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Assignment 2

Physics 105

Section: A

Date - 5-10-2021

## Ans to the qsn NO: 1

$q_1 = 26.0\,\mu C$

$= 26 \times 10^{-6} C$

$q_2 = 47.0\,\mu C$

$= 47 \times 10^{-6} C$

$F = 5.70\ N$

$k = 9 \times 10^9\ Nm^2 C^{-2}$

$r = ?$

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

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

$$r = \sqrt{\frac{k q_1 q_2}{F}}$$

$$= \sqrt{\frac{(9\times10^9)(26\times10^{-6})(47\times10^{-6})}{5.70}}$$

$= 1.389\ m$

Ans:

## Ans to the qsn no: 2

$a_1 = 7 ms^{-2}$

$a_2 = 9 ms^{-2}$

$m_1 = 6.3 \times 10^{-7} kg$

$r = 3.2 \times 10^{-3} m$

$q_1 = q_2$ (a)

the mass of the second particle

$F = ma$

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

$q_1 = q_2 = q$

we know,

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

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

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

$$= \frac{(6.3\times10^{-7})\times 7\times(3.2\times10^{-3})^2}{9\times10^{9}}$$

For $m_2$

$$m_2 a_2 = \frac{ka^2}{r^2}$$

$$m_2 = \frac{(9\times10^{9})\times(7.08\times10^{-11})^2}{(3.2\times10^{-3})^2\times 9}$$

$$= 4.9\times10^{-7}\ kg.$$

(b)

$$F = ma,$$

$$F = \frac{ka_1a_2}{r^2}$$

$$\frac{ka_1a_2}{r^2} = ma$$

$$\frac{a^2k}{r^2} = ma$$

$$q^2 = \frac{mar^2}{k}$$

$$q^2 = \frac{(6.3\times10^{-7}) \times 7 \times (3.2\times10^{-3})^2}{9\times10^{9}}$$

$$q^2 = 5.0176\times10^{-21}$$

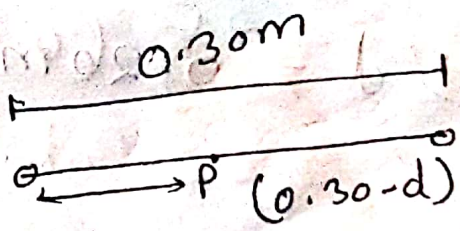
$$q = 7.08\times10^{-11}\ C$$

Ans:

## Ans to the qn 3

$q_1 = +4q$

$q_2 = +q$




$r = 30\ cm$

$= 0.30\ m$

the electric field is zero

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

$$E_1 = E_2$$

$$\frac{4k}{d^2} = \frac{k}{(0.30-d)^2}$$

$$\Rightarrow 4(0.30-d)^2 = d^2$$

$$\Rightarrow (0.30-d)^2 = \frac{d^2}{4}$$

$$\Rightarrow 0.30-d = \frac{d}{2}$$

$$\Rightarrow 0.60-2d = d$$

$$\Rightarrow 3d = 0.60$$

$$\Rightarrow d = 0.20\,m$$

Ans.

## Ans to the qsn No: 4

$$\vec{A} = (4\hat{i} + 5\hat{j})\ m^2$$

(a)

$$E = 2\hat{i}\ NC^{-1}$$

$$\phi = \oint \vec{E} \cdot \vec{dA}$$

$$= \vec{E} \cdot \vec{A}$$

$$= (4\hat{i} + 5\hat{j}) \cdot 2\hat{i}$$

$$= 8\ Nm^2/C$$ Ans

(b)

$$E = 3\hat{k}\ N/C$$

$$A = 4\hat{i} + 5\hat{j}$$

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

$$= (4\hat{i} + 5\hat{j}) \cdot 3\hat{k}$$

$$= 0$$

Ans:

## Ans to the Qun no: 5.

~~E = 3.0 NM/C~~

$E = 3.0\ NM/C$

$= 0.003\ N/C$

$a = 11cm$

$= 0.11m$

Now,

$$\phi = \oint \vec{E} \cdot d\vec{A} \cdot -\hat{i}$$

$$= \oint (0.003) \cdot (d\vec{A}) \cdot -\hat{i}$$

$$= -0.003A$$

$$= -0.003 \times \pi \times (0.11)^2$$

$$= -0.003 \times \pi \times 12.1 \times 10^{-3}$$

$$= -1.14 \times 10^{-4}$$

$$|\phi| = 1.14 \times 10^{-4}\ Nm^2/C$$

Ans

## Ans to the qun No: 6

atmospheric electricity. $E = 100 NC^{-1}$

acting downward, $d = 100 km$

$= 10^5 m$

Ionosphere Voltage $(V) = ?$

We know,

$$E = \frac{V}{d}$$

$$V = Ed$$

$$= 100 \times 10^5$$

$$= 10^7 V$$ Ans.

## Ans to the qnn No: 7

$r = 9.23\ fm = 9.23 \times 10^{-15}\ m$

$\varepsilon_0 = 8.854 \times 10^{-12}\ fm^{-1}$

$e = 1.6 \times 10^{-19}\ C$

$q_1 = 2e \quad (n=2)$

$q_2 = 79e \quad [n = 79]$

We know,

$$\Delta K = -\Delta U$$

$$\Rightarrow K_i + U_i = K_f + U_f$$

$$\Rightarrow K_i + 0 = 0 + U_f$$

$$K_i = U_f$$

$$= \frac{q_1 q_2}{4\pi\varepsilon_0 r}$$

$$= \frac{2e \times 79e}{4\pi \times (8.854 \times 10^{-12}) \times (9.23 \times 10^{-15})}$$

$$= \frac{2 \times (1.6 \times 10^{-19}) \times 79 \times (1.6 \times 10^{-19})}{4\pi \times (8.854 \times 10^{-12}) \times (9.23 \times 10^{-15})}$$

$$= 3.94 \times 10^{-12} \text{ J}$$

kinetic energy $K_i = 3.94 \times 10^{-12}$ J.

Ans.

Ans to the qm No: 8

molecule, $d = 1.12$ pm

$= 1.12 \times 10^{-12}$ m

Charge $q = \pm 18e$

Dipole moment, $P = ?$

we know the value of $e = 1.6 \times 10^{-19}$ C

$P = |q| d$

$= |\pm 18e| \cdot (1.12 \times 10^{-12})$

$= 18e \ (1.12 \times 10^{-12})$

$= 18 \times (1.6 \times 10^{-19}) \times (1.12 \times 10^{-12})$

$= 3.22 \times 10^{-30}$ cm

Ans:

## Ans to the qun No: 9

$m_1 = 23\,g$

$m_2 = 4\,g$

initial speed $v = 10^6$ m/s

$k = 8.99 \times 10^9\ Nm^2C^{-2}$

$q_e = 1.6 \times 10^{-19}\ C$

Now,

$U_e = k$

$$\Rightarrow \frac{k q_1 q_2}{r} = \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2$$

$$\Rightarrow k \frac{11e \times 2e}{r} = \frac{1}{2} v^2 (m_1 + m_2)$$

$$\Rightarrow \frac{22 e^2 k}{r} = \frac{1}{2} v^2 (m_1 + m_2)$$

$$\Rightarrow r = \frac{22 \times 2 \times (1.6 \times 10^{-19})^2 \times (8.99 \times 10^9)}{(10^6)^2 \times (23 + 4)}$$

$\Rightarrow r = 3.75 \times 10^{-10}$ m

Ans.

## Ans to the qsn No: 10

$d = 1$ mm

$= 1 \times 10^{-3}$ m

$r = 10$ cm $= 0.1$ m

$\varepsilon_0 = 8.85 \times 10^{-12}$

we know.

$A = \pi r^2$

$= \pi (0.1)^2$

$= 0.0314$ m

$$C = \frac{A\varepsilon_0}{d} = \frac{0.0314 \times (8.85 \times 10^{-12})}{1 \times 10^{-9}}$$

$$= 2.780 \times 10^{-4}$$

$q = CC = (2.780 \times 10^{-4}) \times 100$

$= 0.0278$ C Ans

## Ans to the qsn NO: 11

$a = 30\,cm = 0.3\,m$

$b = 31\,cm = 0.31\,m$

$v = 500\,V$ $\quad \varepsilon_0 = 8.85 \times 10^{-12}$

we know,

$$e = 4\pi\varepsilon_0 \left(\frac{ab}{b-a}\right)$$

$$= 4\pi \times (8.85 \times 10^{-12}) \left(\frac{0.3 \times 0.31}{0.31 - 0.3}\right)$$

$$= 1.03 \times 10^{-9}\,F$$

$$q = ev$$

$$= (1.03 \times 10^{-09}) \times 500$$

$$= 5.15 \times 10^{-7}\,C$$

Ans:

## Ans to the qun no:12

$r = 6370\ km$

$= 6370 \times 10^3\ m$ $\quad \varepsilon_0 = 8.85 \times 10^{-12}$

we know.

$$e = 4\pi\varepsilon_0 r$$

$$= 4\pi \times (8.85 \times 10^{-12}) \times (6370 \times 10^3)$$

$$= 7.084 \times 10^{-4}\ F$$

Ans:

## Ans to the qun no:13

$a = 0.15\ mm = 0.15 \times 10^{-3}\ m$

$b = 2.1\ mm = 2.1 \times 10^{-3}\ m$

$L = 1$ $\quad \varepsilon_0 = 8.85 \times 10^{-12}$

we know

$$e = 2\pi\varepsilon_0 \frac{L}{\ln\left(\frac{b}{a}\right)}$$

$$= 2\pi\varepsilon_0 \frac{1}{\ln\left(\frac{2.1 \times 10^{-3}}{0.15 \times 10^{-3}}\right)} = 2\pi\varepsilon_0 (0.379)$$

$= 2\pi (8.85 \times 10^{-12}) (0.379)$

$= 2.10748 \times 10^{-11}$ F

Ans.

Am to the qnn no: 14

Sub:

## Ans to the qun No: 19

$C_1 = 10\,\mu F$

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

$V = 10\ V$

(a)

$q_1 = C_1 V$

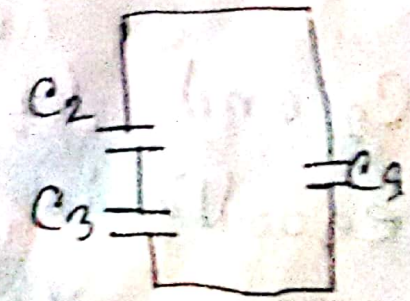
$= (10 \times 10^{-6}) \times 10$

$= 1 \times 10^{-4}\ C$

$= 100\,\mu C$

(b)

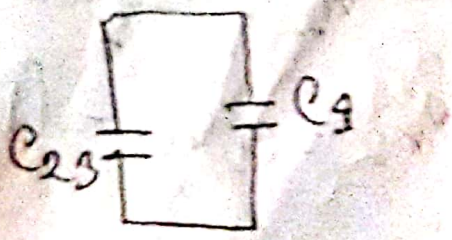
$C_2 = C_3 = C_4 = 10\,\mu F$




$\frac{1}{C_3} = \frac{1}{C_2} + \frac{1}{C_3}$

$= \frac{2}{10} + \frac{1}{10}$

$C_3 = 5\,\mu F$



$C_p = C_{234}$

$= C_{23} + C_4$

$= 5 + 10 = 15\,\mu F$

Now,

$V_1 = 10\,V$

voltage drop $V = \dfrac{C_4}{C_{234} + C_4} V_1$

$= \dfrac{10}{15 + 10} \times 10$

$= 4$

$C_2$ and $C_3$ connected between equally in series

$V_2 = \dfrac{V}{2}$

$q_2 = C_2 V_2 = (10 \times 2) = 20\,\mu C$

$= 20 \times 10^{-6}\,C$

Ans

Sub :

Day

Time :

Date / /

## Ans to the qun No:15

$V_1 = 9.0\,V$

$C_1 = C_2 = 30\,\mu F$

$C_3 = C_4 = 15\,\mu F$

(i)

Charge on capacitor 4

$C_{34} = C_3 + C_4 = 15 + 15 = 30\,\mu F$

$V_1 = 9\,V$

Since $C_3$ and $C_4$ connected between equally in series.

$$V_4 = \frac{V_1}{2} = \frac{9}{2} = 4.5\,V \quad 3\,V$$

$$q_4 = C_4 V_4 = 15 \times \frac{9}{3} = 45\,\mu C$$

$$= 45 \times 10^{-6}\,C$$

Ans

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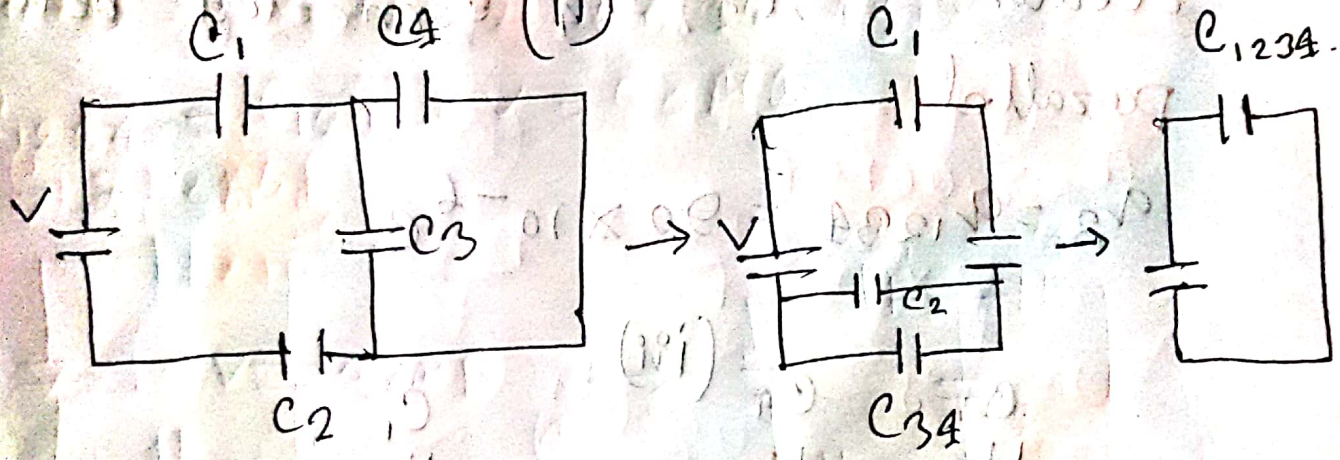
Time : Date : / /

(ii)




$$\frac{1}{C_{1234}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_{34}}$$

$$= \frac{1}{30} + \frac{1}{30} + \frac{1}{30}$$

$$= \frac{3}{30}$$

$C_{34} = C_3 + C_4$

$= 15 + 15$

$= 30$

$C_{1234} = 10\ \mu F$

$q_{1234} = C_{1234} V$

$= 10 \times 9 \quad V = 9$

$= 90\ \mu C$

$= 90 \times 10^{-6}\ C$

Sub :

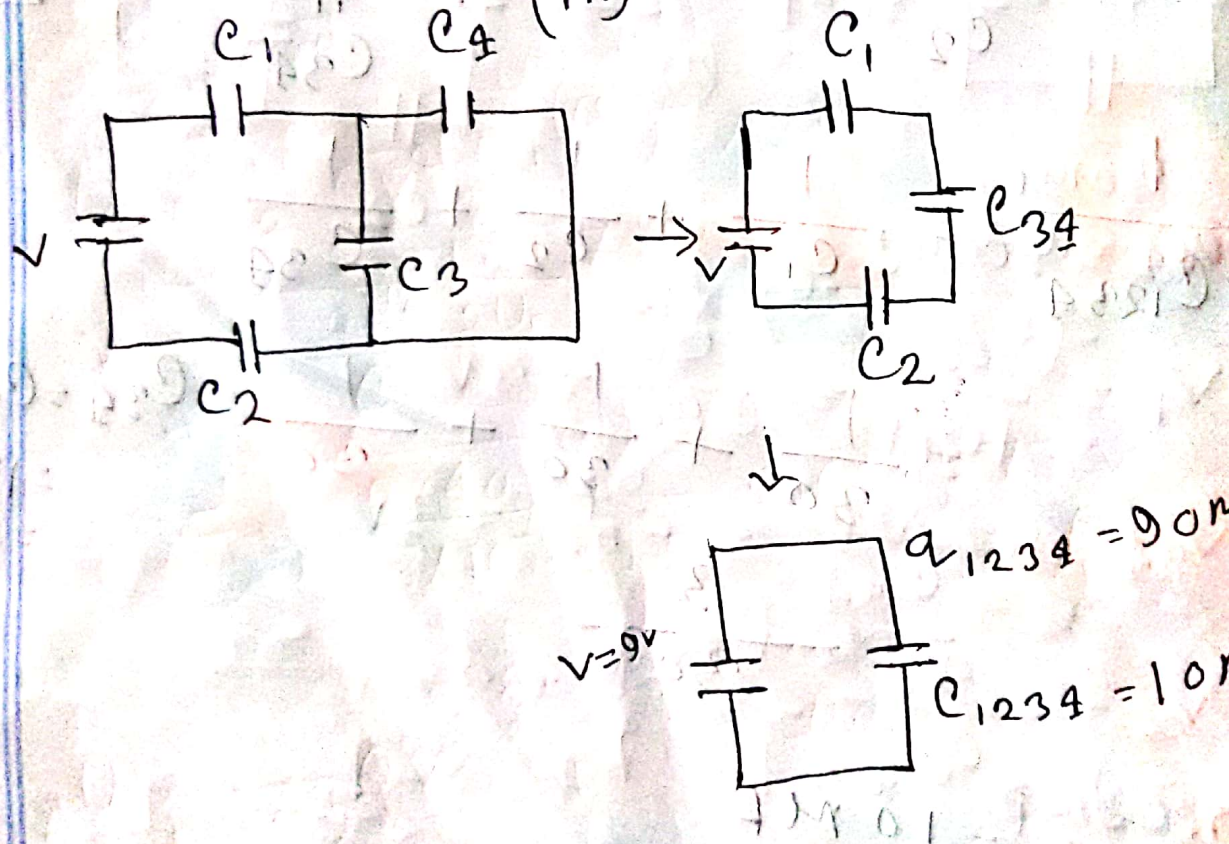
Day

Time Date / /

because $C_1, C_2, C_{34}$ connected between parallel.

$q_2 = q_{1234} = 90 \times 10^{-6} C$

(iii)




Now,

$C_1 = C_2 = 30 MF$

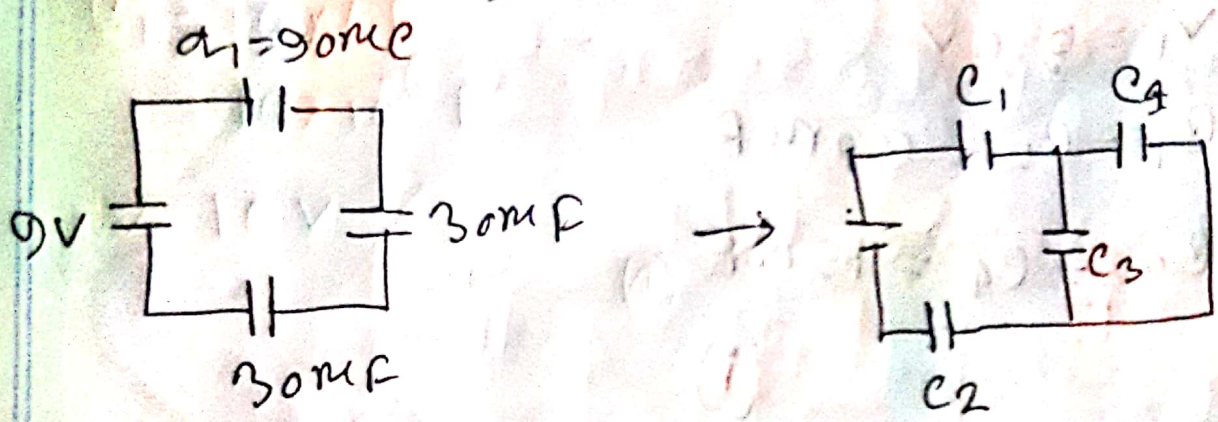
$C_3 = C_4 = 15 MF$

$C_{34} = 30 MF$ [$C_{345} = C_3 + C_4 = 15 + 15 = 30$

$V = 9$

$C_{1234} = 10\,\mu F$

$C_{1234} = C_{1234} \times V = 90\,\mu C$




$q_2 = 90\,\mu C$

$$V_1 = \frac{q_1}{C_1} = \frac{90}{30} = 3V$$

$$V_{34} = \frac{q_{34}}{C_{34}} = \frac{90}{30} = 3V$$

$$V_2 = \frac{q_2}{C_2} = \frac{90}{30} = 3V$$

voltage drop

$$V = \frac{V_{34}}{2} = \frac{3}{2} = 1.5\,V$$

Ans

~~Ans to the qm No: 15~~

(9V)

$C_1 = 30\mu F$

From (ii)

$q_{1234} = q_1 = q_2 = q_{34} = 90\mu C$

$V_1 = \frac{q}{C_1} = \frac{90}{30} = 3V$

Ans.

Sub :

Day

Time : Date : / /

## Ans to the qn No: 16

$C = 8.00\mu F$

$= 8 \times 10^{-6} F$

$U = 40 J$

(a)

$U_c = \frac{1}{2} CV^2$

$V = \sqrt{\frac{2U_c \cdot 2U_c}{C}}$

$= \sqrt{\frac{2 \times 40}{8 \times 10^{-6}}} = 3162.277 V$ Ans:

(b)

$U_c = \frac{1}{2} QV$

$Q = \frac{2U_c}{V}$

$= \frac{2 \times 40}{3162.277}$

$= 0.025 C$

Ans:

Sub:

Day

Time: Date: / /

## Ans to the Qm No: 17

$D = 3.2\,mm$

$= 3.2 \times 10^{-3}\,m$

$L = 4\,m$

$n = 8.49 \times 10^{28}$

$R = 75\,\Omega$

$E = 11\,V$

$r = 0.8\,\Omega$

(a)

$$I = \frac{E}{R+r} = \frac{11}{75+0.8}$$

$= 0.145\,amp$ Ans:

(b)

$$J = \frac{I}{A} = \frac{0.145}{\pi\left(\frac{D}{2}\right)^2} = \frac{0.145}{\pi\left(\frac{3.2\times10^{-3}}{2}\right)^2}$$

$= 1.1719 \times 10^{16}\,Amp/m^2$ Ans.

Sub :

Day

Time Date

(c)

$V = IR = 0.145 \times 75$

$= 10.5\ V$ Ans.

(d)

$P = I^2R = (0.145)^2 \times 75$

$= 1.47\ W$ Ans.

(e)

$P = I^2R = (0.145)^2 \times 0.8$

$= 0.015\ W$ Ans.

(f)

$$\rho = \frac{RA}{L} = \frac{75 \times \pi \times \left(\frac{3.2 \times 10^{-3}}{2}\right)^2}{4}$$

$= 2.23 \times 10^{-15}\ \Omega$

Ans.