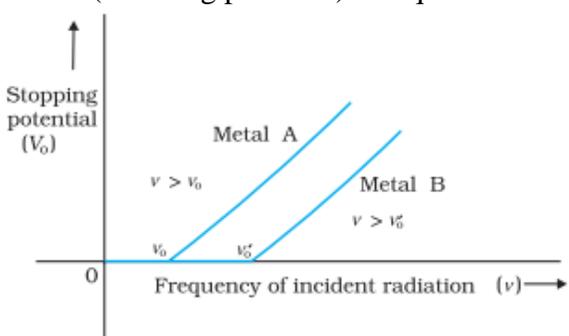


SOLUTIONS : PHYSICS(042)

CODE : 55/7/3

Q.NO.	VALUE POINT/ EXPECTED ANSWERS	MARKS	TOTAL MARKS
SECTION- A			
1.	(C) 30 μC	1	1
2.	(C) holes and few electrons	1	1
3.	(C) 2.0 $^{\circ}\text{C}$	1	1
4.	(D) $[\text{ML}^2\text{T}^{-2}\text{A}^{-2}]$	1	1
5.	(C) same neutron number, but different atomic number.	1	1
6.	(B) 0.2 mV	1	1
7.	(B) 3.20×10^{14} Hz	1	1
8.	(A) 1/200 s	1	1
9.	(A) $BA \sin \alpha$	1	1
10.	(C) 13.6 eV	1	1
11.	(C) capacitive and inductive respectively	1	1
12.	(A) Both the potential barrier height and width of depletion layer decrease.	1	1
13.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of Assertion(A).	1	1
14.	(D) Both Assertion (A) and Reason (R) are 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.	(C) Assertion(A) is true and Reason(R) is false.	1	1
SECTION- B			
17.	<div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;"> Calculating current passing through battery 2 </div> <p>The given circuit forms a balanced Wheatstone bridge so no current flows through 5Ω resistor.</p> $R_{eq} = \frac{30 \times 60}{30 + 60}$ $= 20\Omega$ $I = \frac{V}{R_{eq}}$ $= \frac{6}{20} = \frac{3}{10} \text{ A}$	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	2
18.	<div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;"> Finding the intensity at a point on the screen 2 </div> $I_0 = I_1 + I_2 + 2\sqrt{I_1} \sqrt{I_2} \cos \phi$ $= I + I + 2I \cos 0^{\circ}$	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	

	$\phi_{\text{total}} = \phi_L + \phi_R$ $= 8\pi \times 10^{-2} \text{ Nm}^2/\text{C}$ $= 25.12 \times 10^{-2} \text{ Nm}^2/\text{C}$ <p>Charge $q = \epsilon_0 \phi_{\text{total}}$</p> $= 25.12 \times 10^{-2} \times 8.85 \times 10^{-12}$ $= 0.22 \times 10^{-11} \text{ C}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	3
24.	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Reason for</p> <p>(a) Independence of maximum kinetic energy of photoelectrons & intensity of incident radiation 1</p> <p>(b) Increase in photoelectric current with increase in intensity of incident radiation 1</p> <p>(c) Linear variation in stopping potential with frequency of incident radiation 1</p> </div> <p>(a) With the variation in the intensity of incident radiations, there is a change in the number of photons not on the energies of the photons so the maximum kinetic energy of photoelectrons remains same. 1</p> <p>(b) With the increase in intensity of incident radiation number of photons increases as a result photoelectric current increase. 1</p> <p>(c) With the increase in frequency of incident radiation, the maximum kinetic energy of photoelectrons increases. Hence higher value of stopping potential (retarding potential) is required. 1</p> <div style="text-align: center;">  <p>The graph shows two linear plots of stopping potential V_0 versus frequency ν. The y-axis is labeled 'Stopping potential (V_0)' and the x-axis is labeled 'Frequency of incident radiation (ν)'. The origin is marked '0'. Two lines are shown: 'Metal A' and 'Metal B'. Metal A's line starts at a higher frequency ν_0 on the x-axis than Metal B's line, which starts at ν'_0. Both lines are labeled with $\nu > \nu_0$ and $\nu > \nu'_0$ respectively, indicating the region where photoelectric emission occurs.</p> </div> <p>Alternatively:</p> $K_{\text{max}} = eV_0 = h\nu - h\nu_0$	1 1 1	3
25.	<div style="border: 1px solid black; padding: 5px;"> <p>(a) (i) Writing Biot-Savart's Law in vector form 1</p> <p>(ii) Finding magnitude & direction of net magnetic field at centre of two current carrying coils 2</p> </div>		

$$(i) \vec{dB} = \frac{\mu_0}{4\pi} \frac{I(d\vec{l} \times \vec{r})}{r^3}$$

$$(ii) B_1 = \frac{\mu_0 I}{2R}$$

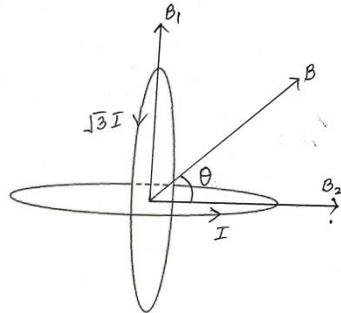
$$B_2 = \frac{\mu_0 \sqrt{3} I}{2R}$$

$$B = \sqrt{B_1^2 + B_2^2}$$

$$\therefore B = \frac{\mu_0 I}{2R} \sqrt{1+3}$$

$$B = \frac{\mu_0 I}{R}$$

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

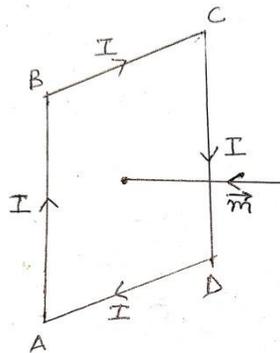


Direction of net magnetic field is 30° with direction of B_2 / 60° with the direction of B_1 .

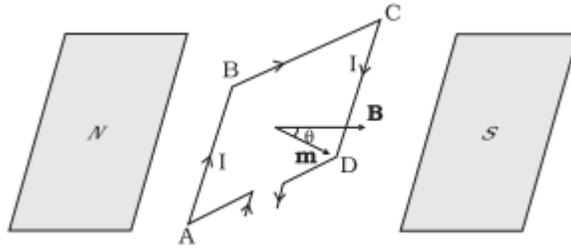
OR

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

$$(i) \vec{m} = I\vec{A}$$



- (ii) $F_1 = F_2 = IbB$ F_1 = Force on AB into the plane
 F_2 = Force on CD out of the plane



Since forces are equal & opposite so net force = 0

Both of them form a couple and magnitude of torque acting on the coil is

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

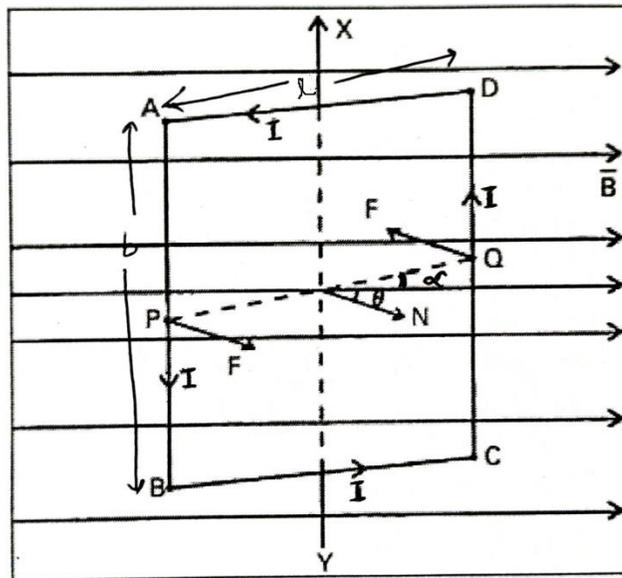
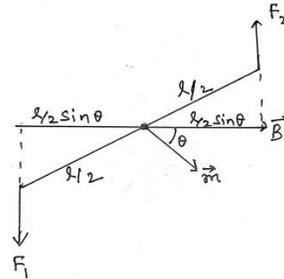
$$= I b B l \sin \theta$$

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

$$= m B \sin \theta$$

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

Alternatively:



If the plane of the current carrying coil makes an angle α with the magnetic field

$$\vec{F}_{DA} = -\vec{F}_{BC} \text{ (cancel each other)}$$

Force on the arm DC is into the plane of the paper

$$|F_{DC}| = IbB$$

Force on the arm AB is out of the plane of the paper.

$$|F_{AB}| = IbB$$

Since forces are equal & opposite so net force = 0

Both of them form a couple and magnitude of torque acting on the coil is

$\tau = \text{either force} \times \text{perpendicular distance between the two forces.}$

$$\tau = IbB \times a \sin \theta$$

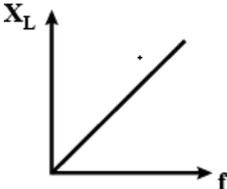
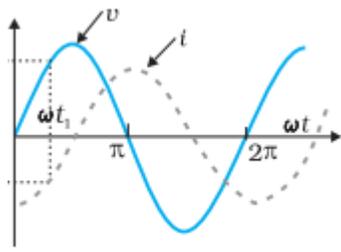
1/2

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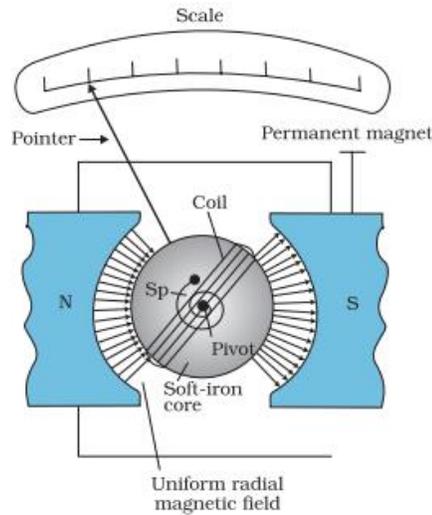
1/2

1/2

1/2

	$\tau = IbB \times l \sin \theta$ $\vec{\tau} = I \vec{A} \times \vec{B}$ $\vec{\tau} = \vec{m} \times \vec{B}$	1/2	
	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Naming the electromagnetic radiation & writing their frequency range 3 </div>		
26.	<p>(a) Name: X- rays Frequency Range: $10^{16} - 10^{20}$ Hz</p> <p>(b) Name: Infra-red radiation Frequency Range: $10^{12} - 10^{14}$ Hz</p> <p>(c) Name: Radio waves Frequency Range: $10^5 - 10^9$ Hz</p>	1/2 1/2 1/2 1/2	3
27.	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> (a) Identifying element X and writing expression for reactance 1 (b) Plotting a graph to show variation of reactance with frequency 1 (c) Plotting variation of voltage & current with time 1 </div> <p>(a) Inductor $X_L = 2\pi fL$</p> <p>(b)</p>  <p>(c)</p> 	1/2 1/2 1 1	3
28.	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Writing the mathematical form of postulates of Bohr's Theory 1 1/2 Proving, (a) radius of the orbit is proportional to n^2 1 (b) Total energy of the atom is proportional to $1/n^2$ 1/2 </div>		

	<p>Mathematical form of postulates of Bohr's Theory</p> <p>(i) $E_n = \frac{-13.6}{n^2} eV$</p> <p>Alternatively : Electron revolve in stable orbits with definite energy called stationary orbits.</p> <p>(ii) $L = mvr = \frac{nh}{2\pi}$</p> <p>(iii) $h\nu = E_f - E_i$</p> <p>(a) $\frac{mv^2}{r} = \frac{Ze^2}{r^2}$ -----(1)</p> <p>$mvr = \frac{nh}{2\pi}$ -----(2)</p> <p>Solving (1) & (2)</p> <p>$r = n^2 \left(\frac{h}{2\pi} \right)^2 \frac{4\pi\epsilon_0}{me^2}$ -----(3)</p> <p>Since energy in the orbit $E_n = \frac{-e^2}{8\pi\epsilon_0 r}$</p> <p>Using eq (3) $E_n = \frac{-me^4}{8n^2\epsilon_0^2 h^2}$</p> <p>or $E_n \propto \frac{1}{n^2}$</p>	<p>½</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p>	<p>3</p>																		
SECTION- D																					
29.	<p>(i) (a) (D) I decreases and II is almost constant</p> <p style="text-align: center;">OR</p> <p>(b) (D) All I, II and III change</p> <p>(ii) (B) 500⁰ C</p> <p>(iii) (C) 3.75×10⁶</p> <p>(iv) (D) 1</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>4</p>																		
30.	<p>(i) (C) First real and then virtual</p> <p>(ii) (A) 10cm</p> <p>(iii) (A) $1/\sqrt{n^2-1}$</p> <p>(iv) (a) (B) 1.4</p> <p style="text-align: center;">OR</p> <p>(b) (D) increase by 19%</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>4</p>																		
SECTION- E																					
31.	<table border="1" style="width: 100%;"> <tbody> <tr> <td>(a)</td> <td>(i) Labelled diagram</td> <td>1</td> </tr> <tr> <td></td> <td>Working principle of moving coil galvanometer</td> <td>1</td> </tr> <tr> <td></td> <td>Use of (i) Radial magnetic field</td> <td>½</td> </tr> <tr> <td></td> <td>(ii) Soft iron core</td> <td>½</td> </tr> <tr> <td></td> <td>(ii) Defining current sensitivity</td> <td>1</td> </tr> <tr> <td></td> <td>Reason</td> <td>1</td> </tr> </tbody> </table>	(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		
(a)	(i) Labelled diagram	1																			
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	Reason	1																			



Principle: A current carrying coil placed in uniform magnetic field experiences a torque.

(i) Radial magnetic field makes the scale linear

Alternatively: Radial magnetic field provides maximum Torque.

(ii) Use of soft iron core is to increase the strength of magnetic field/ increase sensitivity of the galvanometer.

(ii) **Current sensitivity** is defined as deflection per unit current.

Alternatively:

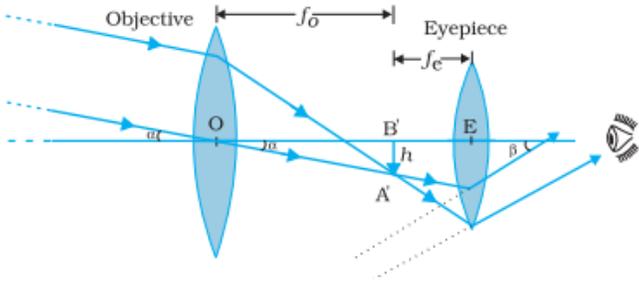
$$I_s = \frac{\Phi}{I} = \frac{NAB}{k}$$

$$\text{Voltage sensitivity } V_s = \frac{\Phi}{V} = \left(\frac{NAB}{k} \right) \frac{I}{V} = \left(\frac{NAB}{k} \right) \frac{I}{R}$$

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.

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 |

	<p>(i) (I) $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_e$ I_e = Total current through the surface B = Magnetic field dl = length of small element</p> <p>(II) As length of solenoid increases, it appears like a long cylindrical metal sheet so field outside approaches zero.</p> <p>(III) For a given perimeter, a circle encloses greater area than any other shape, which maximizes the flux.</p> <p>(ii) $R_1 = \frac{V}{I_g} - G \Rightarrow \frac{V}{I_g} = R_1 + G$ -----(1) $R_2 = \frac{V}{2I_g} - G \Rightarrow \frac{V}{2I_g} = R_2 + G$ -----(2) Solving (1) & (2) $G = R_1 - 2R_2$ $R_3 = \frac{2V}{I_g} - G$ -----(3) Solving using eq (1) & (3) $R_3 = 3R_1 - 2R_2$</p>	<p>1/2</p> <p>1/2</p> <p>1</p> <p>1</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>5</p>								
<p>32.</p>	<p>(a)</p> <table border="1" data-bbox="386 1104 1138 1314"> <tbody> <tr> <td>(i) Drawing labeled Diagram</td> <td>1 1/2</td> </tr> <tr> <td>Explanation</td> <td>1/2</td> </tr> <tr> <td>Writing expression of Magnifying power</td> <td>1</td> </tr> <tr> <td>(ii) Calculating the focal length of objective & eye piece</td> <td>2</td> </tr> </tbody> </table>  <p>(Note: Deduct 1/2 mark, for not showing arrows with the rays) 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.</p>	(i) Drawing labeled Diagram	1 1/2	Explanation	1/2	Writing expression of Magnifying power	1	(ii) Calculating the focal length of objective & eye piece	2	<p>1 1/2</p> <p>1/2</p>	
(i) Drawing labeled Diagram	1 1/2										
Explanation	1/2										
Writing expression of Magnifying power	1										
(ii) Calculating the focal length of objective & eye piece	2										

<p>Magnifying Power = $\frac{f_o}{f_e}$</p>	1	
<p>(ii) Image is formed at least distance of distinct vision</p>		
<p>$20 = m_o \times m_e$</p>	$\frac{1}{2}$	
<p>$m_o = \frac{20}{5} = 4$</p>		
<p>$m_e = 1 + \frac{D}{f_e}$</p>		
<p>$f_e = \frac{25}{4} \text{ cm}$</p>	$\frac{1}{2}$	
<p>$\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$</p>		
<p>$\frac{1}{-25} - \frac{1}{u_e} = \frac{4}{25}$</p>		
<p>$u_e = -5 \text{ cm}$</p>		
<p>$L = v_o + u_e$</p>		
<p>$v_o = 9 \text{ cm}$</p>	$\frac{1}{2}$	
<p>Given, $\frac{v_o}{u_o} = 4$</p>		
<p>$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o}$</p>		
<p>$\frac{1}{f_o} = \frac{1}{9} - \left(-\frac{4}{9}\right)$</p>		
<p>$f_o = \frac{9}{5} \text{ cm}$</p>		
<p>OR</p>		
<p>(b)</p>		
<p>(i) Obtaining the expression for resultant intensity of interference pattern</p>	2	
<p>Writing maximum & minimum values of resultant intensity</p>	1	
<p>(ii) Calculating the distance of</p>		
<p>(I) First order minimum</p>	1	
<p>(II) Second order maximum from centre of screen</p>	1	
<p>(i) $y_1 = a \cos \omega t$</p>		
<p>$y_2 = a \cos (\omega t + \phi)$</p>	$\frac{1}{2}$	
<p>According to Principle of Superposition</p>		
<p>$y = y_1 + y_2$</p>		
<p>$= a [\cos \omega t + \cos (\omega t + \phi)]$</p>	$\frac{1}{2}$	

	$C = \frac{\epsilon_0 A}{\left(d - \frac{d}{4}\right) + \frac{d}{4K}} = \frac{\epsilon_0 A}{d\left(\frac{3}{4} + \frac{1}{4K}\right)}$ $= C_0 \frac{4K}{(3K+1)}$ <p>Alternatively: When dielectric is inserted, the electric field between the plates is $E = E_0/K$ The potential difference will be</p> $V = E_0 \left(\frac{3d}{4}\right) + E \left(\frac{d}{4}\right)$ $= E_0 \left(\frac{3d}{4}\right) + \frac{E_0}{K} \left(\frac{d}{4}\right)$ $= V_0 \left(\frac{3}{4} + \frac{1}{4K}\right)$ $V = V_0 \left(\frac{3K+1}{4K}\right)$ $C = \frac{Q_0}{V} = \left(\frac{4K}{3K+1}\right) \frac{Q_0}{V_0}$ $C = C_0 \left(\frac{4K}{3K+1}\right)$ <p>(ii) Each capacitance can withstand 200V No. of capacitors in each row = $\frac{1200}{200} = 6$ Net capacitance of each row = $1/6 \mu\text{F}$ Number of rows = n $C_{eq} = C_1 + C_2 + \dots + C_n$ $C_{eq} = \frac{1}{6} + \frac{1}{6} + \dots + n$ $2 = \frac{n}{6}$ $\therefore n = 12$ Total no. of capacitors in the arrangement = $6 \times 12 = 72$</p> <p style="text-align: center;">OR</p> <p>(b)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td colspan="2" style="text-align: center;">(i) Deriving the expression of electric potential due to dipole</td> </tr> <tr> <td style="text-align: center;">I. along its axis</td> <td style="text-align: center;">1½</td> </tr> <tr> <td style="text-align: center;">II. along its bisector line</td> <td style="text-align: center;">1½</td> </tr> <tr> <td colspan="2" style="text-align: center;">(ii) Calculating the torque</td> </tr> <tr> <td></td> <td style="text-align: center;">2</td> </tr> </table>	(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	<p>1</p> <p>½</p> <p>½</p> <p>1</p> <p>1</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p>	
(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

$$V_- = \frac{-kq}{x+a}$$

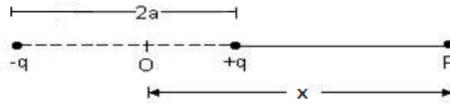
$$V_+ = \frac{kq}{x-a}$$

$$V = V_- + V_+$$

$$= kq \left(\frac{-1}{x+a} + \frac{1}{x-a} \right)$$

$$= kq \frac{2a}{(x^2 - a^2)} = \frac{kp}{x^2 - a^2}$$

$$x \gg a \quad \therefore V = \frac{kp}{x^2}$$



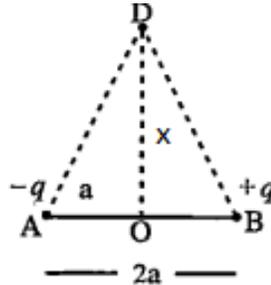
1/2

II. Along the bisector line

$$V_- = \frac{kq}{\sqrt{x^2 + a^2}}$$

$$V_+ = \frac{-kq}{\sqrt{x^2 + a^2}}$$

$$V = V_- + V_+ = 0$$



1/2

1/2

1/2

(ii) $\vec{\tau} = \vec{p} \times \vec{E}$

$$= (0.8\hat{i} + 0.6\hat{j}) \times 10^{-29} \times (1 \times 10^7)\hat{k}$$

$$= [0.8(-\hat{j}) + 0.6\hat{i}] \times 10^{-22}$$

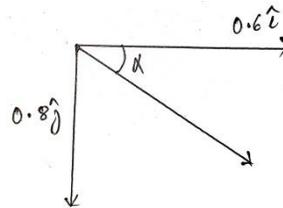
$$\tau = \left[\sqrt{(0.8)^2 + (0.6)^2} \right] \times 10^{-22}$$

$$= 10^{-22} \text{ Nm}$$

$$\tan \alpha = \frac{|0.8|}{0.6}$$

$$\alpha = \tan^{-1} \left(\frac{4}{3} \right)$$

$$\alpha = 53^\circ$$



1/2

1/2

1/2

1/2