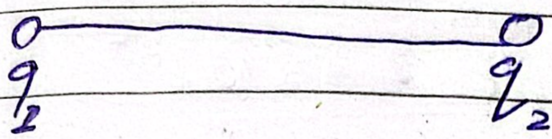
DATE: 27/2/2025 EMO M T W T F S

Coulomb's law :-



$F \propto |q_1||q_2|$ → mod means irrespective of sign whatever is inside is +ve.

$F \propto \frac{1}{r^2}$

$k = 9 \times 10^9 \; Nm^2/C^2$

$F = k \frac{|q_1||q_2|}{r^2}$

$k = \frac{1}{4\pi \varepsilon_0}$

$\varepsilon_0 = 8.859 \times 10^{-12} \; C^2/Nm^2$

absilun means space.

means permivity of free space.

permitivity?

tells how many charges it allows to pass through it.

problem 25.2:-

$q_1 = 1.37 \times 10^5 C$

$q_2 = -1.37 \times 10^5 C$

$r = 100m$

$F = 9 \times 10^9 \times \frac{|1.37 \times 10^5||1.37 \times 10^5|}{(100)^2}$

$F = 1.68 \times 10^{16} C$

Prob 25.4

charge of electron $= -1.6 \times 10^{-19} C$

charge of Proton $= +1.6 \times 10^{-19} C$

$$F = 9\times10^{-9}\ \frac{|1.6\times10^{-19}|\,|1.6\times10^{-9}|}{4\times10^{-15}}$$

$$F = 9\times10^{-9}\ \frac{2.5\times10^{-38}}{4\times10^{-15}}$$

$$\cancel{\frac{2.304\times10^{+46}}{4\times10^{-15}}}$$

$$= 14N \quad \cancel{5.76\times10^{-62}}$$

25.3

$$= 9\times10^{-9}\times\frac{|-1.6\times10^{-19}|\,|1.6\times10^{-19}|}{5.3\times10^{-11}}$$

$$4.347\times10^{-36}N$$

$8.2\times$

Coulomb's law in Vector form:-

$$\text{Curr}\ \frac{\text{charge}}{\text{Time}} = \frac{q}{t}$$

I

25.2

Current $= 2.5\times10^{4}$ $\quad I = \frac{q}{t}$

Time $= 20\,\mu s$ $\quad 20\times10^{-6}$

Charge $= ?$

$q = I.t$

$2.5\times10^{4}\times20$

$$\boxed{q = 0.5C}$$

5C

25-4 2,3,4 & 5th's a part

(2) $q_1 = 26.3\mu C \Rightarrow 26.3\times10^{-6}$

$q_2 = -47.7\mu C$

$F = 5.66$

$F = K\dfrac{q_1 q_2}{r^2}$

$r^2 = K\dfrac{q_1 q_2}{F}$

$r^2 = 9\times10^{-9}\times\dfrac{|26.3\times10^{-6}||-47.7\times10}{5.66}$

$9\times10^{-9}\times\dfrac{1.238\times10^{-9}}{5.66}$

cm → m div by 100

$r^2 = 1.9697 \cancel{\times10^{-18}}$

$r = \sqrt{1.9697\times10^{-18}}$

$r = 1.4034 \cancel{\times10^{-9}}$ — ?

(3) $q_1 = 3.12\times10^{-6}$ ~~C~~

$q_2 = -1.4\times10^{-6}$

$r = 12.3cm \Rightarrow \dfrac{12.3}{100} = 0.123$

$= 9\times10^{9}\ \dfrac{|3.12\times10^{-6}||1.4\times10^{-6}|}{0.123}$

$F = 0.3378$

(4) $r = 3.20\,mm$

$F = ma$

$m_1 \cdot a_1$ given

$F_1 = m_1 a_1$

$F_1 = F_2$; by colomb's

$m_1 a_1 = m_2 a_2$

$a_1 = 7.22\,m/s^2$

$a_2 = 9.16\,m/s^2$

$m_1 = 6.31 \times 10^{-7}\,kg$

(a) mass of second Particle

b) $= F = \frac{kq^2}{r^2}$

a)

$m_2 = \frac{m_1 a_1}{a_2}$

$= 4.555 \times 10^{-6}$

$m_2 = \frac{6.31 \times 10^{-7} \times 7.22\,m/s^2}{9.16\,ms^2}$

$m_2 = 4.9736 \times 10^{-7}$

(b)

$F_1 = 6.31 \times 10^{-7} \times 7.22$

$F_1 = 4.555 \times 10^{-6}$

as $F_1 = F_2$

$$F = k\frac{q^2}{r^2}$$

$$q^2 = \frac{Fr^2}{K}$$

$$q^2 = \frac{4.555 \times 10^{-6} \, (0.0032 m}{9 \times 10^9}$$

$$= \frac{1.4576 \times 10^{-8}}{9 \times 10^9}$$

$$q^2 = 1.6195$$

$$\boxed{q = 1.2726}$$

(5)

$F = ?$ on q_1

$q_1 = q_2 \Rightarrow 21.3 \mu C$

$d = 1.52 m$

$$F = \frac{9 \times 10^9 \times 21.3 \times 10^{-6} \times 21.3 \times 10^{-6}}{1.52}$$

$$F = 9 \times 10^9 \times 2.984 \times 10^{-10}$$

$$F = 2.686 N$$

$$q^2 = \frac{m_1 a_1 r^2}{K}$$

EMO

Electric Field:- → place whose dimensions are clear.

↳ Area/ region where a point charge can attract or repel another charge.

e.g magnets only attract in some specific area.

EF Strength/Intensity:-

Force is vect quantity

$\vec{E} = \frac{F}{q_0}$ N/C (i)

q_0 → it is test charge?

it is very very small in magnitude.

E.F direction is same as of force.

Coulomb's law only apply on point charge.

When we talk about point charg. we apply Coulomb's law.

Coulomb's law apply on two charge only.

point charge? → single charge.

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q q_0}{r^2} \quad \text{—(ii)}$$

put / apply (ii) in (i)

$$E = \frac{1}{\cancel{q_0}} \left[\frac{1}{4\pi\varepsilon_0} \frac{q \cancel{q_0}}{r^2} \right]$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

$$\boxed{E = \frac{kq}{r^2}}$$

$\frac{Er}{K}$

26-1

(i) $F = 3.60 \times 10^{-8} N$

$q = -1.6 \times 10^{-19}$

Positive charge's E.F is outward

-ve " " inward

26.2

$r = 26.5 pm \Rightarrow 26.5 \times 10^{-12}$

$q = \cancel{-1.6 \times 10^{-19}}$ → for electron

helium atom has 2 proton & 2 Elect:

ionized helium atom is the one from which one electron & proton is removed.

nucleus has 2 protons

$$E = \frac{9 \times 10^{9} \; 2(1.6 \times 10^{-19})}{26.5 \times 10^{-12}}$$

$$\frac{9 \times 10^{9} (3.2 \times 10^{-19})}{26.5 \times 10^{-12}} = 4.10 \times 10^{12}$$

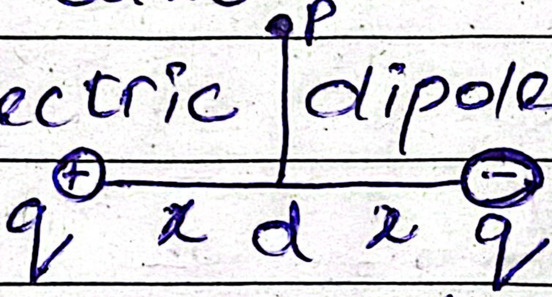
N

4^{th} 5^{th} 6^{th} 7^{th} ~~Exps~~ Exercise to be done from Chap 2.6.

EMQ

Electric Dipole:-

Combination of two charges that r opp in sign & equal in mag & separated by by a distance d is known as electric dipole.



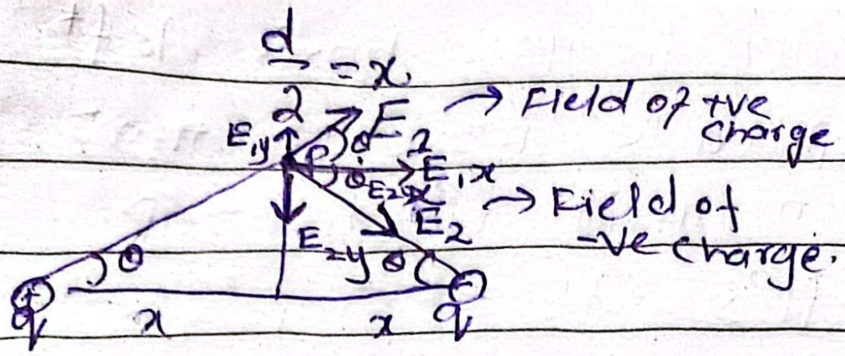
Dipole Moment → strength/Intensity of dipole.

$P = q\,d$

Find EF Intensity at point P.

Prepend = 90°

Bisect = divide in two equal points.



$E = \frac{kq}{r^2}$ → E.F intensity for Point charge

$E_1 = \frac{kq}{r_2}$ $E_2 = \frac{kq}{r^2}$

E_{1x} & E_{1y} are components of Field E_1 on x axis & y axis

E_{1x} → horizont Component

E_{1y} → vertical ״

$E_{1x} = E_1 \cos\theta$

$= \frac{kq}{r^2} \cdot \frac{x}{r}$

$\cos\theta = \frac{x}{r}$ $\therefore r = \sqrt{x^2+a^2}$

$E_y =$ zero

$\frac{kq}{(x^2+a^2)} \cdot \frac{x}{\sqrt{x^2+a^2}}$

$= \frac{kq.x}{(x^2+a^2)^{3/2}}$

$$\text{Also} \quad E_{2x} = k \frac{qx}{(x^2+a^2)^{3/2}}$$

$$E_x = E_{1x} + E_{2x}$$

$$E = \frac{2kqx}{(x^2+a^2)^{3/2}}$$

$$E = \frac{\cancel{2}kq\frac{d}{\cancel{2}}}{\left(\left(\frac{d}{2}\right)^2+a^2\right)^{3/2}}$$

$$E = \frac{kqd}{\left(\left(\frac{d}{2}\right)^2+a^2\right)^{3/2}}$$

$$E = \frac{kP}{\left(\left(\frac{d}{2}\right)^2+a^2\right)^{3/2}}$$

$$\vec{E} = k \frac{P}{\left(\left(\frac{d}{2}\right)^2+a^2\right)^{3/2}} \hat{r}$$

$$\boxed{\vec{E} = k\frac{P}{x^3}\hat{r}}$$

$\boxed{\because \text{using bionomial expansion}}$

Exercises

Q #14, 5, 6, 7

$E = \frac{F}{q}$

(4)

(a) $q = -2.0 \times 10^{-9}$ C

$F = 3.0 \times 10^{-6}$ N

$E = \frac{+3.0 \times 10^{-6}}{+2.0 \times 10^{-9}}$

$\boxed{E = 1.5 \times 10^{3}}$ N/C

(b)

magnitude & direction of force on proton

$F = Eq$

$F = (1.5 \times 10^{3})(1.6 \times 10^{-19})$

$\boxed{F = 2.4 \times 10^{-16}}$ N

(c) Gravitational Force?

$F = mg$

$F = (1.67 \times 10^{-27})(9.8)$

$F = 1.6 \times 10^{-26}$ N

(d) Ratio of Electric Force to gravitational Force

$$= \frac{2.4 \times 10^{-16}}{1.6 \times 10^{-26}} = 1.5 \times 10^{10}$$

$$\left(\left(\frac{d}{2}\right)^2 + a^2\right)^{3/2}$$

$$\left(a^2 + \frac{d^2}{4}\right)^{3/2}$$

M & D by a^2

$$a^2\left(\frac{\cancel{a^2}}{\cancel{a^2}} + \frac{d^2}{4a^2}\right)^{3/2}$$

$$\left(a^{2(3/2)}\left(1 + \frac{d^2}{4a^2}\right)^{3/2}\right.$$

$$a^3\left(1 + \frac{d^2}{4a^2}\right)$$

$$a^3\left[1 + \left(\frac{d}{2a}\right)^2\right]^{3/2}$$

Apply Binomial Exp on this below

$$\vec{E} = k \frac{P}{\left(\left(\frac{d}{2}\right)^2 + a^2\right)^{3/2}} \quad \therefore x = \frac{d}{2}$$

Chapter #26:-

Exercise #5

$$E = \frac{kq}{r^2}$$

$$\frac{Er^2}{k}$$

$q = ?$

$E = \cancel{75cm}\ 2.30\ NC$

$r = 75cm \Rightarrow 75 \times 10^{-2}$

$$q = \frac{Er^2}{k} = \frac{2.30 \times (0.750)^2}{9 \times 10^9} = 1.4375 \times 10^{-10}$$

$$\cancel{E = \frac{q}{kr^2}}$$

Q#6 $P = ?$

$d = 4.30nm$

$q = krE$

For electron & Proton.

No sign included bcz there is no requirement for direction

$q = 1.6 \times 10^{-19}$

$$P = 1.6 \times 10^{-19} (4.3 \times 10^{-9})$$

$$6.88 \times 10^{-28}\ Cm$$

Q#7

$E = ?$

$P = 3.56 \times 10^{-29}$

$d = 25.4nm$

$$E = \frac{KP}{r^3} = \frac{9 \times 10^9 (3.56 \times 10^{-29})}{(25.4 \times 10^{-9})^3}$$

$E = 1.95 \times 10^4\ N/C$

EMO

Gauss's law:-

$\therefore E = \frac{kq}{r^2}$] Point charge

applied on Point charges

$\phi = \vec{E} \cdot \vec{A}$
$\phi_E = \int \vec{E} \cdot \vec{A}$] Electric Flux

applied when charges are more.

$\phi_E = \frac{1}{\varepsilon_0}$ [Total charge enclosed by a surface]

$\phi_E = \frac{1}{\varepsilon_0}(q)$

gauss's law helps finding flux when charges are more.

$\phi_1 = \frac{1}{\varepsilon_0} q_1$

$\phi_2 = \frac{1}{\varepsilon_0} q_2$

$\phi_n = \frac{1}{\varepsilon_0} q_n$

$\phi_E = \phi_1 + \phi_2 + \dots + \phi_n$

$= \frac{1}{\varepsilon_0}[q_1 + q_2 \dots q_n]$

$\phi_E = \frac{1}{\varepsilon_0}$ [Total charge]

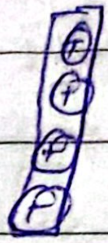
~~Elec~~tri

Has 2 applications :-

-1 E.F. Intensity of Infinite Sheet of charges.

-2 E.F. Intensity of Surface line of charges.

EFI Line of Charges :-



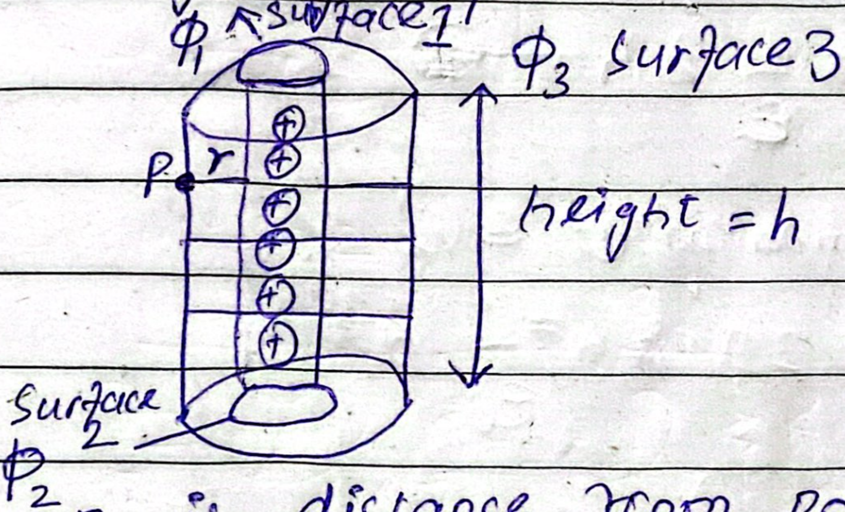
-1 Gaussian Surface → Im

-2 Charge Intensity

-3 ϕ_E by defination

-4 ϕ_E by gauss's law

→ Imaginary Surface



r is distance from point P on gaussian surface to line of charge.

When Charge are Contin distrib linearly / in a line it is linear Charge density.

$\lambda = \dfrac{dq}{d\,\text{[illegible]}}$

Sheet → Area → Charge density
Is represented by sigma

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$dq = \lambda dz$

$\int dq \quad \int \lambda dz$ When to add infinite things ~~at~~ integrate it.

(iii) $\phi_E = \phi_1 + \phi_2 + \phi_3$

$\int \vec{E} \cdot \vec{dA} + \int E \cdot dA + \int \vec{E} \cdot \vec{dA}$

$\int E dA$

$\phi_E = E \int dA$ $\qquad \phi_E = E [2\pi r \times h]$ — (1)

Area of a Cylinder

(iv) $\phi_E = \frac{1}{\varepsilon_0}(q)$ → Flux thru closed surface

$\phi_E = \frac{1}{\varepsilon_0} \lambda h$ — (2)

by comparing (i) & (ii)

$E \, 2\pi r \cancel{h} = \frac{1}{\varepsilon_0} \lambda \cancel{h}$

$E = \frac{\lambda}{2\pi r \varepsilon_0}$

$$\boxed{\vec{E} = \frac{1}{2\pi r \varepsilon_0} \hat{r}}$$

Chapter # 28

Electric Potential Energy

↳ energy due to position of an object (hidden energy)

Potential Energy

work done in moving from pos A the object to pos b is Potential energy.

$$\Delta U = -W_{done}$$

$$U_b - U_a = -W_{a \to b}$$

whenever force is applied on body & it travels then called work done.

$$\Delta U = U_b - U_a = -\int_a^b \vec{F} \cdot d\vec{s}$$

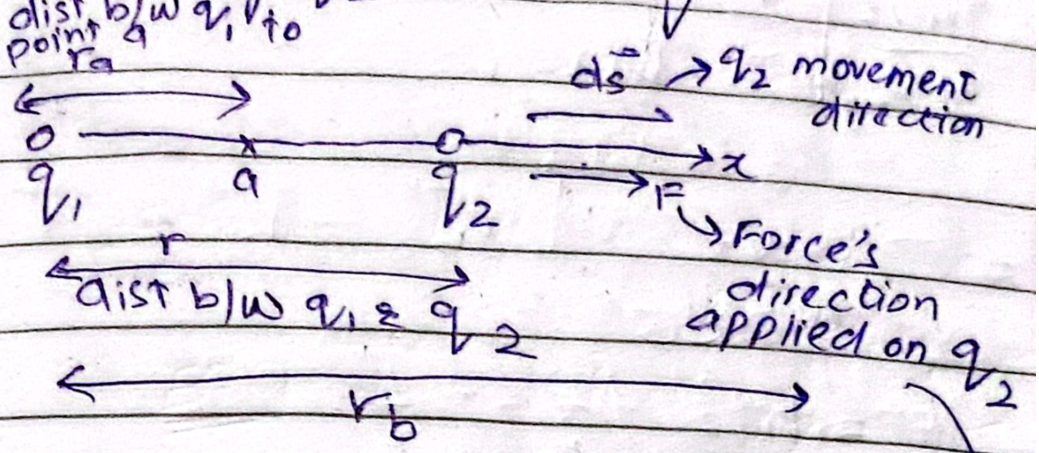
Electric Potent energy of Point charges:-

q_2 moving from pos A to D.

q_1 stationary

q_1 exerts force on q_2 &

thats why q_2 is moving



$$\Delta U = -\int_a^b F \cdot d\vec{s} \rightarrow \text{general form}$$

Form made from above diagram:

$$-\int_{r_a}^{r_b} F . dr$$

∴ From coulomb's $F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$

$$\Delta U = -\int_{r_a}^{r_b} \frac{q_1 q_2}{4\pi\varepsilon_0} \frac{1}{r^2} \, dr$$

as we want to integrate w.r.t r so $\frac{q_1 q_2}{4\pi\varepsilon_0}$ is const

$$= -\frac{q_1 q_2}{4\pi\varepsilon_0} \int_{r_a}^{r_b} r^{-2}$$

$$= -\frac{q_1 q_2}{4\pi\varepsilon_0} \left[\frac{r^{-2+1}}{-2+1} \right]_{r_a}^{r_b}$$

$$= \frac{q_1 q_2}{4\pi\varepsilon_0}\left[\frac{r^{-1}}{-1}\right]_{r_a}^{r_b}$$ = upper limit - lower limit

$$= +\frac{q_1 q_2}{4\pi\varepsilon_0}\left[r_b^{-1} - r_a^{-1}\right]$$

or $= \frac{q_1 q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)$

$$\Delta U = \frac{q_1 q_2}{4\pi\varepsilon_0}\left[\frac{1}{r_b} - \frac{1}{r_a}\right]$$

if one point lies at ∞ (it becomes zero)

$$\boxed{\Delta U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}}$$

28.1 → Exp
~~Proton~~

$r = 6.0\,fm$
$U = ?$

$q_1 = q_2 = 1.6 \times 10^{-19}$

$$\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r2}$$

$$\frac{9\times10^9\,(1.6\times10^{-19})^2}{6\times10^{-15}\,m}$$

$U = 3.8 \times 10^{-14}\,J$

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28-2

object 2 released from rest =

$K_i = 0$

$\cancel{K_f} \Rightarrow$

$r_f = 2.3\,cm$

$r_i = 4.6\,cm$

$q_1 = 32\,\mu C$

$q_2 = -18\,\mu C$

$$\Delta U = -\frac{q_1 q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_f} - \frac{1}{r_i}\right)$$

$$\Delta U = -(9\times10^9)(32\times10^{-6})(-18\times10^{-6})\left(\frac{1}{0.023m} - \frac{1}{0.046m}\right)$$

$\Delta U = 113J$

EMO

March 14, 25

Electric Potential

Potent diff is work done in moving a point charge from one Point to another

Potential Difference / Electric Potentia

$$\Delta V = \frac{\Delta U}{q_o}$$

$$\boxed{V_b - V_a = \frac{U_b - U_a}{q_o}}$$

$$\frac{V_b - V_a}{q} = \frac{\Delta U}{}$$

$$\Delta V = \frac{\Delta U}{q_o}$$

if one point lies at ∞

$$\boxed{V = \frac{U}{q}}$$

$$\boxed{U = Vq}$$

nxt week This chap's quiz in First class

28.4 Exp

$q = 2e$

$V_a = 6.5 \times 10^6$

$V_b = 0$

$\Delta V = \frac{\Delta U}{q_o}$

$\Delta V q = \Delta U$

$\Delta U = U_b - U_a = q(U_b - U_a)$

$= +2(1.6 \times 10^{-19})(0 - 6.5 \times 10^{6})$

$\boxed{\Delta U = -2.08 \times 10^{-12} J}$

Electric Potential from an Electric Field :-

Energy $\Rightarrow U$
Elect Potent = V

$$\Delta V = -\frac{\overset{\overset{\uparrow \text{from}}{U_b - U_a}}{\text{Work done}}_{a \to b}}{q_0}$$

$\therefore \vec{E} = \frac{\vec{F}}{q_0}$ $\therefore F = \vec{E} \cdot q_0$

$$= -\frac{\int_a^b \vec{F} \cdot d\vec{s}}{q_0} \Big\} \to \text{eq of work done}$$

$$= -\frac{\int_a^b \vec{E} \cdot \cancel{q_0}\, d\vec{s}}{\cancel{q_0}}$$

$$\boxed{\Delta V = \int_a^b \vec{E} \cdot d\vec{s}}$$

Electric Potential due to Point Charges :-

eq of Point charges
$\downarrow$

$q_1 \xrightarrow{\text{replaced with}} q$

$q_2 \to q_0$
$\downarrow$
use prev diagram 28.2 on book

$$= \frac{q \cdot q_1}{4\pi\varepsilon_0}\left[\frac{1}{r_b} - \frac{1}{r_a}\right]$$

$V = \frac{1}{4\pi\varepsilon_0 r}$

doing replacement of charges as written

$$= \frac{q q_0}{4\pi\varepsilon_0}\left[\frac{1}{r_b} - \frac{1}{r_a}\right]$$

$$\Delta V = \frac{1}{q_0}\left[\frac{q q_0}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)\right]$$

$$V_b - V_a = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)$$

if one point lies at infinity.

3 — $$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}}$$

→ Exp

28.7 Electric Potential = ?

$r = 7.0 \times 10^{-15}$

atomic Num = 79

Atomic Num

Num of electrons or protons

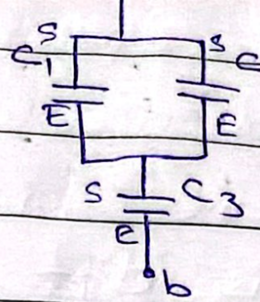
$$V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r}$$

$$= \frac{9 \times 10^{9} (79)(1.6 \times 10^{-19})}{7.0 \times 10^{-15}}$$

$$= 16251428.57$$

$$\boxed{V = 1.6 \times 10^{7}}$$

Sample # 30.5



C_{12} V-

C_{12}

$C_1 = 12\,\mu F$

$C_2 = 5.3\,\mu F$

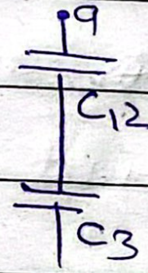
$C_3 = 4.50\,\mu F$

(a) $C_{ab} = ?$

C_1 & C_2 are in parallel

$C_{12} = C_1 + C_2 = 12 + 5.3 = 17.3\,\mu F$

circuit becomes



Q_{12}

Q_1

$Q = CV$

Now they are in Series

$C_{123} = \frac{1}{C_{12}} + \frac{1}{C_3} = \frac{C_{12}C_3}{C_{12}+C_3} \Rightarrow \frac{17.3(4.5)}{17.3+4.5}$

$\boxed{C_{123} = 3.57\,\mu F}$

(b) $\Delta V = 12.5$ charge on C_1

$Q_{Total} = C_{123} V$

$Q = 3.57 \times 12.5 \Rightarrow \boxed{Q = 44.6\,\mu C}$

$Q_{12} = \boxed{Q_{12} = 44.6}$

$V_{12} = \frac{Q}{C_{12}} \Rightarrow \frac{44.6}{17.3} = 2.58V$

Q. $q_1 = C_1 V_{12} \Rightarrow \boxed{31\,\mu C}$

$Q = CV$

$$V_{12} = \frac{Q_{12}}{C_{12}} = \frac{44.6}{17.3} = \boxed{2.58 = V_{12}}$$

So for V_1 & V_2 Voltage is 2.58 but for charge we need to find separately?

$Q_1 = C_1 V_1$

$$Q = 12(2.58) \boxed{= 30.9 = Q_1}$$

C_{1234} Parallel

V Q_1 Q

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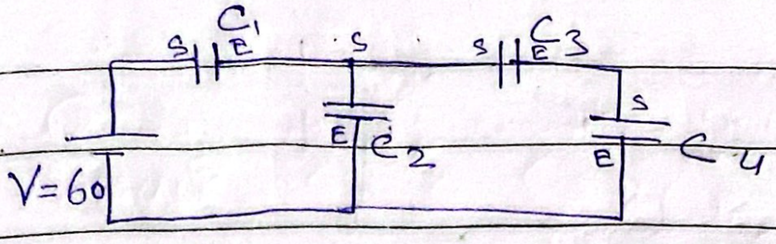


$C_1 = 40\,\mu F$ $C_2 = 20\,\mu F$ $C_3 = 60\,\mu F$

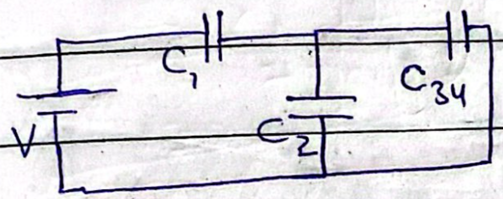
$C_4 = 30\,\mu F$

Find V_1 & V_2 & V_3 & V_4 ?

$Q = CV$

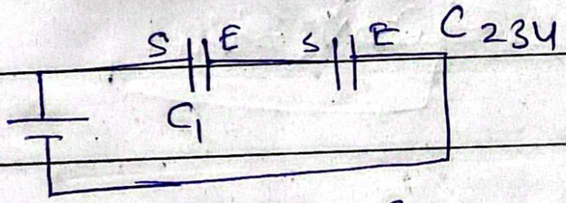
$V = \frac{Q}{C}$

$C_{34} = \cancel{C_3 + C_4 = 90}$ $C_{34} \; \frac{C_3 C_4}{C_3 + C_4} = 20$



charge = divid
Voltage = S

$C_{234} = C_2 + C_{34} = 20 + (20) = 40$



$C_{1234} = \frac{C_1 C_{234}}{C_1 + C_{234}} = \boxed{20 \leftarrow C_{1234}}$

$\boxed{Q_1 = 1200}$

$Q_{eq} = C_{eq} V$

$20(60) \boxed{= 1200\,\mu C}$

$Q_1 = 1200\,\mu C$ $Q_{234} = 1200\,\mu C$

$V_1 = \frac{q_1}{C_1} = \frac{1200}{40} = \boxed{30V \leftarrow V_1}$

$V_{234} = \frac{Q_{234}}{C_{234}}$

1200

Q $\cancel{V_{234}}$ = C_2 & C_{34} are parallel
charge divide Voltage is same

Q_2 & Q_{34} = ?

$$V_{234} \Rightarrow \frac{Q_{234}}{C_{234}} = \frac{1200}{40} \Rightarrow \boxed{30V \Leftarrow V_{234}}$$

$\boxed{V_2 = 30V}$ $V_{34} = 30V$ $Q_{34} = C_{34} V_{34}$

$Q_{34} = (20)(30) = 600$

C_3 & C_4 are in series Current same
Voltage = divide

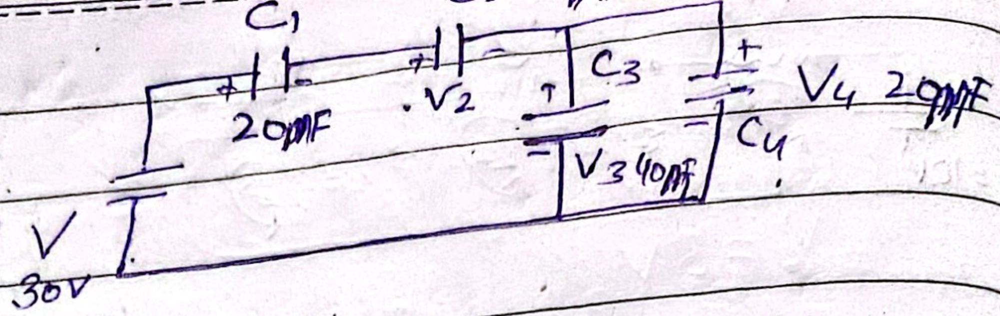
$V_3 = Q_3$

$Q_3 = \cancel{C_3 V_3}$ 600 nC

$Q_4 = \cancel{C_4 V_4}$ 600 nC

$$V_3 = \frac{Q_3}{C_3} = \frac{60\cancel{0}}{6\cancel{0}} = \boxed{10V \Leftarrow V_3}$$

$$V_4 = \frac{60\cancel{0}}{3\cancel{0}} = \boxed{20V \Leftarrow V_4}$$



Find V_1 V_2 V_3 & V_4

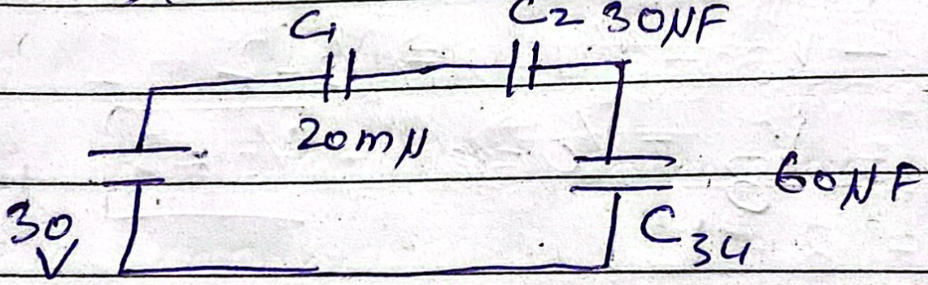
$Q = CV$

Solving C_3 & C_4

$C_{34} = C_3 + C_4$

$C_{34} = 40 + 20$

$C_{34} = 60$



$C_{234} = \frac{1}{C_2} + \frac{1}{C_{34}}$

$C_{234} = \frac{C_2 C_{34}}{C_2 + C_{34}} = \frac{30(60)}{30+60} = 20$

$C_{1234} = \frac{C_1 C_{234}}{C_1 + C_{234}} = \frac{20(20)}{20+20} = 1$

M T W T F S

$C_{1234} = 10\,mN$

As this is series

So charge is same

Voltage is divided

$Q_{eq} = CV$

$Q_{eq} = 10(30)$

$\boxed{Q == 300C}$

$q_1 = 300 \qquad q_{234} = 300mC$

$V_1 = \frac{q_1}{C_1} = \frac{300}{20} \Rightarrow \boxed{V_1 = 15}$

$V_{234} = \frac{300}{20} = \boxed{15V \Leftarrow V_{234}}$

$Q_{234} = C_{234} V_{234}$

$Q_{234} = 20(15) \qquad = 300\,mC$

$q_2 = 300 \qquad q_{34} = 300$

$V_2 = \frac{300}{30} \Rightarrow \boxed{V_2 = 10}$

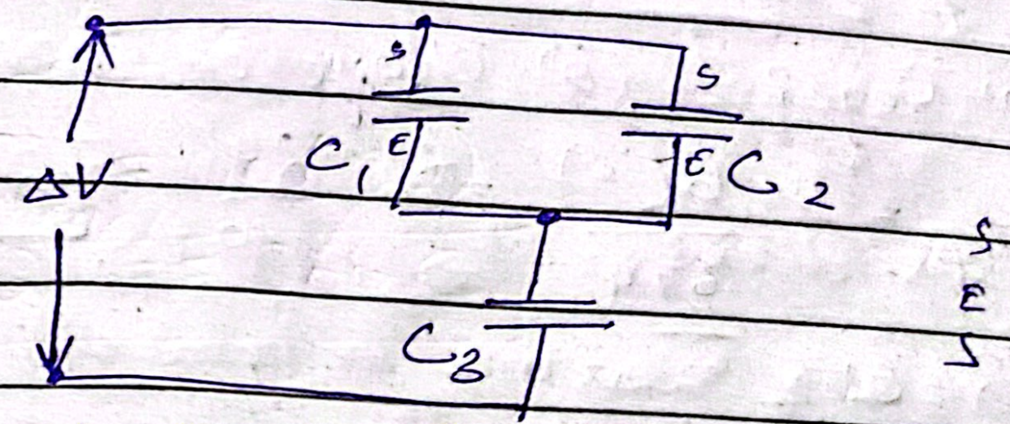
$$V_{34} = \frac{300}{60} = \boxed{50\,V} \quad V_{34}$$

as C_{34} is parallel
so Voltage is same
current is diff

$\boxed{V_3 = 50}$ $\boxed{V_4 = 50}$

Relevant Q's are 9, 10, 11, 13, 14

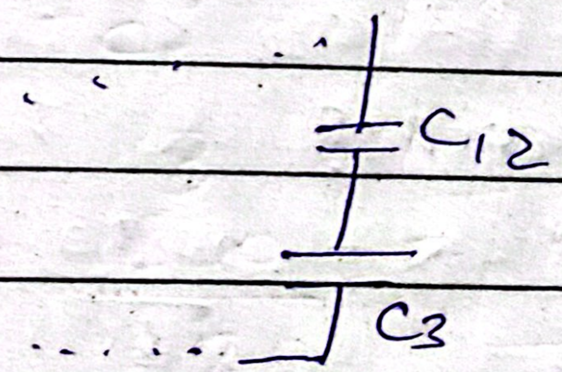
(10) $C_{eq} = ?$



$C_1 = 10.3\ \mu F$ $C_2 = 4.8$ $C_3 = 3.9$

C_1 & C_2 in parallel

$C_{12} = C_1 + C_2 \Rightarrow 10.3 + 4.8 = 15.1$



C_{12} & C_3 in series

so $C_{123} = \dfrac{C_{12}C_3}{C_{12}+C_3} = \dfrac{15.1(3.9)}{15.1+3.9}$

$\boxed{C_{123}\ 3.1\ \mu F}$?