Assignment #3

1. a) $u = \frac{kq^2(r_1 - r_2)}{(r_1 \cdot r_2)} = \frac{(8.988\times10^9)(1.6\times10^{-19}C)^2(1.99998\times10^{-10})}{(2\times10^{-10})(3\times10^{-5})}$

$\therefore = 7.669683024\times10^{-14} J$

b) $v = \sqrt{2KE/m}$

$v = \sqrt{45.96502\times10^{12}}$

$\therefore v = 6.77975\times10^6 m/s$

2. a) $v_{initial} = 3\times10^6 m/s \quad v_{final} = 8\times10^6 m/s$

$KE_1 + PE_1 = KE_2 + PE_2$

$PE_n = qV_n$

$KE_2 - KE_1 = (PE_1 - PE_2) = q(V_1 - V_2) = q(\Delta V)$

$\frac{1}{2}m(8\times10^6)^2 - \frac{1}{2}m(3\times10^6)^2 = -1.602\times10^{-19}(\Delta V)$

$\Delta V = \frac{\frac{1}{2}m(8\times10^6)^2 - \frac{1}{2}m(3\times10^6)^2}{-1.602\times10^{-19}}$

$\Delta V = -1.56 V$

b) $0 - K_1 = -q(V_1 - V_2)$

$-\frac{1}{2}m(8\times10^6)^2 = -q(\Delta V)$

$\Delta V = \frac{-\frac{1}{2}m\cdot(8\times10^6)^2}{-1.602\times10^{-19}}$

$= 182 V$

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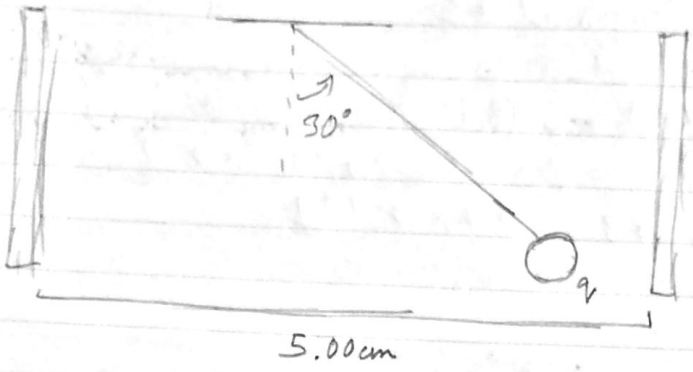
3.



The system is stationary, thus the force is at equilibrium.

$$\Sigma F_y = T\cos\theta - mg = 0$$
$$T = \frac{mg}{\cos\theta}$$

$$\Sigma F_x = q\mathcal{E} - T\sin\theta = 0$$
$$q\mathcal{E} = T\sin\theta = mg\tan\theta$$
$$\mathcal{E} = \frac{mg}{q}\tan\theta$$

The $\mathcal{E}$ field is constant, so the potential difference between the two plate is given by.

$$\Delta V = \int_{left}^{right} \mathcal{E}\cdot dx = \mathcal{E}\int_{left}^{right} dx = \mathcal{E}d$$

The potential difference between the plate is:

$$\Delta V = \mathcal{E}d = \frac{mgd}{q}\tan\theta$$
$$= \left(\frac{(1.5\times10^{-3}\ kg)(9.8\ m/s^2)(5\times10^{-2}\ m)}{8.9\times10^{-6}\ C}\right)\tan(30)$$
$$= 47.7\ V$$

5. a) $C = 4\pi\varepsilon_0 \frac{r_1 r_2}{r_2 - r_1} = \frac{(4\times10^{-3})(38\times10^{-3})}{(8.988\times10^{9})(40-38)\times10^{-3}}$

$= 84.5\ pF$

$\therefore = 84.5\times10^{-12}\ F$

b) $C = \frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{r_2 - r_1}$

$A = \frac{C(r_2 - r_1)}{\varepsilon_0} = \frac{(84.5\times10^{-12})(40-38)\times10^{-3}}{(8.85\times10^{-12})}$

$\therefore = 191\times10^{-4}\ m^2$

4. a) $V_B - V_A = \Delta U / q = -U/(-e) = -(3.94\times10^{19}J)/(-1.6\times10^{-19}C)$

$\therefore = 2.46\ V$

b) $V_C - V_A = V_B - V_A = 2.46\ V$

c) $V_C - V_B = 0$ Because C and B are both on the same Equipotential line.

6. * I don't understand "$C_1 \times 10.0\mu F$"
Assuming "$C_1 = 10.0\mu F$"

$C_1 + C_2 = 10\mu F + 5\mu F = 15\mu F$

The resultant capacitance is in series with C_3.

Equivalent capacitance $= \frac{15\mu F \times 4\mu F}{(15\mu F + 4\mu F)}$

$\therefore = 3.158\mu F$

7. a) New capacitance of squared capacitor = $2 \times 6 = 12\,\mu F$

New total capacitance = $12\,\mu F + 6\,\mu F = 18\,\mu F$

Old total capacitance = $6\,\mu F + 6\,\mu F = 12\,\mu F$

Difference = $18\,\mu F - 12\,\mu F = 6\,\mu F$

$Q = C \cdot V = (6\,\mu F)(10\,V) = 60 \times 10^{-6}\,C$

$\therefore = 6 \times 10^{-5}\,C$

b) $C_2 = C_1 + \frac{1}{2} C_1$

$= 6\,\mu F + 3\,\mu F$

$= 9\,\mu F$

$Q = C_2 V$

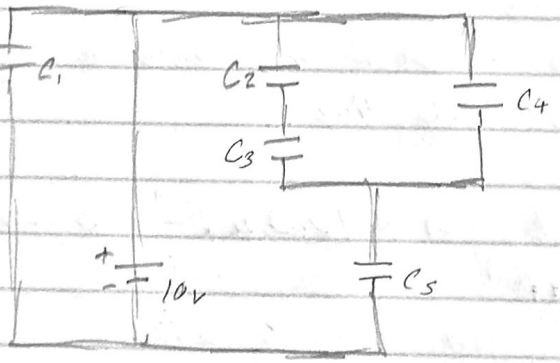
$= (9\,\mu F)(10)$

$= 9 \times 10^{-5}\,C$

$Q - Q_1 = 9 \times 10^{-5} - 6 \times 10^{-5}$

$\therefore = 3 \times 10^{-5}\,C$

8.

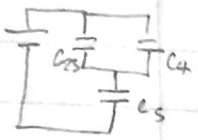


a) $V_1 = 10\,V$

$q_1 = C_1 V_1 = (10\,\mu F)(10\,V)$

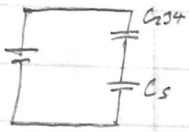
$\therefore q_1 = 100\,\mu C$

b) $C_2 + C_3$ in serie



$$\frac{1}{C_{23}} = \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{10\mu F} + \frac{1}{10\mu F} = \frac{1}{5\mu F}$$

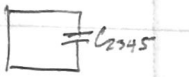
$$\frac{1}{C_{23}} = 0.2\mu F^{-1} \longrightarrow C_{23} = 5\mu F$$



$C_{23} + C_4$ in parallel $\rightarrow$ $C_{234} = C_{23} + C_4$

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

$= 15\mu F$



$$\frac{1}{C_{2345}} = \frac{1}{15\mu F} + \frac{1}{10\mu F} \longrightarrow C_{2345} = 6\mu F$$

$q_{2345} = C_{2345} V_{2345} = (6\mu F)(10V) = 60\mu C \longrightarrow q_{234} = q_5 = 60\mu C$

$V_{234} = \frac{q_{234}}{C_{234}} = \frac{60\mu C}{15\mu C} = 4V \longrightarrow V_{23} = V_4 = 4V$

$(q_4 = C_4 V_4 = 40\mu C)$

$q_{23} = C_{23} V_{23} = (5\mu F)(4V) = 20\mu C \longrightarrow q_2 = q_3 = 20\mu C$

$V_5 = \frac{q_5}{C_5} = \frac{60\mu C}{10\mu F} = 6V$

$V_2 = \frac{q_2}{C_2} = \frac{20\mu C}{10\mu F} = 2V$

$V_3 = \frac{q_3}{C_3} = \frac{20\mu C}{10\mu F} = 2V$

-	q	V
C_1	$100\mu C$	10V
C_2	$20\mu C$	2V
C_3	$20\mu C$	2V
C_4	$40\mu C$	4V
C_5	$60\mu C$	6V

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