 is 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) $\mathbf{I=I_m\sin(\omega t-\pi/2)}$
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) $\mathbf{V_{rms} = V_m/\sqrt{2}}$
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

Section-B

Item no	Question(Description)	Reference	Possible Answer	Detailed Rubrics (Mark Allocation)	Marking
i	Define electrical resistivity. Explain how the resistivity of a copper wire changes as its temperature increases.	KPTBB Grade XII, Ch. 12 , Page No. 60	Definition: Electrical resistivity (ρ) is the resistance offered by a conductor of unit length and unit cross-sectional area. (R = ρL/A). Explanation: The resistivity of copper increases with an increase in temperature.	Definition (2 marks): 1 mark for the core concept of "opposition/resistance". 1 mark for specifying "per unit length and per unit cross-sectional area" or stating the formula R=ρL/A. Explanation (2 marks): Award 2 marks for clearly stating that resistivity increases with temperature. Award only 1 mark if the answer is vague, e.g., "it changes," without specifying the nature of the change.	2+2=4
ii	Briefly explain how thermo-electric e.m.f. varies with temperature in a thermocouple. Define neutral temperature and inversion temperature.	KPTBB Grade XII, Ch. 12, Page No. 73	Variation: The thermo-emf first increases with temperature, reaches a maximum at the neutral temperature, then decreases to zero at the inversion temperature, and reverses beyond it.	Variation (2 marks): 0.5 marks for "increases". 0.5 marks for "reaches maximum". 0.5 marks for "decreases to zero". 0.5 marks for "reverses beyond zero". Definitions (2 marks):	2+1+1

			Neutral Temperature (T_n): The temperature where thermo-emf is maximum. Inversion Temperature (T_i): The temperature where thermo-emf becomes zero.	1 mark for a correct definition of T_n. 1 mark for a correct definition of T_i.	
iii	State the mathematical expression of Faraday's law of electromagnetic induction. Explain the significance of the negative sign in the expression. .	KPTBB Grade XII, Ch. 14,	Expression: $\varepsilon = -N\frac{\Delta\varphi}{\Delta t}$ Negative Sign: It represents Lenz's law, indicating that the induced emf opposes the change in magnetic flux that produced it.	Expression (2 marks): 1 mark for the core formula. 1 mark for including the number of turns (N) and the negative sign. Negative Sign (2 marks): 1 mark for identifying it as Lenz's law. 1 mark for stating it shows opposition to the change in flux.	2+2=4
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.	KPTBB Grade XII, Ch. 14, Page No.131	Given: Initial flux, $\Phi_1 = 0.02$ Wb Final flux, $\Phi_2 = 0.11$ Wb Time interval, $\Delta t = 0.3$ s Formula: $\varepsilon = N \cdot \Delta\Phi / \Delta t$ Calculation: Change in flux, $\Delta\Phi = \Phi_2 - \Phi_1 = 0.11 - 0.02 = 0.09$ Wb Induced EMF, $\varepsilon = (1 \times 0.09) / 0.3 = 0.3$ V Answer: 0.3 V	Award marks as follows: 1 mark for correctly calculating $\Delta\Phi = 0.09$ Wb. 1 mark for writing the correct formula. 1 mark for correct substitution into the formula. 1 mark for the correct final answer with unit (V).	1+1+1+1=4
v	Identify the four main components of a simple AC generator and explain the	KPTBB Grade XII, Ch. 14,	Components: Field magnet, Armature, Slip rings, Brushes.	Components (2 marks): 0.5 marks for each correct component.	2+2 = 4

	function of the component that ensures the output current is alternating.	Page No. 143	Function of Slip Rings: They rotate with the coil and maintain continuous contact with the brushes, allowing the alternating current from the coil to be transferred to the external circuit.	Function (2 marks): 1 mark for stating they rotate with the coil for continuous contact. 1 mark for stating this allows AC to be transferred to the external circuit.	
vi	(a) State the modern view of what causes magnetism in materials. (b) Define a 'magnetic domain'. (c) Describe the arrangement of magnetic domains in an unmagnetized piece of iron and explain how this arrangement changes in a strong external magnetic field.	KPTBB Grade XII, Ch. 16, Page No. 219, 221	(a) The magnetic properties of materials are primarily due to the spin motion of electrons. (b) A magnetic domain is a small region where atomic magnetic moments are aligned. (c) Unmagnetized: Domains are randomly oriented. In a Field: Domains aligned with the field grow, and others rotate to align with the field.	(a) 1 mark: Award the mark for stating "spin motion of electrons". Do not award if only "orbital motion" or "electron motion" is mentioned without specifying spin. (b) 1 mark: Award for "region" + "aligned magnetic moments". (c) 2 marks: 1 mark for randomly oriented for unmagnetized state. 1 mark for domains grow/rotate to align with field.	1+1+1+1=4
vii	Define an intrinsic semiconductor; state the purpose of doping; name the two types of impurities used; and identify the type of semiconductor created by	KPTBB Grade XII, Ch. 17, Page No. 231, 234	1. Intrinsic Semiconductor: A pure semiconductor with no impurities. 2. Purpose of Doping: To increase conductivity. 3. Types of Impurities: Pentavalent and Trivalent. 4. Result of Pentavalent	Award 1 mark for each correct point: • 1 mark for pure semiconductor/no impurities. • 1 mark for "to increase conductivity". • 1 mark for naming both pentavalent and trivalent. • 1 mark for "N-type semiconductor".	1+1+1+1=4

	adding a pentavalent impurity.		Doping: N-type semiconductor.		
viii	The α of a transistor changes from 0.98 to 0.995. What is the corresponding change in its β value?	KPTBB Grade XII, Ch. 17, Page No.247	Formula: $\beta = \alpha / (1 - \alpha)$ For α=0.98: $\beta_1 = 0.98 / (1 - 0.98) = 49$ For α=0.995: $\beta_2 = 0.995 / (1 - 0.995) = 199$ Change in β: $\Delta\beta = 199 - 49 = 150$	Award 1 mark for the following each step: • 1 mark for the correct formula. • 1 mark for calculating $\beta_1 = 49$. • 1 mark for calculating $\beta_2 = 199$. • 1 mark for the correct change, $\Delta\beta = 150$.	1+1+1+1=4
ix	Name any two series of the hydrogen spectrum and state the region of the electromagnetic spectrum in which each series lies.	KPTBB Grade XII, Ch. 19, Page No.302	1. Lyman series: Ultraviolet region. 2. Balmer series: Visible region. (OR: Paschen, Brackett, Pfund - Infrared)	Award 2 marks for naming two series (1 mark each). Award 2 marks for stating the correct region for each named series (1 mark each).	2+2 = 4
x	Define: (a) Population inversion (b) Meta-stable state	KPTBB Grade XII, Ch. 19, 323-324	(a) Population Inversion: A state where the number of atoms in a higher energy state is greater than in a lower energy state. (b) Meta-stable State: An excited energy state where electrons have a longer lifetime than in ordinary excited states.	(a) 2 marks: Award 1 mark for "more atoms in higher state". Award 1 mark for "than in lower state". (b) 2 marks: Award 1 mark for "excited state". Award 1 mark for "longer lifetime/duration".	2+2 = 4
xi	An atom is represented by the symbol $^{A}_{z}X$.	KPTBB Grade XII,	(a) A: Mass Number (protons + neutrons). Z:	(a) 2 marks: 1 mark for each correct identification.	2+2 = 4

	(a) Identify what A and Z represent. (b) State how to determine the number of neutrons.	Ch. 20, Page No.335	Atomic Number (number of protons or electrons). (b) The number of neutrons (N) is found by: N = A - Z.	(b) 2 marks: 1 mark for stating subtraction, and 1 mark for the correct formula (N = A - Z).	
xii	Define isotopes. Explain why isotopes have identical chemical properties but may have different physical properties.	KPTBB Grade XII, Ch. 20, 335-336	Definition: Atoms of the same element with the same atomic number (Z) but different mass numbers (A). Chemical Properties: Identical due to same electron configuration (same Z). Physical Properties: Different due to different atomic masses (different A).	Definition (1 mark): for "same Z, different A". Chemical (1.5 marks): 1 mark for "same electron configuration" and 0.5 marks for linking it to "same Z". Physical (1.5 marks): 1 mark for "different masses" and 0.5 marks for linking it to "different A".	1+1.5+1.5= 4
xiii	The mass defect (Δm) for a nucleus is 0.5 u. (a) Calculate the binding energy in MeV. (b) State what this binding energy represents. (Use: 1 u = 931 MeV)	KPTBB Grade XII, Ch. 20, Page No.339-340	(a) Calculation: B.E. = Δm × 931 MeV/u B.E. = 0.5 u × 931 MeV/u = 465.5 MeV (b) It represents the energy required to break the nucleus into its individual nucleons.	(a) 3 marks: • 1 mark for the correct formula. • 1 mark for correct substitution. • 1 mark for the correct result. (b) 1 mark: Award for "energy to break apart the nucleus".	3+1 = 4

Section-C

Item no	Question(Description)	Reference	Possible Answer	Detailed Rubrics (Mark Allocation)	Marking
3.(a)	Prove that the energy U stored in a capacitor can be expressed by the three formulae: $U = \frac{1}{2}QV, U = \frac{1}{2}CV^2, and\ U = \frac{1}{2}\frac{Q^2}{C}$.	KPTBB Grade XII, Ch. 11, Page No.41	1. U = ½ QV 2. U = ½ CV² 3. U = Q² / (2C) Derivation for U=½QV: The work done to charge a capacitor is stored as energy. The average potential during charging is V/2. Work done = Charge × Average Potential = Q × (V/2) = ½ QV. Other Expressions: Substituting Q=CV into U=½QV gives U=½CV². Substituting V=Q/C into U=½QV gives U=Q²/(2C).	Award 5 marks as follows: • 1 mark for stating the concept of work done stored as energy. • 2 marks for deriving U=½QV using the average potential method (1 for average potential=V/2, 1 for W=Q*(V/2)). • 1 mark for deriving U=½CV² from U=½QV. • 1 mark for deriving U=Q²/(2C) from U=½QV.	1+2+1+1= 5
3.(b)	Three capacitors (2μF, 3μF, 6μF) are connected first in series and then in parallel to a 12V battery. Calculate the equivalent capacitance and total energy stored in each combination.	KPTBB Grade XII, Ch. 11, Page No. 37-38	Series Combination: 1/Cs = 1/2 + 1/3 + 1/6 = 1/1 => Cs = 1 μF Us = ½ × (1×10⁻⁶) × (12)² = 7.2 × 10⁻⁵ J Parallel Combination: Cp = 2 + 3 + 6 = 11 μF	Series (2 marks): • 1 mark for correct equivalent capacitance • 1 mark for correct energy calculation Parallel (2 marks): • 1 mark for correct equivalent capacitance	2+2 = 4

			Up = ½ × (11×10⁻⁶) × (12)² = 7.92 × 10⁻⁴ J	• 1 mark for correct energy calculation	
4.(a)	Define magnetic flux. Write its formula and explain the condition for which it is (i) maximum and (ii) zero.	KPTBB Grade XII, Ch. 13, Page No. 94	Definition: Magnetic flux is the number of magnetic field lines passing through a surface. Formula: Φ = BA cosθ (i) Maximum Flux: When θ=0° (cos0°=1), Φmax = BA. (ii) Zero Flux: When θ=90° (cos90°=0), Φ = 0.	Definition (1 mark): Formula (1 mark): Φ = BA cosθ. Max flux(1.5 marks): Award 1 mark for θ=0°, 0.5 marks for Φmax=BA. Zero flux (1.5 marks): 1 mark for θ=90°, 0.5 marks for Φ=0.	1+1+1.5+1.5 = 5
4.(b)	A 0.5m wire carrying 3A current is placed in a 0.2T field. Calculate force when: (i) Perpendicular, (ii) At 30° to field.	KPTBB Grade XII, Ch. 13, Page No. 92	Formula: F = BIL sinθ (i) θ=90°: F = (0.2)(3)(0.5)(1) = 0.3 N (ii) θ=30°: F = (0.2)(3)(0.5)(0.5) = 0.15 N	Each part (2 marks): • 1 mark for correct formula and substitution. • 1 mark for correct answer with unit.	2+2 = 4
5.(a)	Explain the behavior of a pure capacitor in an AC circuit regarding: i) Phase relationship ii) Capacitive reactance (Xc) formula and frequency dependence iii) Phasor diagram	KPTBB Grade XII, Ch. 15, Page No.172	i) Current leads voltage by 90° (π/2 radians). ii) Xc = 1 / (2πfC). It is inversely proportional to frequency (f) and capacitance (C). iii) Diagram: Current phasor (I) vertical, Voltage phasor (V) horizontal, with I leading V by 90°.	i) 2 marks: • 1 mark for "current leads". • 1 mark for "90° or π/2". ii) 2 marks: • 1 mark for correct formula. • 1 mark for "inversely proportional to f and	2+2+1 = 5

				C". iii) 1 mark: Award for a correct and labeled diagram.	
5.(b)	Describe 'impedance'. How is it different from resistance? Derive $Z = \sqrt{(R^2 + X_L^2)}$ for an RL series circuit.	KPTBB Grade XII, Ch. 15, Page No. 176	Impedance (Z): Total opposition to AC flow, measured in Ohms. It is a vector combination of R and X. Difference: Resistance (R) opposes both AC/DC, Impedance (Z) is for AC Derivation: In RL circuit, $V_R = IR$ (in-phase with I), $V_L = IX_L$ (leads I by 90°). Applied voltage $V = \sqrt{(V_R^2 + V_L^2)} = I\sqrt{(R^2 + X_L^2)}$. Thus, $Z = V/I = \sqrt{(R^2 + X_L^2)}$.	Impedance & Difference (1 mark): Award for defining Z and stating difference from R. Derivation (3 marks): • 1 mark for identifying V_R and V_L phases. • 1 mark for $V = \sqrt{(V_R^2 + V_L^2)}$. • 1 mark for substituting $VR=IR$, $V_L=IX_L$ to get $Z=\sqrt{(R^2+X_L^2)}$.	1+3 =4
6.(a)	State five key experimental observations of the photoelectric effect that contradict classical wave theory.	KPTBB Grade XII, Ch. 18, Page No. 271-272	1. Existence of threshold frequency. 2. Instantaneous emission of electrons. 3. K.E. of photoelectrons depends on frequency, not intensity. 4. K.E. is independent of light intensity.	1 mark for each correct observation.	1x5

			5. Photoelectric current is proportional to light intensity.		
6.(b)	Explain how Einstein's photon theory resolved these contradictions.	KPTBB Grade XII, Ch. 18, Page No. 272-273	1. A single photon's energy (hf) must exceed work function (φ), explaining threshold frequency ($f_0=\varphi/h$). 2. Energy transfer is instantaneous in photon-electron collision. 3. & 4. K.E. = hf - φ, so it depends on f, not intensity. 5. Higher intensity means more photons, ejecting more electrons, increasing current.	1 mark for each correct explanation that matches an observation in (a).	1x4= 4