

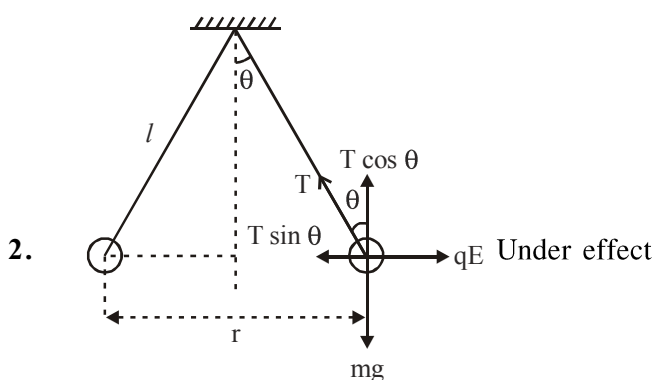
**PHYSICS**

**PART-A**

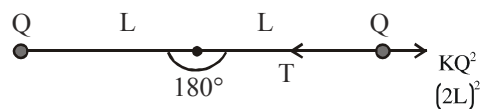
1.  $0.1\% \text{ atoms} = \frac{0.1}{100} \times 4 \times 10^{23} = 4 \times 10^{20}$   
 $= 4 \times 10^{20}$

No of electrons =  $4 \times 10^{20}$

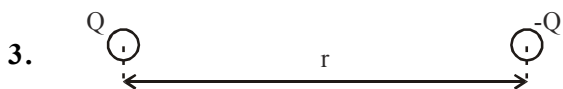
charge =  $ne = 4 \times 10^{20} \times 1.6 \times 10^{-19} = 4 \times 1.6 \times 10^1 = 64C$  (+ve change)



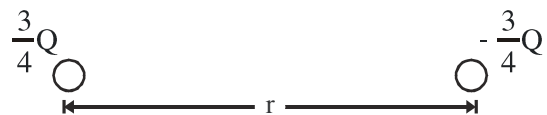
of gravity



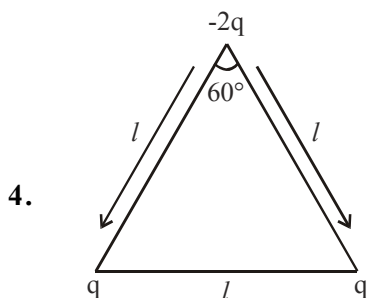
Neglecting effect of gravity



$F = + \frac{KQ^2}{r^2}$  (attracting)



$f' = \frac{KqQ^2}{16 \times r^2}$       $f' = \frac{9}{16} \frac{KQ^2}{r^2} = \frac{9}{16} f$



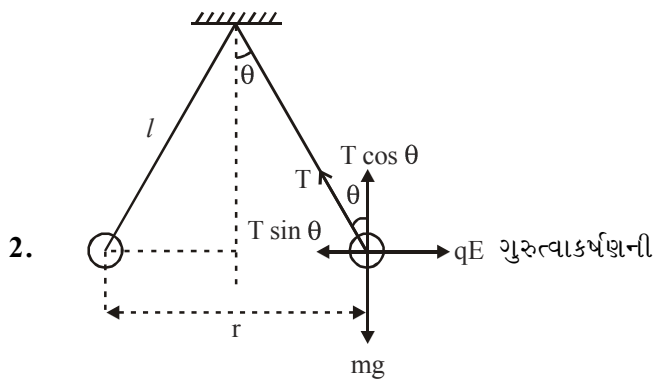
**PHYSICS**

**PART-A**

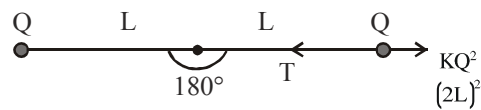
1.  $0.1\% \text{ પરમાણુ} = \frac{0.1}{100} \times 4 \times 10^{23} = 4 \times 10^{20} = 4 \times 10^{20}$

$e^-$  ની સંખ્યા =  $4 \times 10^{20}$

વિ.ભાર =  $ne = 4 \times 10^{20} \times 1.6 \times 10^{-19} = 4 \times 1.6 \times 10^1 = 64C$  (+ve change)



અસર હેઠળ



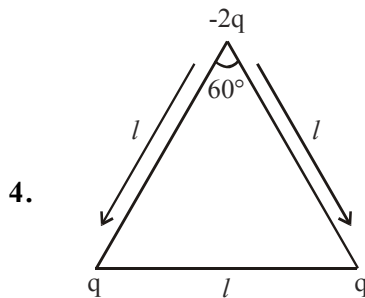
ગુરુત્વાકર્ષણની અસર અવગણતાં

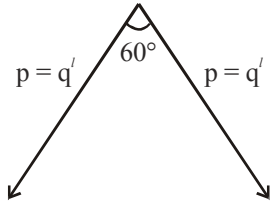


$F = + \frac{KQ^2}{r^2}$  (આકર્ષક)



$f' = \frac{KqQ^2}{16 \times r^2}$       $f' = \frac{9}{16} \frac{KQ^2}{r^2} = \frac{9}{16} f$



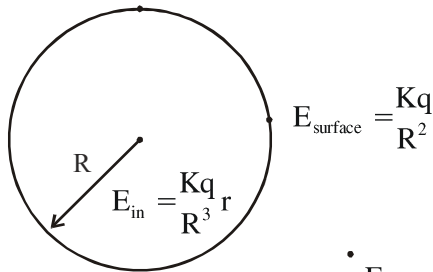


$$P_{\text{net}} = \sqrt{p^2 + p^2 + 2p^2 \frac{1}{2}} = \sqrt{3}P = \sqrt{3}q_l$$

5.  $\lambda = \lambda_0 x^3$  ;  $\frac{dq}{dx} = \lambda_0 x^3$  ;  $\int_0^Q dq = \int_0^L \lambda_0 x^3 dx$  ;

$$Q = \frac{\lambda_0}{4} [x^4]_0^L$$

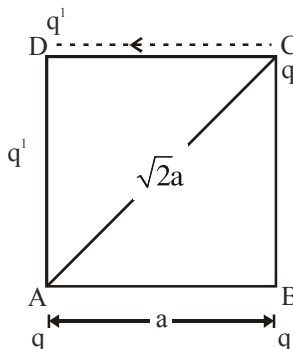
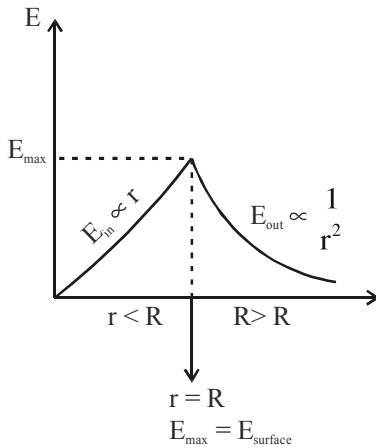
$$Q = \frac{\lambda_0 L^4}{4}$$



6.

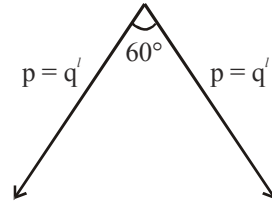
$$E_{\text{out}} = \frac{Kq}{R^2}$$

$$E_{\text{in}} \propto r$$
 ;  $E_{\text{surface}} = \text{max (const)}$  ;  $E_{\text{out}} \propto \frac{1}{r^2}$



7.

$$U_c = \frac{kqq'}{a} + \frac{kqq'}{\sqrt{2}a}$$

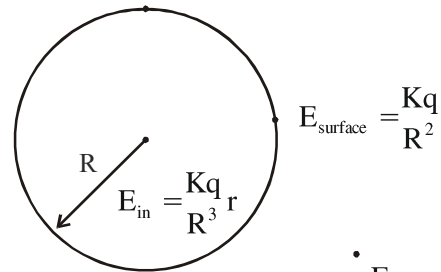


$$P_{\text{net}} = \sqrt{p^2 + p^2 + 2p^2 \frac{1}{2}} = \sqrt{3}P = \sqrt{3}q_l$$

5.  $\lambda = \lambda_0 x^3$  ;  $\frac{dq}{dx} = \lambda_0 x^3$  ;  $\int_0^Q dq = \int_0^L \lambda_0 x^3 dx$  ;

$$Q = \frac{\lambda_0}{4} [x^4]_0^L$$

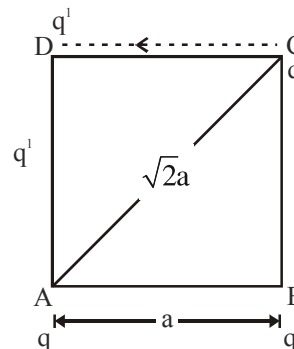
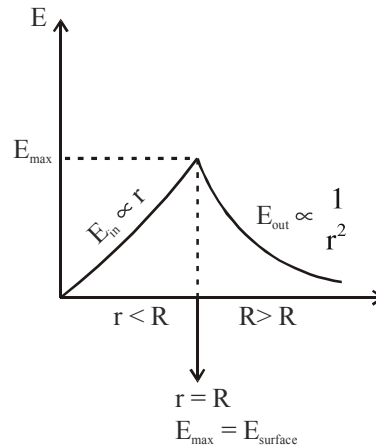
$$Q = \frac{\lambda_0 L^4}{4}$$



6.

$$E_{\text{out}} = \frac{Kq}{R^2}$$

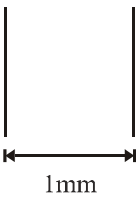
$$E_{\text{in}} \propto r$$
 ;  $E_{\text{surface}} = \text{max (const)}$  ;  $E_{\text{out}} \propto \frac{1}{r^2}$



7.

$$U_c = \frac{kqq'}{a} + \frac{kqq'}{\sqrt{2}a}$$

$$U_D = \frac{kqq'}{a} + \frac{kqq'}{\sqrt{2}a} \quad \Delta U = U_D - U_C = 0$$

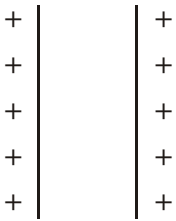
8.   $C = \frac{A\epsilon_0}{d}; \quad 1 = \frac{A \times 8.9 \times 10^{-12}}{10^{-3}};$

$$A = \frac{10^{-3+12}}{8.9} = \frac{10^9}{8.9}; = 0.1123 \times 10^9; A = 1.12 \times$$

$$10^8 \text{ m}^2$$

9.  $\vec{E}$  due one plate on one side =  $\sigma/2\epsilon_0$   
considering two plate, since both  $\vec{E}$  are in one direction

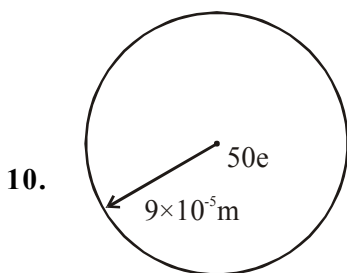
(1)            (2)



$$E_1 \leftarrow$$

$$E_2 \leftarrow P$$

$$E_{\text{net}} = \frac{\sigma}{2\epsilon_0} \times 2; E_{\text{net}} = \frac{\sigma}{\epsilon_0}$$



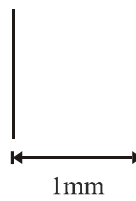
$$V = \frac{kQ}{R} = \frac{9 \times 10^9 \times 50 \times 1.6 \times 10^{-19}}{9 \times 10^{-5}}$$

$$= 80 \times 10^{15+9-19}$$

$$= 80 \times 10^{24-19}$$

$$= 8 \times 10^6$$

$$U_D = \frac{kqq'}{a} + \frac{kqq'}{\sqrt{2}a} \quad \Delta U = U_D - U_C = 0$$

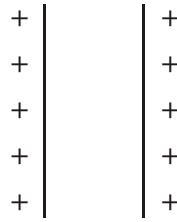
8.   $C = \frac{A\epsilon_0}{d}; \quad 1 = \frac{A \times 8.9 \times 10^{-12}}{10^{-3}};$

$$A = \frac{10^{-3+12}}{8.9} = \frac{10^9}{8.9}; = 0.1123 \times 10^9; A = 1.12 \times$$

$$10^8 \text{ m}^2$$

9.  $\vec{E}$  એક પ્લેટના લીધે એક તરફ વિદ્યુત ક્ષેત્ર =  $\sigma/2\epsilon_0$   
બે પ્લેટ ધ્યાનમાં લો પરંતુ  $\vec{E}$  એક જ દિશામાં છે

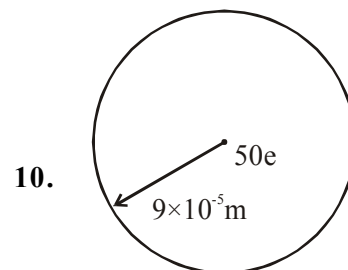
(1)            (2)



$$E_1 \leftarrow$$

$$E_2 \leftarrow P$$

$$E_{\text{net}} = \frac{\sigma}{2\epsilon_0} \times 2; E_{\text{net}} = \frac{\sigma}{\epsilon_0}$$



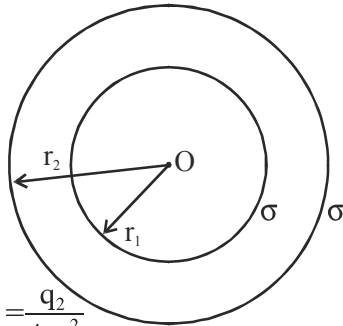
$$V = \frac{kQ}{R} = \frac{9 \times 10^9 \times 50 \times 1.6 \times 10^{-19}}{9 \times 10^{-5}}$$

$$= 80 \times 10^{15+9-19}$$

$$= 80 \times 10^{24-19}$$

$$= 8 \times 10^6$$

11.  $V_0 = \frac{1}{4\pi\epsilon_0} \frac{q_1}{r} + \frac{1}{4\pi\epsilon_0} \frac{q_2}{r_2}$



$$\begin{aligned} \sigma &= \frac{q_1}{4\pi r_1^2} = \frac{q_2}{4\pi r_2^2} \\ &= \frac{1}{4\pi\epsilon_0} \left[ \frac{q_1}{r_1} + \frac{q_2}{r_2} \right] \\ &= \frac{1}{4\pi\epsilon_0} \left[ \frac{\sigma 4\pi r_1^2}{r_1} + \frac{\sigma 4\pi r_2^2}{r_2} \right] \\ &= \frac{1}{4\pi\epsilon_0} + \sigma 4\pi [r_1 + r_2] = \frac{\sigma}{\epsilon_0} [r_1 + r_2] \end{aligned}$$

12.  $C_{eq} = nC$

$$U = \frac{1}{2} C_{eq} v^2 = \frac{1}{2} (nC) V^2 = \frac{1}{2} nCV^2$$

13. work = f.s

$$ev = mas$$

$$a = \frac{ev}{ms}$$

$$u = 0 \text{ m/s}$$

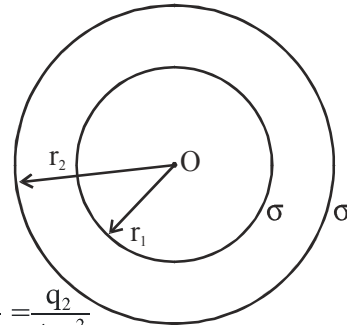
$$v^2 - u^2 = 2as$$

$$v^2 = 2 \left( \frac{ev}{ms} \right) (s)$$

$$v^2 = \frac{2ev}{m}$$

$$v = \sqrt{\frac{2ev}{m}}$$

11.  $V_0 = \frac{1}{4\pi\epsilon_0} \frac{q_1}{r} + \frac{1}{4\pi\epsilon_0} \frac{q_2}{r_2}$



$$\begin{aligned} \sigma &= \frac{q_1}{4\pi r_1^2} = \frac{q_2}{4\pi r_2^2} \\ &= \frac{1}{4\pi\epsilon_0} \left[ \frac{q_1}{r_1} + \frac{q_2}{r_2} \right] \\ &= \frac{1}{4\pi\epsilon_0} \left[ \frac{\sigma 4\pi r_1^2}{r_1} + \frac{\sigma 4\pi r_2^2}{r_2} \right] \\ &= \frac{1}{4\pi\epsilon_0} + \sigma 4\pi [r_1 + r_2] = \frac{\sigma}{\epsilon_0} [r_1 + r_2] \end{aligned}$$

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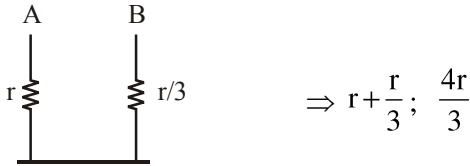
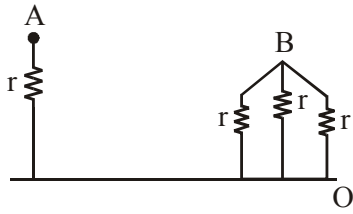
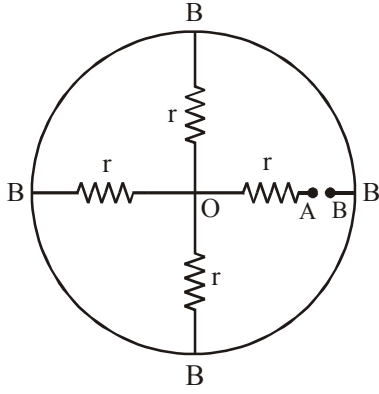
$$v^2 - u^2 = 2as$$

$$v^2 = 2 \left( \frac{ev}{ms} \right) (s)$$

$$v^2 = \frac{2ev}{m}$$

$$v = \sqrt{\frac{2ev}{m}}$$

14.



15.  $i = nq AV_d$ ;  $AV_d = \text{const.}$

$$\frac{\pi r^2 V_{d1}}{\pi (2r)^2 V_{d2}} = \text{const.}; V_{d2} = \frac{V_{d1}}{4} = \frac{V_d}{4}$$

16. Time taken for photoelectrons to eject from a metal surface when light is incident on it is 1 ns or  $10^{-9}$ s.



$$C = Cc = 2 \mu\text{f}$$

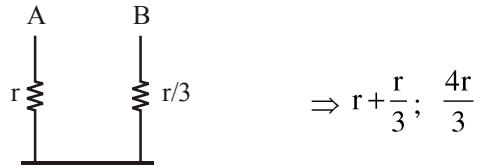
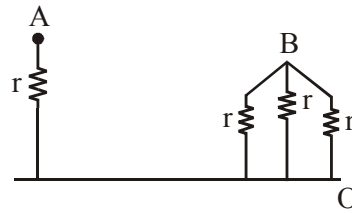
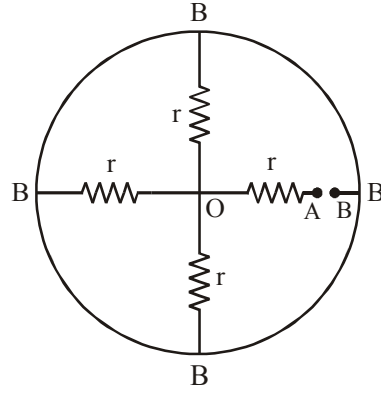
$$C_1 = Cc = 3 \mu\text{F}$$

Let capacitance of removed capacitor be  $C_2$

$$\frac{C_1 C_2}{C_1 + C_2} = C; \frac{3C_2}{3 + C_2} = 2; 3C_2 = 6 + 2C_2; C_2 = 6 \mu\text{F}$$

18. When a black paper is kept at mid of convex lens, then the image is formed at the same point, but its intensity is reduced. So, brightness of image is reduced.

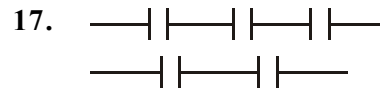
14.



15.  $i = nq AV_d$ ;  $AV_d = \text{અચળ}$

$$\frac{\pi r^2 V_{d1}}{\pi (2r)^2 V_{d2}} = \text{અચળ}; V_{d2} = \frac{V_{d1}}{4} = \frac{V_d}{4}$$

16. ધાતુની સપાટીમાંથી ફોટો  $e^-$  નું ઉત્સર્જન  $10^{-9}$ s માં થાય છે.



$$C = Cc = 2 \mu\text{f}$$

$$C_1 = Cc = 3 \mu\text{F}$$

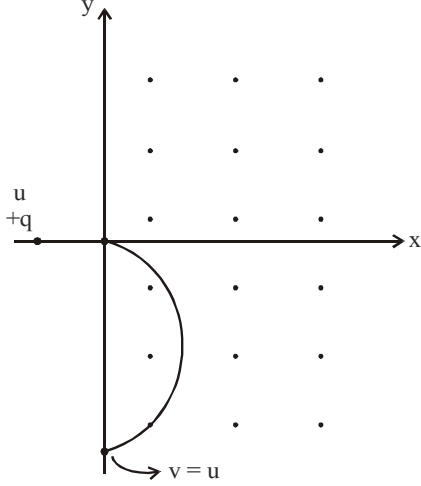
Let capacitance of removed capacitor be  $C_2$

$$\frac{C_1 C_2}{C_1 + C_2} = C; \frac{3C_2}{3 + C_2} = 2; 3C_2 = 6 + 2C_2; C_2 = 6 \mu\text{F}$$

18. જ્યારે કાળો કાગળ બહિર્ગોળ લેન્સના મધ્યમાં મુકવામાં આવે ત્યારે પ્રતિબિંબ તે જ બિંદુએ રચાય છે પરંતુ પ્રતિબિંબની તીવ્રતા ઘટે છે.

19. Convex lens made from three different glass will acts as three lenses. The image formed will be due to combination of these three lenses. Hence, 1 image is formed.

20.



work done by  $\vec{B} = 0$  speed will be const

$$\begin{aligned}\vec{F} &= q(\vec{v} \times \vec{B}) \\ &= q(\hat{u} \times B_0 \hat{k}) \\ &= quB_0(-\hat{j})\end{aligned}$$

&  $y < 0$  (on negative y axis)

21. Linear magnification is given by,  $m = \frac{f}{f-u}$

$$\text{Lateral Magnification} = \frac{\text{length of image}}{\text{length of object}} = m^2$$

$$\therefore \text{Length of image} = \ell \left( \frac{f}{f-u} \right)^2 = \ell \left( \frac{f}{u-f} \right)^2$$

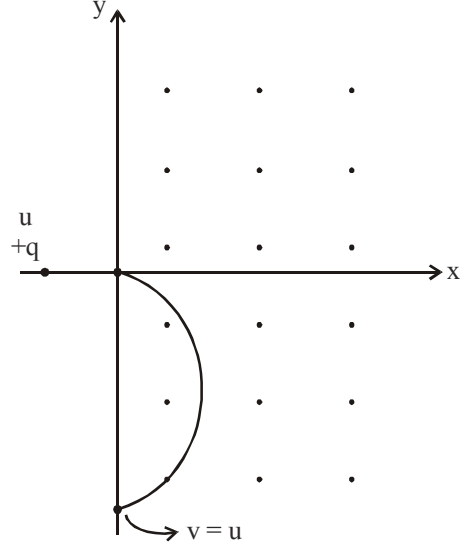
22. Here, far point = 2m

$$\therefore \frac{1}{f} = \frac{-1}{\text{far point}} \Rightarrow \frac{1}{f} = \frac{-1}{2} \Rightarrow f = -2 \text{ m}$$

$$\text{Hence, power of lens, } P = \frac{1}{f} = \frac{-1}{2} = -0.5D$$

19. બહિર્ગોળ લેન્સએ ત્રણ જુદા-જુદા કાયમાંથી બનાવેલ છે. આથી આ ત્રણ કાયનાં સંયોજનથી એક પ્રતિબિંબ મળે.

20.



$\vec{B} = 0$  આથી, ઝડપ અચળ રહે

$$\begin{aligned}\vec{F} &= q(\vec{v} \times \vec{B}) \\ &= q(\hat{u} \times B_0 \hat{k}) \\ &= quB_0(-\hat{j})\end{aligned}$$

અને  $y < 0$  (ઋણ y અક્ષ )

21. રેખીય મોટવણી,  $m = \frac{f}{f-u}$

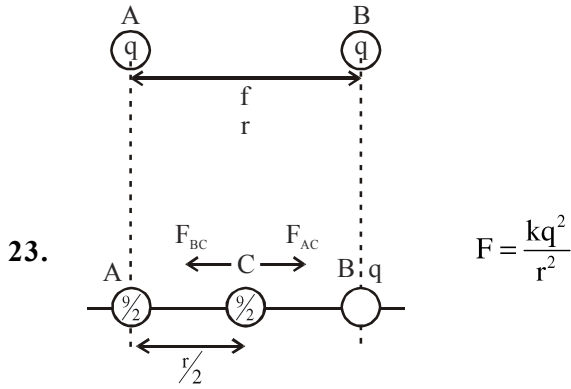
$$\text{રેખીય મોટવણી} = \frac{\text{પ્રતિબિંબની લંબાઈ}}{\text{વસ્તુની લંબાઈ}} = m^2$$

$$\therefore \text{પ્રતિબિંબની લંબાઈ} = \ell \left( \frac{f}{f-u} \right)^2 = \ell \left( \frac{f}{u-f} \right)^2$$

22. અહીં દુર બિંદુ = 2m

$$\therefore \frac{1}{f} = \frac{-1}{\text{દુર બિંદુ}} \Rightarrow \frac{1}{f} = \frac{-1}{2} \Rightarrow f = -2 \text{ m}$$

$$\text{આથી, લેન્સનો પાવર, } P = \frac{1}{f} = \frac{-1}{2} = -0.5D$$

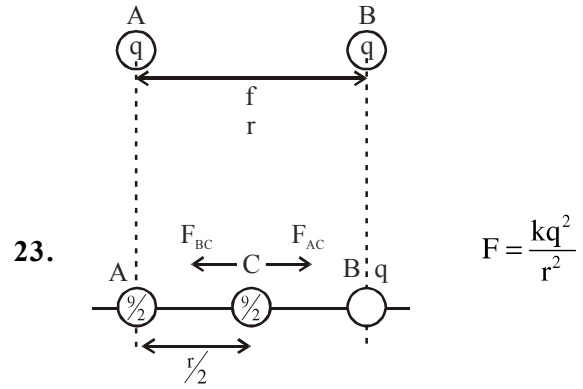


$$\vec{F}_c = \vec{F}_{AC} + \vec{F}_{BC}$$



$$F_{BC} = \frac{kf}{2\left(\frac{r}{2}\right)^2} = 2F$$

$$= \frac{kq^2}{4\left(\frac{r}{2}\right)^2} = F \quad ; \text{ Net force} = F_{(\text{left})}$$



$$\vec{F}_c = \vec{F}_{AC} + \vec{F}_{BC}$$



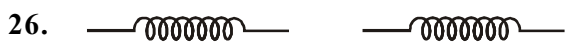
$$F_{BC} = \frac{kf}{2\left(\frac{r}{2}\right)^2} = 2F$$

$$= \frac{kq^2}{4\left(\frac{r}{2}\right)^2} = F \quad ; \text{ પરિણામી બળ} = F_{(\text{left})}$$

24. Davisson – Germer experiment explained wave nature of electrons

25. Since particle is stationary, hence speed,  $v = 0$

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{m(0)} = \infty$$



$$\frac{di}{dt} = 1.6 \text{ A/s}$$

$$\varepsilon = 2.56 \times 10^{-2} \text{ V}$$

$$\varepsilon = \frac{mdi}{dt}$$

$$2.56 \times 10^{-2} = M \times 1.6$$

$$M = \frac{2.56}{1.6} \times 10^{-2}$$

$$= 1.6 \times 10^{-2}$$

$$= 16 \times 10^{-3} \text{ H}$$

$$M = 16 \text{ mH}$$

24. ડેવિસન – ગર્મરના પ્રયોગે ઈલેક્ટ્રોનના તરંગ સ્વભાવની સમજૂતી આપેલી.

25. પદાર્થ સ્થિર છે આથી ઝડપ,  $v = 0$

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{m(0)} = \infty$$



$$\frac{di}{dt} = 1.6 \text{ A/s}$$

$$\varepsilon = 2.56 \times 10^{-2} \text{ V}$$

$$\varepsilon = \frac{mdi}{dt}$$

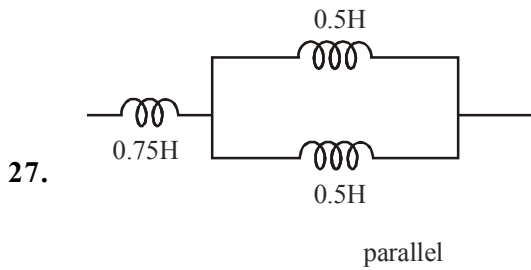
$$2.56 \times 10^{-2} = M \times 1.6$$

$$M = \frac{2.56}{1.6} \times 10^{-2}$$

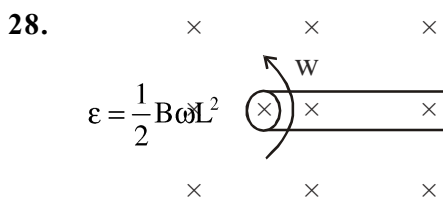
$$= 1.6 \times 10^{-2}$$

$$= 16 \times 10^{-3} \text{ H}$$

$$M = 16 \text{ mH}$$



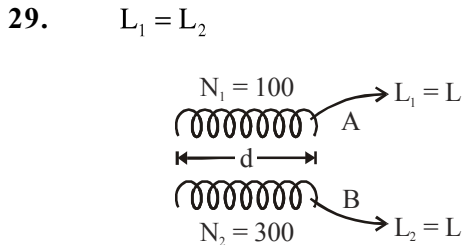
$$L_{eq} = 0.75 + 0.25 = 1H$$



$$\varepsilon = \frac{1}{2} B \omega L^2$$

$$= \frac{1}{2} \times 2 \times 2\pi \times 10 \times 1^2$$

$$= \varepsilon = 20\pi \text{ volt}$$



$$\frac{M_0 N_1^2 A_1}{L_1} = \frac{M_0 N_2^2 A_2}{L_2}$$

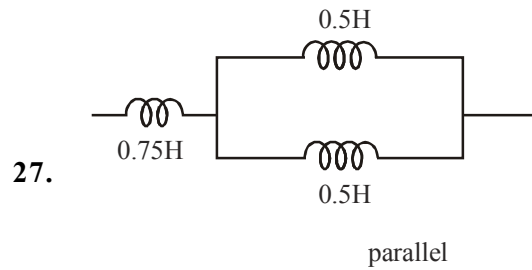
$$\frac{N_1^2 \pi r_1^2}{d} = \frac{N_2^2 \pi r_2^2}{d}$$

$$10^4 \times r_1^2 = (3 \times 10^2)^2 r_2^2$$

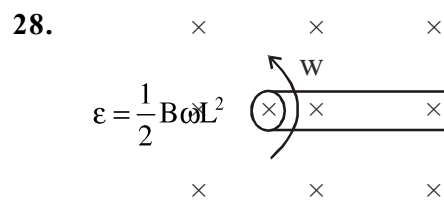
$$10^2 \times r_1 = 3 \times 10^2 r_2$$

$$r_1 = 3r_2$$

$$\frac{r_1}{r_2} = \frac{3}{1}$$



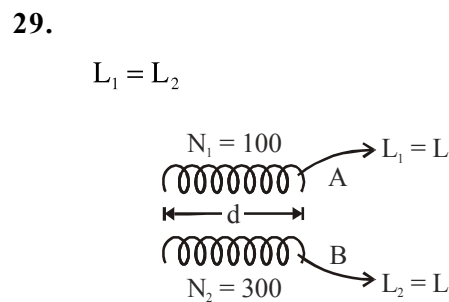
$$L_{eq} = 0.75 + 0.25 = 1H$$



$$\varepsilon = \frac{1}{2} B \omega L^2$$

$$= \frac{1}{2} \times 2 \times 2\pi \times 10 \times 1^2$$

$$\varepsilon = 20\pi \text{ volt}$$



$$\frac{M_0 N_1^2 A_1}{L_1} = \frac{M_0 N_2^2 A_2}{L_2}$$

$$\frac{N_1^2 \pi r_1^2}{d} = \frac{N_2^2 \pi r_2^2}{d}$$

$$10^4 \times r_1^2 = (3 \times 10^2)^2 r_2^2$$

$$10^2 \times r_1 = 3 \times 10^2 r_2$$

$$r_1 = 3r_2$$

$$\frac{r_1}{r_2} = \frac{3}{1}$$

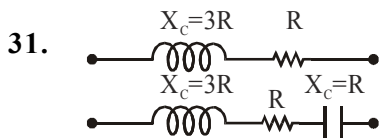


30.  $Q = \frac{1}{R} \sqrt{\frac{L}{C}}$

$$Q = \frac{1}{6} \sqrt{\frac{1}{20 \times 10^{-6}}} = \frac{1}{6 \times 10^{-3}} \sqrt{\frac{1 \times 5}{20 \times 4}}$$

$$= \frac{1}{6 \times 10^{-3}} \frac{\sqrt{5}}{10} = \frac{2.236}{6 \times 10^{-2}}$$

$Q = 37.26$

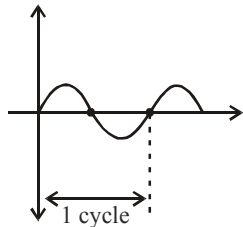


$$pf_{old} = \frac{R}{Z} = \frac{R}{\sqrt{10R}} = \frac{1}{\sqrt{10}}$$

$$pf_{new} = \frac{R}{\sqrt{5R}} = \frac{1}{\sqrt{5}}$$

$$\frac{pf_{new}}{pf_{old}} = \frac{1}{\sqrt{5} \times 1} \times \sqrt{2} \times \sqrt{5} = \sqrt{2}$$

32.



• In one cycle two times zero.

• In 60 cycle 120 times zero.

1 second = 60 cycle = 120 times zero.

33.  $I_{rms} = \frac{I_{max}}{\sqrt{2}} ; \frac{I_{rms}}{I_{max}} = \frac{1}{\sqrt{2}}$

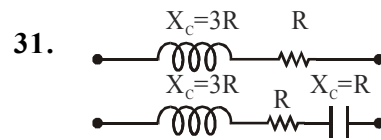
34.  $f = \frac{1}{2\pi\sqrt{LC}} ; f$  can be changed by varying any of L & C.

30.  $Q = \frac{1}{R} \sqrt{\frac{L}{C}}$

$$Q = \frac{1}{6} \sqrt{\frac{1}{20 \times 10^{-6}}} = \frac{1}{6 \times 10^{-3}} \sqrt{\frac{1 \times 5}{20 \times 4}}$$

$$= \frac{1}{6 \times 10^{-3}} \frac{\sqrt{5}}{10} = \frac{2.236}{6 \times 10^{-2}}$$

$Q = 37.26$

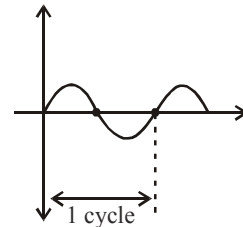


$$pf_{old} = \frac{R}{Z} = \frac{R}{\sqrt{10R}} = \frac{1}{\sqrt{10}}$$

$$pf_{new} = \frac{R}{\sqrt{5R}} = \frac{1}{\sqrt{5}}$$

$$\frac{pf_{new}}{pf_{old}} = \frac{1}{\sqrt{5} \times 1} \times \sqrt{2} \times \sqrt{5} = \sqrt{2}$$

32.



• એક ચક્રમાં બે વાર શૂન્ય થાય છે.

• 60 ચક્રમાં 120 વખત શૂન્ય.

1 સેકન્ડ = 60 ચક્ર = 120 વખત શૂન્ય.

33.  $I_{rms} = \frac{I_{max}}{\sqrt{2}} ; \frac{I_{rms}}{I_{max}} = \frac{1}{\sqrt{2}}$

34.  $f = \frac{1}{2\pi\sqrt{LC}} ; L$  અને  $C$  ના મુલ્યમાં પેરફાર કરવાથી  $f$  નું મુલ્ય બદલી શકાય.

35. In propagation of light, photons move undeflected

$$\therefore F_E = F_B$$

$$qE = qcB$$

$$c = \frac{E}{B}$$

36. Wave number  $= \frac{1}{\lambda} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$

Here,  $n_1 = 2$  &  $n_2 = 3$  [First line of Balmer]

$$= R \left[ \frac{1}{2^2} - \frac{1}{3^2} \right];$$

$$\text{Wave number} = R \left[ \frac{9-4}{36} \right]$$

$$\text{Wave number} = \frac{5R}{36}$$

37. Bohr's orbit radius is given by,  $r_n = r_0 n^2$

$$\therefore r_1 = r_0, r_2 = r_0(2)^2, r_3 = r_0(3)^2$$

$$r_1 : r_2 : r_3 = 1 : 4 : 9$$

38. Energy of electron in hydrogen atom is given

by,  $E = \frac{-13.6}{n^2} \text{eV}$  1<sup>st</sup> excited state,  $n=2$  & 2<sup>nd</sup>

excited state,  $n=3$

$$\therefore \frac{E_2}{E_3} = \frac{\frac{-13.6}{2^2}}{\frac{-13.6}{3^2}} = \frac{9}{4}$$

39. Radius of  $n^{\text{th}}$  orbit of Hydrogen atom  $r_n = r_0 n^2$

Hence, diameter,  $d_n = d_0 n^2$

Here,  $d_0 = 1.06 \text{ \AA}$

For 10<sup>th</sup> orbit,  $d_{10} = 1.06 \times 10^2 = 106 \text{ \AA}$

35. પ્રકાશના પ્રસરણમાં ફોટોન વિચલન પામ્યા વિના ગતિ કરે છે.

$$\therefore F_E = F_B$$

$$qE = qcB$$

$$c = \frac{E}{B}$$

36. તરંગ સંખ્યા  $= \frac{1}{\lambda} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$

અહીં,  $n_1 = 2$  &  $n_2 = 3$  [બામર શ્રેણીની પ્રથમ સંખ્યા]

$$= R \left[ \frac{1}{2^2} - \frac{1}{3^2} \right];$$

$$\text{તરંગ સંખ્યા} = R \left[ \frac{9-4}{36} \right]$$

$$\text{તરંગ સંખ્યા} = \frac{5R}{36}$$

37. બોરની કક્ષીય ત્રિજ્યા,  $r_n = r_0 n^2$

$$\therefore r_1 = r_0, r_2 = r_0(2)^2, r_3 = r_0(3)^2$$

$$r_1 : r_2 : r_3 = 1 : 4 : 9$$

38. હાઈડ્રોજન પરમાણુમાં ઈલેક્ટ્રોનની ઊર્જા,  $E = \frac{-13.6}{n^2} \text{eV}$

1<sup>st</sup> પ્રથમ ઉત્તેજિત અવસ્થા,  $n=2$  & 2<sup>nd</sup> ઉત્તેજિત અવસ્થા,

$n=3$

$$\therefore \frac{E_2}{E_3} = \frac{\frac{-13.6}{2^2}}{\frac{-13.6}{3^2}} = \frac{9}{4}$$

39. હાઈડ્રોજન પરમાણુની  $n$ મી કક્ષાની ત્રિજ્યા  $r_n = r_0 n^2$

અહીં, diameter,  $d_n = d_0 n^2$

Here,  $d_0 = 1.06 \text{ \AA}$

અહીં 10મી ત્રિજ્યા,  $d_{10} = 1.06 \times 10^2 = 106 \text{ \AA}$

40. For nuclear decay,  $N = N_0 e^{-\lambda t}$

$$\frac{N_0}{N} = e^{\lambda t}$$

$$\ln N_0 - \ln N = \lambda t$$

To intercept on t axis,  $\ln N = 0$

$$\therefore t = \frac{\ln N_0}{\lambda}$$

$\left(\frac{\ln N_0}{\lambda}, 0\right)$  are the coordinates

41.  $R_0 = 9750$  dis./min,  $R = 975$  dis/min,  $t = 5$  min

$$R = R_0 e^{-\lambda t}$$

$$975 = 9750 e^{-\lambda t}$$

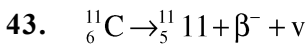
$$e^{5\lambda} = 10$$

$$\lambda = \frac{\ln 10}{5} = \frac{2.303}{5} = 0.461$$

42.  $\lambda = \frac{1}{\tau}$   $\tau$  is average life

In 1 average life, 36.8% of initial nuclei remains.

For  $t = \frac{1}{\lambda} = \tau$ ,  $\therefore 36.8\%$  will remain.



This is a  $\beta^-$  emission in which  $\nu$ (neutrino) is emitted which is a charge less particle and has energy.

44.  $V = E \cdot d$

$$0.5 = E \times 50 \times 10^{-7}$$

$$E = \frac{0.5}{50 \times 10^{-7}} = \frac{0.5}{0.5 \times 10^{-5}} = 10^5 \text{ v/m}$$

40. ન્યુક્લીયસના,  $N = N_0 e^{-\lambda t}$

$$\frac{N_0}{N} = e^{\lambda t}$$

$$\ln N_0 - \ln N = \lambda t$$

સમય t અક્ષ પરનો અંતઃ ખંડ,  $\ln N = 0$

$$\therefore t = \frac{\ln N_0}{\lambda}$$

$\left(\frac{\ln N_0}{\lambda}, 0\right)$  are the coordinates

41.  $R_0 = 9750$  dis./min,  $R = 975$  dis/min,  $t = 5$  min

$$R = R_0 e^{-\lambda t}$$

$$975 = 9750 e^{-\lambda t}$$

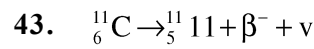
$$e^{5\lambda} = 10$$

$$\lambda = \frac{\ln 10}{5} = \frac{2.303}{5} = 0.461$$

42.  $\lambda = \frac{1}{\tau}$   $\tau$  is average life

સરેરાશ જીવનકાળ પ્રારંભિક ન્યુક્લિયસના, 36.8% ન્યુક્લિયસ વધ્યા હોય.

For  $t = \frac{1}{\lambda} = \tau$ ,  $\therefore 36.8\%$  બાકી રહેશે.

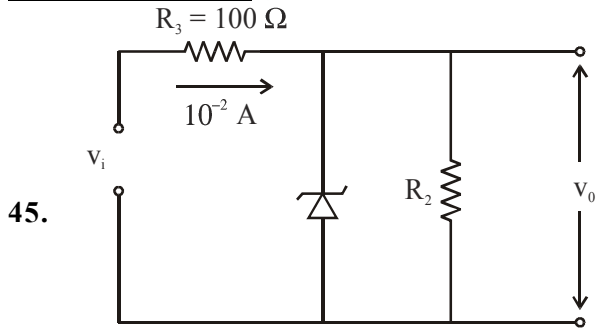


આ  $\beta^-$  ક્ષય છે જેમાં ન્યુટ્રિનોનું ઉત્સર્જન થાય છે જે વિ.ભાર રહિત અને ઊર્જા રહિત કણ છે.

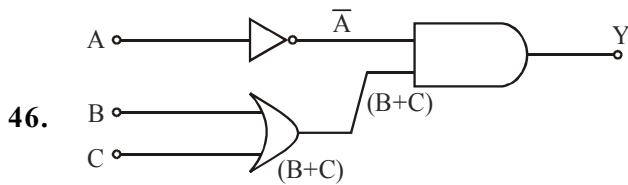
44.  $V = E \cdot d$

$$0.5 = E \times 50 \times 10^{-7}$$

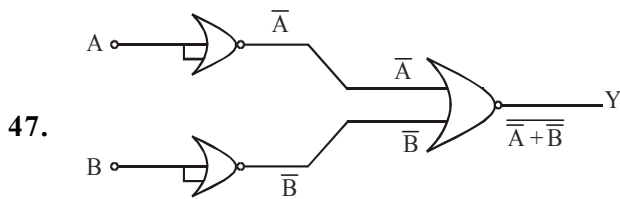
$$E = \frac{0.5}{50 \times 10^{-7}} = \frac{0.5}{0.5 \times 10^{-5}} = 10^5 \text{ v/m}$$



Zener diode is connected across  $R_2$  having voltage  $V_0$  so charge in voltage across zener diode is not possible when zener diode is working in zener breakdown.



$$y = \bar{A} \cdot (B + C)$$

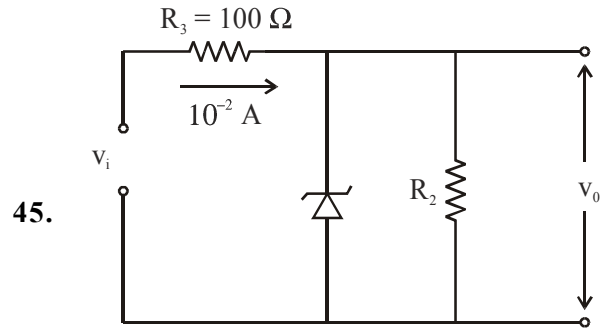
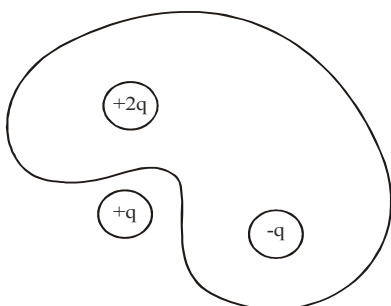


$$y = \overline{\bar{A} + \bar{B}} = \overline{\bar{A}} \cdot \overline{\bar{B}} = A \cdot B$$

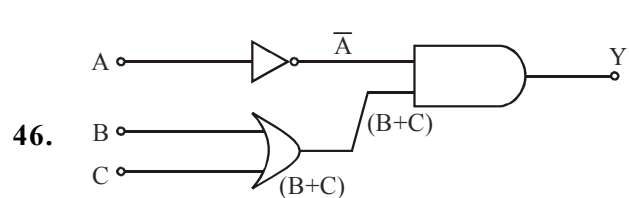
And Gate

48. Soap bubble looks coloured due to interference

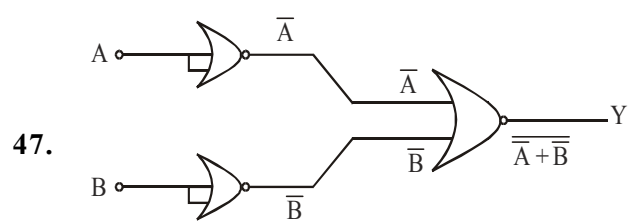
49.  $F_{ele} = 2mg$  ;  $qE = 2mg$  ;  $E = \frac{2mg}{e}$



ઝેનર ડાયોડ  $R_2$  અવરોધના બે છેડે જોડેલ છે. જેનો p.d.  $V_0$  છે. આથી ઝેનર ડાયોડના બે છેડે વોલ્ટેજ શક્ય નથી થજ્યારે ઝેનર ડાયોડ એ ઝેનર બ્રેકડાઉન પર ઉપયોગમાં લેવાયેલ હોય.



$$y = \bar{A} \cdot (B + C)$$

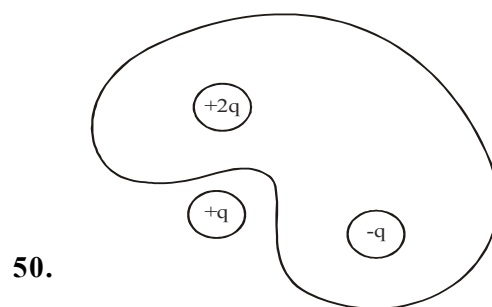


$$y = \overline{\bar{A} + \bar{B}} = \overline{\bar{A}} \cdot \overline{\bar{B}} = A \cdot B$$

And Gate

48. સાબુનો પરપોટો વ્યતિકરણના લીધે રંગબેરંગી દેખાય છે.

49.  $F_{ele} = 2mg$  ;  $qE = 2mg$  ;  $E = \frac{2mg}{e}$



## PART-B

1. Self inductance of coil.  $L_m = \frac{\mu N^2 A}{\ell}$ ,

$\mu$  = permeability of medium

$N$  = No of turns

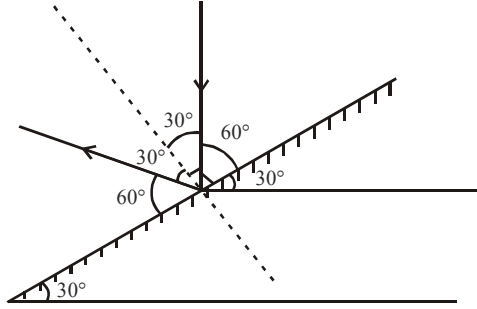
$A$  = crosssectional area

$\ell$  = length of solenoid

Self inductance of coil depends on

(i) Medium inserted inside coil.

(ii) No of turns, crosssectional area of coil & length of coil geometrical factors



2.

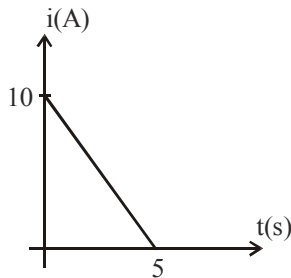
Angle between reflected ray & mirror.

3. Red Orange Yellow Gold

↓ ↓ ↓ ↓

$(2 \quad 3 \quad \times \quad 10^4) \pm 5\%$

Resistance =  $(23 \times 10^4 \pm 5\%) \Omega$



4.

Area of current v/s time gives total charge flown

$$Q = \frac{1}{2} \times (10) \times (5) = 25C$$

$$i = \frac{\Delta Q}{\Delta T} = \frac{25}{5} = 5 \text{ Amp.}$$

## PART-B

1. કોઈલનું આત્મપ્રેરણ  $L_m = \frac{\mu N^2 A}{\ell}$ ,

$\mu$  = માધ્યમની પરમિએબિલિટી

$N$  = આંટાની સંખ્યા

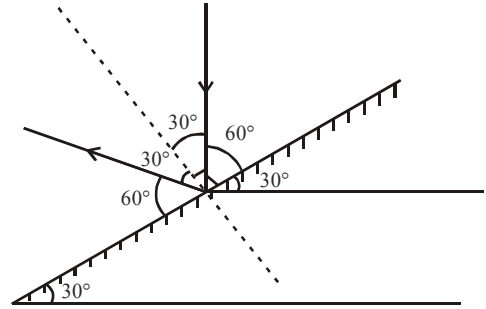
$A$  = આડછેદનું ક્ષેત્રફળ

$\ell$  = સોલેનોઈડની લંબાઈ

ગુંથળાનું આત્મપ્રેરણ નીચેની બાબતો પર આધારિત છે.

(i) કોઈલની અંદરનું માધ્યમ

(ii) આંટાની સંખ્યા, કોઈલના આડછેદનું ક્ષેત્રફળ અને કોઈલની લંબાઈ



2.

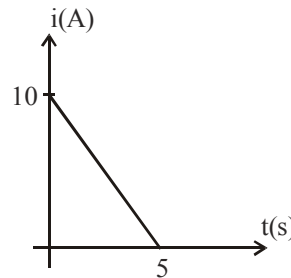
પરાવર્તિત કિરણ અને અરીસા વચ્ચેનો ખૂણો.

3. લાલ નારંગી પીળો સોનેરી

↓ ↓ ↓ ↓

$(2 \quad 3 \quad \times \quad 10^4) \pm 5\%$

અવરોધ =  $(23 \times 10^4 \pm 5\%) \Omega$



4.

વિદ્યુતપ્રવાહ → સમયના આલેખ વડે ઘેરાયેલા પ્રદેશએ કુલ વિ.ભાર ફલક્સ આપે.

$$Q = \frac{1}{2} \times (10) \times (5) = 25C$$

$$i = \frac{\Delta Q}{\Delta T} = \frac{25}{5} = 5 \text{ Amp.}$$

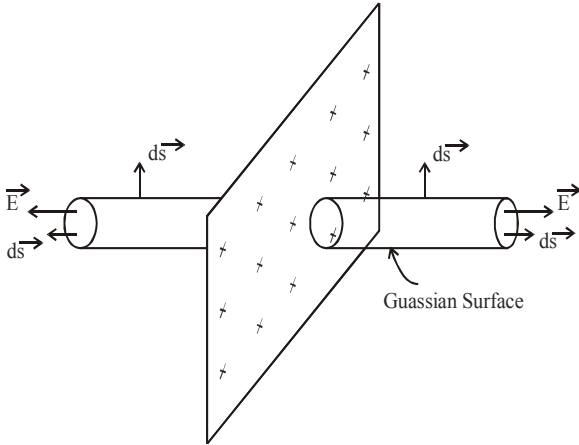
5. (i) They start from +ve point charge and move radially outward. They end at infinity  
(ii) Field lines produced due to negative charge start from infinity and are directed towards the negative charge  
(iii) Field lines do not form closed loop.  
(iv) Field lines never intersect.  
(v) No of electric field lines depends upon the magnitude of electric charge present.

6. Coulomb's law:

It states that "electrostatic force between two point sized charges at rest is directly proportional to product of their charges and inversly proportional to square of distance between them & direction of this force lies along the line joining two charges (central forces).

$$\text{Thus } F \propto \frac{q_1 q_2}{r^2} \Rightarrow F = \frac{k |q_1 q_2|}{r^2}$$

7. Consider a thin, infinite plane sheet of charge with uniform charge density  $\sigma$ .



Considering Gaussian cylindrical surface of Area A & length l.

$\vec{E}$  is perpendicular to area vector ( $\hat{n}$ ) of curved surface

Hence  $\vec{E} \cdot d\vec{s} = 0$  for curved surface

Hence electric field is due to circular ends

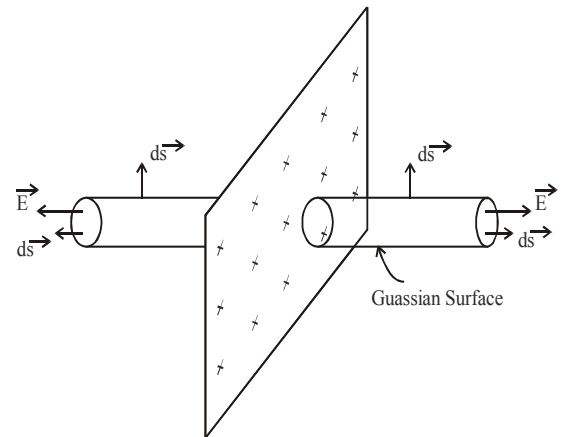
5. (i) They start from +ve point charge and move radially outward. They end at infinity  
(ii) વિદ્યુત ક્ષેત્ર રેખાઓ ધન વિ.ભારથી નીકળીને અનંત શુધી વિસ્તરેલ છે.  
(iii) વિદ્યુત ક્ષેત્ર રેખાઓ ક્યારેય બંધ ગાળા રચતા નથી.  
(iv) વિદ્યુત ક્ષેત્ર રેખાઓ એકબીજાને છેદતી નથી.  
(v) વિદ્યુત ક્ષેત્ર રેખાઓની સંખ્યાએ વિદ્યુતભારના મુલ્ય પર આધાર રાખે છે.

6. કુલંબનો નિયમ :

"બે બિંદુવત વિદ્યુતભારો વચ્ચે ઉદ્ભવતું વિદ્યુતીય બળ એ તે બે વિદ્યુતભારનો ગુણાકારના સમપ્રમાણમાં અને તેમની વચ્ચેના અંતરના વર્ગના વ્યસ્ત પ્રમાણમાં હોય છે.

$$\text{આથી } F \propto \frac{q_1 q_2}{r^2} \Rightarrow F = \frac{k |q_1 q_2|}{r^2}$$

7. નિયમિત પૃષ્ઠ ધિદ્યુતભાર ધનતા જ ધરાવતી અત્યંત પાતળી અનંત લંબાઈની તક્તી ધ્યાનમાં લો



A આડછેદ અને l લંબાઈનું ગોસીયન પૃષ્ઠ ધ્યાનમાં લો.

$\vec{E}$  એ વક્રપાટીને લંબ ક્ષેત્રફળ સદિશ છે ( $\hat{n}$ )

આથી, વક્રપાટીને માટે  $\vec{E} \cdot d\vec{s} = 0$

આથી વર્તુળાકાર અંત બિંદુએ વિદ્યુતક્ષેત્ર

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

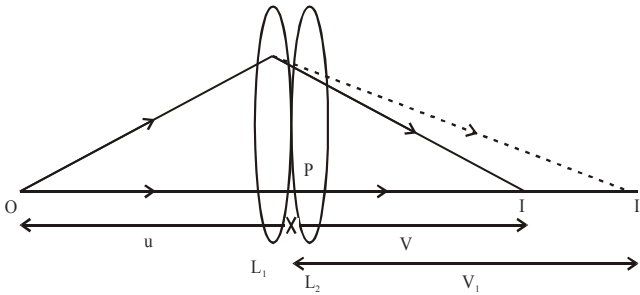
flux associated with 2ends of cylinder = EA  
 $\cos 0 + EA \cos 0 = 2EA$

$$2EA = \frac{\sigma A}{\epsilon_0}$$

$$E = \frac{\sigma}{2\epsilon_0}$$

$\vec{E}$  is independent of 'r'.

8. As shown in figure, let  $L_1$  &  $L_2$  be two thin lenses of focal length  $f_1$  &  $f_2$  respectively, placed coaxially, in contact with one another. O is point object on principle axis of lens system.  $I_1$  is the image formed by lens  $L_1$  which acts as object for lens  $L_2$ . Final image is formed at I. Here,  $OP = u$ ,  $I_1P = V_1$  and  $IP = v$ ,



Using lens formula, for  $L_1$ ,  $\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1}$

..... (1)

for  $L_2$ ,  $\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2}$

..... (2)

Adding (1) & (2),  $\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f}$ ,

Where  $f$  is focal length of this combination

9.  $L = \frac{M_0 N^2 A}{\ell} = \frac{4\pi \times 10^{-7} \times (1.5 \times 10^4)^2 \times \pi (2 \times 10^{-2})^2}{2\pi (10^{-1})}$

$$= 2\pi \times 10^{-7} \times 2.25 \times 10^8 \times 4 \times 10^{-4+1}$$

$$= 2\pi \times 4 \times 2.25 \times 10^{-2}$$

$$= 56.52 \times 10^{-2}$$

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

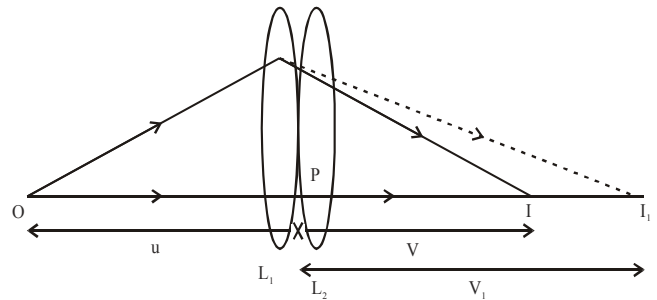
નળાકારના બે અંત્યબિંદુ સાથે સંકળાયેલ ફ્લક્સ = EA  
 $\cos 0 + EA \cos 0 = 2EA$

$$2EA = \frac{\sigma A}{\epsilon_0}$$

$$E = \frac{\sigma}{2\epsilon_0}$$

$\vec{E}$  એ 'r' થી સ્વતંત્ર છે.

8. આકૃતિમાં દર્શાવ્યા બે પાતળા લેન્સ  $L_1$  અને  $L_2$  બે પાતળા લેન્સને કે જેમની કેન્દ્રલંબાઈ અનુક્રમે  $f_1$  અને  $f_2$  છે તેમને એકબીજાના સંપર્કમાં રાખેલ છે. O એ બિંદુવત્ત ઉદ્ભવ  $I_1$  એ પ્રથમ લેન્સ  $L_1$  વડે મળતું પ્રતિબિંબ જે બીજા લેન્સ  $L_2$  માટે વસ્તુ તરીકે વર્તે છે અને અંતિમ પ્રતિબિંબ I પર મળે છે. અહીં  $OP = u$ ,  $I_1P = V_1$  અને  $IP = v$ ,



Using lens formula, for  $L_1$ ,  $\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1}$

..... (1)

for  $L_2$ ,  $\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2}$

..... (2)

(1) અને (2) નો સરવાળો કરતા,  $\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f}$ ,

જ્યાં  $f$  એ આ સંયોજનની કેન્દ્રલંબાઈ છે.

9.  $L = \frac{M_0 N^2 A}{\ell} = \frac{4\pi \times 10^{-7} \times (1.5 \times 10^4)^2 \times \pi (2 \times 10^{-2})^2}{2\pi (10^{-1})}$

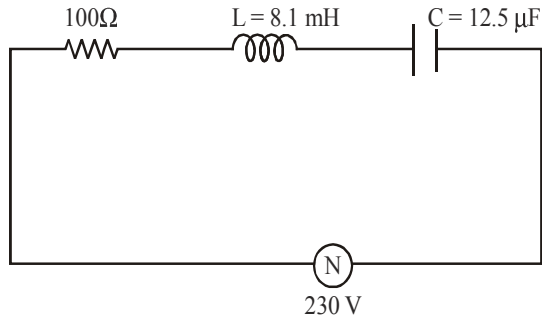
$$= 2\pi \times 10^{-7} \times 2.25 \times 10^8 \times 4 \times 10^{-4+1}$$

$$= 2\pi \times 4 \times 2.25 \times 10^{-2}$$

$$= 56.52 \times 10^{-2}$$

$$L = 0.5652 \text{ H}$$

10.



$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2 \times 3.14 \times 500 \times 8.1 \times 10^{-3}$$

$$= \frac{1}{2 \times 3.14 \times 500 \times 12.5 \times 10^{-6}}$$

$$X_L = 25.4$$

$$X_C = 25.4$$

$$Z = R + j(X_L - X_C)$$

$$= 100 + j(0) = 100$$

$$\text{current flowing in circuit, } i = \frac{230}{100} = 2.3 \text{ A}$$

Voltage across resistor

$$V_R = iR = 2.3 \times 100$$

$$= 230 \text{ V}$$

11. Given,  $d = 1 \text{ mm} = 10^{-3} \text{ m}$

$$\beta = 0.03 \text{ cm} = 3 \times 10^{-4} \text{ m}$$

$$\Delta D = 550 \text{ cm} = 0.5 \text{ m}$$

on displacing the screen,  $\beta' = 2\beta$

$$\therefore \Delta\beta = \beta' - \beta = 2\beta - \beta = \beta$$

$$\Delta\beta = \frac{\lambda \Delta D}{d}$$

$$3 \times 10^{-4} = \frac{\lambda \times 0.5}{10^{-3}}; \quad \lambda = \frac{3 \times 10^{-4} \times 10^{-3}}{0.5};$$

$$\lambda = 6 \times 10^{-7} \text{ m}; \quad \lambda = 6000 \text{ \AA}$$

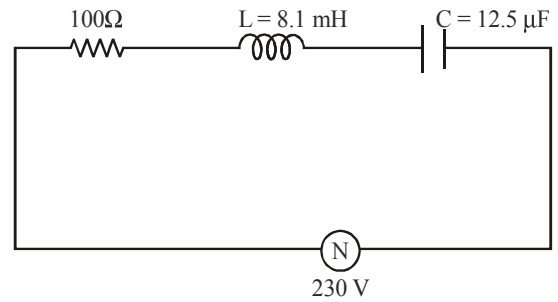
Wave length of light used is  $6000 \text{ \AA}$

12. No. of atoms in 1 kg deuterium,

$$N = \frac{1000}{2} \times N_A = 500 N_A = 500 \times 6.02 \times 10^{23}$$

$$L = 0.5652 \text{ H}$$

10.



$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

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$$X_L = 25.4$$

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$$Z = R + j(X_L - X_C)$$

$$= 100 + j(0) = 100$$

$$\text{current flowing in circuit, } i = \frac{230}{100} = 2.3 \text{ A}$$

અવરોધના બે છેડે સ્થિતિમાન

$$V_R = iR = 2.3 \times 100$$

$$= 230 \text{ V}$$

11. Given,  $d = 1 \text{ mm} = 10^{-3} \text{ m}$

$$\beta = 0.03 \text{ cm} = 3 \times 10^{-4} \text{ m}$$

$$\Delta D = 550 \text{ cm} = 0.5 \text{ m}$$

પડદાનું સ્થાનિતર કરતાં,  $\beta' = 2\beta$

$$\therefore \Delta\beta = \beta' - \beta = 2\beta - \beta = \beta$$

$$\Delta\beta = \frac{\lambda \Delta D}{d}$$

$$3 \times 10^{-4} = \frac{\lambda \times 0.5}{10^{-3}}; \quad \lambda = \frac{3 \times 10^{-4} \times 10^{-3}}{0.5};$$

$$\lambda = 6 \times 10^{-7} \text{ m}; \quad \lambda = 6000 \text{ \AA}$$

ઉપયોગમાં લેવાયેલ પ્રકાશની તરંગલંબાઈ  $6000 \text{ \AA}$  છે.

12. No. of atoms in 1 kg deuterium,

$$N = \frac{1000}{2} \times N_A = 500 N_A = 500 \times 6.02 \times 10^{23}$$



$$P = \frac{N}{t} E \Rightarrow t = \frac{NE}{P}$$

$$t = \frac{500 \times 6.02 \times 10^{23} \times 3.27 \times 1.6 \times 10^{-13}}{100 \times 3.16 \times 10^7} \text{ year}$$

$$t = 6229.56 \text{ years}$$

13. Here, vertical displacement = 1.5 cm = 0.015m & E = 2 × 10<sup>4</sup> N/C

$$\text{Force, } F = qE = ma$$

$$\therefore a = \frac{qE}{m}; \quad \text{using } s = at + \frac{1}{2}at^2, \text{ we get,}$$

$$s = 0 + \frac{1}{2}at^2; \quad t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2ms}{qE}}$$

- (a) For electron, q = 1.6 × 10<sup>-19</sup> C, m = 9.1 × 10<sup>-31</sup> kg

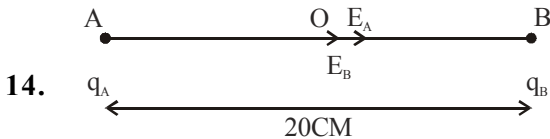
Hence,

$$t = \sqrt{\frac{2 \times 0.015 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19} \times 2 \times 10^4}} = 2.9 \times 10^{-9} \text{ s}$$

- (b) For proton, q = 1.6 × 10<sup>-19</sup>C, m = 1.67 × 10<sup>-27</sup> kg

Hence,

$$t = \sqrt{\frac{2 \times 0.015 \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 2 \times 10^4}} = 1.3 \times 10^{-7} \text{ s}$$



- (a) As seen from above diagram, at point A, electric field due to both charges is in same direction

$$\therefore E_{\text{net}} = E_A + E_B = \frac{kq_A}{r_A^2} + \frac{kq_B}{r_B^2} = \frac{-9 \times 10^9 \times 3 \times 10^{-6}}{(10 \times 10^{-2})^2} \times 2 = 540 \text{ N/C}$$

- (b) Force experienced by test charge

$$F = qE_{\text{net}}$$

$$F = 1.5 \times 10^{-9} \times 540$$

$$F = 8.1 \times 10^{-7} \text{ N}$$

- (c) Consider an infinitely long charged wire with uniform linear charge density λ.

$$P = \frac{N}{t} E \Rightarrow t = \frac{NE}{P}$$

$$t = \frac{500 \times 6.02 \times 10^{23} \times 3.27 \times 1.6 \times 10^{-13}}{100 \times 3.16 \times 10^7} \text{ year}$$

$$t = 6229.56 \text{ years}$$

13. અહીં શિરોલંબ સ્થાનિતર = 1.5 cm = 0.015m & E = 2 × 10<sup>4</sup> N/C

$$\text{બળ, } F = qE = ma$$

$$\therefore a = \frac{qE}{m}; \quad s = at + \frac{1}{2}at^2 \text{ નો ઉપયોગ કરતા}$$

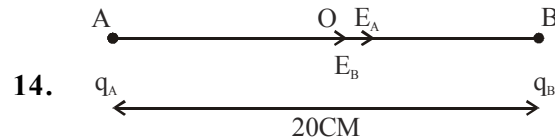
$$s = 0 + \frac{1}{2}at^2; \quad t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2ms}{qE}}$$

- (a) ઈલેક્ટ્રોન માટે, q = 1.6 × 10<sup>-19</sup> C, m = 9.1 × 10<sup>-31</sup> kg

$$\text{આથી, } t = \sqrt{\frac{2 \times 0.015 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19} \times 2 \times 10^4}} = 2.9 \times 10^{-9} \text{ s}$$

- (b) પ્રોટોન માટે, q = 1.6 × 10<sup>-19</sup>C, m = 1.67 × 10<sup>-27</sup> kg

$$\text{આથી, } t = \sqrt{\frac{2 \times 0.015 \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 2 \times 10^4}} = 1.3 \times 10^{-7} \text{ s}$$



- (a) આકૃતિમાં દર્શાવ્યા અનુસાર બિંદુ-A પાસે બન્ને વિદ્યુતભારના લીધે એકજ દિશામાં વિદ્યુતક્ષેત્ર

$$\therefore E_{\text{net}} = E_A + E_B = \frac{kq_A}{r_A^2} + \frac{kq_B}{r_B^2} = \frac{-9 \times 10^9 \times 3 \times 10^{-6}}{(10 \times 10^{-2})^2} \times 2 = 540 \text{ N/C}$$

- (b) પરિક્ષણ વિદ્યુતભાર વડે અનુભવાતું બળ

$$F = qE_{\text{net}}$$

$$F = 1.5 \times 10^{-9} \times 540$$

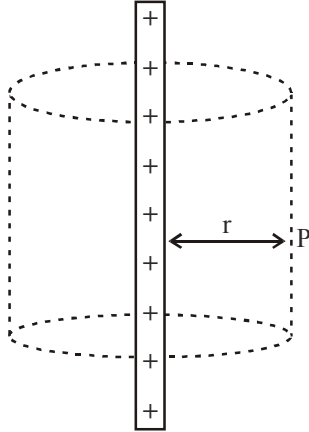
$$F = 8.1 \times 10^{-7} \text{ N}$$

- (c) નિયમિક રેખીય વિદ્યુતભાર ઘનતા λ ધરાવતો અનંત લંબાઈના એક તાર ધ્યાનમાં લો.

To find electric field at point P at distance r from wire, consider a cylindrical gaussian surface of radius r and length l.

For circular ends,  $\vec{E} \cdot \vec{ds} = Eds \cos 90 = 0$

$\therefore$  Electric flux is only along curved surface.



By gauss law,  $\oint \vec{E} \cdot \vec{ds} = \frac{q}{\epsilon_0}$

Here,  $\oint ds = 2\pi r l$  and  $q = \lambda l$ .

$$\therefore E = (2\pi r l) = \frac{\lambda l}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r} \hat{r}$$

### PART-C

15.  $Q = 4x^2 + 3y^3 - 9z^2$

$$\vec{E} = -\frac{dV}{dr} = -\left[ \frac{\partial V}{\partial x} \hat{i} + \frac{\partial V}{\partial y} \hat{j} + \frac{\partial V}{\partial z} \hat{k} \right]$$

$$= -\left[ \frac{\partial}{\partial x}(4x^2 + 3y^3 - 9z^2) \hat{i} + \frac{\partial}{\partial y}(4x^2 + 3y^3 - 9z^2) \hat{j} + \frac{\partial}{\partial z}(4x^2 + 3y^3 - 9z^2) \hat{k} \right]$$

$$\vec{E} = -[8x\hat{i} + 9y^2\hat{j} - 18z\hat{k}]$$

At (3, 4, 5)

$$\vec{E} = -[8 \times 3\hat{i} + 9 \times (4)^2 \hat{j} - 18(5)\hat{k}]$$

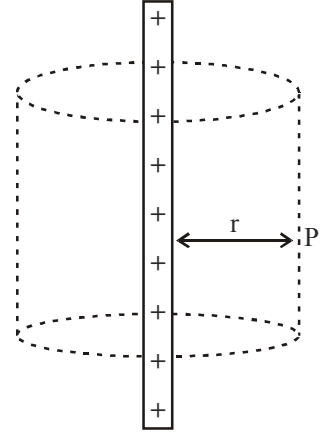
$$\vec{E} = -[24\hat{i} + 144\hat{j} - 90\hat{k}] \text{ N/C and}$$

$$|\vec{E}| = \sqrt{24^2 + 144^2 + 90^2} = 171.5 \text{ N/C}$$

બિંદુ P પાસે વિદ્યુતક્ષેત્ર શોધવા માટે તારથી r અંતરે r ત્રિજ્યા અને l લંબાઈનો નળાકાર ધ્યાનમાં લો.

નળાકાર બિંદુએ,  $\vec{E} \cdot \vec{ds} = Eds \cos 90 = 0$

$\therefore$  વક્રપાટીને અનુલક્ષીને વિદ્યુત ફલક્સ.



ગાઉસના નિયમાનુસાર,  $\oint \vec{E} \cdot \vec{ds} = \frac{q}{\epsilon_0}$

અહીં,  $\oint ds = 2\pi r l$  અને  $q = \lambda l$ .

$$\therefore E = (2\pi r l) = \frac{\lambda l}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r} \hat{r}$$

### PART-C

15.  $Q = 4x^2 + 3y^3 - 9z^2$

$$\vec{E} = -\frac{dV}{dr} = -\left[ \frac{\partial V}{\partial x} \hat{i} + \frac{\partial V}{\partial y} \hat{j} + \frac{\partial V}{\partial z} \hat{k} \right]$$

$$= -\left[ \frac{\partial}{\partial x}(4x^2 + 3y^3 - 9z^2) \hat{i} + \frac{\partial}{\partial y}(4x^2 + 3y^3 - 9z^2) \hat{j} + \frac{\partial}{\partial z}(4x^2 + 3y^3 - 9z^2) \hat{k} \right]$$

$$\vec{E} = -[8x\hat{i} + 9y^2\hat{j} - 18z\hat{k}]$$

At (3, 4, 5)

$$\vec{E} = -[8 \times 3\hat{i} + 9 \times (4)^2 \hat{j} - 18(5)\hat{k}]$$

$$\vec{E} = -[24\hat{i} + 144\hat{j} - 90\hat{k}] \text{ N/C and}$$

$$|\vec{E}| = \sqrt{24^2 + 144^2 + 90^2} = 171.5 \text{ N/C}$$

16. Suppose the displacements of two light waves from two coherent sources  $S_1$  &  $S_2$  at point P at any time t be given by,  $y_1 = A \cos \omega t$  and  $y_2 = A \cos(\omega t + \phi)$ , where A is amplitude of two waves and  $\phi$  is the constant phase difference between them.

Let  $I_0$  be intensity of light produced by each wave.

We know, Intensity  $\propto$  (Amplitude)<sup>2</sup>

Hence,  $I_0 \propto A^2$

$$\Rightarrow I_0 = kA^2 \rightarrow (1)$$

By superposition principle, the resultant displacement at point P is,

$$y = y_1 + y_2$$

$$y = A [\cos \omega t + \cos(\omega t + \phi)]$$

$$y = 2A \cos \frac{\phi}{2} \cos \left( \omega t + \frac{\phi}{2} \right) \left[ \cos C + \cos D = 2 \cos \left( \frac{C+D}{2} \right) \cos \left( \frac{C-D}{2} \right) \right]$$

In above expression,  $2a \cos \phi$  is amplitude

$$\text{Hence, } I \propto \left( 2A \cos \frac{\phi}{2} \right)^2$$

$$I = 4kA^2 \cos^2 \frac{\phi}{2}$$

from (1)

$$I = 4I_0 \cos^2 \left( \frac{\phi}{2} \right)$$

17. For an electron revolving in  $n^{\text{th}}$  orbit of hydrogen atom, electrostatic force acting on

$$\text{it is, } F = \frac{k(e)(e)}{r_n^2} = \frac{ke^2}{r_n^2}$$

This force acts as centripetal force.

$$\text{Hence, } \frac{ke^2}{r_n^2} = \frac{mv^2}{r_n}$$

$$r_n = \frac{ke^2}{mv^2} \dots\dots(1)$$

By 2<sup>nd</sup> postulate of Bohr's hypothesis.

16. બે સુસંબદ્ધ ઉદ્ગમ  $S_1$  અને  $S_2$  માંથી નીકળતા બે પ્રકાશના તરંગો બિંદુ P પાસે પહોંચે છે. તે  $y_1 = A \cos \omega t$  અને  $y_2 = A \cos(\omega t + \phi)$ , વડે આપવામાં આવેલ છે જ્યાં A એ બે તરંગોનો કંપવિસ્તાર છે અને  $\phi$  એ તરંગો વચ્ચેનો અચળ કળાતફાવત છે.

ધારો કે પ્રત્યેક તરંગના પ્રકાશની તીવ્રતા  $I_0$  છે.

આપણે જાણીએ છીએ કે તીવ્રતા  $\propto$  (કંપવિસ્તાર)<sup>2</sup>

આથી,  $I_0 \propto A^2$

$$\Rightarrow I_0 = kA^2 \rightarrow (1)$$

સંપાતપણાના સિદ્ધાંત અનુસાર બિંદુ P પાસે પરિણામી સ્થાનાંતર,

$$y = y_1 + y_2$$

$$y = A [\cos \omega t + \cos(\omega t + \phi)]$$

$$y = 2A \cos \frac{\phi}{2} \cos \left( \omega t + \frac{\phi}{2} \right) \left[ \cos C + \cos D = 2 \cos \left( \frac{C+D}{2} \right) \cos \left( \frac{C-D}{2} \right) \right]$$

In above expression,  $2a \cos \phi$  is amplitude

$$\text{Hence, } I \propto \left( 2A \cos \frac{\phi}{2} \right)^2$$

$$I = 4kA^2 \cos^2 \frac{\phi}{2}$$

from (1)

$$I = 4I_0 \cos^2 \left( \frac{\phi}{2} \right)$$

17. હાઈડ્રોજન પરમાણુની n મી કક્ષામાં ભ્રમણ કરતી e<sup>-</sup> પર

$$\text{લાગતું વિદ્યુતીય બળ, } F = \frac{k(e)(e)}{r_n^2} = \frac{ke^2}{r_n^2}$$

આ બળ કેન્દ્રગામી બળ તરીકે વર્તે છે

$$\text{અર્થાત્, } \frac{ke^2}{r_n^2} = \frac{mv^2}{r_n}$$

$$r_n = \frac{ke^2}{mv^2} \dots\dots(1)$$

બહોરના બીજા આધિતર્ક અનુસાર.

$$L = mvr_n = \frac{nh}{2\pi}$$

$$L = mvr_n = \frac{nh}{2\pi}$$

$$\therefore v = \frac{nh}{2\pi mr_n} \rightarrow (2)$$

From (1) and (2)

$$r_n = \frac{ke^2}{m \left( \frac{nh}{2\pi mr_n} \right)^2}$$

$$r_n = \frac{ke^2 \times 4\pi^2 \times m^2 \times r_n^2}{m n^2 h^2}$$

$$r_n = \frac{n^2 h^2}{4\pi^2 m k e^2}$$

substituting values, we get,

$$r_n = \frac{n^2 (6.63 \times 10^{-34})^2}{4\pi^2 \times (9.1 \times 10^{-31}) (9 \times 10^9) (16 \times 10^{-19})^2}$$

$$r_n = n^2 0.53 \text{ \AA}$$

$$r_n = 5.3 \times 10^{-11} n^2 \text{ m}$$

18. Consider an electric dipole of 2 point charges  $+q$  and  $-q$  separated by small distance  $2a$ .

(a) Electric field at P on axis of dipole.

Let  $\vec{E}_{-q}$  and  $\vec{E}_{+q}$  be fields acting at point P due to  $-q$  &  $+q$  charge respectively.

$$\vec{E}_{-q} = \frac{kq}{(r+a)^2} (-\hat{p}), \hat{p} \text{ is unit vector in}$$

direction of dipole moment

$$\vec{E}_{+q} = \frac{kq}{(r-a)^2} (\hat{p})$$

$$\vec{E}_p = \vec{E}_{-q} + \vec{E}_{+q}$$

$$= kq \left[ \frac{1}{(r-q)^2} - \frac{1}{(r+a)^2} \right] (\hat{p})$$

$$= \frac{kq(4ar)}{(r^2 - a^2)} \hat{p}$$

$$\therefore v = \frac{nh}{2\pi mr_n} \rightarrow (2)$$

(1) અને (2) પરથી

$$r_n = \frac{ke^2}{m \left( \frac{nh}{2\pi mr_n} \right)^2}$$

$$r_n = \frac{ke^2 \times 4\pi^2 \times m^2 \times r_n^2}{m n^2 h^2}$$

$$r_n = \frac{n^2 h^2}{4\pi^2 m k e^2}$$

કિંમતો મુકતી

$$r_n = \frac{n^2 (6.63 \times 10^{-34})^2}{4\pi^2 \times (9.1 \times 10^{-31}) (9 \times 10^9) (16 \times 10^{-19})^2}$$

$$r_n = n^2 0.53 \text{ \AA}$$

$$r_n = 5.3 \times 10^{-11} n^2 \text{ m}$$

18. બિંદુવત વિદ્યુતભાર  $+q$  અને  $-q$  એકબીજાથી  $2a$  અંતરે રહેલ છે જે ડાયપોલનું નિર્માણ કરે છે.

(a) ડાયપોલની અક્ષ પર બિંદુ P પર વિદ્યુતક્ષેત્ર.

ધારો કે  $-q$  અને  $+q$  વિદ્યુતભારના લીધે બિંદુ P પાસે

ઉદ્ભવતું વિદ્યુતક્ષેત્ર અનુક્રમે  $\vec{E}_{-q}$  અને  $\vec{E}_{+q}$  છે.

$$\vec{E}_{-q} = \frac{kq}{(r+a)^2} (-\hat{p}), \hat{p} \text{ એ ડાયપોલ મોમેન્ટની}$$

દિશામાંનો એકમ સદિશ છે.

$$\vec{E}_{+q} = \frac{kq}{(r-a)^2} (\hat{p})$$

$$\vec{E}_p = \vec{E}_{-q} + \vec{E}_{+q}$$

$$= kq \left[ \frac{1}{(r-q)^2} - \frac{1}{(r+a)^2} \right] (\hat{p})$$

$$= \frac{kq(4ar)}{(r^2 - a^2)} \hat{p}$$

$$\vec{E}_p = \frac{2k\vec{p}r}{(r^2 - a^2)}$$

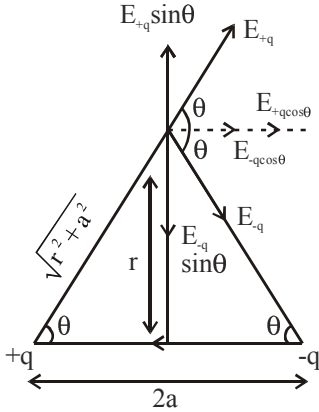
If  $(r \gg 2a)$ , dipole is short

$$\vec{E}_p = \frac{2kp}{r^3} \hat{p}$$

(b) When point P is on equatorial line at distance  $r$  from centre of the dipole

$$\text{Here, } |\vec{E}_{-q}| = |\vec{E}_{+q}| = \frac{kq}{(\sqrt{r^2 + a^2})^2} = \frac{kq}{r^2 + a^2}$$

On resolving  $E_{-q}$  &  $E_{+q}$  along equatorial and perpendicular components, we see  $E_{-q} \cos\theta$  and  $E_{+q} \cos\theta$  add up and  $\sin\theta$  components get cancelled.



$$\text{Hence, } E_{\text{net}} = E_{-q} \cos\theta + E_{+q} \cos\theta$$

$$E_{\text{net}} = 2E_q \cos\theta$$

$$E_{\text{net}} = \frac{2kq}{r^2 + a^2} \times \frac{a}{\sqrt{r^2 + a^2}}$$

$$\vec{E}_{\text{net}} = \frac{-k\vec{p}}{(r^2 + a^2)^{3/2}} \quad (\vec{E} \text{ is opposite to } \hat{p})$$

For short dipole,  $r \gg 2a$ ,

$$\vec{E} = \frac{-kp}{r^3} \hat{p}$$

$$\vec{E}_p = \frac{2k\vec{p}r}{(r^2 - a^2)}$$

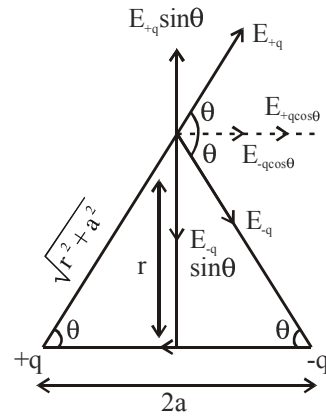
જો  $(r \gg 2a)$ , હોય તો

$$\vec{E}_p = \frac{2kp}{r^3} \hat{p}$$

(b) જ્યારે બિંદુ P એ ડાયપોલની અક્ષથી વિષુવરેખા પર હોય

$$\text{Here, } |\vec{E}_{-q}| = |\vec{E}_{+q}| = \frac{kq}{(\sqrt{r^2 + a^2})^2} = \frac{kq}{r^2 + a^2}$$

$E_{-q}$  અને  $E_{+q}$  સદિશના ડાયપોલ અક્ષને લંબ ઘટકો નાબુદ થશે અને ડાયપોલની અક્ષને સમાંતર ઘટકોનો સરવાળો થશે, we see  $E_{-q} \cos\theta$  and  $E_{+q} \cos\theta$  add up and  $\sin\theta$  components get cancelled.



$$\text{આથી, } E_{\text{net}} = E_{-q} \cos\theta + E_{+q} \cos\theta$$

$$E_{\text{net}} = 2E_q \cos\theta$$

$$E_{\text{net}} = \frac{2kq}{r^2 + a^2} \times \frac{a}{\sqrt{r^2 + a^2}}$$

$$\vec{E}_{\text{net}} = \frac{-k\vec{p}}{(r^2 + a^2)^{3/2}} \quad (\vec{E} \text{ એ } \hat{p} \text{ થી વિરુદ્ધ દિશામાં છે)}$$

$r \gg 2a$  માટે,

$$\vec{E} = \frac{-kp}{r^3} \hat{p}$$