Phys 2
Midterm 2 Part I

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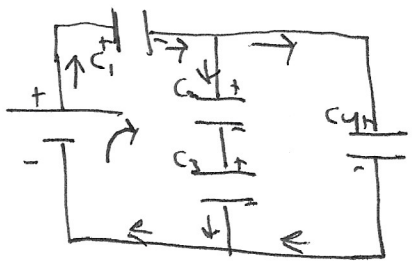
$C_1 = C_2 = C_3 = C_4 = C = 2.00\,\mu F$
$\Delta V = 25.0\,V$



a.) $C_{2,3} = \frac{1}{C_{2,3}} = \frac{1}{C_2} + \frac{1}{C_3} \therefore C_{2,3} = \left(\frac{2}{2\,\mu F}\right)^{-1} = 1\,\mu F$

$C_{2,3,4} = \left(\frac{1}{C_{2,3}} + \frac{1}{C_4}\right)^{-1} = \left(\frac{1}{1} + \frac{1}{2}\right)^{-1} = \frac{2}{3}\,\mu F$

$C_{eq} = C_1 + C_{2,3,4} = 2\,\mu F + \frac{2}{3}\,\mu F = \boxed{\frac{8}{3}\,\mu F}$

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b.) $C = \frac{Q}{\Delta V}$

$\circlearrowleft_{left}: 25V - \frac{Q_1}{C_1} - \frac{Q_2}{C_2} - \frac{Q_3}{C_3} = 0$

$\circlearrowleft_{right}: \frac{Q_3}{C_3} + \frac{Q_2}{C_2} - \frac{Q_4}{C_4} = 0$

C in series have same charge
$\therefore Q_2 = Q_3$
C in Parallel have same voltage
$\therefore \frac{2Q_2}{2} = \frac{Q_4}{2}$ ✓

$\circlearrowleft_{Tot}: 25 - \frac{Q_1}{C_1} - \frac{Q_4}{C_4} = 0$

$Q_2 = 25 - \frac{Q_1}{2}$
$\frac{Q_4}{2} = 25 - \frac{Q_1}{2}$
$Q_4 = 50 - Q_1$

$25 - \frac{Q_1}{2} - \frac{2Q_2}{2} = 0 \rightarrow Q_2 = 25 - \frac{Q_1}{2}$

Same eq

$\frac{2Q_2}{2} = \frac{Q_4}{2} \rightarrow Q_2 = \frac{Q_4}{2}$ ✓

$25 - \frac{Q_1}{2} - \frac{2Q_2}{2} = 0 \rightarrow \frac{Q_1}{2} = 25 - Q_2 \rightarrow Q_1 = 50 - 2Q_2 \rightarrow 50 - 2\left(25 - \frac{Q_1}{2}\right)$
~~$Q_1 = 50 - 50$~~

$\Delta V_1 = \frac{Q_1}{C_1} \rightarrow Q_1 = \Delta V C_1 = 50$

b cont'd on next page

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1) $2SV - \frac{Q_1}{2} - \frac{2Q_2}{2} = 0 \rightarrow Q_2 = 25 - \frac{Q_1}{2}$

$\frac{2Q_2}{2} - \frac{Q_4}{2} = 0 \rightarrow Q_4 = 2Q_2$

$25V - \frac{Q_1}{Q_2} - \frac{Q_4}{2} = 0 \rightarrow Q_4 = 50 - Q_1$

$Q_2 = \frac{Q_4}{2}$

$C_1 = \frac{Q_{2,3,4}}{}$

$Q_1 = 2Q_2 + Q_4$

$Q_2 = 25 - Q_2 - \frac{Q_4}{2}$

$2Q_2 = 25 - \frac{Q_4}{2}$

$Q_4 = 50 - 4Q_2$

$\therefore 50 - Q_1 = 2Q_2$

$Q_1 = 50 - 2Q_2$

$50 - 4Q_2 = 50 - Q_1$

$Q_1 = 4Q_2$

$Q_2 = 25 - 2Q_2$

$3Q_2 = 25$

$Q_2 = \frac{25}{3}\ \mu C$

$Q_3 = \frac{25}{3}\ \mu C$

$25 - \frac{Q_1}{2} = \frac{25}{3}$

$Q_1 = 50 - \frac{50}{3} = \frac{100}{3}\ \mu C = Q_1$

$Q_4 = 50 - Q_1 = 50 - \frac{100}{3} = \frac{50}{3}\ \mu C = Q_4$

$\therefore V_{C1} = \frac{Q_1}{C} = \frac{100}{3 \cdot 2} = \frac{100}{6}\ \mu V$ $\quad V_{C1} = \frac{50}{3}\ \mu V$

$V_{C2} = \frac{Q_2}{C} = \frac{25}{6}\ \mu V$

$V_{C3} = V_{C2} = \frac{25}{6}\ \mu V$

$V_{C4} = \frac{50}{3 \cdot 2} = \frac{25}{3}\ \mu V = V_{C4}$

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(c) $U = \frac{1}{2}CV^2 = \frac{1}{2}C_{eq}V^2 = \frac{1}{2}\frac{8}{3}\,MF\,(25V)^2$

$= \frac{4}{3}(25)^2 = \frac{4(625)}{3} = 833.3\ MFV^2$