

SOLUTIONS: PHYSICS(042)

Code: 55/2/1

Q.No.	VALUE POINTS/EXPECTED ANSWERS	Marks	Total Marks
SECTION A			
1.	(D) CM	1	1
2.	(C) two resistors in series and then this combination in parallel with the third resistor.	1	1
3.	(C) $\frac{5.0}{\sqrt{2}} \times 10^{-10} \hat{k} \text{ T}$	1	1
4.	(A) $\frac{\mu_0}{4\pi} \times \frac{2M}{r^3}$	1	1
5.	(B) Z to Y and then Y to Z	1	1
6.	(C) <div style="text-align: center;"> </div>	1	1
7.	(D) 6750	1	1
8.	(A) conservative and field lines do not form closed loops	1	1
9.	(A) $1.6 \times 10^8 \text{ ms}^{-1}$	1	1
10.	(C) Lyman series	1	1
11.	(D) 5	1	1
12.	(A) resistor / (C) capacitor	1	1
13.	(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).	1	1
14.	(C) If Assertion (A) is true and Reason (R) is false.	1	1
15.	(C) If Assertion (A) is true and Reason (R) is false.	1	1
16.	(B) If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).	1	1

SECTION B											
17.	<p>(a)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Finding current</td> <td style="text-align: right; padding: 5px;">2</td> </tr> </table> $R_1 = \frac{\rho l_1}{A}; R_2 = \frac{\rho l_2}{A}$ $\frac{l_1}{l_2} = \frac{2}{3} \Rightarrow \frac{R_1}{R_2} = \frac{2}{3}$ $I \propto \frac{1}{R}$ $\Rightarrow \frac{I_1}{I_2} = \frac{3}{2}$ $\Rightarrow I_1 = \frac{3}{5} \times 15 = 9A$ $\Rightarrow I_2 = \frac{2}{5} \times 15 = 6A$ <p style="text-align: center;">OR</p> <p>(b)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" style="padding: 5px;">Finding the potential difference</td> </tr> <tr> <td style="padding: 5px;">(i) between P and Q</td> <td style="text-align: right; padding: 5px;">1</td> </tr> <tr> <td style="padding: 5px;">(ii) across capacitor C</td> <td style="text-align: right; padding: 5px;">1</td> </tr> </table> <p>In steady state,</p> $2V - V = i(2R + R)$ $i = \frac{V}{3R}$ <p>(i) $V_P - V_Q = -V - iR$</p> $= -V - \frac{V}{3}$ $V_P - V_Q = -\frac{4V}{3}$ <p>(ii) $V_P - V_Q = -V + V_C$</p> $-\frac{4V}{3} = -V + V_C$ $V_C = -\frac{V}{3}$	Finding current	2	Finding the potential difference		(i) between P and Q	1	(ii) across capacitor C	1	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1</p> <p>1</p>	2
Finding current	2										
Finding the potential difference											
(i) between P and Q	1										
(ii) across capacitor C	1										

18.	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px; display: flex; justify-content: space-between;"> Finding the relation 2 </div> <p>Phase difference for 6th dark fringe = 11π Phase difference for 8th bright fringe = 16π</p> $\Delta\phi + \phi_6 = \phi_8$ $2\pi(n-1)\frac{t}{\lambda} + 11\pi = 16\pi$ $t = \frac{5\lambda}{2(n-1)}$ <p>Alternatively: -</p> <p>Path difference for 6th dark fringe (x_6) = $\frac{11\lambda}{2}$ Path difference for 8th bright fringe (x_8) = 8λ Increase in path difference after introducing the sheet (Δx)</p> $= \frac{\lambda}{2\pi} \times 2\pi(n-1)\frac{t}{\lambda} = (n-1)t$ <p>$\therefore x_6 + \Delta x = x_8$</p> $\frac{11\lambda}{2} + (n-1)t = 8\lambda$ <p>On solving:-</p> $t = \frac{5\lambda}{2(n-1)}$	<p>$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$</p>	2
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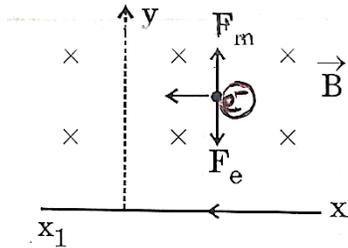
19.	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Finding the position and nature of the final image 1½ + ½</p> </div> <p>For the first lens: -</p> $\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1}$ $\frac{1}{v_1} + \frac{1}{4} = -\frac{1}{8}$ $v_1 = -\frac{8}{3} \text{ cm}$ <p>For the second lens: -</p> $u_2 = -16 - \frac{8}{3} = -\frac{56}{3} \text{ cm}$ $\frac{1}{v_2} - \left(-\frac{3}{56}\right) = -\frac{1}{8}$ $v_2 = -5.6 \text{ cm}$ <p>Image is virtual.</p>	½ ½ ½	2
20.	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Calculating Speed 2</p> </div> <p>$h\nu = \phi_0 + K_{\max}$</p> $\frac{hc}{\lambda} = \phi_0 + \frac{1}{2} m v_{\max}^2$ $\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4 \times 10^{-7}} = 3 \times 10^{-19} + \frac{1}{2} m v_{\max}^2$ $\frac{19.89}{4} \times 10^{-19} = 3 \times 10^{-19} + \frac{1}{2} m v_{\max}^2$ $\frac{4 \times 10^{-19}}{9 \times 10^{-31}} = v_{\max}^2$ $v_{\max} = \frac{2}{3} \times 10^6 \text{ m/s}$	½ ½ ½	2

23.

(a)

(i) Diagram showing direction of electric and magnetic fields	1
(ii) Naming forces acting on the charged particle	1
(iii) Finding the value of v_0	1

(i)



(ii) Electric force
Magnetic force

Alternatively: -

$$F_E = eE$$

$$F_B = evB$$

(iii) $ev_0B = eE$

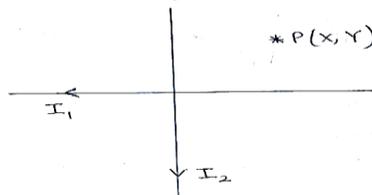
$$v_0 \times \left[\frac{\mu_0 I}{2\pi d} \right] = E$$

$$v_0 = \frac{(2\pi d)E}{\mu_0 I}$$

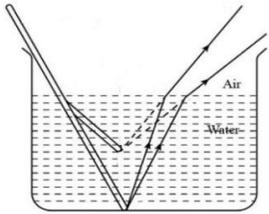
OR

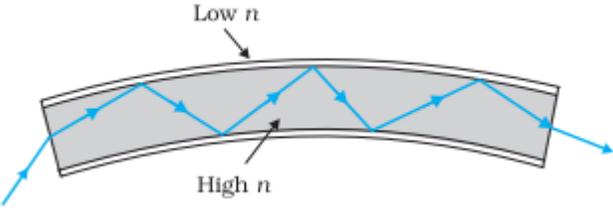
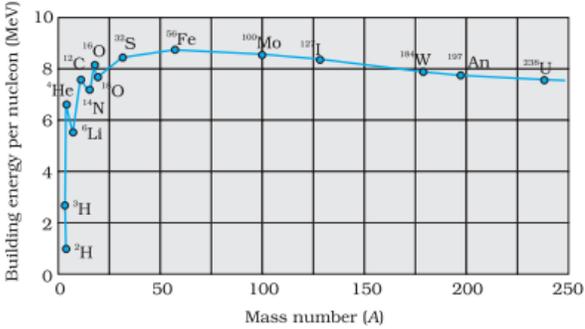
(b)

Finding the magnitude and direction of the net magnetic field	2+1
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	<p>Magnetic field due to conductor carrying current I_1 (\vec{B}_1) = $\frac{\mu_0 I_1}{2\pi Y} (-\hat{k})$</p> <p>Magnetic field due to conductor Carrying current I_2 (\vec{B}_2) = $\frac{\mu_0 I_2}{2\pi X} (\hat{k})$</p> <p>$\vec{B}_p = \vec{B}_1 + \vec{B}_2$</p> <p>$\vec{B}_p = \frac{\mu_0}{2\pi} \left[\frac{I_2}{X} - \frac{I_1}{Y} \right] \hat{k}$</p> <p>Direction will be along the Z-axis.</p>	<p>1/2</p> <p>1/2</p> <p>1</p> <p>1</p>	<p>3</p>										
24.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">(a) Statement of Lenz's law</td> <td style="text-align: right; padding: 5px;">1/2</td> </tr> <tr> <td style="padding: 5px;">(b) (i) Identifying the machine</td> <td style="text-align: right; padding: 5px;">1/2</td> </tr> <tr> <td style="padding: 5px;"> (ii) Naming parts P and Q and R</td> <td style="text-align: right; padding: 5px;">1/2</td> </tr> <tr> <td style="padding: 5px;"> (iii) Giving polarities</td> <td style="text-align: right; padding: 5px;">1/2</td> </tr> <tr> <td style="padding: 5px;"> (iv) Two ways of increasing output voltage</td> <td style="text-align: right; padding: 5px;">1/2 + 1/2</td> </tr> </table> <p>(a) Lenz's law- The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.</p> <p>(b) (i) AC generator</p> <p style="padding-left: 40px;">(ii) P – Slip rings Q – Carbon brushes R- Armature coil</p> <p>(iii) Left side of the magnet is North & right side is South or vice-versa.</p> <p>(iv) (Any two)</p> <p style="padding-left: 40px;">-By increasing the number of turns in the armature coil. -By increasing the speed of rotation of the armature coil. -By increasing the strength of the magnetic field B.</p>	(a) Statement of Lenz's law	1/2	(b) (i) Identifying the machine	1/2	(ii) Naming parts P and Q and R	1/2	(iii) Giving polarities	1/2	(iv) Two ways of increasing output voltage	1/2 + 1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2 + 1/2</p>	<p>3</p>
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25.	<table border="1" data-bbox="326 218 1255 470"> <tr> <td>(a) Describing the direction of magnetic field</td> <td>1</td> </tr> <tr> <td>(b) To state whether wavelength of radiowaves & microwaves is greater or lesser than visible light</td> <td>1</td> </tr> <tr> <td>(c) Use of:</td> <td></td> </tr> <tr> <td> (i) Infrared waves</td> <td>½</td> </tr> <tr> <td> (ii) Gamma rays</td> <td>½</td> </tr> </table> <p>(a) Magnetic field oscillates in the east-west direction as it is mutually perpendicular to the direction of electric field. 1</p> <p>(b) Wavelength of the radiowaves and microwaves is longer than visible light. 1</p> <p>(c) (i) Use of infrared waves: - (Any one) - Used for physical therapy. - Used for maintaining average temperature of the earth. - Used in Earth satellites for military purposes & to observe growth of crops. - Used in remote control ½</p> <p>(ii) Use of Gamma rays: - (Any one) - Used in treatment of cancer. - Used in diagnostic imaging. - Used to sterilize medical equipment ½</p>	(a) Describing the direction of magnetic field	1	(b) To state whether wavelength of radiowaves & microwaves is greater or lesser than visible light	1	(c) Use of:		(i) Infrared waves	½	(ii) Gamma rays	½		3
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(b) Ray diagram	1												
(c) Diagram showing transmission	1												

	<p>(c)</p> 	1	3
27.	<p>(a) Showing variation of binding energy per nucleon with mass number 1 Significance of binding curve 1/2 (b) (i) Stating the type of reaction 1/2 (ii) To state whether total mass of nuclei increases, decreases or remains unchanged 1/2 (iii) Stating whether process requires energy or produces energy 1/2</p> <p>(a)</p>  <p>Note: - Full credit to be given even if the values are not shown.</p> <p>Significance of the binding energy curve – (Any one) 1/2 - Why lighter nuclei undergo fusion and heavier nuclei undergo fission. - Nuclear forces are short ranged. - Energy is released in both nuclear fission and nuclear fusion.</p> <p>(b) (i) Nuclear fusion 1/2 (ii) Decreases 1/2 (iii) Energy is produced 1/2</p>	1	3

30.	<p>(i) (B) are parallel to each other.</p> <p>(ii) (C) me</p> <p>(iii) Full 1 mark to be awarded to all the students who have attempted this part of the question.</p> <p style="text-align: center;">OR</p> <p>(B) $\frac{1}{2}, \frac{1}{2}$</p> <p>(iv) (D) 13.3 μm</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	4
SECTION E			
31.	<p>(a)</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p>(i) Calculating final potential</p> <p>- on sphere A 1</p> <p>- on shell B 1</p> <p>(ii) Two characteristics of of equipotential surface $\frac{1}{2} + \frac{1}{2}$</p> <p>Finding potential at (4m,3m) 2</p> </div> <p>(i) Potential on sphere A = $V = \frac{Q}{4\pi\epsilon_0 r}$</p> <p>Charge on sphere A = $4\pi\epsilon_0 r V$</p> <p>The charge is transferred to shell B.</p> <p>Potential on shell B = $\frac{1}{4\pi\epsilon_0} \times \frac{4\pi\epsilon_0 r V}{R}$</p> <p>Potential on shell B = $\frac{rV}{R}$</p> <p>Potential on sphere A = Potential on shell B</p> <p>(ii) Characteristics of equipotential surfaces: - (Any two)</p> <ul style="list-style-type: none"> - Potential at all points on the surface is same. - Equipotential surface is normal to the direction of the electric field. - The work done in moving a charge on an equipotential surface is zero. 	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>1</p> <p>$\frac{1}{2} + \frac{1}{2}$</p>	

$$V_0 - V = E d = 50 \times 4$$

$$V_0 - V = 200 \text{ V}$$

$$V = 220 \text{ V} - 200 \text{ V}$$

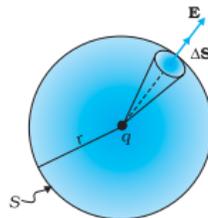
$$V = 20 \text{ V}$$

OR

(b)

(i) Difference between an open surface and a closed surface	1/2
Diagram of elementary surface vector \vec{ds}	1
(ii) Definition of electric flux	1
Significance of Gaussian Surface	1/2
Reason	1/2
(iii) Finding charge Q	1 1/2

(i) Open Surface – A surface which does not enclose a volume.
 Closed Surface – A surface which does enclose a volume.



(ii) Electric flux is defined as the number of electric field lines crossing an area normally.

Alternatively-

$$\phi = \vec{E} \cdot \vec{A}$$

Alternatively-

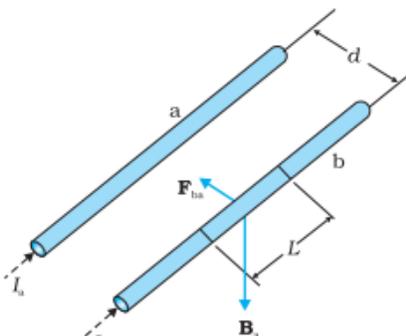
$$\phi = EA \cos \theta$$

Significance of Gaussian Surface: -

It helps in finding the electric field in a simpler way.

Reason: -

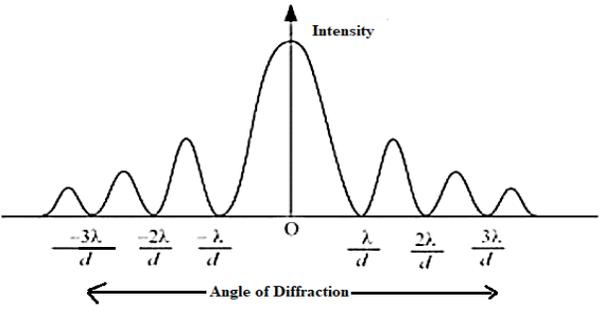
Because any electric field line from the charge which enters the surface at one point will exit at another, resulting in a net zero flux.

	<p>(iii) Total charge enclosed by $S_1 = (-3-2+9) \mu C = 4 \mu C$ Total charge enclosed by $S_2 = Q + 4 \mu C$ $\phi_{s_2} = 4\phi_{s_1}$ $\frac{Q + 4\mu C}{\epsilon_0} = 4 \left(\frac{4\mu C}{\epsilon_0} \right)$ $Q = 12 \mu C$</p>	1/2											
		1/2											
		1/2	5										
32.	<p>(a)</p> <table border="1"> <tbody> <tr> <td>(i) Source of force</td> <td>1/2</td> </tr> <tr> <td>Obtaining expression for force</td> <td>1 1/2</td> </tr> <tr> <td>Definition of 'ampere'</td> <td>1</td> </tr> <tr> <td>(ii) Finding work done by the magnetic force</td> <td>1</td> </tr> <tr> <td>(iii) Necessary conditions</td> <td>1</td> </tr> </tbody> </table> <p><u>Reason</u> –</p> <p>(i) The source of force is the interaction between the field produced by the current carrying conductor and the external field in which it is placed.</p>  <p>Two long parallel conductors a & b, separated by a distance d, carrying currents I_a and I_b, respectively. The magnetic field due to a, $B_a = \frac{\mu_0 I_a}{2\pi d}$ The force F_{ba}, is the force on a segment L of 'b' due to 'a'. $F_{ba} = I_b L B_a$ $= \frac{\mu_0 I_a I_b}{2\pi d} L$</p> <p>Definition – The 'ampere' is that value of steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and</p>	(i) Source of force	1/2	Obtaining expression for force	1 1/2	Definition of 'ampere'	1	(ii) Finding work done by the magnetic force	1	(iii) Necessary conditions	1	1/2	
(i) Source of force	1/2												
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		1/2											
		1											
		1											

<p>placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newton per metre of length.</p> <p>(ii) Work done by the magnetic force on the charge is zero as force is perpendicular to \vec{v}.</p> <p>(iii) The velocity (\vec{v}) is at an arbitrary angle θ w.r.t the magnetic field (\vec{B}).</p>	<p>1</p> <p>1</p>											
OR												
<p>(b)</p> <table border="1" data-bbox="337 625 1269 840"> <tr> <td>(i) Explanation</td> <td>1</td> </tr> <tr> <td>(ii) Obtaining relation for \vec{M}, and direction of \vec{M}.</td> <td>1+1</td> </tr> <tr> <td>(iii) Net force on coil</td> <td>1</td> </tr> <tr> <td> Obtaining orientation</td> <td>$\frac{1}{2}$</td> </tr> <tr> <td> Showing flux is maximum</td> <td>$\frac{1}{2}$</td> </tr> </table>	(i) Explanation	1	(ii) Obtaining relation for \vec{M} , and direction of \vec{M} .	1+1	(iii) Net force on coil	1	Obtaining orientation	$\frac{1}{2}$	Showing flux is maximum	$\frac{1}{2}$		
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Obtaining orientation	$\frac{1}{2}$											
Showing flux is maximum	$\frac{1}{2}$											
<p>(i) The two faces of a current carrying loop behave like two poles of a magnet therefore can be considered as a magnetic dipole placed along its axis.</p>	<p>1</p>											
<p>(ii) Magnetic moment (M) \propto Current (I) \propto Area (A) $\therefore \vec{M} = I\vec{A}$</p>	<p>1</p>											
<p>Direction is same as the area vector.</p>	<p>1</p>											
<p><u>Alternatively:</u> -</p> <p>Magnetic moment is perpendicular to the plane of the coil.</p>												
<p>(iii) Net force acting on the coil is zero. The potential energy (U_B) of a current carrying loop in an external magnetic field $= -\vec{M} \cdot \vec{B}$</p>	<p>1</p>											
<p>For the coil to be in stable equilibrium U_B should be minimum so $\theta = 0^\circ$.</p>	<p>$\frac{1}{2}$</p>											
<p>Therefore, magnetic flux (ϕ) due to the total field $= (\vec{B}_{\text{coil}} + \vec{B}_{\text{ext}}) \cdot \vec{A}$, which is its maximum value.</p>	<p>$\frac{1}{2}$</p>											
<p><u>Alternatively:</u> -</p> <p>Orientation of stable equilibrium is one where the area vector A of the loop is in the direction of external magnetic field. In this orientation, the magnetic field produced by the loop is in the same direction as external field, both normal to the plane of the loop, thus giving rise to maximum flux of the total field.</p>		<p>5</p>										

33.	<p>(a)</p> <table border="1" data-bbox="310 264 1252 415"> <tr> <td>(i) Calculating magnification</td> <td>2½</td> </tr> <tr> <td>(ii) Showing emergent ray is normal</td> <td>1½</td> </tr> <tr> <td>Finding refractive index</td> <td>1</td> </tr> </table> <p>(i) As the pencil lies between f and $2f$ such that one end of the pencil coincides with $2f$.</p> <p>Position of the other end (u) = $-\left(2f - \frac{f}{4}\right) = -\frac{7f}{4}$</p> <p>Magnification (m) = $\frac{f}{f - u}$</p> $= \frac{-f}{-f - \left(-\frac{7f}{4}\right)}$ $m = -\frac{4}{3}$ <p><u>Alternatively: -</u></p> <p>As the pencil lies between f and $2f$ such that one end of the pencil coincides with $2f$.</p> <p>Position of the other end (u) = $-\left(2f - \frac{f}{4}\right) = -\frac{7f}{4}$</p> $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{v} - \frac{4}{7f} = -\frac{1}{f}$ $\frac{1}{v} = -\frac{1}{f} + \frac{4}{7f}$ $v = -\frac{7f}{3}$ $m = -\frac{v}{u} = -\frac{4}{3}$	(i) Calculating magnification	2½	(ii) Showing emergent ray is normal	1½	Finding refractive index	1	<p>½</p> <p>½</p> <p>½</p> <p>1</p> <p>½</p> <p>½</p> <p>½</p> <p>1</p>	
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(ii) Showing emergent ray is normal	1½								
Finding refractive index	1								

	<p>(ii) For prism;</p> $i + e = A + \delta$ $45^\circ + e = 30^\circ + 15^\circ$ $\therefore e = 0^\circ$ <p>Hence, $r_2 = 0^\circ$</p> <p>\therefore Emergent ray is perpendicular to face AC.</p> <p>Alternatively: - If the same is shown using diagram full credit to be given.</p> $r_1 + r_2 = A$ <p>As $r_2 = 0$, hence $r_1 = 30^\circ$</p> <p>Refractive index(n) = $\frac{\sin i}{\sin r}$</p> $= \frac{\sin 45^\circ}{\sin 30^\circ}$ $n = \sqrt{2}$ <p style="text-align: center;">OR</p> <p>(b)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>(i) (1) Calculating distance of the third bright fringe from central maximum</td> <td style="text-align: right;">1</td> </tr> <tr> <td>(2) Finding the least distance</td> <td style="text-align: right;">1</td> </tr> <tr> <td>(ii) (1) Diagram showing variation of intensity with angle of diffraction</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Writing expression for value of angle corresponding to zero intensity</td> <td style="text-align: right;">1</td> </tr> <tr> <td>(2) Difference between diffraction of light and sound waves</td> <td style="text-align: right;">1</td> </tr> </table> <p>(i)</p> <p>(1) Distance of the nth bright fringe from the central maximum(x_n) = $\frac{n\lambda D}{d}$</p> <p>For $n = 3$</p> $x_3 = \frac{3 \times 600 \times 10^{-9} \times 1}{1 \times 10^{-9}}$ $= 1800\text{m}$	(i) (1) Calculating distance of the third bright fringe from central maximum	1	(2) Finding the least distance	1	(ii) (1) Diagram showing variation of intensity with angle of diffraction	1	Writing expression for value of angle corresponding to zero intensity	1	(2) Difference between diffraction of light and sound waves	1	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	
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	<p>(2)</p> $n_1 \lambda_1 = n_2 \lambda_2$ $n_1 \times 600 = n_2 \times 480$ $\frac{n_1}{n_2} = \frac{480}{600}$ $\frac{n_1}{n_2} = \frac{4}{5}$ <p>Position of the 4th bright fringe of 600 nm = 4 x 600 = 2400 m</p> <p>Alternatively: - Position of the 5th bright fringe of 480 nm = 5 x 480 = 2400 m</p> <p>Alternatively: - $(n-1)\lambda_1 = n\lambda_2$ $(n-1) \times 600 = n \times 480$</p> <p>on solving n = 4</p> <p>Position of the 4th bright fringe of 600 nm = 4 x 600 = 2400 m Position of the 5th bright fringe of 480 nm = 5 x 480 = 2400 m</p> <p>(ii) (1)</p>  <p>Angle of diffraction for zero intensity, $\theta = \frac{n\lambda}{a}$; n = 0, 1, 2,</p> <p>(2) Diffraction of the light waves is not generally seen as compared to diffraction of sound waves as light waves have low wavelength.</p>	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1</p> <p>1</p> <p>1</p>	<p>5</p>
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