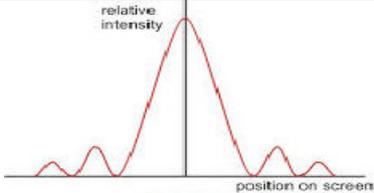


Q.NO.	VALUE POINTS/ EXPECTED ANSWERS	MARKS	TOTAL MARKS
<b>SECTION A</b>			
1	<p>The power of a lens equals to the reciprocal of its focal length( in meter).</p> <p>Also accept</p> $P = \frac{1}{f(\text{meter})}$ <p>Do not deduct mark if student does not write the word meter.</p> <p>( Alternatively</p> <p>Power of a lens is the ability of conversion /diversion of the rays incident on the lens.)</p> <p>SI Unit: Diopetre(D)</p>	<p>½</p> <p>½</p>	1
2		1	1
3	<p>Normal : Circular</p> <p>At an angle of 30° it will follow helical path</p>	<p>½</p> <p>½</p>	1
4	$v = \sqrt{\frac{2eV}{m}}$	1	1
5	From few MHz to 30-40 MHz	1	1
<b>SECTION B</b>			

<p>6</p>	<table border="1" data-bbox="215 129 1145 257"> <tbody> <tr> <td>(a) One use</td> <td>1</td> </tr> <tr> <td>(b) One example each</td> <td>½+ ½</td> </tr> </tbody> </table> <p>(a) used to destroy cancer cells</p> <p>(b) (i)The region, between the plates of a capacitor, connected to time varying voltage source,has a displacement current but no conduction current.</p> <p>(ii) The wires, connected to the plates of a capacitor, joined to a time varying or steady voltage source, carry a conduction current but no displacement current.</p> <p>( Alternatively</p> <p>A circuit, having no capacitor in it, and carrying a current has conduction current but no displacement current. )</p>	(a) One use	1	(b) One example each	½+ ½	<p>1</p> <p>½</p> <p>½</p>	<p>2</p>				
(a) One use	1										
(b) One example each	½+ ½										
<p>7</p>	<table border="1" data-bbox="204 929 1145 1093"> <tbody> <tr> <td>Formula</td> <td>½</td> </tr> <tr> <td>(i) Frequency of first case</td> <td>½</td> </tr> <tr> <td>(ii) Frequency of second case</td> <td>½</td> </tr> <tr> <td>Ratio</td> <td>½</td> </tr> </tbody> </table> <p>We have</p> $h\nu = E_f - E_i$ $= \frac{E_0}{n_f^2} - \frac{E_0}{n_i^2}$ <p>(i) <math>h\nu_1 = E_0 \left( \frac{1}{1^2} - \frac{1}{2^2} \right) = E_0 \times \frac{3}{4}</math></p> <p>(ii) <math>h\nu_2 = E_0 \left( \frac{1}{2^2} - \frac{1}{\infty^2} \right) = E_0 \times \frac{1}{4}</math></p> $\therefore \frac{\nu_1}{\nu_2} = 3$	Formula	½	(i) Frequency of first case	½	(ii) Frequency of second case	½	Ratio	½	<p>½</p> <p>½</p> <p>½</p> <p>½</p>	<p>2</p>
Formula	½										
(i) Frequency of first case	½										
(ii) Frequency of second case	½										
Ratio	½										
<p>8</p>	<table border="1" data-bbox="199 1787 1145 1883"> <tbody> <tr> <td>Finding the Work function</td> <td>1</td> </tr> <tr> <td>Finding the Frequency of incident light</td> <td>1</td> </tr> </tbody> </table>	Finding the Work function	1	Finding the Frequency of incident light	1						
Finding the Work function	1										
Finding the Frequency of incident light	1										

We have

$$\begin{aligned}
 W &= h\nu_0 \\
 &= 6.63 \times 10^{-34} \times 8 \times 10^{14} \text{ J} \\
 &= \frac{6.63 \times 10^{-20} \times 8}{1.6 \times 10^{-19}} \\
 &= 3.315 \text{ eV}
 \end{aligned}$$

½

We have

$$\begin{aligned}
 h\nu &= W + eV_s \\
 &= (3.315 + 3.3) \text{ eV} \\
 \therefore \nu &= \frac{6.615 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}} \text{ Hz} \\
 &= 1.596 \times 10^{15} \text{ Hz}
 \end{aligned}$$

½

½

2

**OR**

Calculating

(i) Energy of a photon

½ + ½

(ii) Number of photons emitted

½ + ½

Energy of photon =  $h\nu$

$$\begin{aligned}
 &= 6.63 \times 10^{-34} \times 6.0 \times 10^{14} \text{ J} \\
 &= 3.978 \times 10^{-19} \text{ J} \\
 &\cong 2.49 \text{ eV}
 \end{aligned}$$

½

½

Number of photons emitted per second =  $\frac{\text{power}}{\text{energy of photon}}$

½

$$\begin{aligned}
 &= \frac{2.0 \times 10^{-3} \text{ J / s}}{3.978 \times 10^{-19} \text{ J}} \\
 &= 5.03 \times 10^{15} \text{ photons / second}
 \end{aligned}$$

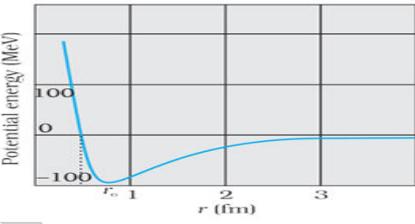
½

<p><b>9</b></p>	<table border="1" style="width: 100%;"> <tbody> <tr> <td>(a) Definition</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>Relation</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>(b) Identification of A and B</td> <td style="text-align: right;">1/2+ 1/2</td> </tr> </tbody> </table> <p>(a) Measure of the response of magnetic material to an external magnetic field. Also accept</p> $\chi = \frac{ M }{ H }$ <p>We have</p> $\chi = (\mu_r - 1)$ <p>(b) 0.96 : Diamagnetic 500 : Ferromagnetic</p>	(a) Definition	1/2	Relation	1/2	(b) Identification of A and B	1/2+ 1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>2</p>		
(a) Definition	1/2										
Relation	1/2										
(b) Identification of A and B	1/2+ 1/2										
<p><b>10</b></p>	<table border="1" style="width: 100%;"> <tbody> <tr> <td>SHM nature of oscillation of the wire AB</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>Expression for instantaneous magnetic flux</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>Expression for instantaneous induced emf</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>Qualitative explanation</td> <td style="text-align: right;">1/2</td> </tr> </tbody> </table> <p>The wire AB would oscillate in a simple harmonic way</p> <p>We can write</p> $x = -a \cos \omega t$ <p>(as <math>x = -a</math> at <math>t = 0</math>)</p> <p>Therefore Instantaneous magnetic Flux</p> $\phi(t) = Blx \quad (l = AB)$ <p>Instantaneous induced emf</p> $e(t) = -\frac{d\phi}{dt} = aBl\omega \sin \omega t$ <p>The induced emf, therefore varies with time sinusoidally.</p> <p>( Alternatively</p> <p>Arm AB executes SHM under the influence of restoring force developed in the spring, consequently an induced emfis produced across the ends of</p>	SHM nature of oscillation of the wire AB	1/2	Expression for instantaneous magnetic flux	1/2	Expression for instantaneous induced emf	1/2	Qualitative explanation	1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p>	
SHM nature of oscillation of the wire AB	1/2										
Expression for instantaneous magnetic flux	1/2										
Expression for instantaneous induced emf	1/2										
Qualitative explanation	1/2										

	<p>moving arm AB which varies sinusoidally.)</p> <p>(Give full credit for the above part if the student explains qualitatively without using mathematical equations)</p>		2
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<b>SECTION C</b>			
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<b>11</b>	<p>Labelled circuit diagram – 1</p> <p>Working as a voltage amplifier - 2</p> <div style="text-align: center;"> </div> <p>Working as a voltage amplifier:</p> <p>When a small sinusoidal voltage (with amplitude <math>v_s</math>) is connected in series with the dc bias voltage supply, <math>V_{BB}</math>, the base current will have sinusoidal variations super imposed on the value of <math>I_B</math>.</p> <p>As a result, the collector current will also have sinusoidal variations super imposed on the value of <math>I_C</math>.</p> <p>This results in corresponding sinusoidal variations in the value of the output voltage <math>V_o</math>.</p> <p>These sinusoidal variations in output voltage are an amplified version of the corresponding variations in the input voltage. This implies that the transistor can be used as a voltage amplifier.</p> <p>(Note : Give 1 mark to those students also who only draw either this circuit diagram or the circuit diagram given below:</p> <div style="text-align: center;"> </div>	1	3
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<p><b>12</b></p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>a) Writing the truth table – 1 b) Photodiode and its operation – 1 + 1</p> </div> <p>(a) The inputs of the third gate are <math>\bar{A}</math> and <math>\bar{B}</math>. Hence the truth table is as given below.</p> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th>A</th> <th>B</th> <th><math>\bar{A}</math></th> <th><math>\bar{B}</math></th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> </tr> </tbody> </table> <p>(Note: The student need not write the columns for <math>\bar{A}</math> and <math>\bar{B}</math> in her/ his answer)</p> <p>(b) A photodiode is a special purpose <math>p - n</math> junction diode fabricated with a transparent window to allow light to fall on the diode.</p> <p>Incident light, with photon energy greater than the energy gap of the semiconductor, generates electron -hole pairs. The magnitude of the photo current depends on the intensity of intensity of incident light.</p> <p>The photodiode is usually operated under reverse bias conditions.</p> <p>This is because this makes it easier to detect changes in light intensity and makes the photodiode work as a detector of optical signals.</p>	A	B	$\bar{A}$	$\bar{B}$	C	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	1	0	0	1	<p>1</p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p>3</p>
A	B	$\bar{A}$	$\bar{B}$	C																								
0	0	1	1	0																								
0	1	1	0	0																								
1	0	0	1	0																								
1	1	0	0	1																								
<p><b>13</b></p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>a) Drawing the plot – 1 Marking the relevant regions - <math>\frac{1}{2} + \frac{1}{2}</math></p> <p>b) Finding values of a and b – <math>\frac{1}{2} + \frac{1}{2}</math></p> </div> <p>a)</p>  <p>For <math>r &gt; r_0</math>, the force is attractive</p> <p>For <math>r &lt; r_0</math>, the force is repulsive</p> <p>a) We have,  <math>1 + 235 = a + 94 + 2 \times 1</math>  <math>\therefore a = 236 - 96 = 140</math></p>	<p>1</p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>																										





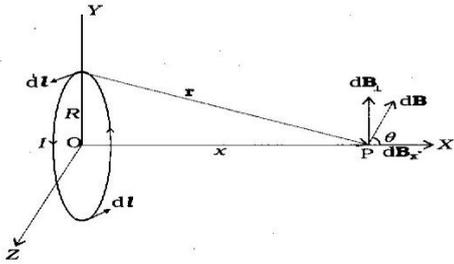


Its direction is perpendicular to the plane containing  $d\vec{l}$  and  $\vec{r}$ .

In vector notation,

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

(b)



We have  $\vec{dB} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \vec{r}}{r^3}$

$$r^2 = x^2 + R^2$$

$$\therefore dB = \frac{\mu_0 I}{4\pi} \frac{dl}{(x^2 + R^2)^{3/2}}$$

We need to add only the components of  $d\vec{B}$  along the axis of the coil.

Hence,  $B = \int \frac{\mu_0}{4\pi} \frac{Idl}{(x^2 + R^2)^{3/2}} \cos\theta.$

$$= \int \frac{\mu_0}{4\pi} \frac{(Idl) R}{(x^2 + R^2)^{3/2}}.$$

$$= \frac{\mu_0 IR^2}{2(x^2 + R^2)^{3/2}}.$$

$$\therefore B = \frac{\mu_0 IR^2}{2(x^2 + R^2)^{3/2}} \hat{i}$$

1/2

1/2

1/2

1/2

1/2

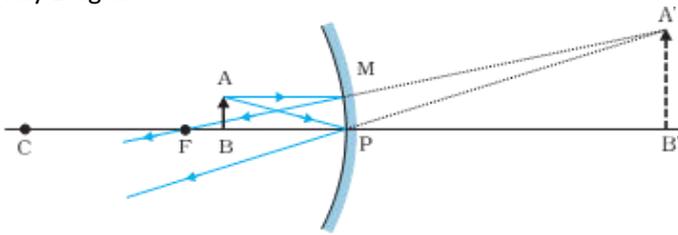
1/2

3

18

a) Ray diagram	- 1
b) Obtaining	
i. mirror formula	- 1 1/2
ii. expression for liner magnification	- 1/2

a) Ray Diagram



From similar triangles  $A'B'F$  and  $MPF$ , we have

$$\frac{B'A'}{PM} = \frac{B'F}{FP} \text{ or } \frac{B'A'}{BA} = \frac{B'F}{FP} \quad (\text{since } PM = BA)$$

From similar triangles  $A'B'P$  and  $ABP$ , we have

$$\frac{B'A'}{BA} = \frac{B'P}{BP}$$

Hence  $\frac{B'F}{FP} = \frac{B'P}{BP}$

Now  $B'F = B'P + PF = (+v) + (-f)$

$$= v - f$$

$$BP = -u$$

$$\therefore \frac{v - f}{-f} = \frac{+v}{-u}$$

$$\text{or } \frac{-v}{f} + 1 = \frac{-v}{u}$$

$$\therefore \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

This is the mirror formula.

Linear magnification =  $\frac{B'A'}{BA}$

From similar triangles  $A'B'P$  and  $ABP$ , we get

$$\frac{B'A'}{BA} = \frac{B'P}{BP}$$

$\therefore$  Linear magnification

$$\frac{B'P}{BP} = \frac{+v}{-u} = -\frac{v}{u}$$

1

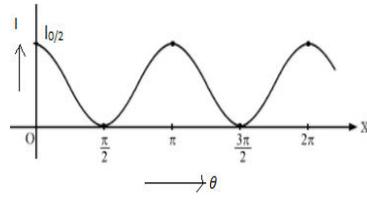
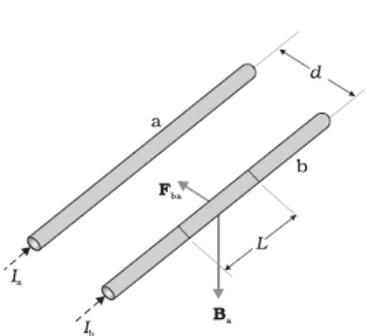
$\frac{1}{2}$

$\frac{1}{2}$

$\frac{1}{2}$

$\frac{1}{2}$

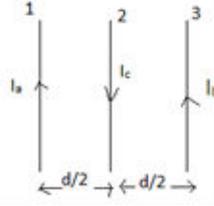
3

<p>19</p>	<table border="1" style="width: 100%;"> <tr> <td style="width: 80%;">a) Intensity of linearly polarized light – <math>\frac{1}{2}</math></td> <td style="width: 20%; text-align: right;">– <math>\frac{1}{2}</math></td> </tr> <tr> <td>Dependence on orientation</td> <td style="text-align: right;">– <math>\frac{1}{2}</math></td> </tr> <tr> <td>Explanation</td> <td style="text-align: right;">– 1</td> </tr> <tr> <td>b) Graphical representation</td> <td style="text-align: right;">– 1</td> </tr> </table> <p>(a) The intensity of the linearly polarized light would be <math>I_0/2</math>. No; it does not depend on the orientation.</p> <p>Explanation : The polaroid will let the component of the unpolarized light, parallel to its pass axis, to pass through it irrespective of its orientation.</p> <p>(b) We have <math>I = I_0 \cos^2 \theta</math> ∴ The graph is as shown below</p> 	a) Intensity of linearly polarized light – $\frac{1}{2}$	– $\frac{1}{2}$	Dependence on orientation	– $\frac{1}{2}$	Explanation	– 1	b) Graphical representation	– 1	<p style="text-align: center;"><math>\frac{1}{2}</math></p> <p style="text-align: center;"><math>\frac{1}{2}</math></p> <p style="text-align: center;">1</p>	<p style="text-align: center;">3</p>
a) Intensity of linearly polarized light – $\frac{1}{2}$	– $\frac{1}{2}$										
Dependence on orientation	– $\frac{1}{2}$										
Explanation	– 1										
b) Graphical representation	– 1										
<p>20</p>	<table border="1" style="width: 100%;"> <tr> <td style="width: 80%;">(a) Definition of SI unit Of current</td> <td style="width: 20%; text-align: right;">1</td> </tr> <tr> <td>(b) Explanation of the force of attraction</td> <td style="text-align: right;"><math>\frac{1}{2}</math></td> </tr> <tr> <td>Finding the resultant force acting on the third conductor</td> <td style="text-align: right;"><math>1\frac{1}{2}</math></td> </tr> </table> <p>(a) The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to <math>2 \times 10^{-7}</math> newton per metre of length.</p> <p>(b) The wire (b) experiences a force due to the magnetic field caused by the current flowing in wire (a).</p> 	(a) Definition of SI unit Of current	1	(b) Explanation of the force of attraction	$\frac{1}{2}$	Finding the resultant force acting on the third conductor	$1\frac{1}{2}$	<p style="text-align: center;">1</p>			
(a) Definition of SI unit Of current	1										
(b) Explanation of the force of attraction	$\frac{1}{2}$										
Finding the resultant force acting on the third conductor	$1\frac{1}{2}$										

The magnetic field at any point on the wire (b) due to the current in wire (a) is perpendicular to the plane of two wires and pointing inwards and hence force on it will be towards wire (a). Similarly force on wire (a) will be towards wire (b). Hence two wires carrying currents in same direction attract each other.

Force on wire (3) due to wire (1)

$$= \frac{\mu_0 I_a I_c}{2\pi \left(\frac{d}{2}\right)} \text{ towards right}$$



Force on wire 3 due to wire 2

$$\left( \frac{\mu_0 I_b I_c}{2\pi \left(\frac{d}{2}\right)} \right) \text{ towards left}$$

Net force on wire 3

$$= \frac{\mu_0 I_c}{\pi d} [I_a - I_b] \text{ towards right}$$

Also accept

$$= \frac{\mu_0 I_c}{\pi d} [I_b - I_a] \text{ towards left}$$

Note: please do not deduct last 1/2 mark if the student does not write the direction of force.

1/2

1/2

1/2

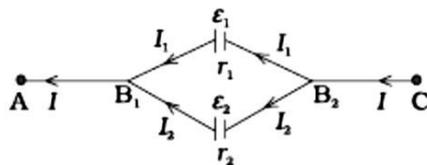
1/2

3

21

Obtaining Expression for the equivalent

- |                |   |
|----------------|---|
| (i) resistance | 1 |
| (ii) emf       | 2 |



1/2

	$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2}$ $\therefore r = \frac{r_1 r_2}{r_1 + r_2}$ $I = I_1 + I_2$ $V = E_1 - I_1 r_1 \quad \text{and} \quad V = E_2 - I_2 r_2$ $\therefore I = \left( \frac{E_1 - V}{r_1} \right) + \left( \frac{E_2 - V}{r_2} \right)$ $V = \left( \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2} \right) - I \left( \frac{r_1 r_2}{r_1 + r_2} \right)$ $\text{also } V = E_{eq} - I r_{eq}$ $\Rightarrow \frac{E_{eq}}{r_{eq}} = \frac{E_1}{r_1} + \frac{E_2}{r_2}$	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>3</p>								
<p>22</p>	<table border="1" data-bbox="204 801 1141 940"> <tbody> <tr> <td>Definition of Electric flux</td> <td>1</td> </tr> <tr> <td>SI unit</td> <td>1/2</td> </tr> <tr> <td>Formula (Gauss's Law)</td> <td>1/2</td> </tr> <tr> <td>Calculation of Charge within the cube</td> <td>1</td> </tr> </tbody> </table> <p>Electric Flux is the dot product of electric field and area vector.</p> <p>Also Accept</p> $\phi = \oint \vec{E} \cdot d\vec{s}$ <p>SI Unit : Nm<sup>2</sup>/C or volt -meter</p> <p>For a given case</p> $\phi = \phi_1 + \phi_2 = [E_x(\text{at } x = 2a) - E_x(\text{at } x = a)] a^2$ $= [\alpha(2a) - \alpha(a)] a^2$ $= \alpha a^3$ $= 100 \times (0.1)^3 = 0.1 \text{ Nm}^2 / \text{C}$ <p>But</p> $\phi = \frac{q}{\epsilon_0}$ $\therefore q = \epsilon_0 \phi = 8.854 \times 10^{-12} \times 10^{-1} \text{ C}$ $= 0.8854 \text{ pC}$	Definition of Electric flux	1	SI unit	1/2	Formula (Gauss's Law)	1/2	Calculation of Charge within the cube	1	<p>1</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	
Definition of Electric flux	1										
SI unit	1/2										
Formula (Gauss's Law)	1/2										
Calculation of Charge within the cube	1										

OR

Relevant formulae	1
Calculation of time taken by the electron	1
Calculation of time taken by the proton	1

We have

Force =  $qE$

Acceleration  $a = \frac{qE}{m}$

$\frac{1}{2}$

Also

$$s = \frac{1}{2}at^2 \quad \text{as } u = 0$$

$$\therefore t = \sqrt{\frac{2s}{a}}$$

$\frac{1}{2}$

(i) For the electron

$$a = \frac{eE}{m}$$

$\frac{1}{2}$

$$\therefore t = \sqrt{\frac{3 \times 10^{-2} \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19} \times 2.0 \times 10^4}}$$

$$= 2.92 \text{ ns}$$

$\frac{1}{2}$

(ii) for proton

$$t = \sqrt{\frac{2 \times 1.5 \times 10^{-2} \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 2 \times 10^4}}$$

$$= 0.125 \mu\text{s}$$

$\frac{1}{2}$

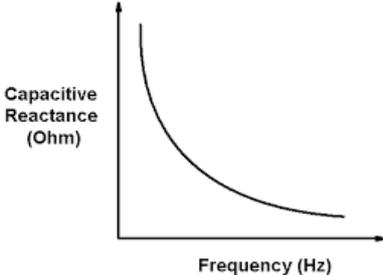
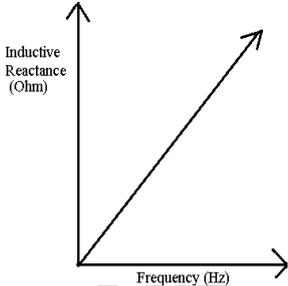
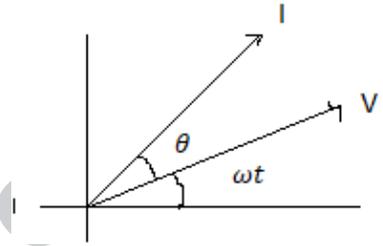
$\frac{1}{2}$

3

**SECTION D**

23

- |                            |                    |
|----------------------------|--------------------|
| (a) Name of e.m. radiation | $\frac{1}{2}$ Mark |
| (b) Method of production   | $\frac{1}{2}$ Mark |
| (c) Range of wavelength    | 1 Mark             |
| (d) Two values             | 1 + 1 Marks        |

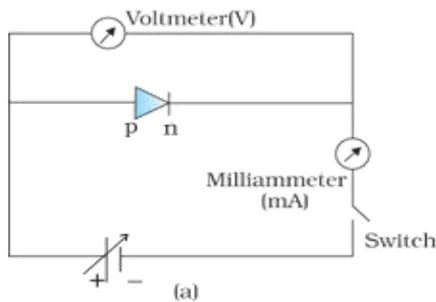
	<p>(a) X-rays                  (b) By using X-ray tubes                  (Alternatively : By bombarding a metal target with high energy electrons)                  (c) Wave length range of X-rays is from about (10 nm to <math>10^{-4}</math> nm)                  (d) Alertness, empathy; concern for her mother, knowledgeable (any two)</p>	<p><math>\frac{1}{2}</math>  <math>\frac{1}{2}</math>                  1                  (1 + 1)</p>	<p>4</p>
<b>SECTION E</b>			
<p><b>24</b></p>	<p>a) Drawing the two graphs <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span>                  b) Drawing the phaser diagram <span style="float: right;">1</span>                  c) i) Naming the devices <span style="float: right;"><math>\frac{1}{2} + \frac{1}{2}</math></span>                  ii) Calculating the current flowing <span style="float: right;">2</span></p> <p>a) The two graphs are as shown</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Capacitive Reactance (Ohm)</p> <p>Frequency (Hz)</p> </div> <div style="text-align: center;">  <p>Inductive Reactance (Ohm)</p> <p>Frequency (Hz)</p> </div> </div> <p>b) (The current leads the voltage by an angle <math>\theta</math> where <math>0 &lt; \theta &lt; \frac{\pi}{2}</math>). The required phaser diagram is as shown.</p> <div style="text-align: center;">  <p>[Here <math>\theta = \tan^{-1} \left[ \frac{1}{\omega CR} \right]</math>]</p> </div>	<p><math>\frac{1}{2} + \frac{1}{2}</math>                  1</p>	
	<p>(C) In device X:                  Current lags behind the voltage by <math>\frac{\pi}{2}</math>  <math>\therefore</math> X is an inductor.</p> <p><u>In device Y:</u>                  Current is in phase with the applied voltage</p>	<p><math>\frac{1}{2}</math></p>	

	<p><math>\therefore X</math> is a resistor.</p> <p>We are given that</p> $0.25 = \frac{220}{X_L}$ <p>or <math>X_L = \frac{220}{0.25} \Omega = 880 \Omega</math></p> <p>Also <math>0.25 = 0.25 = \frac{220}{X_R}</math></p> $\therefore X_R = \frac{220}{0.25} \Omega = 880 \Omega$ <p>For the series combination of X and Y,</p> <p>Equivalent impedance = <math>\sqrt{X_L^2 + X_R^2} = (880\sqrt{2}) \Omega</math></p> <p><math>\therefore</math> Current flowing = <math>\frac{220}{880\sqrt{2}} A = 0.177 A</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>5</p>
	<p style="text-align: center;">OR</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>a) Principal of working – 1  b) Defining efficiency – 1  c) Any two factor – <math>\frac{1}{2} + \frac{1}{2}</math>  d) Calculating the current drawn - 2</p> </div> <p>a) A transformer works on the principle of mutual induction.  (Alternatively – an emf is induced in the secondary coil when the magnetic flux, linked with it changes with time due to a (time) changing magnetic flux linked with the primary coil).</p> <p>b) The efficiency of a transformer equals the ratio of the output power to the input power.  (Alternatively :  Efficiency = <math>\frac{\text{output power}}{\text{input power}}</math>  or Efficiency <math>\frac{V_S I_S}{V_P I_P}</math>)</p> <p>c) i) Eddy current losses  ii) joule heat losses  iii) hysteresis losses  iv) magnetic flux leakage losses  (Any two)</p>	<p>1</p> <p>1</p> <p><math>\frac{1}{2} + \frac{1}{2}</math></p>	

	<p>d) We have</p> $\frac{V_S I_S}{V_P I_P} = 90\% = 0.9$ $\therefore \frac{220 I_S}{22 I_P} = 0.9$ $\text{or } \frac{I_S}{I_P} = \frac{0.9}{0.1} = 9$ $\therefore I_P = \frac{I_S}{9} = \frac{(22/440)}{9} \text{ A}$ $= \frac{1}{180} \text{ A}$ $= 0.0056 \text{ A}$	<p>½</p> <p>½</p> <p>½</p> <p>½</p>	
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<p>25</p>	<table border="1" data-bbox="199 761 1145 963"> <tr> <td>a) Explaining the two processes- Defining the two terms -</td> <td>1 + 1 ½ + ½</td> </tr> <tr> <td>b) Circuit diagram Working</td> <td>- 1 - 1</td> </tr> </table> <p>a) The two important processes are diffusion and drift Due to concentration gradient, the electrons diffuse from the <b>n</b> side to the <b>p</b> side and holes diffuse from the <b>p</b> side to the <b>n</b> side.</p> <div data-bbox="379 1153 957 1400" data-label="Diagram"> <p>The diagram shows a p-n junction with a depletion region in the center. On the left is the p-region and on the right is the n-region. In the depletion region, there are circles with minus signs (acceptor ions) and circles with plus signs (donor ions). Arrows indicate the following processes: Electron diffusion (left-pointing arrow), Electron drift (right-pointing arrow), Hole diffusion (right-pointing arrow), and Hole drift (left-pointing arrow). The depletion region is labeled with a double-headed arrow.</p> </div> <p>Due to the diffusion, an electric field develops across the junction. Due to the field, an electron moves from the p-side to the n-side, a hole moves from the n-side to the p-side. The flow of the charge carriers due to the electric field, is called drift.</p> <p>Depletion region: It is the space charge region on either side of the junction, that gets depleted of free charges, is known as the depletion region.</p> <p>Potential Barrier The potential difference, that gets developed across the junction and opposes the diffusion of charge carries and brings about a condition of equilibrium, is known as the barrier potential.</p>	a) Explaining the two processes- Defining the two terms -	1 + 1 ½ + ½	b) Circuit diagram Working	- 1 - 1	<p>½</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p> <p>½</p>	
a) Explaining the two processes- Defining the two terms -	1 + 1 ½ + ½						
b) Circuit diagram Working	- 1 - 1						

b) The circuit diagram is as shown



Working

In forward bias condition, the direction of the applied voltage is opposite to the barrier potential. This reduces the width of the depletion layer as well as the height of the barrier. A current can, therefore, flow through the circuit. This current increases (non-linearly) with increase in the applied voltage.

1

1

5

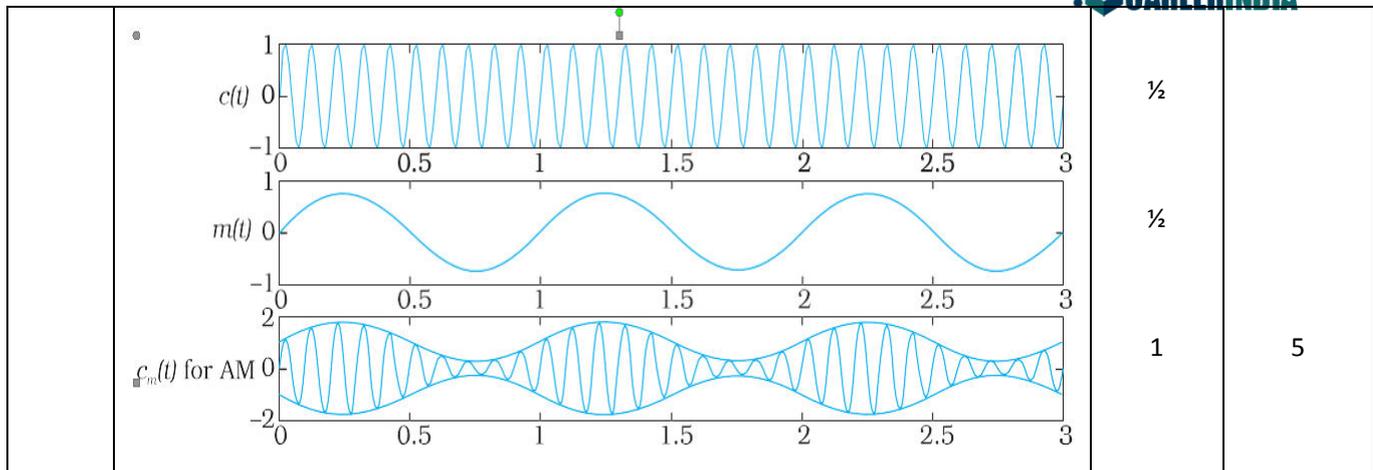
OR

- a) Describing the three factors – 3  
b) Drawing the wave forms – 2

a) It is necessary to modulate the audio frequency signals because of the following three reasons:

- i. Size of the antenna or aerial  
This size needs to be comparable to the wavelength of the signal. It would be unmanageably long for audio frequency signals. ½  
½
- ii. Effective power radiated  
Power radiated, being proportional to  $\left(\frac{f}{\lambda}\right)^2$  would be very small for a audio frequency signal. ½  
½
- iii. Mixing up of different signals  
The audible frequency range is quite small. Hence if transmission is done at audio frequencies, the chances of mixing up of different signals are very high. ½  
½

- b) The required wave forms are as shown
- i. Carrier wave
  - ii. Modulating Signal
  - iii. Amplitude Modulated wave



1/2

1/2

1

5

26

- |   |         |
|---|---------|
| (a) Finding the electrostatic potential                                 | 2 Marks |
| (b) Finding the work done   | 1 Mark  |
| (c) Effect of change of path  | 1 Mark  |
| (d) Potential energy of the system<br>(with justification in each case) | 1 Mark  |

(a) We have, for a point charge,

$$V = \frac{1}{4\pi \epsilon_0} \frac{q}{r}$$

(i) At point (0, 0, z) :

Potential due to the charge (+q),

$$V_+ = \frac{1}{4\pi \epsilon_0} \frac{q}{(z+a)}$$

Potential due to the charge (-q),

$$V_- = \frac{1}{4\pi \epsilon_0} \frac{(-q)}{(z-a)}$$

$$\text{Total potential at } (0, 0, z) = \frac{q}{4\pi \epsilon_0} \left[ \frac{1}{z+a} - \frac{1}{z-a} \right]$$

$$= \frac{-2qa}{4\pi \epsilon_0 (z^2 - a^2)}$$

(ii) At point (x, y, 0)

Potential due to the charge + q

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

1/2

1/2

Potential due to the charge (-q)

$$V_2 = \frac{1}{4\pi\epsilon_0} \frac{-q}{\sqrt{x^2 + y^2 + a^2}}$$

½

Total potential at (x, y, 0)

$$= \frac{q}{4\pi\epsilon_0} \left( \frac{1}{\sqrt{x^2 + y^2 + a^2}} - \frac{1}{\sqrt{x^2 + y^2 + a^2}} \right) = 0$$

½

Give full credit of part (ii) if a student writes that the point (x,y,0) is equidistant from charges +q and -q, Hence total potential due to them at the given point will be zero.

$$(b) \text{ Work done} = q [V_1 - V_2]$$

$$V_1 = 0 \text{ and } V_2 = 0$$

½

$$\therefore \text{ work done} = 0$$

½

Where  $V_1$  and  $V_2$  are the total potential due to dipole at point (5,0,0) and (-7,0,0)

(c) There would be no change

½

This is because the electrostatic field is a conservative field.

½

**( Alternatively :** The work done, in moving a test charge between two given points is independent of the path taken)

(d) The two given charges make an electric dipole of dipole moment  $\vec{p} = q \cdot 2\vec{a}$

½

P.E. in position of unstable equilibrium (where  $\vec{p}$  and  $\vec{E}$  are antiparallel to each other)

½

$$= + pE = 2 aq E$$

OR

(a) Finding the total energy before the capacitors are connected 1 Mark

(b) Finding the total energy in the parallel combination 3 Marks

(c) Reason for difference 1 Mark

(a) We have

$$\text{Energy Stored in a capacitor} = \frac{1}{2} CV^2$$

½

$$\therefore \text{ Energy stored in the charged capacitors } E_1 = \frac{1}{2} C_1 V_1^2 \text{ And } E_2 = \frac{1}{2} C_2 V_2^2$$

<p>∴ Total energy stored = <math>\frac{1}{2}C_1V_1^2 + C_2V_2^2</math></p> <p>(b) Let V be the potential difference across the parallel combination.</p> <p>Equivalent capacitance = <math>(C_1 + C_2)</math></p> <p>Since charge is a conserved quantity, we have</p> <p><math>(C_1 + C_2)V = C_1V_1 + C_2V_2</math></p> $V = \left[ \frac{C_1V_1 + C_2V_2}{(C_1 + C_2)} \right]$ <p>∴ Total energy stored in the parallel combination</p> $= \frac{1}{2}(C_1 + C_2)V^2$ $= \frac{1}{2} \frac{(C_1V_1 + C_2V_2)^2}{(C_1 + C_2)}$ <p><b>(c)</b> The total energy of the parallel combination is different (less) from the total energy before the capacitors are connected. This is because some energy gets used up due to the movement of charges during sharing of charge.</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p>1</p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p>1</p>	<p>5</p>
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