SECOND MIDTERM

Name (Print) __________________________ Name (Signed) __________________________

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REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

With the switch $S$ closed, a dielectric of $\varepsilon = 3.50$ is inserted into $C_2$. Then the switch is opened. After opening the switch the dielectric is removed from $C_2$. At this point, with the switch still open, calculate:

(a) the voltage and charge on $C_1$.
(b) the voltage and charge on $C_2$.
(c) the voltage and charge on $C_3$.
(d) the voltage between points A and B.

(Capacitance values given are without dielectric.)

When the switch is closed:

- $C_1 = 20 \, \text{pF}$
- $C_2 = 35 \times 10 = 35 \, \text{pF}$
- $C_3 = 40 \, \text{pF}$
- $C_{12} = C_1 + C_2 = 55 \, \text{pF}$
- $V_B = 150 \, \text{V}$

\[
C_T = \frac{C_3 C_{12}}{C_3 + C_{12}} = \frac{40 \times 55}{40 + 55} = 23.2 \, \text{pF}
\]

\[
Q = C_T V = 23.2 \times 150 = 3473.7 \, \text{pC}
\]

\[
V_{12} = \frac{Q}{C_{12}} = \frac{3473.7}{55} = 63.16 \, \text{volt}
\]

\[
V_3 = 150 - 63.16 = 86.8 \, \text{volt}
\]

When the switch is open:

\[
C_{12}' = C_1' + C_2' = 24 + 10 = 30
\]

\[
V_{12}' = \frac{3473.7}{30} = 115.9
\]

(a) \[
V_1' = V_{12}' = 115.9 \, \text{volt} \quad Q_1 = \frac{C_1'}{C_1' + C_2'} Q = \frac{70}{20 + 10} \times 3473.7
\]

\[
= 2315.8 \, \text{pC}
\]

(b) \[
V_2' = V_{12}' = 115.9 \, \text{volt} \quad Q_2 = \frac{C_2'}{C_1' + C_2'} Q = \frac{10}{20 + 10} \times 3473.7 = 1157.9 \, \text{pC}
\]
c. \( Q \) is the same

\[ q_3 = Q = 3473.7 \text{ (PC) } \]

and voltage \( V_3 \) keep the same

\[ V_3 = 86.8 \text{ (volt) } \]

d.

\[ V_{ab} = 86.8 + 115.8 \]

\[ = 202.6 \text{ (volt) } \]