Name________________________

Physics 125: Analytical Physics II
"No Risk" Quiz

In the circuit shown, the capacitors have values

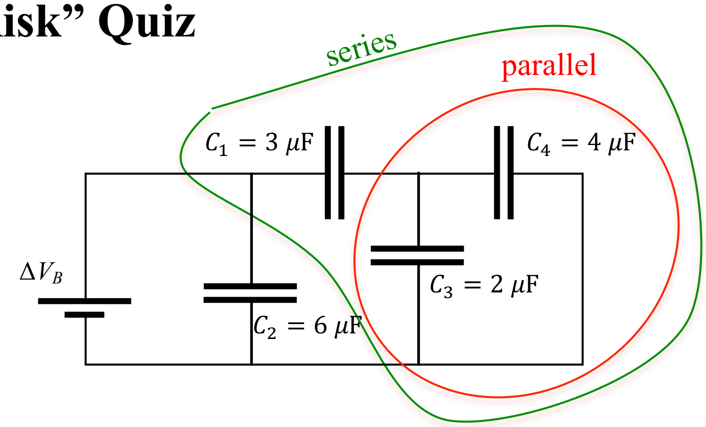
$C_1 = 3\ \mu\text{F}$

$C_2 = 6\ \mu\text{F}$

$C_3 = 2\ \mu\text{F}$

$C_4 = 4\ \mu\text{F}$

The power supply is set to $V_B = 24$ V.



(a) Circle any groups of *individual* capacitors that can be considered either "in parallel" or "in series," and label them. (You *may* then circle how that/those equivalent capacitors combine with others, but that will not be graded.) Only 3&4 in parallel. 1 & 2 can't be combined with any other single capacitor.

(b) Once all resulting currents stop flowing, what is the charge on capacitor C_4?

First, work our way out:

- $C_{34} = C_3 + C_4 = 6\mu\text{F}$ (parallel)
- $1/C_{134} = 1/C_1 + 1/C_{34} = \frac{1}{3\mu\text{F}} + \frac{1}{6\mu\text{F}} = \frac{1}{2\mu\text{F}} \rightarrow C_{134} = 2\mu\text{F}$ (series)
- $C_{1234} = C_2 + C_{134} = 8\mu\text{F}$ (parallel)

Then, work our way back in:

- $\Delta V_B = \Delta V_2 = \Delta V_{134}$ (parallel) so that we really didn't need to worry about the 2+134 combination after all
- 1 and 34 in series: $Q_1 = Q_{34} = Q_{134} = C_{134}\Delta V_{134} = 2\mu\text{F} \cdot 24\text{V} = 48\mu\text{C}$
- 3 and 4 in parallel: $\Delta V_3 = \Delta V_4 = \Delta V_{34} = Q_{34}/C_{34} = 48\mu\text{C}/6\mu\text{F} = 8\text{V}$
- $Q_4 = C_4\Delta V_4 = 4\mu\text{F} \cdot 8\text{V} = 32\mu\text{C}$

There is a shortcut: Parallel capacitors split charge proportionally to their capacitance. C_4 has twice the capacitance of C_3, so:

$Q_4 = \frac{2}{3}Q_{34}$ and $Q_3 = \frac{1}{3}Q_{34}$

However, like most shortcuts, this should only be used if you have a very solid understanding of the basic method.

From the Formula Sheet:

$k = 8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$

$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2$

$q = CV$

$C = \kappa \frac{\varepsilon_0 A}{d}$

$C_{eq} = C_1 + C_2 + C_3 + \cdots$

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$