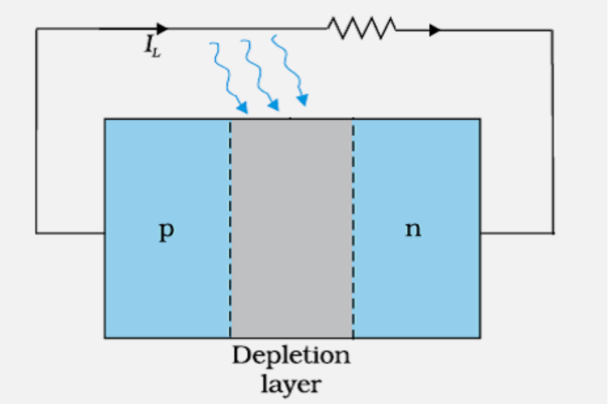
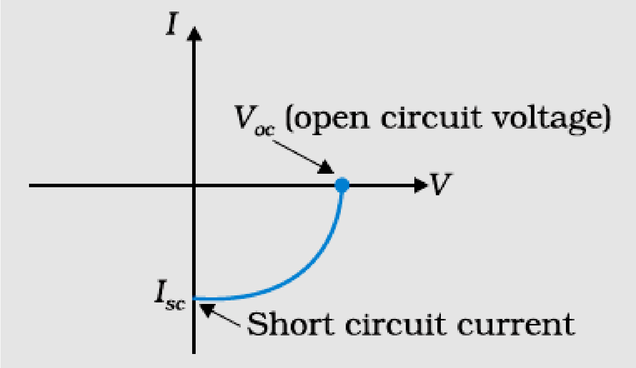
MARKING SCHEME
SET 55/1/G

Q. No.	Expected Answer / Value Points	Marks	Total Marks
Section A			
Set1,Q1 Set2,Q5 Set3,Q2	Capacitive Reason: As current leads voltage (by phase angle $\frac{\pi}{2}$)	½ ½	1
Set1,Q2 Set2,Q4 Set3,Q5	X – Transmitter Y - Channel	½ ½	1
Set1,Q3 Set2,Q2 Set3,Q4	Focal length gets doubled. Power is halved.	½ ½	1
Set1,Q4 Set2,Q3 Set3,Q1	Copper wire is longer. Reason: $\rho_C l_C = \rho_m l_m \quad (as\ \rho l = constant)$ $\therefore\ l_c > l_m \because \rho_m > \rho_c$	½ ½	1
Set1,Q5 Set2,Q1 Set3,Q3	Positive Reason: Negative charge moves from a point at a lower potential energy to one at a higher potential energy.	½ ½	1
Section B			
Set1,Q6 Set2,Q7 Set3,Q10	Definition of Power loss ½ Form in which the power loss appear ½ Proof- (To minimise power loss in transmission cables 1 Voltage should be high) Electrical energy lost per second in the resistor, is Power loss ∵ Power loss appears in the form of heat/ e. m. radiations. Consider a device ‘R’, to which power P is to be delivered via transmission cables having a resistance R_C , Let V be the voltage across ‘R’ , and I be the current through it, then $P = V I \qquad \therefore I = \frac{P}{V}$ Power dissipated in the cable (P_C) $= I^2 R_C$ $= \frac{P^2 R_c}{V^2}$ $\therefore\ P_c \propto \frac{1}{V^2}$ ∴ Energy transmission, at high voltage, minimizes the power loss.	½ ½ ½ ½	2
Set1,Q7 Set2,Q10 Set3,Q8	Formula 1 Calculation of kinetic energy 1		

	$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m\, E_k}}$ $\therefore\ \lambda^2 = \frac{h^2}{2m\, E_k}$ $E_k = \frac{(6.63\ \times\ 10^{-34})^2}{2 \times 9.1 \times 10^{-31} \times (589 \times 10^{-9)^{2}}}\ J$ $= 6.95\ \times\ 10^{-25} J$ Alternatively ,$E_k\ = 4.35\ \mu\ eV$	½ ½ ½ ½	2
Set1,Q8 Set2,Q6 Set3,Q9	Formula ½ Calculation & result 1 ½ $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (i) $\therefore\ \frac{1}{f} = \frac{1}{90-u} - \frac{1}{-u} = \frac{1}{90-u} + \frac{1}{u}$ --------------(1) (ii) $\frac{1}{f} = \frac{1}{70-u} - \frac{1}{-(u+20)} = \frac{1}{70-u} + \frac{1}{u+20}$ ---------------(2) Solving eq^n (1) and (2), u=35 cm Using lens formula f = 21.4 cm (Alternatively if a candidate calculates the focal length by using the formula 4 $f\,D$=$D^2 - d^2$, award full marks.)	½ ½ ½ ½	2
Set1,Q9 Set2,Q8 Set3,Q7	(a) Value of Z ½ Value of A ½ (b) Explanation 1 (a) Z= 56 A=89 (b) Difference in the total mass of the nuclei on the two sides of the reaction gets converted into energy or vice versa **Alternatively.** The number is conserved but the B.E./ nucleon can be different for different nuclei.	½ ½ 1	2
Set1,Q10 Set2,Q9 Set3,Q6	Explanation (4 steps) ½ ×4=2 Mobile telephony takes place in following ways: (i) Physical area is divided into smaller cell zones. (ii) Radio antenna in each cell receives and transmits radio signals, to and from, mobile phones. (iii) These radio antenna are connected to each other through a network. (Controlled and managed by a central control room called Mobile Telephone Switching Office (MTSO)) (iv) MTSO records the location and identifies the cell of the mobile phone.	½ ½ ½ ½	2

	OR Basic mode of communication ½ Type of mode 1 Expression for d ½ Line of sight / Broadcast Space wave $d = \sqrt{2Rh_1} + \sqrt{2Rh_2}$, R is radius of earth (Also accept if the student writes $d \propto \sqrt{h}$)	½ 1 ½	2
	Section C		
Set1,Q11 Set2,Q20 Set3,Q15	(a) Equivalent capacitance 1 (b) Charge on each capacitor 1+1 (a) Equivalent capacitance (C_n) $=\frac{C}{3} + C$ $= \frac{4C}{3} = \frac{40}{3}\ \mu F$ (b) Charge on C_4, $q_4 = C_4 \times V = 10 \times 500\ \mu C$ $= 5 \times 10^{-3}$ C=5mC Charge on C_1, C_2, C_3 is same and is equal to $\frac{C}{3} \times V$ $= \frac{5}{3} \times 10^{-3} C$ =1.67 mC	½ ½ ½ ½ ½ ½	3
Set1,Q12 Set2,Q21 Set3,Q16	Current drawn from the source 1 P.D across C and D 1 P.D across one of the diagonals 1 Net resistance of the circuit, $R_{eq} = 3\ \Omega$ ∴ Current, $I = \frac{V}{R_{eq}} = \frac{9}{3} = 3$ A P.D across CD, $V_{CD} = I_{CD} \times R_{CD}$ $= \left(3 \times \frac{1}{4} A\right) \times 4\Omega = 3V$ When the wire is stretched to double its length, each resistance becomes four times, i.e. 16Ω each. P.D across one of the diagonal, V_{AC} or $V_{BD} = \left(\frac{9}{12} \times \frac{1}{4} A\right) \times 32\Omega = 6$ V	½ ½ ½ ½ ½ ½	3
Set1,Q13 Set2,Q22 Set3,Q17	Path of the electron ½ Determination of frequency of revolution 1 ½ Dependence of frequency on speed ½ Explanation / Reason ½ The force, on the electron, due to the magnetic field, at any instant is perpendicular to its instantaneous velocity.	½	

	Alternatively, Because necessary centripetal force is provided by Lorentz magnetic force acting on the electron. $\nu = \frac{qB}{2\pi m}$ $= \frac{1.6\times10^{-19}\times6.5\times10^{-4}}{2\times3.14\times9.1\times10^{-31}}$ Hz $= 1.8 \times 10^{7}\, Hz$ No As $\nu = \frac{qB}{2\pi m}$ i.e. ν is independent of v	½ ½ ½ ½ ½	3
Set1,Q14 Set2,Q16 Set3,Q18	Circuit Diagram ½ Three basic processes 1 ½ I-V characteristics of solar cell ½ Important criteria ½  Three basic processes which take place to generate the emf in a solar cell are: (i) Generation of electron hole pairs due to the light incident close to the junction. (ii) Seperation of electrons and holes due to the electric field of the depletion region. (iii) Collection of electrons and holes by n-side and p-side respectively. I-V characteristics of solar cell 	½ ½ ½ ½ ½	

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Any one criteria of the following:
(i) Small band gap (1.0 to 1.8 eV)
(ii) High optical absorption
(iii) Electrical conductivity
(iv) Availability of raw material
(v) Cost

OR
<table>
<tr><td>Fabrication of LED</td><td>½</td></tr>
<tr><td>Working</td><td>1</td></tr>
<tr><td>Three advantages of LEDs</td><td>1 ½</td></tr>
</table>

An LED is fabricated from a semiconductor having a band gap ≥ 1.8 eV / LEDs of different colours are made from compound semiconductors.

Working
When LED is forward biased, the electrons move from n→p and holes from p→n; thus concentration of minority charge carriers at the junction increases.

Excess minority charge carriers combine with majority charge carriers near the junction and release energy as photons.

Advantages (Any three)
(i) Low operational voltage and less power
(ii) Fast action and no warm-up time required.
(iii) The bandwidth of emitted light is 100Å to 500 Å or, in other words, it is nearly (but not exactly) monochromatic
(iv) Long life and ruggedness
(v) Fast on-off switching capability
</td>
<td>½

½

½

½

½ ×3
=1 ½</td>
<td>3

3</td>
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<tr>
<td>Set1,Q15
Set2,Q17
Set3,Q11</td>
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<table>
<tr><td>Comparison and Explanation of three distinguishing features.</td><td>3</td></tr>
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<table>
<tr><th>Interference</th><th>Diffraction</th></tr>
<tr><td>1)Equally spaced fringes

2)All maxima have equal brightness
3)Formed by superposition of wavefronts from two coherent sources
4)There is a maxima at the angle λ/a
5)Quite a large number of fringes are easily observable</td><td>1)Fringes are not equally spaced
2)Intensity of maxima keeps on decreasing
3)Formed through superposition of wavelets from a single wavefront
4)First minima occurs at an angle λ/a
5)It becomes difficult to distinguish maxima and minima after a few fringes</td></tr>
</table>
(Any three)
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<td>1 ×3</td>
<td>3</td>
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Set1,Q16
Set2,Q18
Set3,Q12

Expression for K.E	2
Relation for P.E	1

For an electron (mass 'm' and charge 'e') revolving in nth stable circular orbit of radius 'r_n' , with velocity v_n , in the hydrogen atom (z=1), we have ½

$$\frac{m{v_n}^2}{r_n} = \frac{1}{4\pi\varepsilon_o}\frac{e^2}{{r_n}^2}$$ ½

$$\therefore\ E_k = \frac{1}{2}\, m{v_n}^2 = \frac{e^2}{8\pi\epsilon_o r_n}$$ 1

$$\therefore\ E_p = \frac{1}{4\pi\epsilon_o}\frac{(+e)\times(-e)}{r_n}$$ ½

$$= -\frac{e^2}{4\pi\epsilon_o\, r_n}$$ ½

3

Set1,Q17
Set2,Q19
Set3,Q13

Showing that AND gate followed by NOT gate is NAND gate	1
Truth table of NAND gate	1
Why is NAND gate called universal gate?	1

A	B	Output of AND gate (Input of NOT gate)	Output of NOT gate
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

1

Truth table of NAND Gate		
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

1

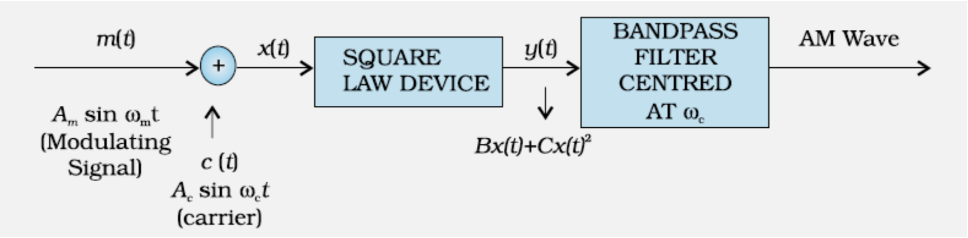
NAND gate is called universal gate because all other basic gates like AND, OR, NOT gate, can be realised by using NAND gates only. 1

3

Set1,Q18
Set2,Q11
Set3,Q14

Block Diagram / Explanation of AM	1
Can AM wave be transmitted as such	1
Explanation	1

Block Diagram



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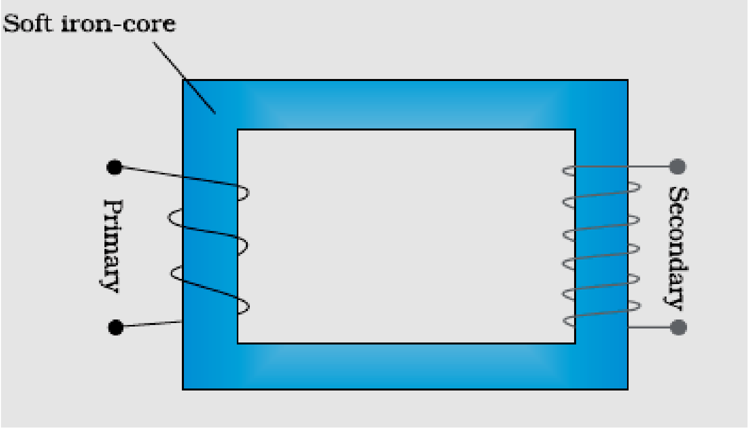
	Alternatively, Explanation of Amplitude Modulation No / AM wave cannot be transmitted as such **Explanation** The A.M. wave has to be fed to power amplifier to provide the necessary power. It is then fed to the antenna for transmission.	1 1	3
Set1,Q19 Set2,Q12 Set3,Q21	(a) Formula 1 Calculation of number of photons per second 1 (b) Identification of Metal ½ Reason/explanation ½ (a) $P = Nh\nu$ $N = \frac{2 \times 10^{-3}}{(6.63 \times 10^{-34} \times 6.0 \times 10^{14})}$ $N = 5.0 \times 10^{15}\ photons\ per\ second$ (b) Metal X $(K.E = h\nu - \phi_o)$ / $\because\ \phi_y > \phi_x, \therefore (K.E)_x > (K.E)_y$	1 ½ ½ ½ ½	3
Set1,Q20 Set2,Q13 Set3,Q22	(a) Formula ½ Calculation and Result 1 (b) Formula ½ Calculation and Result 1 (a) $\Delta\theta = \frac{1.22\lambda}{D}$ $= \frac{1.22 \times 6 \times 10^{-7}}{2.5}\ radian$ $\simeq 2.9\ \times 10^{-7}\ radian$ (b) $10\frac{\lambda D}{d} = 2\frac{\lambda}{a}$ $a = \frac{d}{5D} = \frac{10^{-3}}{5 \times 1}\ m$ $=2\times10^{-4}$ m=0.2 mm	½ ½ ½ ½ ½ ½	3
Set1,Q21 Set2,Q14 Set3,Q19	(a) Derivation for induced emf 2 (b) Expression for power 1 (a) Emf induced $=\int_0^l Bwrdr$ $= \frac{1}{2}Bwl^2$ $\because \omega = 2\pi\nu$ $\therefore \varepsilon = \pi B\nu l^2$ (b) $P = \frac{\epsilon^2}{R} = \frac{(\pi B\nu l^2)^2}{R}$ $= \frac{\pi^2 B^2 \nu^2 l^4}{R}$	½ ½ 1 ½ ½	3

Set1,Q22 Set2,Q15 Set3,Q20	Expression for generalized Ampere's Circuital law 1 Explanation of significance of time dependent term 1 Suitable Example 1 $\oint \vec{B} . \vec{dl} = \mu_o i_c + \mu_o \varepsilon_o \frac{d\phi_E}{dt}$ $= \mu_o \left(i_c + \varepsilon_o \frac{d\phi_E}{dt} \right) = \mu_o (i_C + i_D)$ The time dependent term i.e. $\varepsilon_o \frac{d\phi_E}{dt}$ represents the displacement current. It exists in the region in which the electric flux (φ_o) i.e. the electric field ($\vec{E}$) changes with time. Example- During charging or discharging of a capacitor, the current in the wire connecting the capacitor plates to the source is conduction current whereas in between the plates it is displacement current due to the change of electric field between the plates which makes the circuit complete. The conduction current is always equal to the displacement current.	1 ½ ½ ½ ½	3
Section D			
Set1,Q23 Set2,Q23 Set3,Q23	a) Principle of a dynamo 1 Working of a dynamo 1 b) Two values displayed by Hari ½ + ½ Two values displayed by Science teacher ½ + ½ (a) Principle When magnetic flux through a coil changes , an emf is induced across its ends. Working : When the coil (Armature) is rotated in a uniform magnetic field by some external means , the magnetic flux through it changes . So an emf is induced across the ends of the coil connected to an external circuit by means of slip rings and brushes. (b) Two values displayed by Hari (Any two) Scientific temperament / curiosity / learning attitude / any other quality Two values displayed by Science teacher (Any two) Responsive / caring and concerned / encouraging / any other quality	1 1 ½ + ½ ½ + ½	4
Section E			
Set1,Q24 Set2,Q26 Set3,Q25	(a) Principle of working of a transformer 1 Labelled Diagram 1 (b) Deducing expression for the ratio of (i) Output voltage to input voltage 1 (ii) Output current to input current 1 (c) One main source of energy loss ½ How is the energy loss reduced? ½		

(a) Principle of working :

When the current through the primary coil changes , the magnetic flux linked with the secondary coil also changes . Hence an emf is induced across the ends of the secondary coil. 1

(If the student just writes , ‘mutual induction’ , award ½ mark)



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(b) (i) $\frac{V_S}{V_P} = -N_S\frac{d\varphi}{dt} / (-N_P)\frac{d\varphi}{dt}$ ½

$= \frac{N_S}{N_P}$ ½

(ii) $V_S I_S = V_P I_P$ ½

$\therefore \frac{I_S}{I_P} = \frac{N_P}{N_S}$ ½

(c) Main source of energy losses (any one)

Flux leakage / Joule’s loss / loss due to eddy currents / Hysteresis loss ½

How they are reduced (any one in the same order)

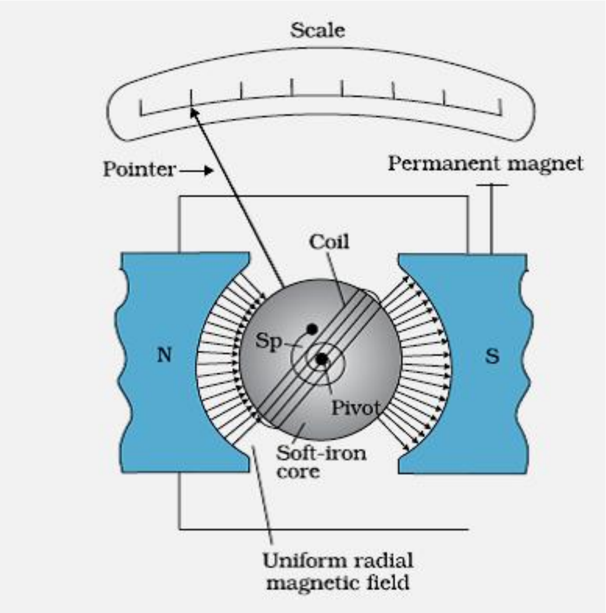
Winding the primary and secondary coils one over the other / using thick wires / having laminated core / using a magnetic materal which has a low hysterisis loss ½ 5

OR

(a) Labelled diagram of a moving coil galvanometer 1
Working Principle ½
Function of soft iron core ½

(b) Definition of
(i) Current sensitivity ½
(ii) Voltage sensitivity ½

(c) Underlying Principle used in converting a galvanometer into
(i) Voltmeter 1
(ii) Ammeter 1

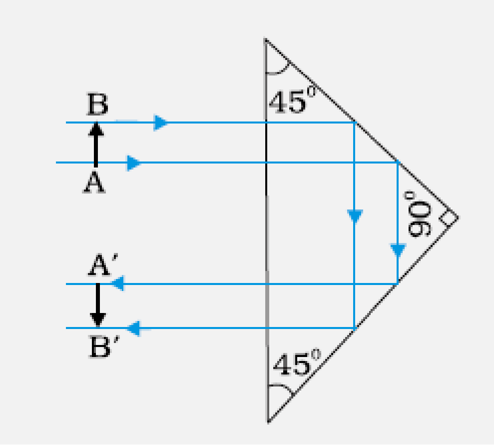
	 	1	
	Principle : When a current carrying coil is kept in a magnetic field , it experiences a torque .	½	
	Cylindrical soft iron core makes the magnetic field radial.	½	
	(b)(i) Current sensitivity : It is defined as deflection produced per unit current flowing through the galvanometer.	½	
	(ii) Voltage sensitivity : It is defined as deflection produced per unit voltage applied across the galvanometer.	½	
	(c) (i) Conversion of galvanometer, into a voltmeter, is based on the fact that the voltmeter should have very high resistance so that very little (negligible) current flows through it.	1	
	(ii) Conversion of galvanometer, into an ammeter, is based on the fact that the ammeter should have very little (negligible) resistance so that it does not reduce the current in the circuit.	1	
	Alternatively, A galvanometer can be converted into (i) a voltmeter by connecting a suitable high resistance in series with its coil. (ii) an ammeter by connecting a suitable shunt (I_{av}) resistance parallel with its coil. [Note: If the student just writes (i) $R = \left(\frac{V}{i_g} - G\right)$ and (ii) $S = \left(\frac{i_g}{I - i_g}\right) G$ award ½ mark in each case]		5
Set1,Q25 Set2,Q24 Set3,Q26	(a) Two essential conditions for the phenomenon of total internal reflection 1+1 (b) Ray diagram 1 (c) Diagram with explanation 1 ½ Example to illustrate the use of optical fibre in transmission ½		

(a) Essential conditions

(1) The ray should pass from an optically denser medium into an optically rarer medium. 1

(2) Angle of incidence should be greater than the critical angle for the given pair of media. 1

(b) Ray Diagram



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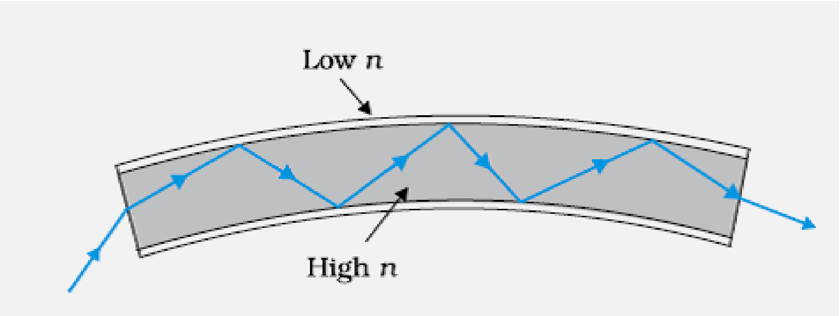
(c)



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When ray of light enters into an optical fibre through one of its ends , it undergoes repeated total internal reflections along the length of the optical fibre as the angle of incidence at every point inside optical fibre is greater than the critical angle. ½

Example :

Optical fibres are used for transmitting and receiving optical signals to facilitate visual examination of internal organs of human body / for long distance communication through optical fibre cables. (any one) ½

OR

5

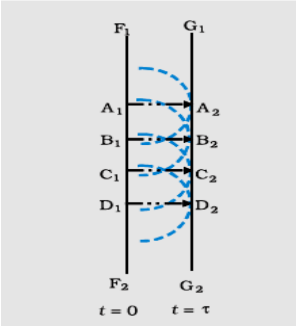
(a) Diagram demonstrating the location and shape of a wavefront using Huygen's principle 1

(b) Diagram 1

Verification of Snell's law 1 ½

Reasons for decrease of wavelength and speed but no change in frequency 1 ½

(a)



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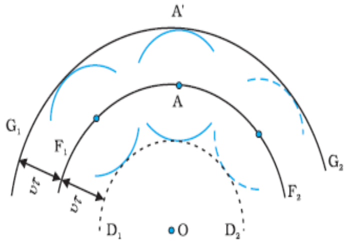
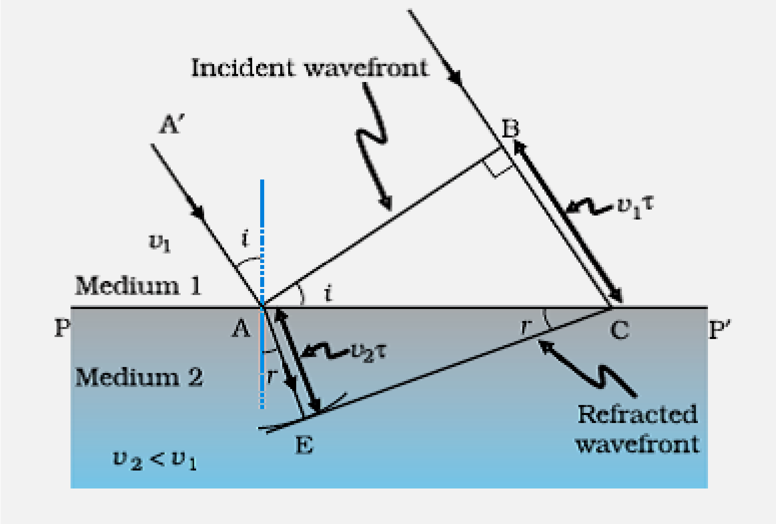
Alternatively,



(Any one of the above diagram)

(b)



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Let t be the time taken by the wavefront to travel the distance BC in rarer medium and AE in the denser medium

$$\therefore BC = v_1 t \text{ and } AE = v_2 t$$ ½

$$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AC} \times \frac{AC}{AE} = \frac{v_1 t}{v_2 t}$$

$$= \frac{v_1}{v_2} = \text{constant}$$ ½

This constant is called 'refractive index' of the denser medium with respect to the rarer medium . Thus , Snell's law is verified. ½

	Reason : If λ_1 and λ_2 denote the wavelengths of light in medium 1 and medium 2 , then if BC = λ_1 , AE = λ_2	½	
	$\frac{\lambda_1}{\lambda_2} = \frac{BC}{AE} = \frac{v_1}{v_2}$ Or $\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2}$	½	
	This equation implies that when a wave gets refracted into a denser medium , its wavelength and speed decrease but its frequency (v/λ)remains the same.	½	5
Set1,Q26 Set2,Q25 Set3,Q24	(a) Definition of Electric flux 1 S.I unit ½ (b) Formula for Electric flux ½ Calculation and result for net flux 2 Formula and result for net charge ½ + ½		
	(a) Definition : Total number of electric field lines passing perpendicularly through a surface is called electric flux.	1	
	(Also accept: $\phi = \oint_S \vec{E}.\overrightarrow{ds}$) S.I unit of electric flux is Nm^2C^{-1}	½	
	(b)From $\phi = \oint \vec{E}.\overrightarrow{ds}$ Net flux through the cube (Φ) = Net flux through the two faces of the cube (Perpendicular to X-axis + perpendicular to Y-axis + Perpendicular to Z-axis)	½	
	$\Phi = \phi_x + 0 + 0$ (As $\vec{E}.\overrightarrow{ds}$ is (separately) zero for ($\vec{E} = \propto x\,\hat{\imath}$) for the faces perpendicular to the y and the z-axis)	½	
	$= EdS\cos 180^o + EdS\cos 0^o$	½	
	$= [\alpha(a)(-1) + \alpha(2a)]a^2$ (**Alternatively:** $[\propto (x)(-1) + \propto (a+x)(+1)]a^2$)	½	
	$= \alpha a^3$	½	
	Net charge inside cube (Q)=$\Phi\epsilon_0$ = $\alpha a^3\epsilon_0$	½ ½	5
	OR (a) Definition of equipotential surface 1 Reason (Electric field directed normal to the surface) 1 (b) Diagram 1 Reason 1 (c) Plot of V versus X 1		

(a) A surface having same potential at all points on it , is called an equipotential surface. 1

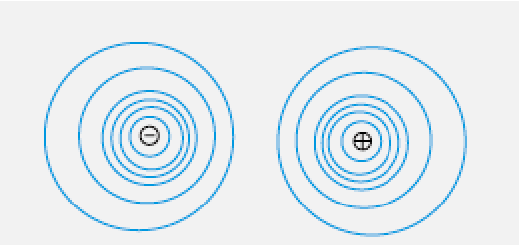
If the electric field were not normal to the equipotential surface , it will have a non-zero component along the surface . Hence, work will be done in moving a unit test charge from one point to another point on the surface against this component of the field , which is not true. 1

Alternatively:

Component of $\vec{E}$ along the equipotential surface
$= -$ (rate of change of potential along the equipotential surface)
$=$ zero

Hence $\vec{E}$ has to be normal to the equipotential surface at all points.

(b)



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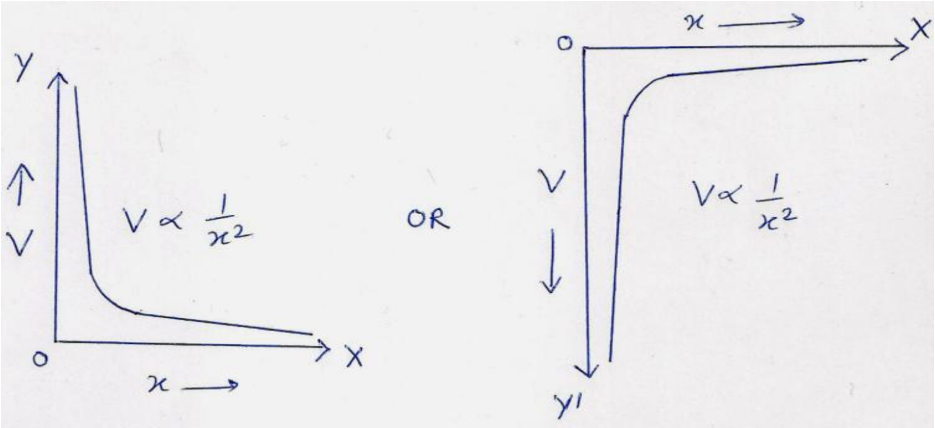
Reason :
Electric field decreases as the distance from the charges increases. Also, electric field component, in any direction, equals the negative of rate of change of potential in that direction. 1

(c)



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