MARKING SCHEME

Q.NO.	Expected Answer/Value Points	Marks	Total Marks
	(SECTION – A)		
1	Dipole moment should be parallel/ along the electric field.	**1**	**1**
2	$\lambda = \frac{h}{\sqrt{2meV}}$ Alternatively, $\lambda = \frac{1.227}{\sqrt{V}}$ nm	**1**	**1**
3	Glass lens will become invisible.	**1**	**1**
4	Intrinsic is pure and Extrinsic is doped/impure.	½ + ½	**1**
5	Statement of the law The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.	**1**	**1**
	(SECTION – B)		
6	(i) Definition 1 mark (ii) Orientation of Polaroid 1 mark **(i)** Light, in which electric field vibrations are in a single plane, also containing the direction of propagation of light. (ii) At 45^0 to either of the two crossed polaroids.	 **1** **1**	 **2**
7	Definition of space wave propagation 1 mark Two examples ½ + ½ mark The mode of propagation in which waves propagate in a straight line from the transmitting antenna to the receiving antenna. (**Alternately:** Line of sight propagation) Examples: 1) Satellite communication 2) Television Broadcast 3) Microwave Linking (Any two)	 **1** ½ + ½	 **2**
8	Expression 1 mark Explanation 1 mark		

	$\vec{F} = q(\vec{v} \times \vec{B})$ It is because this force acts perpendicular to the velocity/displacement.	**1** **1**	**2**
9	a) Formula — ½ mark Calculation of resistance — ½ mark b) Formula — ½ mark Calculation of current — ½ mark (a) $P = \frac{V^2}{R}$ $R = \frac{220 \ X\ 220}{100}\,\Omega$ $= 484\ \Omega$ (b) $I = \frac{V}{R}$ $= \frac{220}{484} = 0.45$ A	½ ½ ½ ½	 **2**
10	Two rules — ½ + ½ mark Their justification — ½ + ½ mark **(i)** <u>Junction Rule</u> **:** At any junction the sum of currents, entering and leaving the junction, is the same. <u>Justification:</u> There is no accumulation of charge at any junction or at any point/ conservation of charge. **(ii)** <u>Loop Rule</u> **:** The algebraic sum of changes, in potential around any closed loop involving resistors and cells, is zero. <u>Justification:</u> Electric potential is dependent on the location of point. Here starting with any point, we come back to the same point. The total change must be zero. **OR** Expression for acceleration — ½ mark Expression for velocity — ½ mark Expression for average velocity — ½ mark Expression for drift velocity — ½ mark Acceleration of electron in electric field, $a = \frac{eE}{m}$	½ ½ ½ ½ ½	 **2**

	Velocity of electron, $v_i = u_i + at_i$ $v_d = \overline{v_i} = \overline{u_i} + a\overline{t_i}$ $= 0 + \frac{eE}{m}\tau = \frac{eE}{m}\tau$ ($\because \overline{u_i}$ = average thermal velocity of elctrons =0) (τ= Average time between successive collisions / relaxation time)	½ ½ ½	2
	Section C		
11	Formula for energy stored ½ mark Formula for series combination ½ mark Formula for parallel combination ½ mark Ratio of potential difference ½ mark Ratio of energy stored when the applied potential difference is same ½ mark Energy Stored = E = $\frac{1}{2}CV^2$ $C_s = \frac{C_1 C_2}{C_1 + C_2} = \frac{3}{4}C$ $C_p = C_1 + C_2$ $= C + 3C = 4C$ $E_s = E_p$ $\Rightarrow \frac{1}{2}C_s {V_s}^2 = \frac{1}{2}C_p {V_p}^2$ $\Rightarrow \frac{3}{4}C{V_s}^2 = 4C{V_p}^2$ $\Rightarrow \frac{V_S}{V_P} = \sqrt{\frac{16}{3}} = \frac{4}{\sqrt{3}}$ For same value of V, we have $\frac{E_S}{E_P} = \frac{\frac{1}{2}C_S V^2}{\frac{1}{2}C_P V^2}$ $= \frac{3}{16}$	½ ½ ½ ½ ½ ½	3

12	(i) Frequency range of Microwaves ½ mark Use of Microwaves ½ mark (ii) Frequency range of IR waves ½ mark Use of IR waves ½ mark (iii) Frequency range of Gamma rays ½ mark Use of Gamma rays ½ mark		
	(i) 10^9- 10^{12} Hz	½	
	Used for heating in microwave ovens/ Used in radar system for navigation or any other one use.	½	
	(ii) 10^{12}- 10^{14} Hz	½	
	Used in remotes/ night vision devices/ lamps used in heat treatment (any one)	½	
	(iii) 10^{18} Hz onwards	½	
	Used to destroy cancer cells.	½	**3**
	OR		
	Meaning of displacement current 1 mark Modified form of Ampere's Circuital Law 2 marks		
	Changing electric flux is equivalent of a current called displacement current I_d.	**1**	
	Therefore, in modified Ampere's circuital law, displacement current is added to the conduction current	**1**	
	$$\oint \vec{B}.\vec{dl} = \mu_0(I_c + I_d)$$	**1**	**3**
13	Working of telescope 1 mark Formula for magnifying power ½ mark Formula for length of telescope ½ mark Finding focal lengths ½ + ½ marks		
	Astronomical telescope consists of two convex lenses. Objective is of large focal length and large aperture and forms an inverted, real and diminished image in its focal plane. Eye piece is a convex lens of smaller focal length and forms an enlarged image at infinity. Final image is magnified and inverted.	**1**	
	$m = \frac{f_0}{f_e}$	½	
	$L = f_0 + f_e$	½	

	$\Rightarrow 20 = \dfrac{f_0}{105 - f_0}$ $\Rightarrow 2100 - 20f_0 = f_0$ $\Rightarrow f_0 = 100$ cm and $f_e = 5$ cm	 ½ ½	 **3**
14	Definition 1 mark Photoelectric Equation 1 mark Calculation of ϑ 1 mark The minimum negative potential given to the plate, for which photo electric current becomes zero/stops, is called stopping potential. We have , $h\vartheta = h\vartheta_0 + \phi$ or $\vartheta = \dfrac{1.6 \times 10^{-19} \times 4.1 + 2.5 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$ Hz $=1.6 \times 10^{15}$Hz	 **1** **1** ½ ½	 **3**
15	Explanation 1 mark Expression for force ½ mark Expression for magnetic field ½ mark Direction of force between conductors 1 mark A current in a straight conductor sets up a magnetic field around it whose direction is given by right hand thumb rule. The second conductor lies in the region of the magnetic field of the first conductor which will be into the plane or out of the plane of the two current carrying conductors. Hence, the force on the second conductor is given by $\overrightarrow{F_2} = I_2(\vec{l} \times \overrightarrow{B_1})$ where $B_1 = \dfrac{\mu_0}{4\pi}\dfrac{2I_1}{d}$ (**Also accept** if the student writes $F = \dfrac{\mu_0 I_1 I_2}{2\,\pi\, d}\ l$) Force between the conductors is attractive, if the currents in the two	 **1** ½ ½	

	conductors are in the same direction. It is repulsive if the currents are in the opposite directions.	½ ½	**3**
16	a) Formation of barrier potential — 2 marks b) Working of Zener diode — 1 mark a) (i) p-side has holes and n-side has electrons as majority carriers. (ii)This results in their diffusion across the junction. (iii) The p-side acquires a negative polarity and the n-side acquires a positive polarity. (iv) The potential, across the junction, at equilibrium, is the barrier potential. b) Zener diode works in Zener region/voltage at which the voltage across Zener remains same even when current changes by a large amount. This property is used in getting a constant dc voltage from the unregulated dc output of a rectifier.	 ½ ½ ½ ½ ½ ½	 **3**
17	a. Modes of communication — ½ + ½ marks Difference between them — 1 mark b. Explanation of 'modulation' — 1 mark a) Point to point Broadcast In point to point mode of communication, one reciever is linked to one transmitter, whereas in broadcast mode of communication many recievers are linked to one transmitter. b) Modulation is the process of loading a base band signal on a high frequency carrier wave by changing either the amplitude or the frequency or the phase of the carrier waves in accordance with the modulating signal. (**Also accept:** Suitable and proper combination of modulating signal and carrier wave)	 ½ ½ ½ ½ **1**	 **3**
18	a) Expression for centripetal force — ½ mark Expression for angular momentum/ Bohr's postulate — ½ mark Expression for r_n — 1 mark b) Proof of $E\alpha\ \frac{1}{n^2}$ — 1 mark		

	a) $\frac{mv_n^2}{r_n} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r_n^2}$	½	
	$L_n = mv_n r_n = \frac{nh}{2\pi}$	½	
	$\Rightarrow m^2 {v_n}^2 = (\frac{nh}{2\pi r_n})^2$		
	$\Rightarrow \frac{m}{4\pi\epsilon_0}\frac{e^2}{r_n} = \frac{n^2h^2}{4\pi^2 r_n^2}$		
	$\Rightarrow r_n = \frac{n^2h^2\epsilon_0}{\pi m e^2}$		
	$\Rightarrow r_n \alpha\, n^2$	**1**	
	b) Total energy = - KE		
	= - $\frac{1}{2}mv_n^2$		
	=- $\frac{1}{8\pi\epsilon_0}\frac{e^2}{r_n}$		
	$E \propto \frac{1}{r_n}$	½	
	and $r_n \propto n^2$		
	$\therefore E \propto \frac{1}{n^2}$	½	**3**
19	a) Property of nuclear force ½ mark Explanation 1 mark b) Formula ½ mark Calculation of time 1 mark		
	a) Nuclear force is a short range force.	½	
	Explanation: A nucleon inside a nucleus will be under the influence of only some of the neighbours which are within the small range of nuclear force. Any nucleon at a distance more than the range of nuclear force will have no influence on the binding energy of this nucleon. Since most of the nucleons in a		

	large nucleus reside inside and not on the surface of nucleus, the change in binding energy per nucleon would be small. b) $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ $\Rightarrow \frac{3125}{100000} = \left(\frac{1}{2}\right)^n$ $\Rightarrow \frac{1}{32} = \left(\frac{1}{2}\right)^n$ $\left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^n$ $\Rightarrow$ n = 5 half lives $\therefore$ t = 5 X 20 = 100 years (**Also accept** if the student writes 3.125% $=\frac{1}{2^5}$ $\therefore$ Time = 5 × half life = 100 years)	1 ½ 1	 3
20	Statement of Biot Savart's law — ½ mark Vector form of Biot Savart's law — ½ mark Magnetic field due to coil P — ½ mark Magnetic field due to coil Q — ½ mark Net field — ½ mark Direction of Field — ½ mark The magnitude of magnetic field *dB* due to a current element *dl* of the conductor is proportional to the current *I*. the element length *dl* and inversely proportional to the square of the distance *r* of the field point from the current element. Its direction is perpendicular to the plane containing $\vec{dl}$ *and* $\vec{r}$. $d\vec{B}\alpha \frac{I\vec{dl} \times \vec{r}}{r^3}$ $\Rightarrow d\vec{B} = \frac{\mu_0}{4\pi} \frac{I\vec{dl} \times \vec{r}}{r^3}$ Magnetic field at the centre due to coil P, $B_P = \frac{\mu_0}{4\pi} \frac{2\pi I}{R}$ along Zaxis. Magnetic field at the centre, due to Q, $B_q = \frac{\mu_0}{4\pi} \frac{2\pi(\sqrt{3}I)}{R}$ along X axis.	 ½ ½ ½ ½	

	Net Field $B = \sqrt{{B_p}^2 + {B_q}^2}$ $= \frac{\mu_0}{4\pi}\frac{4\pi}{R} = \frac{\mu_0}{R}$ Direction $\tan\theta = \frac{B_p}{B_q} = \frac{1}{\sqrt{3}}$ $\theta = 30^\circ$ with X direction	½ ½	3
21	Two features — 1 + 1 marks Formula — ½ mark Calculation — ½ mark a) (i) Fringe width is same in interference pattern but it is not so in the single slit diffraction pattern. (ii) All maxima have equal intensity in interference pattern. In diffraction pattern, the intensity of maxima decreases rapidly for the secondary maxima, b) Angular width = 2θ = $\frac{2\lambda}{a}$ $= \frac{2 \text{ X } 500 \text{ X } 10^{-9}}{0.2 \text{ X } 10^{-3}}$ $= 5 \times 10^{-3}$ radians [Note: Award ½ mark only if the student uses $\theta = \lambda/a$]	1 1 ½ ½	3
22	Fabrication of transistor — 1 mark Defintion of input resistance — 1 mark Definition of current amplification factor β — 1 mark In fabrication of n-p-n transistor, two segments of heavily and moderately doped n-type semiconductor (called emitter and collector respectively) are seperated by a lightly doped segment of p-type semiconductor (called the base). Input resistance r_i is defined as the ratio of change in base emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_B) at constant collector-emitter voltage (V_{CE}).	1 1	

	$\left[\textbf{Alternatively}, r_i = \left(\Delta V_{BE}/\Delta I_B\right)_{V_{CE}}\right]$ Current amplification factor β is defined as the ratio of change in collector current to the change in base current at the constant collector emitter voltage (V_{CE}). $\left[\textbf{Alternatively}, \boldsymbol{\beta} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}\right]$	**1**	**3**
	SECTION D		
23	a) Values displayed by Dr Verma — 1 mark Values displayed by Veena's parent — 1 mark b) Reason for safety in car — 1 mark c) Definition — ½ mark Significance — ½ mark a) Sympathetic, helpful – Dr. Verma (or any other two values) Gratefulness, thankful, concerned, caring – Veena's parents (or any other two values) b) The electric field inside the cavity of a conductor is zero. **<u>Alternately:</u>** Electrostatic shielding c) The maximum electric field that a dielectric can withstand without breakdown. Significance: There is a limit to the amount of charge that can be stored on an object without significant leakage.	 ½ + ½ ½ + ½ 1 ½ ½	 **4**
24	a) Derivation of condition for resonance — 3 marks b) Definition of Q factor — 1 mark c) Definition of wattless current — 1 mark a) $X_c = \frac{1}{\omega C}$, $X_L = \frac{1}{\omega L}$ Thus, if ω is varied, then at a particular frequency, say ω_o, $X_C = X_L$ $\Rightarrow \omega_O = \frac{1}{\sqrt{LC}}$ This is the condition for resonance b) (i) Q factor is the ratio of inductive /capacitive reactance to the total impedance of a series LCR circuit at resonance.	 **1** **1** **1** **1**	

(<u>Alternatively</u>

$$Q = \frac{\omega_0 L}{R} \quad \left(/ \frac{1}{\omega_0 CR} \right)$$

Note: Award ½ mark if the student writes: "The Q-factor is a measure of the 'sharpness of resonance' of a series LCR circuit.")

ii) The current that flows without any net dissipation of power, over a complete cycle, is known as a wattless current. **1** **5**

OR

a)	Principle of transformer	1 mark
	Working	2 mark
b)	Sources of energy loss	½ + ½ marks
c)	Conservation of energy	½ mark
	Justification	½ mark

a) Principle – it works on the principle of mutual induction
(<u>Alternatively</u>
Whenever current in a coil changes, an emf is induced in a neighbouring coil.**)** **1**

Working – Number of turns in the secondary coil is more than number of turns in the primary coil in a step up transformer.

$$E_{s=} \; N_s \frac{d\phi}{dt}$$

$$E_{p=} \; N_p \frac{d\phi}{dt}$$ ½

$$\therefore \quad \frac{E_S}{E_P} = \frac{N_S}{N_P}$$ ½

In an ideal transformer, output power is equal to input power ½

$$\therefore E_S \; I_S = E_P \; I_P$$

$$= \frac{E_S}{E_p} = \frac{I_p}{I_s}$$

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$ ½

	b) Source of energy loss (any two) i) Flux leakage ii) Resistance of the windings/ joule heat losses iii) Eddy currents iv) Hysteresis c) It does not violate the law of conservation of energy. Low input voltage at a particular input power means high input current. But high output voltage means low output current, while the output power remains the same as the input power.	½ + ½ ½ ½	5
25	a) Condition for Coherence — 1 mark Condition for dark and bright fringes — ½ + ½ marks Expression for fringe width — 2 marks b) Bright fringe intensity — ½ mark Dark fringe intensity — ½ mark (a) Two sources of light are said to be coherent if they emit light waves having same frequency and a constant/zero phase difference between the waves. Condition for bright fringes – When path difference between interfering waves is an integral multiple of λ. (**Alternatively:** Path difference $=n\lambda$ or Phase difference = $2n\pi$) Condition for dark fringes – Path difference should be an odd multiple of $\lambda/_2$. (**Alternatively:** Path difference $=(2n+1)^{\lambda}/_2$ Phase difference = $(2n+1)\pi$) In Young's experiment Path difference $=\frac{xd}{D}$ ∴ for bright fringes: $\frac{xd}{D} = n\lambda$ or $x = \frac{n\lambda D}{d}$	 **1** ½ ½ ½ ½	

	$\therefore$ fringe width β =distance between any two consecutive bright fringes $\therefore \beta = (n+1)\frac{\lambda D}{d} - \frac{n\lambda D}{d}$	½	
	$= \frac{\lambda D}{d}$	½	
	(Also accept if the student works out this expression using the condition for dark fringes.)		
	(b) Intensity $I \alpha R^2$ and $R = 2a\cos\frac{\delta}{2}$ For bright fringe $I = 4a^2$ ($\because$ δ=0, π, 2 π, …)	½	
	and for dark fringe I= 0 ($\because$ δ= $\pi/_2, 3\pi/_2$, ...)	½	
	(**Alternatively** At the bright fringes: Resultant amplitude = $a+a = 2a$ $\therefore$ intensity = $(2a)^2 = 4a^2$ At the dark fringes: Resultant amplitude = $a - a$ =0 $\therefore$ intensity = $(0)^2 = 0$) **OR**		5
	Name of phenomenon — 1 mark Condition for observation — 1 mark Angle of minimum deviation — 2 marks Refractive index of the material of prism — 1 mark		
	a) This phenomenon is due to combined effect of dispersion, reflection and refraction of light by spherical droplets of water.	**1**	
	<u>**Conditions for observation**</u> There should be raindrops in the atmosphere and the observer should have his/ her back towards the Sun.	**1**	
	b) i) $i = \frac{3}{4} \times 60^0 = 45^0$	½	
	Since ray passes symmetrically $i = e$ and $D = D_m$	½	
	$A + D_m = i + e = 2\,i$ $\Rightarrow D_m = 2i - A$	½	
	$= 90^0 - 60^0 = 30^0$	½	

	ii) $\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$	½	
	$= \frac{\sin\ 45^0}{\sin\ 30^0} = \sqrt{2}$	½	**5**
26	Definition of electrical resistivity — 1 mark Variation of resistivity with temperature for metals — 1 mark Variation of resistivity with temperature for semiconductor — 1 mark Numerical — 2 marks		
	a) Electrical resistivity is defined as resistance of a conductor of unit length and unit area of cross section.	**1**	
	<u>For metals</u> When temprature increases, resistivity decreases the average time τ between collisions, hence ρ increases.	**1**	
	<u>For semi-conductors</u> As the temperature increases, number of electron-hole pairs increases; hence resistivity decreases.	**1**	
	b) We have $\frac{x}{y} = \frac{35}{65}$	½	
	and $\frac{x+15}{y} = \frac{50}{50}$	½	
	$\Leftrightarrow x + 15 = y$ $\therefore \frac{x}{x+15} = \frac{7}{13}$ $\Leftrightarrow 13\,x = 7x + 105$ $\Leftrightarrow 6x = 105$ $\Leftrightarrow x = \frac{105}{6}\,\Omega$		
	$= 17.5\ \Omega$	½	
	$and\ \ y = (17.5 + 15)\ \Omega$		

	$= 32.5\ \Omega$ **OR** a) Difference between EMF and Terminal potential difference — 1 mark Relation — 1 mark b) Principle — 1 mark Definition of potential gradient — ½ mark SI unit — ½ mark	½	**5**
	a) EMF is the potential difference across the terminals of a cell when no current is drawn from it (or it is in open circuit).	½	
	Terminal potential difference is the potential difference across the terminals of a cell when some current is being drawn from it.	½	
	$$V = E - Ir$$	**1**	
	b) Potential drop along any length of a uniform potentiometer wire is directly proportional to that length of a wire when a constant (steady) current flows through it.	**1**	
	Potential gradient is defined as potential drop per unit length of the wire.	½	
	SI unit : Vm^{-1}	½	
	Find balance length l_1 of the potentiometer wire when cell of emf E_1 is used. Next, find balance length l_2 of potentiometer wire when cell of emf E_2 is used. $$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$	**1**	**5**