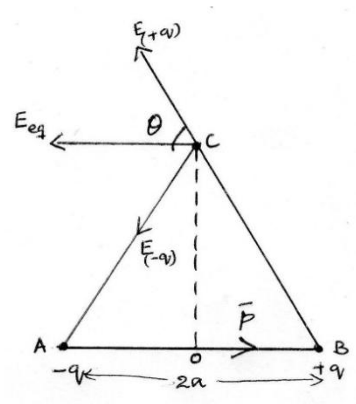
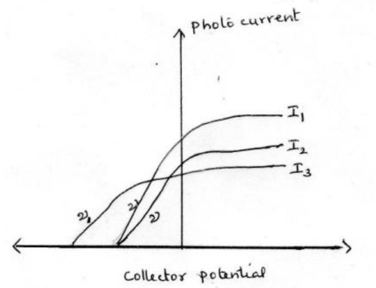
MARKING SCHEME
SET 55/1/S

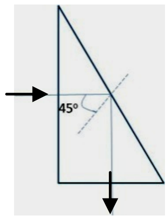
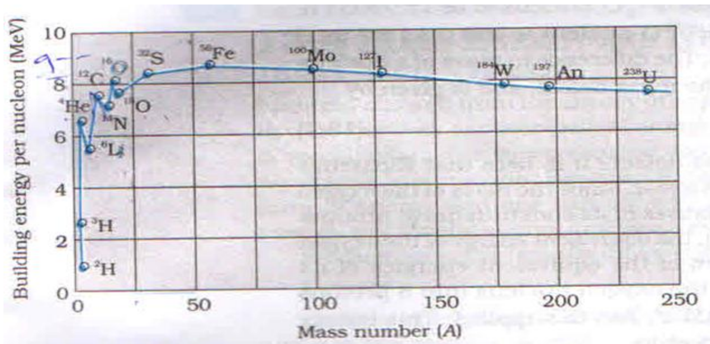
Q. No.	Expected Answer / Value Points	Marks	Total Marks
Section A			
Set1,Q1 Set2,Q3 Set3,Q2	(i) Manganin (ii) $R = \frac{\rho l}{A}$. As ρ increases A also increases **Alternatively,** $R_c = \rho_c \frac{l}{A_c}; R_m = \rho_m \frac{l}{A_m}. since\ \rho_m > \rho_c \therefore A_m > A_c$	½ ½	1
Set1,Q2 Set2,Q2 Set3,Q5	Phase angle = 60° **[Note : If the student only writes,** [$\cos\varphi = 0.5$] , **give ½ mark]**	1	1
Set1,Q3 Set2,Q1 Set3,Q4	Between plates of capacitor during charging / discharging **Alternatively,** In the region of time varying electric field	1	1
Set1,Q4 Set2,Q5 Set3,Q1	(i) P = NOT gate (ii) Q = OR gate	½ ½	1
Set1,Q5 Set2,Q4 Set3,Q3	Def: The average time, between successive collisions of electrons, (in a conductor) is known as relaxation time	1	1
Section B			
Set1,Q6 Set2,Q6 Set3,Q10	Electrostatic Shielding ½ Using this property in actual practice 1 Potential in a cavity ½ The field inside a conductor is zero. Sensitive instruments are shielded from outside electrical influences by enclosing them in a hollow conductor . (**any other relevant answer.)** Potential inside the cavity is not zero/ potential is constant.	½ 1 ½	2
Set1,Q7 Set2,Q7 Set3,Q8	Two properties of electromagnetic waves ½ +½ Showing e m waves have momentum 1 **Any two properties** of electromagnetic waves Such as (a) transverse nature (b) does not get deflected by electric fields or magnetic fields (c) same speed in vacuum for all waves (d) no material medium required for propagation (e) they get refracted, diffracted and polarised / **(any two properties)** Electric charges present on a plane, kept normal to the direction of propagation of an e.m. wave can be set and sustained in motion by the electric and magnetic field of the electromagnetic wave. The charges thus acquire energy and momentum from the waves.	½ + ½ 1	

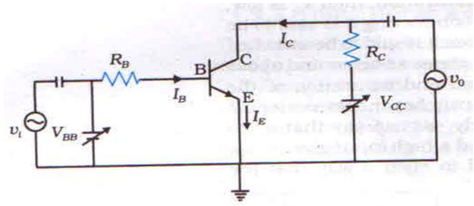
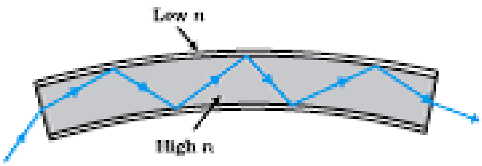
	Alternatively Radiation Pressure – Electromagnetic waves exert radiation pressure. Hence, they carry momentum.		2
Set1,Q8 Set2,Q8 Set3,Q9	Principle ½ Calculation of λ 1 ½ Diffraction effects are observed for beams of electrons scattered by the crystals $\lambda = \frac{1.227nm}{\sqrt{V}}$ $\lambda = \frac{1.227nm}{\sqrt{120}}$ Value λ= 0.112nm **Alternatively** $\lambda = \frac{h}{\sqrt{2meV}}$ $= \frac{6.63 \text{ x } 10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\times120}}$ λ =0.112nm	½ ½ ½ ½ ½ ½ ½	2
Set1,Q9 Set2,Q10 Set3,Q7	Function of Transducer 1 Function of Repeater 1 (i) Transducer: The device which converts one form of energy into another (ii) Repeater: A repeater picks up signal, amplifies and retransmits them to receiver	1 1	2
Set1,Q10 Set2,Q9 Set3,Q6	Finding the principal quantum number 1 Finding the total energy 1 (i) $r = r_0 n^2$ $21.2\text{x}10^{-11} = 5.3\text{x}10^{-11}\ n^2$ implies n = 2 (ii) $E = \frac{-13.6eV}{n^2}$ $= \frac{-13.6eV}{2^2}$ =-3.4eV **[Award ½ mark if the student just writes E= E_1/4]** **OR** Calculation of energy of photon 1½ Identification of transistion ½ (i) Energy of photon = $\frac{hc}{\lambda} = \frac{6.64\times10^{-34}\times3\times10^{8}}{275\times10^{-9}\times1.6\times10^{-18}} eV$ =4.5 eV (ii) The corresponding transition is B	½ ½ ½ ½ ½ + ½ + ½ ½	2 2

Section C

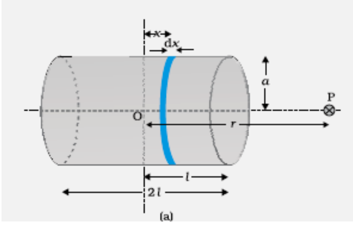
Set1,Q11 Set2,Q20 Set3,Q22	Diagram — 1 Deriving expression for E_{eq} — 1 ½ Direction of E_{eq} — ½  E_{+q} = Kq / (r^2 +a^2) and E_{-q} = Kq / (r^2 +a^2) The two Electric fields have equal magnitudes and their directions are as shown in diagram Components along dipole axis get added up while normal components cancel each other. $\therefore \mathbf{E}=-[E_{-q}+E_{+q}]\cos\theta\ \hat{r}$ so $E = -\frac{K2qa}{[r^2+a^2]^{\frac{3}{2}}}\hat{r}$ $=\frac{kp}{[r^2+a^2]^{\frac{3}{2}}}(p = 2qa\hat{r}) = \frac{-1}{4\pi\epsilon_o}\frac{p}{[r^2+a^2]^{\frac{3}{2}}}$ ∴Direction of electric field is opposite to that of dipole moment.	1 ½ ½ ½ ½	3
Set1,Q12 Set2,Q15 Set3,Q16	a) To find charge accumulated in capacitor C_2 — ½ b) To find the ratio of energy stored — 2 ½ a) Zero b) We have $C_{series}= \frac{3\mu F}{3}$ = 1 μF Also, $C_{parallel}$= (3+3+3)=9μF Energy stored = $\frac{1}{2}CV^2$ ∴Energy in series combination = $\frac{1}{2}1 \times 10^{-6} \times V^2$ Energy in parallel combination = $\frac{1}{2}9 \times 10^{-6} \times V^2$ ∴Ratio = 1:9	½ ½ ½ ½ ½ ½	3

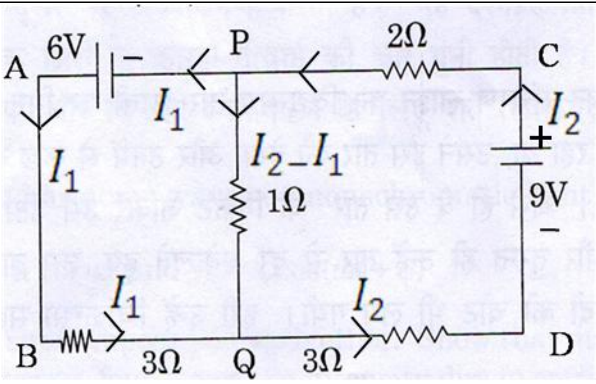
Set1,Q13 Set2,Q16 Set3,Q19	a) Definition of intensity — 1 b) Required graph — 1 c) Explanation of nature of the curves — 1 a) Intensity of radiation equals the energy of all the Photons incident normally per unit area per unit time. **Alternatively,** The intensity of radiation is proportional to the number of photons emitted per unit area per unit time. b)  c) As per Einstein's equation, (i) The stopping potential is same for I_1 and I_2 as they have the same frequency. (ii) The saturation currents are as shown , because $I_1 > I_2 > I_3$	1 1 ½ ½	3
Set1,Q14 Set2,Q14 Set3,Q12	(i) To explain the process of emission — 1 (ii) Material preferred to make LED and reason — ½ + ½ (iii)Two advantages of using LED — ½ + ½ (i) During Forward bias of LED, electrons move from n side to p side and holes move from p side to n side. During recombination, energy is released in the form of photons having energy $h\nu$ of the order of band gap. (ii) GaAs/ GaAsP (any one) Band gap should be 1.8 eV to 3 eV These materials have band gap which is suitable to produce desired visible light wavelengths. **(iii)**Low operational voltage, fast action , no warm up time required, nearly monochromatic, long life ,ruggedness, fast on and off switching capacity. **(any two points)**	1 ½ ½ ½ + ½	3
Set1,Q15 Set2,Q13 Set3,Q14	Calculation of capacitance — 1 Calculation of Impedence — 1 Calculation of Power dissipitated — 1 Capacitance = C = $\frac{1}{L\omega^2}$ $= \frac{1}{\frac{4}{\pi^2}(2\pi\times50)^2}$F	½ ½	

	$= 2.5 \times 10^{-5}\, F$ Impedence = resistance(since V and I are in phase) ∴Impedence = 100Ω Power discipated = $\frac{E_{rms}^2}{R}$ $= \frac{(200)^2}{100} W$ = 400 watt	½ ½ ½ ½	 3
Set1,Q16 Set2,Q19 Set3,Q20	(i) To calculate angle of prism 1 ½ (ii) To trace the path of incident light inside the prism 1 ½ (i) $\mu = \frac{sin\left(\frac{A+D}{2}\right)}{sin\frac{A}{2}}$ $= \frac{sin\left(\frac{2A}{2}\right)}{Sin\frac{A}{2}}$ = 2cosA/2 = $\sqrt{3}$ ∴A= 60°  **(ii)** $\mu = \sqrt{3} = \frac{1}{Sini_c}$ ∴ $Sini_c = \frac{1}{\sqrt{3}} \cong 0.58$ Lies between 30^0 and 45^0 Hence, TIR takes place. **Alternatively,** $sinc = \frac{1}{\sqrt{3}}$ which is less than $\frac{1}{\sqrt{2}}$ ∴ angle of incidence > i_c ∴TIR	 ½ ½ ½ ½ 1	 3
Set1,Q17 Set2,Q18 Set3,Q17	To plot (BE/A) *vs* mass number graph 1½ To state the property of nuclear force ½ To explain the release of energy in fission and fusion using the graph ½ + ½  Nuclear force is Saturated, or short ranged [any one] The final system is more tightly bound when heavy nucleus undergoes nuclear fission. Hence, there is a release of energy. The final system is more tightly bound when light nuclei undergoes nuclear fusion. Hence, there is a releases of energy.	 1½ ½ ½ ½	

	Alternatively : There is an increase in BE/nucleon both during (i) Nuclear fission of heavy nuclei and **(ii)** Nuclear fussion of light nuclei	 ½ ½	3
Set1,Q18 Set2,Q17 Set3,Q18	To draw circuit diagram of amplifier 1 ½ Deriving the expression for β ac 1 ½ a)  b) $A_V = \beta_{ac} . \frac{R_L}{r}$ $\therefore \beta_{ac} = A_V \frac{r}{R_L}$ **Alternatively:** [If the student writes $\beta_{ac} = \frac{\delta I_c}{\Delta I_B}$ award full credit]	2 1	3
Set1,Q19 Set2,Q22 Set3,Q21	(i) Naming the phenomenon 1 (ii) Two conditions for TIR ½ + ½ (iii) Labelled diagram of optical fibre 1 (i) Total internal reflection (ii) Rays of light have to travel from optically denser medium to optically rarer medium and Angle of incidence in the denser medium should be greater than critical angle (iii)  **[Note: Deduct ½ mark if labelling is not done]**	1 ½ ½ 1	3
Set1,Q20 Set2,Q12 Set3,Q15	Three applications of internet ½ + ½ + ½ Explanation of any one 1 ½ Applications of internet- e mail, social networking sites, e –commerce, mobile telephony, GPS, [Any three] Explanation of any one	½ + ½ + ½ 1½	3

Set1,Q21 Set2,Q11 Set3,Q11	To show that the intensity of maximum is four times the intensity of light from each slit — 2 Conditions for constructive and destructive interference — ½ + ½ Resultant displacement $y=y_1+y_2$ $= a[\cos(\omega t) + \cos(\omega t + \phi)]$ $= 2a\cos\left(\frac{\phi}{2}\right)cos\left(\omega t + \frac{\phi}{2}\right)$ $\therefore$ amplitude of resultant wave $= 2a\cos\left(\frac{\phi}{2}\right)$ $\therefore$ Intensity $= 4I_o cos^2\left(\frac{\phi}{2}\right)$, where $I_o = a^2$ is the intensity of each harmonic wave At the maxima , $\phi = \pm 2n\pi \ \therefore cos^2\frac{\phi}{2}=1$ At the maxima , $I = 4I_o = 4 \times$ intensity due to one slit $I=4I_o cos^2\left(\frac{\phi}{2}\right)$ For constructive interference, I is maximum It is possible when $cos^2\left(\frac{\phi}{2}\right) = 1; \frac{\phi}{2} = n\pi; \phi = 2n\pi$ For destructive interference, I is minimum, i.e, I=0 It is possible when $cos^2\left(\frac{\phi}{2}\right) = 0; \frac{\phi}{2} = \frac{(2n-1)\pi}{2}; \phi = (2n \pm 1)\frac{\pi}{2}$	½ ½ ½ ½ ½ ½	3
Set1,Q22 Set2,Q21 Set3,Q13	(i) Two properties of soft iron — ½ + ½ (ii) Statement of Gauss's law in magnetism — 1 Difference and Explanation — ½ + ½ (i) Low coercivity and high permeability (ii) The net magnetic flux through any closed surface is zero/ $\oint B.ds = 0$ $\oint E.ds = \frac{q}{\epsilon_0}$ /The net electric flux through any closed surface is $\frac{1}{\epsilon_o}$ times the net charge. which indicates magnetic monopoles do not exist/ magnetic poles always exists in pairs **[Note :** If the student just states Guass's Law in electrostatics these 2 marks may be awarded.] **OR** a) Deriving the expression for Magnetic field at a point outside the current carrying solenoid — 2 b) Writing the condition — 1	½ + ½ 1 ½ ½	3

	 a) The magnitude of the total field is obtained due to small elements $dB = \frac{\mu_o n dx I a^2}{2[(r-x)^2 + a^2]^{\frac{3}{2}}}$ x varies from $x = -l \; to \; x = +l$ $B = \frac{\mu_o n I a^2}{2} \int_{-l}^{l} \frac{dx}{[(r-x)^2 + a^2]^{\frac{3}{2}}}$ For $r \gg a \; and, we \; have \; r \gg x$ $B \simeq \frac{\mu_o n I a^2}{2r^3} \int_{-l}^{l} dx = B = \frac{\mu_o n I a^2 (2\ell)}{2r^3}$ $Here \; magnetic \; moment \; m = n2I(\pi a^2)$ $Thus \; B = \frac{\mu_o 2m}{4\pi r^3}$ This is also the far axial magnetic field of a bar magnet. Hence, the magnetic field, due to current carrying solenoid along its axial line is similar to that of a bar magnet for far off axial points.	½ ½ ½ ½ 1	3
Section D			
Set1,Q23 Set2,Q23 Set3,Q23	a) Two values 1+1 b) Reason 1 c) Reason, for why power is transmitted at high voltage 1 a) Caring, helpful, presence of mind (or any other (two) relevant values) b) Current passes between two points only when there is a potential difference between them/ c) To minimise power loss during transmission.	2 1 1	4
Section E			
Set1,Q24 Set2,Q25 Set3,Q26	(i) To fine the magnitude and the direction of current in 1Ω resistor 3 (ii) (Shift and reason) in each case (½ + ½) x 2		



For the mesh APQBA

$-6-1\,(I_2-\,I_1)+\,3\,I_1=\,0$

Or $-I_2+\,4I_1=\,6$ ……………………………………(1) — 1

For the mesh PCDQP

$2I_2-9+3I_2+1\,(I_2-\,I_1)=\,0$

Or $6I_2-I_1=\,9$ ……………………………………(2) — 1

Solving (1) and (2) , we get

$$I_1=\frac{45}{23}\,A$$ ½

$$I_2=\frac{42}{23}\,A$$ ½

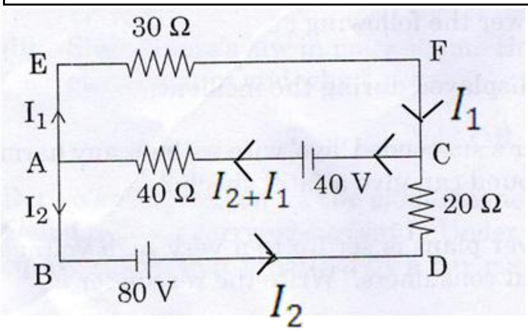
∴Current through the 1A resistor = $\frac{-3}{23}\,A$ — ½

a) Balancing length increases — ½
When series resistance increases, the potential gradient decreases. Hence ℓ increases. Null point shifts towards point B. — ½

b) Balancing length decreases — ½
V= E- I'r. As I' increases V decreases. Hence balancing length decreases. Null point shifts towards A. — 5

OR

a)	To calculate the current in the arm AC	3
b)	Principle of meter bridge	1
c)	Why metal strips are used in meter bridge	1

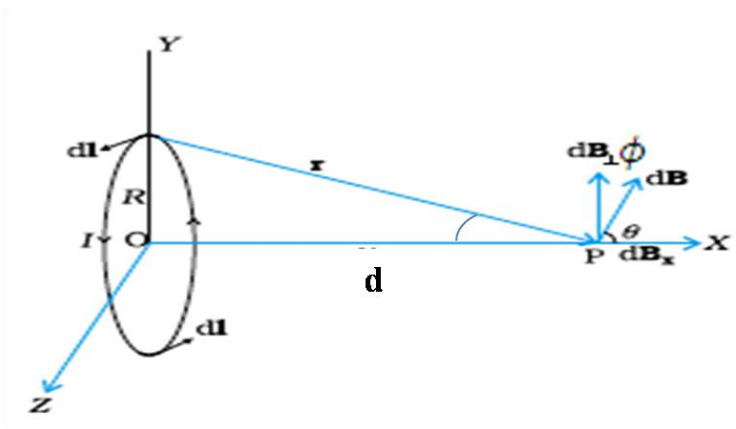


For the mesh EFCAE

$-30I_1+40-40\,(I_1+\,I_2)=\,0$ — 1

Or $-7I_1-4I_2=\,-4$

Or $7I_1+4I_2=\,4$ …………………………………(1)

	For the mesh ACDBA $40\,(I_1 + I_2) - 40 + 20I_2 - 80 = 0$ Or $40I_1 + 60I_2 - 120 = 0$ Or $2I_1 + 3I_2 = 6$ ……………………………….(2) Solving (1) and (2) , we get $I_1 = \frac{-12}{13}\ A$ $I_2 = \frac{34}{13}\ A$ ∴Current through arm AC = $I_1 + I_2$ $= \frac{22}{13}\ A$ a) Metre bridge works on Wheatstone's bridge balancing condition. b) Metal strips will have less resistance / to maintain continuity, without adding to the resistance of the circuit.	1 1 1 1	5
Set1,Q25 Set2,Q26 Set3,Q24	(i) Biot-Savart law in vector form — 1 (ii) Deriving an expression for the magnetic field at a point on the axial line of current carrying coil — 3 (iii) Ratio of magnetic field at the centre and given outside point — 1 (i) $\overrightarrow{dB} = \frac{\mu_o I \overrightarrow{d\ell} \times \hat{r}}{4\pi r^2} = \frac{\mu_o I \overrightarrow{d\ell} \times \vec{r}}{4\pi r^3}$ (ii) $dB = \frac{\mu_0 I dl \sin\theta}{4\pi r^2}$ here θ =90; $dB = \frac{\mu_0 I dl}{4\pi r^2}$ = dB Sinϕ= $\frac{\mu_o I d\ell}{4\pi r^2}$ sinϕ $B = \int_0^R \frac{\mu_o I dl}{4\pi r^2} \sin\varphi = \frac{\mu_o I (2\pi R^2)}{4\pi r^3}$ $B = \frac{\mu_o NI (R^2)}{2r^3} = \frac{\mu_o NIR^2}{2(R^2 + d^2)^{\frac{3}{2}}}$ 	1 ½ ½ ½+ ½ ½ ½	

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<td>(i) Magnetic field at the centre of the coil $B_1 = \frac{\mu_o NI}{2R}$

Magnetic field at the outside point $B_2 = \frac{\mu_o NIR^2}{2[R^2+3R^2]^{\frac{3}{2}}} = \frac{\mu_o NIR^2}{2[4R^2]^{\frac{3}{2}}} = \frac{\mu_o NI}{2*8R}$

$\frac{B_1}{B_2} = 8$

[Note :If the student takes r= $\sqrt{3}$ R, the ratio of B centre to B axial would be 3 $\sqrt{3}$: 1. Award 1 mark in this case also.]

OR

a) Velocity selection condition — 1
b) Name of device — ½
What does the machine do — ½
Use of two fields — ½ + ½
Regions of existence of field — ½ + ½
Nature of fields — ½ + ½

a) qE = Bqv
v =E/B

(b) Name of the device: Cyclotron
It accelerates charged particles/ions
Electric field accelerates the charged particles.
Magnetic field makes particles to move in circle.
Electric field exists between the Dees.
Magnetic field exists both inside and outside the dees.
Magnetic field is uniform / constant.
Electric field is oscillating/ alternating in nature.</td>
<td>½
½
2

1

½
½
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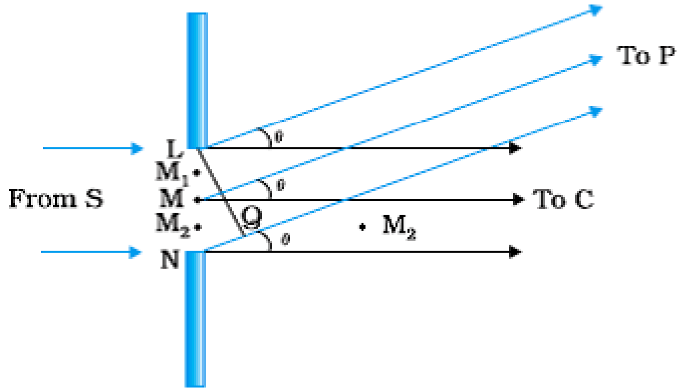
<td>Set1,Q26
Set2,Q24
Set3,Q25</td>
<td>Explaining the formation of the diffraction pattern — 3
Secondary maxima — ½
Minima — ½
Why do secondary maxima get weaker in intensity — 1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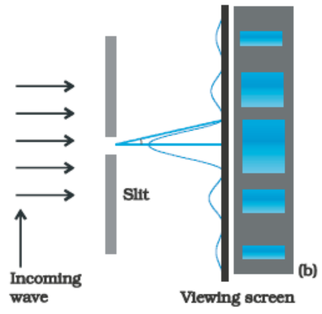
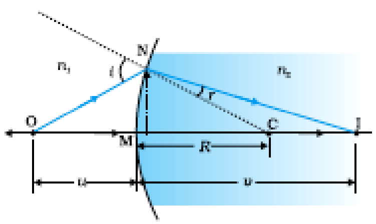
	The diffraction pattern formed can be understood by adding the contributions from the different wavelets of the incident wavefront, with their proper phase differences.	1	
	For the cental point, we imagine the slit to be divided into two equal halves. The contribution of corresponding wavelets, in the two halves, are in phase with each other. Hnce we get a maxima at the central point. The entire incident wavefront contributes to this maxima.	½	
	All other points, for which $\theta = (n + \frac{1}{2})\frac{\lambda}{a}$, get a net non zero contribution from all the wavelets. Hence all such points are also points of maxima. Points for which $\theta = \frac{n\lambda}{a}$,the net contribution, from all the wavelets, is zero. Hence these points are point of minima.	½	
	We thus get a diffraction pattern on the screen, made up of points of maxima and minima.	½	
	(a)	1	
	Secondary maxima keep on getting weaker in intensity, with increasing n. This is because, at the (i) First secondary maxima, the net contribution is only from (effectively) 1/3 rd of the incident wavefront on the slit. (ii) Second secondary maxima, the net contribtion is only from (effectively) 1/5th of the incident wavefront on the slit.And so on.	1	5
	OR		
	(i) Ray diagram — 1 Deriving the relation between refractive indices, u and v — 2 (ii) Change in focal length changes when the wavelength of light increases — 1 (iii)Change in focal length changes when the lens is dipped in water — 1		
	(i) 	1	

	$$\tan\alpha = \frac{AN}{ON} \approx \alpha$$ $$\tan\beta = \frac{AN}{ON} \approx \beta$$ $$\tan\gamma = \frac{AN}{ON} \approx \gamma$$ $$\alpha + \gamma = i; r = \gamma - \beta$$ $$\frac{AN}{ON} + \frac{AN}{CN} = i; r = \frac{AN}{CN} - \frac{AN}{NI}$$ $$n_{21} = \frac{\sin i}{\sin r} \approx \frac{i}{r}$$ $$\frac{n_2}{n_1} = \frac{\frac{AN}{ON} + \frac{AN}{CN}}{\frac{AN}{CN} - \frac{AN}{NI}}$$	1	
	$$n_2\left(\frac{AN}{CN} - \frac{AN}{NI}\right) = n_1\left(\frac{AN}{ON} + \frac{AN}{CN}\right)$$ $$CN = R; NI = V; ON = -u$$	½	
	$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$	½	
	(ii) focal length increases with increase of wavelength	½	
	$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\frac{2}{R}$ as wavelength increases μ_2/μ_1 decreases hence focal length increases	½	
	(iii)As μ_1 increases focal length increases	½	
	$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\frac{2}{R}$$	½	5