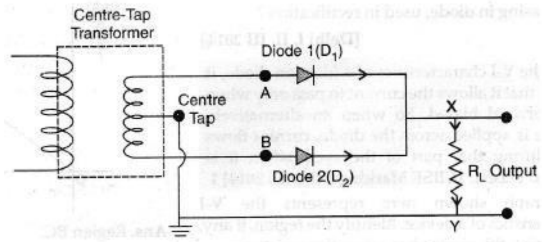
Q.NO	SECTION A	Marks
1	(a) In second case, charges will be −2 μC and +3 μC Since F a Q_1Q_2 i.e. $\frac{F}{F'} = \frac{Q_1Q_2}{Q_1'Q_2'}$ F’=10N (Attractive)	1
2	(a) $P_{net} = \sqrt{P_1^2 + P_2^2 + 2P_1P_2\cos 60}$	1
3	(c) $i_A = 2A, r_A = 2cm, \theta_A = 2\pi - \frac{\pi}{2} = \frac{3\pi}{2}$ $I_B = 3A, r_B = 4cm, \theta_B = 2\pi - \frac{\pi}{3} = \frac{5\pi}{3}$ $B = \frac{\mu_0 I\theta}{4\pi R}$ $\frac{B_A}{B_B} = \frac{I_A}{I_B} \times \frac{\theta_A R_B}{\theta_B R_A} = \frac{6}{5}$	1
4	(b) Explanation : The net magnetic force on a current currying closed loop is zero. Here, $\vec{F}_{BC} = \vec{F}$ $\because \vec{F}_{AB} = 0$ $\therefore \vec{F}_{AB} + \vec{F}_{BC} + \vec{F}_{AC} = 0$ $\Rightarrow \vec{F}_{AC} = -\vec{F}_{BC} \quad (\because \vec{F}_{AB} = 0)$	1
5	(c) Dipole moment of circular loop is m . $m_1 = I.A = I.\pi R^2 \{R = radius\ of\ the\ loop\}$ $B_1 = \frac{\mu_0 I}{2R}$ moment becomes double ⇒ R becomes √2R (keeping current constant) $m_2 = I.\pi(\sqrt{2}R)^2 = 2.I\pi R^2 = 2m_1$ $B_2 = \frac{\mu_0 I}{2(\sqrt{2}R)} = \frac{B_1}{\sqrt{2}}$ $\frac{B_1}{B_2} = \sqrt{2}$	1

6	(a) For a solenoid of n turns per unit length carrying current I, H=nI. $\therefore M = (\mu_r - 1)nI$ $M = (1000 - 1) \times 1000 \times 0.5$ $M = 5 \times 10^5 \, Am^{-1}$ As magnetic moment, $m = M \times V$ $\therefore m = 5 \times 10^5 \times 10^{-3} = 500 Am^2$	1
7	(c) Given $n = 2\times10^4$; I = 4 A Initially, the magnetic field at the centre of the solenoid is given as $B_i = \mu_o nI = 4\pi\times10^{-7}\times2\times10^4\times4 = 32\pi \times 10^{-3}$ T Initial magnetic flux through the coil is given as $\phi_i = NBA \quad = 100\times32\pi\times10^{-3}\times\pi\times (0.01)^2 = 32\pi^2\times10^{-5} Tm^2$ Finally I = 0 A $\therefore B_f = 0$ or $\phi_f = 0$ Induced charge, $q = \lvert\Delta\phi\rvert/R = \lvert\phi_f - \phi_i\rvert / R = 32\pi^2\times10^{-5}/10\pi^2 = 32\times10^{-6} C = 32\mu C$	1
8	(d) The phase difference ϕ between current and voltage is given by $\tan\phi = \frac{X_C - X_L}{R}$ Or $\frac{X_C - X_L}{R} = \tan 45^\circ = 1$ Or $X_C = X_L + R$ Or $\frac{1}{2\pi fC} = 2\pi fL + R$ Or $C = \frac{1}{2\pi f(2\pi fL + R)}$	1
9	(a)	1

10	(b) $\frac{hc}{\lambda_1} - \phi = K_1$ $\frac{hc}{\lambda_2} - \phi = K_2$ $\lambda_1 = 3\lambda_2$ $3K_1 = \frac{3hc}{\lambda_1} - 3\phi$ $3K_1 = \frac{hc}{\lambda_2} - 3\phi$ $3K_1 = K_2 - 2\phi$ $3K_1 < K_2$ $K_1 < \frac{K_2}{3}$	1
11	(b) T α n^3 and R α n^2 Hence, $T \alpha R^{3/2}$ $\frac{T_1}{T_2} = (\frac{r}{4r})^{3/2} = \frac{1}{8}$	1
12	(b) $\frac{1}{} = R\,(\frac{1}{2^2} - \frac{1}{\infty^2}) = \frac{R}{4} \Rightarrow \lambda = \frac{4}{R}$	1
13	(a)	1
14	(c)	1
15	(c)	1
16	(c)	1
17	a) Temperature coefficient definition b) Formula used to find the temperature coefficient of resistance is $\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$ substituting the values t = 5020	1 1
18	For total internal reflection at the vertical face, i = i_c (if μ is minimum) Let r be angle of refraction of ray into the prism Clearly, r + i_c = 90 ° r= 90 ° - i_c $\mu = \frac{\sin i}{\sin r} = \frac{\sin 45^0}{\sin(90 - i_C)} = \frac{1}{\sqrt{2}\cos i_C}$ Also, $\mu = \frac{1}{\sin i_C}$ => $\sin i_c = \sqrt{2}\cos i_C$ Or, $\tan i_c = \sqrt{2}$	 1 ½

	Hence $\sin i_c = \sqrt{\frac{2}{3}}$ $\mu = \frac{1}{\sin i_c} = \sqrt{\frac{3}{2}}$	½
19	Let phase difference be ϕ $I = 4I_0\cos^2(\phi/2) = 4I_0/2 = 2I_0$ $\Rightarrow \phi = \pi/2$ Path difference $= \phi\lambda/2\pi = \lambda/4$ $\Rightarrow y = \lambda D/4d$ **OR** For λ_1, $\delta_m = A$, $n_1 = \sqrt{3}$ For λ_2, $\delta_m = 30°$, $n_2 = ?$ Hence, $n_1 = \sqrt{3} = \frac{\sin(\frac{A+A}{2})}{\sin(\frac{A}{2})} = \frac{\sin A}{\sin A/2} = \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}} = 2\cos A/2$ $\frac{\sqrt{3}}{2} = \cos\frac{A}{2} \Rightarrow A = 60^0$ $n_2 = \frac{\sin(\frac{60+30}{2})}{\sin 30} = \frac{\sin 45}{\sin 30} = \sqrt{2}$	½ ½ ½ ½ 1 1
20	*(i)* $\frac{\text{Energy of photon}}{\text{K.E. of electron}} = \frac{2m\lambda c}{h}$ $= \frac{2 \times 9.11 \times 10^{-31} \times 10^{-9} \times 3 \times 10^{8}}{6.6 \times 10^{-34}}$ $= \frac{9110}{11} = 9110:11$ (ii) Any two features that cannot be explained by wave theory of light	1 1
21	 Explanation	1 1

22	Equivalent capacitance = (200/3)pF Voltage across C_1 = 100V Voltage across C_2=50V Charge across C_1 = Charge across C_2 = 10^{-8} C	1 ½ ½ 1
23	The three cells are in parallel and hence effective emf = 40/3 V There will be no current in the branch having capacitor after complete charging Hence the charge on the capacitor q=CV= 200/3 μC	2 1
24	(a) (i) Diagram Derivation of expression of radius (ii) $r = \frac{\sqrt{2mE}}{Bq}$ E = same $r \propto \frac{\sqrt{m}}{q}$ $\therefore r_e < r_p = r_{He}$ **OR** (b) (i) By connecting high resistance in series Derivation of R Effective resistance (ii) $I_s = \frac{\theta}{I}, V_s = \frac{I_s}{R}$ $I'_s = I_s + \frac{50}{100} I_s = \frac{3}{2} I_s$ $V'_s = \frac{I'_s}{2R} = \frac{\frac{3}{2} I_s}{2R} = \frac{3}{4} V_s$ $V'_s = 0.75\% V_s$ So, V_s decreases by 25%.	1 1 ½ ½ ½ ½ ½ ½ ½ ½
25	Diagram Derivation $M_{12} = M_{21}$	1 1 1

26	(i) $\lambda_1 \rightarrow$ IR, $\lambda_2 \rightarrow$ radiowaves $\lambda_3 \rightarrow$ X – rays $\lambda_2 > \lambda_1 > \lambda_3$ (ii) Figure	1½ ½ 1
27	(a) Statement of Bohr's postulate of quantisation of angular momentum Justification using de Broglie hypothesis for third excited state, n=4 Now, the total number of possible spectral lines is given by the formula, N=n(n−1)/2 On putting n=4 ⇒N=4(4−1)/2 Hence, we get N=6	½ 1½ 1
28	(a) Density of nucleus is independent of A (b) R = RoA$^{1/3}$ where Ro is a constant $\therefore \quad \frac{R_{Al}}{R_{Cu}} = \frac{(27)^{1/3}}{(64)^{1/3}} = \frac{3}{4}$ or $\quad R_{Cu} = \frac{4}{3} \times R_{Al}$ $= \frac{4}{3} \times 3.6$ fermi $= 4.8$ fermi	2 1
29	(i)(b) Eyepiece acts as a simple microscope. It forms a virtual and erect final image. f_e =6.25 cm, v_e= -25 cm using $\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$ we get, $u_e = -5cm$ (ii)(b) $L = v_0 + \|u_e\| \Rightarrow v_0 = L - \|u_e\|$ $\Rightarrow v_0 = 15 - 5 = 10\ cm$ f_0 = 2 cm $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$	1

<table>
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<td>Substituting, we get $u_o = -2.5\ cm$

(iii)(a)$M = \frac{v_0}{u_0}(1 + \frac{D}{f_e}) = \frac{10}{2\cdot5}(1 + \frac{25}{6\cdot25}) = 20$

(iv) (a)

OR

(d)</td>
<td>1

1

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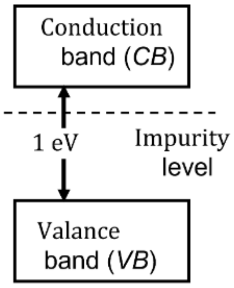
<td>i) (c) Doping increases the resistivity of semiconductor

OR

Which of the following energy band diagram shows the n type semiconductor?

(d)



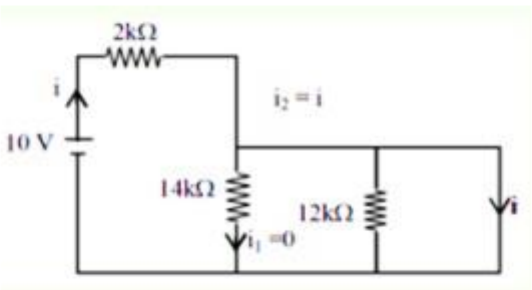
ii) (b) $E_{min} = \frac{hC}{max}$

λ_{max}= 589 nm

iii) (a) Width of the depletion region,

d=V/E = 0.4/10^6 = 4x10^{-7} m

iv) (c) The equivalent circuit is



After observing this circuit we get that,

i=10/2=5 mA=i_2

i_1=0 mA</td>
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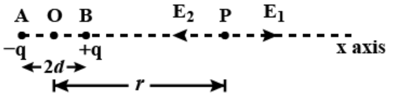
a) (i)



Electric field at a Point on the axial line

The electric field at the point P due to +q placed at B is,

$$E_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r-d)^2}\ \text{(along BP)}$$

The electric field at the point P due to −q placed at A is,

$$E_2 = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r+d)^2}\ \text{(along PA)}$$

1

Therefore, the magnitude of resultant electric field (E) acts in the direction of the vector with a greater, magnitude. The resultant electric field at P is

$E=E_1+(-E_2)$

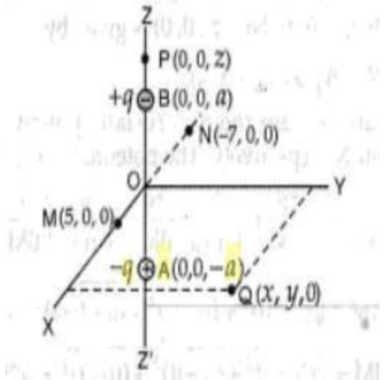
$$E = \frac{q}{4\pi\varepsilon_0}\left[\frac{4rd}{(r^2-d^2)^2}\right]\ \text{along BP}$$

If the point P is far away from the dipole, then d≪r

$$E = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}\ \text{along BP}$$

1

(ii) Two point charges q and - q are located at point (0,0,-a) and (0, 0, a).



(1) The electrostatic potential at (0 , 0 , z)

$$V = \frac{1}{4\pi\varepsilon_0}\frac{-q}{AP} + \frac{1}{4\pi\varepsilon_0}\frac{+q}{BP} = \frac{p}{4\pi\varepsilon_0(z^2-a^2)}$$ 1

and The electrostatic potential at (x, y , 0)

$$V = \frac{1}{4\pi\varepsilon_0}\cdot\frac{-q}{AQ} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{+q}{BQ}$$

Since, AQ=BQ

We have, electric potential at (x,y,0)=0. 1

(2) Potential at (5 , 0 , 0)

$$V_1 = \frac{-q}{4\pi\varepsilon_0}\frac{1}{\sqrt{(5-0)^2+(-a)^2}} + \frac{q}{4\pi\varepsilon_0}\frac{1}{\sqrt{(5-0)+a^2}} = \frac{-q}{4\pi\varepsilon_0}\sqrt{25+a^2} = 0$$

Potential at point (-7 , 0 ,0)

$$V_2 = \frac{-q}{4\pi\varepsilon_0}\frac{1}{\sqrt{(-7-0)^2+a^2}} + \frac{q}{4\pi\varepsilon_0}\frac{1}{(-7-0)^2+a^2} = \frac{-q}{4\pi\varepsilon_0}\cdot\frac{1}{\sqrt{4a+a^2}} + \frac{q}{4\pi\varepsilon_0}\frac{1}{\sqrt{4a+a^2}} = 0$$ 1

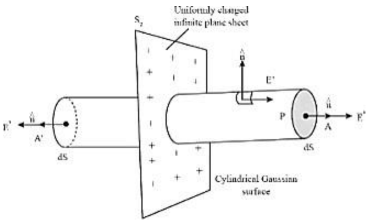
Work done $=$ Change $\times$ Potential $\left(V = \frac{W}{Q}\right)$

Charge $\times (V_2 - V_1)$ Charge $\times\ 0 - 0$

$= 0$ $W = 0$

OR

(b) (i)



1

Let σ be the surface charge density of the sheet. From symmetry, E on either side of the sheet must be perpendicular to the plane of the sheet having same magnitude at all points equidistant from the sheet .

We take a cylinder of cross-sectional area A and length 2 r as the Gaussian surface.

Net flux through the flat surface = EA + E A = 2 EA

The flux through curved surface are zero because E and dA are at right angle ,

∴ Total electric flux over the entire surface of cylinder

$\phi_E = 2EA$

Total charge enclosed by the cylinder q = σA

According to Gauss.s law $\phi_E = q/\varepsilon_0$

∴ $2EA = \sigma A/\varepsilon_0$ or $E = \sigma/2\varepsilon_0$ 1

ii) When no electric field is applied, the time period of oscillation is:

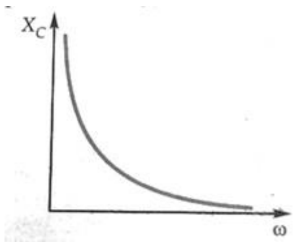
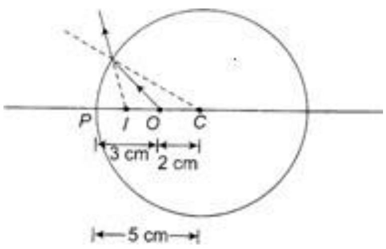
$$T = 2\pi\sqrt{\frac{l}{g}}$$

When electric field is applied, T’ 1

$$= 2\pi\sqrt{\frac{l}{g-a}} \qquad \left[a = \frac{qE}{m} = 2.5\right]$$

solving above two equations T’=2.6 s 1

Therefore time taken for 25 oscillations = 25 T’ = 65 s 1

32	(a) (i) X → capacitor (ii) curve B → voltage curve C → current curve A → power (iii) $X_c = \frac{1}{\omega C}$ $X_c \propto \frac{1}{\omega}$  (iv) Derivation of expression for the current Phase relation **OR** b (i) Diagram Principle Working *(ii)* $I_s = \frac{E_s}{R_s} = \frac{22}{440} = \frac{1}{20} A$ $\eta = \frac{E_S I_S}{E_P I_P}$ $\frac{90}{100} = \frac{22 \times \left(\frac{1}{20}\right)}{220 \times I_P}$ $\Rightarrow I_p = 0.0056A$ (iii) There is no change in magnetic field due to dc	½ 1½ ½ ½ 1½ ½ 1 ½ 1½ ½ ½ ½ ½
33	(a) (i) Ray diagram Derivation of $\frac{n2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ (ii) $\frac{n2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ $where\ n_1 = 1.5, n_2 = 1, u = -3\ cm, R = -5$ Substituting and simplifying, we get v=-2.5 cm  (Award full marks for correct answer without figure) **OR**	1 2 1 ½ ½

	(b) Huygen's principle Diagram…………………NCERT Fig. 10.15………….. Application to diffraction pattern: All the points of incoming wavefront (parallel to plane of slit) are in phase at plane of slit. However, the contribution of the secondary wavelets from different points, at any point on the observation screen have phase differences dependent on the corresponding path differences. Total contribution at any point on screen is sum total of contribution due to all secondary wavelets with proper phase difference. Intensity distribution Explanation for secondary maxima to be weaker in intensity	1 1 1 1 1