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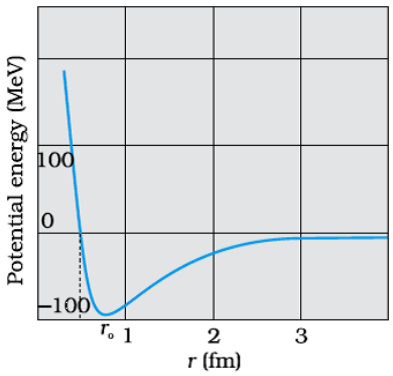
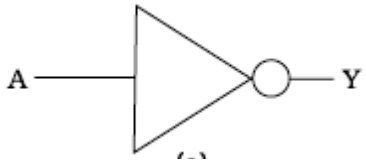
MARKING SCHEME
SET 42/3 (SPL)

Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	i. When a charged particle is moving parallel/anti parallel to the magnetic field. ii. When a charged particle is moving perpendicular to the magnetic field.	½ ½	1
2.		1	1
3.	$\oint \vec{B}.d\vec{l} = \mu_0 i_c + \mu_0 \varepsilon_o \frac{d\phi_E}{dt}$ **Alternatively :** $\oint \vec{B}.d\vec{l} = \mu_0 (I_c + I_d)$	1	1
4.	Loss of strength of the signal while propagating through a medium.	1	1
5.	$\mu = \frac{Am}{Ac}$ $= \frac{1.5}{3.0}$ $= 0.5$ [**Note:** Award this one mark, if a student writes answer directly without calculation.]	½ ½	1
6.	Net dipole moment per unit volume developed in the dielectric medium in presence of an external electric field is called electric polarization. SI unit : coulomb/m^2	½ ½	1
7.	Two factors on which drift velocity of charge carriers depends; Applied electric field and temperature of the conductor. (or any other correct 2 factors.)	½ ½	1
8.	i. There is no chromatic aberration. ii. Spherical aberration is reduced. iii. Easy mechanical support. (Any one /any other one correct reason.)	1	1
9.	a) Distinction between digital & analogue signals 1 b) Logic symbol and truth table ½ + ½ **i.** **Analogue signals** are in the form of continuos, time varying voltage or current. **Digital signals** are those which can take only discrete stepwise values i.e. only two levels of voltage / current.	½ ½	

ii.



Input	Output
A	Y
0	1
1	0

½

½

2

10.

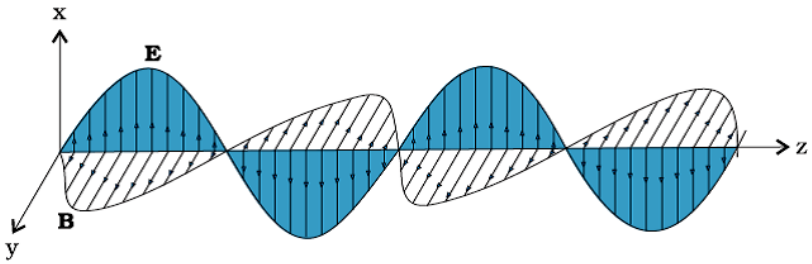
(a) Mathematical expressions for electric and magnetic field components ½ + ½

(b) Drawing of the sketch of the plane electromagnetic wave 1

a) $E_x = E_o \sin(kz - 2\pi vt)$ ½

$B_y = B_o sin(kz - 2\pi vt)$ ½

b)

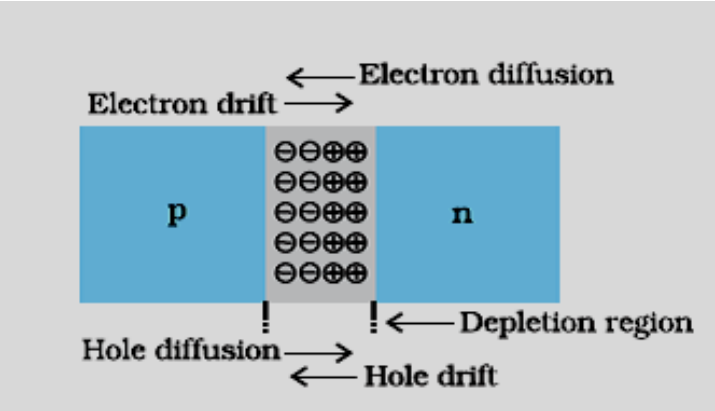


1

2

11.

Processes involved in the formation of p-n junction 2

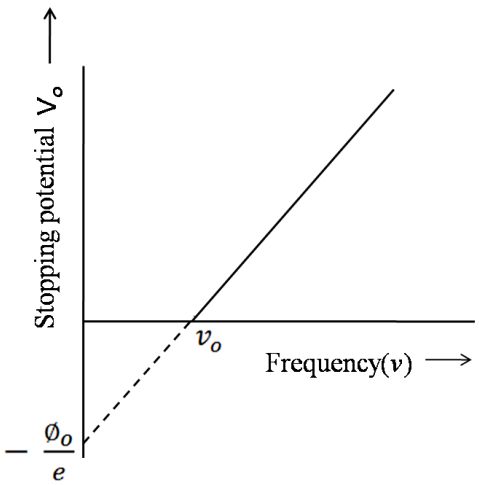


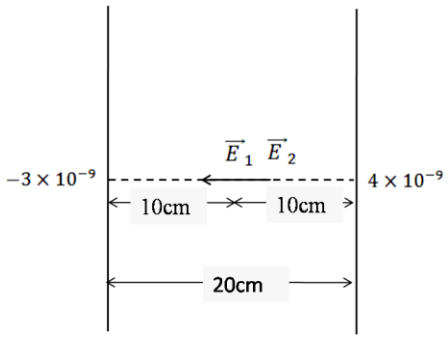
1

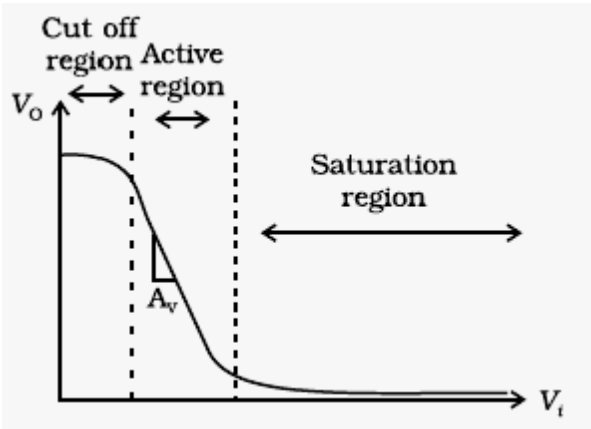
Two processes involved during the formation of p-n junction are diffusion and drift. Due to the concentration gradient, across p and n sides of the junction , holes diffuse from p → n, and electrons from n→ p. This movement of charge carriers leaves behind ionised acceptors on the p-side and donors on the n- side of the junction. This space charge region on either side of the junction, together, is known as depletion region.

1

2

12.	(a) Identification of factor ½ (b) Determination of charge on the capacitor 1 ½ a) Limiting factor – break down field of air. b) $c = \frac{A\epsilon_o}{d}$ as dielectric strength $E = \frac{\sigma}{\epsilon_o} = \frac{q}{A\epsilon_o}$ ⇨ $c = \frac{q}{Ed}$ $1 \times 10^{-6} = \frac{q}{9\times10^{6}\times10^{-2}}$ $q = 9 \times 10^{-2}$ C = 90mC	½ ½ ½ ½	2
13.	Identification of circuits ½ + ½ Reasons ½ + ½ i. For circuit I, $X_c > X_L$ Reason: Current is leading the voltage in phase. ii. For circuit II, $X_c < X_L$ Reason: Current is lagging the voltage in phase.	½ ½ ½ ½	2
14.	i. Einstein's photoelectric equation ½ ii. Drawing of suitable graph 1 ½ $hv = \emptyset_o + eV_o$  work function = -(e × intercept on the y-axis) Planek's constant = e × slope of the curve.	½ ½ ½ ½	2
15.	Showing, that the virtual image produced by convex mirror is always diminished and between focus & pole 2 For a convex mirror, $f > 0$ and for an object on left side i.e. $u < 0$,	½	

	Using the mirror formula $\frac{1}{f} = \frac{1}{V} + \frac{1}{u}$ ⇨ $\frac{1}{V} = \frac{1}{f} - \frac{1}{u}$ (as $u < 0$ and $f > 0$) ⇨ $\frac{1}{V} > \frac{1}{f}$ ⇨ $v < f$ ∴Image is between Pole and focus of the mirror. Linear magnification m=$\frac{f-v}{f}$ for $v > 0,\ f > 0,\ m < 1,$ Hence, image is diminished **OR** Effect on interference pattern when i. Source S is displaced upwards. 1 ii. Source S is replaced by white light. 1 i. Fringe pattern on the screen will shift downwards with central fringe below point 0, on the screen. ii. Central fringe will be white, fringe closest on either side of central white fringe will be red and farthest will appear blue, after a few fringes, no clear pattern will be seen.	½ ½ ½ 1 1	2 2
16.	Finding the direction and magnitude of magnetic field. 2 $\vec{F} = q(\vec{v} \times \vec{B})$ Since, charged particle is moving along +*y* axis and experiences a force along –*z* axis. Therefore direction of magnetic field should be along +*x* axisi.e. along $\hat{\imath}$. (applying appropriate rule) $F = qv\text{BSin}\theta$ $B = \frac{F}{qV}$ (as $\theta = 90^o$) $B = \frac{4 \times 10^{-5}}{2 \times 10^{-9} \times 2 \times 10^{5}}$ $= 1 \times 10^{-1}$T = 0.1 T	½ ½ ½ ½	2
17.	Finding the magnitude and direction of the electric field. 2  Electric field at a point distant 10cm from each wire E = $E_1 + E_2$ E = $\frac{1}{4\pi\epsilon_o}\frac{2}{r}[\lambda_1 + \lambda_2]$	½ ½	

	$= 9 \times 10^9 \times \frac{2}{10^{-1}} (3 \times 10^{-9} + 4 \times 10^{-9})$ $= 9 \times 7 \times 2 \times 10$ *N/C* $= 1260$ *N/C* (towards the wire having negative linear charge density.) [**Note :** Give full credit, if a student doesn't draw diagram.]	½ ½	2
18.	Calculation of ratio of kinetic energy of electron and energy of photon. 2 for electron $\lambda = \frac{h}{\sqrt{2m(KE)}}$ $\Rightarrow$ K.E. $= \frac{h^2}{2m\lambda^2}$ For photon, energy(E) $= \frac{hc}{\lambda}$ $\Rightarrow \frac{(KE)_{electron}}{E_{photon}} = \frac{h}{2mc\lambda}$ $= \frac{6.63 \times 10^{-34}}{2 \times 9.1 \times 10^{-31} \times 3 \times 10^8 \times 1326 \times 10^{-9}}$ $= 9.15 \times 10^{-4}$	½ ½ ½ ½	2
19.	Draw of the transfer characteristic 1 Identification of regions for amplifier and switch ½ + ½ Brief working of a transistor as a switch 1  i. Region for transistor to be used as an amplifier : Active region. ii. Region to be used as a switch : cut off region and saturation region. **Working:** when input voltage (v_i) is low and unable to forward bias the transistor, V_o is high. If v_i is high enough to drive the transistor into saturation then V_o is low. Therefore when transistor is not conducting, it is switched off and when it is driven into saturation it is switched on.	1 ½ ½ 1	3
20.	Calculation of wavelength (λ) of light used 1 ½ Calculation of linear width of second dark fringe ½ Variation of Intensity of fringes. 1 Linear width of principal maxima(w)		

	$\omega = \frac{2\lambda D}{a}$ $4.88 \times 10^{-3} = \frac{2\times\lambda\times1.5}{0.3\times10^{-3}}$ $\lambda = \frac{4.88\times10^{-3}\times0.3\times10^{-3}}{3}$ = 488nm Linear width of second dark fringe $= \frac{\lambda D}{a}$ = half of the linear width of principal maxima = 2.44mm Intensity of bright fringes, falls rapidly on moving from centre to the ends of the screen and for the dark fringes intensity remains zero. [**Note :** Also accept the intensity distribution curve of diffraction for this part.)	½ ½ ½ ½ 1	3
21.	Distinction between Spacewave and sky wave Modes of propagation 1 Calculation of maximum distance. 2 Space wave travels in a straight line from transmitting antenna to receiving antenna. In sky wave mode of propagation long distance communication is achieved by ionospheric reflection of radiowaves back towards the earth.(or any other relevant difference.) Maximum distance $= \sqrt{2Rh_T} + \sqrt{2Rh_R}$ $= \sqrt{2\times25\times6.4\times10^6} + \sqrt{2\times6.4\times10^6\times90}$ $= 17.88 \times 10^3 + 33.94\times10^3$ = 51.82 x 10^3m = 51.82Km	½ ½ ½ ½ ½ ½	3
22	Deduction of the expression for the average power 2 Showing the average power dissipation is maximum at resonance 1 V = $V_m sin\omega t$ I = $i_m$sin $(\omega t + \emptyset)$ Instantaneous power 'p' supplied by the source P = VI $= V_m sinwt.i_m$sin $(wt + \emptyset)$ $= \frac{V_m i_m}{2}[cos\emptyset - cos2(wt + \emptyset]$ Average power over a complete cycle P = $\frac{V_m i_m}{2} cos\emptyset$ (because the average of time dependent term is zero.) $= \frac{v_m}{\sqrt{2}} \times \frac{i_m}{\sqrt{2}} cos\emptyset$ $= V_{rms} I_{rms} cos\theta$ At resonance V and I are in same phase i.e. $\emptyset = 0\ i.e.\ cos\emptyset = 1$, P = $V_{rms} I_{rms}$, which is maximum	½ ½ ½ ½ 1	3

23.	Statement of Lenz's law 1 Description of a simple example 1 Prediction of direction of induced current ½ + ½ The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. This law is in conformity with the principle of conservation of energy, consider a situation where induced current is in the direction opposite to that given by lenz's law. Then in this situation kinetic energy will continuously increase without expanding any energy and hence one can construct a perpetual motion machine by a suitable arrangement, which violates the conservation of energy. In irregular loop induced current will be in the sense. pqrsp, as induced current will oppose the increase in magnetic flux. In other loop, induced current will be in the sense abcda, as the induced current will oppose the decrease in magnetic flux.	1 1 ½ ½	3
24.	Calculation of energy stored and charge acquired in given cases. 1½+1½ i. For series combination, of the given capacitors $C_{net} = \frac{C_1}{4}$ ii. For parallel combination, of the given capacitors $C_{net} = \frac{4}{3}C_1$ a) As energy stored U ∝ C_{net}, for same voltage source, ∴ Energy stored in parallel combination of capacitors will be more, b) Charge acquired, Q ∝ C_{net} for same Voltage source, Hence charge acquired will be more in parallel combination. [**Note :** Also give full credit, for alternative methods.]	½ ½ ½ ½ ½ ½	3
25.	Calculation of equivalent e.m.f. 1 ½ Calculation of equivalent resistance 1 ½ $\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}$ $\frac{1}{r_{eq}} = \frac{1}{0.3} + \frac{1}{0.4} + \frac{1}{0.6}$ $r_{eq} = \frac{2}{15}\Omega$ $\frac{\epsilon_{eq}}{r_{eq}} = \frac{\epsilon_1}{r_1} + \frac{\epsilon_2}{r_2} + \frac{\epsilon_3}{r_3}$ $\frac{\epsilon_{eq}}{(\frac{2}{15})} = \frac{1.5}{0.3} + \frac{2.0}{0.4} + \frac{3.0}{0.6}$ = 5+5+5 $\epsilon_{eq} = 15 \times \frac{2}{15}$ = 2.0V	½ ½ ½ ½ ½ ½	3

	OR Finding the value of I_1 and I_2 3 In loop abcda $-20\ I_1 + 40 - 40\ I_3 = 0$ $I_1 + 2\ I_3 = 2$ ----------(1) As $I_3 = I_1 + I_2 \therefore$ *equation 1 takes the form.* $I_1 + 2\ I_1 + 2\ I_2 = 2$ $3\ I_1 + 2I_2 = 2$ ----------(2) In loop adefa $40\ I_3 - 40 - 80 + 20\ I_2 = 0$ $2\ I_3 + I_2 = 6$ ----------(3) Substituting $I_3 = I_1 + I_2$ $2\ I_1 + 2I_2 + I_2 = 6$ $2\ I_1 + 3I_2 = 6$ ----------(4) solving equation 2 and 4 $I_2 = \frac{14}{5}$A And $I_1 = -\frac{6}{5}$A	½ ½ ½ ½ ½ ½	3
26.	Explanation of parts a, b and c 1 +1+1 a) It is because, light which is produced from an ordinary source (like a sodium lamp) is unpolarised, when an unpolarised light wave is passed through a Polaroid sheet, it gets linearly polarised with the electric vector oscillating along the direction perpendicular to the aligned molecules. b) Ray of light parallel to the pricipal axis, gets deviated away from the normal at the first surface and towards the normal at the second surface since deviation at two surfaces is in same sense, $\therefore$ net deviation from both the surfaces make the ray diverge away from the principal axis. **Alternatively:** It is because the relative refractive index of lens becomes less than 1 and $\frac{1}{f}\alpha(\mu - 1)$ $\therefore f$ becomes –ve. Hence, lens behave like a diverging lens. [**Note :** Also accept the explanation through diagram.] c) Due to short focal length of eye piece, angular magnification of eye piece increases and magnification of objective is large when $\lvert u_o \rvert$ is slighty greater than f_o, since the microscope is used for viewing very close object therefore $\lvert u_o \rvert$ is small and hence f_o, should be small.	1 1 1	3
27.	Answer of the parts i, ii and iii 1+1+1 i. Concerned/ Caring(or any other one relevant value) ii. Because, one can get electric shock, as water conducts electricity, Yes, relatively safer, because distilled water is a bad conductor of electricity. iii. Any example displaying similar value in real life situation.	1 1 1	3

28.

a) Statement of the first two postulates of Bohr's theory.	1+1
Brief explanation of the necessity	1
b) Rydberg formula	1
c) Calculations of wavelength	1

a)

i. An electron in an atom revloves in certain stable orbit without the emission of radiant energy. — 1

ii. Electron revolves around the nucleus only in those orbit for which the angular momentum is an integral multiple of $\frac{h}{2\pi}$. — 1

Alternatively: $mvr = \frac{nh}{2\pi}$ where n is an integer

According to classical electromagnetic theory, an accelerated electron emits radiation in the form of electromagnetic waves. Therefore energy of electron would decrease continuously and electron would spiral inward and eventually fall into the nucleus, such an atom can not be stable. As the electrons spiral inwards, their frequency would change continuously, thus they would emit a continuous spectrum in contradiction to the line spectrum observed. To overcome above shortcomings, Bohr's theory came into existence. — 1

b) Bohr's third postulate $E_f - E_i = hv$, gives the Rydberg Formula

$$hv_{if} = \frac{me^4}{8 \in_0^2 n^2}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$ — 1

$$Also\ accept\ \frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

For first member of spectral line in lyman series, $n_i = 2\ and\ n_f = 1$ — ½

$$\frac{1}{\lambda} = 1.03 \times 10^7\left(\frac{1}{1} - \frac{1}{4}\right)$$

$$\frac{1}{\lambda} = 1.03 \times 10^7\left(\frac{3}{4}\right)$$

$$\frac{1}{\lambda} = \frac{4}{3 \times 1.03 \times 10^7}$$

= 129nm — ½ — 5

OR

a) One example each for (i) and (ii)	1+1
b) Explanation of release of energy	1
c) Showing that nuclear density is independent of mass number	1

a)

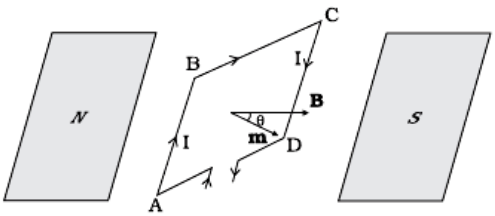
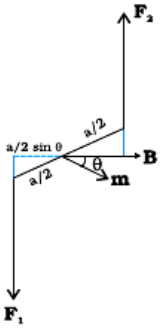
i. $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He + Q$ — 1

Alternatively

$$^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He + Q$$

ii. $^{32}_{15}P \rightarrow {}^{32}_{16}S + e^- + \bar{v}$ — 1

Alternatively:

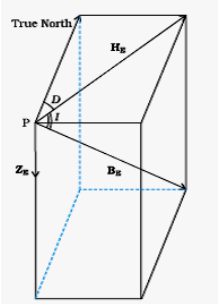
	$^{A}_{Z}X \rightarrow {}_{z+1}^{A}Y + e^{-} + \bar{v}$ b) Binding energy per nucleon of the fussed muclei ($^{3}_{2}He$) is more than the binding energy per nucleon of the lighter nuclei ($^{2}_{1}H$) i.e. final system is more tightly bound than the initial system therefor energy is released. c) Let A be the mass number and m be the average mass of a nucleon, $\therefore$Nuclear density $= \frac{Mass\ of\ nucleus}{volume\ of\ nucleus}$ $= \frac{mA}{\frac{4}{3}\pi R^3}$ Substituting R = $R_o A^{\frac{1}{3}}$ $= \frac{mA}{\frac{4}{3}\pi R_o^3 A}$ $= \frac{3m}{4\pi R_o^3}$ Which is constant and independent of Mass Number(A).	1 ½ ½ ½ ½	5
29.	a) Derivation of the expression for torque 3 b) Mentioning the conditions for (i) & (ii) 1+1 **a)**  (a)  Forces on the arms BC and DA are equal, opposite and act along the axis of coil, being collinear along the axis, they cancel each other, Forces on arms AB and CD are F_1 and F_2 which are equal and opposite, but not collinear. $F_1 = F_2$ =IbB therefore magnitude of torque acting on the loop $\tau = F_1 \frac{a}{2} sin\theta + F_2 \frac{a}{2} sin\theta$ $= IabB\ sin\theta$ (Area of the loop A = ab)	½ ½ ½ ½ ½	

	$= IAB\ sin\theta = I\vec{A} \times \vec{B}$ b) i. In moving coil galvanometer, this expression is applied at $\theta = 90^0$ i.e. τ = NIAB ii. Senstivity of a galvanometer is increased by increasing number of turns/ increasing area of coil/ increasing magnetic field/ by decreasing torsional constant.	1 1	5

OR

a)	Brief description of three elements	½ + ½ + ½
	Necessary diagram	½
	Necessary formula	½ + ½
b)	Drawing the behavior of magnetic field lines	½ + ½
	Justification	½ + ½

a)



½

Three physical quantities are Magnetic declination, angle of dip (inclination) and horizontal component of Earth's field. ½

The angle between the true geographic north and north shown by compass needle is called magnetic declination. ½

Dip is the angle that the total magnetic field of earth makes with the surface of Earth. ½

Component of total magnetic field of earth along the surface of earth is called horizontal component.

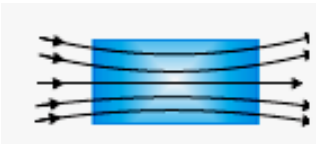
$H_E = B_E cosI$, $Z_E = B_E sinI$ ½

And

$\tan I = \frac{Z_E}{H_E}$ ½

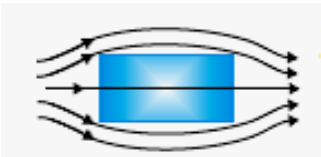
where H_E and Z_E are horizintal and vertical component of the earth's field and I is the inclination at a place.

b)



½

The field lines gets concentrated inside the material and field inside is enhanced. ½



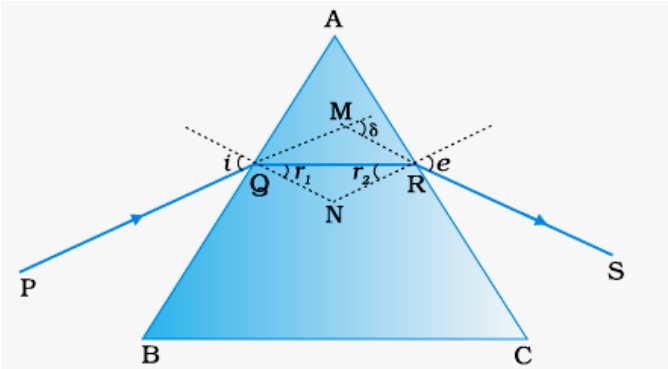
½

The field lines are repelled or expelled and the field inside the material is reduced. ½ 5

30.

Ray diagram showing the passage of ray	1
Obtaining the relation for refractive index	3
Nature of graph.	1

a)



1

In the quadrilateral AQNR

$\angle A + \angle QNR = 180^o$ ----------(1) ½

From the triangle QNR

$r_1 + r_2 + \angle QNR = 180^o$ ----------(2)

Comparing these two equations

$r_1 + r_2$ =A ----------(3) ½

The total devation δ is the sum of derivations at the two faces.

$\delta = (i - r_1) + (e - r_2)$

That is δ = i+$e - A$----------(4) ½

At the minimum derivation D_m, the refracted ray inside the prism becomes parallel to its base.

$\delta = D_m$, i = e which implies $r_1 = r_2$ ½

Equation (3) becomes

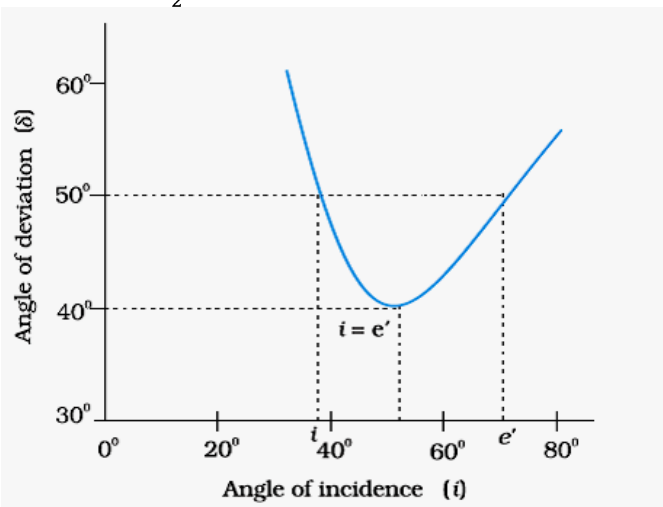
2r = A or r = $\frac{A}{2}$

In the same way equation (4) becomes

D_m = 2i-A, => i=$\left(\frac{A+D_m}{2}\right)$ ½

The refractive index of the prism is

$n_{21} = \frac{n_2}{n_1} = \frac{\sin i}{\sin r} = \frac{\sin\left[\frac{(A+Dm)}{2}\right]}{\sin\frac{A}{2}}$ ½



1

5

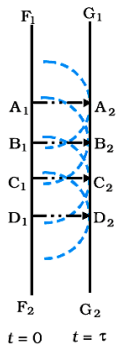
OR

a)	Definition of wave front	1
	Showing (i) and (ii) using Huygen's construction	1+1
b)	Verification of Snell's law.	2

a) Wave front is the surface of constant phase 1

Alternatively: locus of points, which orscillate in phase.

i.

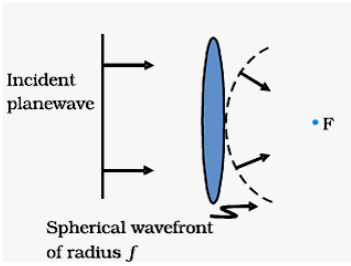


½

To produce the plane wave at a later time t, draw spheres of radius vt from each point on the plane wave front F_1F_2. By drawing the common tangent to all these spheres a plane wave at a later time t is obtained. ½

(where v is the speed of waves in the medium)

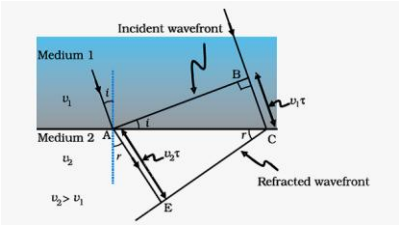
ii.



½

The central part of the incident plane wave traverses the thickest portion of the lens and is delayed the most. Therefore the emerging wavefront has a depression at the centre and hence it becomes spherical and converges at the focus. ½

b)



1

$\sin i = \dfrac{BC}{AC}$

$\sin r = \dfrac{AE}{AC}$ ½

$\therefore \dfrac{\sin i}{\sin r} = \dfrac{v_1\tau}{v_2\tau} = = \dfrac{v_1}{v_2}$ =(Refractive index of rarer medium *wrt* denser medium.) ½ 5