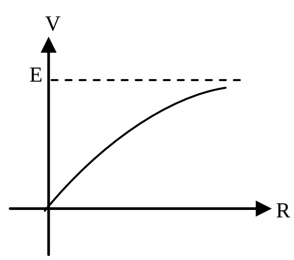
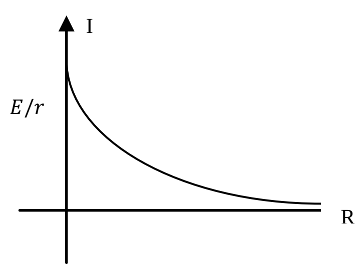
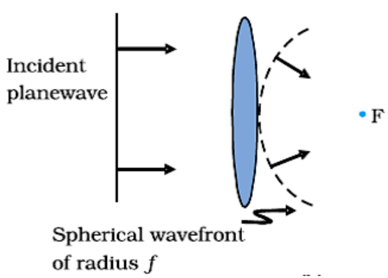
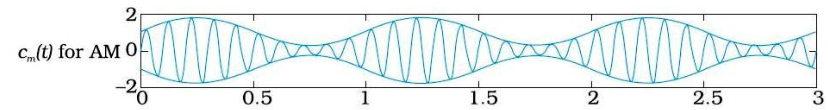
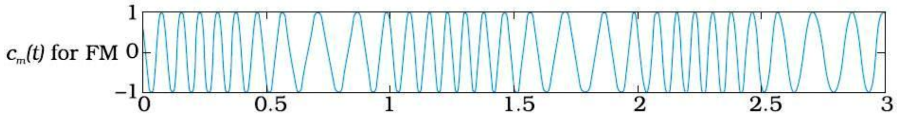
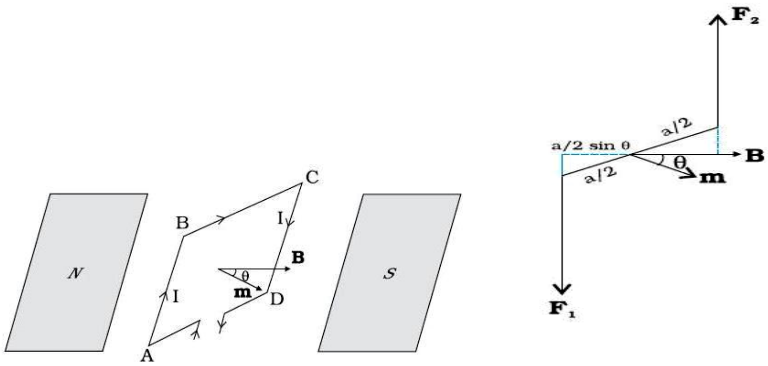
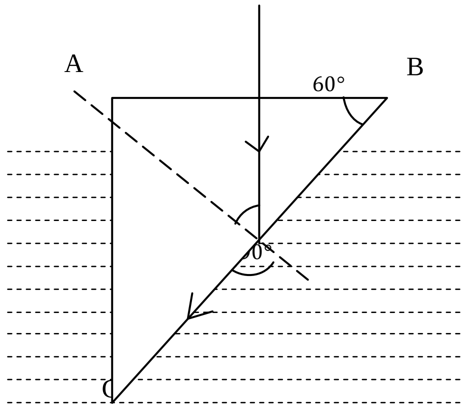
MARKING SCHEME
SET 55/1/A

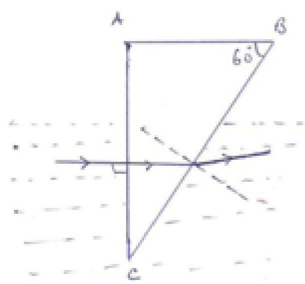
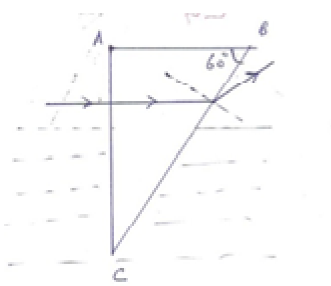
Q. No.	**Expected Answer / Value Points**	**Marks**	**Total Marks**
	Section - A		
Set -1,Q1 Set- 2,Q5 Set-3, Q2	Dielectric Constant of a medium is the ratio of intensity of electric field in free space to that in the dielectric medium. **Alternatively** It is the ratio of capacitance of a capacitor with dielectric medium to that without dielectric medium. **Alternatively** Any other equivalent definition S.I. Unit : No Unit	½ ½	 1
Set -1, Q2 Set- 2, Q4 Set-3, Q5	$T_1 > T_2$ Slope of T_1 is higher than that of T_2. (or Resistance, at T_1, is higher than that of T_2)	½ ½	 1
Set -1, Q3 Set- 2,Q2 Set-3, Q4	No induced current hence no direction.	½ ,½	 1
Set -1, Q4 Set- 2,Q3 Set-3, Q1.	Critical angle depends upon the refractive index (n) of the medium and refractive index is different for different colours of light.	½ +½	 1
Set -1, Q5 Set- 2,Q1 Set-3, Q3.	It rejects dc and **sinusoids** of frequency ω_m, $2\omega_m$ and $2\omega_c$ and retain frequencies ω_c, $\omega_c \pm \omega_m$. (**Alternatively:** It allows only the desired/ required frequencies to pass through it)		1
	Section - B		
Set -1, Q6 Set- 2,Q7 Set-3, Q10	Graph of V vs R 1 Graph of I vs R 1 (i) V vs R: $V = \frac{ER}{R+r}$  (ii) I vs R: $I = \frac{E}{R+r}$  (Award ½ mark in each if child writes only formulae)	 1 1	 2

Set -1, Q7 Set- 2,Q10 Set-3, Q8	de Broglie Relation ½ Dependence of λ on n 1 de Broglie wavelength $\lambda = \frac{h}{mv}$ $\therefore\ \lambda \propto \frac{1}{v}$; $v \propto \frac{1}{n}$ $\therefore \lambda \propto n$ $\therefore$ *de* Broglie wavelength will increase **Alternative method** As $2\pi r_n = n\lambda$; $\lambda = \frac{2\pi r_n}{n}$ $(\lambda \propto \frac{r_n}{n})$ $r_n \propto n^2$ $\therefore\ \lambda \propto \frac{n^2}{n} \Rightarrow \lambda \propto n$ $\therefore$ *de* Broglie wavelength will increase (Note: Accept any other alternative method)	½ 1 ½ 1 ½ ½	2 2
Set -1, Q8 Set- 2,Q6 Set-3, Q9	Definition of Wave front 1 Diagram 1 Wave front : It is the locus of points which oscillate in phase. Or It is a surface of constant phase.  **Or** a) Characteristics & reason ½+½ b) Ratio of Velocity 1 a) Frequency does not change, as frequency is a characteristic of the source of waves. (**Alternatively:** $\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2} = n$) b) The ratio of velocities of wave in two media of refractive indices μ_1 and μ_2 is $\frac{\mu_2}{\mu_1}$. (**Alternatively:** $\frac{v_1}{v_2} = \frac{\mu_1}{\mu_2}$)	1 1 ½+½ 1	 2 2

Set -1, Q9 Set- 2,Q8 Set-3, Q7	Diagrams of AM and FM 1 Reason 1   <u>Why FM is preferred over AM'?</u> Low noise/ disturbance// reduced channel interference// more power can be transmitted// high fidelity. (Any one reason)	½ ½ 1	 2
Set -1,Q10 Set- 2,Q9 Set-3, Q6	Formula ½ Calculation & result 1½ Distance of the closest approach $r_o = \frac{1}{4\pi\epsilon_0} \cdot \frac{2ze^2}{E_\propto}$ $= \frac{2 \times 9\times10^9 \times 80 \times (1.6 \times 10^{-19})^2}{4.5 \times 10^6 \times 1.6 \times 10^{-19}}$ $= 5.12 \times 10^{-14}\ m$	½ 1 ½	 2
Section – C			
Set -1,Q11 Set- 2,Q20 Set-3, Q15	Diagram ½ Force on each arm ½ Calculation of moment of couple 1 Orientation in stable equilibrium 1		

	 Force on each perpendicular arm $F_1 = F_2 = I\ b\ B$ Moment of couple = $I\ b\ B.a \sin\theta$ $\tau = I\ ab\ B\ sin\theta$ $\tau = \mathrm{I}\ AB\ sin\theta \quad \vec{\tau} = \mathrm{I}\vec{A} \times \vec{B}$ When the plane of the loop is perpendicular to the magnetic field, the loop will be in stable equilibrium ($\vec{A} \parallel \vec{B}$), $\Longrightarrow \theta = 0°$ (If the student follows the following approach, award ½ marks only) $\vec{M} =$ Equivalent magnetic moment of the planer loop = $\mathrm{I}\vec{A}$ ∴ Torque = $\vec{M} \times \vec{B} = \mathrm{I}\vec{A} \times \vec{B}$ $\lvert Torque \rvert = \mathrm{IAB}sin\theta$	½ ½ 1 ½ ½	3
Set -1,Q12 Set- 2,Q21 Set-3, Q16	Production of em waves 1 Source of energy 1 Identification ½+½ Electromagnetic waves are produced by accelerated / oscillating charges which produces oscillating electric field and magnetic field (which regenerate each other). Source of the Energy: Energy of the accelerated charge. (or the source that accelerates the charges) Identification: (1) Infra red radiation (2) X - rays	1 1 ½ ½	3
Set -1,Q13 Set- 2,Q22 Set-3, Q17	a) To draw path of light ray in prism ½ Formula and calculation of refractive index of liquid 1½ b) Tracing the path of the ray 1		

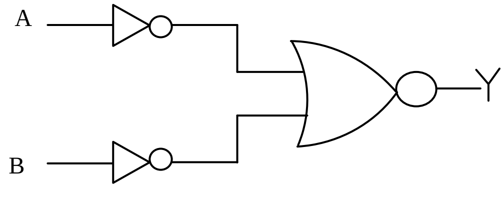
<table>
<tr><td></td><td>a)

$$sin i_c = \frac{1}{\mu_{mg}} = \frac{\mu_m}{\mu_g}$$
⇨ $\mu_m = \mu_g sin i_c$
$=1.5 \times \frac{\sqrt{3}}{2} \quad (i_c = 60°)$
$= 1.299 \simeq 1.3$

(b)


Alternatively</td><td>½

½

½
½

1</td><td>

3</td></tr>
<tr><td>Set -1,Q14
Set- 2,Q16
Set-3, Q18</td><td><table><tr><td>Logic circuit –</td><td>1</td></tr><tr><td>Truth Table -</td><td>1</td></tr><tr><td>Identification -</td><td>1</td></tr></table>
To draw the logic circuit
</td><td>1</td><td></td></tr>
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<table>
<tr><td></td><td>Truth Table

<table><tr><th>A</th><th>B</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>
Identification : AND gate

Or

Identification of logic operation in circuit (a) & (b) ½+½
Truth table for circuit (a) & (b) ½+½
Identification of equivalent gates ½+½

Logic Operation a) Y = A.B
b) Y = A+B

Truth Table

a)
<table><tr><th>A</th><th>B</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>
b)
<table><tr><th>A</th><th>B</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>
Identification
a) AND gate
b) OR gate</td><td>1

1

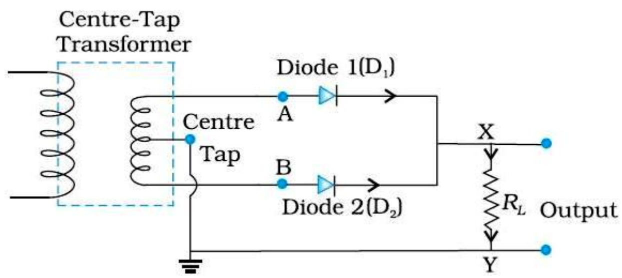
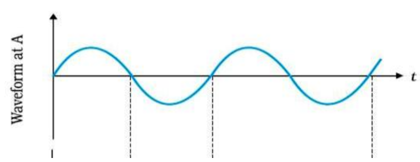
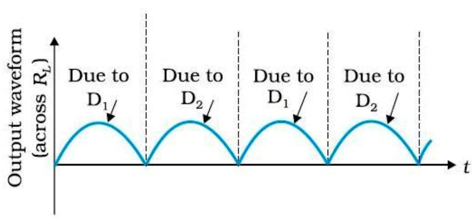
½
½

½

½

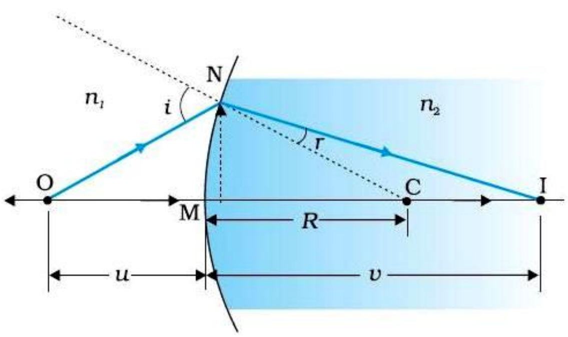
½
½</td><td>3

3</td></tr>
<tr><td>Set -1,Q15
Set- 2,Q17
Set-3, Q11</td><td>Circuit diagram 1
Working ½
Wave forms and Input & Output ½+½
Characteristic property ½</td><td></td><td></td></tr>
</table>

	Circuit Diagram  Description of Working- During the positive half of input ac diode D_1 get forward bias and D_2, reverse biased and during negative half of input ac, polarity get reversed, D_2 get forward bias and D_1 reverse bias. Hence, output is obtained across R_L during entire cycle of ac. Wave forms Input  Output  **<u>Characteristic property</u>** Diode allows the current to pass only when it is forward based.	1 ½ ½ ½ ½	3
Set -1,Q16 Set- 2,Q18 Set-3, Q12	Explanation of (i), (ii) and (iii) with justification 1×3 (i) Drift velocity will become half as $v_d \propto V$ (ii) Drift velocity will become half as $v_d \propto \frac{1}{L}$ (iii) Drift velocity will remain the same as v_d is independent of diameter (D).	½+½ ½+½ ½+½	3
Set -1,Q17 Set- 2,Q19 Set-3, Q13	Determination of magnetic field 1½ Determination of kinetic energy in MeV 1½		

	Magnetic field $B = 2\pi mv/q$ $= \frac{2 \times 3.14 \times 1.67 \times 10^{-27} \times 10^{7}}{1.6 \times 10^{-19}} = 0.66T$ Final velocity of proton $v = R \times 2\pi v = 0.6 \times 2 \times 3.14 \times 10^{7}$ $= 3.77 \times 10^{7} m/s$ Energy = $\frac{1}{2}mv^{2} = \frac{1}{2} \times 1.67 \times 10^{-27} \times (3.77 \times 10^{7})^{2} j$ $= 7.4\ MeV$	½ 1 ½ ½ ½	3
Set -1,Q18 Set- 2,Q11 Set-3, Q14	a) Calculation of distance of third bright fringe 1 b) Calculation of distance from the central maxima 2 a) Distance of third bright fringe-$y_3 = \frac{n\lambda D}{d}$ $= \frac{3 \times 520 \times 10^{-9} \times 1}{1.5 \times 10^{-3}}$ $= 1.04 \times 10^{-3} m \simeq 1\ mm$ b) Let n^{th} maxima of $650nm$ coincides with the $(n+1)^{th}$ maxima of $520nm$ $\therefore n \times 650 \times 10^{-9} = (n+1)520 \times 10^{-9}$ $\Rightarrow n = 4$ $\therefore$ The least distance of the point is given by $y = \frac{nD\lambda_1}{d}$ $= \frac{4 \times 1 \times 650 \times 10^{-9}}{1.5 \times 10^{-3}} m = 1.733 \times 10^{-3} m \simeq 1.7mm$	½ ½ ½ ½ 1	3
Set -1,Q19 Set- 2,Q12 Set-3, Q21	a) Pointing out and Reason of two processes 1+1 b) Identification of radioactive radiations ½+½ a) Nuclear fission of E to D and C; as there is a increase in binding energy per nucleon b) Nuclear fusion of A and B into C; as there is a increase in binding energy per nucleon b) First step - $\propto$ particle Second step – β particle	½ + ½ ½ + ½ ½ ½	3

Set -1,Q20 Set- 2,Q13 Set-3, Q22	Three modes of propagation 1½ Brief explanation of reflection by Ionosphere 1 Effect of increased frequency range ½ Three modes of propagation i) Ground Waves ii) Sky Waves iii) Space Waves Ionosphere acts as a reflector for the range of frequencies from few MHz to 30 MHz . The ionospheric layers bend the radio waves back to the Earth. Waves of frequencies greater than 30 MHz penetrate the ionosphere and escape	 ½ ½ ½ 1 ½	3
Set -1,Q21 Set- 2,Q14 Set-3, Q19	Definition of Stopping Potential and threshold frequency 1+1 Determination using Einstein's Equation 1 Stopping Potential: The minimum negative potential applied to the anode/ plate for which photoelectric current become zero. Threshold frequency: The minimum (cut off) frequency of incident radiation, below which no emission of photoelectrons takes place. By Einstein's Equation $eV_0 = hv - \phi_o$ For any given frequency $v > v_o, V_o$ can be determined. Stopping Potential $V_0 = \left(\frac{h}{e}\right) v - \frac{\phi_o}{e}$ as $\phi_0 = hv_0$ Threshold frequency, $V_0 = \frac{\phi_0}{h}$	 1 1 ½ ½	3
Set -1,Q22 Set- 2,Q15 Set-3, Q20	Calculation of voltage across each capacitor in (a), (b) and (c) 1½ Explanation with reason for the change/no change 1½ (a) $V_L = 3V$ $V_R = 3V$ (L: Left, R: Right) (b) $V_L = 6V$ $V_R = 3V$ (c) $V_L = 2V$ $V_R = 3V$ <u>Reasons</u> (a) No change – (potential same on both capacitors as ($V_L = V_R$)) (b) Charge on left hand capacitor will decrease ($V_L > V_R$) (c) Charge on left hand capacitor will increase ($V_R > V_L$)	 ½ ½ ½ ½ ½ ½	3

Set -1,Q23 Set- 2,Q23 Set-3, Q23	(a) Naming the principle involved — 1 (b) Explanation — 1 (c) Two qualities — 2 (a) Metal detector works on the principle of resonance in ac circuits. (b) When a person walks through the gate of a metal detector, the impedance of the circuit changes, resulting in significant change in current in the circuit that causes a sound to be emitted as an alarm. (c) Two qualities (i) Following the rules/regulations (ii) Responsible citizen (iii) Scientific temperament (iv) Knowledgable (Any two)	1 1 1+1	4
	Section - E		
Set -1,Q24 Set- 2,Q26 Set-3, Q25	(a) Drawing labeled ray diagram — 1½ (b) Deducing relation between u , v and R — 2½ (c) Obtaining condition for real image — 1  From the diagram : $\angle i = \angle NOM + \angle NCM$ $\angle r = \angle NCM - \angle NIM$ By Snell's law , $n_1 \sin i = n_2 \sin r$ Substituting for i and r. and simplifying, we get $\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$ Substituting values of OM , MI and MC $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	1½ ½ ½ ½ ½ ½	

(b)Condition for real image : v is positive

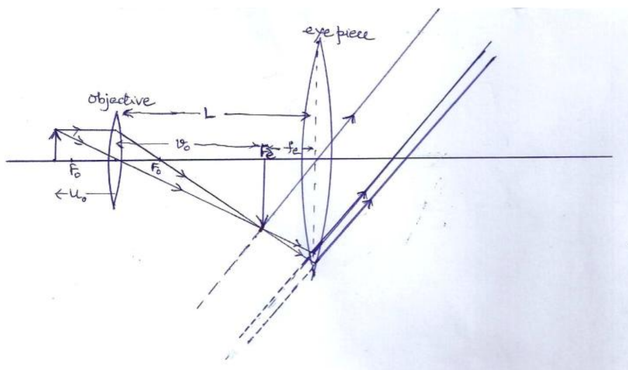
$$\therefore \frac{n_2}{v} > 0$$ ½

From the derived relation , we have $\frac{n_1}{|u|} < \frac{n_2 - n_1}{R}$

$$\therefore |u| > \frac{n_1 R}{n_2 - n_1}$$ ½ 5

OR

(a)	Ray diagram	1½
	Derivation of expression for magnifying power	1½
(b)	Effect on resolving power in each case; with justification	1+1



1½

(Award 1 mark if the student draws the diagram for image at distance of distinct vision, deduct ½ mark for not showing the direction of Propogation of ray)

Derivation:

- Magnification due to objective ½

$$m_o = \frac{L}{f_o}$$

- Magnification due to eyelens ½

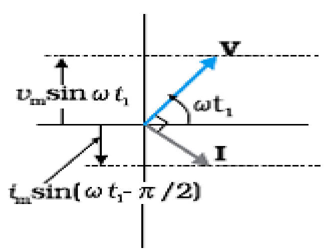
$$m_e = \frac{D}{f_e}$$

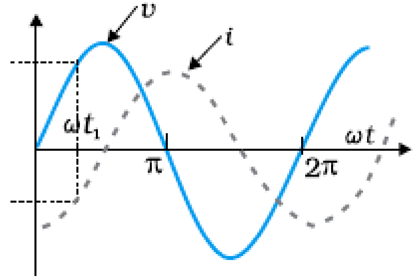
- Total magnification $m = m_o m_e$ ½

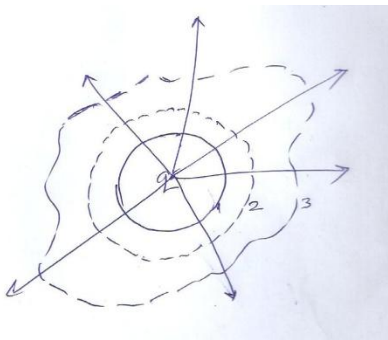
$$m_o = \frac{L}{f_o} . \frac{D}{f_e}$$

(b) The resolving power of microscope 1

(i) Will decrease with decrease of the diameter of objective lens as resolving power is directly proportional to the diameter 5

	(ii) Will decrease with increase of the wavelength of the incident light as resolving power is inversely proportional to the wave length	1	
Set -1,Q25 Set- 2,Q24 Set-3, Q26	(a) Faraday's law 1 (b) Explanation with example 2 (c) Derivation for induced emf 2		
	(a) Faraday's law – "The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit." (Alternatively : Induced emf = $\frac{-d\emptyset}{dt}$)	1	
	(b) A bar magnet experiences a repulsive force when brought near a closed coil and attractive force when moved away from the coil, due to induced current. Therefore, external work is required to be done in the process.	2	
	(c) Since workdone is moving the charge 'q' across the length 'l' of the conductor is W=qvBl Since emf is the work done per unit charge $\mathcal{E} = \frac{W}{q}$ $\mathcal{E}$ = Blv	1 1	5
	OR (a) Derivation for the current using phasor diagram 1 Plot of graphs (i) and (ii) 1+1 (b) Derivation for the average power 2		
	Phasor diagram for the circuit:  	½	
	From the Phasor diagram: V makes an angle 'ωt' with axis, current 'I' lags behind the voltage 'V' by $\frac{\pi}{2}$, (makes an angle of – ($\frac{\pi}{2} - wt$) with the axis.) $\therefore, i = i_m \sin\left[-\left(\frac{\pi}{2} - \omega t\right)\right] = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$ [Award this 1mark even if derivation is done by analytical method]	½	

<table>
<tr>
<td></td>
<td>Graph showing variation of voltage and current as function of ωt

Instantaneous power in LCR circuit:
p = v × i
= $v_m \sin \omega t \times i_m \sin(\omega t + \varphi)$
p = $\frac{v_m i_m}{2}$ $[\cos\varphi - \cos(2\omega t + \varphi)]$
average power $P_{av} = \frac{v_m i_m}{2} \cos\varphi$
$P_{av} = \frac{v_m}{\sqrt{2}} \frac{i_m}{\sqrt{2}} \cos\varphi$
$P = V_{eff} I_{eff} \cos\phi$</td>
<td>1+1
½
½
½
½</td>
<td>5</td>
</tr>
<tr>
<td>Set -1,Q26
Set- 2,Q25
Set-3, Q24</td>
<td>a)Statement of Gauss law 1
Explanation with diagram 1
b)Magnitude and direction of net electric field in (i) and (ii) 1½ +1 ½

(a) Gauss Law: Electric flux through a closed surface is $\frac{1}{\epsilon_0}$ times the total charge enclosed by the surface.
Alternatively: $\phi = \frac{1}{\epsilon_0} . q$
The term q equals the sum of all charges enclosed by the surface and remain unchanged with the size and shape of the surface.
Alternatively- The total number of electric field lines emanating from the enclosed charge ‘q’ are same for all surfaces 1,2 &3

(b) We have $|E_1| = \frac{\sigma}{\epsilon_o}; |E_2| = \frac{2\sigma}{\epsilon_o}$
(i) Between the plates
$E_{in} = E_1 + E_2$</td>
<td>1
½
½
1</td>
<td></td>
</tr>
</table>

$= \frac{\sigma}{2\epsilon_o} + \frac{2\sigma}{2\epsilon_o} = \frac{3\sigma}{2\epsilon_o}$ ½

(Directed towards sheet '2')

(ii) Outside near the sheet '1' ½

$E_{out} = E_2 - E_1$ 5

$= \frac{2\sigma}{2\epsilon_o} - \frac{\sigma}{2\epsilon_o} = \frac{\sigma}{2\epsilon_o}$

(Directed towards sheet '2')

OR

a) Definition of electrostatic potential and SI unit	1+½
Derivation for the electrostatic potential energy	1+½
b) Equipotential surface for (i) & (ii)	1+1

5

a) Electrostatic potential : Work done by an external force in bringing a unit positive charge from infinity to the given point 1

SI unit- volt or J/C)

Net work done in moving charges $q_1 . q_2$ &q_3 from infinity to A, B and C respectively ½

$$W = 0 + q_2 V_{13} + q_3 (V_{13} V_{23})$$

½

$$= \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{12}} + \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$$

½

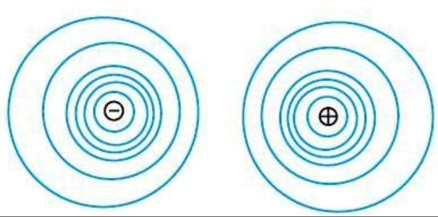
But potential energy of the system is equal to the work done.

$$\therefore U = w = \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$$

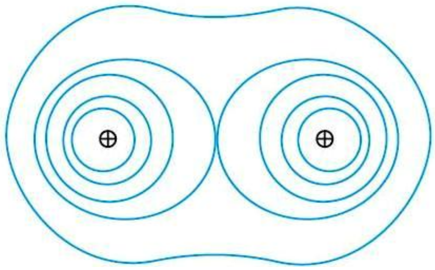
(Award these 1 mark if the student directly writes the expression for U) ½

(b) Equipotential surface due to

(i) An electric dipole



1

	(ii) Two identical positive changes 	1	5