Don’t waste time on problems you aren’t sure of. Be clear and concise. A cluttered response will not get full credit.

1. Two capacitors \( C_1 = 36 \, \mu F \) and \( C_2 = 18 \, \mu F \) have charges \( Q_1 = 12 \, \mu C \) and \( Q_2 = 27 \, \mu C \), plates a1 and a2 being +, b1 and b2 being –. Find the voltage differences and electrical energy for each capacitor.

\[
\begin{align*}
V_{b1} - V_{b2} & = -Q_2 - Q_1 = -39 \mu C + 27 \mu C = 2 \mu C \quad V \approx 0.33 \mu V \\
\Delta V_1 & = \frac{Q_1}{C_1} = \frac{27}{18} = 1.5 \mu V \\
\Delta V_2 & = \frac{Q_2}{C_2} = \frac{27}{18} = 0.5 \mu V
\end{align*}
\]

a. \( \frac{a_2}{b_2} \) \( \frac{C_2}{b_1} \) \( \frac{a_1}{b_1} \) \( C_1 \) \( U_1 = \frac{1}{2} C_1 (\Delta V_1)^2 = 2 \mu J \) \( U_2 = \frac{1}{2} C_2 (\Delta V_2)^2 = 20.25 \mu J \)

b. Now connect the plates, a1 to a2 and b1 to b2. Find \( V_{a1} - V_{b1} \) and \( V_{a2} - V_{b2} \), the charges on each plate, and the electrical energy for each capacitor.

\[
\begin{align*}
C_1 \text{ and } C_2 \text{ are in parallel with } Q &= Q_1 + Q_2 = 27 + 12 = 39 \mu C \\
\Delta V' &= \frac{Q}{C_1 + C_2} = \frac{39 \mu C}{54 \mu F} = 0.72 \mu V
\end{align*}
\]

\[
\begin{align*}
Q_1' &= \frac{1}{2} C_1 (\Delta V')^2 = 4.62 \mu J \\
Q_2' &= \frac{1}{2} C_2 (\Delta V')^2 = 0.69 \mu J
\end{align*}
\]

Note: \( U_1' + U_2' = 14.08 \mu J = U_{\text{final}} \quad U_{\text{final}} = 22.25 \mu J = U_{\text{initial}} \quad \Rightarrow \quad U_{\text{final}} < U_{\text{initial}}\)

2. Consider three capacitors. \( C_1 = 35 \, \mu F \) and \( C_2 = 55 \, \mu F \) are in parallel, and \( C_3 = 45 \, \mu F \) is in series with them. \( V_c = -30 \, V \) and \( V_a = -12 \, V \). Find the charge and voltage difference for each capacitor. Find \( V_6 \).

\[
C = C_1 + C_2 = 90 \, \mu F
\]

\[
C = (C_3^{-1} + C_2^{-1})^{-1} = (45^{-1} + 90^{-1})^{-1} = 30 \, \mu F
\]

\[
Q = C \Delta V = (30 \, \mu F)(18 \, V) = 540 \, \mu C
\]

\[
Q_3 = Q \quad \text{(top is negative)}
\]

\[
\Delta V_3 = \frac{Q_3}{C_3} = \frac{540 \, \mu F}{45 \, \mu F} = 12 \, V
\]

Thus \( V_b = V_c + \Delta V_3 = -30 + 12 = -18 \, V \)

\[
\Delta V_1 = \Delta V_2 = V_2 - V_1 = 6 \, V \quad \text{(top are negative)}
\]

\[
Q_1 = C_1 \Delta V_1 = 210 \, \mu C
\]

\[
Q_2 = C_2 \Delta V_2 = 330 \, \mu C
\]

Note: \( Q_1 + Q_2 = 540 \, \mu C = Q \), as expected.