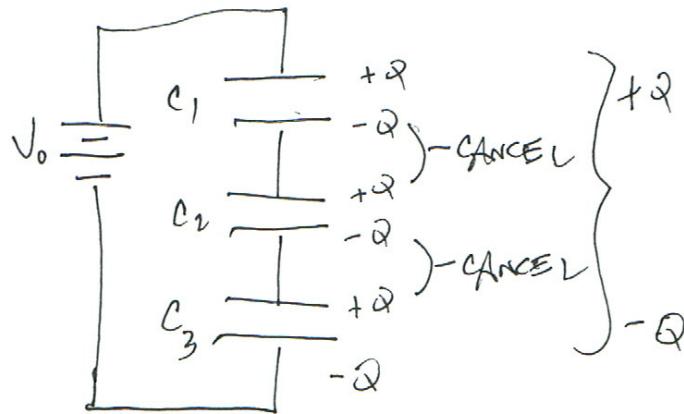


6/13/13 (1)

SERIES - ALL C's HAVE SAME Q



$$C = \frac{Q}{V} \quad V = \frac{Q}{C}$$

$$V_0 = V_1 + V_2 + V_3$$

KIRCHOFF'S  
RULE

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

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

POTENTIAL ON EACH CAP  $V_i = \frac{Q}{C_i}$

Q = CONSTANT FOR ALL C's

i. SMALLEST  $C_i$  HAS  
LARGEST  $V_i$

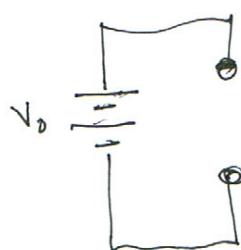
ENERGY STORED IN CAP  $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{Q^2}{2C}$

i. SMALLEST  $C_i$  HAS THE HIGHEST ENERGY

THIS MIGHT SEEM COUNTER-INTEUTIVE

THERE IS A DIFFERENCE BETWEEN CHARGING  
A SINGLE CAP AND CHARGING SEVERAL CAPS  
IN SERIES.

$$C_1 < C_2$$



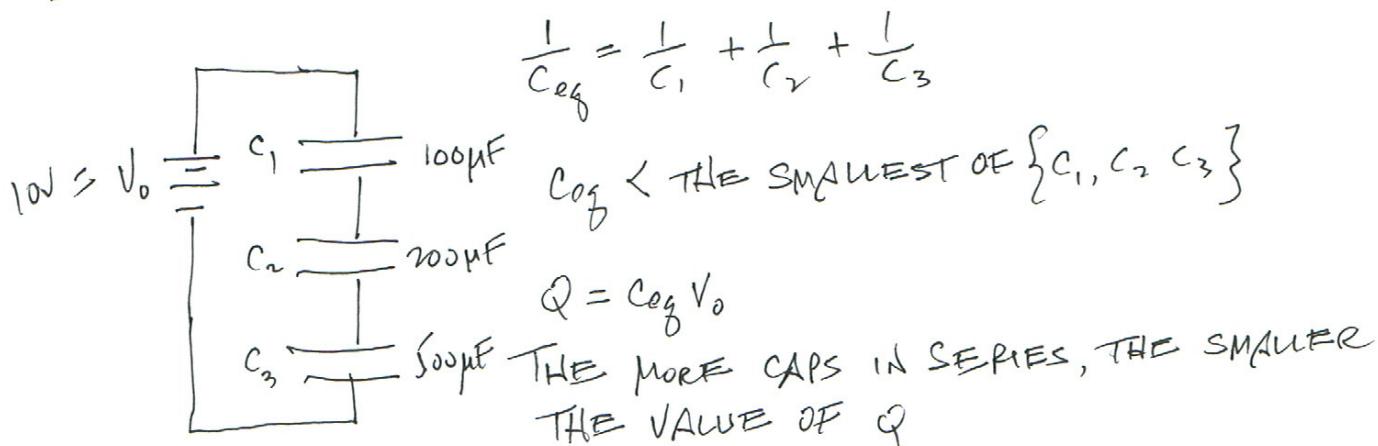
CAP CHARGING  
STATION

$$\frac{C_1}{T} \quad V_1 = \frac{1}{2}C_1V_0$$

$$\frac{C_2}{T} \quad V_2 = \frac{1}{2}C_2V_0$$

CHARGED INDIVIDUALLY THEY ARE EACH  
CHARGED TO THE SAME VOLTAGE  $V_0$

$$\frac{V_2}{V_1} = \frac{\frac{1}{2}C_2V_0}{\frac{1}{2}C_1V_0} = \frac{C_2}{C_1} > 1 \quad \frac{\text{LARGER CAP}}{\text{HAS LARGER } V}$$

SERIES (CONTINUED)

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{100} + \frac{1}{200} + \frac{1}{500} = 0.010 + 0.005 + 0.002$$

$$\frac{1}{C_{eq}} = 0.017 \quad C_{eq} = \frac{1000}{17} = 58.8 \mu F \approx 60 \mu F$$

$$Q = C_{eq} V_0 = 60 \times 10^{-6} \times 10 = \underline{\underline{600 \mu C}}$$

$$V_1 = \frac{Q}{C_1} = \frac{600 \mu C}{100 \mu F} = 6.0 \text{ V}$$

$$V_2 = \frac{Q}{C_2} = \frac{600}{200} = 3.0 \text{ V}$$

$$V_3 = \frac{Q}{C_3} = \frac{600}{500} = \underbrace{1.2 \text{ V}}$$

$$U_1 = \frac{Q^2}{2C_1} = \frac{(600 \times 10^{-6})^2}{2 \cdot 100 \times 10^{-6}} = \frac{36 \times 10^4 \times 10^{-12}}{200 \times 10^{-6}} = \frac{36 \times 10^{-8}}{2 \times 10^{-4}} = 18 \times 10^{-4} \text{ J}$$

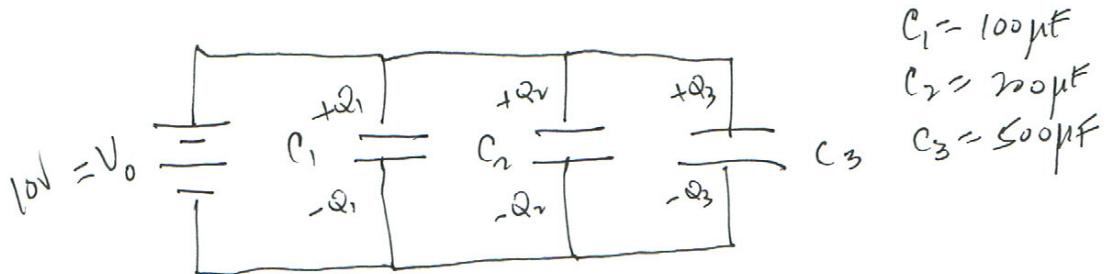
$$U_2 = \frac{Q^2}{2C_2} = \frac{36 \times 10^{-8}}{4 \times 10^{-6}} = 9 \times 10^{-4} \text{ J}$$

$$U_3 = \frac{Q^2}{2C_3} = \frac{36 \times 10^{-8}}{10 \times 10^{-4}} = 3.6 \times 10^{-4} \text{ J}$$

$$\begin{aligned} 18 \times 10^{-4} \\ 9 \times 10^{-4} \\ 3.6 \times 10^{-4} \\ \hline 30.6 \times 10^{-4} \text{ J} \end{aligned}$$

$$U_T = \frac{36 \times 10^{-8}}{2 \cdot 60 \times 10^{-6}} = \frac{18}{60} \times 10^{-2} = 30.6 \times 10^{-4} \text{ J} \quad \checkmark \quad =$$

PARALLEL CAPACITORS - ALL CAPS HAVE SAME V



$$C_1 = 100 \mu F$$

$$C_2 = 200 \mu F$$

$$C_3 = 500 \mu F$$

$$10V = V_0$$

$$Q_T = Q_1 + Q_2 + Q_3$$

$$C_{eq}^P V_0 = C_1 V_0 + C_2 V_0 + C_3 V_0$$

$$C_{eq}^P = C_1 + C_2 + C_3$$

$$Q_i = C_i V_0 \quad Q_i \sim V$$

LARGEST  $C_i$  HAS LARGEST  $Q$

$$Q_1 = C_1 V_0 = 1000 \mu C$$

$$Q_2 = 2000 \mu C$$

$$Q_3 = 5000 \mu C$$

SAME RESULT AS IF  
THE CAPS WERE  
CHARGED ONE AT A  
TIME AND THEN  
WIRED IN A PARALLEL  
ARRANGEMENT.

$U_i = \frac{1}{2} C_i V^2 \Rightarrow$  LARGEST  $C_i$  HAS THE LARGEST ENERGY

$$\begin{aligned} U_T &= \frac{1}{2} C_{eq}^P V_0^2 = \frac{1}{2} C_1 V_0^2 + \frac{1}{2} C_2 V_0^2 + \frac{1}{2} C_3 V_0^2 \\ &= \frac{V_0^2}{2} (C_1 + C_2 + C_3) \\ &= \frac{10^2}{2} 800 \times 10^{-6} \end{aligned}$$

$$U_T = \frac{100}{2} 8 \times 10^{-4}$$

$$U_T = 400 \times 10^{-4} J$$