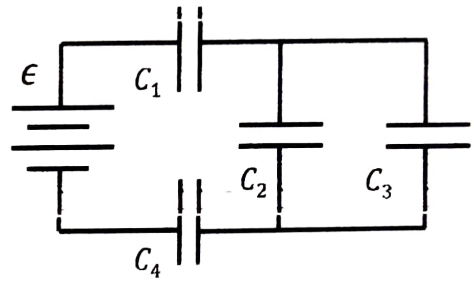
Section	Group	Name	Signature
Grade		Jacob Harkins	Jacob Harkins

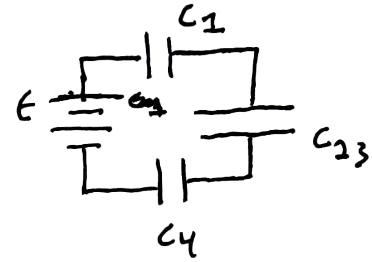
After this activity you should know: • *solve circuits involving capacitors that are neither all in parallel nor all in series.*

Capacitors cannot always be combined into one capacitor in one step. Usually one needs to combine capacitors in multiple steps.



1. Four capacitors are connected to a 30 Volt EMF as shown with $C_1 = 6\ \mu F$, $C_2 = 2\ \mu F$, $C_3 = 10\ \mu F$ and $C_4 = 4\ \mu F$. What is the charge on, and voltage drop across, each capacitor?
   a. Start by finding the equivalent capacitance in steps. Note that C_2 and C_3 are in parallel. Combine these two capacitors into a single equivalent capacitor C_{23}. Determine C_{23} and redraw the circuit with C_1, C_{23}, and C_4.

$C_{23} = 12 \mu F$



   b. Now C_{23} can be combined with C_1 and C_4 into a single capacitor.

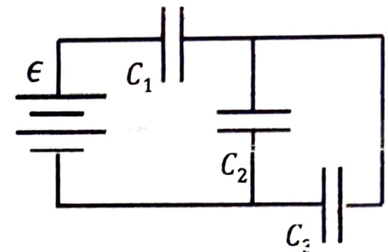
$$C_{1234} = \left(\frac{1}{6} + \frac{1}{12} + \frac{1}{4}\right)^{-1} = 2 \mu F$$

   c. Since the circuit is reduced to a single capacitor connected to a single EMF, the voltage across the equivalent capacitor must be equal to the EMF. Use this and the properties of parallel and series capacitors to complete the table below. Show work. Make sure that $Q = C\Delta V$ for each column.

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

	C_1	C_2	C_3	C_4	C_{23}	C_{1234}
C F	$6 \cdot 10^{-6}$	$2 \cdot 10^{-6}$	$10 \cdot 10^{-6}$	$4 \cdot 10^{-6}$	$12 \cdot 10^{-6}$	$2 \cdot 10^{-6}$
ΔV V	10	5	5	15	5	30
Q C	$60 \cdot 10^{-6}$	$10 \cdot 10^{-6}$	$50 \cdot 10^{-6}$	$60 \cdot 10^{-6}$	$60 \cdot 10^{-6}$	$60 \cdot 10^{-6}$

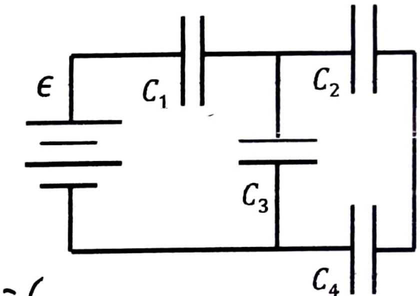
2. Three capacitors $C_1 < C_2 < C_3$ are connected to an EMF as shown. Rank the charges $Q_1, Q_2,$ and Q_3 on the capacitors from largest to smallest. Place an equal sign between any charges that are equal. *Hint: use what you know about charges on parallel and series capacitors.*



$C_1 > C_3 > C_2$

LARGEST: C_1 :SMALLEST C_2

3. Four capacitors are connected to a EMF as shown with $C_1 = 20\ \mu F$, $C_2 = 4\ \mu F$, $C_3 = 3\ \mu F$, and $C_4 = 4\ \mu F$. The emf is 50 Volts.



a. What is the equivalent capacitance of the circuit? Redraw circuit at each step.

$$C_{1234} = \left(\frac{1}{20} + \frac{1}{3+\left(\frac{1}{4}+\frac{1}{4}\right)^{-1}}\right)^{-1} = 4\cdot 10^{-6}\,F$$

b. What is the charge on C_3? You may (but do not need to) make a table similar to the first problem to help organize your calculation.

$$Q_{1234} = 4\cdot 10^{-6}\cdot 50\,V = 200\cdot 10^{-6}\,C$$

$$Q_1 = Q_{234} = Q_{1234}$$

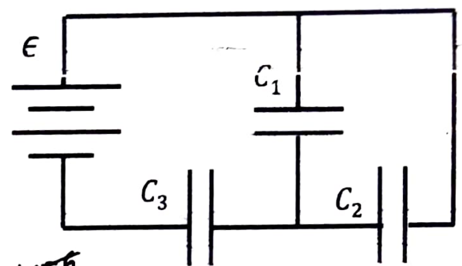
$$C_{234} = \left(\frac{1}{3+\left(\frac{1}{4}+\frac{1}{4}\right)^{-1}}\right)^{-1} = 5\cdot 10^{-6}\,F$$

$$V_{234} = \frac{200\cdot 10^{-6}\,C}{5\cdot 10^{-6}\,F} = 40\,V$$

$$V_3 = V_{24} = V_{234}$$

$$Q_3 = 3\cdot 10^{-6}\,F\cdot 40\,V = \boxed{120\cdot 10^{-6}\,C}$$

4. Three capacitors are attached to the EMF as shown. The capacitances are $C_1 = 1\,\mu F, C_2 = 5\,\mu F$ and $C_3 = 3\,\mu F$. The charge on C_2 is $20\,\mu C$.



a. What is the charge on C_3?

$$Q_{C_3} = Q_{C_1} + Q_{C_2}$$

$$V_{C_{12}} = \frac{20\cdot10^{-6}}{5\cdot10^{-6}} = 4V$$

$$Q_{C_1} = 1\cdot10^{-6}F\cdot4V$$

$$Q_{C_3} = 4\cdot10^{-6}C + 20\cdot10^{-6}C$$

$$Q_{C_3} = \boxed{24\cdot10^{-6}\,C}$$

b. What is the EMF?

$$V_{C_3} = \frac{24\cdot10^{-6}C}{3\cdot10^{-6}F} = 8V$$

$$EMF = V_{C_3} + V_{C_{12}} = 8+4 = \boxed{12V}$$