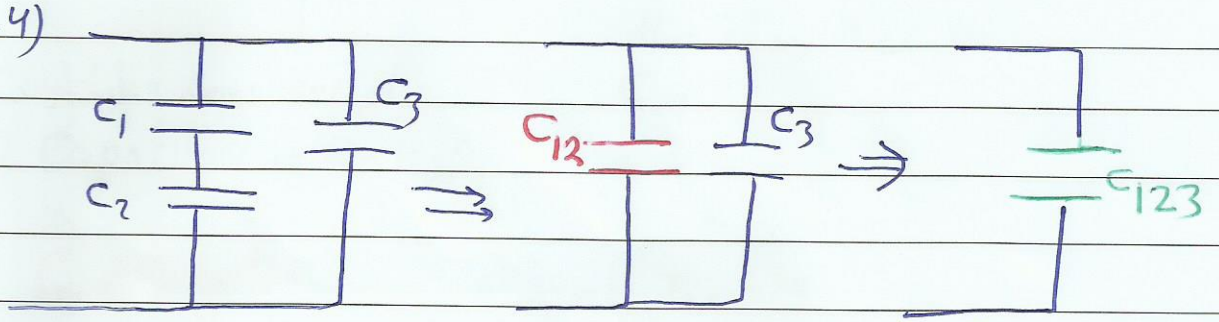
(25) Capacitance Discussion

(25-4)



$C_1 = 10\mu F$
$C_2 = 8\mu F$ Find
$C_3 = 4\mu F$ C_{eq}

$C_1 + C_2$ in Series

$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{12}} = \frac{1}{10} + \frac{1}{8}$$

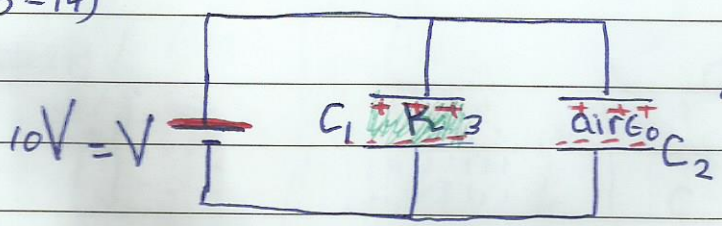
$$\frac{1}{C_{12}} = \frac{4+5}{40}$$

$$C_{12} = \frac{40}{9}\,\mu F = 4.44\,\mu F$$

C_{12} and C_3 in Parallel

$$C_{123} = C_{12} + C_3$$
$$= 4.44 + 4$$
$$C_{123} = 8.44\,\mu F$$

(25-14)



$A = 5 \times 10^{-3}\,m^2$
$d = 2\,mm$

$$C_1 = \frac{K\epsilon_0 A}{d} = \frac{3(8.85\times10^{-12})(5\times10^{-3})}{2\times10^{-3}}$$

$$C_1 = 3(2.2125\times10^{-11})$$
$$= 6.64\times10^{-11}\,F$$
$$= 66.4\,pF$$

$$q_1 = C_1 V = (66.4\,pF)(10)$$
$$= 664\,pC$$

$$C_2 = \frac{\epsilon_0 A}{d} = \frac{8.85\times10^{-12}\times5\times10^{-3}}{2\times10^{-3}}$$

$$C_2 = 2.21\times10^{-11}\,F$$
$$= 22.1\,pF$$

$$q_2 = C_2 V = (22.1\,pF)(10V)$$
$$= 221\,pC$$

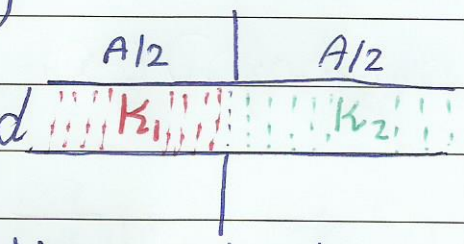
$$q_{tot} = q_1 + q_2 = 664 + 221 = 885\,pC$$

(or)

$$q_{tot} = C_{eq} V = (C_1 + C_2)V = (22.1\,pF + 66.4\,pF)(10) = 885\,pC$$

①

(25-18)



$A = 5.56\ cm^2$

$d = 5.56\ mm$

$K_1 = 7$,,, $K_2 = 10$

C_{eq} ?

Could be considered
2 Capacitors in Parallel

$$C_1 = \frac{K_1 \epsilon_0 A/2}{d} \qquad C_2 = \frac{K_2 \epsilon_0 A/2}{d}$$

$$C_1 = \frac{K_1 \epsilon_0 A}{2d} \qquad C_2 = \frac{K_2 \epsilon_0 A}{2d}$$

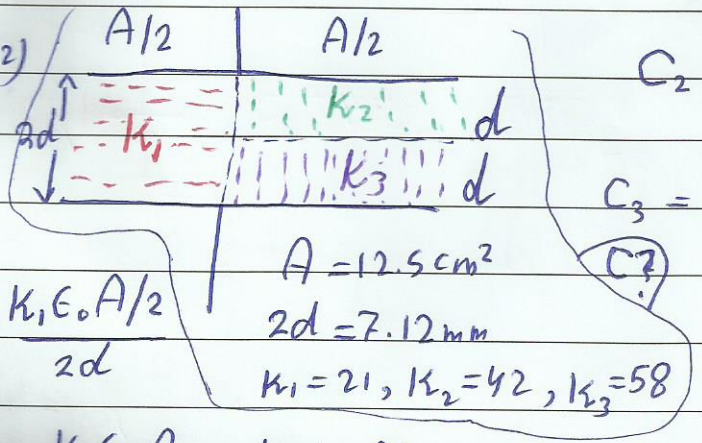
$$C_{eq} = C_1 + C_2 = \frac{K_1 \epsilon_0 A}{2d} + \frac{K_2 \epsilon_0 A}{2d}$$

$$= \frac{\epsilon_0 A}{d}\left(\frac{K_1 + K_2}{2}\right) = \frac{(8.85\times10^{-12})(5.56\times10^{-4})}{5.56\times10^{-3}}\left(\frac{7+10}{2}\right)$$

$$= 8.85\times10^{-13}\left(\frac{17}{2}\right) = 7.52\times10^{-12}\ F$$

$C = 7.52\ pF$

(25-22)



$A = 12.5\ cm^2$

$2d = 7.12\ mm$

$K_1 = 21$, $K_2 = 42$, $K_3 = 58$

$$C_1 = \frac{K_1 \epsilon_0 A/2}{2d}$$

$$C_1 = \frac{K_1 \epsilon_0 A}{4d} = \frac{K_1}{2}\left(\frac{\epsilon_0 A}{2d}\right)$$

$$= \frac{K_1}{2}\left(\frac{8.85\times10^{-12}\times12.5\times10^{-4}}{7.12\times10^{-3}}\right)$$

$$= \frac{21}{2}\left(1.554\times10^{-12}\right)$$

$C_1 = 1.63\times10^{-11}\ F$

$C_1 = 16.3\ pF$

$$C_2 = \frac{K_2 \epsilon_0 A/2}{d} = \frac{K_2 \epsilon_0 A}{2d}$$

$$C_3 = \frac{K_3 \epsilon_0 A/2}{d} = \frac{K_3 \epsilon_0 A}{2d}$$

C?

$$C_2 = K_2\left(\frac{\epsilon_0 A}{2d}\right)$$

$$= 42\left(1.554\times10^{-12}\right)$$

$$= 6.53\times10^{-11}\ F$$

$$C_3 = K_3\left(\frac{\epsilon_0 A}{2d}\right)$$

$$= 58\left(1.554\times10^{-12}\right)$$

$$= 9\times10^{-11}\ F$$

$C_2 = 65.3\ pF$

$C_3 = 90\ pF$

C_2 & C_3 in Series $\Rightarrow \frac{1}{C_{23}} = \frac{1}{C_2} + \frac{1}{C_3}$

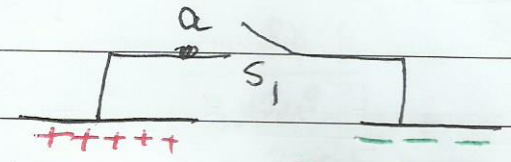
$\frac{1}{C_{23}} = \frac{1}{65.3} + \frac{1}{90} \Rightarrow C_{23} = \frac{(65.3)(90)}{65.3+90} = 37.8\ pF$

C_{23} is in Parallel with C_1

$C_{231} = C_{23} + C_1 = 37.8 + 16.3$

$C_{231} = 54.14\ pF$

(25-39)

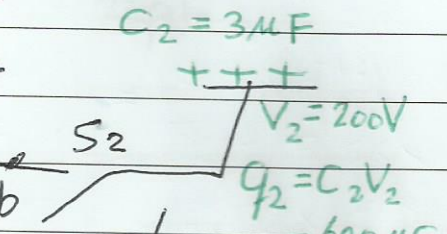


$C_1 = 1\mu F$

$V_1 = 200V$

$q_1 = C_1 V_1$

$= 200\mu C$

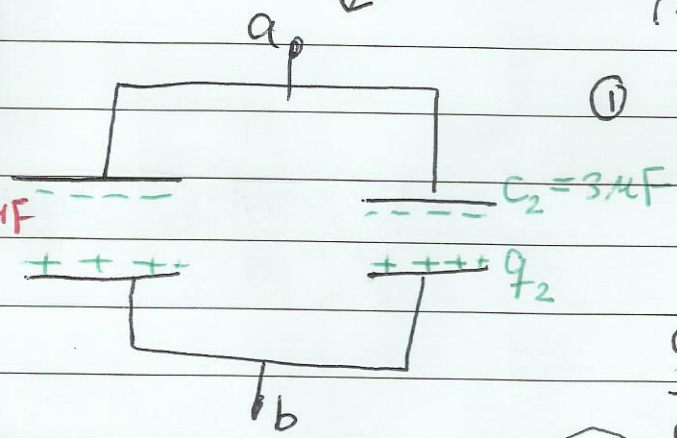


$C_2 = 3\mu F$

$V_2 = 200V$

$q_2 = C_2 V_2$

$= 600\mu C$



After closing S_1 & S_1

① $V_{ab} = V_1' = V_2'$

$V_{ab} = \frac{q_1'}{C_1'} = \frac{q_2'}{C_2}$

$\frac{q_{tot}}{C_{eq}} = \frac{q_1'}{1} = \frac{q_2'}{3}$

$\frac{400}{C_1 + C_2} = \frac{q_1'}{1} = \frac{q_2'}{3}$

$\frac{400}{4} = 100V = \frac{q_1'}{1} + \frac{q_2}{3}$

$q_1' = 100\mu C$,, $q_2 = 3(100) = 300\mu C$

② $q_{t_{before}} = q_{after}$

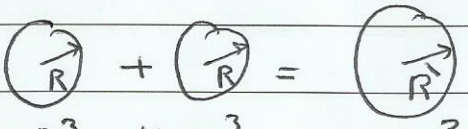
$q_1 + q_2 = q_1' + q_2'$

$600 + 200 = q_1' + q_2'$

$400 = q_1' + q_2'$

$V_{ab} = 100V$

(25-45)



$\text{Mass}_i = \text{Mass}_f$

$R = 3\,mm$

$$\frac{4}{3}\pi R^3 + \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R'^3$$

$$2\left(\frac{4}{3}\pi R^3\right) = \frac{4}{3}\pi R'^3 \Rightarrow R'^3 = 2R^3$$

$$R' = \sqrt[3]{2}\,R = 1.26R = 1.26(3\times10^{-3})$$

$$R' = 3.78\,mm = 3.78\times10^{-3}\,m$$

$$C' = 4\pi\epsilon_0 R' = 4\pi\epsilon_0(1.26R)$$

$$= \frac{3.78\times10^{-3}}{9\times10^{9}} = 4.2\times10^{-13}\,F$$

$$= 0.42\,pF$$