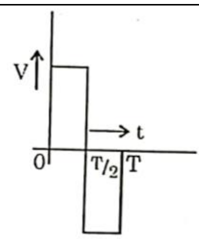
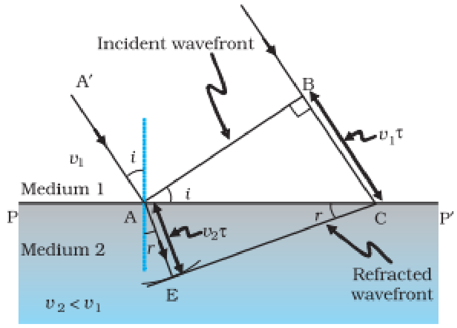
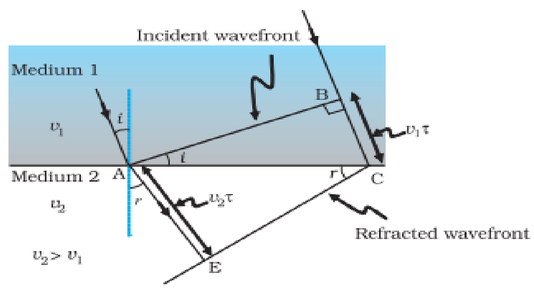
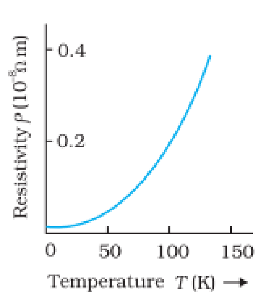
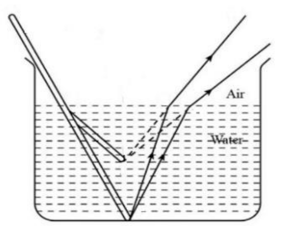
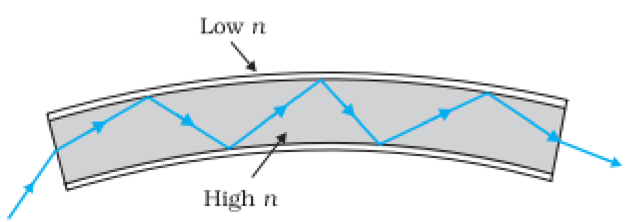
SOLUTIONS: PHYSICS(042)			
Code: 55/2/2			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(D) Zero	1	1
2.	(A) 1.05	1	1
3.	(C) 	1	1
4.	(D) repelled by north pole as well as by south pole	1	1
5.	(A) $\frac{n_1}{n_2}$	1	1
6.	(C) $\frac{5.0}{\sqrt{2}}$ x $10^{-10}\hat{k}$ T	1	1
7.	(C) 0.63 V	1	1
8.	(C) Lyman series	1	1
9.	(D) f	1	1
10.	(A) conservative and field lines do not form closed loops.	1	1
11.	(A) resistor / (C) capacitor	1	1
12.	(D) 5	1	1
13.	(C) If Assertion (A) is true but Reason (R) is false.	1	1
14.	(B) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).	1	1
15.	(C) If Assertion (A) is true but Reason (R) is false.	1	1
16.	(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).	1	1
	SECTION B		
17.	Finding the value of V 2 $V - V_o = IR$ $V - 0.7 = (15 \times 10^{-3}) \times 1000$ V = 15.7 volt	½ 1 ½	2

18.	Diagram showing refraction of light using Huygen's Principle 1 Proving Snell's Law 1  **<u>Alternatively</u>: -**  Consider the triangles ABC and AEC, $\text{Sin } i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$................(i) $\text{Sin } r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$..............(ii) Divide eq. (i) & (ii): - $\frac{\text{Sin } i}{\text{Sin } r} = \frac{v_1}{v_2}$........................(iii) Refractive index of medium 1, $n_1 = \frac{c}{v_1}$................................(iv) Refractive index of medium 2, $n_2 = \frac{c}{v_2}$................................(v) From eq. (iii); (iv) & (v): - $\frac{n_2}{n_1} = \frac{\text{Sin } i}{\text{Sin } r}$	1 1	2

19.	Finding nature and position of the final image. ½+1½ For the first lens: - $\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1}$ $\frac{1}{v_1} + \frac{1}{30} = \frac{1}{10}$ $v_1 = 15$ cm For the second lens: - $u_2 = -20 - (-15) = -5$ cm $\frac{1}{v_2} - \left(-\frac{1}{5}\right) = \frac{1}{10}$ On solving: - $v_2 = -10$ cm Image is virtual.	½ ½ ½ ½	2

20.	Finding the ratio of maximum speed of electrons emitted in the two cases. 2		
	$h\nu = \phi_o + K_{max}$	½	
	For radiation having photons of energy 2.5 eV		
	$2.5\text{ eV} = 2\text{ eV} + \frac{1}{2}mv_1^2$		
	$0.5\text{ eV} = \frac{1}{2}mv_1^2$............(i)	½	
	For radiation having photons of energy 4.5 eV		
	$4.5\text{ eV} = 2\text{ eV} + \frac{1}{2}mv_2^2$		
	$2.5\text{ eV} = \frac{1}{2}mv_2^2$...........(ii)	½	
	Dividing eq. (i) by (ii): -		
	$\frac{v_1}{v_2} = \sqrt{\frac{1}{5}}$	½	
	OR		
	$\frac{v_2}{v_1} = \sqrt{5}$		2
21.	(a)		
	Finding current 2		
	$R_1 = \frac{\rho l_1}{A}$; $R_2 = \frac{\rho l_2}{A}$	½	
	$\frac{l_1}{l_2} = \frac{2}{3}$ => $\frac{R_1}{R_2} = \frac{2}{3}$		
	$I \ \alpha \ \frac{1}{R}$		
	=> $\frac{I_1}{I_2} = \frac{3}{2}$	½	
	=> $I_1 = \frac{3}{5}$ x 15 = 9A	½	
	=> $I_2 = \frac{2}{5}$ x 15 = 6A	½	
	OR		

	(b) Finding the potential difference (i) between P and Q 1 (ii) across capacitor C 1 In steady state, $2V - V = i(2R+R)$ $i = \frac{V}{3R}$ (i) $V_P - V_Q = -V - iR$ $= -V - \frac{V}{3}$ $V_P - V_Q = -\frac{4V}{3}$ (ii) $V_P - V_Q = -V + V_R$ $-\frac{4V}{3} = -V + V_C$ $V_C = -\frac{V}{3}$	 1 1	 2
	SECTION C		
22.	(a) Defining resistivity 1 Discussing its dependence on temperature ½ Plotting graph of resistivity with temperature for copper ½ (b) (i) Justification ½ (ii) Justification ½ (a) Resistivity is the resistance of a material of unit length having unit area of cross-section. On increasing the temperature of a conductor, the resistivity increases.  **Note**: Full credit to be given if values are not shown on the graph.	 1 ½ ½	

	(b) (i) A low internal resistance allows large current to be drawn even at a low voltage. (ii) To limit the current.	½ ½	 3
23.	(a) Effect on the width of the beam 1 (b) Ray diagram 1 (c) Diagram showing transmission 1 (a) Width of the parallel beam of light increases in water. **Alternatively**: - If a student explains using diagram, full credit to be given. (b) Due to refraction of light, the image of the portion immersed in water appears to be raised.  (c) 	1 1 1	 3
24.	Differentiating between peak value & root mean square value of AC. 1 Deriving expression for rms value of AC 2 Peak value is the maximum value of the alternating current. rms current is the equivalent dc current that would produce the same average power loss as the alternating current.	 ½ ½	

Alternatively: -

$I_{rms} = \frac{I_O}{\sqrt{2}}$

Alternatively: -

$I_{rms} = 0.707\ I_o$

The instantaneous power dissipated in the resistor is $P = i^2R = i_m^2 R \sin^2 \omega t$ ½

The average power over a cycle is: -

$\overline{P} = \langle i^2R \rangle = \langle i_m^2 R \sin^2 \omega t \rangle$ ½

$\langle \sin^2 \omega t \rangle = \frac{1}{2}$

$\overline{P} = \frac{1}{2} i_m^2 R \quad = I_{rms}^2 R$ ½

$I_{rms} = \sqrt{\frac{i_m^2}{2}} = \frac{i_m}{\sqrt{2}}$ ½

Alternatively: -

$i = i_o \sin \omega t$

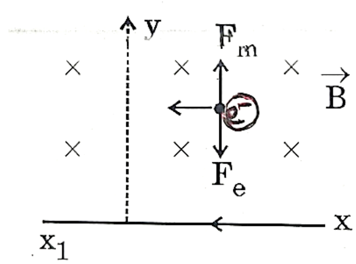
$I_{rms}^2 = \frac{1}{T}\int_0^T i_o^2 \sin^2 \omega t\, dt$ ½

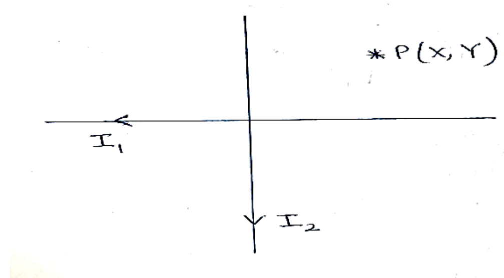
$= \frac{i_o^2}{T}\int_0^T \left(\frac{1-\cos 2\omega t}{2}\right)dt$ ½

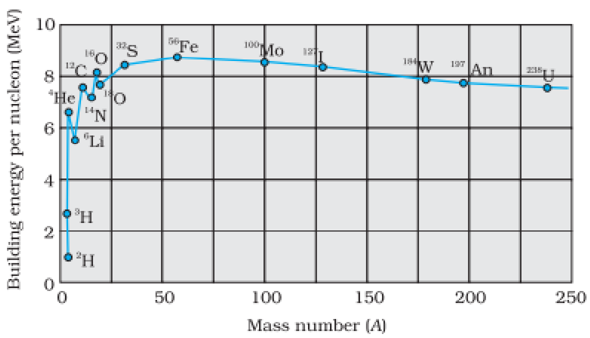
$I_{rms}^2 = \frac{i_o^2}{2T}(T-0) \qquad \left[\text{As} \int_o^T \frac{\cos 2\omega t}{2} dt = 0\right]$ ½

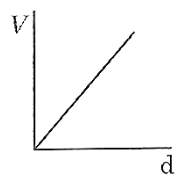
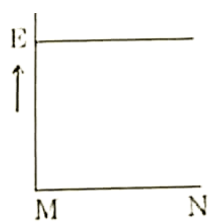
$I_{rms} = \frac{i_o}{\sqrt{2}}$ ½

3

25.	(a) Production of em wave 1 (b) Direction of magnetic field 1 (c) Estimating the ratio 1		
	(a) Electromagnetic waves are produced by accelerating / oscillating charges.	1	
	(b) South direction	1	
	(c) $\frac{\text{Shortest wavelength of radio waves}}{\text{Longest wavelength of gamma waves}} = \frac{0.1}{10^{-12}} = 10^{11}$	1	3
26.	(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_o 1		
	(i) 	1	
	(ii) Electric force	½	
	Magnetic force	½	
	<u>Alternatively</u>: -		
	$F_E = eE$		
	$F_B = evB$		
	(iii) $ev_oB = eE$	½	
	$v_o \times \left[\frac{\mu_o I}{2\pi d}\right] = E$		
	$v_o = \frac{(2\pi d)E}{\mu_o I}$	½	
	OR		

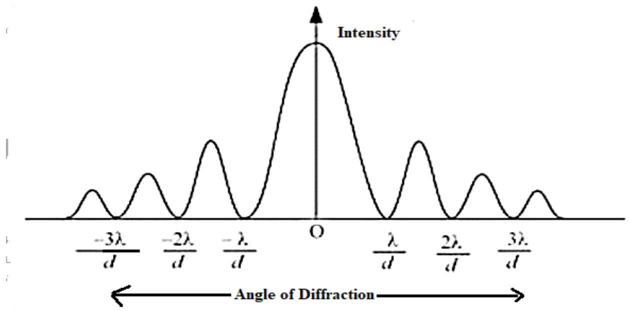
	(b) Finding the magnitude and direction of the net magnetic field 2+1  Magnetic field due to conductor carrying current I_1 $(\vec{B}_1) = \frac{\mu_0 I_1}{2\pi Y}(-\hat{k})$ Magnetic field due to conductor Carrying current I_2 $(\vec{B}_2) = \frac{\mu_0 I_2}{2\pi X}(\hat{k})$ $\vec{B}_P = \vec{B}_1 + \vec{B}_2$ $\vec{B}_P = \frac{\mu_0}{2\pi}\left[\frac{I_2}{X} - \frac{I_1}{Y}\right]\hat{k}$ Direction will be along the Z-axis.	½ ½ 1 1	3
27.	(a) Defining majority and minority charge carries in an extrinsic semiconductor ½+½ (b) Describing movement of the charge carriers when pn-junction diode is forward biased 1 (c) Estimating Dynamic resistance 1 (a) In an extrinsic semiconductor, the charge carriers whose number density is large are known as majority charge carriers. In an extrinsic semiconductor, the charge carriers whose number density is small are known as minority charge carriers. (b) Due to the applied forward voltage, electrons from n-side cross the depletion region and reach p-side. Similarly, holes from p-side cross the junction and reach the n-side. Due to the movement of these charge carriers current is produced.	½+½ 1	

	(c) At V = -0.6 volt, I = 0, so dynamic resistance is infinite.	1	3
28**.**	(a) Showing variation of binding energy per nucleon with mass number 1 Significance of binding curve ½ (b) (i) Stating the type of reaction ½ (ii) To state whether total mass of nuclei increases, decreases or remains unchanged ½ (iii) Stating whether process requires energy or produces energy ½ (a)  **Note**: - Full credit to be given even if the values are not shown. Significance of the binding energy curve – (Any one) - 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. (b) (i) Nuclear fusion (ii) Decreases (iii) Energy is produced	1 ½ ½ ½ ½	3
	SECTION D		
29.	(i) (B) are parallel to each other. (ii) (C) me (iii) Full 1 mark to be awarded to all the students who have attempted this part of the question.	1 1 1	

	OR (B) $\frac{1}{2}, \frac{1}{2}$ (iv) (D) 13.3 μm	1	4
30.	(i) (C) $\frac{E}{4}$ (ii) (D)  (iii) (C)  (iv) (A) $(\vec{E}_1+\vec{E}_2).\vec{d}$ OR (C) CK	1 1 1 1	4
	SECTION E		
31.	(a) (i) Calculating magnification 2½ (ii) Showing emergent ray is normal 1½ Finding refractive index 1 (i) As the pencil lies between f and 2f such that one end of the pencil coincides with 2f. Position of the other end (u) = $-\left(2f - \frac{f}{4}\right) = -\frac{7f}{4}$	½	

	Magnification (m) = $\frac{f}{f-u}$ $= \frac{-f}{-f-\left(-\frac{7f}{4}\right)}$ $m = -\frac{4}{3}$ **Alternatively: -** As the pencil lies between f and 2f such that one end of the pencil coincides with 2f. Position of the other end (u) = $-\left(2f-\frac{f}{4}\right) = -\frac{7f}{4}$ $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ $\frac{1}{v}-\frac{4}{7f}=-\frac{1}{f}$ $\frac{1}{v}=-\frac{1}{f}+\frac{4}{7f}$ $v=-\frac{7f}{3}$ $m=-\frac{v}{u}=-\frac{4}{3}$ (ii) For prism; $i+e=A+\delta$ $45^o+e=30^o+15^o$ $\therefore e=0^o$ Hence, $r_2 = 0^o$ $\therefore$ Emergent ray is perpendicular to face AC. **Alternatively**: - If the same is shown using diagram full credit to be given. $r_1 + r_2 = A$ As $r_2 = 0$, hence $r_1 = 30^o$	½ ½ 1 ½ ½ ½ 1 ½ ½ ½ ½	

	Refractive index(n) = $\frac{\sin i}{\sin r}$ $= \frac{\sin 45^o}{\sin 30^o}$ $n = \sqrt{2}$	½	
	OR (b) (i) (1) Calculating distance of the third bright fringe from central maximum — 1 (2) Finding the least distance — 1 (i) (1) Distance of the nth bright fringe from the central maximum(x_n) = $\frac{n\lambda D}{d}$	½	
	For n = 3 $x_3 = \frac{3x600x10^{-9}x1}{1x10^{-9}}$ =1800m	½	
	(2) $n_1\lambda_1 = n_2\lambda_2$ $n_1 x\ 600 = n_2\ x\ 480$ $\frac{n_1}{n_2} = \frac{480}{600}$ $\frac{n_1}{n_2} = \frac{4}{5}$	½	
	Position of the 4th bright fringe of 600 nm = 4 x 600 = 2400 m	½	
	Alternatively: - Position of the 5th bright fringe of 480 nm = 5 x 480 = 2400 m **Alternatively**: - $(n-1)\lambda_1 = n\lambda_2$ (n-1) x 600 = n x 450 on solving n = 4	½	

	Position of the 4^{th} bright fringe of 600 nm = 4 x 600 = 2400 m Position of the 5^{th} bright fringe of 480 nm = 5 x 480 = 2400 m	½	
	(ii) (1)  	1	
	Angle of diffraction for zero intensity, $\theta = \frac{n\lambda}{a}$; n = 0, 1, 2, ………..	1	
	(2) Diffraction of the light waves is not generally seen as compared to diffraction of sound waves as light waves have low wavelength.	1	5
32.	(a) (i) Calculating final potential - on sphere A 1 - on shell B 1 (ii) Two characteristics of of equipotential surface ½+½ Finding potential at (4m,3m) 2		
	(i) Potential on sphere A = V = $\frac{Q}{4\pi\varepsilon_o r}$ Charge on sphere A = $4\pi\varepsilon_0 r V$	½	
	The charge is transferred to shell B. Potential on shell B = $\frac{1}{4\pi\varepsilon_0} x \frac{4\pi\varepsilon_0 rV}{R}$ Potential on shell B = $\frac{rV}{R}$	½	
	Potential on sphere A = Potential on shell B	1	

(ii) Characteristics of equipotential surfaces: -
(Any two)
- Potential at all points on the surface is same.
- Equipotential surface is normal to the direction of the electric field. ½+½
- The work done in moving a charge on an equipotential surface is zero.

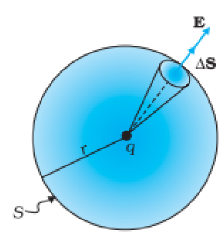
$V_0 - V = E\,d = 50 \times 4$ ½
$V_0 - V = 200$ V ½
$V = 220$ V – 200 V ½
$V = 20$ V ½

OR

(b)

(i) Difference between an open surface and a closed surface	½
Diagram of elementary surface vector $\vec{ds}$	1
(ii) Definition of electric flux	1
Significance of Gaussian Surface	½
Reason	½
(iii) Finding charge Q	1½

(i) Open Surface – A surface which does not enclose a volume. ½
Closed Surface – A surface which does enclose a volume.



1

(ii) Electric flux is defined as the number of electric field lines crossing an area normally. 1

Alternatively-

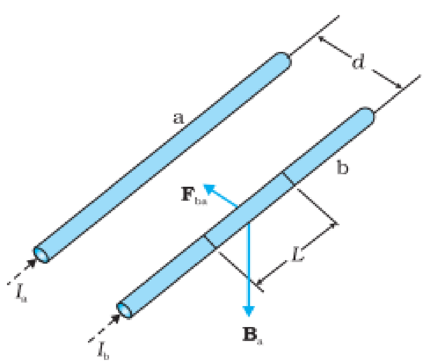
$\phi = \vec{E}.\vec{A}$

Alternatively-

$\phi = EA\cos\theta$

Significance of Gaussian Surface: -

It helps in finding the electric field in a simpler way. ½

	<u>Reason: -</u>		
	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.	½	
	(iii) Total charge enclosed by S_1 = (-3-2+9) μC = 4 μC	½	
	Total charge enclosed by S_2= Q + 4 μC		
	$\phi_{s_2} = 4\phi_{s_1}$	½	
	$\frac{Q + 4\mu C}{\varepsilon_O} = 4\left(\frac{4\mu C}{\varepsilon_O}\right)$		
	Q = 12 μC	½	5
33.	(a)		
	(i) Source of force — ½		
	Obtaining expression for force — 1½		
	Definition of 'ampere' — 1		
	(ii) Finding work done by the magnetic force — 1		
	(iii) Necessary conditions — 1		
	<u>Reason</u> –		
	(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.	½	
			
	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,		
	$B_a = \frac{\mu_0 I_a}{2\pi d}$	½	
	The force F_{ba}, is the force on a segment L of 'b' due to 'a'.		

	$F_{ba} = I_b L B_a$ $= \frac{\mu_0 I_a I_b}{2\pi d} L$	1	
	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 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.	1	
	(ii) Work done by the magnetic force on the charge is zero as force is perpendicular to $\vec{v}$.	1	
	(iii) The velocity ($\vec{v}$) is at an arbitrary angle θ w.r.t the magnetic field ($\vec{B}$).	1	
	OR (b)		
	(i) Explanation — 1 (ii) Obtaining relation for $\vec{M}$, and direction of $\vec{M}$. — 1+1 (iii) Net force on coil — 1 Obtaining orientation — ½ Showing flux is maximum — ½		
	(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.	1	
	(ii) Magnetic moment (M) α Current (I) α Area (A) $\therefore \vec{M} = I\vec{A}$ Direction is same as the area vector.	1 1	
	<u>Alternatively</u>: - Magnetic moment is perpendicular to the plane of the coil.		
	(iii) Net force acting on the coil is zero. The potential energy (U_B) of a current carrying loop in an external magnetic field $= -\vec{M}.\vec{B}$	1	
	For the coil to be in stable equilibrium U_B should be minimum so $\theta = 0^o$.	½	
	Therefore, magnetic flux (ϕ) due to the total field $= (B_{coil} + B_{ext})A$, which is its maximum value.	½	

	<u>Alternatively</u>: - 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.		5