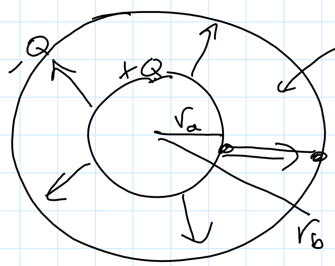
Phy 4B 5/9

Tuesday, May 9, 2017 6:23 PM

Goals for the Lecture:

1) Be able to calculate the capacitance of a capacitor from Gauss's Law and the definition of capacitance (Q=CV)
2) Be able to find equivalent capacitance of capacitors in series and parallel circuits
3) Be able to calculate the energy stored in a capacitor

Find C : Two concentric spherical conductors



$$E = \frac{kQ}{r^2}$$

$$\Delta V = -\int \vec{E} \cdot d\vec{s}$$

$$\Delta V = -\int_{r_a}^{r_b} \frac{kQ}{r^2}\, dr \cos 0°$$

$$= kQ \left[+\frac{1}{r} \Big|_{r_a}^{r_b} \right]$$

$$|\Delta V| = \left| kQ \left(\frac{1}{r_b} - \frac{1}{r_a} \right) \right|$$

$$\Delta V = kQ \left(\frac{1}{r_a} - \frac{1}{r_b} \right)$$

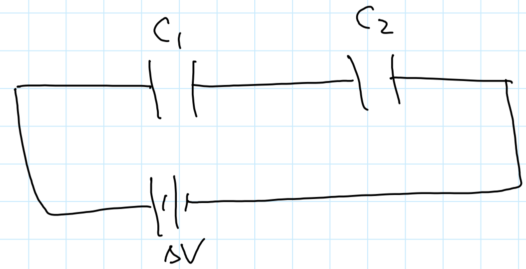
for a capacitor: $Q = C\, \Delta V$

$$Q = \frac{1}{k\left(\frac{1}{r_a} - \frac{1}{r_b}\right)} \Delta V$$

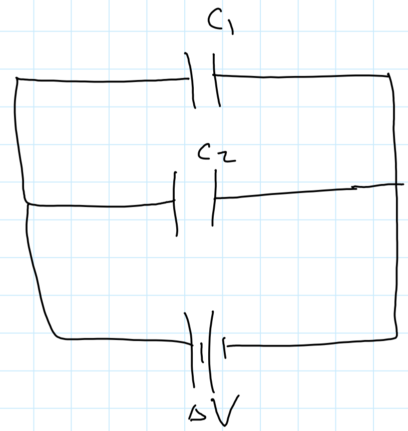
$$C = \frac{1}{k\left(\frac{1}{r_a} - \frac{1}{r_b}\right)}$$ for a spherical capacitor

Combinations of Capacitors:

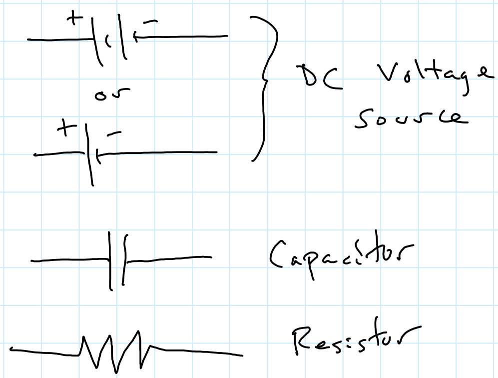
Series:



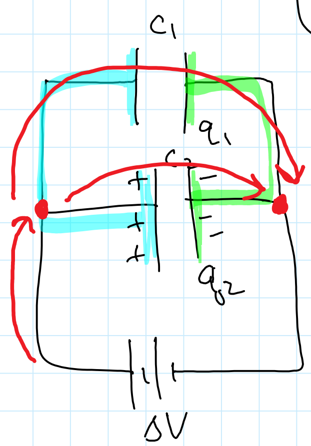
Parallel:



Circuits:



Parallel

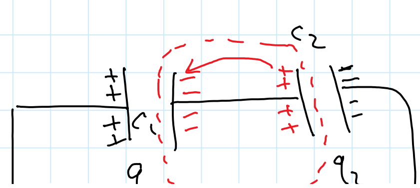


In Parallel:

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

Voltage is same on every cap. in parallel

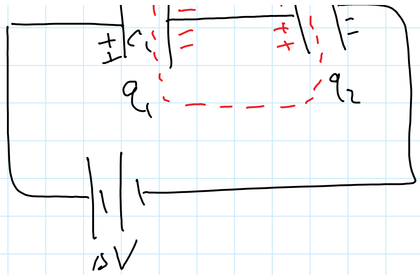
Series



Charge on every cap. in series

$$q_1 = q_2 = \cdots$$

is the same



$q_1 = q_2 = \dots$

is the same

In series:

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

$$Q = CV$$

$$q_1 = C_1 V_1 \qquad q_2 = C_2 V_2$$

$$q_1 = q_2 = q$$

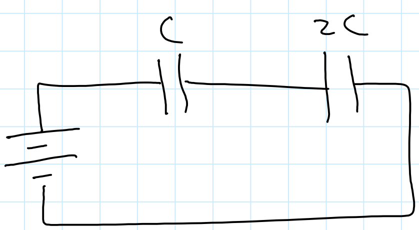
$$\Delta V = V_1 + V_2$$

$$\Delta V = \frac{q}{C_1} + \frac{q}{C_2}$$

$$\Delta V = \left(\frac{1}{C_1} + \frac{1}{C_2}\right) q$$

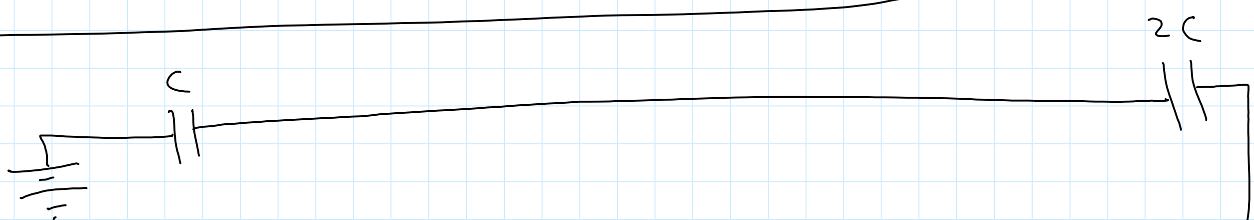
$$\left(\frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}\right) \Delta V = q$$

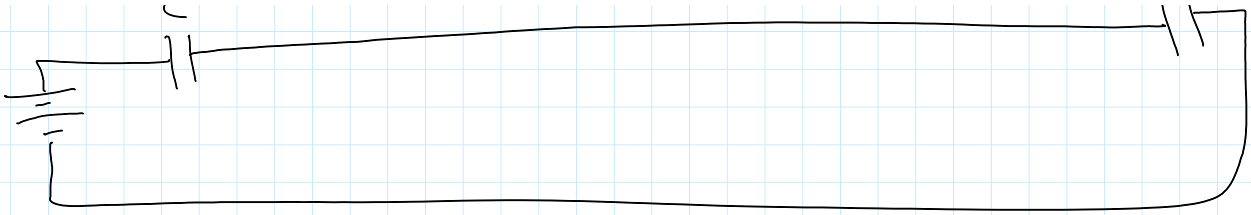
↑ C_{eq}



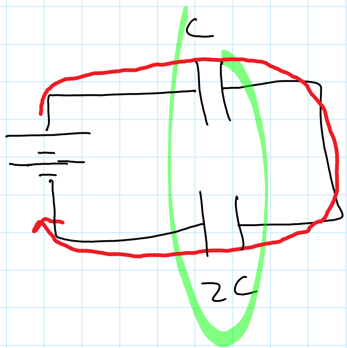
$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{2C} = \frac{3}{2C}$$

$$C_{eq} = \frac{2C}{3}$$



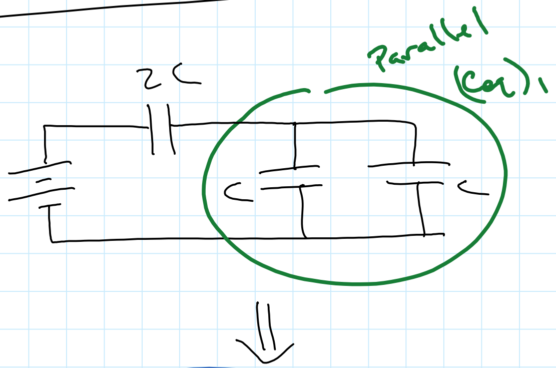


$$C_{eq} = \frac{2}{3}C$$

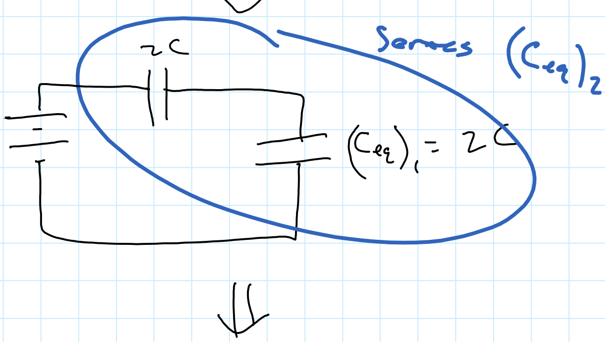


In Series

$$C_{eq} = \frac{2}{3}C$$

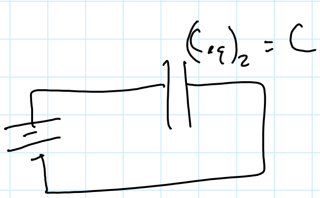


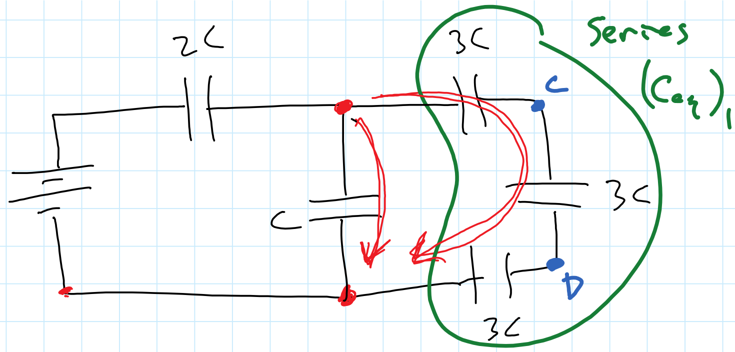
$$(C_{eq})_1 = C + C = 2C$$



$$\frac{1}{(C_{eq})_2} = \frac{1}{2C} + \frac{1}{(C_{eq})_1} = \frac{2}{2C}$$

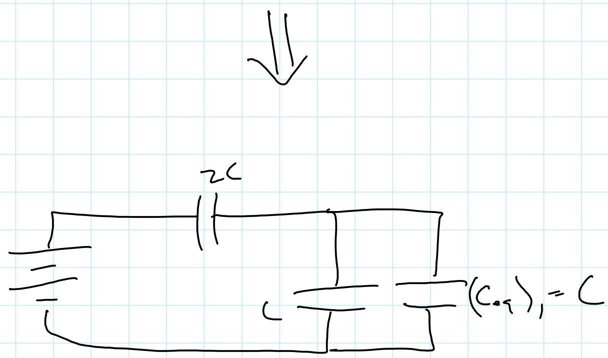
$$(C_{eq})_2 = C$$



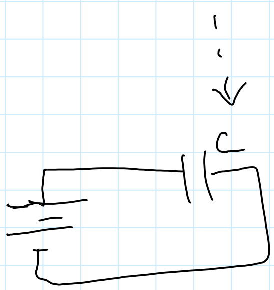


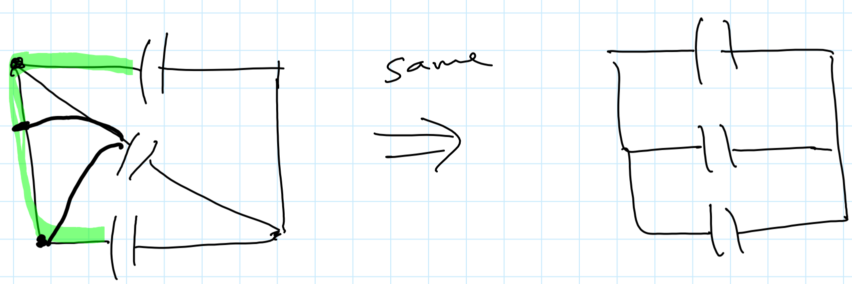
$$\frac{1}{(C_{eq})_1} = \frac{1}{3C} + \frac{1}{3C} + \frac{1}{3C} = \frac{3}{3C}$$

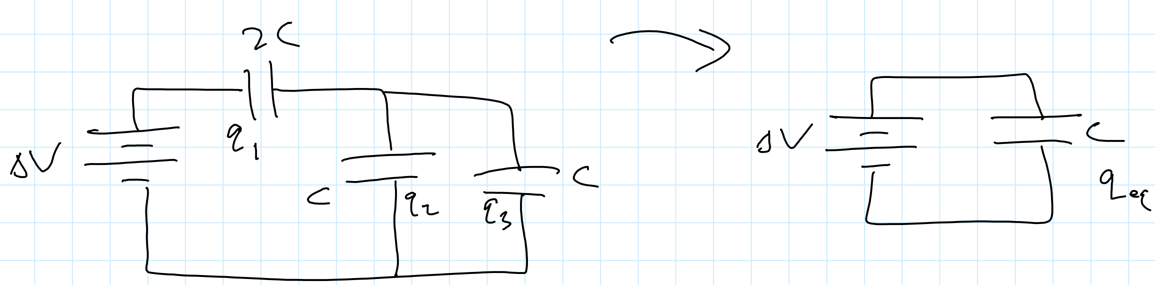
$$(C_{eq})_1 = C$$



Like above







Let $C = 1\ F$

$\Delta V = 6\ V$

$q_{eq} = C_{eq} V$

$= (1\ F)(6\ V)$

$= 6\ C$

work backwards

$\Downarrow$