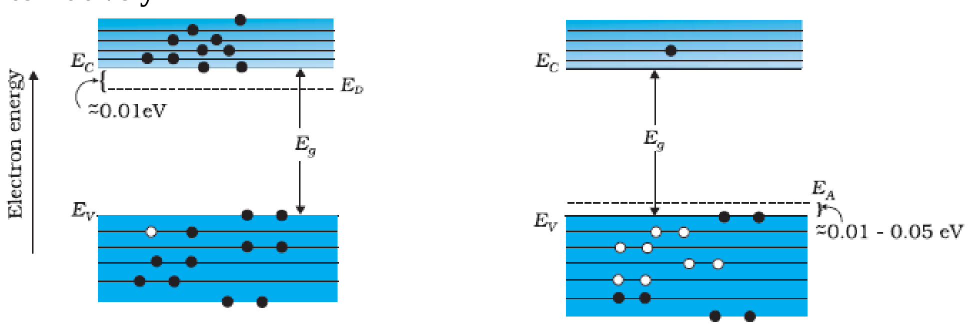
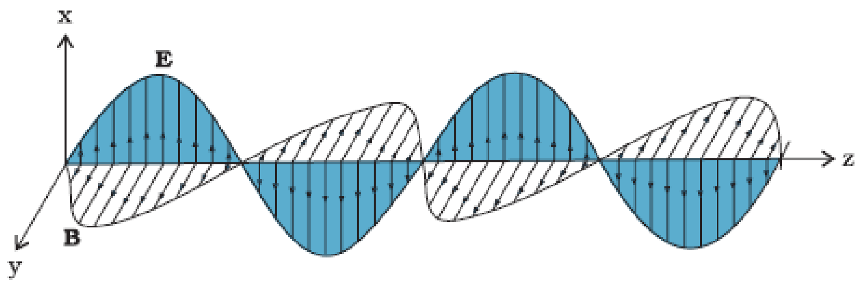
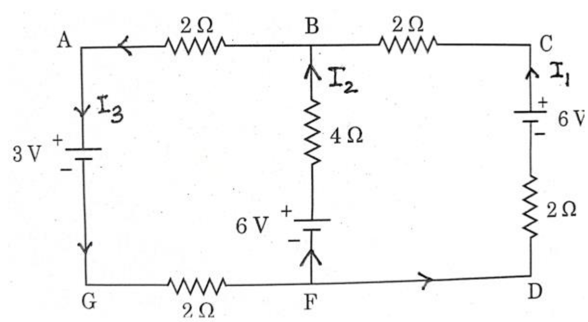
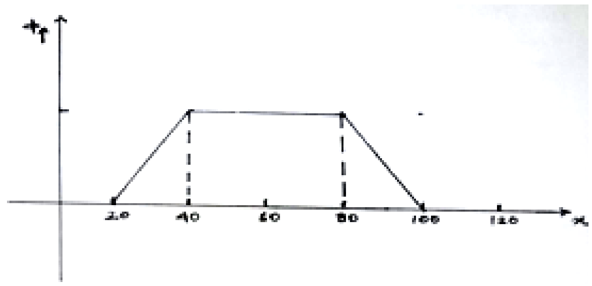
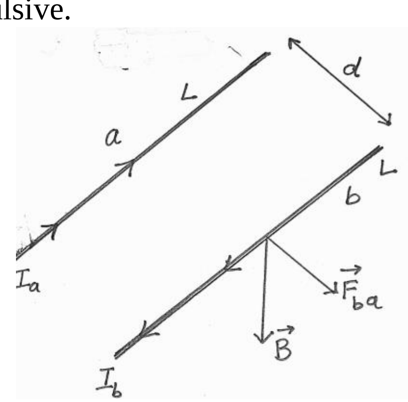
MARKING SCHEME : PHYSICS (042)			
CODE : 55/2/2			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
SECTION -A			
1.	(C) $\frac{C}{4}$	**1**	**1**
2.	(A) $\frac{v_d}{2}$	**1**	**1**
3.	(D) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$	**1**	**1**
4.	(C) 31.4μWb	**1**	**1**
5.	(D) Magnetic Flux and Power both	**1**	**1**
6.	(A) $\frac{10^5}{4\pi}$ Hz	**1**	**1**
7.	(B) Ultraviolet rays	**1**	**1**
8.	(D) 2.14 e V	**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.	(C) Assertion (A) is true, but Reason (R) is false	**1**	**1**
14.	(A) Both Assertion (A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
15.	(B) Both Assertion (A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	**1**	**1**
16.	(A) Both Assertion (A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
SECTION – B			
17	(a) Explanation 1 (b) Explanation 1 (a) Electric field is established throughout the circuit, almost instantly. It causes a local electron drift at every point, thus establishment of current does not have to wait for electrons from one end of the conductor to travel to other end. (b) Ohm's law asserts that the plot of I versus V is linear i.e. R is independent of V, while equation V=IR defines resistance and it may be applied to all conducting devices whether they obey Ohm's law or not.	**1** **1**	**2**
18	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. $\frac{1}{f_l}=\left(\frac{n_g}{n_l}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $\frac{f_l}{f_a}=\frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\, f_a$ $= -99\text{cm}$ Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	2
19.	**(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. **(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.	½ ½ ½ ½ **1**	

	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	2
20.	Calculating energy released/ absorbed 2 Energy = mass defect x 931 Mev Mass defect $= \Delta m =$ $(2 \times 12.000000 - 19.992439 - 4.002603)$ $= 0.004958$u Energy released = 0.004958 x 931 MeV = 4.62 MeV	½ ½ ½ ½	2
21.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band. (ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½ ½ ½	2
	SECTION-C		
22.	(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	½ + ½	
	(b) Accelerated charges or oscillating charges produce electromagnetic waves	1	
	(c) 	1	3
23.	Finding magnitude and direction of current in AG, BF and CD 1+1+1		
		½	
	By Kirchoff's Laws (at point B) $I_1 + I_2 = I_3$ …….(1) In the closed loop AGFBA $3+ 2I_3 – 6 + 4I_2 + 2I_3 = 0$	½	
	$I_2 + I_3 = \frac{3}{4}$ …….(2) From (i)	½	
	$2I_1 + I_2 = \frac{3}{4}$ …….(3) In closed loop BFDCB	½	
	$- 4I_2 + 6 + 2I_1 - 6 + 2I_1=0$ $I_2 - I_1 = 0$ $I_2 = I_1$ ……..(4) Putting in (3)	½	
	$I_1 = \frac{1}{4}A$ From (4) $I_2 = \frac{1}{4}A$ From (2) $I_3 = \frac{1}{2}A$	½	3

24.	(a) Plotting graph 1½ (b) Finding magnetic flux 1 (c) Requirement of external work ½		
	(a)		
		**1 ½**	
	(b) $\phi = B.A$	½	
	$= 5\times10^{-3}\times20\times10^{-2}\times10\times10^{-2}$		
	$= 10^{-4}Wb$	½	
	(c) Yes, external work is required.	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		
	$B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards	½	
	Force experienced by conductor b on its segment of length *l*		
	$F_{ab} = I_b l B_{ab}$		
	$= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left	½	
	Similarly Force experienced by conductor a on its segment of length *l*		

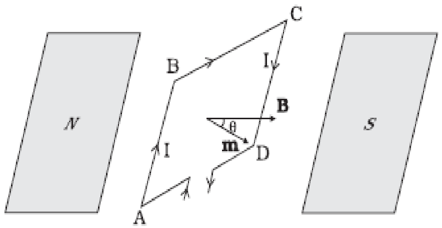
$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

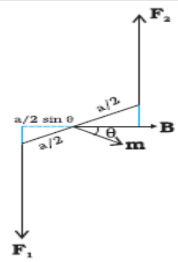
One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2x10 $^{-7}$ N/m on each conductor. **1**

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. ½

$F_1 = F_2 = IbB$

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

$\tau = IabB\sin\theta$

$\tau = IAB\sin\theta$ (where A = ab & m = IA)

$\vec{\tau} = \vec{m}\times\vec{B}$ ½ **3**

26.

(a) Explaining de Broglie hypothesis	1
(b) Finding ratio of de Broglie wavelength	
i) Accelerated through same potential difference	1
ii) Moving with same kinetic energy	1

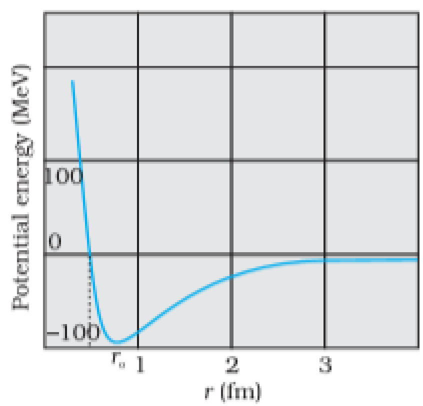
(a) Moving particles of matter display wave like properties under suitable conditions.
The wave length λ associated with a particle of momentum p is given as

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$ **1**

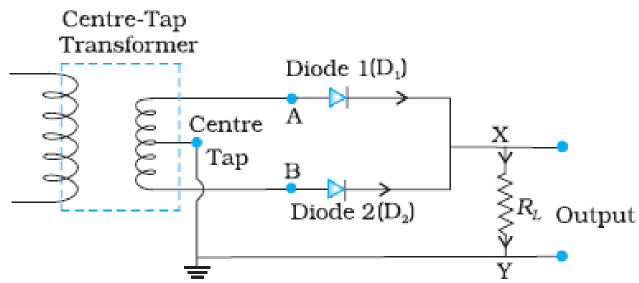
λ is the attribute of a wave while momentum is a typical attribute of particle.

(b) (i) $\lambda = \frac{h}{\sqrt{2meV}}$ ½

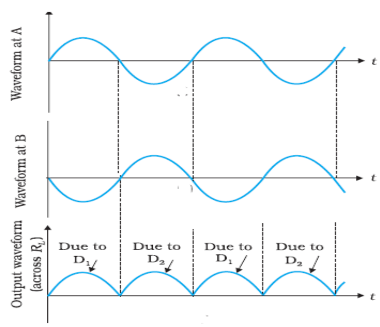
$$\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{2\times 4m_p \times 2e\times V}}{\sqrt{2\times m_p \times e\times V}}$$

	$= 2\sqrt{2}$	½	
	(ii) $\lambda = \dfrac{h}{\sqrt{2mK}}$	½	
	$\dfrac{\lambda_p}{\lambda_\alpha} = \dfrac{\sqrt{2 \times 4m_p \times K}}{\sqrt{2 \times m_p \times K}}$ $= 2$	½	3
27.	(a) Plotting graph — 1 (b) Identifying and justifying regions i) Attracting nuclear force — ½ + ½ ii) Repulsive nuclear force — ½ + ½		
	(a) 	**1**	
	(Give full credit for graph without values)		
	(b) $F = -\dfrac{dU}{dx}$ i) For distance larger than r_o, force is attractive	½	
	Since slope of the curve is positive	½	
	ii) For distance less than r_o, force is repulsive	½	
	Since slope of the curve is negative	½	3
28.	Explaining working of full wave rectifier — 2 Drawing input and output wave forms — 1		

<table>
<tr><td></td><td>



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, 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.



</td><td>1

½

½

1</td><td>3</td></tr>
<tr><td>29</td><td>(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) $\sin^{-1}\sqrt{n^2-1}$</td><td>1
1

1

1</td><td>4</td></tr>
<tr><td>30</td><td>(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</td><td>1
1
1

1</td><td>4</td></tr>
</table>

31. **(a)**

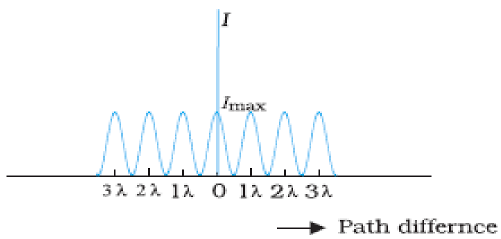
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands are 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

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

$$\phi = \pi / 3$$

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

½

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

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

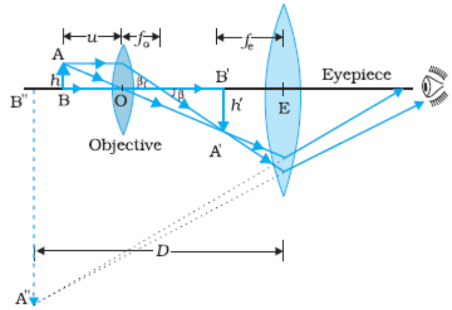
½

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

$(ii)\, \mathrm{m} = \left|\frac{f_0}{f_e}\right|$ 1

Identification of focal length of objective and eyepiece

$f_0 = 100cm$ ½

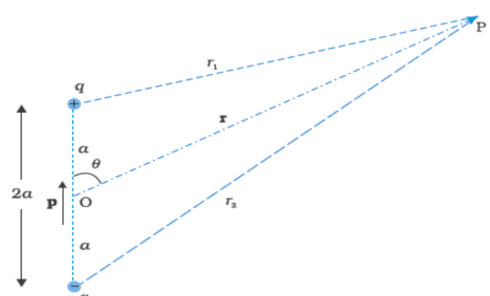
$f_e = 5cm$

$m = \left|\frac{100}{5}\right| = 20$ ½ 5

32. **(a)**

(i) Obtaining expression for electric potential	3
(ii) Finding the value of n	2

(i)



½

Potential due to the dipole is the sum of potentials due to charges q and -q

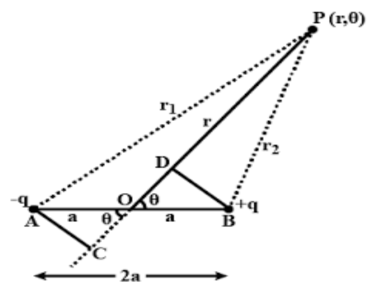
$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right)$ ---------------------------------(1) ½

By geometry

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

$r_2^2 = r^2 + a^2 + 2ar\cos\theta$ ½

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		
	$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$		
	$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right)$ -------------------------------------(2)		
	$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2}$ ------------------------------(3)		
	$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$	½	
	Using eqn. (1) (2), (3) and p = 2qa		
	$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$		
	$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$	½	
	Alternatively –		
		½	
	$r_2 = r + a\cos\theta$		
	$r_1 = r - a\cos\theta$	½	
	$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$		
	$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$	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 $\frac{a^2}{r^2}$		
	V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$	½	
	(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

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

$$3n = -2$$

$$n = -\frac{2}{3}$$ ½

OR

(b)

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

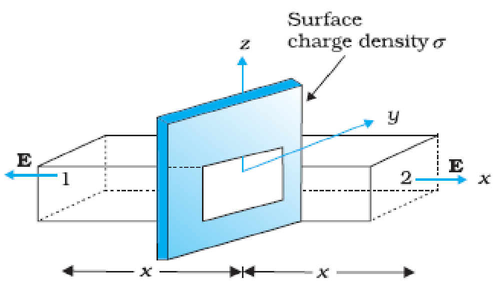
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$ **1**

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 marks 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. ½

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

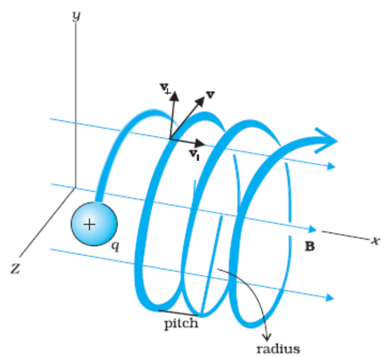
The charge enclosed by surface is σA, where σ is surface charge density

According to Gauss's theorem

$$2EA = \sigma A / \varepsilon_0$$ ½

$$E = \sigma / 2\varepsilon_0$$ ½

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

	(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
33.	**(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		
	$\dfrac{mv_\perp^2}{r} = B\,qv_\perp$	½	
	$v_\perp = \dfrac{Bqr}{m}$ $\quad (v_\perp = v\sin\theta)$	½	
	Time period = $T = \dfrac{2\pi r}{v_\perp}$		

	$= \frac{2\pi m}{Bq}$		
	$frequency\ v = \frac{1}{T} = \frac{Bq}{2\pi m}$	½	
	(ii) Magnetic moment $m = I\ A$		
	$I = \frac{e}{T} = ev$		
	$= 1.6 \times 10^{-19} \times 8 \times 10^{14}$	½	
	$= 1.28 \times 10^{-4}\ A$	½	
	$M = 1.28 \times 10^{-4} \times 3.14 \times (2 \times 10^{-10})^2$	½	
	$= 5.12\pi \times 10^{-24}\ Am^2 = 1.6 \times 10^{-23}\ Am^2$	½	
	OR		
	(b) <table><tr><td>(i) Definition of current sensitivity</td><td>1</td></tr><tr><td>Showing dependence of current sensitivity & explanation</td><td>1+1</td></tr><tr><td>(ii) Calculation of resistance</td><td>2</td></tr></table>		
	(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	
	$= \frac{100}{20 \times 10^{-3}} - 15$	½	
	$= 5000 - 15$ $= 4985\Omega$	½	
	By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V)	½	5