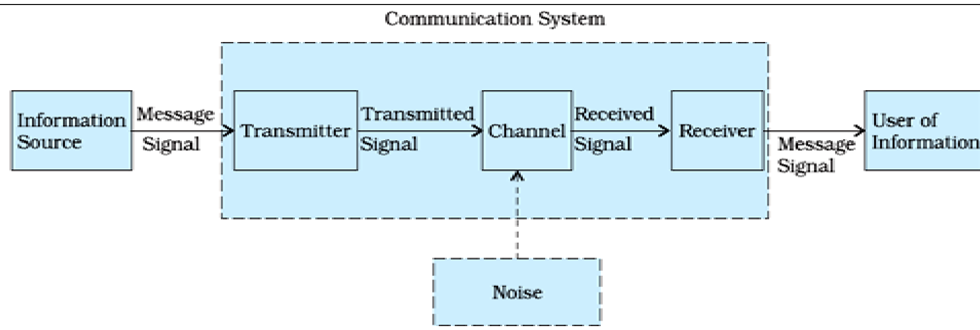
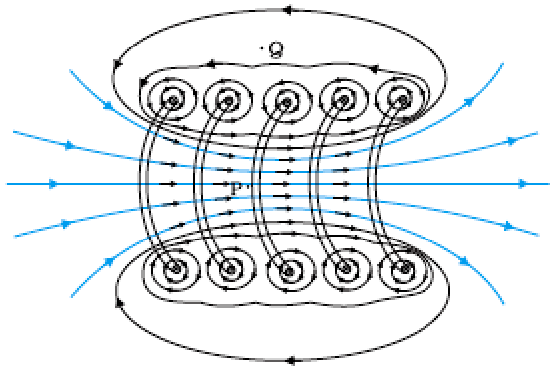
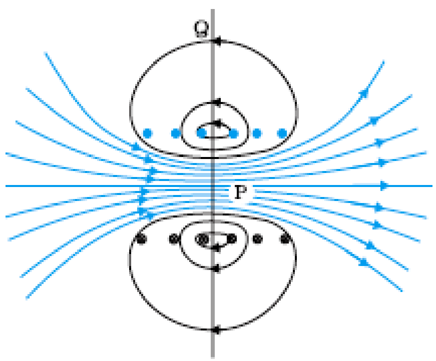
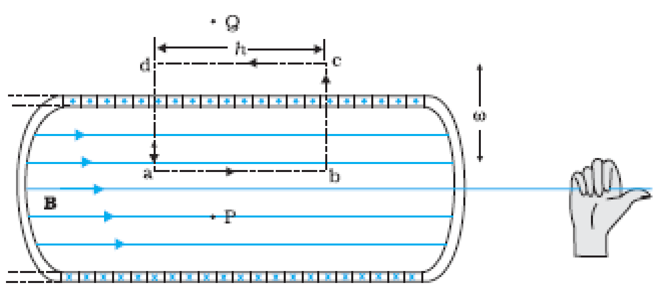
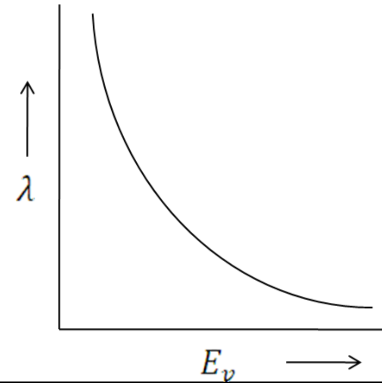
MARKING SCHEME
SET 55/1/1 (Compartment)

Q.No.	Expected Answer/Value Points	Marks	Total Marks
1.	i. The two point charges(q_1 and q_2) should be of opposite nature. ii. Magnitude of charge q_1 must be greater than that of charge q_2	½ ½	 1
2.	Random motion of free electrons gets directed towards the point at a higher potential. **Alternatively:** Random motion becomes a (partially) directed motion.	1	1
3.	Diamagnetic material $\mu_r = 1 + \chi_m$	½ ½	 1
4.	Due to the heating effect of eddy currents set up in the metallic piece.	1	1
5.	Effective power $\alpha \frac{1}{\lambda^2}$ **(Alternatively:** Effective power radiated decreases with an increase in wavelength.)	1	1
6.	 **Alternatively:** Also accept if the student gives only the following diagram:  	1	1
7.	Two monochromatic sources, which produce light waves, having a constant phase difference, are known as coherent sources.	1	1
8.	When a constant current flows through a wire, the Potential difference, between any two points on the wire of uniform cross section, is directly proportional to the length of the wire between these points. **Alternatively:** $V \alpha \ell$ or $dV/d\ell$ = constant	1	1
9	Charges on the inner and outer surfaces ½ + ½ Expression for electric field 1 Charge on inner surface : - Q Charge on outer surface : + Q Electric field at point P_1 $E = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r_1^2}$	 ½ ½ 1	2

10.	Drawing of magnetic field lines ½ Obtaining the expression for magnetic field 1 ½		
		½	
	Alternatively:		
			
		½	
	Applying Ampere circuital law for the rectangular loop abcd		
	$\oint \vec{B} \cdot \vec{d\ell} = \mu_o I$	½	
	Bh = $\mu_o I$(nh)	½	2
	B = $\mu_o nI$		
11.	Finding the relation 1 ½ Drawing the graph ½		
	$E_v = \phi_o + K_{max}$	½	
	As $\phi_o = 0$		
	⇨ $E_v = K_{max}$		
	⇨ $K_{max} = \frac{p^2}{2m} = E_v$	½	
	⇨ $p = \sqrt{2mE_v}$		
	∴ wavelength (λ)of emitted electrons, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE_v}}$	½	

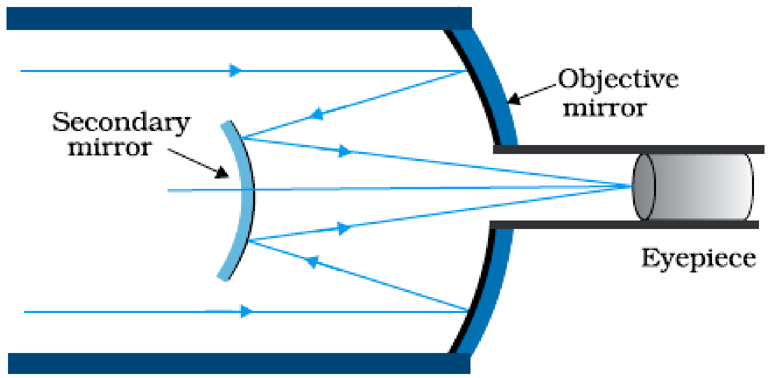


½

2

12.

Schematic diagram of reflecting telescope	1
Two advantages	½ + ½



1

(Any two of the following)

i. No chromatic aberration.
ii. Less spherical aberration.
iii. Large magnifying power.
iv. Large resolving power

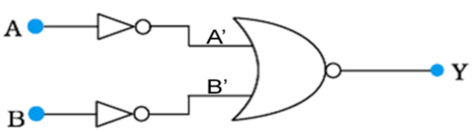
[**Note :** or any other two advantages.]

½ + ½

2

13.

Drawing the logic circuit of the combination	½
Truth table	1
Identification	½



½

Input				Output
A	A'	B	B'	Y
0	1	0	1	0
0	1	1	0	0
1	0	0	1	0
1	0	1	0	1

1

Identification : AND Gate

½

2

14.

Obtaining the expression for the torque	2

Equivalent magnetic moment of the coil

$\vec{m} = IA\hat{n}$

$\therefore \vec{m} = I\ell b\hat{n}$ — ½

($\hat{n}$= unit vector ⊥ to the plane of the coil)

$\therefore$Torque $= \vec{m} \times \vec{B}$ — ½

$= I\ell b\hat{n} \times \vec{B}$ — ½

$= 0$ — ½

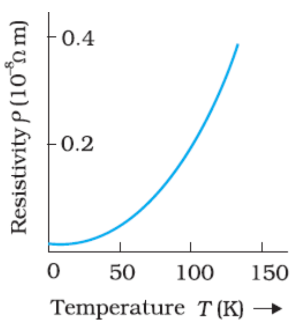
(as $\hat{n}$ *and* $\vec{B}$ are parallel or antiparallel, to each other)

[Note: Also give credit, when student obtains the relation $\boldsymbol{\tau = mB\sin\theta}$, and substitutes $\boldsymbol{\theta = 0}$ or $\boldsymbol{180^o}$ and writes $\boldsymbol{\tau = 0}$] — 2

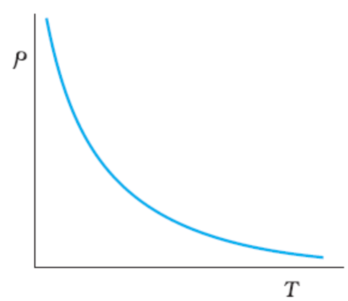
15.

Drawing the two plots	½ + ½
Explanation of Behaviour	½ + ½

(i) Conductor



(ii) Semiconductor



½ + ½

$\rho = \frac{m}{ne^2\tau}$

In conductors, average relaxation time decreases with increase in temperature, resulting in an increase in resistivity. — ½

In semiconductors, the increase in number density (with increase in temperature) is more than the decrease in relaxation time; the net result is, therefore, a decrease in resistivity. — ½ — 2

16.

Calculation of

i.	emf induced in the arm PQ	1
ii.	Current induced in the loop	1

i. emf induced — ½

$e = B\ell v$

$= 0.1 \times 10 \times 10^{-2} \times 20$ V

$= 0.2$ volt — ½

ii. Current in the loop

$i = \frac{e}{R}$ — ½

$= \frac{0.2}{2}$ A $= 0.1$ A — ½ — 2

17.	Explanation of parts (i) and (ii) 1+1 (i) Intensity of incident radiation I = nh$v$, where n is number of photons incident per unit time per unit area. For same intensity of two monochromatic radiations of frequency v_1 and v_2 $n_1 h v_1 = n_2 h v_2$ As $v_1 > v_2$ ⇨ $n_2 > n_1$ Therefore the number of electrons emitted for monochromatic radiation of frequency v_2, will be more than that for radiation of frequency v_1 **[<u>Alternatively:</u>** Also accept if the student says that, for same intensity of incident radiation, the number of emitted electrons is same for each of the two frequencies of incident radiation.] (ii) hv = $\phi_o + K_{max}$ ∴ For given ϕ_o (work function of metal) K_{max} increases with v ∴ Maximum Kinetic energy of emitted photoelectrons will be more for monochromatic light of frequency v_1 (as $v_1 > v_2$)	½ ½ ½ ½	2
18.	Obtaining the expression for total work done 2 Work done in bringing the charge q_1 from infinity to position r_1 $W_1 = q_1 V(r_1)$ work done in bringing charge q_2 to the position r_2 $W_2 = q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ Hence, total work done in assembling the two charges $W = W_1 + W_2$ $= q_1 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ **OR** Derivation of relation between Electric field and potential gradient 1 Two important conclusions ½ + ½ Work done in moving a unit positive charge along distance $\delta\ell$ $\lvert E_l \rvert \, \delta\ell = V_A - V_B$ = V – (V + δV) = - δV E= - $\frac{\delta V}{\delta\ell}$ (i) Electric field is in the direction in which the potential decreases steepest. (ii) Magnitude of Electric field is given by the change in the magnitude of potential per unit displacement, normal to the equipotential surface at the point.	½ ½ +½ ½ ½ ½ ½ ½	2 2

19.

Finding the ratio of	
i. Net capacitance	1 ½
ii. Energy stored	1 ½

(i) Net capacitance before filling the gap with dielectric slab

$C_{initial} = C_1 + C_2 = 2\,C_2 + C_2 = 3C_2$ ½

Net capacitance after filling the gap with dielectric slab of dielectric constant 'K'

$C_{final} = KC_1 + KC_2 = 2\,KC_2 + KC_2 = 3KC_2$ ½

Ratio of net capacitance, $\frac{C_{initial}}{C_{final}} = \frac{3C_2}{3KC_2} = \frac{1}{K}$ ½

(ii) Energy stored in the combination before introduction of dielectric slab

$$U_{initial} = \frac{Q^2}{3C_2}$$ ½

Energy stored in the combination after introduction of dielectric slab

$$U_{final} = \frac{Q^2}{3KC_2}$$ ½

Ratio of energy stored

$$\frac{U_{initial}}{U_{final}} = \frac{K}{1}$$ ½

[Note: Accept any other alternative correct method for part (ii).) 3

20.

a) Circular path + angular frequency expression	1 + ½
b) Trace of path; justification	½+ 1

a) Force acting on the charged particle, moving with a velocity $\vec{v}$, in a magnetic field $\vec{B}$: ½

$\vec{F} = q(\vec{v} \times \vec{B})$

As, $\vec{v} \perp \vec{B}$, $|Force| = qvB$

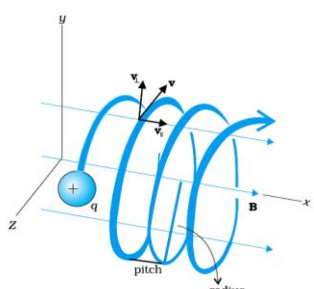
Since, $\vec{F} \perp \vec{v}$, it acts as a centripetal force and makes the particle move in a circular path, in the plane, perpendicular to the magnetic field. ½

$\therefore qvB = \frac{mv^2}{r}$

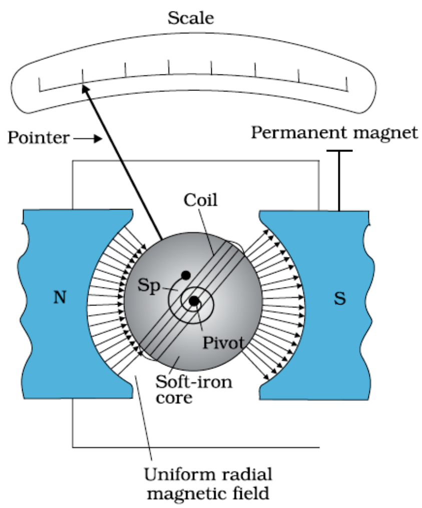
$\therefore r = \frac{mv}{qB}$ ½

Now $\omega = \frac{v}{r}$ $\quad \therefore \omega = \frac{qB}{m}$

b)

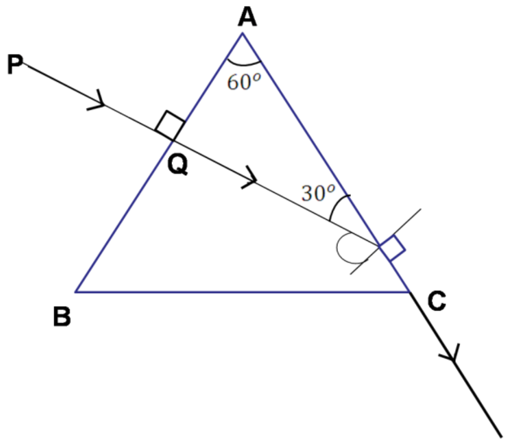


½

	Component of velocity $\vec{v}$ parallel to magnetic field, will make the particle move along the field. Perpendicular component of velocity $\vec{v}$ will cause the particle to move along a circular path in the plane perpendicular to the magnetic field. Hence, the particle will follow a helical path, as shown	1	3
	OR		
	Schematic sketch and brief description of working 1+1 Justification 1		
	 	1	
	When a current, I, flows through the coil, a torque $\tau = NIAB$ acts on it. A spring provides a counter torque ($K\varphi$)which balances the deflecting torque	½	
	$\therefore K\varphi = NIAB$ $\varphi = \left(\frac{NAB}{K}\right) I$; or $\varphi \propto I$	½	
	Current sensitivity = $\frac{NAB}{K}$ Voltage sensitivity = $\frac{NAB}{KR}$	½	
	On increasing number of turns, the resistance of the coil increases proportionally. ∴ Increase in current sensitivity does not necessarily increase voltage sensitivity.	½	3
21.	Answers of part (i), (ii) and (iii) 1+1+1		
	(i) Consider a plane perpendicular to the direction of propagation of the wave. An electric charge, on the plane, will be set in motion by the electric and magnetic fields of em wave, incident on this plane. This illustrates that em waves carry energy and momentum.	1	
	(ii) Microwaves are produced by special vacuum tubes like the klystron,/ Magnetron/ Gunn diode.	½	
	The frequency of microwaves is selected to match the resonant frequency of water molecules, so that energy is transferred efficiently to the kinetic energy of the molecules.	½	
	(iii) a. Associated with the green house effect.	½	
	b. In remote switches of household electrical appliances. ***(or any other two uses.)***	½	3

22.

Tracing of the path of the ray	1
Calculation of angle of emergence and angle of deviation	1 + 1



1

If i_c is the critical angle for the prism/material, $\mu = \frac{1}{\text{Sin}i_c}$

$\therefore \sin i_c = \frac{1}{\mu} = \frac{\sqrt{3}}{2}$ ½

$=> i_c = 60^o$

Angle of incidence at face AC of the prism $= 60^o$ ½

Hence, refracted ray grazes the surface AC.

⇨ Angle of emergence = 90^o ½

⇨ Angle of deviation = 30^o ½

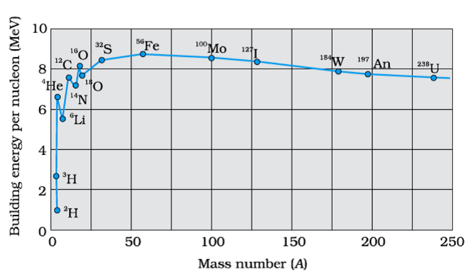
[Note: Accept other correct alternative method.] 3

23.

a) Relation for binding energy	1
b) Plot of BE/A versus mass number A	1
Explanation of release of energy	1

a) B.E = $[ZM_P + (A - Z)M_n - {}^{A}_{Z}M\ ] \times c^2$ 1

b)



1

From the binding energy per nucleon curve, it is clear that binding energy per nucleon , of the fused nuclei is more than those of the light nuclei taking part in nuclear fusion. Hence energy gets released in the process. 1 3

24.

a) Calculation of radius in n = 3 orbit	1
b) Finding the	
i. Kinetic energy	
ii. Potential energy	1 + 1

a) Radius of orbit

	$r_n = n^2 r_o$ where r_o is Bohr's radius = 5.3 x 10^{-11}m ∴ radius of n=3 orbit $r_3 = (3)^2 \times 5.3 \times 10^{-11} m$ $= 47.7 \times 10^{-11}\ m$ $= 4.77 \times 10^{-10}$m (i) kinetic energy = - Total energy = - (- 3.4)eV = 3.4 eV (ii) Potential energy = - 2 x Kinetic energy (or $2 \times total\ energy$) = -6.8 eV	½ ½ ½ ½ ½ ½	 3
25.	(i) Values displayed 1+1 (ii) Calculation of maximum distance 1 (i) a. Concern b. Scientific temperament c. Keen observer d. Alertness (or any other two correct values.) (ii) d $=\sqrt{2hR}$ $= \sqrt{2 \times 20 \times 6.4 \times 10^6}$ m = 2 x 8 x 10^3m = 16 km	 1+1 ½ ½	 3
26.	Explanation of part (i) and (ii) 1 ½ + 1 ½ (i) In diffraction pattern, intensity will be minimum at an angle $\theta = n\lambda/a$ ∴ There will be a first minimum at an angle $\theta = \lambda/a$, on either side of central maximum ∴ width of central maxima = $2\lambda/a$, whereas the width of other minimum/ maximum $\approx \lambda/a$ (ii) The intensity of maxima decreases as the order (n) or diffraction maxima increases. This is because, on dividing the slit into odd number of parts, the contributions of the corresponding (outermost) pairs cancel each other, leaving behind the contribution of only the innermost segment. For example, for first maximum, dividing slit into three parts out of these three parts of the slit, the contributions from first two parts cancel each other; only $\frac{1}{3}$rd portion of the slit contributes to the maxima of intensity. Similarly for, second maxima, dividing slit into five parts, contribution of first four parts will be zero(as they cancel each other). The remaining $\frac{1}{5}$th portion, only, will contribute for maxima; and so on.	 ½ ½ ½ ½ ½ ½	 3

27.

Calculation of power consumed by the resistance R	3

For loop ABCDA

$-12 + 2I_1 + 4(I_1 + I_2) = 0$ ½

$\therefore 3I_1 + 2I_2 = 6$ ------------------------(i)

For loop ADFEA

$-4(I_1 + I_2) + 6 = 0$ ½

$\therefore 2I_1 + 2I_2 = 3$ -----------------------(ii)

Solving (i) and (ii), we get

$I_1 = 3A$ ½

$I_2 = -1.5A$ ½

Hence, power consumed by the resistor R = $(I_1 + I_2)^2R$ ½

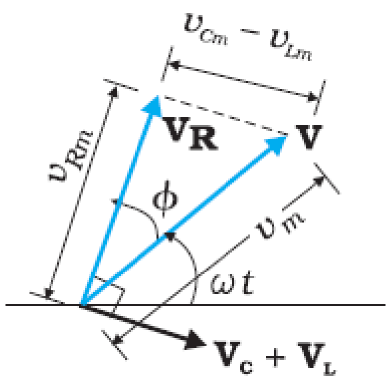
$= (1.5)^2 \times 4$ W

$= 9$ watt ½ **3**

28.

a)	Derivation of expression for amplitude of current and phase angle	1+1
b)	Condition at resonance	½
c)	Drawing of plot	1
d)	Definition of Q factor and its role in tuning	1 +½

a)



½

From the phasor diagram

$\vec{V} = \vec{V_L} + \vec{V_R} + \vec{V_C}$

Magnitude of net voltage

$V_m = \sqrt{(V_{RM})^2 + (V_{Cm} - V_{Lm})^2}$

$V_m = I_m\sqrt{[R^2 + (X_C - X_L)^2]}$ ½

$I_m = \dfrac{V_m}{\sqrt{[R^2 + (X_C - X_L)^2]}}$ ½

From the figure

$\tan\phi = \dfrac{V_{Cm} - V_{Lm}}{V_{Rm}}$

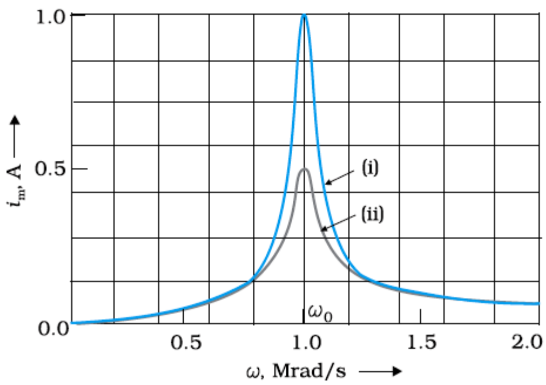
$= \dfrac{I_m(X_c - X_L)}{I_m R}$

$\therefore \phi = \tan^{-1}\left(\dfrac{X_c - X_L}{R}\right)$ ½

b) At resonance, I_m *is maximum*

⇨ $X_L = X_c$,

[Alternatively: $\omega_o = \frac{1}{\sqrt{LC}}$] ½



(ii) plot is for R_1

(i) plot is for R_2 ½ + ½

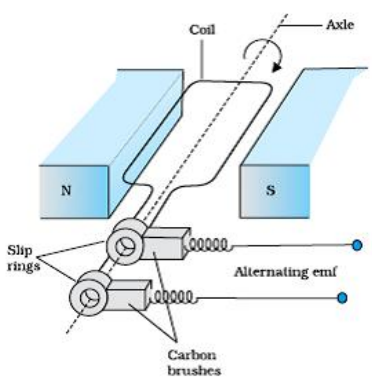
Quality factor of LCR circuit is defined as $\frac{\omega_o}{2\Delta\omega} = \frac{\omega_o L}{R}$ 1

A larger value of quality factor corresponds to a sharper resonance. ½ 5

OR

a)	Labelled diagram & working principle	1+1
b)	Explanation of change in magnetic flux	½
c)	Derivation of expression of maximum value of induced emf and statement of the rule	1 + ½
d)	Showing the variation of emf	1

a)



1

It works on the principle of electromagnetic induction, i.e. when a coil continuously rotates in a magnetic field, the magnetic flux associated with it keeps on changing; thus an induced emf is produced in it. 1

b) When the coil rotates in a magnetic field, its effective area i.e. A cosθ, (i.e. area normal to the magnetic field) keeps on changing. Hence magnetic flux ϕ= NBAcosθ, keeps on changing. ½

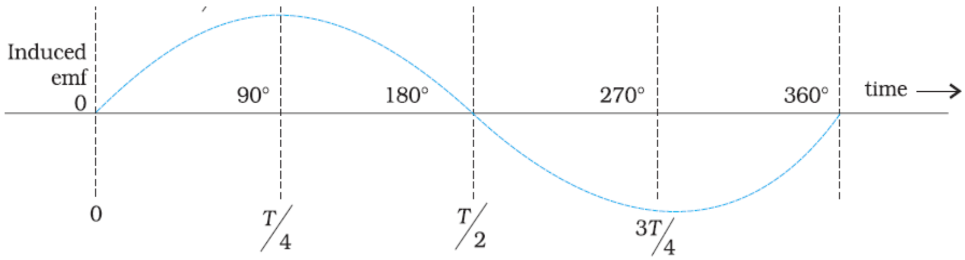
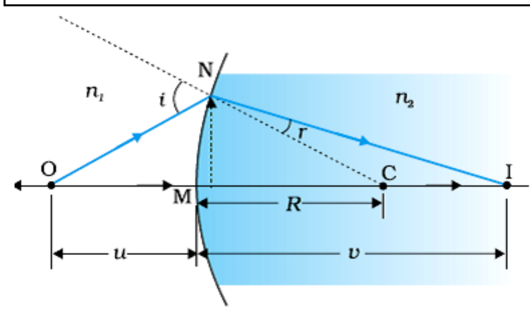
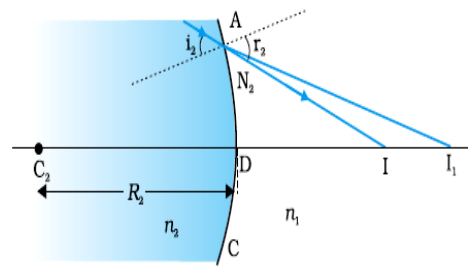
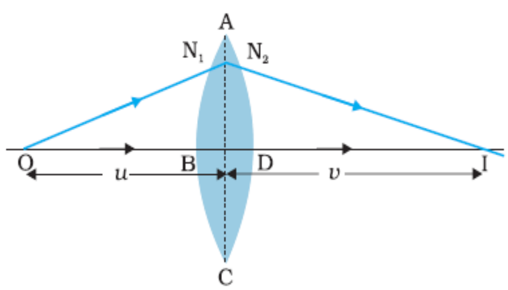
c) Let the coil be rotating with angular velocity 'ω', at any instant 't' when the normal to the plane of the coil makes an angle θ with the magnetic field. Hence magnetic flux ½

ϕ =NBAcos ωt, Therefore induced emf(e) = - $\frac{d\phi}{dt}$ ½

⇨ e = NBAωsin ωt

Induced emf will be maximum when ωt = 90^0 ½

Hence, e_{max} = NBAω

	Direction of induced emf can be determined using Flemming's Right hand rule. ***Alternatively:*** Statement of the above rule. d)  	1	5
29.	Ray diagram — 1 Derivation of relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2-n_1}{R}$ — 2 Obtaining the expression $\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ — 2   The incident rays coming from the object 'O' kept in the rarer medium of refractive index n_1, incident on the refracting surface NM, produce the real image at I. From the diagram $\angle i = \angle NOM + \angle NCM$ $= \frac{NM}{OM} + \frac{NM}{MC}$ $\angle r = \angle NCM - \angle NIM$ $= \frac{NM}{MC} - \frac{NM}{MI}$ From Snell's law $\therefore \frac{n_2}{n_1} = \frac{\sin i}{\sin r} \sim \frac{i}{r}$ (for small angles $\sin\theta \sim \theta$) $\therefore n_2 r = n_1 i$ $or\ n_2\left(\frac{NM}{MC} - \frac{NM}{MI}\right) = n_1\left(\frac{NM}{OM} + \frac{NM}{MC}\right)$ $or\ n_2\left(\frac{1}{+R} - \frac{1}{+v}\right) = n_1\left(\frac{1}{-u} + \frac{1}{R}\right)$ $or\ \frac{n_2-n_1}{R} = \frac{n_2}{v} - \frac{n_1}{u}$ Lens makers formula  	1 ½ ½ ½ ½ ½	

The first refracting surface ABC forms the image I_1 of the object O. The image I_1 acts as a virtual object for the second refracting surface ADC which forms the real image I as shown in the diagram

∴ for refraction at ABC

$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2-n_1}{R_1}$ ---------------------(i)

For refraction at ADC

$\frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1-n_2}{R_2}$ ---------------------(ii) ½

Adding equation (i) and equation (ii), we get

$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½

$\frac{1}{v} - \frac{1}{u} = (\frac{n_2}{n_1} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ => $\frac{1}{f} = (\mu_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½ 5

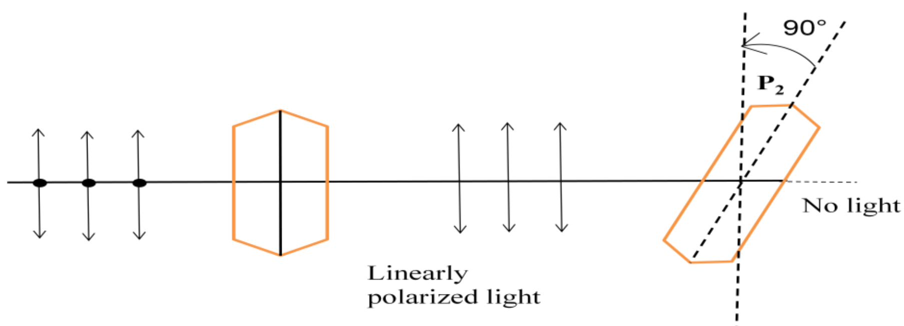
OR

a)	Distinguishing between linearly polarized and unpolarized light	1
b)	Transverse nature	2
c)	Rise or fall of intensity of sunlight	2

a) A light wave, in which the electric vector oscillates in all possible directions in a plane perpendicular to the direction of propagation, is known as unpolarized light. ½

If the oscillations of the electric vectors are restricted to just one direction, in a plane perpendicular to the direction of propagation, the corresponding light is known as linearly polarized light. ½

b)

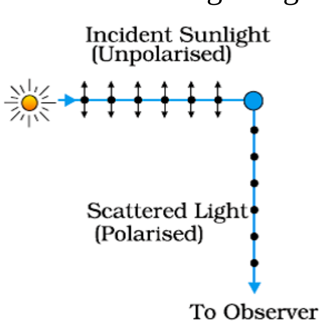


1

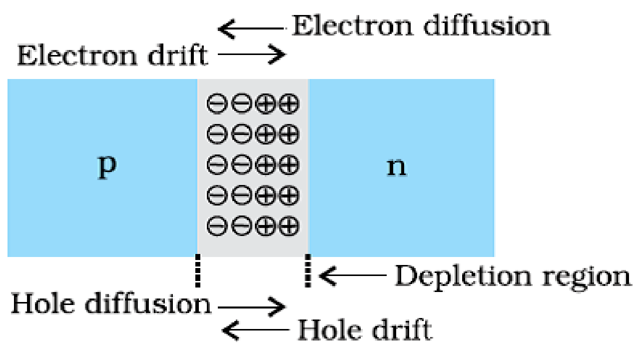
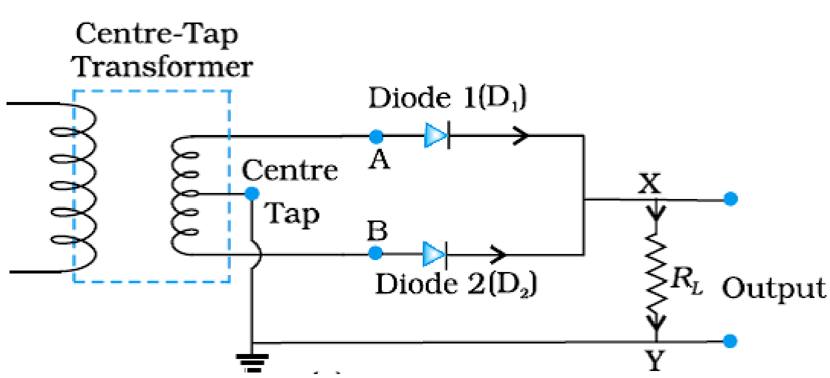
Unpolarized light passing through Polaroid P_1 gets linearly polarized.
[As the electric field vector components parallel to the pass axis of P_1 are transmitted whereas the others are blocked]. ½

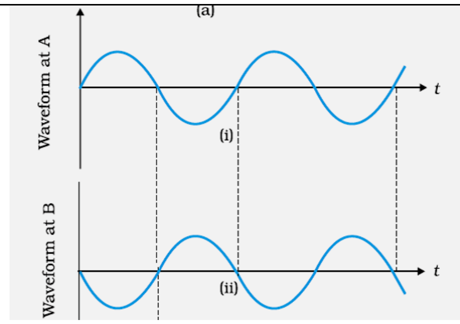
When this polarized light is incident on a Polaroid P_2 , kept crossed with respect to P_1, then these components also gets blocked and no light is transmitted beyond P_2. ½

c) It is due to scattering of light by molecules of earth's atmosphere

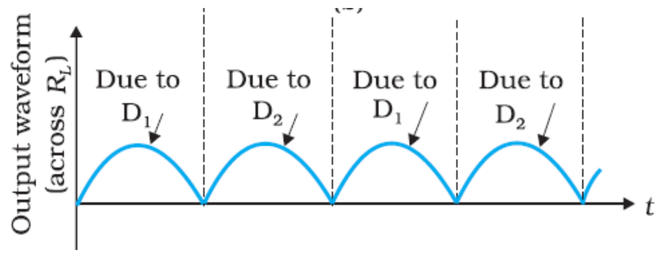


1

	Under the influence of the electric field of the incident (unpolarized) wave, the electrons in the molecules acquire components of motion in both these directions. Charges, accelerating parallel to the double arrows, do not radiate energy towards the observer since their acceleration has no transverse component. The radiation scattered by the molecule is therefore represented by dots , i.e. it is polarized perpendicular to plane of figure.	1	5
30.	a) Explanation of Depletion Layer and barrier potential. 1+1 b) Circuit diagram of full wave rectifier 1 Explanation of working and drawing of input and output Waveforms 1+ ½ + ½		
	a)  	½	
	Due to the diffusion of electrons and the holes, from their majority zone to minority zone, a layer of positive and negative space charge region on either side of the junction is formed. This is called the depletion region.	½	
	The loss of electrons, from n-region and gain of electrons by the p-region, causes a difference of potential across the junction. This tends to prevent the movement of charge carriers across the junction and is, therefore, termed as barrier potential.	1	
	b)  	1	
	For positive half cycle of input ac, one of the two diodes gets forward biased and conducts and output is obtained across the load R_L For negative half cycle of input ac, the other diode gets forward biased and thus output is obtained due to it. Therefore, output is obtained for both the cycles of input ac.	1	



½

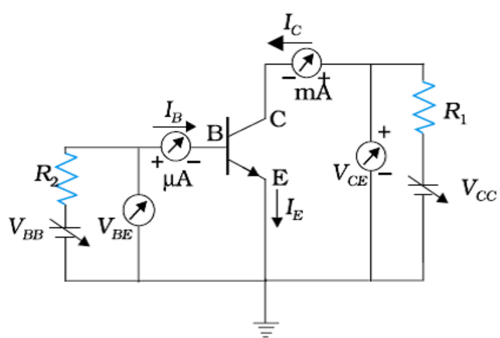


½ 5

OR

a) Labelled circuit diagram and explanation	1 ½ + 1
b) Underlying principle and working	1 + 1 ½

a)



1 ½

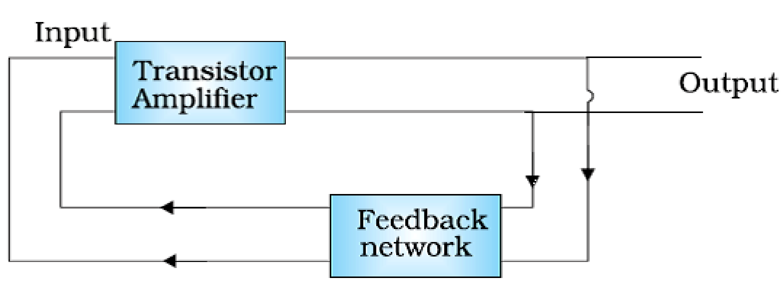
For input characteristics

At constant V_{CE} , for different values of V_{BE}, different values of I_b are obtained. ½

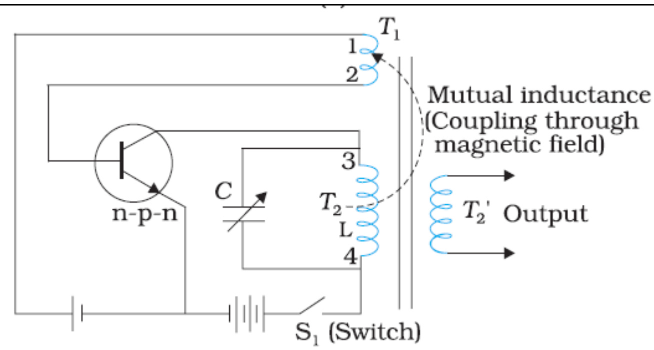
For output characteristics

At constant I_b, for different values of V_{CE}, different values of I_c are obtained. ½

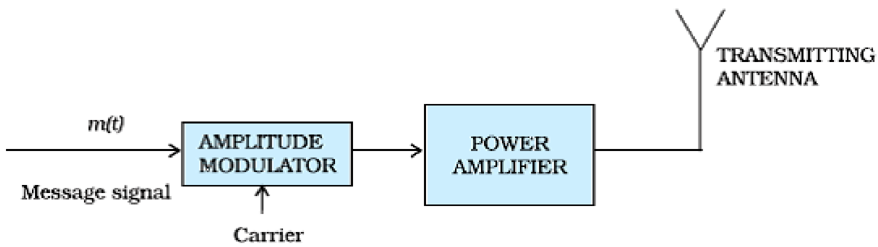
b) A portion of output power is returned at the input in same phase as that of starting power; hence the output in the oscillator gets self sustained. This is termed as positive feedback.



1

	 As the switch S_1 is closed, a surge of collector current flows through coil T_2, which causes a changing magnetic flux around it. Hence a portion of the output is fedback to the coil T_1, as a result of the positive feedback. The emitter current, therefore, also starts oscillating.	1 ½	5

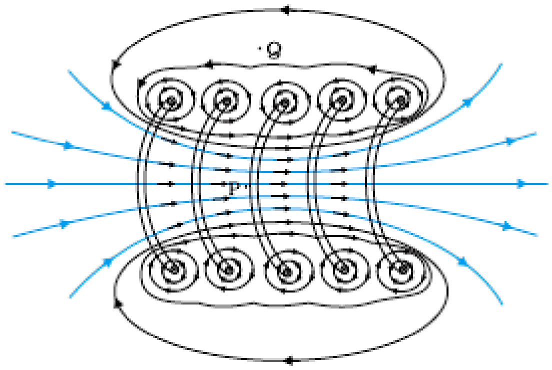
MARKING SCHEME
SET 55/1/2 (Compartment)

Q.No.	Expected Answer/Value Points	Marks	Total Marks
1.	When a constant current flows through a wire, the Potential difference, between any two points on the wire of uniform cross section, is directly proportional to the length of the wire between these points. **Alternatively:** $V \alpha \ell$ or $dV/d\ell$ = constant	1	1
2.	Due to the heating effect of eddy currents set up in the metallic piece.	1	1
3.	Effective power $\alpha \frac{1}{\lambda^2}$ **(Alternatively:** Effective power radiated decreases with an increase in wavelength.)	1	1
4.		1	1
5.	i. The two point charges(q_1 and q_2) should be of opposite nature. ii. Magnitude of charge q_1 must be greater than that of charge q_2	½ ½	1
6.	Two monochromatic sources, which produce light waves, having a constant phase difference, are known as coherent sources.	1	1
7.	Ferromagnetic material	1	1
8.	Random motion of free electrons gets directed towards the point at a higher potential. **Alternatively:** Random motion becomes a (partially) directed motion.	1	1
9	Obtaining the expression for total work done 2 Work done in bringing the charge q_1 from infinity to position r_1 $W_1 = q_1 V(r_1)$ work done in bringing charge q_2 to the position r_2 $W_2 = q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ Hence, total work done in assembling the two charges $W = W_1 + W_2$ $= q_1 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ **OR**	½ ½ +½ ½	2

	Derivation of relation between Electric field and potential gradient 1 Two important conclusions ½ + ½ Work done in moving a unit positive charge along distance $\delta\ell$ $\lvert E_l \rvert\, \delta\ell = V_A - V_B$ $= V - (V + \delta V)$ $= -\delta V$ $E = -\frac{\delta V}{\delta \ell}$ (i) Electric field is in the direction in which the potential decreases steepest. (ii) Magnitude of Electric field is given by the change in the magnitude of potential per unit displacement, normal to the equipotential surface at the point.	½ ½ ½ ½	2
10.	Charges on the inner and outer surfaces ½ + ½ Expression for electric field 1 Charge on inner surface : - Q Charge on outer surface : + Q Electric field at point P_1 $E = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r_1^2}$	½ ½ 1	2
11.	Obtaining the expression for the torque 2 Equivalent magnetic moment of the coil $\vec{m} = IA\hat{n}$ $\therefore \vec{m} = I\ell b\hat{n}$ ($\hat{n}$= unit vector ⊥ to the plane of the coil) $\therefore$Torque $= \vec{m} \times \vec{B}$ $= I\ell b\hat{n} \times \vec{B}$ $= 0$ (as $\hat{n}$ *and* $\vec{B}$ are parallel or antiparallel, to each other) **[Note: Also give credit, when student obtains the relation $\tau = mB\sin\theta$, and substitutes $\theta = 0$ or 180^o and writes $\tau = 0$]**	½ ½ ½ ½	2
12.	Calculation of i. emf induced in the arm PQ 1 ii. Current induced in the loop 1 i. emf induced $e = B\ell v$ $= 0.2 \times 20 \times 10^{-2} \times 15$ $= 0.6$ volt ii. Current in the loop $i = \frac{e}{R}$ $= \frac{0.6}{5} = 0.12$ A	½ ½ ½ ½	2

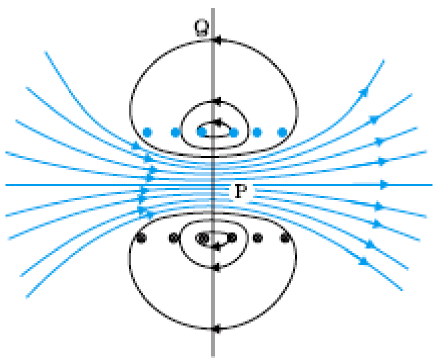
13.

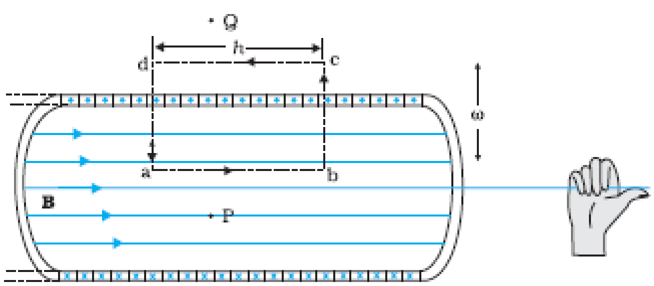
Drawing of magnetic field lines	½
Obtaining the expression for magnetic field	1 ½



½

Alternatively:





½

Applying Ampere circuital law for the rectangular loop abcd

$\oint \vec{B} \cdot \vec{d\ell} = \mu_o I$ ½

Bh = $\mu_o I$(nh) ½

B = $\mu_o n I$ — 2

14.

Finding the relation	1 ½
Drawing the graph	½

$E_v = \phi_o + K_{max}$ ½

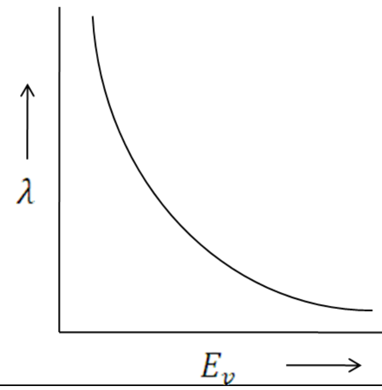
As $\phi_o = 0$

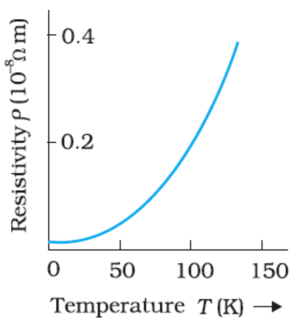
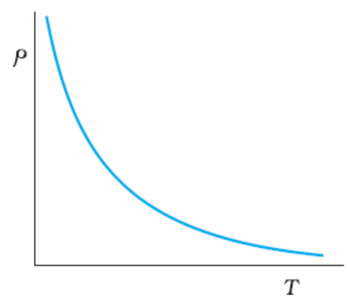
⇨ $E_v = K_{max}$

⇨ $K_{max} = \frac{p^2}{2m} = E_v$ ½

⇨ $p = \sqrt{2mE_v}$

∴ wavelength (λ)of emitted electrons, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE_v}}$ ½

<table>
<tr><td></td><td>
</td><td>½</td><td>2</td></tr>
<tr><td>15.</td><td>Drawing the two plots ½ + ½
Explanation of Behaviour ½ + ½

(i) Conductor (ii) Semiconductor



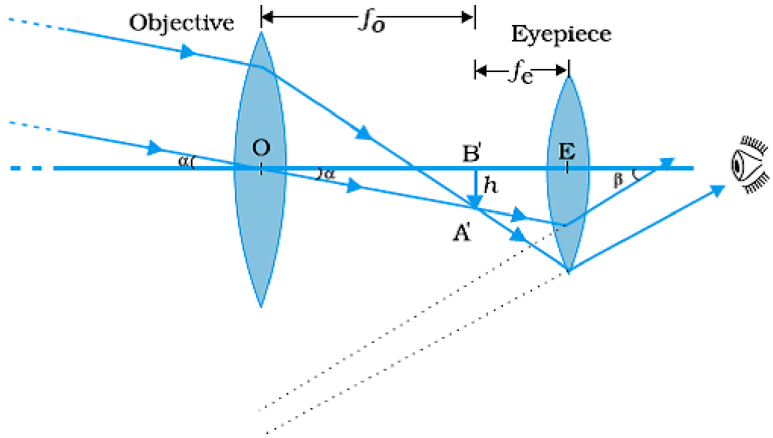
$\rho = \frac{m}{ne^2\tau}$
In conductors, average relaxation time decreases with increase in temperature, resulting in an increase in resistivity.
In semiconductors, the increase in number density (with increase in temperature) is more than the decrease in relaxation time; the net result is, therefore, a decrease in resistivity.</td><td>½ + ½

½

½</td><td>2</td></tr>
<tr><td>16.</td><td>Naming of gates P and Q ½ + ½
Truth table & Identification ½ + ½
P: OR Gate
Q: NOT Gate
<table>
<tr><td colspan="2">Inputs</td><td>Output</td></tr>
<tr><td>A</td><td>B</td><td>Y</td></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td></tr>
</table>
NOR Gate</td><td>½
½

½

½</td><td>2</td></tr>
</table>

17.	Schematic diagram 1 Two important limitations ½ + ½		
		1	
	i. It suffers chromatic aberration ii. It has spherical aberration iii. Magnifying power small. iv. Small resolving power (**Any two**)	½ + ½	2
18.	Explanation of parts (i) and (ii) 1+1		
	(i) Intensity of incident radiation I = nh$v$, where n is number of photons incident per unit time per unit area. For same intensity of two monochromatic radiations of frequency v_1 and v_2	½	
	$n_1 h v_1 = n_2 h v_2$ As $v_1 > v_2$ ⇨ $n_2 > n_1$ Therefore the number of electrons emitted for monochromatic radiation of frequency v_2, will be more than that for radiation of frequency v_1	½	
	[<u>Alternatively:</u> Also accept if the student says that, for same intensity of incident radiation, the number of emitted electrons is same for each of the two frequencies of incident radiation.] (ii) hv = $\phi_o + K_{max}$ ∴ For given ϕ_o (work function of metal)	½	
	K_{max} increases with v ∴ Maximum Kinetic energy of emitted photoelectrons will be more for monochromatic light of frequency v_1 (as $v_1 > v_2$)	½	2
19.	a) Circular path + angular frequency expression 1 + ½ b) Trace of path; justification ½+ 1		
	a) Force acting on the charged particle, moving with a velocity $\vec{v}$, in a magnetic field $\vec{B}$: $\vec{F} = q(\vec{v} \times \vec{B})$	½	

As, $\vec{v} \perp \vec{B}$, $|Force| = qvB$

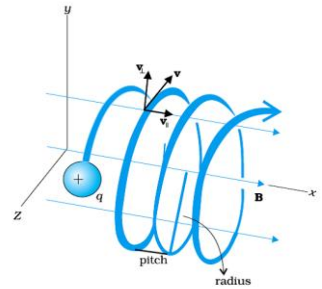
Since, $\vec{F} \perp \vec{v}$, it acts as a centripetal force and makes the particle move in a circular path, in the plane, perpendicular to the magnetic field. ½

$\therefore qvB = \frac{mv^2}{r}$

$\therefore r = \frac{mv}{qB}$ ½

Now $\omega = \frac{v}{r}$ $\therefore \omega = \frac{qB}{m}$

b)



½

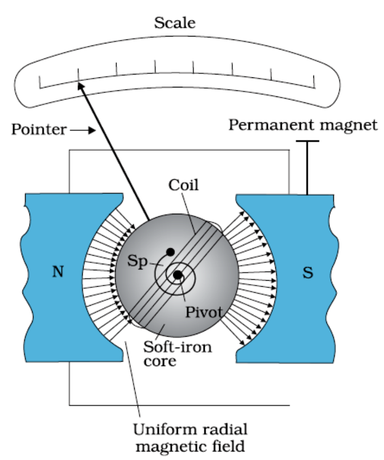
Component of velocity $\vec{v}$ parallel to magnetic field, will make the particle move along the field.

Perpendicular component of velocity $\vec{v}$ will cause the particle to move along a circular path in the plane perpendicular to the magnetic field.

Hence, the particle will follow a helical path, as shown 1 3

OR

Schematic sketch and brief description of working	1+1
Justification	1



1

When a current, I, flows through the coil, a torque $\tau = NIAB$ acts on it. ½

A spring provides a counter torque ($K\varphi$)which balances the deflecting torque

$\therefore K\varphi = NIAB$

$\varphi = \left(\frac{NAB}{K}\right) I$; or $\varphi \propto I$ ½

Current sensitivity = $\frac{NAB}{K}$

Voltage sensitivity = $\frac{NAB}{KR}$ ½

On increasing number of turns, the resistance of the coil increases proportionally.

$\therefore$ Increase in current sensitivity does not necessarily increase voltage sensitivity. ½ 3

20.	(i) Values displayed 1+1 (ii) Calculation of maximum distance 1 (i) a. Concern b. Scientific temperament c. Keen observer d. Alertness (or any other two correct values.) (ii) d $=\sqrt{2hR}$ $= \sqrt{2 \times 20 \times 6.4 \times 10^6}$ m = 2 x 8 x 10^3m = 16 km	1+1 ½ ½	3
21.	Calculation of power consumed by the resistance R 3 For loop ABCDA $-12 + 4I_1 + 8(I_1 + I_2) = 0$ $12 I_1 + 8I_2 = 12$ $3 I_1 + 2I_2 = 3$ ------------------------(i) For loop ADFEA $- 8(I_1 + I_2) + 8 = 0$ $I_1 + I_2 = 1$ -----------------------(ii) Simplifying (i) and (ii) For loop ABCDA $I_1 = 1A$ $I_2 = 0A$ Hence, power consumed by the resistor = $(I_1)^2R$ = 9 watt	½ ½ ½ ½ ½ ½	3
22.	Finding the rate of i. Net capacitance 1 ½ ii. Energy stored 1 ½ i. Net capacitance before filling the gap with dielectric $C_{initial} = C_1 + C_2 = \frac{C_2}{2} + C_2 = \frac{3}{2}C_2$ Net capacitance after filling the gap with dielectric slab of dielectric constant 'K' $C_{final} = KC_1 + KC_2 = \frac{KC_2}{2} + KC_2 = \frac{3}{2}KC_2$ Ratio of net capacitance : Hence, $\frac{C_{initial}}{C_{final}} = \frac{1}{K}$ ii. Energy stored in the combination before introduction of dielectric slab $U_{initial} = \frac{2Q^2}{3C_2}$	½ ½ ½ ½	

Energy stored in the combination after introduction of dielectric slab

$$U_{final} = \frac{2Q^2}{3KC_2}$$ ½

$$\frac{U_{initial}}{U_{final}} = \frac{K}{1}$$ ½

[Note: Accept any other alternative correct method.] 3

23.

a. Calculation of radius in n = 2 orbit	1
b. Finding of	
i. Kinetic energy	1
ii. Potential energy	1

a. Radius of nth orbit = $n^2 r_o$ ½

∴ radius of n=2 orbit

$r_2 = (2)^2 \times 5.3 \times 10^{-11}$

$= 21.2 \times 10^{-11}$m ½

b. As kinetic energy = - Total energy ½

= - (- 1.51)eV

= 1.51eV ½

Potential energy = 2 x Total energy ½

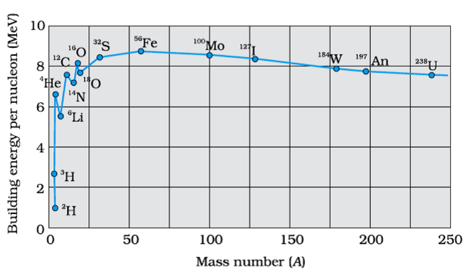
= -2 x 1.51 = -3.02 eV ½ 3

24.

a) Relation for binding energy	1
b) Plot of BE/A versus mass number A	1
Explanation of release of energy	1

a) B.E = $[ZM_P + (A - Z)M_n - {}^{A}_{Z}M\ ]$ x c^2 1

b)



1

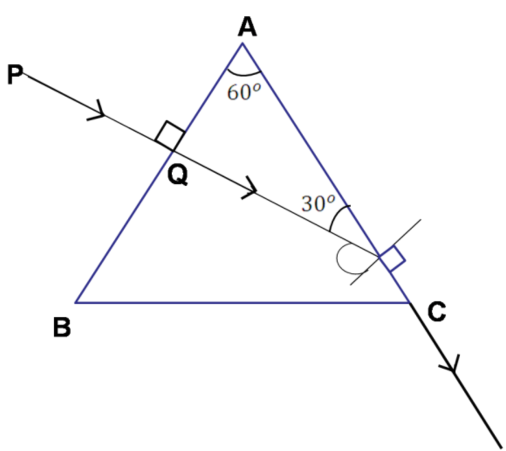
From the binding energy per nucleon curve, it is clear that binding energy per nucleon , of the fused nuclei is more than those of the light nuclei taking part in nuclear fusion. Hence energy gets released in the process. 1 3

25.

Explanation of part (i) and (ii)	1 ½ + 1 ½

(i) In diffraction pattern, intensity will be minimum at an angle $\theta = n\lambda/a$ ½

∴ There will be a first minimum at an angle $\theta = \lambda/a$, on either side of central maximum

	∴ width of central maxima = $2\lambda/a$, whereas the width of other minimum/ maximum ≈ λ/a (ii) The intensity of maxima decreases as the order (n) or diffraction maxima increases. This is because, on dividing the slit into odd number of parts, the contributions of the corresponding (outermost) pairs cancel each other, leaving behind the contribution of only the innermost segment. For example, for first maximum, dividing slit into three parts out of these three parts of the slit, the contributions from first two parts cancel each other; only $\frac{1}{3}$rd portion of the slit contributes to the maxima of intensity. Similarly for, second maxima, dividing slit into five parts, contribution of first four parts will be zero(as they cancel each other). The remaining $\frac{1}{5}$th portion, only, will contribute for maxima; and so on.	½ ½ ½ ½ ½	3
26.	Answers of part (i), (ii) and (iii) 1+1+1 (i) Consider a plane perpendicular to the direction of propagation of the wave. An electric charge, on the plane, will be set in motion by the electric and magnetic fields of em wave, incident on this plane. This illustrates that em waves carry energy and momentum. (ii) Microwaves are produced by special vacuum tubes like the klystron,/ Magnetron/ Gunn diode. The frequency of microwaves is selected to match the resonant frequency of water molecules, so that energy is transferred efficiently to the kinetic energy of the molecules. (iii) a. Associated with the green house effect. b. In remote switches of household electrical appliances. ***(or any other two uses.)***	1 ½ ½ ½ ½	3
27.	Tracing of the path of the ray 1 Calculation of angle of emergence and angle of deviation 1 + 1  If i_c is the critical angle for the prism/material, $\mu = \frac{1}{\text{Sin}i_c}$ $\therefore \sin i_c = \frac{1}{\mu} = \frac{\sqrt{3}}{2}$ $=> i_c = 60^o$ Angle of incidence at face AC of the prism = 60^o	1 ½	

Hence, refracted ray grazes the surface AC. ½

⇨ Angle of emergence = 90^o

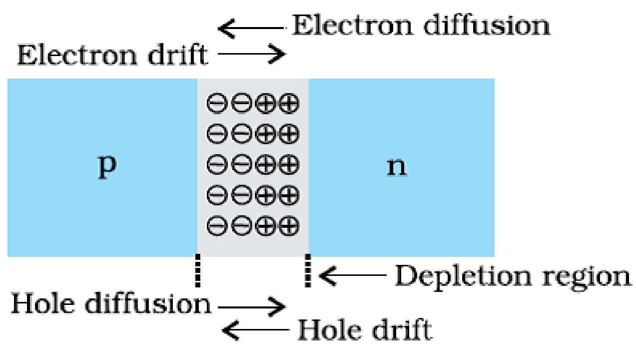
⇨ Angle of deviation = 30^o ½

[Note: Accept other correct alternative method.] ½ 3

28.

a) Explanation of Depletion Layer and barrier potential.	1+1
b) Circuit diagram of full wave rectifier	1
Explanation of working and drawing of input and output Waveforms	1+ ½ + ½

a)

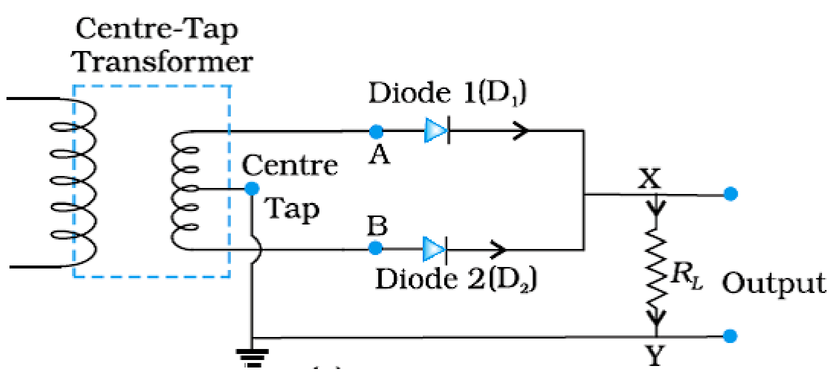


½

Due to the diffusion of electrons and the holes, from their majority zone to minority zone, a layer of positive and negative space charge region on either side of the junction is formed. This is called the depletion region. ½

The loss of electrons, from n-region and gain of electrons by the p-region, causes a difference of potential across the junction. This tends to prevent the movement of charge carriers across the junction and is, therefore, termed as barrier potential. 1

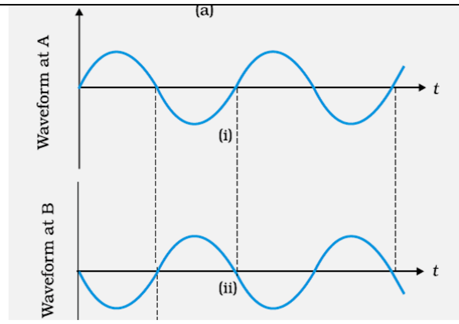
b)



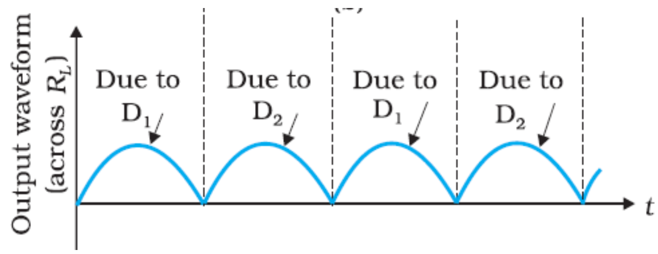
1

For positive half cycle of input ac, one of the two diodes gets forward biased and conducts and output is obtained across the load R_L

For negative half cycle of input ac, the other diode gets forward biased and thus output is obtained due to it. Therefore, output is obtained for both the cycles of input ac. 1



½

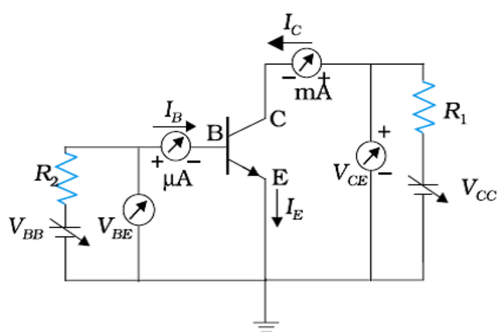


½ | 5

OR

a)	Labelled circuit diagram and explanation	1 ½ + 1
b)	Underlying principle and working	1 + 1 ½

a)



1 ½

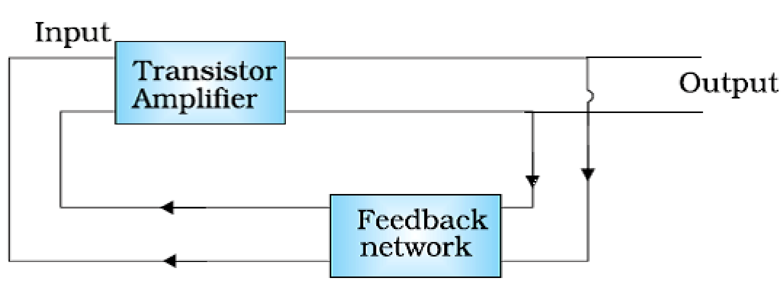
For input characteristics

At constant V_{CE} , for different values of V_{BE}, different values of I_b are obtained. ½

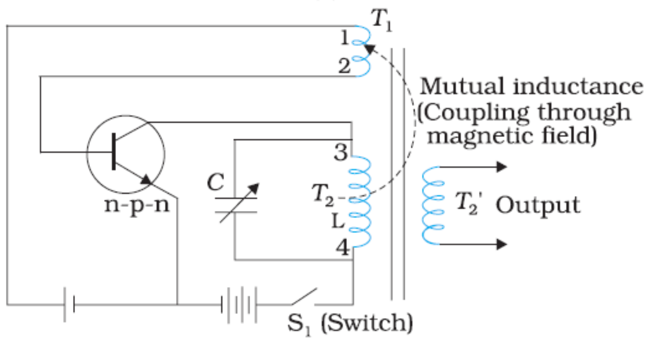
For output characteristics

At constant I_b, for different values of V_{CE}, different values of I_c are obtained. ½

b) A portion of output power is returned at the input in same phase as that of starting power; hence the output in the oscillator gets self sustained. This is termed as positive feedback.



1



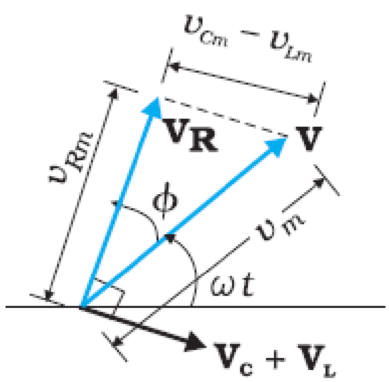
1

As the switch S_1 is closed, a surge of collector current flows through coil T_2, which causes a changing magnetic flux around it. Hence a portion of the output is fedback to the coil T_1, as a result of the positive feedback. The emitter current, therefore, also starts oscillating. ½ 5

29.

a)	Derivation of expression for amplitude of current and phase angle	1+1
b)	Condition at resonance	½
c)	Drawing of plot	1
d)	Definition of Q factor and its role in tuning	1 +½

a)



½

From the phasor diagram

$$\vec{V} = \vec{V_L} + \vec{V_R} + \vec{V_C}$$

Magnitude of net voltage

$$V_m = \sqrt{(V_{RM})^2 + (V_{Cm} - V_{Lm})^2}$$

$$V_m = I_m\sqrt{[R^2 + (X_C - X_L)^2]}$$ ½

$$I_m = \frac{V_m}{\sqrt{[R^2 + (X_C - X_L)^2]}}$$ ½

From the figure

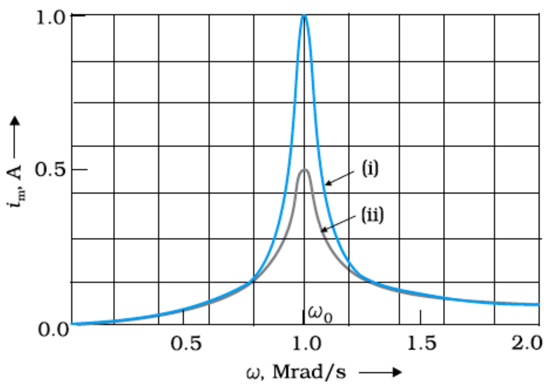
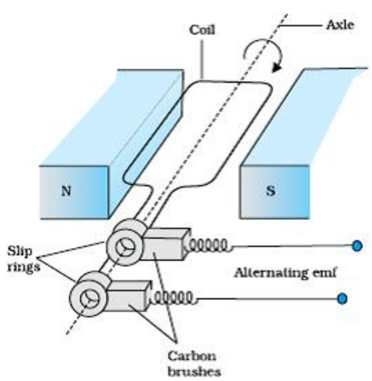
$$\tan\phi = \frac{V_{Cm} - V_{Lm}}{V_{Rm}}$$

$$= \frac{I_m(X_C - X_L)}{I_m R}$$

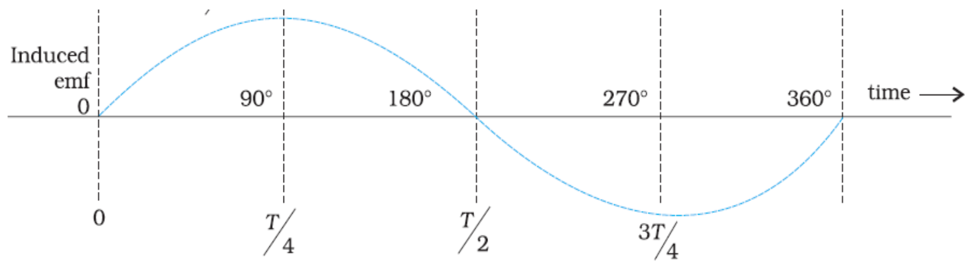
$$\therefore \phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$$ ½

b) At resonance, I_m *is maximum*

⇨ $X_L = X_c$,

	[Alternatively: $\omega_o = \frac{1}{\sqrt{LC}}$]	½	
	 (ii) plot is for R_1 (i) plot is for R_2	½ + ½	
	Quality factor of LCR circuit is defined as $\frac{\omega_o}{2\Delta\omega} = \frac{\omega_o L}{R}$	1	
	A larger value of quality factor corresponds to a sharper resonance. **OR**	½	5
	a) Labelled diagram & working principle — 1+1 b) Explanation of change in magnetic flux — ½ c) Derivation of expression of maximum value of induced emf and statement of the rule — 1 + ½ d) Showing the variation of emf — 1		
	a) 	1	
	It works on the principle of electromagnetic induction, i.e. when a coil continuously rotates in a magnetic field, the magnetic flux associated with it keeps on changing; thus an induced emf is produced in it.	1	
	b) When the coil rotates in a magnetic field, its effective area i.e. A cosθ, (i.e. area normal to the magnetic field) keeps on changing. Hence magnetic flux ϕ= NBAcosθ, keeps on changing.	½	
	c) Let the coil be rotating with angular velocity 'ω', at any instant 't' when the normal to the plane of the coil makes an angle θ with the magnetic field. Hence magnetic flux	½	
	ϕ =NBAcos ωt, Therefore induced emf(e) = - $\frac{d\phi}{dt}$	½	
	⇨ e = NBAωsin ωt Induced emf will be maximum when ωt = 90^0 Hence, e_{max} = NBAω	½	
	Direction of induced emf can be determined using Flemming's Right hand rule. ***Alternatively:*** Statement of the above rule.		

d)

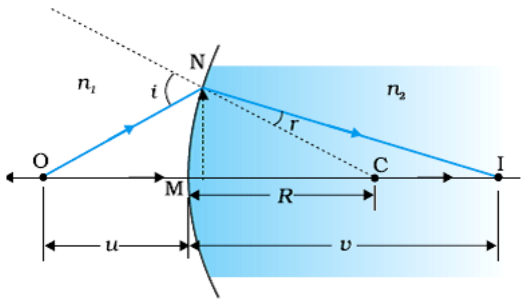


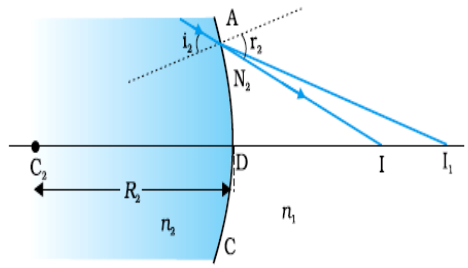
1

5

30.

Ray diagram	1
Derivation of relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	2
Obtaining the expression $\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	2





1

The incident rays coming from the object 'O' kept in the rarer medium of refractive index n_1, incident on the refracting surface NM, produce the real image at I.

From the diagram

$\angle i = \angle NOM + \angle NCM$

$= \frac{NM}{OM} + \frac{NM}{MC}$ ½

$\angle r = \angle NCM - \angle NIM$

$= \frac{NM}{MC} - \frac{NM}{MI}$ ½

From Snell's law

$\therefore \frac{n_2}{n_1} = \frac{\sin i}{\sin r} \sim \frac{i}{r}$ (for small angles $\sin\theta \sim \theta$)

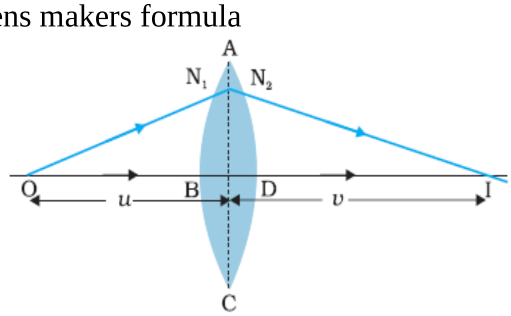
$\therefore n_2 r = n_1 i$ ½

$or\ n_2\left(\frac{NM}{MC} - \frac{NM}{MI}\right) = n_1\left(\frac{NM}{OM} + \frac{NM}{MC}\right)$

$or\ n_2\left(\frac{1}{+R} - \frac{1}{+v}\right) = n_1\left(\frac{1}{-u} + \frac{1}{R}\right)$ ½

$or\ \frac{n_2 - n_1}{R} = \frac{n_2}{v} - \frac{n_1}{u}$

Lens makers formula ½



The first refracting surface ABC forms the image I_1 of the object O. The image I_1 acts as a virtual object for the second refracting surface ADC which forms the real image I as shown in the diagram

∴ for refraction at ABC

$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$ ---------------------(i)

For refraction at ADC

$\frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1 - n_2}{R_2}$ ---------------------(ii) ½

Adding equation (i) and equation (ii), we get

$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½

$\frac{1}{v} - \frac{1}{u} = (\frac{n_2}{n_1} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \Rightarrow \frac{1}{f} = (\mu_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½ 5

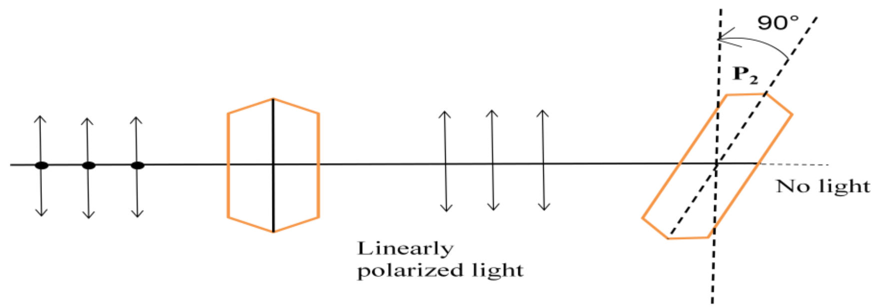
OR

a)	Distinguishing between linearly polarized and unpolarized light	1
b)	Transverse nature	2
c)	Rise or fall of intensity of sunlight	2

a) A light wave, in which the electric vector oscillates in all possible directions in a plane perpendicular to the direction of propagation, is known as unpolarized light. ½

If the oscillations of the electric vectors are restricted to just one direction, in a plane perpendicular to the direction of propagation, the corresponding light is known as linearly polarized light. ½

b)



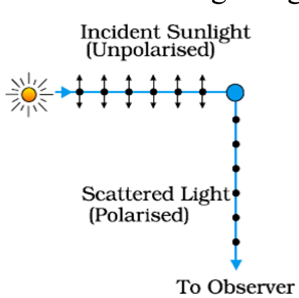
1

Unpolarized light passing through Polaroid P_1 gets linearly polarized. ½

[As the electric field vector components parallel to the pass axis of P_1 are transmitted whereas the others are blocked].

When this polarized light is incident on a Polaroid P_2, kept crossed with respect to P_1, then these components also gets blocked and no light is transmitted beyond P_2. ½

c) It is due to scattering of light by molecules of earth's atmosphere

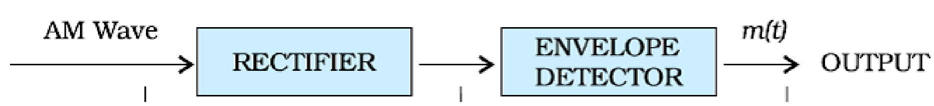
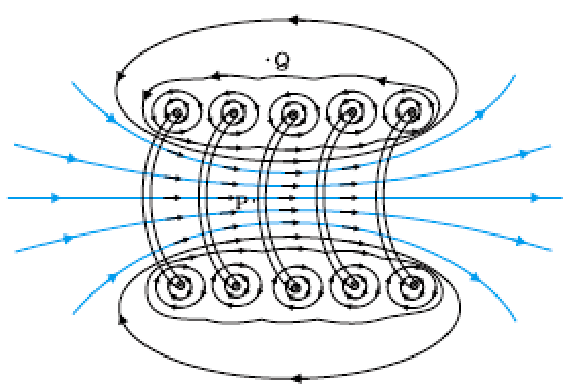


1

Under the influence of the electric field of the incident (unpolarized) wave, the electrons in the molecules acquire components of motion in both these directions. Charges, accelerating parallel to the double arrows, do not radiate energy towards the observer since their acceleration has no transverse component.

The radiation scattered by the molecule is therefore represented by dots, i.e. it is polarized perpendicular to plane of figure. 1 5

MARKING SCHEME
SET 55/1/3 (Compartment)

Q.No.	Expected Answer/Value Points	Marks	Total Marks
1.	Random motion of free electrons gets directed towards the point at a higher potential. **Alternatively:** Random motion becomes a (partially) directed motion.	1	1
2.	Two monochromatic sources, which produce light waves, having a constant phase difference, are known as coherent sources.	1	1
3.		1	1
4.	Paramagnetic material	1	1
5.	Effective power $\alpha \frac{1}{\lambda^2}$ **(Alternatively:** Effective power radiated decreases with an increase in wavelength.)	1	1
6.	Due to the heating effect of eddy currents set up in the metallic piece.	1	1
7.	When a constant current flows through a wire, the Potential difference, between any two points on the wire of uniform cross section, is directly proportional to the length of the wire between these points. **Alternatively:** $V \alpha \ell$ or $dV/d\ell$ = constant	1	1
8.	i. The two point charges(q_1 and q_2) should be of opposite nature. ii. Magnitude of charge q_1 must be greater than that of charge q_2	½ ½	1
9	Drawing of magnetic field lines ½ Obtaining the expression for magnetic field 1 ½ 	½	

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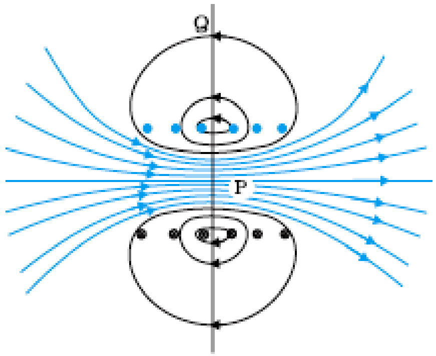
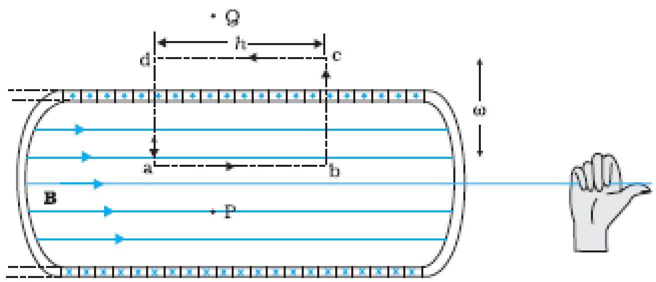
Alternatively:





Applying Ampere circuital law for the rectangular loop abcd

$\oint \vec{B} \cdot \vec{d\ell} = \mu_o I$

Bh = $\mu_o I$(nh)

B = $\mu_o nI$

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Explanation of parts (i) and (ii)	1+1

(i) Intensity of incident radiation I = nh$v$,
where n is number of photons incident per unit time per unit area.
For same intensity of two monochromatic radiations of frequency
v_1 and v_2
$n_1 h v_1 = n_2 h v_2$
As $v_1 > v_2$
⇨ $n_2 > n_1$
Therefore the number of electrons emitted for monochromatic radiation of frequency v_2, will be more than that for radiation of frequency v_1

[Alternatively: Also accept if the student says that, for same intensity of incident radiation, the number of emitted electrons is same for each of the two frequencies of incident radiation.]

(i) hv = $\phi_o + K_{max}$
∴ For given ϕ_o (work function of metal)
K_{max} increases with v
∴ Maximum Kinetic energy of emitted photoelectrons will be more for monochromatic light of frequency v_1 (as $v_1 > v_2$)

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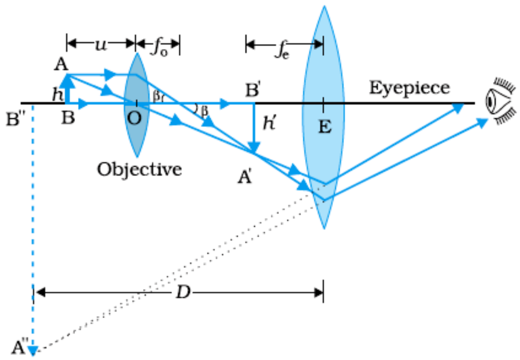
11.	Ray diagram of formation of image by a compound microscope 1 Expression for total magnification 1  Total magnification $m = m_o \times m_e$ $= \frac{L}{f_o} \times \frac{D}{f_e}$	1 1	2
12.	Obtaining the expression for total work done 2 Work done in bringing the charge q_1 from infinity to position r_1 $W_1 = q_1 V(r_1)$ work done in bringing charge q_2 to the position r_2 $W_2 = q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ Hence, total work done in assembling the two charges $W = W_1 + W_2$ $= q_1 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_{12}}$ **OR** Derivation of relation between Electric field and potential gradient 1 Two important conclusions ½ + ½ Work done in moving a unit positive charge along distance $\delta\ell$ $\lvert E_l \rvert \delta\ell = V_A - V_B$ $= V - (V + \delta V)$ $= - \delta V$ $E = - \frac{\delta V}{\delta\ell}$ (i) Electric field is in the direction in which the potential decreases steepest. (ii) Magnitude of Electric field is given by the change in the magnitude of potential per unit displacement, normal to the equipotential surface at the point.	½ ½ +½ ½ ½ ½ ½ ½	2 2

13.

Naming of gates P and Q	½ + ½
Truth Table of combination & Identification	½ + ½

P: NOT Gate ½

Q: AND Gate ½

Input A	Output Y
0	1
1	0

½

NOT gate ½ | 2

14.

Obtaining the expression for the torque	2

Equivalent magnetic moment of the coil

$\vec{m} = IA\hat{n}$

$\therefore \vec{m} = I\ell b\hat{n}$ ½

($\hat{n}$= unit vector ⊥ to the plane of the coil)

$\therefore$Torque = $\vec{m} \times \vec{B}$ ½

$= I\ell b\hat{n} \times \vec{B}$ ½

$= 0$ ½

(as $\hat{n}$ *and* $\vec{B}$ are parallel or antiparallel, to each other)

[Note: Also give credit, when student obtains the relation $\tau = mBsin\theta$, and substitutes $\theta = 0$ *or* 180^o and writes $\tau = 0$] | 2

15.

Finding the relation	1 ½
Drawing the graph	½

$E_v = \phi_o + K_{max}$ ½

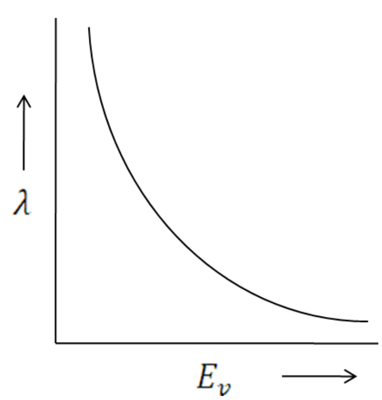
As $\phi_o = 0$

⇨ $E_v = K_{max}$

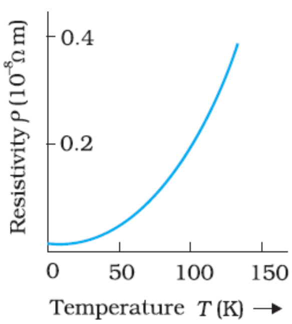
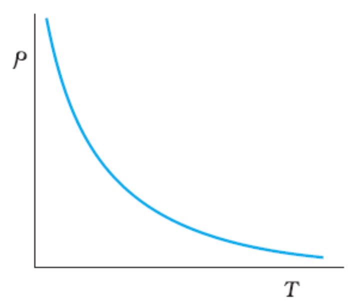
⇨ $K_{max} = \frac{p^2}{2m} = E_v$ ½

⇨ $p = \sqrt{2mE_v}$

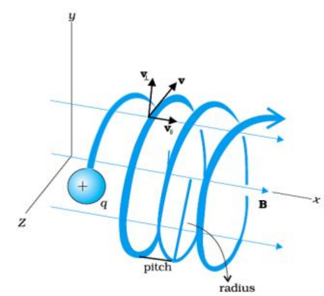
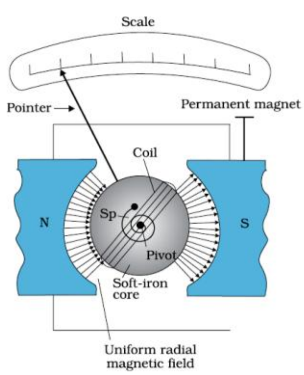
$\therefore$ wavelength (λ)of emitted electrons, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE_v}}$ ½

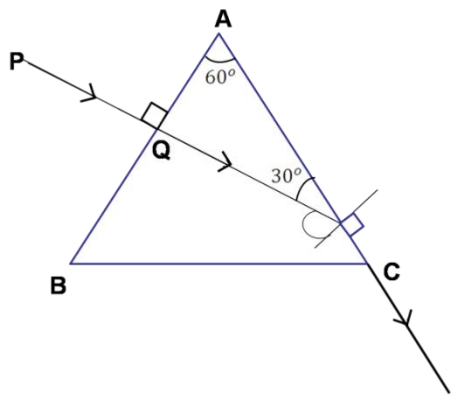
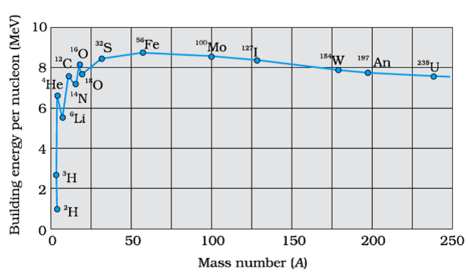


½ | 2

16.	**Calculation of** i. emf induced in the arm PQ — 1 ii. Current induced in the loop — 1 i. emf induced e = $B\ell v$ = 0.25 x 15 x 10^{-2} x 25 = 0.9375 volt = 0.94 volt ii. Current in the loop $i = \frac{e}{R}$ $= \frac{0.94}{4}$ = 0.23 A	½ ½ ½ ½	2
17.	**Drawing the two plots** — ½ + ½ **Explanation of Behaviour** — ½ + ½ (ii) Conductor (ii) Semiconductor   $\rho = \frac{m}{ne^2\tau}$ In conductors, average relaxation time decreases with increase in temperature, resulting in an increase in resistivity. In semiconductors, the increase in number density (with increase in temperature) is more than the decrease in relaxation time; the net result is, therefore, a decrease in resistivity.	½ + ½ ½ ½	2
18.	**Charges on the inner and outer surfaces** — ½ + ½ **Expression for electric field** — 1 Charge on inner surface : - Q Charge on outer surface : + Q Electric field at point P_1 $E = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r_1^2}$	½ ½ 1	2
19.	**Explanation of part (i) and (ii)** — 1 ½ + 1 ½ (i) In diffraction pattern, intensity will be minimum at an angle $\theta = n\lambda/a$ ∴ There will be a first minimum at an angle $\theta = \lambda/a$, on either side of central maximum	½	

	∴ width of central maxima = $2\lambda/a$, whereas the width of other minimum/ maximum $\approx \lambda/a$ (ii) The intensity of maxima decreases as the order (n) or diffraction maxima increases. This is because, on dividing the slit into odd number of parts, the contributions of the corresponding (outermost) pairs cancel each other, leaving behind the contribution of only the innermost segment. For example, for first maximum, dividing slit into three parts out of these three parts of the slit, the contributions from first two parts cancel each other; only $\frac{1}{3}$rd portion of the slit contributes to the maxima of intensity. Similarly for, second maxima, dividing slit into five parts, contribution of first four parts will be zero(as they cancel each other). The remaining $\frac{1}{5}$th portion, only, will contribute for maxima; and so on.	½ ½ ½ ½ ½	 3
20.	Finding the ratio of i. Net capacitance 1 ½ ii. Energy stored 1 ½ i. Net capacitance before filling the gap $C_{initial} = C_1 + C_2 = 3C_2 + C_2 = 4C_2$ Net capacitance after filling the gap $C_{final} = KC_1 + KC_2 = 3KC_2 + C_2 = 4KC_2$ Hence Net capacitance, $\frac{C_{initial}}{C_{final}} = \frac{1}{K}$ ii. Energy stored in the combination before introduction of dielectric slab $U_{initial} = \frac{Q^2}{4C_2}$ Energy stored in the combination after introduction of dielectric slab $U_{final} = \frac{Q^2}{4KC_2}$ $\frac{U_{initial}}{U_{final}} = \frac{K}{1}$ = K:1 **[Note: Accept any other alternative correct method.]**	 ½ ½ ½ ½ ½ ½	 3
21.	Answers of part (i), (ii) and (iii) 1+1+1 (i) Consider a plane perpendicular to the direction of propagation of the wave. An electric charge, on the plane, will be set in motion by the electric and magnetic fields of em wave, incident on this plane. This illustrates that em waves carry energy and momentum. (ii) Microwaves are produced by special vacuum tubes like the klystron,/ Magnetron/ Gunn diode. The frequency of microwaves is selected to match the resonant frequency of water molecules, so that energy is transferred efficiently to the kinetic	 1 ½	

	energy of the molecules.	½	
	(iii) a. Associated with the green house effect.	½	
	b. In remote switches of household electrical appliances. ***(or any other two uses.)***	½	3
22.	a) Circular path + angular frequency expression 1 + ½ b) Trace of path; justification ½+ 1		
	a) Force acting on the charged particle, moving with a velocity $\vec{v}$, in a magnetic field $\vec{B}$:	½	
	$\vec{F} = q(\vec{v} \times \vec{B})$ As, $\vec{v} \perp \vec{B}$, $\lvert Force \rvert = qvB$ Since, $\vec{F} \perp \vec{v}$, it acts as a centripetal force and makes the particle move in a circular path, in the plane, perpendicular to the magnetic field.	½	
	$\therefore qvB = \frac{mv^2}{r}$ $\therefore r = \frac{mv}{qB}$	½	
	Now $\omega = \frac{v}{r}$ $\therefore \omega = \frac{qB}{m}$		
	b)  	½	
	Component of velocity $\vec{v}$ parallel to magnetic field, will make the particle move along the field. Perpendicular component of velocity $\vec{v}$ will cause the particle to move along a circular path in the plane perpendicular to the magnetic field. Hence, the particle will follow a helical path, as shown	1	3
	OR		
	Schematic sketch and brief description of working 1+1 Justification 1		
	 	1	

	When a current, I, flows through the coil, a torque $\tau = NIAB$ acts on it. A spring provides a counter torque ($K\varphi$)which balances the deflecting torque $\therefore K\varphi = NIAB$ $\varphi = \left(\frac{NAB}{K}\right) I$; or $\varphi \propto I$ Current sensitivity = $\frac{NAB}{K}$ Voltage sensitivity = $\frac{NAB}{KR}$ On increasing number of turns, the resistance of the coil increases proportionally. $\therefore$ Increase in current sensitivity does not necessarily increase voltage sensitivity.	½ ½ ½ ½	3
23.	Tracing of the path of the ray — 1 Calculation of angle of emergence and angle of deviation — 1 + 1  If i_c is the critical angle for the prism/material, $\mu = \frac{1}{\text{Sin} i_c}$ $\therefore \sin i_c = \frac{1}{\mu} = \frac{\sqrt{3}}{2}$ $\Rightarrow i_c = 60^o$ Angle of incidence at face AC of the prism = 60^o Hence, refracted ray grazes the surface AC. ⇨ Angle of emergence = 90^o ⇨ Angle of deviation = 30^o **[Note: Accept other correct alternative method.]**	1 ½ ½ ½ ½	3
24.	a) Relation for binding energy — 1 b) Plot of BE/A versus mass number A — 1 Explanation of release of energy — 1 a) B.E = $[ZM_P + (A-Z)M_n - {}^{A}_{Z}M\ ] \times c^2$ b)  	1 1	

	From the binding energy per nucleon curve, it is clear that binding energy per nucleon , of the fused nuclei is more than those of the light nuclei taking part in nuclear fusion. Hence energy gets released in the process.	1	3
25.	a. Calculation of radius in n = 3 orbit 1 b. Finding of i. Kinetic energy 1 ii. Potential energy 1 a. Radius of orbit $r_n = n^2 r_o$ $\frac{r_3}{r_2} = \frac{{n_3}^2 r_0}{{n_2}^2 r_0}$ $\therefore\ r_3 = 21.2 \times 10^{-11} \times \frac{9}{4}$ $= 4.77 \times 10^{-10} m$ b. As kinetic energy = - Total energy = - (- 13.6)eV = 13.6 eV ∴ Kinetic energy in first excited state = $\frac{+13.6}{4}$ =3.4eV Potential energy $= -2 \times KE$ $= -6.8\ eV$	½ ½ ½ ½ ½ ½	3
26.	(i) Values displayed 1+1 (ii) Calculation of maximum distance 1 (i) a. Concern b. Scientific temperament c. Keen observer d. Alertness (or any other two correct values.) (ii) d =$\sqrt{2hR}$ = $\sqrt{2 \times 20 \times 6.4 \times 10^6}$ m = 2 x 8 x 10^3m = 16 km	1+1 ½ ½	3
27.	Calculation of power consumed by the resistance R 3 For loop ABCDA -8 + I_1 + 8(I_1 +I_2) = 0 9 I_1 + 8I_2 = 8 ------------------------(i) For loop ADFEA - 8(I_1 +I_2) + 4 = 0 8I_1 + 8I_2 = 4 2 I_1 + 2I_2 = 1 -----------------------(ii) Simplifying (i) and (ii) I_1 = 4A	½ ½ ½ ½	

$I_2 = -3.5A$

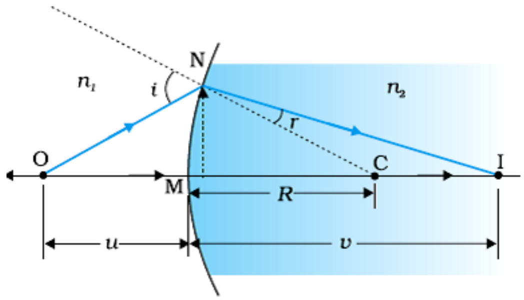
Hence, power consumed by the resistor = $(I_1 + I_2)^2 R$ ½

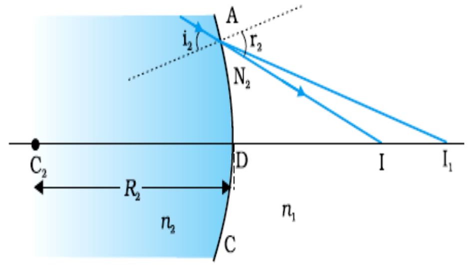
$= (0.5)^2 \times 8$

$= 2$ watt ½ 3

28.

Ray diagram	1
Derivation of relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	2
Obtaining the expression $\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	2





1

The incident rays coming from the object 'O' kept in the rarer medium of refractive index n_1, incident on the refracting surface NM, produce the real image at I.

From the diagram

$\angle i = \angle NOM + \angle NCM$

$= \frac{NM}{OM} + \frac{NM}{MC}$ ½

$\angle r = \angle NCM - \angle NIM$

$= \frac{NM}{MC} - \frac{NM}{MI}$ ½

From Snell's law

$\therefore \frac{n_2}{n_1} = \frac{\sin i}{\sin r} \sim \frac{i}{r}$ (for small angles $\sin\theta \sim \theta$)

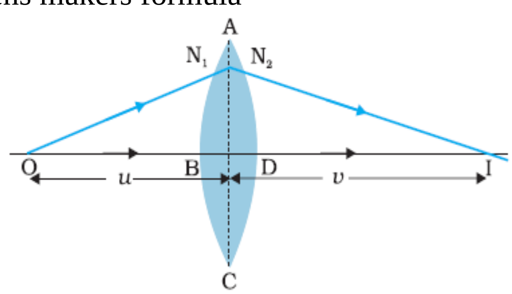
$\therefore n_2 r = n_1 i$ ½

$or\ n_2\left(\frac{NM}{MC} - \frac{NM}{MI}\right) = n_1\left(\frac{NM}{OM} + \frac{NM}{MC}\right)$

$or\ n_2\left(\frac{1}{+R} - \frac{1}{+v}\right) = n_1\left(\frac{1}{-u} + \frac{1}{R}\right)$

$or\ \frac{n_2 - n_1}{R} = \frac{n_2}{v} - \frac{n_1}{u}$ ½

Lens makers formula

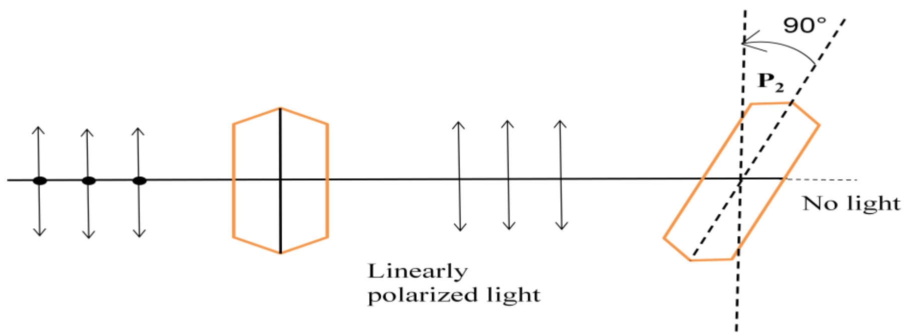
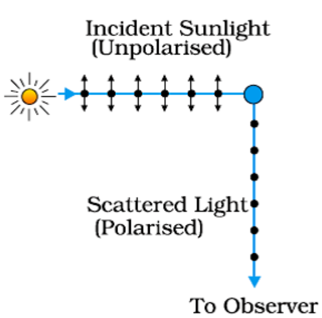


½

The first refracting surface ABC forms the image I_1 of the object O. The image I_1 acts as a virtual object for the second refracting surface ADC which forms the real image I as shown in the diagram

$\therefore$ for refraction at ABC

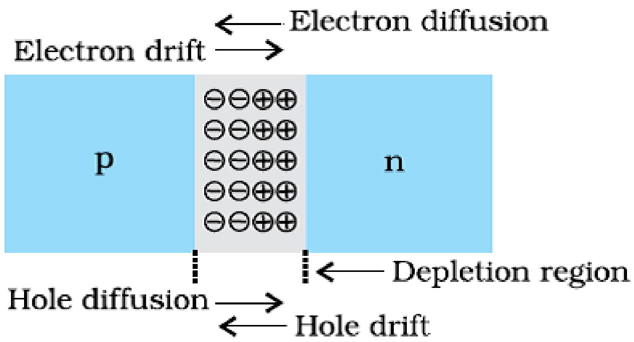
$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$ ---------------------(i)

	For refraction at ADC $\frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1 - n_2}{R_2}$ ---------------------(ii)	½	
	Adding equation (i) and equation (ii), we get $\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	
	$\frac{1}{v} - \frac{1}{u} = (\frac{n_2}{n_1} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ => $\frac{1}{f} = (\mu_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	5
	OR		
	a) Distinguishing between linearly polarized and unpolarized light 1 b) Transverse nature 2 c) Rise or fall of intensity of sunlight 2		
	a) A light wave, in which the electric vector oscillates in all possible directions in a plane perpendicular to the direction of propagation, is known as unpolarized light.	½	
	If the oscillations of the electric vectors are restricted to just one direction, in a plane perpendicular to the direction of propagation, the corresponding light is known as linearly polarized light.	½	
	b)  	1	
	Unpolarized light passing through Polaroid P_1 gets linearly polarized. [As the electric field vector components parallel to the pass axis of P_1 are transmitted whereas the others are blocked].	½	
	When this polarized light is incident on a Polaroid P_2 , kept crossed with respect to P_1, then these components also gets blocked and no light is transmitted beyond P_2.	½	
	c) It is due to scattering of light by molecules of earth's atmosphere  	1	
	Under the influence of the electric field of the incident (unpolarized) wave, the electrons in the molecules acquire components of motion in both these directions. Charges, accelerating parallel to the double arrows, do not radiate energy towards the observer since their acceleration has no transverse component. The radiation scattered by the molecule is therefore represented by dots , i.e. it is polarized perpendicular to plane of figure.	1	5

29.

a) Explanation of Depletion Layer and barrier potential.	1+1
b) Circuit diagram of full wave rectifier	1
Explanation of working and drawing of input and output Waveforms	1+ ½ + ½

a)

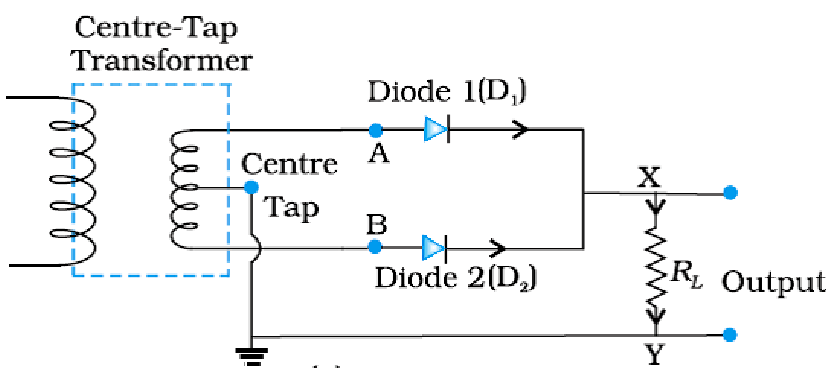


½

Due to the diffusion of electrons and the holes, from their majority zone to minority zone, a layer of positive and negative space charge region on either side of the junction is formed. This is called the depletion region. ½

The loss of electrons, from n-region and gain of electrons by the p-region, causes a difference of potential across the junction. This tends to prevent the movement of charge carriers across the junction and is, therefore, termed as barrier potential. 1

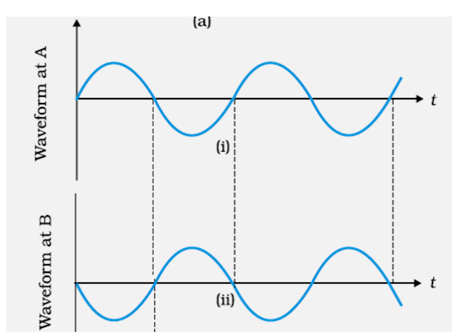
b)



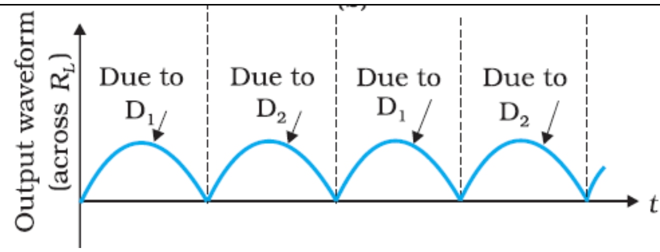
1

For positive half cycle of input ac, one of the two diodes gets forward biased and conducts and output is obtained across the load R_L

For negative half cycle of input ac, the other diode gets forward biased and thus output is obtained due to it. Therefore, output is obtained for both the cycles of input ac. 1



½

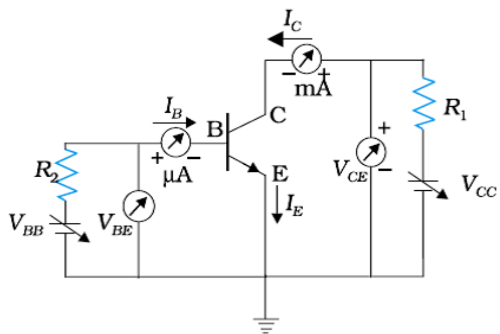


½ 5

OR

a)	Labelled circuit diagram and explanation	1 ½ + 1
b)	Underlying principle and working	1 + 1 ½

a)



1 ½

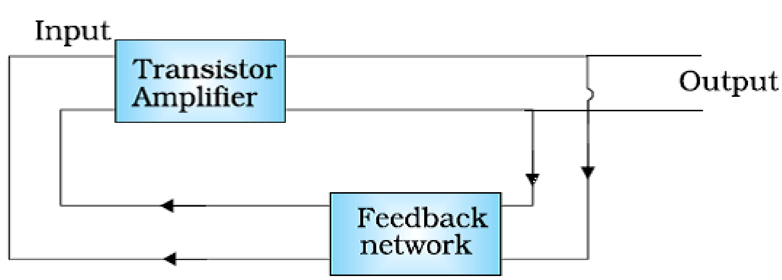
For input characteristics

At constant V_{CE} , for different values of V_{BE}, different values of I_b are obtained. ½

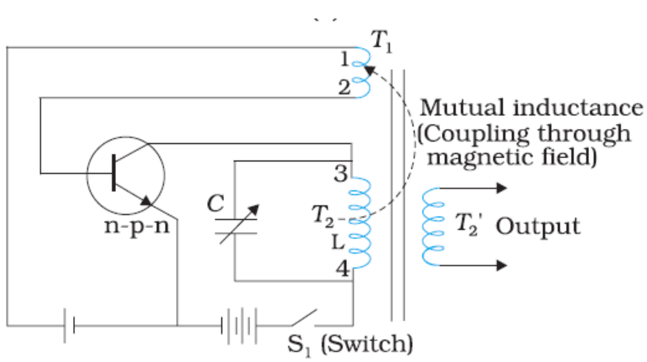
For output characteristics

At constant I_b, for different values of V_{CE}, different values of I_c are obtained. ½

b) A portion of output power is returned at the input in same phase as that of starting power; hence the output in the oscillator gets self sustained. This is termed as positive feedback.



1



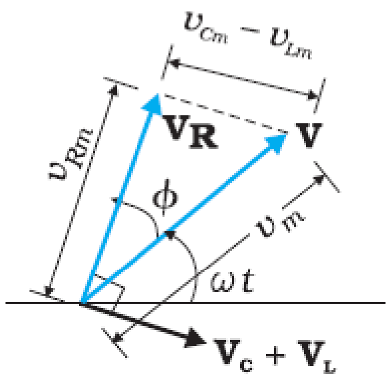
1

As the switch S_1 is closed, a surge of collector current flows through coil T_2, which causes a changing magnetic flux around it. Hence a portion of the output is fedback to the coil T_1, as a result of the positive feedback. The emitter current, therefore, also starts oscillating. ½ 5

30.

a) Derivation of expression for amplitude of current and phase angle	1+1
b) Condition at resonance	½
c) Drawing of plot	1
d) Definition of Q factor and its role in tuning	1 +½

a)



½

From the phasor diagram

$\vec{V} = \vec{V_L} + \vec{V_R} + \vec{V_C}$

Magnitude of net voltage

$V_m = \sqrt{(V_{RM})^2 + (V_{Cm} - V_{Lm})^2}$

$V_m = I_m\sqrt{[R^2 + (X_C - X_L)^2]}$ ½

$I_m = \dfrac{V_m}{\sqrt{[R^2 + (X_C - X_L)^2]}}$ ½

From the figure

$\tan\phi = \dfrac{V_{Cm} - V_{Lm}}{V_{Rm}}$

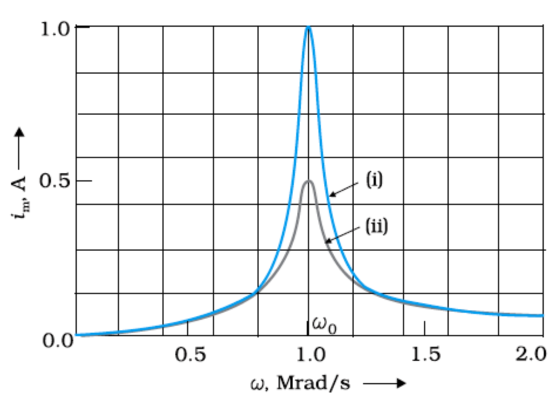
$= \dfrac{I_m(X_C - X_L)}{I_m R}$

$\therefore \phi = \tan^{-1}\left(\dfrac{X_C - X_L}{R}\right)$ ½

b) At resonance, I_m *is maximum*

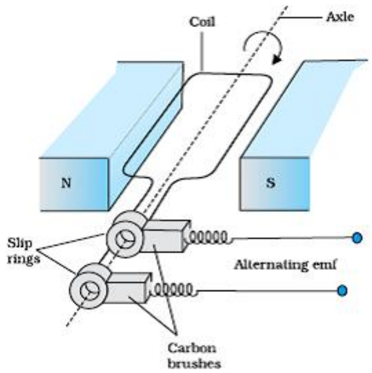
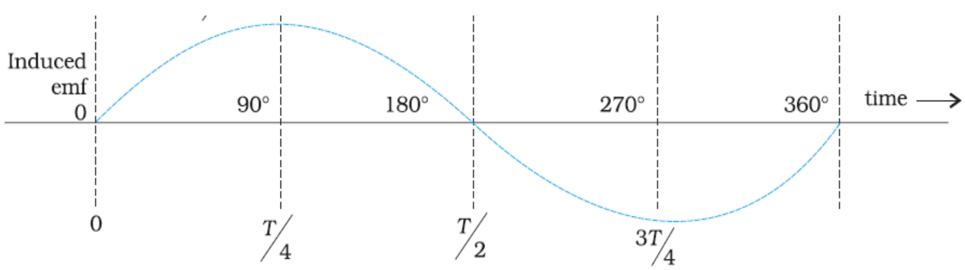
⇨ $X_L = X_c$,

[Alternatively: $\omega_o = \frac{1}{\sqrt{LC}}$] ½



(ii) plot is for R_1

(i) plot is for R_2 ½ + ½

	Quality factor of LCR circuit is defined as $\frac{\omega_o}{2\Delta\omega} = \frac{\omega_o L}{R}$	1	
	A larger value of quality factor corresponds to a sharper resonance.	½	5
	OR		
	a) Labelled diagram & working principle 1+1 b) Explanation of change in magnetic flux ½ c) Derivation of expression of maximum value of induced emf and statement of the rule 1 + ½ d) Showing the variation of emf 1		
	a) 	1	
	It works on the principle of electromagnetic induction, i.e. when a coil continuously rotates in a magnetic field, the magnetic flux associated with it keeps on changing; thus an induced emf is produced in it.	1	
	b) When the coil rotates in a magnetic field, its effective area i.e. A cosθ, (i.e. area normal to the magnetic field) keeps on changing. Hence magnetic flux ϕ= NBAcosθ, keeps on changing.	½	
	c) Let the coil be rotating with angular velocity 'ω', at any instant 't' when the normal to the plane of the coil makes an angle θ with the magnetic field. Hence magnetic flux	½	
	ϕ =NBAcos ωt, Therefore induced emf(e) = - $\frac{d\phi}{dt}$	½	
	⇨ e = NBAωsin ωt Induced emf will be maximum when ωt = 90^0 Hence, e_{max} = NBAω Direction of induced emf can be determined using Flemming's Right hand rule. ***Alternatively:*** Statement of the above rule.	½	
	d) 	1	5