Strictly Confidential (For Internal and Restricted Use only)
Senior School Certificate Examination
Marking Scheme - Physics (Code 55/1/1, Code 55/1/2, Code 55/1/3)

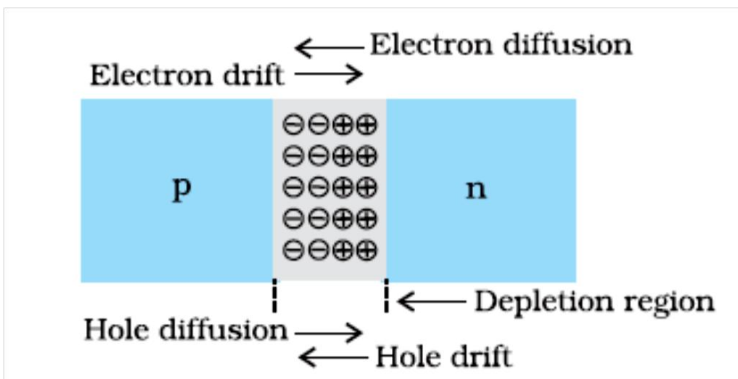
1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. In value based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.
3. Evaluation is to be done as per instructions provided in the marking scheme. It should not be done according to one's own interpretation or any other consideration. Marking scheme should be adhered to and religiously followed.
4. If a question has parts, please award in the right hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left hand margin and circled.
5. If a question does not have any parts, marks are to be awarded in the left hand margin only.
6. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.
7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.
8. Deduct ½ mark for writing wrong units, missing units, in the final answer to numerical problems.
9. Formula can be taken as implied from the calculations even if not explicitly written.
10. In short answer type question, asking for two features / characteristics / properties if a candidate writes three features, characteristics / properties or more, only the correct two should be evaluated.
11. Full marks should be awarded to a candidate if his / her answer in a numerical problem is close to the value given in the scheme.
12. In compliance to the judgement of the Hon'ble Supreme Court of India, Board has decided to provide photocopy of the answer book(s) to the candidates who will apply for it along with the requisite fee. Therefore, it is all the more important that the evaluation is done strictly as per the value points given in the marking scheme so that the Board could be in a position to defend the evaluation at any forum.
13. The Examiner shall also have to certify in the answer book that they have evaluated the answer book strictly in accordance with the value points given in the marking scheme and correct set of question paper.
14. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title paper, correctly totaled and written in figures and words.
15. In the past it has been observed that the following are the common types of errors committed by the Examiners
    - Leaving answer or part thereof unassessed in an answer script.
    - Giving more marks for an answer than assigned to it or deviation from the marking scheme.
    - Wrong transference of marks from the inside pages of the answer book to the title page.
    - Wrong question wise totaling on the title page.
    - Wrong totaling of marks of the two columns on the title page.
    - Wrong grand total.
    - Marks in words and figures not tallying.
    - Wrong transference to marks from the answer book to award list.
    - Answer marked as correct (√) but marks not awarded.
    - Half or part of answer marked correct (√) and the rest as wrong (×) but no marks awarded.
16. Any unassessed portion, non carrying over of marks to the title page or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	SECTION A		
Q1	No, Because the charge resides only on the surface of the conductor.	½ ½	1
Q2	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
Q3	$B_H = B_E \cos\delta$ $B = B_E \cos 60^0 \Rightarrow B_E = 2B$ At equator $\delta = 0^0$ $\therefore B_H = 2B\cos 0 = 2B$ [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
Q4	Solar cell	1	1
Q5	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 $C = \frac{E_o}{B_o}$]	1	1
	SECTION B		
Q6	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
Q7	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 $r_c = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2Ze^2}{K}$ 'K' is doubled, $\therefore$ r_c becomes $\frac{r}{2}$	1 ½ ½	

	[Alternatively: If a candidate writes directly $\frac{r}{2}$ 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. **2.** As electron spirals inwards; its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum.	 1 1	2 2
Q8	Calculation of wavelength of electron in ground state 2 Radius of ground state of hydrogen atom =0.53Å = $0.53 \times 10^{-10} m$ According to de Broglie relation $2\pi r = n\lambda$ For ground state n=1 $2 \times 3.14 \times 0.53 \times 10^{-10} = 1 \times \lambda$ $\therefore \lambda = 3.32 \times 10^{-10}$m $= 3.32$Å Alternatively Velocity of electron, in the ground state, of hydrogen atom $= 2.18 \times 10^{-6} m/s$ Hence momentum of revolving electron p = mv = $9.1 \times 10^{-31} \times 2.18 \times 10^{-6} kg\ m/s$ $\lambda = \frac{h}{p} = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 2.18 \times 10^{6}}$ m $= 3.32$Å [Note: Also accept the following answer: Let λ_n be the wavelength of the electron in the n^{th} orbit, we then have $$2\pi r_n = n\lambda$$ For ground state n=1 $$2\pi r_0 = \lambda$$ (r=r_0 is the radius of the ground state) [Alternatively $$\lambda_n = \frac{h}{mv_n}$$ and $v_n = v_0$ (velocity of electron in ground state) $$\lambda = \frac{h}{mv_0}$$	½ ½ ½ ½ ½ ½ ½ ½ 1 1 1 1	 2 2 2 2

Q9	Definition of magnifying power 1 Reason for short focal lengths of objective and eyepiece 1 Magnifying power is defined as the angle subtended at the eye by the image to the angle subtended (at the unaided eye) by the object. (Alternatively: Also accept this definition in the form of formula) $m = m_0 \times m_e = \frac{L}{f_o} \times \frac{D}{f_e}$ To increase the magnifying power both the objective and eyepiece must have short focal lengths $\left(\text{as } m = \frac{L}{f_o} \times \frac{D}{f_e}\right)$	1 ½ +½	2
Q10	Name of basic mode of communication ½ Type of wave propagation ½ Range of frequencies and reason ½ + ½ Broadcast / point to point, mode of communication Space wave propagation Above 40 MHz Because e.m. waves, of frequency above 40MHz, are not reflected back by the ionosphere / penetrate through the ionosphere.	½ ½ ½ ½	2
	SECTION C		
Q11	(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) $X_L = \omega L = (1000 \times 100 \times 10^{-3})\Omega$=100Ω $X_C = \frac{1}{\omega C} = \left(\frac{1}{1000 \times 2 \times 10^{-6}}\right)$ Ω = 500Ω Phase angle $\tan \Phi = \frac{X_L - X_C}{R}$ $\tan \Phi = \frac{100-500}{400}$ = -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	½ ½ ½ ½	

<table>
<tr><td></td><td>$C' = 10\mu\text{F}$</td><td>½</td><td></td></tr>
<tr><td></td><td>$C' = C + C_1$
$10 = 2 + C_1$
$C_1 = 8\mu F$</td><td>½</td><td>3</td></tr>
<tr><td>Q12</td><td>Names of the two processes ½ + ½
Diagram 1
Explanation of formation of depletion region and Barrier Potential ½ + ½</td><td></td><td></td></tr>
<tr><td></td><td>Diffusion</td><td>½</td><td></td></tr>
<tr><td></td><td>Drift</td><td>½</td><td></td></tr>
<tr><td></td><td>
</td><td>1</td><td></td></tr>
<tr><td></td><td>Due to the diffusion of electrons and holes across the junction a region of (immobile) positive charge is created on the n-side and a region of (immobile) negative charge is created on the p-side, near the junction; this is called depletion region.</td><td>½</td><td></td></tr>
<tr><td></td><td>Barrier potential is formed due to loss of electrons from n-region and gain of electrons by p-region. Its polarity is such that it opposes the movement of charge carriers across the junction.</td><td>½</td><td>3</td></tr>
<tr><td>Q13</td><td>(i) Derivation of the expression for cyclotron frequency 2
(ii) Reason / justification for the correct answer 1</td><td></td><td></td></tr>
<tr><td></td><td>(i) $\frac{mv^2}{r} = qvB$</td><td>½</td><td></td></tr>
<tr><td></td><td>$r = \frac{mv}{qB}$</td><td>½</td><td></td></tr>
<tr><td></td><td>Frequency of revolution($\mathcal{V}$) = $\frac{1}{Time\ Period} = \frac{v}{2\pi r}$</td><td>½</td><td></td></tr>
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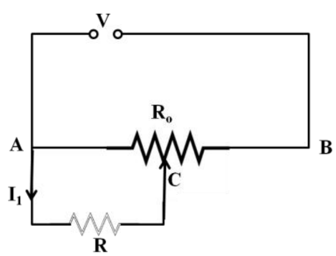
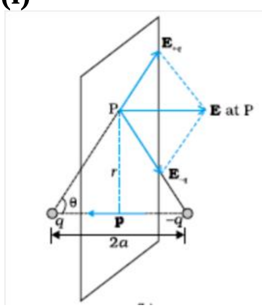
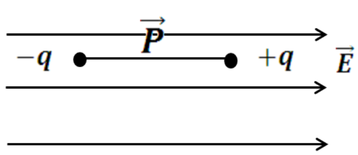
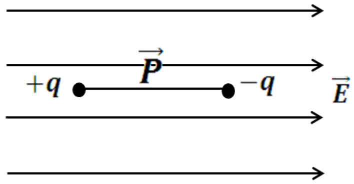
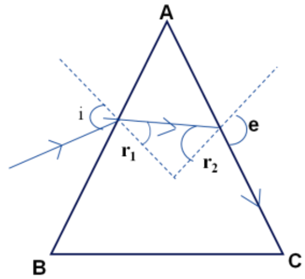
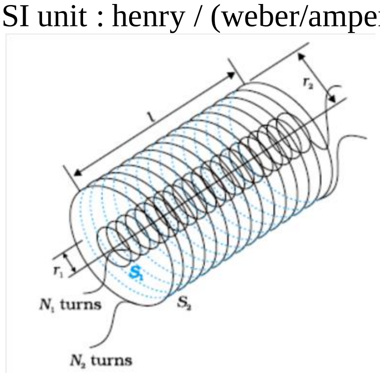
	$\mathcal{V} = \frac{qB}{2\pi m}$ (ii) No The mass of the two particles, i.e deuteron and proton, is different. Since (cyclotron) frequency depends inversely on the mass, they cannot be accelerated by the same oscillator frequency.	½ ½ ½	 3
Q14	(i) Explanation of emission of electrons from the photosensitive surface 1½ (ii) Identification of metal/s which does/do not cause photoelectric effect 1 / photoelectric emission Effect produced ½ (i) Einstein's Photoelectric equation is $$h\upsilon = \varphi_{0+K_{\max}}$$ When a photon of energy $'h\upsilon'$ is incident on the metal, some part of this energy is utilized as work function to eject the electron and remaining energy appears as the kinetic energy of the emitted electron. (ii) $E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^{8}}{3.3\times10^{-7}\times 1.6\times10^{-19}}\,e\mathrm{V}$ = 3.77 eV The work function of Mo and Ni is more than the energy of the incident photons; so photoelectric emission will not take place from these metals. Kinetic energy of photo electrons will not change, only photoelectric current will change.	 ½ 1 ½ ½ ½	 3
Q15	Derivation of expression of voltage across resistance R 3  Resistance between points A & C $\frac{1}{R_1} = \frac{1}{R} + \frac{1}{\left(\frac{R_O}{2}\right)}$ Effective resistance between points A & B $$R_2 = \left(\frac{R\,\frac{R_o}{2}}{R+\frac{R_o}{2}}\right) + \frac{R_o}{2}$$ Current drawn from the voltage source, $\mathrm{I} = \frac{\mathrm{V}}{R_2}$ $\mathrm{I} = \frac{V}{\left(\frac{R\,\frac{R_O}{2}}{R+\frac{R_O}{2}}\right)+\frac{R_O}{2}}$	 ½ ½ ½	

	Let current through R be I_1 $I_1 = \dfrac{I\left(\frac{R_O}{2}\right)}{R + \frac{R_O}{2}}$ Voltage across R $V_I = I_I\, R$ $= \dfrac{\boldsymbol{I}R_O}{\mathbf{2}\left(R+\frac{R_O}{2}\right)} . R$ $= \dfrac{R\,R_O}{2\left(R+\frac{R_O}{2}\right)} \cdot \dfrac{V}{\left(\frac{R\,R_O}{2R+R_O}\right)+\frac{R_O}{2}}$ $= \dfrac{2RV}{R_O + 4R}$	½ ½ ½	3
Q16	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
Q17	(i) Calculation of equivalent capacitance — 1 (ii)Calculation of charge and energy stored — 1+1 (i) Capacitors C_2, C_3 *and* C_4 are in parallel $\therefore C_{234} = C_2 + C_3 + C_4$ $\therefore C_{234} = 6\mu F$ Capacitors C_1, C_{234} *and* C_5 are in series $\dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_{234}} + \dfrac{1}{C_5} = \dfrac{1}{2} + \dfrac{1}{6} + \dfrac{1}{2}$ $= {}^{7}/_{6}$ µF $C_{equivalent} = {}^{6}/_{7}$ µF (ii) Charge drawn from the source	½ ½	

	$Q = C_{eq}V$, $= \frac{6}{7} \times 7\mu C = 6\mu C$ Energy stored $U = \frac{Q^2}{2C}$ $= \frac{6\times6\times10^{-12}\times7}{2\times6\times10^{-6}}$ J =21 μ J	½ ½ ½ ½	3
Q18	(i) Derivation of expression of electric field on the equatorial line of the dipole — 2 (ii) Depiction of orientation for stable and unstable equilibrium — ½ + ½ **(i)**  Let the point 'P' be at a distance 'r' from the mid point of the dipole. $E_{+q} = \frac{q}{4\pi\varepsilon_0(r^2+a^2)}$ $E_{-q} = \frac{q}{4\pi\varepsilon_0(r^2+a^2)}$ Both are equal and their directions are as shown in the figure. Hence net electric field $\vec{E} = \left[-\left(E_{+q} + E_{-q}\right)cos\theta\right]\hat{p}$ $= -\frac{2qa}{4\pi\varepsilon_0(r^2+a^2)^{\frac{3}{2}}}\hat{p}$ (ii) Stable equilibrium, $\theta = 0^0$/  Unstable equilibrium, $\theta = 180^0$/	½ ½ ½ ½ ½	

	 	½	3
Q19	(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 Atomic Number : 69 (ii) A : Mass Number :180 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
Q20	(i) Calculation of speed of light 1 ½ (ii) Calculation of angle of incidence at face AB 1 ½ **(i)** $\mu = \dfrac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ $= \dfrac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60^o}{2}\right)} = \sqrt{2}$ Also $\mu = \frac{c}{v} \Longrightarrow v = \frac{3\times10^8}{\sqrt{2}}$m/s $= 2.122 \times 10^8 m/s$ (ii)	 ½ ½ ½	

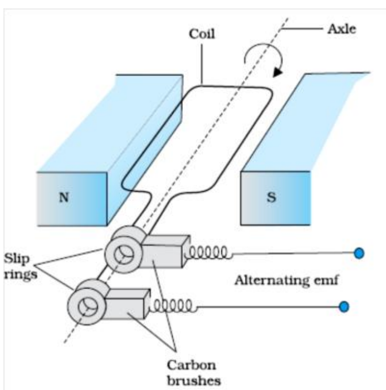
			
	At face AC, let the angle of incidence be r_2. For grazing ray, e = 90^o $\Longrightarrow \mu = \frac{1}{sinr_2} \Longrightarrow r_2 = sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ $=45^o$	½	
	Let angle of refraction at face AB be r_1. Now $r_1 + r_2 = A$ $\therefore r_1 = A - r_2 \ = 60^o - 45^o \ = 15^o$	½	
	Let angle of incidence at this face be i $\mu = \frac{\sin i}{sinr_1}$ $\Longrightarrow \sqrt{2} = \frac{\sin i}{sin15^o}$ $\therefore i = \ sin^{-1}(\sqrt{2}\,.\sin 15^o\,)$	½	3
Q21	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 $10^3\Omega$ $V_{CE} = I_c\,R_c$	½	
	$I_c = \frac{V_{CE}}{R_c} = \frac{2}{2 \times 10^3}A$ = $10^{-3}A$ = 1mA	½	
	current gain $\beta = \frac{I_c}{I_B}$	½	
	$\therefore 100 = \frac{10^{-3}}{I_B}$ $\therefore I_B = 10^{-5}A$	½	
	Input signal voltage $V_i = I_B\,R_B$	½	
	= 1 x $10^{-5} \times 10^3\Omega$ $=10^{-2}V$	½	
	[**Note** : Give full credit if student calculates the required quantities by any other alternative method]		3
Q22	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).	1	
	(i) To have deflection proportional to current / to maximize the deflecting torque acting on the current carrying coil.	½	
	(ii) To make magnetic field radial / to increase the strength of magnetic field.	½	
	Expression for current sensitivity $I_s = \frac{\theta}{I}$ or $\frac{NAB}{K}$ where θ is the deflection of the coil	½	
	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]	½	3
	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.	1	
	SI unit : henry / (weber/ampere) / (ohm second.)	½	
		½	
	When current I_2 is passed through coil S_2, it in turn sets up a magnetic flux through S_1: $\Phi_1 = (n_1\ell)(\pi r_1^2)(B_2)$	½	
	$\Phi_1 = (n_1\ell)(\pi r_1^2)(\mu_o n_2 I_2)$ $\Phi_1 = \mu_o n_1 n_2 I_2 \pi r_1^2 \ell I_2$ But $\Phi_1 = M_{12} I_2$ $\Rightarrow M_{12} = \mu_o n_1 n_2 \pi r_1^2 \ell$	½	
	[Note : If the student derives the correct expression, without giving the diagram of two coaxial coils, full credit can be given]		3

SECTION D

Q23	a) Two qualities each of Anuja and her mother ½ x 4 b) Explanation, using lens maker's formula 2 a) Anuja : Scientific temperament, co-operative, knowledgeable (any two) Mother : Inquisitive, scientific temper/keen to learn/has no airs(any two)(or any other two similar values) b) $\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ As the refractive index of plastic material is less than that of glass material therefore, for the same power $(= {}^{1}/_{f})$, the radius of currature of plastic material is small. Therefore plastic lens is thicker. Alternatively**,** If student just writes that plastic has a different refractive index than glass, award one mark for this part.	½+ ½ ½ + ½ ½ ½ ½ ½	4

SECTION E

Q24	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  [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 ϕ_B = BA cos ω t ∴Induced emf e = -N$\frac{d\phi_B}{dt}$ e = NBA ω sin ω t e= e_o sin ω t where e_o= NBA ω b) Maximum value of emf e_o= NBA ω = 20 x 200 x 10^{-4} x 3 x 10^{-2} x 50V = 600 mV	1 ½ ½ ½ ½ ½ ½ ½	

Maximum induced current $i_o = \frac{e_o}{R} = \frac{600}{R}$mA ½

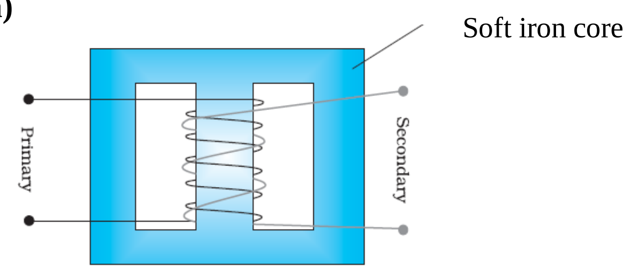
[Note 1: It the student calculates the value of the maximum induced emf and says that " since R is not given, the value of maximum induced current cannot be calculated", the ½ mark, for the last part, of the question, can be given.]

[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

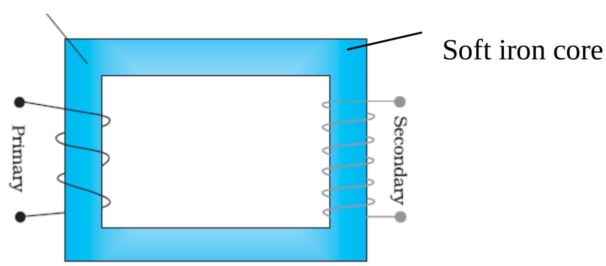
OR

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)



Alternatively



1 ½

[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

$$e_s = -N_s \frac{d\varphi}{dt}$$

This flux, also induces an emf, called back emf, in the primary coil.

$$e_p = -N_p \frac{d\varphi}{dt}$$ ½

But $e_p = V_p$

and $e_s = V_s$

$$\Rightarrow \frac{V_s}{V_p} = \frac{N_s}{N_p}$$ ½

	For an ideal transformer $i_p\ V_p = i_s\ V_s$ $\Rightarrow \frac{V_s}{V_p} = \frac{i_p}{i_s}$ b) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{N_s}{3000} = \frac{220}{2200}$ $\therefore N_s = 300$	½ ½ ½ ½ ½	5
Q25	a) Distinction between unpolarised and linearly polarized light — 2 Obtaining linearly polarized Light — 1 b) Calculation of intensely of light — 2 a) In an unpolarized light, the oscillations, of the electric field, are in random directions, in planes perpendicular to the direction of propagation. For a polarized light, the oscillations are aligned along one particular direction. Alternatively Polarized light can be distinguished, from unpolarized light, when it is allowed to pass through a polaroid. Polarized light does can show change in its intensity, on passing through a Polaroid; intensity remains same in case of unpolarized light. When unpolarised light wave is incident on a polaroid, then the electric vectors along the direction of its aligned molecules, get absorbed; the electric vector, oscillating along a direction perpendicular to the aligned molecules, pass through. This light is called linearly polarized light. b) According to Malus' Law: $I = I_o \cos^2\theta$ $\therefore I = (\frac{I_o}{2}) \cos^2\theta$, where I_o is the intensity of unpolarized light. $\theta = 60^o$ (given) $I = \frac{I_o}{2} \cos^2 60^o = \frac{I_o}{2} \times \left(\frac{1}{2}\right)^2$	1 1 1 1 ½	

$= \frac{I_o}{8}$ ½ 5

OR

a) Explanation of two features (distinguishing between interference pattern and diffraction pattern.)	2
b) Calculation of angular width of central maxima	2
Estimation of number of fringes	1

a)

Interference Pattern	Diffraction pattern
1) All fringes are of equal width.	1) Width of central maxima is twice the width of higher order bands.
2) Intensity of all bright bands is equal.	2) Intensity goes on decreasing for higher order of diffraction bands.

1+1

[Note: Also accept any other two correct distinguishing features.]

b) Angular width of central maximum

$$\omega = \frac{2\lambda}{a}$$ ½

$$= \frac{2\times500\times10^{-9}}{0.2\times10^{-3}} \text{ radian}$$ ½

$$= 5\times10^{-3} \text{ radian}$$ 1

$$\beta = \frac{\lambda D}{d}$$

Linear width of central maxima in the diffraction pattern

$$\omega' = \frac{2\lambda D}{a}$$ ½

Let 'n' be the number of interference fringes which can be accommodated in the central maxima

$$\therefore n \times \beta = \omega'$$

$$n = \frac{2\lambda D}{a} \times \frac{d}{\lambda D}$$

$$n = \frac{2d}{a}$$

[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

Q26

i.	Derivation of the expression for drift velocity	2
	Deduction of Ohm's law	2
ii.	Name of quantity and justification	½ + ½

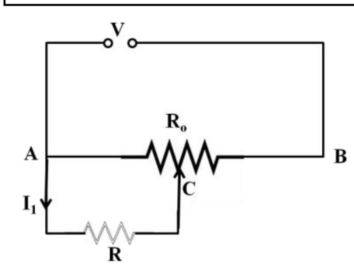
	Let an electric field E be applied the conductor. Acceleration of each electron is		
	$a = -\frac{eE}{m}$	½	
	Velocity gained by the electron		
	$v = -\frac{eE}{m}t$	½	
	Let the conductor contain n electrons per unit volume. The average value of time $'t'$, between their successive collisions, is the relaxation time, $'\tau'$.	½	
	Hence average drift velocity $v_d = \frac{-eE}{m}\tau$	½	
	The amount of charge, crossing area A, in time Δt,is		
	$\equiv neAv_d\Delta t = I\Delta t$	½	
	Substituting the value of v_d, we get		
	$I\Delta t = neA\left(\frac{eE\tau}{m}\right)\Delta t$		
	$\therefore I = \left(\frac{e^2A\tau n}{m}\right)E = \sigma E, \left(\sigma = \frac{e^2\tau n}{m} \text{ is the conductivity}\right)$	½	
	But I = JA, where J is the current density		
	$\Rightarrow$ J = $\left(\frac{e^2\tau n}{m}\right)E$	½	
	$\Rightarrow$ J = σE	½	
	This is Ohm's law		
	[Note : Credit should be given if the student derives the alternative form of Ohm's law by substituting E = $\frac{V}{\ell}$]		
	ii) Electric current well remain constant in the wire.	½	
	All other quantities, depend on the cross sectional area of the wire.	½	5
	OR		
	(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.	1	
	Loop Rule: The Algebraic sum, of changes in potential, around any closed loop involving resistors and cells, in the loop is zero.	1	
	$\sum(\Delta V) = 0$		
	Justification: The first law is in accord with the law of conservation of charge.	½	
	The Second law is in accord with the law of conservation of energy.	½	
	ii) Equivalent resistance of the loop		

	$R = r/3$ Hence current drawn from the cell $I = \frac{E}{r/3 + r} = \frac{3E}{4r}$ Power consumed $P = I^2\,(r/3)$ $= \frac{9E^2}{16r^2} \times 4r/3 = \frac{3E^2}{4r}$ [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.)	½ ½ ½ ½	5

MARKING SCHEME

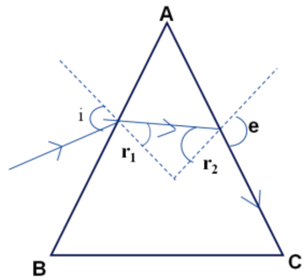
Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	SECTION B		
Q1	$B_H = B_E \cos \delta$ $B = B_E \cos 60^0 \Rightarrow B_E = 2B$ At equator $\delta = 0^0$ $\therefore B_H = 2B\cos 0 = 2B$ [Alternatively, Award full one mark, if student doesn't take the value (=2B)of B_E, while finding the value of horizontal component at equator, and just writes the formula only.]	½ ½	1
Q2	Solar cell	1	1
Q3	No, Because the charge resides only on the surface of the conductor.	½ ½	1
Q4	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 $C = \frac{E_o}{B_o}$]	1	1
Q5	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
Q6	Calculation of wavelength of electron in first excited state 2 Radius of nth orbit $r = r_o n^2 = 0.53 n^2 Å$ $= 0.53 \times 4$ Å $= 2.12$ Å For an electron revolving in nth orbit, according to de Broglie relation $2\pi r_n = n\lambda$, For 1st excited state $n = 2$ $2 \times 3.14 \times 2.12 \times 10^{-10} = 2\lambda$ $\lambda = 3.14 \times 2.12 \times 10^{-10} n$ $= 6.67$ Å **Alternatively** $\lambda = \frac{h}{p} = \frac{h}{m_e v}$ velocity of electron in first excited state, $v = 1.1 \times 10^6 \mathrm{m/s}$ $\lambda = \frac{6.63 \times 10^{-34}}{9 \times 10^{-31} \times 1.1 \times 10^6}$ $= 6.67 \times 10^{-10}$m $= 6.67$Å Alternatively	 ½ ½ ½ ½ ½ ½ ½ ½	 2 2

	Let λ_n be the wavelength of the electron in the n[th] orbit. We then have $$2\pi r_n = n\lambda_n$$ $$\therefore \lambda_2 = \pi r_2$$ Also $$r_2 = 4r_0$$ (r_0 = radius of the ground state orbit) $$\therefore \lambda_2 = 4\pi r_0$$ Alternatively, Let λ_n be the wavelength of the electron in the n[th] orbit. We then have $$\lambda_n = \frac{h}{mv_n}$$ But $$v_n = \frac{v_0}{n}$$ $$\therefore \lambda_2 = \frac{2\,h}{mv_0}$$ where v_0 is the velocity of electron in ground state.	1 ½ ½ 1 ½ ½	2 2
Q7	Distinction between transducer and repeater 2 **Transducer** : A device which converts one form of energy into another. **Repeater** : A combination of receiver and transmitter / It picks signals from a transmitter; amplifies and retransmits them.	1 1	2
Q8	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

Q9	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 $$r_c = \frac{1}{4\pi\varepsilon_0} . \frac{2Ze^2}{K}$$ 'K' is doubled, $\therefore$ r_c becomes $\frac{r}{2}$ [Alternatively: If a candidate writes directly $\frac{r}{2}$ without mentioning formula, award the 1 mark for this part.]	1 ½ ½	 2
	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. **2.** As electron spirals inwards; its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum.	1 1	 2
Q10	Reasons for having large focal length and large aperture of objective of telescope and their justification 1+1 Large focal length : to increase magnifying power $\left(\because m = \frac{f_o}{f_e}\right)$ Large aperature : to increase resolving power. $\left(\because \text{RP} = \frac{2a}{1.22\lambda}\right)$	½ ½ ½ ½	 2
Q11	Derivation of expression of voltage across resistance R 3  Resistance between points A & C $\frac{1}{R_1} = \frac{1}{R} + \frac{1}{\left(\frac{R_O}{2}\right)}$ Effective resistance between points A & B	 ½	

	$$R_2 = \left(\frac{R\ \frac{R_o}{2}}{R + \frac{R_o}{2}}\right) + \frac{R_o}{2}$$ Current drawn from the voltage source, $\mathrm{I} = \frac{\mathrm{V}}{R_2}$ I = $\frac{V}{\left(\frac{R\frac{R_O}{2}}{R+\frac{R_O}{2}}\right)+\frac{R_O}{2}}$ Let current through R be I_1 $$\mathrm{I}_1 = \frac{\mathrm{I}\left(\frac{R_o}{2}\right)}{R + \frac{R_o}{2}}$$ Voltage across R $V_I = I_I\ R$ $= \frac{\boldsymbol{I}R_O}{\boldsymbol{2}\left(R+\frac{R_O}{2}\right)}.R$ $= \frac{R\ R_O}{2\left(R+\frac{R_O}{2}\right)} \cdot \frac{V}{\left(\frac{R\ R_O}{2R\ +\ R_O}\right)+\frac{R_O}{2}}$ $= \frac{2RV}{R_O + 4R}$	½ ½ ½ ½ ½	3
Q12	Identification of metal which has higher threshold frequency ½ Determination of the work function of the metal which has greater value 1½ Calculation of maximum kinetic energy (K_{max}) of electron emitted by light of frequency $8 \times 10^{14}\ Hz$ 1 i) Q has higher threshold frequency ii) Work function ϕ_o=$h\nu_o$ $$h\nu_o = (6.6 \times 10^{-34}) \times \frac{6 \times 10^{-14}}{1.6 \times 10^{-19}}\,e\mathrm{V}$$ = 2.5eV $K_{max} = h(\nu - \nu_o)$ $= \frac{6.6\times10^{-34}\times2\times10^{14}}{1.6\times10^{-19}}\,e\mathrm{V}$ $K_{max} = 0.83e\mathrm{V}$	½ ½ ½ ½ ½ ½	3
Q13	Calculation of electrostatic energy in 12 pF capacitor 1 Total charge stored in combination 1 Potential difference across each capacitor ½ + ½ Energy stored, in the capacitor of capacitance 12 pF,		

	$U = \frac{1}{2}\ CV^2$ $= \frac{1}{2} \times\ 12\ \times\ 10^{-12} \times 50\ \times 50$ J $= 1.5\times\ 10^{-8}$ J C= Equivalent capacitance of 12 pF and 6 pF, in series, is given by $\frac{1}{C} = \frac{1}{12} + \frac{1}{6} = \frac{1+2}{12}$ $\therefore$ C = 4 pF $\therefore$ Charge stored across each capacitor $q = C\ V$ $= 4 \times 10^{-12} \times 50$ C $= 2 \times 10^{-10}$ C Charge on each capacitor 12 pF as well as 6 pF $\therefore$ Potential difference across capacitor C_1 $\therefore\ V_1 = \frac{2\ \times 10^{-10}}{12 \times 10^{-12}}$ volt $= \frac{50}{3}$ V Potential difference across capacitor C_2 $V_2 = \frac{2\ \times 10^{-10}}{6 \times 10^{-12}}$ volt $= \frac{100}{3}$ V	½ ½ ½ ½ ½ ½	3
Q14	i. Calculation of speed of light 1 ½ ii. Calculation of angle of incidence at face AB 1 ½ **i.** $\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ $= \frac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60^0}{2}\right)} = \sqrt{2}$ Also $\mu = \frac{c}{v} \Longrightarrow v = \frac{3\times10^8}{\sqrt{2}}$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 $\Longrightarrow \mu = \frac{1}{sinr_2} \Longrightarrow r_2 = sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ $=45^o$ 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 $\mu = \frac{\sin i}{sinr_1}$ $\Longrightarrow \sqrt{2} = \frac{\sin i}{sin15^o}$ $\therefore i = \ sin^{-1}(\sqrt{2}\,.\sin 15^o)$	½ ½ ½	3
Q15	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 Atomic Number : 69 ii. A : Mass Number :180 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 $n \rightarrow p + {}_{-1}^{0}e + \bar{v}$ **[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

Q16

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). — 1

(i) To have deflection proportional to current / to maximize the deflecting torque acting on the current carrying coil. — ½

(ii) To make magnetic field radial / to increase the strength of magnetic field. — ½

Expression for current sensitivity

$$I_s = \frac{\theta}{I} \; or \; \frac{NAB}{K}$$ — ½

where θ is the deflection of the coil

No — ½

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]

Total: 3

OR

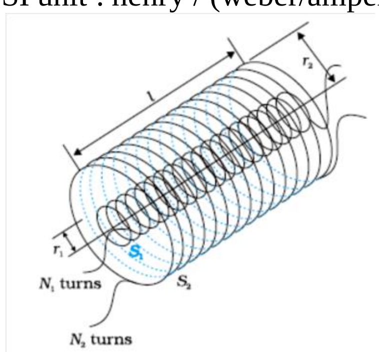
a)	Definition of self inductance and its SI unit	1 + ½
b)	Derivation of expression for mutual inductance	1 ½

Self inductance of a coil equals, the magnitude of the magnetic flux, linked with it, when a unit current flows through it. — 1

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.) — ½



½

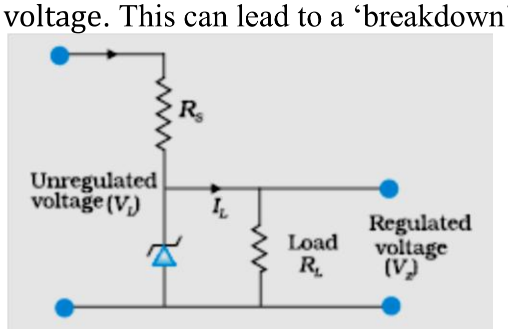
When current I_2 is passed through coil S_2, it in turn sets up a magnetic flux through S_1: $\Phi_1 = (n_1\ell)(\pi r_1^2)(B_2)$ — ½

$\Phi_1 = (n_1\ell)(\pi r_1^2)(\mu_o n_2 I_2)$

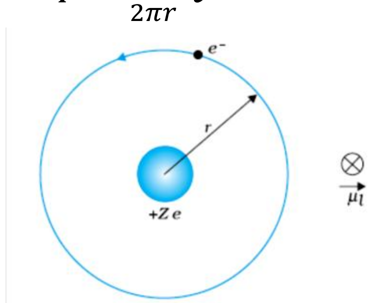
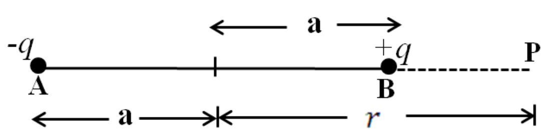
$\Phi_1 = \mu_o n_1 n_2 I_2 \pi r_1^2 \ell I_2$

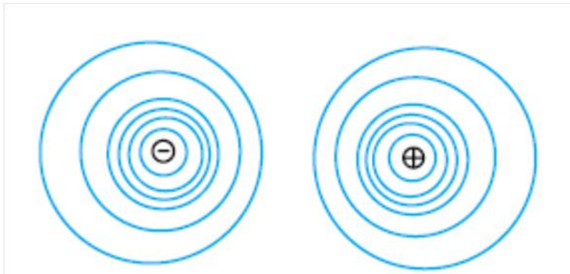
But $\Phi_1 = M_{12} I_2$ — ½

$\Rightarrow M_{12} = \mu_o n_1 n_2 \pi r_1^2 \ell$

	[Note : If the student derives the correct expression, without giving the diagram of two coaxial coils, full credit can be given]		3
Q17	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 $10^3 \Omega$ $V_{CE} = I_c R_c$ $I_c = \frac{V_{CE}}{R_c} = \frac{2}{2 \times 10^3} A$ $= 10^{-3} A$ $= 1 \text{m}A$ 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 x $10^{-5} \times 10^3 \Omega$ $=10^{-2} V$ [**Note** : Give full credit if student calculates the required quantities by any other alternative method]	½ ½ ½ ½ ½ ½	3
Q18	Explanation of heavily doping of both p and n sides of Zener diode 1 Circuit diagram of Zener diode as a dc voltage regulator 1 Explanation of the use of Zener diode as a dc voltage regulator. 1 By heavily doping both p and n sides of the junction, depletion region formed is very thin, i.e. < 10^{-6} m. Hence, electric field, across the junction is very high ($\sim 5 \times 10^6$ V/m) even for a small reverse bias voltage. This can lead to a 'breakdown' during reverse biasing.  If the input voltage increases/decreases, current through resister R_s , and Zener diode, also increases/decreases. This increases/decreases the voltage drop across R_s without any change in voltage across the Zener diode. This is because, in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes.	1 1 1	3

Q19	(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. $X_L = \omega L = (1000 \times 100 \times 10^{-3})\Omega$=100Ω $X_C = \frac{1}{\omega C} = \left(\frac{1}{1000 \times 2 \times 10^{-6}}\right)$ Ω = 500Ω Phase angle $\tan\Phi = \frac{X_L - X_C}{R}$ $\tan\Phi = \frac{100-500}{400}$ = -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 ½	3
Q20	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,	1 1 ½ + ½	

	increases. (iii)To avoid mixing up of signals from different transmitters. (Any two)		3
Q21	i. Behaviour of revolving electron as a tiny magnetic dipole 1 ii. Proof of the relation $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$ 1 ½ iii. Significance of negative sign ½		
	Electron, in circular motion around the nucleus, constitutes a current loop which behaves like a magnetic dipole.	1	
	Current associated with the revolving electron: $I = \frac{e}{T}$ and $T = \frac{2\pi r}{v}$ $\therefore I = \frac{e}{2\pi r}v$	½	
			
	Magnetic moment of the loop, $\mu = IA$ $\mu = IA = \frac{ev}{2\pi r}\pi r^2 = \frac{evr}{2} = \frac{e.m_e vr}{2m_e}$	½	
	Orbital angular momentum of the electron, $L = m_e vr$ $\vec{\mu} = \frac{-e}{2m_e}\vec{L}$	½	
	-ve sign signifies that the angular momentum of the revolving electron is opposite in direction to the magnetic moment associated with it.	½	3
Q22	(i) Derivation of expression for the electric potential due to an electric dipole at a point on the axial line 2 (ii) Depiction of equipotential surfaces due to an electric dipole 1		
	Potential due to charge at A, $V_A = \frac{1}{4\pi\epsilon_0}\frac{-q}{(r+a)}$	½	
	Potential due to charge at B , $V_B = \frac{1}{4\pi\epsilon_0}\frac{+q}{(r-a)}$	½	
			
	$\therefore$ Potential at point P, $V = V_B + V_A$	½	

	$\therefore$ Net Potential at P $= \frac{q}{4\pi\epsilon_0}\left[\frac{-1}{(r+a)} + \frac{1}{(r-a)}\right]$ $V = \frac{q\times 2a}{4\pi\epsilon_0(r^2 - a^2)}$ [**Note** : Also accept any other alternative correct method.] 	½ 1	3
Q23	a) Two qualities each of Anuja and her mother ½ x 4 b) Explanation, using lens maker's formula 2 a) Anuja : Scientific temperament, co-operative, knowledgeable (any two) Mother : Inquisitive, scientific temper/keen to learn/has no airs(any two)(or any other two similar values) b) $\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ As the refractive index of plastic material is less than that of glass material therefore, for the same power $(= {}^{1}/_{f})$, the radius of currature of plastic material is small. Therefore plastic lens is thicker. Alternatively**,** If student just writes that plastic has a different refractive index than glass, award one mark for this part.	½+ ½ ½ + ½ ½ ½ ½ ½	4
Q24	a) Distinction between unpolarised and linearly polarized light 2 Obtaining linearly polarized Light 1 b) Calculation of intensely of light 2 a) In an unpolarized light, the oscillations, of the electric field, are in random directions, in planes perpendicular to the direction of propagation. For a polarized light, the oscillations are aligned along one particular direction. Alternatively Polarized light can be distinguished, from unpolarized light, when it is allowed to pass through a polaroid. Polarized light does can show change in its intensity, on passing through a Polaroid; intensity remains same in case of unpolarized light.	1 1 1	

When unpolarised light wave is incident on a polaroid, then the electric vectors along the direction of its aligned molecules, get absorbed; the electric vector, oscillating along a direction perpendicular to the aligned molecules, pass through. This light is called linearly polarized light. 1

b) According to Malus' Law:

$I = I_o \cos^2\theta$ ½

$\therefore I = (\frac{I_o}{2}) \cos^2\theta$, where I_o is the intensity of unpolarized light.

$\theta = 60^o$ (given)

$I = \frac{I_o}{2} \cos^2 60^o = \frac{I_o}{2} \times \left(\frac{1}{2}\right)^2$

$= \frac{I_o}{8}$ ½ 5

OR

a) Explanation of two features (distinguishing between interference pattern and diffraction pattern.)	2
b) Calculation of angular width of central maxima	2
Estimation of number of fringes	1

a)

Interference Pattern	Diffraction pattern
1) All fringes are of equal width.	1) Width of central maxima is twice the width of higher order bands.
2) Intensity of all bright bands is equal.	2) Intensity goes on decreasing for higher order of diffraction bands.

1+1

[Note: Also accept any other two correct distinguishing features.]

b) Angular width of central maximum

$\omega = \frac{2\lambda}{a}$ ½

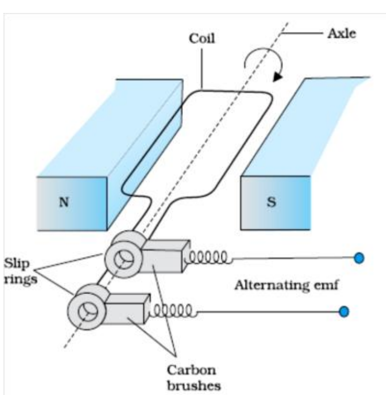
$= \frac{2\times500\times10^{-9}}{0.2\times10^{-3}}$ radian ½

$= 5 \times 10^{-3}$ radian 1

$\beta = \frac{\lambda D}{d}$

Linear width of central maxima in the diffraction pattern

	$\omega' = \frac{2\lambda D}{a}$ Let 'n' be the number of interference fringes which can be accommodated in the central maxima $\therefore n \times \beta = \omega'$ $n = \frac{2\lambda D}{a} \times \frac{d}{\lambda D}$ $n = \frac{2d}{a}$ [Award the last ½ mark if the student writes the answers as 2 (taking d=a), or just attempts to do these calculation.]	½ 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 $a = -\frac{eE}{m}$ Velocity gained by the electron $v = -\frac{eE}{m}t$ Let the conductor contain n electrons per unit volume. The average value of time $'t'$, between their successive collisions, is the relaxation time, $'\tau'$. Hence average drift velocity $v_d = \frac{-eE}{m}\tau$ The amount of charge, crossing area A, in time Δt,is $\equiv neAv_d\Delta t = I\Delta t$ Substituting the value of v_d, we get $I\Delta t = neA\left(\frac{eE\tau}{m}\right)\Delta t$ $\therefore I = \left(\frac{e^2 A\tau n}{m}\right)E = \sigma E, \left(\sigma = \frac{e^2\tau n}{m}\text{ is the conductivity}\right)$ But I = JA, where J is the current density $\Rightarrow$ J = $\left(\frac{e^2\tau n}{m}\right)E$ $\Rightarrow$ 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 = $\frac{V}{\ell}$] 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

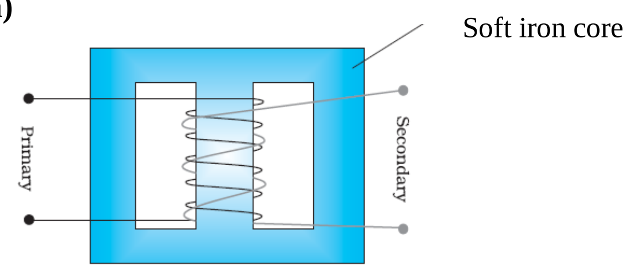
	(i) Statement of Kirchoff's laws — 1+1 Justification — ½ + ½ (ii) Calculation of i) current drawn and — 1 ii) Power consumed — 1 (i) Junction Rule: At any Junction, the sum of currents, entering the junction, is equal to the sum of currents leaving the junction. Loop Rule: The Algebraic sum, of changes in potential, around any closed loop involving resistors and cells, in the loop is zero. $\sum(\Delta V) = 0$ 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 $R = {}^{r}/_{3}$ Hence current drawn from the cell $I = \frac{E}{{}^{r}/_{3}+r} = \frac{3E}{4r}$ Power consumed $P = I^2\,({}^{r}/_{3})$ $= \frac{9E^2}{16r^2} \times {}^{4r}/_{3} = \frac{3E^2}{4r}$ [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	

Value points	Marks	Total marks
[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		
ϕ_B = BA cos ω t	½	
∴Induced emf e = $-N\frac{d\phi_B}{dt}$	½	
e = NBA ω sin ω t		
e= e_o sin ω t		
where e_o= NBA ω	½	
b) Maximum value of emf		
e_o= NBA ω	½	
= 20 x 200 x 10^{-4} x 3 x 10^{-2} x 50V	½	
= 600 mV	½	
Maximum induced current $i_o = \frac{e_o}{R} = \frac{600}{R}$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

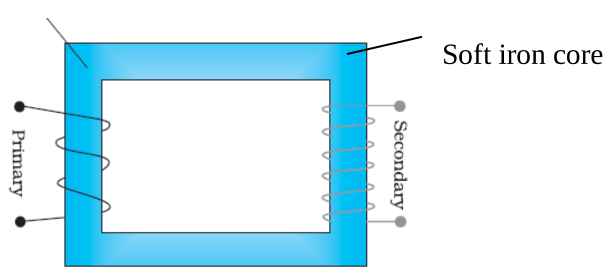
a)	Labelled diagram of a step up transformer	1 ½
	Derivation of ratio of secondary and primary voltage	2
b)	Calculation of number of turns in the secondary	1 ½

a)



1 ½

Alternatively



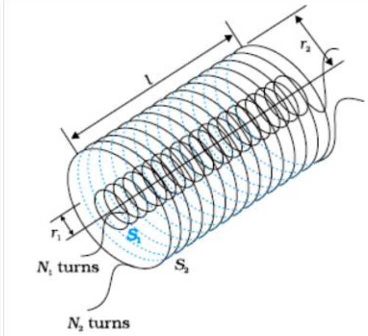
	[Note: Deduct ½ mark, if labeling is not done] a) When ac voltage is applied to primary coil the resulting current produces an alternating magnetic flux, which also links the secondary coil. The induced emf, in the secondary coil, having N_s turns, is $e_s = -N_s \frac{d\varphi}{dt}$ This flux, also induces an emf, called back emf, in the primary coil. $e_p = -N_p \frac{d\varphi}{dt}$ But $e_p = V_p$ and $e_s = V_s$ $\Rightarrow \frac{\mathrm{V_s}}{\mathrm{V_p}} = \frac{N_s}{N_p}$ For an ideal transformer $l_p\ V_p = i_s\ V_s$ $\Rightarrow \frac{\mathrm{V_s}}{\mathrm{V_p}} = \frac{i_p}{i_s}$ b) $\frac{N_s}{N_p} = \frac{\mathrm{V_s}}{\mathrm{V_p}}$ $\frac{N_s}{3000} = \frac{220}{2200}$ $\therefore N_s = 300$	½ ½ ½ ½ ½ ½ ½	5

MARKING SCHEME

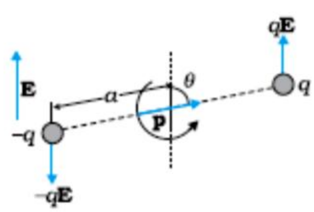
Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	SECTION B		
Q1	No, As the magnetic field due to current carrying wire will be in the plane of the circular loop, so magnetic flux will remain zero. Alternatively [Magnetic flux does not change with the change of current.]	½ ½	1
Q2	Speed of em waves is determined by the ratio of the peak values of electric and magnetic field vectors. [Alternatively, Give full credit, if student writes directly $C = \frac{E_o}{B_o}$]	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 $\delta = 0^0$ $\therefore B_H = 2Bcos\, 0 = 2B$ [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 $$r_c = \frac{1}{4\pi\varepsilon_0} . \frac{2Ze^2}{K}$$ 'K' is doubled, $\therefore$ r_c becomes $\frac{r}{2}$ [Alternatively: If a candidate writes directly $\frac{r}{2}$ 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

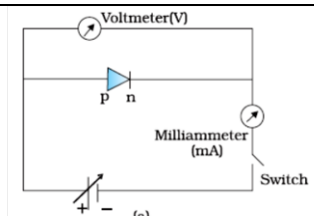
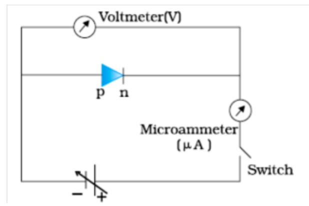
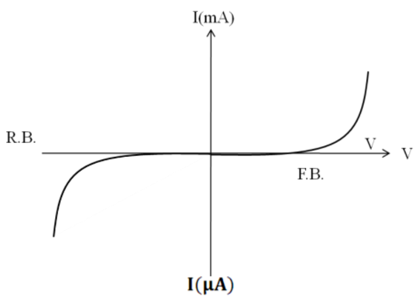
	2. As electron spirals inwards; its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum.	1	2
Q7	Condition, when two objects are just resolved ½ For increasing the resolving power of a compound microscope 1 ½ Two objects are said to be just resolved when, in 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 $d_{min} = \frac{1.22\lambda}{2\ n\ Sin\ \beta}$ Resolving power is the reciprocal of limit of resolution (d_{min}) Therefore, to increase resolving power λ can be reduced and refractive index of the medium 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. $d = \sqrt{2hR}$	1 ½ ½	2
Q9	Finding the ratio of de Broglie wavelength $\left(\frac{\lambda\alpha}{\lambda p}\right)$ $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2mqV}}$ $\therefore \frac{\lambda\alpha}{\lambda p} = \frac{h}{\sqrt{2m_\alpha\ q_\alpha V}} \times \frac{\sqrt{2m_p q_p V}}{h}$ $\frac{\lambda_\alpha}{\lambda_p} = \frac{\sqrt{m_p q_p}}{\sqrt{m_\alpha q_\alpha}}$ $= \frac{\sqrt{m_p q_p}}{\sqrt{4m_p 2q_p}}$ $= \frac{1}{2\sqrt{2}}$ $\lambda_\alpha : \lambda_p = 1 : 2\sqrt{2}$	½ ½ ½ ½	2

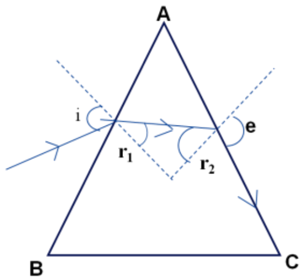
Q10	Explanation of flow of current through capacitor 1 Expression for displacement current 1 During charging, electric flux between the plates of capacitor keeps on changing; this results in the production of a displacement current between the plates. $I_d = \epsilon_o \frac{d\varphi_E}{dt} \left(/ I_d = \epsilon_o A \frac{dE}{dt} \right)$	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

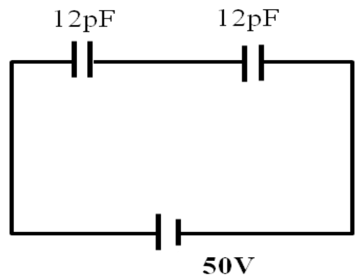
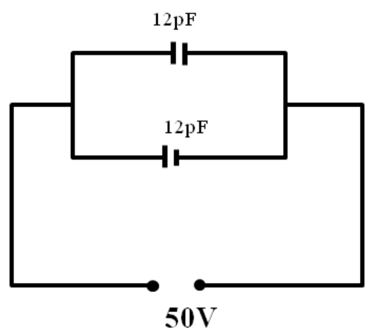
	 When current I_2 is passed through coil S_2, it in turn sets up a magnetic flux through S_1: $\Phi_1 = (n_1\ell)(\pi r_1^2)(B_2)$ $\Phi_1 = (n_1\ell)(\pi r_1^2)(\mu_o n_2 I_2)$ $\Phi_1 = \mu_o n_1 n_2 I_2 \pi r_1^2 \ell I_2$ But $\Phi_1 = M_{12} I_2$ $\Rightarrow M_{12} = \mu_o n_1 n_2 \pi r_1^2 \ell$ [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 $p \rightarrow n + {}^0_1e + v$ 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	

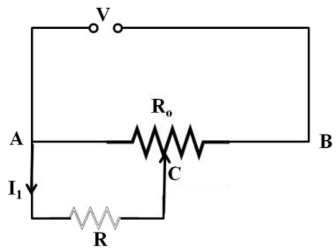
	$V_{CE} = I_c R_c$ $I_c = \frac{V_{CE}}{R_c} = \frac{2}{2 \times 10^3} A$ $= 10^{-3} A$ $= 1 mA$ current gain $\beta = \frac{I_c}{I_B}$ $\therefore 100 = \frac{10^{-3}}{I_B}$ $\therefore I_B = 10^{-5} A$ Input signal voltage $V_i = I_B R_B$ $= 1 \times 10^{-5} \times 10^3 \Omega$ $= 10^{-2} V$ [**Note** : 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	

	$\tan\Phi = \frac{X_L - X_C}{R}$ $\tan\Phi = \frac{100-500}{400}$ = -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 $C' = C \quad + C_1$ $10 = 2 + C_1$ $C_1 = 8\mu F$	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		

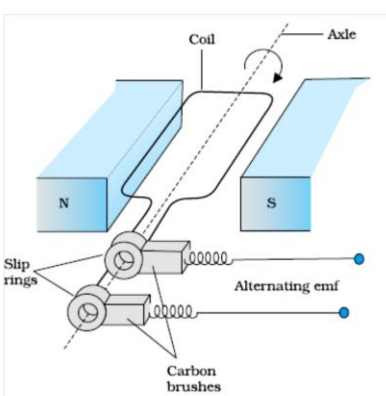
	  In forward bias, applied voltage does not support potential barrier. As a result, the depletion layer width decreases and barrier height is reduced. Due to the applied voltage, electrons from n side cross the depletion region and reach p side. Similarly holes from p side cross the junction and reach 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)** $\mu = \dfrac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ $= \dfrac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60^{0}}{2}\right)} = \sqrt{2}$ Also $\mu = \dfrac{c}{v} \Longrightarrow v = \dfrac{3\times10^{8}}{\sqrt{2}}$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 $r_1 + r_2 = A$ $\therefore r_1 = A - r_2$ = $60^o - 45^o = 15^o$ 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		

		½	
	In series combination: $\frac{1}{C_s} = \left(\frac{1}{12} + \frac{1}{12}\right)(pF)^{-1}$ $\therefore\ C_s = 6 \times 10^{-12} pF$ $U_s = \frac{1}{2} CV^2$ $U_s = \frac{1}{2} \times 6 \times 10^{-12} \times 50 \times 50$ J $\therefore\ U_s = 75 \times 10^{-10} J$	½	
	$q_s = C_s\, V$ $= 6 \times 50$ $= 300 \times 10^{-12} C = 3 \times 10^{-10} C$	½	
			
	In parallel combination: $C_p = (12 + 12) pF$ $\therefore C_p = 24 \times 10^{-12} F$	½	
	$U_s = \frac{1}{2} \times 24 \times 10^{-12} \times 2500$ J $= 3 \times 10^{-8}$J	½	
	$q_p = C_p\, V$ $q_p = 24\ \times 10^{-12} \times 50$ C $q_p = 1.2 \times 10^{-9}\ C$	½	3
Q21	(a) Expression for force acting on charged particle 1 (i) Condition for circular path ½ (ii) Condition for helical path ½ (b) Showing Kinetic energy is constant 1		
	(a) $\vec{F} = q(\vec{v} \times \vec{B})$	1	
	(i) When velocity of charged particle and magnetic field are perpendicular to each other.	½	
	(ii) When velocity is neither parallel nor perpendicular to the		

	magnetic field. (b) The force, experienced by the charged particle, is perpendicular to the instantaneous velocity $\vec{v}$, at all instants. Hence the magnetic force cannot bring any change in the speed of the charged particle. Since speed remains constant, the kinetic energy also stays constant.	½ 1	3
Q22	Derivation of expression of voltage across resistance R 3  Resistance between points A & C $\frac{1}{R_1} = \frac{1}{R} + \frac{1}{\left(\frac{R_o}{2}\right)}$ Effective resistance between points A & B $R_2 = \left(\frac{R\,\frac{R_o}{2}}{R + \frac{R_o}{2}}\right) + \frac{R_o}{2}$ Current drawn from the voltage source, $I = \frac{V}{R_2}$ $I = \frac{V}{\left(\frac{R\frac{R_o}{2}}{R+\frac{R_o}{2}}\right)+\frac{R_o}{2}}$ Let current through R be I_1 $I_1 = \frac{I\left(\frac{R_o}{2}\right)}{R + \frac{R_o}{2}}$ Voltage across R $V_I = I_I\, R$ $= \frac{\boldsymbol{I}R_o}{\boldsymbol{2}\left(R+\frac{R_o}{2}\right)}.R$ $= \frac{R\,R_o}{2\left(R+\frac{R_o}{2}\right)} \cdot \frac{V}{\left(\frac{R\,R_o}{2R+R_o}\right)+\frac{R_o}{2}}$ $= \frac{2RV}{R_o+4R}$	 ½ ½ ½ ½ ½ ½	 3
Q23	a) Two qualities each of Anuja and her mother ½ x 4 b) Explanation, using lens maker's formula 2 a) Anuja : Scientific temperament, co-operative, knowledgeable (any	 ½+ ½	

	two) Mother : Inquisitive, scientific temper/keen to learn/has no airs(any two)(or any other two similar values) b) $\frac{1}{f}=\left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ As the refractive index of plastic material is less than that of glass material therefore, for the same power $(= {}^{1}/_{f})$, the radius of currature of plastic material is small. Therefore plastic lens is thicker. Alternatively**,** If student just writes that plastic has a different refractive index than glass, award one mark for this part.	½ + ½ ½ ½ ½ ½	4
Q24	(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 $a=-\frac{eE}{m}$ Velocity gained by the electron $v=-\frac{eE}{m}t$ Let the conductor contain n electrons per unit volume. The average value of time $'t'$, between their successive collisions, is the relaxation time, $'\tau'$. Hence average drift velocity $v_d=\frac{-eE}{m}\tau$ The amount of charge, crossing area A, in time Δt,is $\equiv neAv_d\Delta t = I\Delta t$ Substituting the value of v_d, we get $I\Delta t = neA\left(\frac{eE\tau}{m}\right)\Delta t$ $\therefore I=\left(\frac{e^2A\tau n}{m}\right)E=\sigma E, \left(\sigma=\frac{e^2\tau n}{m}\text{ is the conductivity}\right)$ But I = JA, where J is the current density ⇒ J = $\left(\frac{e^2\tau n}{m}\right)E$ ⇒ 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 = $\frac{V}{\ell}$] 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. $\sum(\Delta V) = 0$ 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 $R = r/3$ Hence current drawn from the cell $I = \frac{E}{r/3 + r} = \frac{3E}{4r}$ Power consumed $P = I^2 \, (r/3)$ $= \frac{9E^2}{16r^2} \times 4r/3 = \frac{3E^2}{4r}$ [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
Q25	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  [Deduct ½ mark, If diagram is not labeled]	1 ½	

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 $\theta = \omega t$, ½

Therefore, magnets flux, (ϕ_B), at this instant, is

ϕ_B = BA cos ω t

∴Induced emf $e = -N\frac{d\phi_B}{dt}$ ½

e = NBA ω sin ω t

e= e_o sin ω t

where e_o= NBA ω ½

b) Maximum value of emf

e_o= NBA ω ½

= 20 x 200 x 10^{-4} x 3 x 10^{-2} x 50V ½

= 600 mV ½

Maximum induced current $i_o = \frac{e_o}{R} = \frac{600}{R}$mA ½

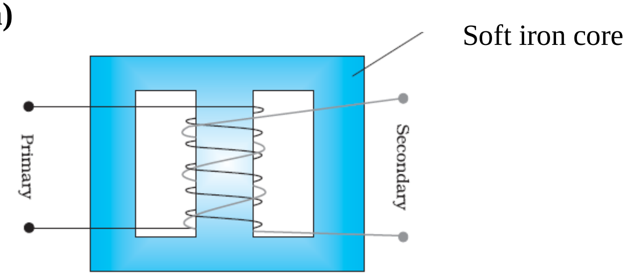
[Note 1: It the student calculates the value of the maximum induced emf and says that " since R is not given, the value of maximum induced current cannot be calculated", the ½ mark, for the last part, of the question, can be given.]

[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

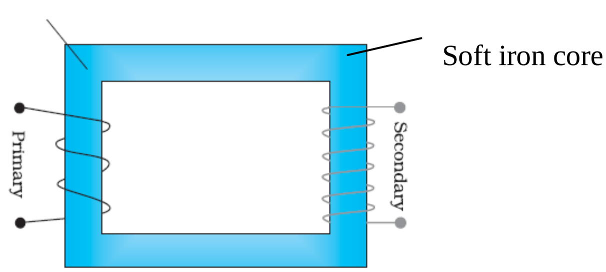
a)	Labelled diagram of a step up transformer	1 ½
	Derivation of ratio of secondary and primary voltage	2
b)	Calculation of number of turns in the secondary	1 ½

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 $e_s = -N_s \frac{d\varphi}{dt}$ This flux, also induces an emf, called back emf, in the primary coil. $e_p = -N_p \frac{d\varphi}{dt}$ But $e_p = V_p$ and $e_s = V_s$ $\Rightarrow \frac{V_s}{V_p} = \frac{N_s}{N_p}$ For an ideal transformer $l_p\ V_p = i_s\ V_s$ $\Rightarrow \frac{V_s}{V_p} = \frac{i_p}{i_s}$ b) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{N_s}{3000} = \frac{220}{2200}$ $\therefore N_s = 300$	½ ½ ½ ½ ½ ½ ½	5
Q26	a) Distinction between unpolarised and linearly polarized light — 2 Obtaining linearly polarized Light — 1 b) Calculation of intensely of light — 2 a) In an unpolarized light, the oscillations, of the electric field, are in random directions, in planes perpendicular to the direction of propagation. For a polarized light, the oscillations are aligned along one particular direction. Alternatively Polarized light can be distinguished, from unpolarized light, when it is allowed to pass through a polaroid. Polarized light does can show change in its intensity, on passing through a Polaroid; intensity remains same in case of unpolarized light. When unpolarised light wave is incident on a polaroid, then the electric vectors along the direction of its aligned molecules, get absorbed; the electric vector, oscillating along a direction	1 1 1	

perpendicular to the aligned molecules, pass through. This light is called linearly polarized light. 1

b) According to Malus' Law:

$I = I_o \cos^2\theta$ ½

$\therefore I = \left(\frac{I_o}{2}\right)\cos^2\theta$, where I_o is the intensity of unpolarized light.

$\theta = 60^o$ (given)

$I = \frac{I_o}{2}\cos^2 60^o = \frac{I_o}{2} \times \left(\frac{1}{2}\right)^2$

$= \frac{I_o}{8}$ ½ 5

OR

a) Explanation of two features (distinguishing between interference pattern and diffraction pattern.)	2
b) Calculation of angular width of central maxima	2
Estimation of number of fringes	1

a)

Interference Pattern	Diffraction pattern
1) All fringes are of equal width.	1) Width of central maxima is twice the width of higher order bands.
2) Intensity of all bright bands is equal.	2) Intensity goes on decreasing for higher order of diffraction bands.

1+1

[Note: Also accept any other two correct distinguishing features.]

b) Angular width of central maximum

$$\omega = \frac{2\lambda}{a}$$ ½

$= \frac{2\times500\times10^{-9}}{0.2\times10^{-3}}$ radian ½

$= 5\times10^{-3}$ radian 1

$$\beta = \frac{\lambda D}{d}$$

Linear width of central maxima in the diffraction pattern

$$\omega' = \frac{2\lambda D}{a}$$ ½

Let 'n' be the number of interference fringes which can be accommodated in the central maxima

	$\therefore n \times \beta = \omega'$ $n = \frac{2\lambda D}{a} \times \frac{d}{\lambda D}$ $n = \frac{2d}{a}$ [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