

**Marking Scheme**  
**Strictly Confidential**  
**(For Internal and Restricted use only)**  
**Senior School Certificate Examination, 2025**  
**SUBJECT NAME PHYSICS (PAPER CODE 55/4/1)**

**General Instructions: -**

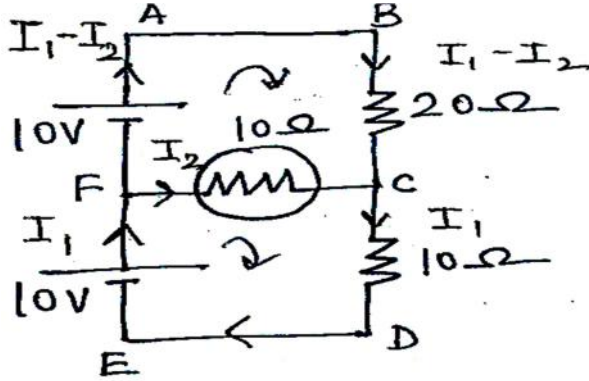
<b>1</b>	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
<b>2</b>	<b>“Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its’ leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC.”</b>
<b>3</b>	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one’s own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. <b>However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.</b>
<b>4</b>	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
<b>5</b>	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after deliberation and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
<b>6</b>	Evaluators will mark( $\surd$ ) wherever answer is correct. For wrong answer CROSS ‘X’ be marked. Evaluators will not put right ( $\surd$ ) while evaluating which gives an impression that answer is correct and no marks are awarded. <b>This is most common mistake which evaluators are committing.</b>
<b>7</b>	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
<b>8</b>	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
<b>9</b>	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note <b>“Extra Question”</b> .
<b>10</b>	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
<b>11</b>	A full scale of marks <u>70</u> (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer

	deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines). This is in view of the reduced syllabus and number of questions in question paper.
13	<p>Ensure that you do not make the following common types of errors committed by the Examiner in the past:-</p> <ul style="list-style-type: none"> <li>● Leaving answer or part thereof unassessed in an answer book.</li> <li>● Giving more marks for an answer than assigned to it.</li> <li>● Wrong totaling of marks awarded on an answer.</li> <li>● Wrong transfer of marks from the inside pages of the answer book to the title page.</li> <li>● Wrong question wise totaling on the title page.</li> <li>● Wrong totaling of marks of the two columns on the title page.</li> <li>● Wrong grand total.</li> <li>● Marks in words and figures not tallying/not same.</li> <li>● Wrong transfer of marks from the answer book to online award list.</li> <li>● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.)</li> <li>● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.</li> </ul>
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0) Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the “ <b>Guidelines for spot Evaluation</b> ” before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

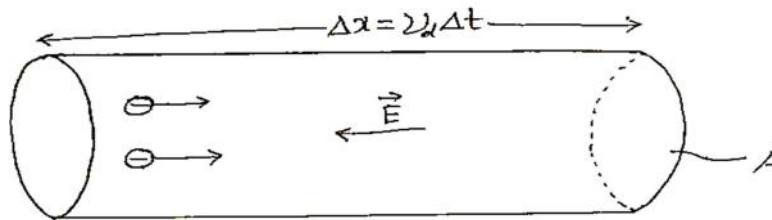
**MARKING SCHEME: PHYSICS(042)**

**Code: 55/4/1**

<b>Q.No.</b>	<b>VALUE POINTS/EXPECTED ANSWERS</b>	<b>Marks</b>	<b>Total Marks</b>								
<b>SECTION A</b>											
1.	(C) decreases by $4.55 \times 10^{-23}$ kg	1	1								
2.	(C) $R^3$	1	1								
3.	(B) a semicircular path in XY plane	1	1								
4.	(C) $60^\circ$	1	1								
5.	(B) Sodium Chloride	1	1								
6.	(A) $10\sqrt{2}A$	1	1								
7.	(D) $3.33 \times 10^{-6} T$	1	1								
8.	(B) Concave and real	1	1								
9.	(C) Photons of light and electrons both exhibit dual nature	1	1								
10.	(B) The red beam has more numbers of photons than the blue beam	1	1								
11.	(A) Sn	1	1								
12.	(C) Concentric horizontal circles around the wire	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.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1								
15.	(C) Assertion (A) is true but Reason (R) is false.	1	1								
16.	(B) Both Assertion (A) and Reason (R) are true but reason (R) is not the correct explanation of the Assertion (A)	1	1								
<b>SECTION-B</b>											
17.	<p>(a)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">(i) Comparison of brightness of bulbs P and Q with bulb S</td> <td align="right" style="padding: 5px;"><math>\frac{1}{2}</math></td> </tr> <tr> <td style="padding: 5px;">Justification</td> <td align="right" style="padding: 5px;"><math>\frac{1}{2}</math></td> </tr> <tr> <td style="padding: 5px;">(ii) Comparison of brightness of bulb S with Q</td> <td align="right" style="padding: 5px;"><math>\frac{1}{2}</math></td> </tr> <tr> <td style="padding: 5px;">Justification</td> <td align="right" style="padding: 5px;"><math>\frac{1}{2}</math></td> </tr> </table> <p>(i) Brightness of the bulb 'S' will be more than bulbs 'P' and 'Q' The current flowing through the bulb 'S' is twice of the current in bulbs 'P' and 'Q'.</p> <p>(ii) Brightness of the bulb 'S' and 'Q' will be same The current flowing through both bulbs is same.</p> <p><b>Alternatively-</b></p> <p>(i) Brightness of the bulb 'S' will be more than bulbs 'P' and 'Q' The potential difference across 'S' is twice than the potential</p>	(i) Comparison of brightness of bulbs P and Q with bulb S	$\frac{1}{2}$	Justification	$\frac{1}{2}$	(ii) Comparison of brightness of bulb S with Q	$\frac{1}{2}$	Justification	$\frac{1}{2}$	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	
(i) Comparison of brightness of bulbs P and Q with bulb S	$\frac{1}{2}$										
Justification	$\frac{1}{2}$										
(ii) Comparison of brightness of bulb S with Q	$\frac{1}{2}$										
Justification	$\frac{1}{2}$										

	<p>difference across bulbs 'P' and 'Q'</p> <p>(ii) Brightness of both bulbs 'S' and 'Q' is same. The potential difference across 'S' and 'Q' will be same.</p> <p style="text-align: center;"><b>OR</b></p> <p>(b)</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Finding the current through the bulb 'B' <span style="float: right;">2</span></p> </div>  <p>By applying Kirchoff's loop rule to closed loops ABCFA and FCDEF</p> $2I_1 - 3I_2 = 1 \text{ ----(1)}$ $I_1 + I_2 = 1 \text{ ----(2)}$ <p>On solving, Current through the bulb,</p> $I_2 = \frac{1}{5} \text{ A}$	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p style="text-align: right;"><b>2</b></p>	
<p><b>18.</b></p>	<div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Finding the angle of diffraction for first secondary maximum. <span style="float: right;">2</span></p> </div> $\theta = (2n+1) \frac{\lambda}{2a}$ <p>For first secondary maxima n=1</p> $\theta = \frac{3\lambda}{2a}$ $\theta = \frac{3 \times 550 \times 10^{-9}}{2 \times 0.55 \times 10^{-3}}$ $\theta = 1.5 \times 10^{-3} \text{ radian} = 0.086 \text{ degree}$	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p style="text-align: right;"><b>2</b></p>	
<p><b>19.</b></p>	<div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Calculation of radius of curvature <span style="float: right;">2</span></p> </div> $\frac{1}{f} = (n_{21} - 1) \left[ \frac{1}{R_1} - \frac{1}{R_2} \right]$	<p>1/2</p>	

	$R_1=R$ and $R_2=-R$ $\frac{1}{15}=(1.55-1)\left[\frac{2}{R}\right]$ $R=16.5\text{ cm}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	<b>2</b>
<b>20.</b>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">           Calculation of mass of an <math>\alpha</math>-particle in u <span style="float: right;">2</span> </div> $1u = \frac{1}{12} \text{ mass of carbon atom} = \frac{1.9926 \times 10^{-26} \text{ kg}}{12} = 1.66 \times 10^{-27} \text{ kg}$ mass of an electron = $9.1 \times 10^{-31} \text{ kg}$ $\text{mass of two electrons} = \frac{2 \times 9.1 \times 10^{-31}}{1.66 \times 10^{-27}}$ $= 0.00109638 \text{ u}$ mass of $\alpha$ -particle = mass of the normal helium atom - mass of two electrons $= 4.0026030 - 0.00109638$ $= 4.00150662 \text{ u}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	<b>2</b>
<b>21.</b>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">           (a)            (i) Identifying the type of dopant <span style="float: right;"><math>\frac{1}{2}</math></span>            (ii) Identifying the type of extrinsic semiconductor <span style="float: right;"><math>\frac{1}{2}</math></span>            (b) Calculating the electron concentration <span style="float: right;">1</span> </div> (a) (i) Trivalent <span style="float: right;"><math>\frac{1}{2}</math></span> (ii) p – type semi conductor <span style="float: right;"><math>\frac{1}{2}</math></span> (b) Electron concentration $n_e = \frac{n_i^2}{n_h}$ $n_e = \frac{(5 \times 10^8)^2}{8 \times 10^{12}}$ $n_e = 3.125 \times 10^4 \text{ m}^{-3}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	<b>2</b>
<b>SECTION-C</b>			
<b>22.</b>	<b>(a)</b> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">           (i) Deriving the expression for resistivity of a conductor <span style="float: right;">2</span>            (ii) Comparison of charges <math>Q_1</math> and <math>Q_2</math> <span style="float: right;">1</span> </div>		



Total charge transported along E is

$$I\Delta t = \frac{e^2 A}{m} \tau n \Delta t E$$

$$\frac{I}{A} = \frac{ne^2}{m} \tau E$$

$$J = \frac{1}{\rho} E$$

$$\rho = \frac{m}{ne^2 \tau}$$

**Alternatively-**

Current in the conductor-

$$I = neAv_d$$

$$\frac{I}{A} = ne \frac{eE}{m} \tau$$

$$J = \frac{ne^2 \tau}{m} E$$

$$J = \frac{1}{\rho} E$$

$$\rho = \frac{m}{ne^2 \tau}$$

(ii) From given graph

$$\frac{Q_1}{Q_2} = \frac{A_1 (\text{Area of rectangle})}{A_2 (\text{Area of triangle})}$$

$$\frac{Q_1}{Q_2} = \frac{2}{3/2}$$

$$Q_1 > Q_2$$

1/2

1/2

1/2

1/2

1/2

1/2

OR

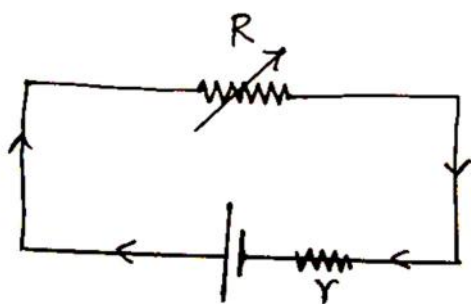
(b)

(i) (I)

- Obtaining the expression for current 1/2
- Finding value of maximum current 1/2

(II) Obtaining terminal voltage V and its maximum possible value 1

(ii) Obtaining the internal resistance of the battery 1



- $V = E - Ir$

$$IR = E - Ir$$

$$I = \frac{E}{R + r}$$

For maximum value of current  $R=0$

$$I_{\max} = \frac{E}{r}$$

(II)  $V = V_+ + V_- - Ir$

$$V = E - Ir$$

$$V_{\max} = E, \quad \text{when } I=0$$

(ii)  $I_1 R_1 + I_1 r = I_2 R_2 + I_2 r$

$$r = \frac{I_2 R_2 - I_1 R_1}{I_1 - I_2}$$

1/2

1/2

1/2

1/2

1/2

1/2

3

23.

(a) Vector form of Biot – Savart Law 1

(b) Finding ,

- Magnitude of resultant magnetic field 1 1/2

- Direction of resultant magnetic field 1/2

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

1

	<p>(b) As <math>B = \frac{\mu_0 2I}{4\pi a}</math></p> <p><math>\therefore B_1 =</math> Magnetic field due to current carrying wire along <math>XX'</math></p> $\vec{B}_1 = \frac{\mu_0 2I}{4\pi a} = \frac{2 \times 2 \times 10^{-7}}{5} = (8 \times 10^{-8} \text{ T})(\hat{k})$ <p><math>B_2 =</math> Magnetic field due to current carrying wire along <math>YY'</math></p> $\vec{B}_2 = \frac{\mu_0 2I}{4\pi a} = \frac{2 \times 2 \times 10^{-7}}{4} = 10 \times 10^{-8} \text{ T } (-\hat{k})$ $\vec{B}_{\text{net}} = \vec{B}_2 + \vec{B}_1$ $= 2 \times 10^{-8} \text{ T } (-\hat{k})$ <ul style="list-style-type: none"> <li>Direction of resultant magnetic field along <math>-Z</math> axis.</li> </ul>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p><b>3</b></p>
<p><b>24.</b></p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Finding direction of induced current in coil and justification</p> <p>(a) coil '2' is moving toward coil '1' <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span></p> <p>(b) coil '2' is moving away from coil '1' <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span></p> <p>(c) Resistance connected with coil '2' is increased keeping both the coils stationary <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span></p> </div> <p>(a) Induced current will be clockwise. <span style="float: right;"><math>\frac{1}{2}</math></span>  Due to the direction flow of current in coil 2, the face approaching to coil 1 behaves like south pole. Induced polarity on coil 1 viewed from the side of coil 2 will be south pole <span style="float: right;"><math>\frac{1}{2}</math></span></p> <p>(b) Induced current will be Anticlockwise <span style="float: right;"><math>\frac{1}{2}</math></span>  Due to direction of flow of current in coil 2, face going away from coil 1 behaves like south pole. Induced polarity on coil 1 viewed from the side of coil 2, will be north pole. <span style="float: right;"><math>\frac{1}{2}</math></span></p> <p>(c) Induced current will be Anticlockwise <span style="float: right;"><math>\frac{1}{2}</math></span>  Till the resistance in coil 2 is increasing, the magnetic flux associated with coil 1 is decreasing. Hence according to Lenz's law current will induce in coil 1, momentarily and after that no induced current in coil <span style="float: right;"><math>\frac{1}{2}</math></span></p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p><b>3</b></p>
<p><b>25.</b></p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>(a) Three characteristics of electro- magnetic wave <span style="float: right;"><b><math>1\frac{1}{2}</math></b></span></p> <p>(b) Explanation of displacement current, <span style="float: right;"><b>1</b></span></p> <ul style="list-style-type: none"> <li>• how <span style="float: right;"><b>1</b></span></li> <li>• Where it exists <span style="float: right;"><math>\frac{1}{2}</math></span></li> </ul> </div> <p>(a) (Any three) <span style="float: right;"><math>\frac{1}{2}</math></span></p> <ul style="list-style-type: none"> <li>• Electromagnetic wave carries energy. <span style="float: right;"><math>\frac{1}{2}</math></span></li> <li>• Electromagnetic wave carries momentum. <span style="float: right;"><math>\frac{1}{2}</math></span></li> <li>• Electromagnetic wave moves with velocity of light in vacuum. <span style="float: right;"><math>\frac{1}{2}</math></span></li> <li>• In electromagnetic wave, electric field vector, magnetic field vector</li> </ul>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	

	<p>and direction of propagation, all are mutually perpendicular.</p> <ul style="list-style-type: none"> <li>• Electromagnetic waves are transverse in nature.</li> <li>• Electromagnetic waves do not require a physical medium to propagate and can travel through a vacuum.</li> <li>• Electromagnetic waves consist of oscillating electric and magnetic fields.</li> </ul> <p>(b)</p> <ul style="list-style-type: none"> <li>• During charging of capacitor, time varying electric field / electric flux between the plates of capacitor induces the displacement current.</li> <li>• Displacement current exists between the plates of capacitor.</li> </ul>	<p>1 ½</p>	<p><b>3</b></p>						
<p><b>26.</b></p>	<table border="1" data-bbox="245 730 1253 898"> <tr> <td>Effect on</td> <td></td> </tr> <tr> <td>(a) Speed, frequency and wavelength of light</td> <td>1½</td> </tr> <tr> <td>(b) Fringe width, shape of fringes and shift of position of central maximum</td> <td>1½</td> </tr> </table> <p>(a)</p> <ul style="list-style-type: none"> <li>• Speed of light will decrease</li> <li>• Frequency remains unaffected</li> <li>• Wavelength decreases</li> </ul> <p>(b)</p> <ul style="list-style-type: none"> <li>• Fringe width decreases</li> <li>• Shapes does not change</li> <li>• Position of central maxima does not change.</li> </ul>	Effect on		(a) Speed, frequency and wavelength of light	1½	(b) Fringe width, shape of fringes and shift of position of central maximum	1½	<p>½ ½ ½</p> <p>½ ½ ½</p>	<p><b>3</b></p>
Effect on									
(a) Speed, frequency and wavelength of light	1½								
(b) Fringe width, shape of fringes and shift of position of central maximum	1½								

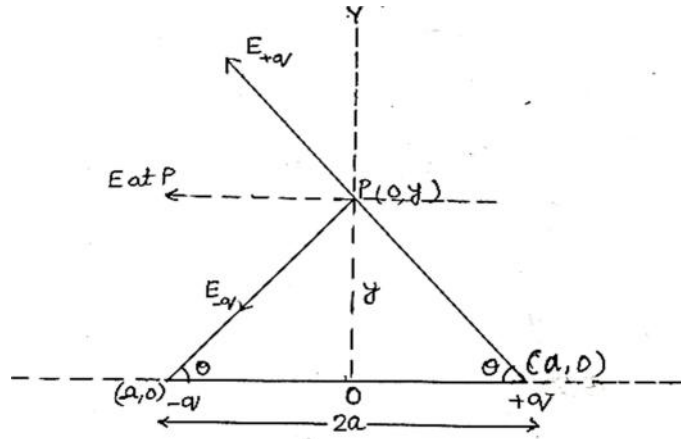
<p>27.</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Explanation of</p> <p>(a) Photoelectric emission 1</p> <p>(b) Dependency of maximum kinetic energy on frequency only 1</p> <p>(c) Explanation of slope of cut off voltage versus frequency graph 1</p> </div> <p>(a) Einstein Photo electric equation  <math>h\nu = h\nu_o + K_{\max}</math>  <math>K_{\max} = h(\nu - \nu_o)</math>  For <math>\nu &lt; \nu_o</math>, <math>K_{\max}</math> will be negative  Hence, Photoelectric emission is not possible.</p> <p>(b) According to Einstein Photoelectric equation  <math>K_{\max} = h(\nu - \nu_o)</math>  Hence <math>K_{\max} \propto \nu</math>  It shows <math>K_{\max}</math> depends upon frequency only and not depends upon intensity.</p> <p>(c) <math>eV_o = h\nu - h\nu_o</math>  <math>V_o = \frac{h}{e}\nu - \frac{h}{e}\nu_o</math>  This equation represents the equation of straight line (<math>y = mx + c</math>) with the slope <math>\frac{h}{e}</math>.</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p><b>3</b></p>
<p>28.</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>(a) Majority and minority charge carriers in p-type and n-type semiconductor 2</p> <p>(b) Brief explanation for formation of diffusion current and drift current 1</p> </div> <p>(a) In p-type semiconductor  Majority charge carriers - holes  Minority charge carriers - electrons  In n-type semiconductors  Majority charge carriers - electrons  Minority charge carriers – holes</p> <p>(b) Diffusion current – during the formation of p n junction , and due to the concentration gradient across p and n – sides , holes diffuse from p side to n</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	

	<p>side (<math>p \rightarrow n</math>) and electrons diffuse from <math>n</math> – side to <math>p</math> – side (<math>n \rightarrow p</math>). This motion of charge carriers gives rise to diffusion current across the junction.</p> <p>Drift current –Due to electric field at junction, an electron on <math>p</math> – side of the junction moves to <math>n</math>- side and a hole on <math>n</math> – side of the junction moves to <math>p</math>-side. This motion of charge carriers due to electric field gives drift current.</p>	$\frac{1}{2}$	<b>3</b>
<b>SECTION-D</b>			
<b>29.</b>	<p>(i) (C) <math>\frac{2\epsilon_0 KL^2}{d}</math></p> <p>(ii) (B) <math>\frac{\epsilon_0 VKL^2}{d}</math></p> <p>(iii) (A) <math>\frac{V}{d}</math></p> <p>(iv) (a)</p> <p>(C) <math>\frac{d}{2K}</math></p> <p>OR</p> <p>(b)</p> <p>(D) Zero</p>	<b>1</b>	<b>1</b>
		<b>1</b>	<b>1</b>
		<b>1</b>	<b>4</b>
<b>30.</b>	<p>(i) (C) <math>\sqrt{\frac{Ke^2}{mr}}</math></p> <p>(ii) (B) <math>\frac{-Ke^2}{2r}</math></p> <p>(iii) (C) -2.48, 2.48</p> <p>(iv) (a)</p> <p>(D) <math>\frac{1}{n^3}</math></p> <p>OR</p> <p>(b)</p> <p>(C) <math>1.59 \text{ \AA}</math></p>	<b>1</b>	<b>1</b>
		<b>1</b>	<b>1</b>
		<b>1</b>	<b>4</b>

31.

(a)

- |   |   |
|---|---|
| (i) Finding electric field at a far off point ( $y \gg a$ ) | 3 |
| (ii) Calculation of work done in shifting the charges       | 2 |



1/2

Magnitude of electric field due to the two charges +q and -q are given by

$$E_{+q} = \frac{q}{4\pi\epsilon_0} \frac{1}{y^2 + a^2}$$

1/2

$$E_{-q} = \frac{q}{4\pi\epsilon_0} \frac{1}{y^2 + a^2}$$

1/2

Components normal to the dipole axis cancel out.

The components along the dipole axis add up.

The total electric field is opposite to the dipole moment will be given by-

$$\vec{E} = - (E_{+q} + E_{-q}) \cos \theta \hat{p}$$

1/2

$$= - \frac{2qa}{4\pi\epsilon_0 (y^2 + a^2)^{3/2}} \hat{p} \quad (\hat{p} \text{ is a unit vector along dipole moment})$$

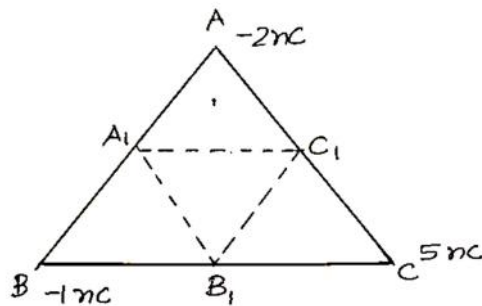
1/2

At large distance ( $y \gg a$ )

$$\vec{E} = \frac{-2qa}{4\pi\epsilon_0 y^3} \hat{p}$$

1/2

(ii)



Initial electrostatic potential energy of the system

$$U_1 = \frac{1}{4\pi\epsilon_0} \left( \frac{q_A q_B}{AB} + \frac{q_C q_A}{AC} + \frac{q_C q_B}{BC} \right)$$

$$= \frac{9 \times 10^9}{0.2} [(-2 \times -1) + (-2 \times 5) + (-1 \times 5)] \times 10^{-18}$$

$$U_1 = -5.85 \times 10^{-7} \text{ J}$$

$$U_2 = \frac{1}{4\pi\epsilon_0} \left( \frac{q_{A_1} q_{B_1}}{A_1 B_1} + \frac{q_{C_1} q_{A_1}}{A_1 C_1} + \frac{q_{C_1} q_{B_1}}{B_1 C_1} \right)$$

$$U_2 = -11.7 \times 10^{-7} \text{ J}$$

$$W = U_2 - U_1 = -5.85 \times 10^{-7} \text{ J}$$

**OR**

(b)

(i)

- Showing consistency of Gauss's theorem with Coulomb's law 1
- Derivation for electric field due to uniformly charged thin spherical shell at (I)  $y > r$  (II)  $y < r$  2

(ii) Finding type and magnitude of charge 2

(i)

- Gauss's theorem is based on the inverse square dependence on distance contained in the coulomb's law.

**Alternatively-**

According to Gauss's theorem

1/2

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$$\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$$

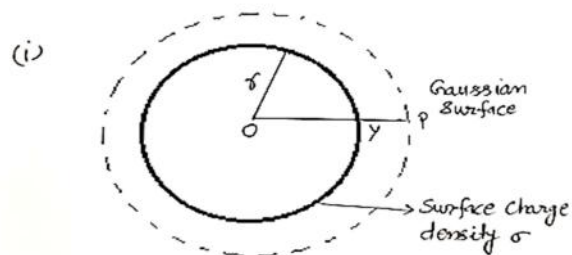
$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

According to Coulomb's law, force on charge  $q_0$  in this field

$$F = \frac{1}{4\pi\epsilon_0} \frac{qq_0}{r^2}$$

Therefore, Gauss's law is consistent with Coulomb's law

- (I) For  $y > r$



Electric flux through Gaussian surface  $E \times 4\pi y^2$

The charge enclosed by the surface  $\sigma \times 4\pi r^2$

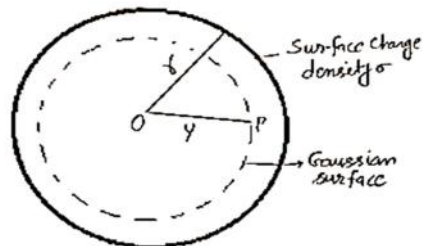
Using Gauss theorem

$$E(4\pi y^2) = \frac{\sigma 4\pi r^2}{\epsilon_0}$$

$$\vec{E} = \frac{q}{4\pi\epsilon_0 y^2} \hat{r}$$

- (II) For  $y < r$

(ii)

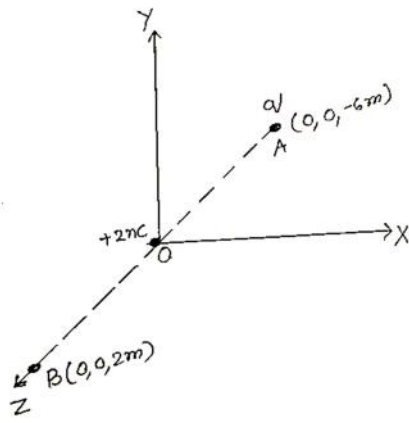


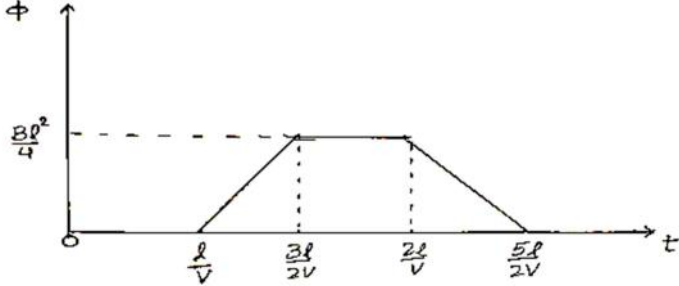
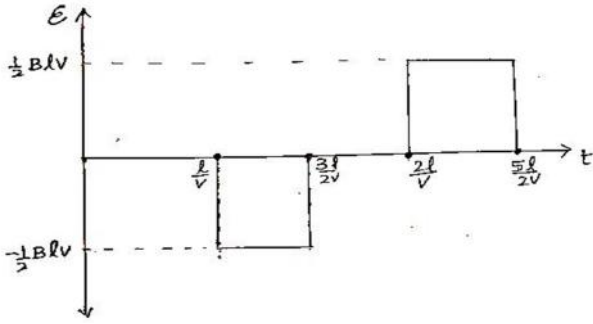
1/2

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	<p>The charge enclosed by Gaussian surface = 0  Using Gauss theorem  Electric flux = <math>E(4\pi r^2) = 0</math>  i.e. <math>E = 0</math> (<math>y &lt; r</math>)</p> <p>(ii)</p>  <p>Let the charge is kept at A be <math>q</math>  Potential at point B due to charge at the origin O and charge (<math>q</math>) at A</p> $V = V_1 + V_2$ $V = \frac{1}{4\pi\epsilon_0} \left[ \frac{2 \times 10^{-9}}{2} + \frac{q}{6+2} \right]$ $\frac{1}{4\pi\epsilon_0} \left[ 10^{-9} + \frac{q}{8} \right] = 0$ $q = -8 \times 10^{-9} \text{C}$	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p><b>5</b></p>
<p><b>32.</b></p>	<p>(a)</p> <div style="border: 1px solid black; padding: 10px;"> <p>(i)</p> <ul style="list-style-type: none"> <li>• Statement of Lenz's law <span style="float: right;"><math>\frac{1}{2}</math></span></li> <li>• Explaining, how this law is a consequence of law of conservation of energy <span style="float: right;"><math>\frac{1}{2}</math></span></li> </ul> <p>(ii)</p> <p>(I) Direction of induced current when loop enters and loop leaves <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span></p> <p>(II) Plots showing variation of magnetic flux (<math>\phi</math>) with time (t), <span style="float: right;">1</span>  induced emf (E) with time (t) and <span style="float: right;">1</span>  relevant values E, (<math>\phi</math>) and t on the graph <span style="float: right;">1</span></p> </div>		

<p>Lenz's law – Polarity of the induced emf is such that it tends to produce a current, which opposes the change in magnetic flux that produces it.</p>	<p>1/2</p>	
<p>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 converted into electrical energy which is consistent with the law of conservation of energy.</p>	<p>1/2</p>	
<p>(ii) (I)</p> <ul style="list-style-type: none"> <li>• Anticlockwise</li> <li>• Clockwise</li> </ul>	<p>1/2 1/2</p>	
<p>(II)</p> 	<p>1 1/2</p>	
	<p>1 1/2</p>	
<p><b>OR</b></p>		
<p>(b)</p>		
<p>(i) Difference between Peak value and rms value of ac Relation</p>	<p>1 1/2</p>	
<p>(ii) (I) Identification of elements X and Y by phasor diagram (II) Obtaining</p> <ul style="list-style-type: none"> <li>• Resonance condition</li> <li>• Expression for resonant frequency</li> <li>• Impedance value</li> </ul>	<p>1 1 1 1/2</p>	

(i)

Peak value - It is the maximum value of Alternating current.

rms value – It is the equivalent dc current that would produce the same average power loss as alternating current.

1

**Alternatively-**

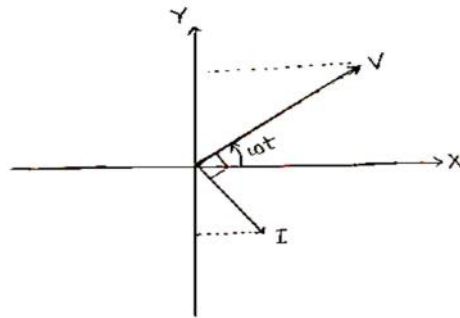
Peak value - It is the maximum value of Alternating current.

rms value- It is the effective value of an ac representing the equivalent dc, that would produce the same heating effect in same resistor in same time period.

Relation  $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$

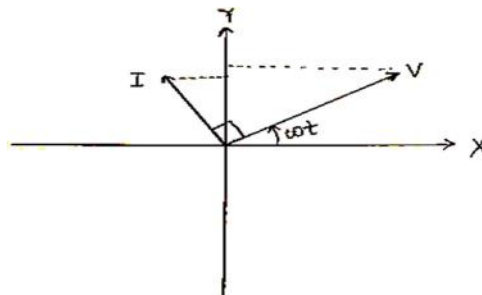
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(ii) (I) X- Inductor (L)



1/2

Y- Capacitor (C)



1/2

	<p>(II) Impedance of the circuit</p> $Z = (X_L - X_C)$ <p>At resonance <math>Z = 0</math></p> $X_L = X_C$ $\omega L = \frac{1}{\omega C}$ $\omega^2 = \frac{1}{LC}, \quad \omega = \frac{1}{\sqrt{LC}}$ $v = \frac{1}{2\pi\sqrt{LC}}$ <p>Impedance at resonance <math>Z = 0</math></p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p><b>5</b></p>								
<p><b>33.</b></p>	<p><b>(a)</b></p> <table border="1" data-bbox="264 919 1229 1087"> <tr> <td>(i) Calculation of focal length of concave lens</td> <td>3</td> </tr> <tr> <td>(ii) Calculation of</td> <td></td> </tr> <tr> <td>• Angle of minimum deviation</td> <td>1</td> </tr> <tr> <td>• Angle of incidence</td> <td>1</td> </tr> </table> <p>For real image form by Convex lens</p> $\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u_1}$ $\frac{1}{10} = \frac{1}{v_1} - \frac{1}{(-30)}$ <p><math>v_1 = 15 \text{ cm}</math></p> <p>For Combination of lenses, let the focal length of combination of lens is <math>f_3</math></p> $\frac{1}{f_3} = \frac{1}{v_3} - \frac{1}{u_3}$ $\frac{1}{f_3} = \frac{1}{(15+45)} + \frac{1}{30}$ <p><math>f_3 = 20 \text{ cm}</math></p> <p>Let the focal length of concave lens is <math>f_2</math></p> $\frac{1}{f_3} = \frac{1}{f_1} + \frac{1}{f_2}$ $\frac{1}{f_2} = \frac{1}{20} - \frac{1}{10}$	(i) Calculation of focal length of concave lens	3	(ii) Calculation of		• Angle of minimum deviation	1	• Angle of incidence	1	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	
(i) Calculation of focal length of concave lens	3										
(ii) Calculation of											
• Angle of minimum deviation	1										
• Angle of incidence	1										

<p><math>f_2 = -20\text{cm}</math></p> <p>(ii) Angle of minimum deviation</p> $\mu = \frac{\sin \frac{(A + \delta_m)}{2}}{\sin \frac{A}{2}}$ $\sqrt{3} = \frac{\sin \frac{(60^\circ + \delta_m)}{2}}{\sin 30}$ $\frac{\sqrt{3}}{2} = \sin \frac{(A + \delta_m)}{2}$ $60^\circ = \frac{(A + \delta_m)}{2}$ $\delta_m = 60^\circ$ <p>Angle of incidence</p> $i + e = A + \delta$ $2i = A + \delta_m$ $i = \frac{A + \delta_m}{2}$ $i = 60^\circ$ <p style="text-align: center;"><b>OR</b></p> <p>(b)</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	
<p>(i)</p> <p>(I) Finding the slit separation <span style="float: right;">1½</span></p> <p>(II) Calculation of distance between central maximum and first minimum <span style="float: right;">1½</span></p> <p>(ii) Calculation of distance between first order minima on both sides of central maxima <span style="float: right;">2</span></p>		
<p>(i)</p> <p>(I) Slit separation</p> $\beta = \frac{D\lambda}{d}$	<p><math>\frac{1}{2}</math></p>	

$d = \frac{D\lambda}{\beta}$ $= \frac{633 \times 10^{-9} \times 5}{5 \times 10^{-3}}$ $= 633 \times 10^{-6} \text{ m}$ $= 633 \mu\text{m}$			
(II) Distance of first minimum from central maximum			
$x_n = \frac{(2n-1)\lambda D}{2d}$		$\frac{1}{2}$	
n = 1			
$x = \frac{633 \times 10^{-9} \times 5}{2 \times 5 \times 10^{-3}}$		$\frac{1}{2}$	
x = 316.5 × 10 <sup>-6</sup> m		$\frac{1}{2}$	
x = 316.5 μm			
(ii) Distance between first order minima on both the side			
$W = \frac{2D\lambda}{d}$		$\frac{1}{2}$	
$= \frac{2 \times 650 \times 10^{-9}}{0.6 \times 10^{-3}} \times 60 \times 10^{-2}$		<b>1</b>	
= 1.3 × 10 <sup>-3</sup> m		$\frac{1}{2}$	<b>5</b>