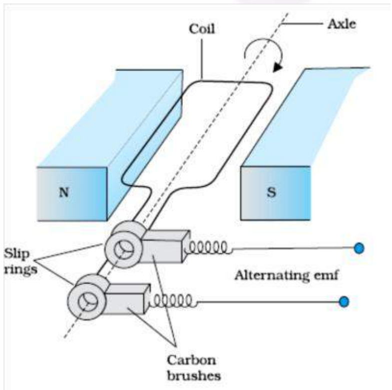
	Let ‘n’ be the number of interference fringes which can be accommodated in the central maxima [Award the last ½ mark if the student writes the answers as 2 (taking $d=a$), or just attempts to do these calculation.]	½ ½	5
Q25	i. Derivation of the expression for drift velocity — 2 Deduction of Ohm’s law — 2 ii. Name of quantity and justification — ½ + ½ Let an electric field E be applied the conductor. Acceleration of each electron is Velocity gained by the electron Let the conductor contain n electrons per unit volume. The average value of time , between their successive collisions, is the relaxation time, Hence average drift velocity The amount of charge, crossing area A, in time ,is $\Delta t = I\Delta$ Substituting the value of v_d, we get , (But I = JA, where J is the current density J = ⇒ J = σE This is Ohm’s law [Note : Credit should be given if the student derives the alternative form of Ohm’s law by substituting E = −] ii) Electric current well remain constant in the wire. All other quantities, depend on the cross sectional area of the wire. **OR**	½ ½ ½ ½ ½ ½ ½ ½ ½ ½	5

	(i) Statement of Kirchoff's laws 1+1 Justification ½ + ½ (ii) Calculation of i) current drawn and 1 ii) Power consumed 1 (i) Junction Rule: At any Junction, the sum of currents, entering the junction, is equal to the sum of currents leaving the junction. Loop Rule: The Algebraic sum, of changes in potential, around any closed loop involving resistors and cells, in the loop is zero. $V) = 0$ Justification: The first law is in accord with the law of conservation of charge. The Second law is in accord with the law of conservation of energy. ii) Equivalent resistance of the loop $R = {}^{r}/$ Hence current drawn from the cell $I = \frac{}{r} = -$ Power consumed P = $({}^{r}\ {}_{3})$ = —— x = —— [Note: Award the last 1 ½ marks for this part, if the calculations, for these parts, are done by using (any other) value of equivalent resistance obtained by the student.)	1 1 ½ ½ ½ ½ ½ ½	5
Q26	a) Labelled diagram of AC generator 1 ½ Expression for instantaneous value of induced emf. 1 ½ b) Calculation of maximum value of current 2  	1 ½	

[Deduct ½ mark, If diagram is not labeled]
When the coil is rotated with constant angular speed ω, the angle θ between the magnetic field and area vector of the coil, at instant t, is given by θ $= \omega$ t,
Therefore, magnets flux, (ϕ_B), at this instant, is

= BA cos ω t — ½

∴Induced emf e = -N—— — ½

e = NBA ω sin ω t

e= e_o sin ω t

where e_o= NBA — ½

b) Maximum value of emf

= NBA ω — ½

= 20 x 200 x x 3 x x 50V — ½

= 600 mV — ½

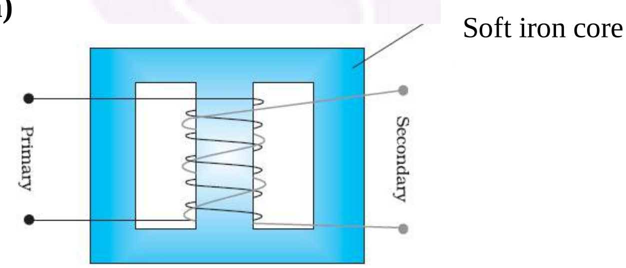
Maximum induced current = — ——mA — ½

[Note 1: It the student calculates the value of the maximum induced emf and says that " since R is not given, the value of maximum induced current cannot be calculated", the ½ mark, for the last part, of the question, can be given.]
[Note 2: The direction of magnetic field has not been given. If the student takes this direction along the axis of rotation and hence obtains the value of induced emf and, therefore, maximum current, as zero, award full marks for this part.] — 5

OR

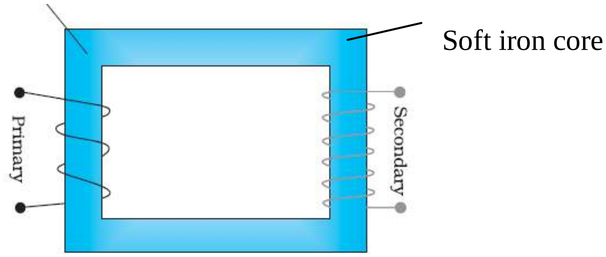
a)	Labelled diagram of a step up transformer	1 ½
	Derivation of ratio of secondary and primary voltage	2
b)	Calculation of number of turns in the secondary	1 ½

a)



1 ½

Alternatively



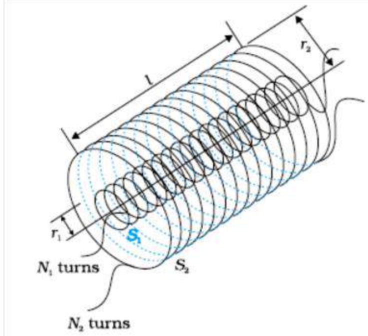
	[Note: Deduct ½ mark, if labeling is not done] a) When ac voltage is applied to primary coil the resulting current produces an alternating magnetic flux, which also links the secondary coil. The induced emf, in the secondary coil, having N_s turns, is — This flux, also induces an emf, called back emf, in the primary coil. — But and — = — For an ideal transformer = ⇨— = — b) — = — — = — = 300	½ ½ ½ ½ ½ ½ ½	5

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
Q1	No, As the magnetic field due to current carrying wire will be in the plane of the circular loop, so magnetic flux will remain zero. Alternatively [Magnetic flux does not change with the change of current.]	½ ½	1
Q2	Speed of em waves is determined by the ratio of the peak values of electric and magnetic field vectors. [Alternatively, Give full credit, if student writes directly —	1	1
Q3	Solar cell	1	1
Q4	$B_H = B_E \cos \delta$ $B = B_E \cos 60^0 \Rightarrow B_E = 2B$ At equator $\delta = 0^0$ [Alternatively, Award full one mark, if student doesn't take the value (=2B)of B_E, while finding the value of horizontal component at equator, and just writes the formula only.]	½ ½	1
Q5	No, Because the charge resides only on the surface of the conductor.	½ ½	1
Q6	Definition of distance of closest approach 1 Finding of distance of closest approach when Kinetic energy is doubled 1 It is the distance of charged particle from the centre of the nucleus, at which the whole of the initial kinetic energy of the (far off) charged particle gets converted into the electric potential energy of the system. Distance of closest approach (r_c) is given by 'K' is doubled, $\therefore$ r_c becomes – [Alternatively: If a candidate writes directly – without mentioning formula, award the 1 mark for this part.] **OR** Two important limitations of Rutherford nuclear model 1+1 1. According to Rutherford model, electron orbiting around the nucleus, continuously radiates energy due to the acceleration; hence the atom will not remain stable.	1 ½ ½ 1	2

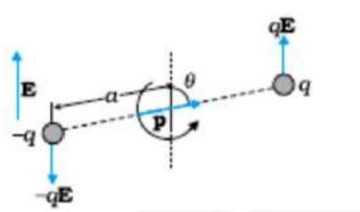
	2. As electron spirals inwards; its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum.	1	2
Q7	Condition, when two objects are just resolved ½ For increasing the resolving power of a compound microscope 1 ½ Two objects are said to be just resolved when, in their diffraction patterns, central maxima of one object coincides with the first minima, of the diffraction pattern of the second object. Limit of resolution of compound microscope Resolving power is the reciprocal of limit of resolution (d Therefore, to increase resolving power λ can be reduced and refractive index can be increased.	½ ½ ½ ½	2
Q8	(i) Definition of line of sight communication 1 (ii) Reason why it is not possible to use sky waves for transmission of T.V. signals ½ Range of an antenna ½ (i) Communication, using waves which travel in straight line from transmitting antenna to receiving antenna. (ii) Because T.V. signal waves are not reflected back by the ionosphere.	1 ½ ½	2
Q9	Finding the ratio of de Broglie wavelength = =	½ ½ ½ ½	2

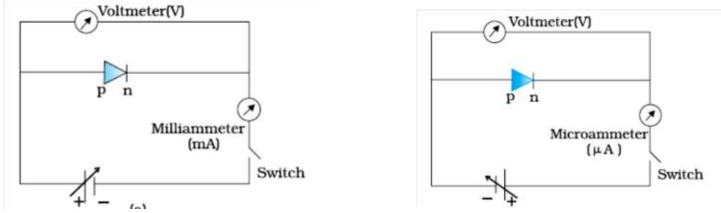
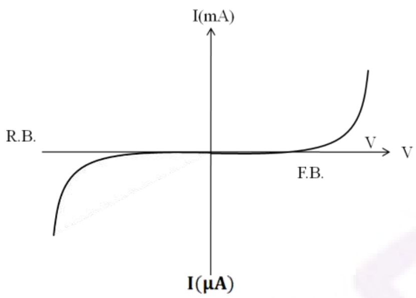
Q10	Explanation of flow of current through capacitor 1 Expression for displacement current 1 During charging, electric flux between the plates of capacitor keeps on changing; this results in the production of a displacement current between the plates. $I_d = \epsilon_o \frac{d\varphi_E}{dt} \left(/ I_d = \epsilon_o A \frac{dE}{dt} \right)$	1 1	2
Q11	Working Principle of moving coil galvanometer 1 Necessity of (i) radial magnetic field ½ (ii) cylindrical soft iron core ½ Expression for current sensitivity ½ Explanation of use of Galvanometer to measure current ½ When a coil, carrying current, and free to rotate about a fixed axis, is placed in a uniform magnetic field, it experiences a torque (which is balanced by a restoring torque of suspension). (i) To have deflection proportional to current / to maximize the deflecting torque acting on the current carrying coil. (ii) To make magnetic field radial / to increase the strength of magnetic field. Expression for current sensitivity $I_s = \frac{\theta}{I}$ or $\frac{NAB}{K}$ where θ is the deflection of the coil No The galvanometer, can only detect currents but cannot measure them as it is not calibrated. The galvanometer coil is likely to be damaged by currents in the (mA/A) range] **OR** a) Definition of self inductance and its SI unit 1 + ½ b) Derivation of expression for mutual inductance 1 ½ Self inductance of a coil equals, the magnitude of the magnetic flux, linked with it, when a unit current flows through it. Alternatively Self inductance, of a coil, equals the magnitude of the emf induced in it, when the current in the coil, is changing at a unit rate. SI unit : henry / (weber/ampere) / (ohm second.)	1 ½ ½ ½ ½ 1 ½	3

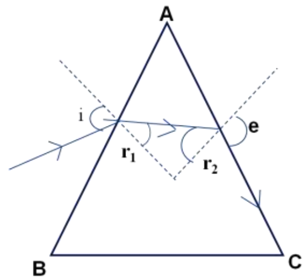


	When current I_2 is passed through coil S_2, it in turn sets up a magnetic flux through S_1: $\Phi_1 = (n_1\ell)(\pi r_1^2)(B_2)$ $\Phi_1 = (n_1\ell)(\pi r_1^2)(\mu_o n_2 I_2)$ $\Phi_1 = \mu_o n_1 n_2 I_2 \pi r_1^2 \ell I_2$ But $\Phi_1 = M_{12} I_2$ $\Rightarrow M_{12} = \mu_o n_1 n_2 \pi r_1^2 \ell$ [Note : If the student derives the correct expression, without giving the diagram of two coaxial coils, full credit can be given]	½ ½ ½	3
Q12	(i) Determining the mass and atomic number of A_4 and A ½ x 4 (ii) Basic nuclear processes of β^+ and β^- decays ½ + ½ **(i)** A_4 : Mass Number : 172 **i.** Atomic Number : 69 (ii) A : Mass Number :180 i. Atomic Number : 72 **[**Alternatively **:** Give full credit if student considers β^+ decay and find atomic and mass numbers accordingly ${}^{180}_{72}A \xrightarrow{\alpha} {}^{176}_{70}A_1 \xrightarrow{\beta^-} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{r} {}^{172}_{69}A_4$ Gives the values quoted above. If the student takes β^+ decay ${}^{180}_{74}A \xrightarrow{\alpha} {}^{176}_{72}A_1 \xrightarrow{\beta^+} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{r} {}^{172}_{69}A_4$ This would give the answers: (A_4:172,69);(A:180,74)**]** Basic nuclear process for β^+ decay $p \rightarrow n + {}^{0}_{1}e + v$ For β^-decay $n \rightarrow p + {}^{0}_{-1}e + \bar{v}$ **[Note:** Give full credit of this part, if student writes the processes as conversion of proton into neutron for β^+decay and neutron into proton for β^-decay.]	½ ½ ½ ½ ½ ½	3
Q13	Calculation of collector current I_c, base current I_B and input signal voltage V_i 1+1+1 Given R_c =2kΩ = 2 x 10^3Ω	½	

	$V_{CE} = I_c R_c$ $I_c = \frac{V_{CE}}{R_c} = \frac{2}{2 \times 10^3} A$ $= 10^{-3} A$ $= 1 mA$ current gain $\beta = \frac{I_c}{I_B}$ $\therefore 100 = \frac{10^{-3}}{I_B}$ $\therefore I_B = 10^{-5} A$ Input signal voltage $V_i = I_B R_B$ $= 1 \times 10^{-5} \times 10^3 \Omega$ $=10^{-2} V$ [**Note** : Give full credit if student calculates the required quantities by any other alternative method]	½ ½ ½ ½ ½	3
Q14	(i) Two important features of Einstein's photo electric equation ½ + ½ (ii) Explanation of observations and finding value of work function of Surface Q 1+1 (i) Maximum kinetic energy (K_{max}), of emitted electrons, depends linearly on frequency of incident radiations $(KE)_{max} = h\nu - h\nu_o$ Existence of threshold frequency for the metal surface $\phi_0 = h\nu_o$ (Any other relevant feature) (ii) Since no photoelectric emission takes place from P it means frequency of incident radiation (10^{15} Hz) is less than its threshold frequency $(\nu_o)_p$. Photo emission takes place from Q but kinetic energy of photoelectrons is zero. This implies that frequency of incident radiation is just equal to the threshold frequency of Q. For Q, work function $\phi_0 = h\nu_o$ $= \frac{6.6 \times 10^{-34} \times 10^{15}}{1.6 \times 10^{-19}} eV$ $= 4.125 eV$	½ + ½ ½ ½ ½ ½	3
Q15	(i) Calculation of phase difference between current and voltage 1 Name of quantity which leads ½ (ii) Calculation of value of 'C', is to be connected in parallel 1 ½ (i) $X_L = \omega L = (1000 \times 100 \times 10^{-3})\Omega = 100\Omega$ $X_C = \frac{1}{\omega C} = \left(\frac{1}{1000 \times 2 \times 10^{-6}}\right) \Omega = 500\Omega$ Phase angle	½	

	$\tan\Phi = \dfrac{X_L - X_C}{R}$ $\tan\Phi = \frac{100-500}{400} = -1$ $\Phi = -\frac{\pi}{4}$ As $X_C > X_L$, (/phase angle is negative), hence current leads voltage (ii) To make power factor unity $X_{C'} = X_L$ $\frac{1}{WC'} = 100$ $C' = 10\mu$F $C' = C \; + C_1$ $10 = 2 + C_1$ $C_1 = 8\mu F$	½ ½ ½ ½ ½	3
Q16	(i) Obtaining of the expression for torque experienced by an electric dipole 2 (ii) Effect of non uniform electric field 1 (i)  Force on + q, $\vec{F} = q\vec{E}$ Force on - q, $\vec{F} = -q\vec{E}$ Magnitude of torque $\tau = qE \times 2a \sin\theta$ $= 2qa\, E \sin\theta$ $\vec{\tau} = \vec{p} \times \vec{E}$ (ii) If the electric field is non uniform, the dipole experiences a translatory force as well as a torque.	½ ½ ½ ½ 1	3
Q17	Circuit diagrams of p n junction under forward bias and reverse bias ½ + ½ Explanation of p n junction working for forward and reverse bias ½ + ½ Characteristic curves for the two cases ½ + ½		

	 In forward bias, applied voltage does not support potential barrier. As a result, the depletion layer width decreases and barrier height is reduced. Due to the applied voltage, electrons from n side cross the depletion region and reach p side. Similarly holes from p side cross the junction and reach the n side. The motion of charged carriers, on either side, give rise to current. In reverse bias, applied voltage support potential barrier. As a result, barrier height is increased, depletion layer widens. This suppresses the flow of electrons from n $\rightarrow p$ and holes from p $\rightarrow n$. Diffusion current decreases. The electric field direction of the junction is such that if electrons on p side or holes on n side in their random motion comes close to the junction, they will be swept to its majority zone. This drift of carriers give rise to the current called reverse current.  	½ + ½ ½ ½ ½ + ½	3
Q18	(i) Calculation of speed of light 1 ½ (ii) Calculation of angle of incidence at face AB 1 ½ **(i)** $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ $= \frac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60^o}{2}\right)} = \sqrt{2}$ Also $\mu = \frac{c}{v} \Rightarrow v = \frac{3\times10^8}{\sqrt{2}}$m/s $= 2.122 \times 10^8 m/s$	½ ½ ½	

	(ii)  At face AC, let the angle of incidence be r_2. For grazing ray, e = 90^o $\Rightarrow \mu = \frac{1}{sinr_2} \Rightarrow r_2 = sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ $=45^o$ Let angle of refraction at face AB be r_1. Now $r_1 + r_2 = A$ $\therefore r_1 = A - r_2 \quad = 60^o - 45^o \; = 15^o$ Let angle of incidence at this face be i $\mu = \frac{\sin i}{sinr_1}$ $\Rightarrow \sqrt{2} = \frac{\sin i}{sin15^o}$ $\therefore i = \; sin^{-1}(\sqrt{2}\,.\sin 15^o)$	½ ½ ½	3
Q19	Definition of amplitude modulation 1 Explanation of two factors justifying the need of modulation 2 It is the process of superposition of information/message signal over a carrier wave in such a way that the amplitude of carrier wave is varied according to the information signal/message signal. Direct transmission, of the low frequency base band information signal, is not possible due to the following reasons; (i) Size of Antenna: For transmitting a signal, minimum height of antenna should be $\frac{\lambda}{4}$; with the help of modulation wavelength of signal decreases, hence height of antenna becomes manageable. (ii) Effective power radiated by an antenna: Effective power radiated by an antenna varies inversely as λ^2, hence effective power radiated into the space, by the antenna, increases. (iii)To avoid mixing up of signals from different transmitters. (Any two)	1 1 ½ + ½	3
Q20	Equivalent capacitance in series ½ Energy in series combination ½ Charge in series combination ½ Equivalent capacitance in parallel combination ½ Energy in parallel combination ½ Charge in parallel combination ½		

	$\therefore n \times \beta = \omega'$ $n = \frac{2\lambda D}{a} \times \frac{d}{\lambda D}$ $n = \frac{2d}{a}$ [Award the last ½ mark if the student writes the answers as 2 (taking d=a), or just attempts to do these calculation.]	½	5