MARKING SCHEME : PHYSICS (042)

CODE :55/2/1

Q.No	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
	SECTION –A		
1.	(C) $\sqrt{\frac{m_p}{m_Q}}$	1	1
2.	(A) $\frac{v_d}{2}$	1	1
3.	(B) 1.54Am^2	1	1
4.	(C) 31.4μWb	1	1
5.	(D) Magnetic Flux and Power both	1	1
6.	(B) 100V	1	1
7.	(B) Ultraviolet rays	1	1
8.	(C) 375 nm	1	1
9.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	1	1
10.	(C) $\frac{1}{K}$	1	1
11.	(C) P	1	1
12.	(B) The barrier height increases and the depletion region widens.	1	1
13.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
14.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	1	1
15.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
16.	(C) Assertion(A) is true, but Reason (R) is false	1	1
	SECTION -B		
17.	Defining resistivity 1 Dependence of resistivity on (a) Number density of free electron ½ (b) Relaxation time ½		
	Resistance offered by a material of unit length and having unit cross-sectional area is called resistivity.	**1**	
	$\rho=\frac{m}{ne^2\tau}$		
	(a) $\rho\,\alpha\,\frac{1}{n}$	½	
	(b) $\rho\,\alpha\,\frac{1}{\tau}$	½	**2**

18.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t+\phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t+\phi))$ $= a(2\cos(\omega t+\frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t+\frac{\phi}{2})$ Intensity I = K (amplitude)^2 where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Note : Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear. **Alternatively** Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½ ½ ½ 1 ½ ½	2
19.	Finding focal length 1 ½ Nature of the lens ½ For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$		

For convex lens in liquid.

$$\frac{1}{f_l} = \left(\frac{n_g}{n_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ ½

$$\frac{f_l}{f_a} = \frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$$ ½

$= -6.6$

$f_l = -6.6\, f_a$

$= -99\text{cm}$ ½

Nature of the lens: Diverging/ behaves like a concave lens. ½ **2**

20.

Calculation of binding energy	2

Binding Energy $= (Zm_p + (A - Z)m_n - M_N) \times 931.5$ MeV ½

B. E.$= (6 \times 1.007825 + 6 \times 1.008665 - 12.000000)$ x 931.5 MeV ½

= (0.09894) x 931.5 MeV ½

B. E. = 92.16 MeV ½ **2**

21.

Effect on energy gap and justification	
(i) Trivalent impurity	½ + ½
(ii) Pentavalent impurity	½ + ½

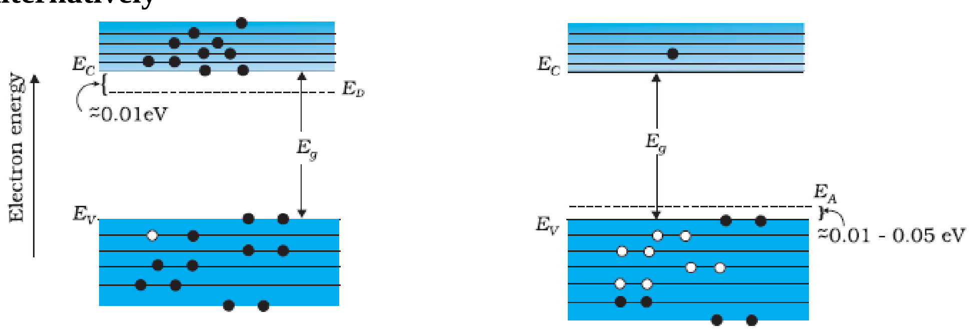
(i) Decreases ½

Justification: An acceptor energy level is formed just above the top of the valence band. ½

(ii) Decreases ½

Justification: A donor level is formed just below the bottom of conduction band. ½ **2**

Alternatively

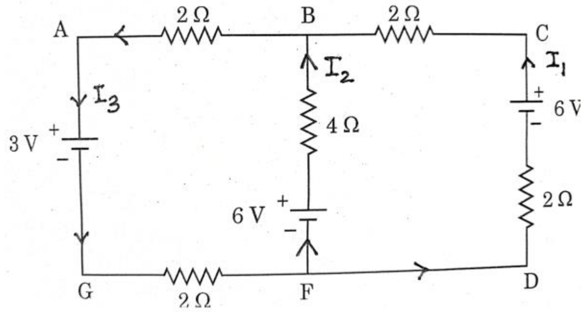
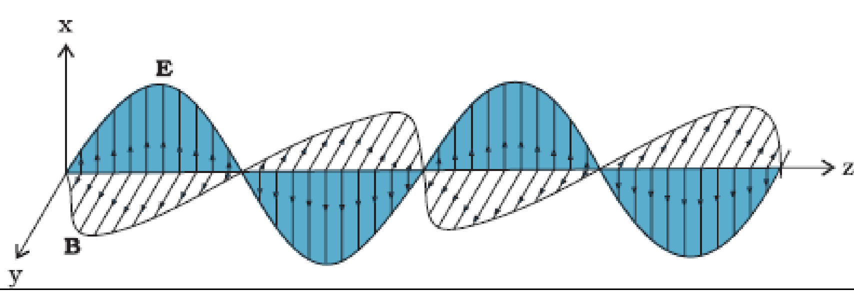


(Note : Award the credit of justification if a student draws band diagram)

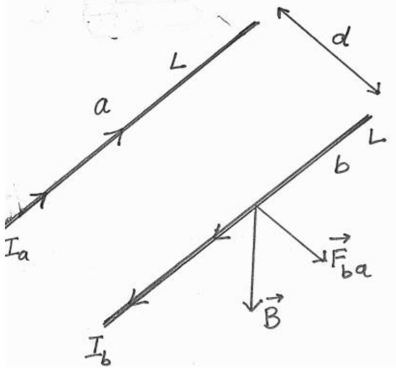
SECTION C

22.

Finding magnitude and direction of current in AG, BF and CD	1+1+1

	 By Kirchoff's Laws (at point B) $I_1 + I_2 = I_3$ ....(1) In the closed loop AGFBA $3 + 2I_3 - 6 + 4I_2 + 2I_3 = 0$ $I_2 + I_3 = \frac{3}{4}$ ....(2) From (i) $2I_1 + I_2 = \frac{3}{4}$ ....(3) In closed loop BFDCB $-4I_2 + 6 + 2I_1 - 6 + 2I_1 = 0$ $I_2 - I_1 = 0$ $I_2 = I_1$ ....(4) Putting in (3) $I_1 = \frac{1}{4}A$ From (4) $I_2 = \frac{1}{4}A$ From (2) $I_3 = \frac{1}{2}A$	½ ½ ½ ½ ½ ½	3
23.	(a) Factors affecting speed of Electromagnetic wave 1 (b) Production of Electromagnetic wave 1 (c) Sketch of Electromagnetic wave 1 (a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$ Speed depends upon (i) Permittivity (ε) of medium (ii) Magnetic permeability (μ) of medium (b) Accelerated charges or oscillating charges produce electromagnetic waves (c) 	½ + ½ 1 1	3

24.	Calculation of current induced in the coil 3		
	Induced emf $(\varepsilon) = \frac{-Nd\phi}{dt}$	½	
	$= \frac{-NAdB}{dt}$		
	$= -NA\frac{d}{dt}(\mu_0 nI)$		
	$= -N\mu_0 n(\pi r^2)\frac{dI}{dt}$		
	$\varepsilon = \frac{100\times4\pi\times10^{-7}\times250\times10^{2}\times\pi\times(1.6\times10^{-2})^2\times1.5}{25\times10^{-3}}$	**1**	
	=0.1536V	½	
	$I = \frac{\varepsilon}{R}$	½	
	= 0.03A	½	
	Alternatively		
	$\varepsilon = -M\frac{dI}{dt}$	½	
	$M = \mu_0 n_1 n_2 \pi r_1^2 l$		
	$= \mu_0 (n_1 l) n_2 \pi r_1^2$	½	
	$= 4\pi\times10^{-7}\times100\times250\times10^{2}\times\pi\times(1.6\times10^{-2})^2$		
	$= 2.56\times10^{-3} H$	½	
	$= -2.56\times10^{-3}\times\frac{(0-1.5)}{25\times10^{-3}}$		
	=0.1536V	½	
	$I = \frac{\varepsilon}{R} = \frac{0.1536}{5}$	½	
	= 0.03A	½	**3**
25.	**(a)** Explaining nature of force ½ Obtaining expression of force 1½ Defining one ampere 1		
	Nature of force is repulsive.	½	



½

Magnetic field due to current I_a at all points of conductor b

$B_{ab} = \dfrac{\mu_0 I_a}{2\pi d}$ directed downwards ½

Force experienced by conductor b on its segment of length l

$F_{ab} = I_b l B_{ab}$

$= \dfrac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left ½

Similarly

Force experienced by conductor a on its segment of length l

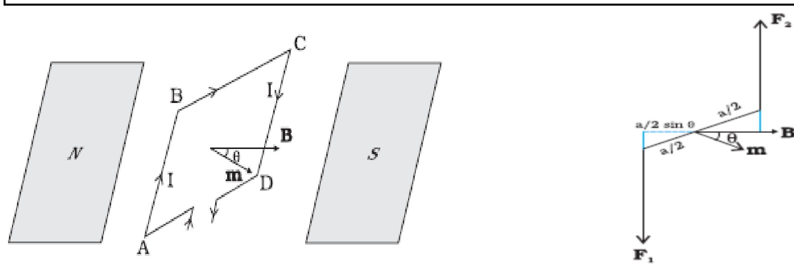
$F_{ba} = \dfrac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor. **1**

OR

(b)

Obtaining expression of torque	2
Drawing diagram	1



1

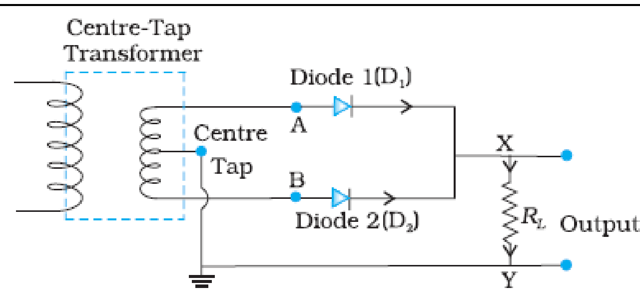
Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other. ½

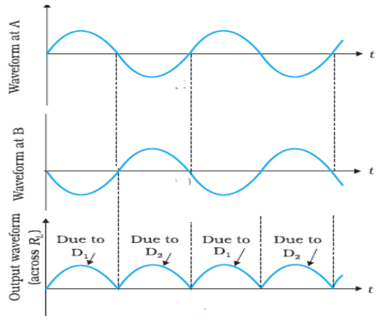
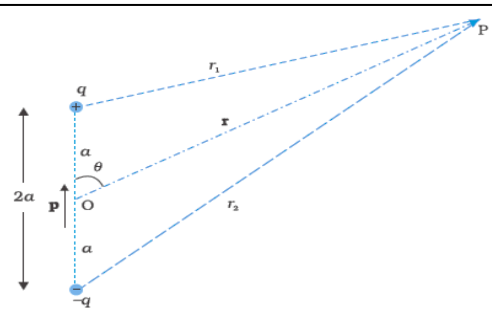
Forces on arms AB and CD are equal and opposite but not collinear. They form a couple.

$F_1 = F_2 = IbB$ ½

$\tau = F_1 \dfrac{a}{2}\sin\theta + F_2 \dfrac{a}{2}\sin\theta$ ½

$\tau = IabB\sin\theta$

	$\tau = IAB\sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½	3
26.	Deriving expression for radius 2 Finding numerical value of a_o 1 From Bohr's second postulate $mvr = \frac{nh}{2\pi}$ ……(1) Also $\frac{mv^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2}$ (z=1) $v = \frac{e}{\sqrt{4\pi\varepsilon_0 mr}}$ Substituting in (1) and simplifying $r = \frac{n^2h^2\varepsilon_0}{\pi me^2}$ For n = 1 r = a_o (Bohr's radius) $a_o = \frac{(6.63\times10^{-34})^2\times8.854\times10^{-12}}{3.14\times9.1\times10^{-31}\times(1.6\times10^{-19})^2}$ $= 5.29\text{x}10^{-11}$m = 0.53Å	½ ½ ½ ½ ½ ½	3
27.	(a) Interpretation of slope of line and justification ½ + ½ (b) Identification and justification ½ + ½ (c) Validation of graph and justification ½ + ½ (a) $\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2m}} \times \frac{1}{\sqrt{K}}$ $slope = \frac{h}{\sqrt{2m}}$ (b) $slope \, \alpha \, \frac{1}{\sqrt{m}}$ Slope of m_2 is more than that of m_1. Therefore, m_1 is heavier. (c) No Momentum (p) = $\sqrt{2mK}$ is not valid for a photon	½ ½ ½ ½ ½ ½	3
28.	Explaining working of full wave rectifier 2 Drawing input and output wave forms 1  When input voltage at A with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative,	1 ½	

	during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct. Hence during positive half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive hence D_1 would not conduct but D_2 would be giving an output current and output voltage. We get output voltage in both positive and negative half cycles. 	½ 1	3
29.	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	4
30.	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	4
31.	**(a)** (i) Obtaining expression for electric potential 3 (ii) Finding the value of n 2 (i)  Potential due to the dipole is the sum of potentials due to charges q and -q	½ ½	

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right) \quad \text{------------------------------------(1)}$$

By geometry

½

$$r_1^2 = r^2 + a^2 - 2ar\cos\theta$$

$$r_2^2 = r^2 + a^2 + 2ar\cos\theta$$

For r >> a, retaining terms only up to first order in a/r

$$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r} + \frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$

Similarly

½

$$r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$

Using the binomial theorem and retaining terms up to the first order in a/r

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$$

$$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right) \quad \text{------------------------------------(2)}$$

$$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2} \quad \text{------------------------------(3)}$$

½

$$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$$

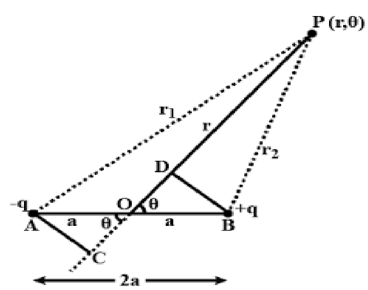
Using eqn. (1) (2), (3) and p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$$

½

$$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$

Alternatively –



½

½

$$r_2 = r + a\cos\theta$$

$$r_1 = r - a\cos\theta$$

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

½

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$$

½

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right)$$

½

$$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1-\frac{a^2}{r^2}\cos^2\theta}\right)$$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$ ½

$$V = \frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$$

(ii) Consider the side of equilateral triangle as 'a'

Potential energy $= U = \frac{kq_1q_2}{a} + \frac{kq_2q_3}{a} + \frac{kq_1q_3}{a}$ ½

According to question

$$U = \frac{k(q)(2q)}{a} + \frac{k(2q)(nq)}{a} + \frac{k(q)(n\,q)}{a} = 0$$ ½

$$= \frac{2q^2}{a} + \frac{2nq^2}{a} + \frac{n\,q^2}{a} = 0$$ ½

$$2 + 2n + n = 0$$

$$3n = -2$$

$$n = -\frac{2}{3}$$

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

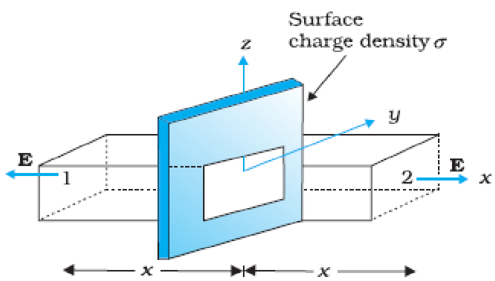
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$ **1**

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$$\oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0}$$

(Award ½ mark for writing the formula only.)



½

(Gaussian surface can be cylindrical also)

As seen from figure, only two faces 1 and 2 will contribute to the flux.

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up. ½

The charge enclosed by surface is σA, where σ is surface charge density
According to Gauss's theorem

$2EA = \sigma A / \varepsilon_0$ ½

$E = \sigma / 2\varepsilon_0$

$\vec{E} = \dfrac{\sigma}{2\varepsilon_0}\hat{n}$ where $\hat{n}$ is unit vector directed normally out of the plane ½

(ii) $\vec{E} = \dfrac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$

According to question

E_1 (at point P) $= \dfrac{\lambda_1}{2\pi\varepsilon_0 r_1}$

$\vec{E} = \dfrac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}\ (-\hat{j})\ N/C$ ½

E_2 (at point P) $= \dfrac{\lambda_2}{2\pi\varepsilon_0 r_2}$

$\vec{E} = \dfrac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}\ (-\hat{j})\ N/C$ ½

$E_{net} = \dfrac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\dfrac{1}{0.1}+\dfrac{2}{0.2}\right)(-\hat{j})\ N/C$

$= 3.6\times10^{6}\ (-\hat{j})\ N/C$ ½

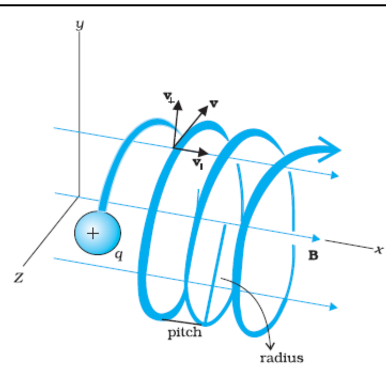
$\vec{F}_{net} = q\times\vec{E}_{net}$

$\vec{F} = -1.6\times10^{-19}\times3.6\times10^{6}\,(-\hat{j})\ N$

$= 5.76\times10^{-13}\,N\ (\hat{j})$ ½ 5

32. **(a)**

(i) Showing helical path	1 ½
Obtaining frequency of revolution	1 ½
(ii) Finding magnetic moment of electron	2



½

$v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and

$v_\parallel = v\cos\theta$ is parallel to $\vec{B}$

Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. **1**

The centripetal force

	$\frac{mv_\perp^2}{r} = B\,qv_\perp$	½	
	$v_\perp = \frac{Bqr}{m}$ $(v_\perp = v\sin\theta)$	½	
	Time period = $T = \frac{2\pi r}{v_\perp}$ $= \frac{2\pi m}{Bq}$		
	frequency $v = \frac{1}{T} = \frac{Bq}{2\pi m}$	½	
	(ii) Magnetic moment $m = I\,A$		
	$I = \frac{e}{T} = ev$	½	
	$= 1.6\times10^{-19}\times8\times10^{14}$		
	$= 1.28\times10^{-4}\,A$	½	
	$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$	½	
	$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$	½	
	OR		
	(b) (i) Definition of current sensitivity — 1 Showing dependence of current sensitivity & explanation — 1+1 (ii) Calculation of resistance — 2		
	(i) Deflection produced per unit current is called its current sensitivity. $I_s = \frac{\theta}{I} = \frac{NBA}{K}$	1	
	Current sensitivity can be increased by (a) increasing number of turns in coil (b) increasing area of coil in magnetic field (c) decreasing *K* (Torsional Constant) **(any one)**	1	
	$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$ If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase.	1	
	(ii) $V = I_G(R+G)$		
	$R = \frac{V}{I_G} - G$	½	
	$= \frac{100}{20\times10^{-3}} - 15$	½	
	$= 5000 - 15$ $= 4985\Omega$	½	
	By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V)	½	5

33. **(a)**

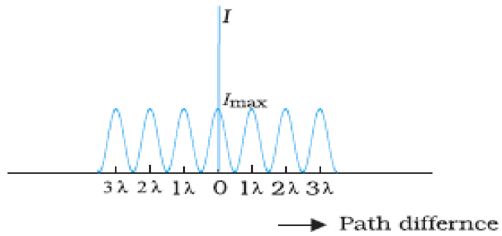
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands is same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a

1 + 1

(ii)



1

(iii) Path difference $(\Delta) = \lambda$

$$\phi = \frac{2\pi\Delta}{\lambda}$$

$$\phi = 2\pi$$

½

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \quad = 4I_0$$

½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$

½

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$

$$= 4I_0 \times \frac{3}{4}$$

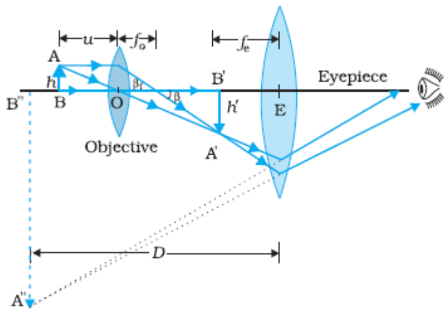
$$= \frac{3}{4}\text{K}$$

½

OR

(b)

(i) Drawing labeled ray diagram	1
Derivation of magnifying power	2
(iii) Finding magnifying power	2

	(i)  	1	
	The magnification obtained by eye-piece lens $m_e = \left(1+\frac{D}{f_e}\right)$	½	
	The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$	½	
	Hence the total magnifying power is $m = m_0 \times m_e$	½	
	$= \frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$	½	
	$(ii)\,\mathrm{m} = \left\lvert\frac{f_0}{f_e}\right\rvert$	1	
	Identification of focal length of objective and eyepiece $f_0 = 100cm$ $f_e = 5cm$	½	
	$m = \left\lvert\frac{100}{5}\right\rvert = 20$	½	**5**