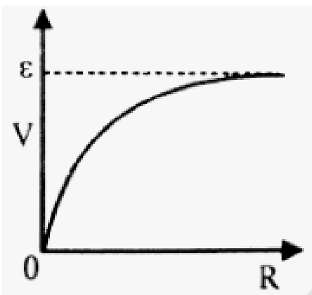
SOLUTIONS : PHYSICS (042)			
CODE: 55/7/1			
Q.NO.	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION- A		
1.	(A) 250 V	1	1
2.	(C) 16/3 Ω	1	1
3.	(A) BA sin α	1	1
4.	(A) 1/200 s	1	1
5.	(C) capacitive and inductive respectively	1	1
6.	(B) 0.2 mV	1	1
7.	(D) $\left[ML^2T^{-2}A^{-2}\right]$	1	1
8.	(B) 3.20×10^{14} Hz	1	1
9.	(C) holes and few electrons	1	1
10.	(A) n=4 to n=3	1	1
11.	(A) Both the potential barrier height and width of depletion layer decrease.	1	1
12.	(C) same neutron number but different atomic number.	1	1
13.	(D) Both Assertion (A) and Reason (R) are false.	1	1
14.	(C) Assertion(A) is true and Reason(R) is false.	1	1
15.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is **not** the correct explanation of Assertion(A).	1	1
16.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is **not** the correct explanation of Assertion(A).	1	1
	SECTION- B		

17.

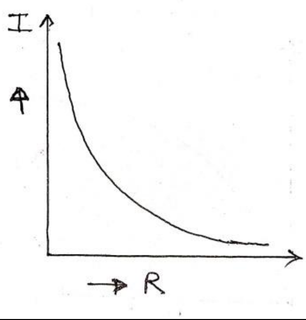
Showing variation graphically
(a)Terminal voltage with resistance R 1
(b)Current supplied by cell with resistance R 1

(a)



1

(b)



1

2

18.	(a) Deducing for (a)Size 1 (b)Location of the image produced by convex mirror 1		
	Let, u= nf From the Mirror formula, $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$	½	
	$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$ $=\frac{1}{f}+\frac{1}{nf}$ $v=\frac{nf}{n+1}$ $n=+ve \quad \therefore v<f$	½	
	$m=\frac{-v}{u}=\frac{1}{n+1}$	½	
	m is always positive & less than 1.	½	
	Note: **Award full credit if correctly concluded by any other method**.		
	OR		
	(b) Finding the nature & focal length of lens 1½ Stating answer for changing thickness ½		
	$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}$	½	
	$\frac{1}{12}=\frac{1}{10}-\frac{1}{15}+\frac{1}{f_3}$ $\frac{1}{f_3}=\frac{5-6+4}{60}$ $f_3=20\,cm$	½	
	Nature: Convex	½	
	Yes	½	2
19.	Difference between Interference & Diffraction patterns 1 Reason 1		

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Interference pattern	Diffraction pattern
1. The interference pattern has a number of equally spaced bright and dark bands. 2. The interference pattern is obtained by superposing two waves originating from the two narrow slits. 3. The maximas are of same intensity.	1. The diffraction pattern has a central bright maximum which is twice as wide as the other maxima. 2. The diffraction pattern is obtained by superposition of a continuous family of waves originating from each point on a single slit. 3. The intensity falls as we go to successive maxima away from the centre, on either side.

(Any two differences)
The light wave coming out of two independent source of light will not have constant phase with time.
Alternatively:
Two sodium lamps are incoherent source of light.
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1</td>
<td>2</td>
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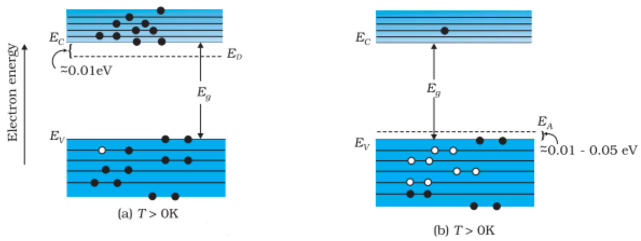
Drawing Energy band diagram of	
n type semiconductor	½
p type semiconductor	½
Showing donor/acceptor energy level	½+½



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<td>1+1</td>
<td>2</td>
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Explaining energy produced in stars	1
Two examples of nuclear reactions involved	½+½

Energy is produced in stars due to Nuclear fusion.
Two lighter nuclei fuse to form a heavier nucleus which is more stable, hence energy is released.
Alternatively: Due the difference in masses in reactants and products, mass is converted into energy. Hence energy is released.
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½</td>
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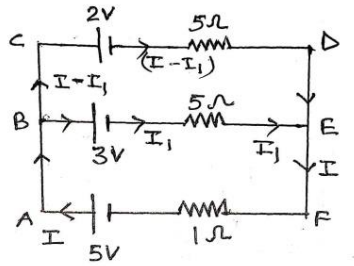
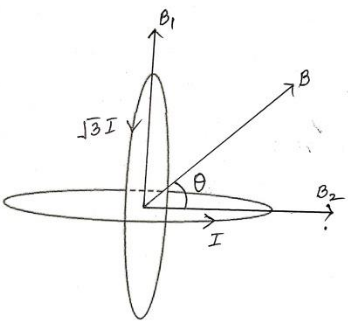
	${}_{1}^{1}H+{}_{1}^{1}H\rightarrow {}_{1}^{2}He+e^{+}+\nu$ ${}_{1}^{2}H+{}_{1}^{2}H\rightarrow {}_{2}^{3}He+{}_{0}^{1}n$ ${}_{2}^{3}He+{}_{2}^{3}He\rightarrow {}_{2}^{4}He+{}_{1}^{1}H+{}_{1}^{1}H$ **Any two above equation.**	½+ ½	2
	SECTION- C		
22.	Calculating the current through cells A, B and C 3  	½	
	In loop ABEFA, $5-3-5I_1-I=0$ $2=5I_1+I \quad -----(1)$	½	
	In loop CBEDC, $2-3-5I_1+5I-5I_1=0$ $-1=10I_1-5I \quad -----(2)$	½	
	Solving equation (1) and (2) $I=\frac{5}{7}A$ in arm AF/through the cell of 5V(A)	½	
	$I_1=\frac{9}{35}A$ in arm BE/through the cell of 3V(B)	½	
	$I-I_1=\frac{16}{35}A$ in arm CD/through the cell of 2V(C)	½	3
23.	(a) (i)Writing Biot-Savart's Law in vector form 1 (ii)Finding magnitude & direction of net magnetic field at centre of two current carrying coils 2		
	(i) $\vec{dB}=\frac{\mu_0}{4\pi}\frac{I(\vec{dl}\times\vec{r})}{r^3}$	1	
	(ii) $B_1=\frac{\mu_0 I}{2R}$ $B_2=\frac{\mu_0\sqrt{3}I}{2R}$  	½	
	$B=\sqrt{B_1^2+B_2^2}$ $\therefore B=\frac{\mu_0 I}{2R}\sqrt{1+3}$	½	

$$B = \frac{\mu_0 I}{R}$$ ½

$$\tan\theta = \frac{B_1}{B_2} = \frac{1}{\sqrt{3}}$$ ½

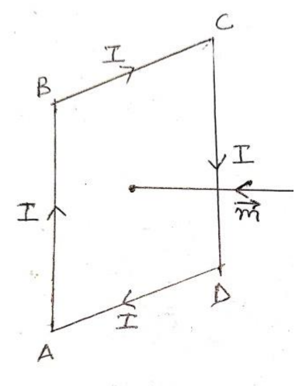
Direction of net magnetic field is 30° with direction of B_2/ 60° with the direction of B_1.

OR

(b)

Writing the expression for magnetic moment & showing its direction	1
Proving no net force	1
Torque $(\vec{\tau}) = \vec{m} \times \vec{B}$	1

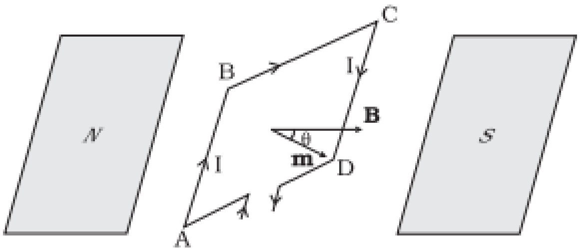
(i) $\vec{m} = I\vec{A}$ ½



½

(ii) $F_1 = F_2 = IbB$ $\quad F_1 = \text{Force on AB into the plane}$

$F_2 = \text{Force on CD out of the plane}$ ½



Since forces are equal & opposite so net force = 0 ½

Both forces form a couple, magnitude of torque acting on the coil is

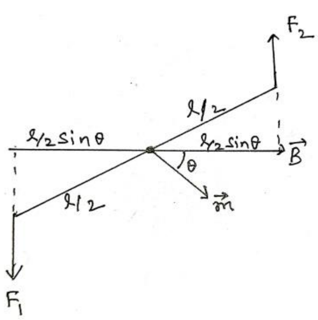
$$\therefore \tau = F_1 \frac{l}{2}\sin\theta + F_2 \frac{l}{2}\sin\theta$$ ½

$= I\,b\,B\,l\sin\theta$

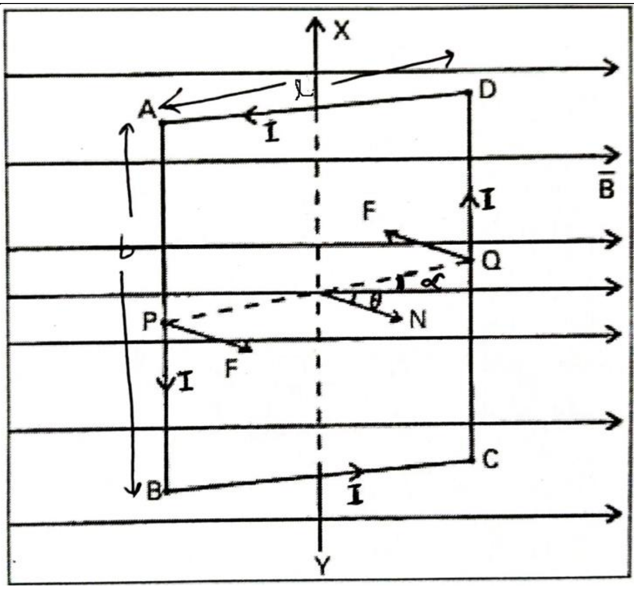
$= I\,A\,B\,\sin\theta$

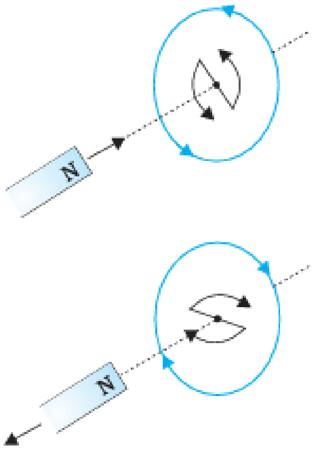
$= m\,B\sin\theta$

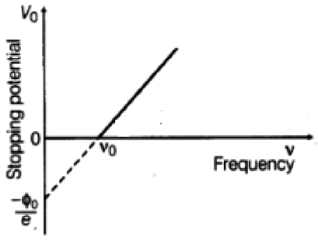
$\vec{\tau} = \vec{m} \times \vec{B}$ ½

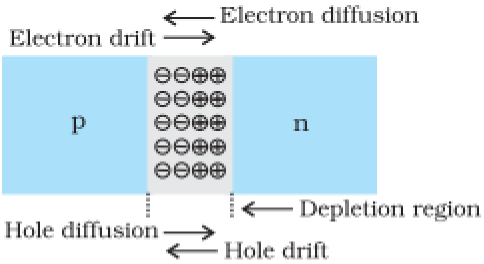


Alternatively:

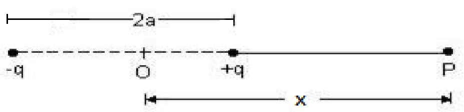
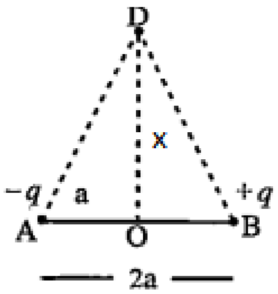
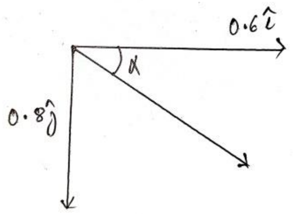
	 If the plane of the current carrying coil makes an angle ∝ with the magnetic field $\vec{F}_{DA} = -\vec{F}_{Bc}$ (cancel each other) Force on the arm DC is into the plane of the paper $\lvert F_{DC} \rvert = IbB$ Force on the arm AB is out of the plane of the paper. $\lvert F_{AB} \rvert = IbB$ Since forces are equal & opposite so net force = 0 Both of them form a couple and magnitude of torque acting on the coil is τ=either force ×perpendicular distance between the two forces. $\tau = IbB \times l \sin\theta$ $= IAB \sin\theta$ $\vec{\tau} = I\vec{A} \times \vec{B}$ $\vec{\tau} = \vec{m} \times \vec{B}$	½ ½ ½ ½	3
24.	(a)Stating Faraday's law of electromagnetic Induction 1 Explaining the role of negative sign 1 (b)Explaining consistency of Lenz law with conservation of energy 1 (a) The magnitude of induced emf in a circuit is equal to the time rate of change of magnetic flux. Mathematically, $e = -d\Phi/dt$ Negative sign indicates that the direction of induced emf and hence induced current in closed loop opposes its cause. (b) When magnet is moved closer/away from the loop, same/ opposite pole is developed on the approaching face of the loop. So, mechanical work is required to move a magnet which gets	1 1 1	

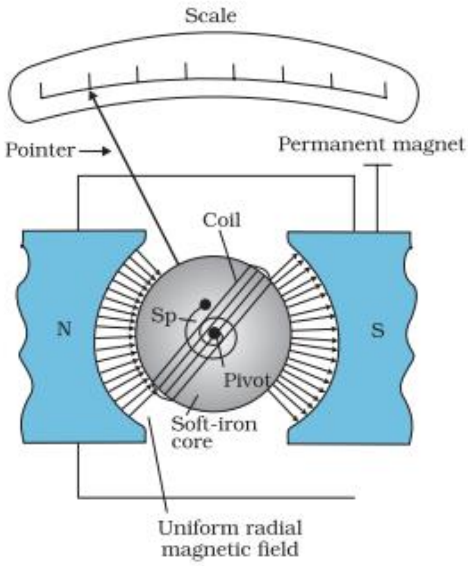
	converted into electrical energy which is consistent with law of conservation of energy.  **(Note: Please do not deduct marks for not showing figures)**		3
25.	(a)Similarity & dissimilarity between conduction & displacement current 1+1 (b)Explaining existence of em wave in free space 1 (a) **<u>Similarity</u>** Both give rise to magnetic field. **<u>Dissimilarity(any one)</u>** • Conduction current is due to flow of charges in the conductor. • Displacement current arises due to change in electric field/ time varying electric flux. (b) A magnetic field, changing with time, gives rise to an electric field. Then, an electric field changing with time gives rise to a magnetic field and is a consequence of the displacement current being a source of a magnetic field. Thus, time- dependent electric and magnetic fields give rise to each other and hence em wave is generated. **(Note: Please award ½ mark of this part if a child writes the expression only)** $\oint \vec{B}.\vec{dl} = \mu_0 I_c + \mu_0 \varepsilon_0 \frac{d\Phi_e}{dt}$	1 1 1	3
26.	(a)Defining work function ½ Determining the value of work function from graph 1 (b)Calculating wavelength of light 1½ Minimum energy required by an electron to escape from metal surface. The intercept on the y axis for a graph between stopping potential & frequency gives ϕ_0/e .	½	

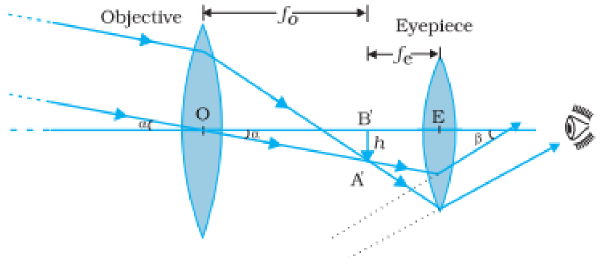
	$\therefore \phi_0$ =e × intercept on y-axis.	1	
	Alternatively: Work function ϕ_0 =h × intercept on x-axis. **(Note: Please award ½ mark, even if a student draws the following graph instead of determining the value of work function)**  		
	(b) $eV_0 = \frac{hc}{\lambda} - \phi_0$	½	
	$0.6 = \frac{hc}{\lambda} - 2.4$ $3 = \frac{hc}{\lambda} \Rightarrow 3 \times 1.6 \times 10^{-19} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{\lambda}$	½	
	$\lambda = \frac{1241}{3} = 413.6nm$	½	3
27.	Writing the mathematical form of postulates of Bohr's Theory 1½ Proving, (a) radius of the orbit is proportional to n^2 1 (b) Total energy of the atom is proportional to $1/n^2$ ½		
	Mathematical form of postulates of Bohr's Theory (i) $E_n = \frac{-13.6}{n^2} eV$	½	
	Alternatively : Electron revolve in stable orbits with definite energy called stationary orbits. (ii) $L = mvr = \frac{nh}{2\pi}$	½	
	(iii) $h\nu = E_f - E_i$	½	
	(a) $\frac{mv^2}{r} = \frac{Ze^2}{r^2}$ -----(1)	½	
	$mvr = \frac{nh}{2\pi}$ -----(2) Solving (1) & (2)		
	$r = n^2 \left(\frac{h}{2\pi}\right)^2 \frac{4\pi\varepsilon_0}{me^2}$ ----(3)	½	

	Since energy in the orbit $E_n = \frac{-e^2}{8\pi\varepsilon_0 r}$ Using eq (3) $E_n = \frac{-me^4}{8n^2\varepsilon_0^2h^2}$ or $E_n \propto \frac{1}{n^2}$	½	3
28.	Explaining the formation of depletion layer and potential barrier 1+1 Feature of junction diode for its use as rectifier 1 When an electron diffuses from n-side to p-side, it leaves behind an ionized donor on n side. Similarly when a hole diffuses from p-side to n-side, it leaves behind an ionized acceptor on p side. This space charge region consisting of immobile ions on either side of the junction is known as depletion layer. As diffusion process continues, width of depletion layer increases and consequently strength of electric field increases across the junction and thus the drift current. The potential that prevents the movement of electron from n region into p region is called potential barrier.  **(Note: Please award full credit of formation of depletion layer, even if a student draws above diagram)** Diode allows current to pass only when it is forward biased as resistance is small, whereas in reverse bias, its resistance is very large. **Alternatively**: Diode is unidirectional.	1 1 1	3
	SECTION -D		
29.	(i) (D) 1 (ii) (C) 3.75×10^6 (iii) (B) 500^0 C (iv) (a) (D) I decreases and II is almost constant **OR** (b) (D) All I, II and III change	1 1 1 1	4
30.	(i) (A) $1/\sqrt{n^2-1}$ (ii) (a) (B) 1.4 **OR**	1 1	

	(b) (D) increase by 19%. (iii) (C) First real and then virtual (iv) (A) 10cm	 1 1	 4
	SECTION- E		
31.	(a) (i) Finding the new value of capacitance 3 (ii) Finding the number of capacitors 2 (i) $C_0 = \frac{\varepsilon_0 A}{d}$ $C = \frac{\varepsilon_0 A}{(d-t) + \frac{t}{K}}$ $t = d/4$ $C = \frac{\varepsilon_0 A}{\left(d - \frac{d}{4}\right) + \frac{d}{4K}} = \frac{\varepsilon_0 A}{d\left(\frac{3}{4} + \frac{1}{4K}\right)}$ $= C_0 \frac{4K}{(3K+1)}$ **Alternatively**: When dielectric is inserted, the electric field between the plates is E= E_0/K The potential difference will be $V = E_0\left(\frac{3d}{4}\right) + E\left(\frac{d}{4}\right)$ $= E_0\left(\frac{3d}{4}\right) + \frac{E_0}{K}\left(\frac{d}{4}\right)$ $= V_0\left(\frac{3}{4} + \frac{1}{4K}\right)$ $V = V_0\left(\frac{3K+1}{4K}\right)$ $C = \frac{Q_0}{V} = \left(\frac{4K}{3K+1}\right)\frac{Q_0}{V_0}$ $C = C_0\left(\frac{4K}{3K+1}\right)$ (ii) Each capacitance can withstand 200V No. of capacitors in each row = $\frac{1200}{200} = 6$ Net capacitance of each row= 1/6 µF Number of rows = n $C_{eq} = C_1 + C_2 + \_\_\_\_\_\_ + C_n$ $C_{eq} = \frac{1}{6} + \frac{1}{6} + ----- n$ $2 = \frac{n}{6}$	 ½ ½ 1 1 ½ ½ 1 1 ½ ½	

	$\therefore n = 12$	½	
	Total no. of capacitors in the arrangement = 6 × 12 = 72	½	
	OR		
	(b) (i) Deriving the expression of electric potential due to dipole I. along its axis 1½ II. along its bisector line 1½ (ii) Calculating the torque 2		
	I. Along its axis		
	$V_- = \frac{-kq}{x+a}$ 		
	$V_+ = \frac{kq}{x-a}$	½	
	$V = V_- + V_+$ $= kq\left(\frac{-1}{x+a} + \frac{1}{x-a}\right)$		
	$= kq\frac{2a}{\left(x^2-a^2\right)} = \frac{kp}{x^2-a^2}$	½	
	$x \gg a \quad \therefore V = \frac{kp}{x^2}$	½	
	II. Along the bisector line		
	$V_- = \frac{kq}{\sqrt{x^2+a^2}}$ 	½	
	$V_+ = \frac{-kq}{\sqrt{x^2+a^2}}$	½	
	$V = V_- + V_+$ $= 0$	½	
	(ii) $\vec{\tau} = \vec{p} \times \vec{E}$	½	
	$= (0.8\hat{i} + 0.6\hat{j}) \times 10^{-29} \times (1 \times 10^{7})\hat{k}$		
	$= \left[0.8\left(-\hat{j}\right) + 0.6\hat{i}\right] \times 10^{-22}$	½	
	$\tau = \left[\sqrt{(0.8)^2 + (0.6)^2}\right] \times 10^{-22}$		
	$= 10^{-22}\ Nm$	½	
	$\tan\alpha = \frac{\lvert 0.8 \rvert}{0.6}$ 		
	$\alpha = \tan^{-1}\left(\frac{4}{3}\right)$	½	
	$\alpha = 53^0$		5

32.	(a) (i) Labelled diagram 1 Working principle of moving coil galvanometer 1 Use of (i) Radial magnetic field ½ (ii) Soft iron core ½ (ii) Defining current sensitivity 1 Reason 1		
		1	
	Principle:A current carrying coil placed in uniform magnetic field, experiences a torque.	1	
	(i) Radial magnetic field makes the scale linear **Alternatively**: Radial magnetic field provides maximum Torque.	½	
	(ii) Use of soft iron core is to increase the strength of magnetic field/ increase sensitivity of the galvanometer.	½	
	(ii) **Current sensitivity** is defined as deflection per unit current. **<u>Alternatively</u>**: $I_s = \frac{\Phi}{I} = \frac{NAB}{k}$	1	
	Voltage sensitivity $V_s = \frac{\Phi}{V} = \left(\frac{NAB}{k}\right)\frac{I}{V} = \left(\frac{NAB}{k}\right)\frac{1}{R}$	½	
	Increase in number of turns, increases the current sensitivity and resistance of the galvanometer in the same proportion of current sensitivity therefore Voltage sensitivity remains unchanged.	½	
	OR		

	(b)	(i) (I) Writing Ampere circuital law & explaining the terms. 1 (II) Reason for magnetic field outside long solenoid approaching zero 1 (III) Reason for irregular shaped loop changing to circular loop in uniform magnetic field 1 (ii) Finding the value of Resistance R_3 2		
		(i) **(I)** $\oint \vec{B}.\vec{dl} = \mu_0 I_e$ I_e= Total current through the surface B= Magnetic field dl = length of small element **(II)** As length of solenoid increases, it appears like a long cylindrical metal sheet, so field outside approaches zero. **(III)** For a given perimeter, a circle encloses greater area than any other shape, which maximizes the flux. (ii) $R_1 = \frac{V}{I_g} - G \quad \Rightarrow \frac{V}{I_g} = R_1 + G$ -----(1) $R_2 = \frac{V}{2I_g} - G \quad \Rightarrow \frac{V}{2I_g} = R_2 + G$ -----(2) Solving (1) & (2) $G = R_1 - 2R_2$ $R_3 = \frac{2V}{I_g} - G$ -----(3) Solving using eq (1) & (3) $R_3 = 3R_1 - 2R_2$	½ ½ 1 1 ½ ½ ½ ½	5
33.	(a)	(i) Drawing labeled Diagram 1½ Explanation ½ Writing expression of Magnifying power 1 (ii) Calculating the focal length of objective & eye piece 2		
		 **(Note: Deduct ½ mark, for not showing arrows with the rays)**	1½	

	Light from distant object enters the objective lens & forms a real image A'B' at f_o . This image A'B' acts as an object for eye piece and eye piece forms a magnified image at infinity. Magnifying Power = f_o/f_e (ii) Image is formed at least distance of distinct vision $20 = m_o \times m_e$ $m_o = \frac{20}{5} = 4$ $m_e = 1 + \frac{D}{f_e}$ $f_e = \frac{25}{4} cm$ $\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$ $\frac{1}{-25} - \frac{1}{u_e} = \frac{4}{25}$ $u_e = -5cm$ $L = v_0 + \|u_e\|$ $v_0 = 9cm$ Given, $\frac{v_0}{u_0} = 4$ $\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$ $\frac{1}{f_0} = \frac{1}{9} - \left(-\frac{4}{9}\right)$ $f_0 = \frac{9}{5} cm$ **OR** (b) (i) Obtaining the expression for resultant intensity of interference pattern 2 Writing maximum & minimum values of resultant intensity 1 (ii) Calculating the distance of **(I)** First order minimum 1 **(II)** Second order maximum from centre of screen 1 (i) $y_1 = a\cos\omega t$ $y_2 = a\cos(\omega t + \phi)$ According to Principle of Superposition	½ 1 ½ ½ ½ ½ ½	

	$y = y_1 + y_2$ $= a\left[\cos\omega t + \cos(\omega t + \phi)\right]$ $= 2a\cos\phi/2\,\cos(\omega t + \phi/2)$ $y = A\cos\left(\omega t + \phi/2\right)$ where, $A = 2a\cos\phi/2$ $I = kA^2$ $I = k\left(4a^2\cos^2\phi/2\right)$ $I = 4I_0\cos^2\phi/2$ **<u>Alternatively</u>**: If student writes $I = I_1 + I_1 + 2\sqrt{I_1 I_1}\cos\phi$ **(award one mark)** Maximum value $I = 4I_0$ Minimum value $I = 0$ (ii) (**I**) Position of first order minimum $y = \frac{n\lambda D}{a}$ $y_1 = \frac{\lambda D}{a}$ $= \frac{600\times10^{-9}\times1.5}{3\times10^{-3}} = 3\times10^{-4}\,m$ (**II**) Position of second order maximum $y_n = (2n+1)\frac{\lambda D}{2a}$ $n = 2,\quad y_2 = \frac{5\lambda D}{2a}$ $= \frac{5\times600\times10^{-9}\times1.5}{2\times3\times10^{-3}} = 7.5\times10^{-4}\,m$	½ ½ ½ ½ ½ ½ ½ ½ ½	5