EXAMINATION 2020-21

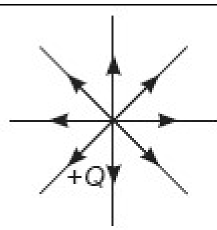
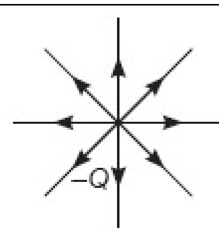
(SAMPLE PAPER)

MARKING SCHEME

Class: XII

Subject: Physics (Theory)

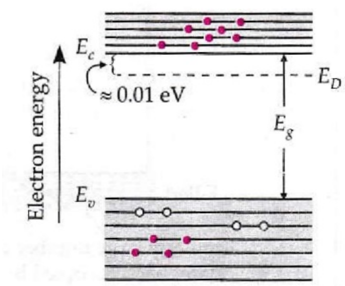
Maximum Marks: 70 Marks **Time Allowed: 3 hours**

QUESTION No.	SOLUTION	MARKS DISTRI-BUTION
Q1	$[F] = [MLT^{-2}],\ [r] = [L],\ [q] = [AT]$ $\because\ F = \frac{1}{4\pi\varepsilon_0}.\frac{q_1q_2}{r^2} \Rightarrow 4\pi\varepsilon_0 = \frac{q_1q_2}{Fr^2} \Rightarrow [\varepsilon_0] = \frac{[AT]^2}{[MLT^{-2}][L^2]} = [M^{-1}\ L^{-3}$	1
Q2	(I) It is applied only for point charges. (ii) It is applied only on stationary charges only.	½ 1/2
Q3	(i) $Q > 0$  (ii) $Q < 0$ 	½ ½
Q4	10 V, as the potential inside the hollow metal sphere is same everywhere. OR Potential will become $\frac{1}{K}$ times.	1 1
Q5	Electrical permittivity $(\varepsilon \text{ or } \varepsilon_0)$.	1
Q6	: Dry cells used in series will have high resistance (=10 Ω) and hence provide low current, while a car battery has low internal resistance (0.1 Ω) and hence gives high current for the same emf, needed to start the car.	1

	OR on cooling the copper, its resistivity decreases. While for Si increses	½ ½
Q7	: (i) Low value of k (torsional constant), (ii) High conductivity.	½ ½
Q8	Phase difference between the current and voltage is π/2. So, the power dissipation $P_{av} = P_{rms} \cos \phi$ is zero. OR The brightness will increase $\left(\because X_C \propto \frac{1}{\nu}\right)$, and heat produced $H \propto I^2$, where $I_{rms} = \frac{V_{rms}}{\sqrt{X_C^2 + R^2}}$	1 1
Q9	$E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mE_k}$ $\therefore \quad \lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE_k}}$ As $\quad \lambda \propto \frac{1}{\sqrt{m}}$ $\because \quad m_e < m_p \quad \therefore \quad \lambda_p < \lambda_e$ OR $\frac{\lambda}{\sqrt{2mE}}$	½ ½
Q10	The energy of electron in n^{th} Bohr orbit of hydrogen atom is given $E = -\frac{13.6}{n^2}\text{eV} \quad \therefore \quad -3.4 = -\frac{13.6}{n^2} \Rightarrow n^2 = 4 \quad \therefore \quad n = 2$ Angular momentum of an electron in n^{th} orbit, $L = \frac{nh}{2\pi}$. Putting $n = 2$, we get $L = \frac{2h}{2\pi} = \frac{h}{\pi}$	1
Q11	A	1
Q12	A	1
Q13	A	1
Q14	C	1
Q15	1. A 2. B 3. C	1 1 1

	4. C 5. B	1 1
Q16	1. A 2. B 3. C 4. B 5. A	1 1 1 1 1
Q17	Drift velocity, $v_d = \frac{eE\tau}{m} = \frac{eV\tau}{ml} \Rightarrow v_d' = \frac{e2V\tau}{m(l/2)} = 4v_d$ When V is doubled and l is halved, drift velocity becomes 4 times original v_d. OR (i) The temperature coefficient of resistance for alloys is low. («) Alloys have has a high value of resistivity.	1 1 1 1
Q18	Consider a long solenoid of length l and radius r with r << l and having n turns per unit length. If a current I flows through the coil, then the magnetic field inside the coil is almost constant and is given by Relevant Diagram(to be drawn) ……………………….. $B = \mu_0 nI$ Magnetic flux linked with each turn $= BA = \mu_0 nIA$ where $A = \pi r^2$ = the cross-sectional area of the solenoid. ∴ Magnetic flux linked with the entire solenoid is ϕ = Flux linked with each turn × total number of turns $= \mu_0 nIA \times nl = \mu_0 n^2 IAl$ But ϕ = LI ∴ Self-inductance of the long solenoid is $L = \mu_0 n^2 lA$ If N is the total number of turns in the solenoid, then n= N/l and so $L = \frac{\mu_0 N^2 A}{l}$	 ½ ½ ½ ½
Q19	As the magnet is moved, its S-pole moves towards C_2 coil and its N-pole moves away from C_1 coil. By Lenz's law, the induced current in the two coils must flow clockwise when seen from the magnet side so as to oppose the change in flux linked with the coils C_1 and C_2.	1 1

	OR Self induction 1. Self-Induction is the phenomenon of production of induced emf in a coil when a changing current passes through it. 2. Self-inductance depends upon the size, shape and the number of turns of the coil. Larger the number of turns and area of cross-section, larger is the self-inductance. Mutual induction Mutual induction is the phenomenon of production of induced emf in one coil due to a change of current in the neighboring coil. The mutual inductance of two coils depends on the number of turns in the two coils, their geometrical shape and their relative separation.	½ ½ ½ ½
Q20	Consider a pure capacitor C connected across a source of alternating emf ε given by $\varepsilon = \varepsilon_0 \sin \omega t$ ...(1) $I = I_0 \cos \omega t = I_0 \sin(\omega t + \pi/2)$ ...(2) where $I_0 = \omega C \varepsilon_0 = \frac{\varepsilon_0}{1/\omega C}$ = the current amplitude. Capacitive reactance. Comparing the relation, $I_0 = \frac{\varepsilon_0}{1/\omega C}$ with the ohmic relation $I_0 = \frac{\varepsilon_0}{R}$, we find that the factor $\frac{1}{\omega C}$ is the effective resistance or opposition offered by the capacitor to the flow of a.c. through it. It is called capacitive reactance and is denoted by X_C. Thus $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$	½ ½ ½ ½
Q21	. (i) $\frac{E}{B}$ = c, speed of light. (ii) For an electromagnetic wave travelling along y-direction, its electric and magnetic field vectors are along 2-axis and x-axis respectively. The direction of $\vec{E} \times \vec{B}$ is same as that of direction of wave propagation and $\hat{k} \times \hat{\imath} = \hat{\jmath}$. OR (a) Microwaves. (b) Radiowaves.	1 1 ½ ½

	(c) Gamma rays, (d) X-rays.	½ ½
Q22	The phenomenon in which a rap of light travelling at an angle of incidence greater than the critical angle from denser to a rarer medium is totally reflected back into the denser medium is called **total internal reflection.** Necessary conditions for total internal reflection : 1. Light must travel from an optically denser to an optically rarer medium. 2. The angle of incidence in the denser medium must be greater than the critical angle for the two media.	1 ½ ½
Q23	n-type semiconductor. This semiconductor is obtained by doping the tetravalent semiconductor Si (or Ge) with pentavalent impurities such as As, P or Sb of group V of the periodic table 	1 1
Q24	Here $\mu_1 = 1$, $\mu_2 = 1.5$, u = -30 cm, R = +20 cm As light travels from rarer to denser medium, so $$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$ or $\frac{1.5}{v} + \frac{1}{30} = \frac{1.5-1}{20} = \frac{1}{40}$ or $\frac{1.5}{v} = \frac{1}{40} - \frac{1}{30} = \frac{3-4}{120} = -\frac{1}{120}$ $\therefore v = -1.5 \times 120 = -180$ cm The negative sign shows that a virtual image is formed in air. OR . Here R_1 = + 15cm, R_2 = - 30cm, μ = 1.5 $$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ $$= (1.5 - 1)\left[\frac{1}{15} - \frac{1}{-30}\right] = \frac{1}{20}$$ or f = +20 cm.	½ ½ ½ ½ ½ ½ ½ ½

Q25	Width ratio, $$\frac{w_1}{w_2}=\frac{I_1}{I_2}=\frac{a_1^2}{a_2^2}$$ $$=\left(\frac{\sqrt{2}}{1}\right)^2=2:1$$	1 1
Q26	**K.E.** of the electron, K = 3.4eV = 3.4 × 1.6 × 10^{-19} J de-Broglie wavelength associated with the electron, $\lambda=\frac{h}{mv}=\frac{h}{\sqrt{2mK}}$ $=\frac{6.63\times10^{-34}}{\sqrt{(2\times9.1\times10^{-3}\ \times3.4\times1.6\times10^{-19})}}$ = 6.63 × 10^{-10}m OR Mass of α-particle, m = 4 m_p = 4 × 1.67 × 10^{-27}kg Charge on α-particle = 2e If the α-particle acquires velocity v, then qV = $\frac{1}{2}$ mv^2 or 2 eV = $\frac{1}{2m}$ m^2v^2 ∴ mv = $\sqrt{4meV}$ $\lambda=\frac{h}{mv}=\frac{h}{\sqrt{4meV}}$ $=\frac{6.6\times10^{-3}}{\sqrt{4\times4\times1.67\times10^{-27}\times1.6\times10^{-1}\ \times200}}$ m $=\frac{6.6\times10^{-34}}{10^{-23}16\times1.67\times1.6\times200}=\frac{6.6\times10^{-11}}{92.47}$ = 0.07138 × 10^{-11}m = 0.007138 Å**.**	1 1 1 1 1 1
Q27	The linear width of central bright maximum is given by **β_0 =** $\frac{2D\lambda}{a}$ (i) If monochromatic yellow light is replaced with red light, the linear width of the central maximum increases because $\lambda_{red} > \lambda_{yellow}$.	1 1

	(ii) If the distance (D) between the slit and the screen is increased, the linear width of the central maximum increases. OR Fringe width, $\beta = \frac{D\lambda}{d}$ Angular separation, $\theta = \frac{\beta}{D} = \frac{\lambda}{d}$ (i) When the screen is moved away from the slits, the distance D increases. Fringe width β increases but angular separation θ(=λ /d) remains unchanged. (ii) The interference pattern becomes less and less sharp. When the source slit becomes so wide that the condition $\frac{s}{S} < \frac{\lambda}{d}$ is not satisfied, the interference pattern disappears. But the angular width θ(=λ / d) remains unchanged.	1 ½ ½ 1 1
Q28	electrostatic force of attraction between the nucleus and the electron is $F = \frac{k\,Ze.e}{r^2} = \frac{kZe^2}{r^2}$ To keep the electron in its orbit, the centripetal force on the electron must be equal to the electrostatic attraction. Therefore, $\frac{mv^2}{r} = \frac{kZe^2}{12}$ or $mv^2 = \frac{kZe^2}{r}$ …(1) or $r = \frac{kZe^2}{mv^2}$ …(2) where m is the mass of the electron and v, its speed m an orbit of radius r. Bohr's quantisation condition for angular momentum $L = mvr = \frac{nh}{2\pi}$ or $\frac{r=nh}{2\pi mv}$ …(3) From equations (2) and (3), we get $\frac{kZe^2}{mv^2} = \frac{nh}{2\pi\, mv}$ Or $v = \frac{2\pi kZe^2}{nh}$ …(4) Substituting this value of vm equation (3), we get $r = \frac{nh}{2\,\pi m} . \frac{nh}{2\pi kZe^2}$ or $r = \frac{n^2h^2}{4\pi^2 mkZe^2}$ Energy of the electron. It includes the electron's kinetic energy and the electrostatic potential energy of the two charges. Kinetic energy of the electron in nth orbit is K.E. = $\frac{1}{2}mv^2 = \frac{kZe^2}{2r}$ [Using equation (1)] Potential energy of the electron in nth orbit is P.E. = $k = \frac{q_1q_2}{r} = \frac{k\,Ze.(e)}{r} = -\frac{kZ\ ^2}{r}$ Hence total energy of the electron in nth orbit is E_n = K.E.+ P.E. $k = \frac{kZe^2}{2r} - \frac{k\,Ze^2}{r} = -\frac{kZe^2}{2r}$ $= \frac{kZe^2}{2} . \frac{4\pi^2\, mk\, Ze^2}{n^2h^2}$	½ ½ ½ ½ ½

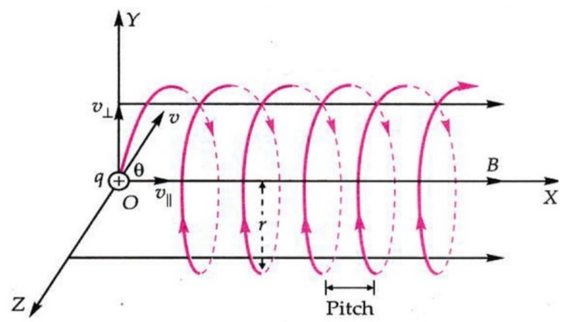
	[Using equation (5)] or $E_n = -\frac{2\pi^2 mk^2 Z^2 e^4}{n^2h^2}$ …(6)	½

Q29

. When a charged particle having charge q and velocity $\vec{v}$ enters a magnetic field B, it experiences a force ½

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

When the initial velocity makes an arbitrary angle with the field direction. A uniform magnetic field B is set up along +ve X-axis. A particle of charge q and mass m enters the field $\vec{B}$ with velocity $\vec{v}$ inclined at angle θ with the direction of the field $\vec{B}$ ½



½

. The radius of the circular path is

$$r = \frac{mv_\perp}{qB} = \frac{mv\sin\theta}{qB}$$ ½

The period of revolution is

$$T = \frac{2\pi r}{v_\perp} = \frac{2\pi}{v\sin\theta} \cdot \frac{mv\sin\theta}{qB} = \frac{2\pi m}{qB}$$ ½

The linear distance travelled by the charged particle in the direction of the magnetic field during its period of revolution is called pitch of the helical path.

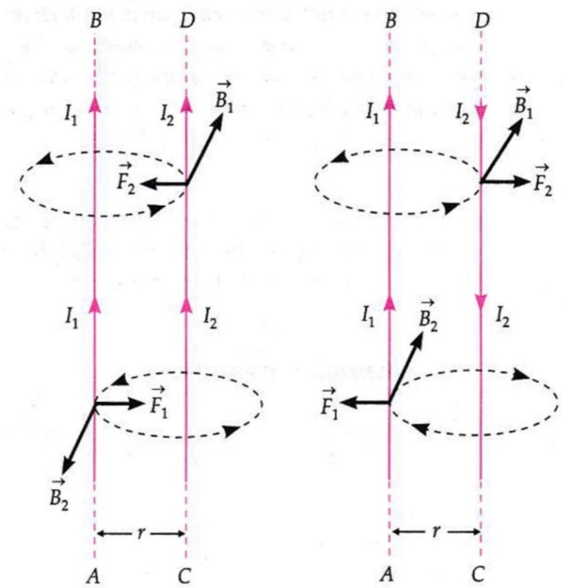
$$\text{pitch } = v_\parallel \times T = v\cos\theta \times \frac{2\pi m}{qB} = \frac{2\pi mv\cos\theta}{qB}$$ ½

OR

Consider two long parallel wires AB and CD carrying currents I_1 and I_2. Let r be the separation between them.

The magnetic field produced by current f at any point on wire CD is ½

$$B_1 = \frac{\mu_0 I_1}{2\pi r}$$



½

It exerts a force on current carrying wire CD. The force acting on length l of the wire CD will be

$$F_2 = I_2 l B_1 \sin 90^\circ = I_2 l \cdot \frac{\mu_0 I_1}{2\pi r} = \frac{\mu_0 I_1 I_2}{2\pi r} . l$$ ½

Force per unit length,

$$f = \frac{F_2}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

Parallel currents attract and antiparallel currents repel.

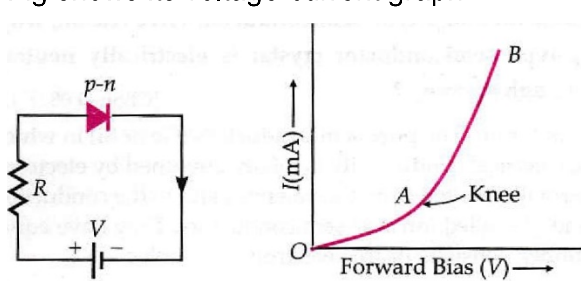
Definition of ampere.

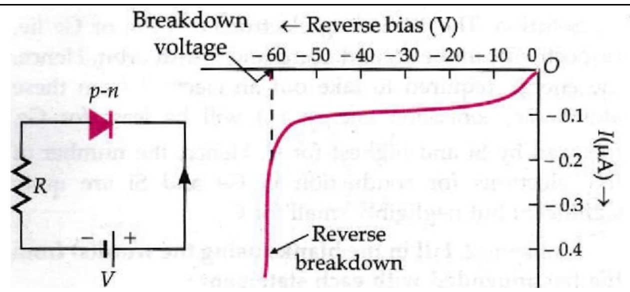
When $f = I_2 = 1$ A and r = 1 m, we get

$$f = \frac{\mu_0}{2\pi} = 2 \times 10^{-7} \text{Nm}^{-1}$$ ½

One ampere is that value of steady current, which on flowing in each of the two parallel infinitely long conductors of negligible cross-section placed in vacuum at a distance of Im from each other, produces between them a force of 2 × 10~^{7} newton per metre of their length. ½

Definition of coulomb in terms of ampere. If a steady current of 1 ampere is set up in a conductor, then the quantity of charge that flows through its cross-section in 1 second is called one coulomb. ½

Q30	One atomic mass unit is defined as $\frac{1}{12}$ th of the actual mass of carbon-12 atom. Atomic mass unit is denoted by amu or just by u. Thus 1 amu = $\frac{1}{12}$ x Mass of carbon-12 atom (ii) The difference between the rest mass of a nucleus and the sum of the rest masses of its constituent nucleons is called its mass defect. mass defect will be $Am = Zm + (A - Z)m_n - m$ (iii) We have $m = 1\text{amu} = 1.660565 \times 10^{-27}\text{Kg}$ $c = 2.9979\text{x}10^{8}\text{ms}^{-1}$ $\therefore\ E = mc^2 = 1.660565 \times 10^{-27} \times \left(2.9979 \times 10^{8}\right)^2 \text{J}$ $= 1.4924 \times 10^{-10}\,\text{J}$ $= \frac{1.4924 \times 10^{-10}}{1.602 \times 10^{-13}}\,\text{MeV}$ $\left[\because 1\text{MeV} = 1.602 \times 10^{-13}\,\text{J}\right]$ = 931.5 MeV	1 1 1
Q31	Figure shows a forward biased p-n junction diode in which p-side is connected to the +ve terminal and n-side is connected to the -ve terminal of the battery and Fig shows its voltage-current graph.  	1 ½ ½

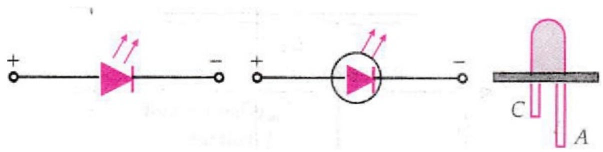


½

½

LED

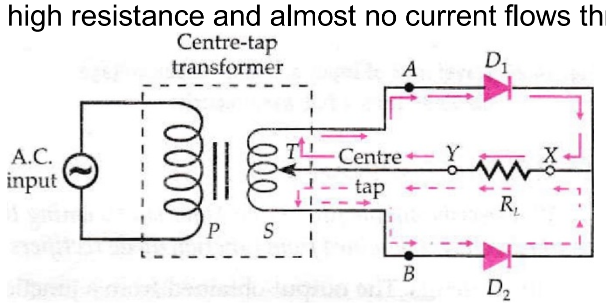
), it is a heavily-doped forward-biased p-n junction which spontaneously converts the biasing electrical energy into optical energy, like infrared and visible light. 1



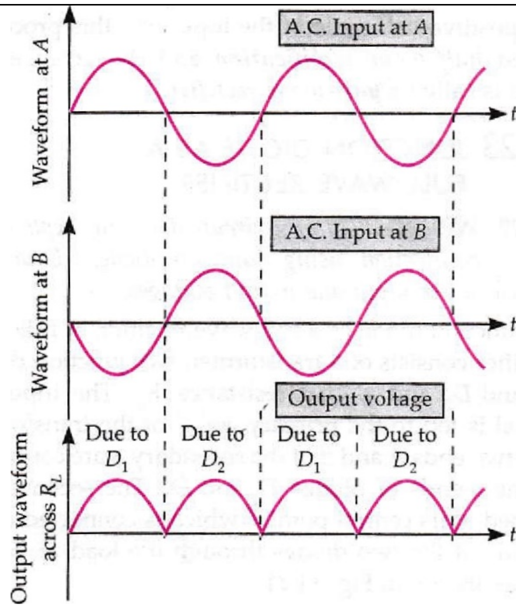
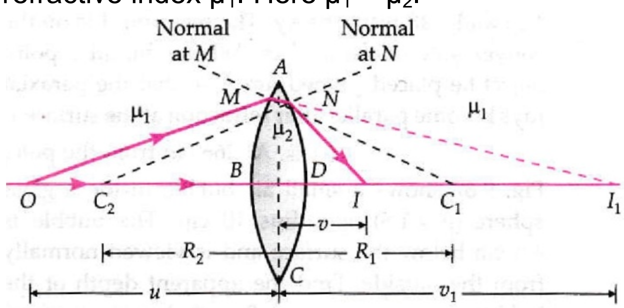
). When it is forward biased through a series resistance R, light photons are emitted from the non-metallised surface of the π-region. The series resistance R limits the current through the LED and hence controls the intensity of light emitted by it. 1

OR

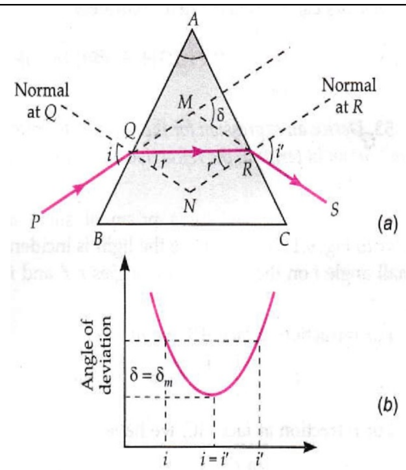
Principle of a rectifier. When a p-n junction diode is forward biased, it offers less resistance and a current flows through it; but when it is reverse biased, it offers high resistance and almost no current flows through it. 1



1

	 (b) (i) As the hole concentration increases, the p-type semi-conductor is obtained after doping. (ii) As $n_c n_h = n_i^2$ $\therefore \quad n_e = \frac{n_i^2}{n_h} = \frac{(2 \times 10^8)^2}{4 \times 10^{10}} = 10^6 \mathrm{m}^{-3}$	½ ½ 1 1
Q32	consider a thin double convex lens of refractive index μ_2 placed in a medium of refractive index μ_1. Here $\mu_1 < \mu_2$.  For refraction at surface ABC, we can write the relation between the object distance u, image distance v_1 and radius of curvature R_1 as $\frac{\mu_2}{v_1} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1}$ …(1) Therefore, the relation between the object distance v_1, image distance v and radius of curvature R_2 can be written as $\frac{\mu_1}{v} - \frac{\mu_2}{v_1} = \frac{\mu_1 - \mu_2}{R_2}$ …(2) Adding equations (1) and (2), we get	1 ½ ½

	$$\frac{\mu_1}{v} - \frac{\mu_2}{u} = (\mu_2 - \mu_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ or $\frac{1}{v} - \frac{1}{u} = \left[\frac{\mu_2 - \mu_1}{\mu_1}\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ …(3)	
	If the object is placed at infinity ($u = \infty$), the image will be formed at the focus, i.e., $v = f$. Therefore,	½
	$$\frac{1}{f} = \left[\frac{\mu_2 - \mu_1}{\mu_1}\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \ldots(4)$$	½
	we know $$\frac{1}{f_a} = \left(\frac{\mu_g}{\mu_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ *in water*	
	$$\frac{1}{f_w} = \left(\frac{\mu_g}{\mu_w} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ *solving we get*	½
	$$\frac{f_w}{f_a} = \frac{\left(\frac{\mu_g}{\mu_a} - 1\right)}{\left(\frac{\mu_g}{\mu_w} - 1\right)}$$	½
	$$f_w = f_a\left(\frac{1.5 - 1}{1.128 - 1}\right)$$ $$f_w = \frac{0.2 \times 0.5}{0.128} = 0.78m$$	½
	$$\Delta f = (0.78 - 0.20)m$$ $$= 0.58m$$	½
	OR In equilateral prism ABC	



½

½

From the quadrilateral AQNR, A + ∠ QNR = 180°

From the triangle QNR,

r + r' + ∠ QNR = 180° ∴ A = r + r'

Now, from the triangle MQR, the deviation produced by the prism. is

δ = ∠ MQR + ∠ MRQ = (i - r) + (e – r')

or δ = deviation at the first face ½

+ deviation at the second face

= (i+e)-(r + r')

or δ = i + e - A or i + e= A + δ

½

a ray of light passes symmetrically (parallel to the base) through the prism so that ½

i = e, r = r',δ = δ_m

As A + δ =i+e

∴ A + δ_m = i + i or i = $\frac{A+\delta_m}{2}$

Also A = r+ r' = r+ r = 2r

∴ $r = \frac{A}{2}$

From Snell's law, the refractive index of the material of the prism will be ½

$\mu = \frac{\sin i}{\sin r}$ $or\ \mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$

(ii) Given

	$A=60°\ \ \delta_m=30°$ $as\ i+i=A+\delta_m \Rightarrow i=45°$ $r+r=60° \Rightarrow r=30°$ $also\ as$ $\mu=\dfrac{\sin 45°}{\sin 30°}$ $\mu=\sqrt{2}$	1 1
Q33	Line resistance = Length of two-wire line × Resistance per unit length = 2 × 15 km × 0.5Ω km^{-1} = 15Ω Voltage at which power is sent through the line = 4000 V Power supplied to town sub-station = 800 kW = 800 × 10^3 W ∴ rms value of current in the line $=\dfrac{\text{Power}}{\text{Voltage}}=\dfrac{800\ \times\ 10^3}{4000}\text{A}=200\text{A}$ (a) Line power loss = I^2R = $(200)^2$ × **15** W = **600 kW.** (b) Power supplied by the plant = Power received at sub – station + line power loss = 800 + 600 = **1400 kW.** OR Average value of a.c. It is defined as that value of direct current which sends the same charge in a circuit in the same time as is sent by the given alternating current in its half time period. It is denoted by I_{av} or I_m	1 1 1 1 1 1

	amount of charge that flows through the circuit in small time dt is given by dq = I. dt = I_0 sin ωt. dt The total charge that flows through the circuit, say in the first half cycle, i.e., from t = 0 to t = T / 2 is given by $q = \int_0^{T/2} dq = \int_0^{T/2} I_0 \sin \omega t\, dt = I_0 \left[-\frac{\cos \omega t}{\omega}\right]_0^{T/2}$ $= -\frac{I_0}{2\pi/T}\left[\cos \frac{2\pi}{T} t\right]_0^{T/2}$ $= -\frac{I_0 T}{2\pi}[\cos \pi - \cos 0] \left[\because \omega = \frac{2\pi}{T}\right]$ $= -\frac{I_0 T}{2\pi}[-1-1] = \frac{I_0 T}{\pi}$ ∴ The average value of a.c. over the first half cycle is $I_{av} = \frac{\text{Charge}}{\text{Time}} = \frac{q}{T/2} = \frac{2q}{T} = \frac{2}{T}.\frac{I_0 T}{\pi}$ $I_{av} = \frac{2}{\pi} I_0 = 0.637\, I_0$ (ii) Given peak value of current $I_0 = 15A$ As rms value of current is $I_{rms} = \sqrt{2} I_0$ *therfore* $I_{rms} = 1.41 \times 15$ $= 21.15A$	1 ½ ½ 1 1