September 17th

Chapter 26

Capacitance

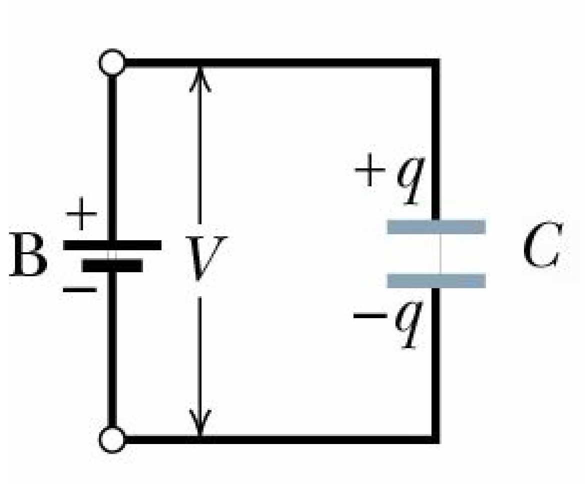
Capacitance

- Parallel-plate capacitor charged to potential *V* by battery
- Disconnect battery to have an isolated system
- If the distance, *d*, between the plates is decreased what happens to *C* ?

LARGER

- What happens to *V* ?

Isolated system *q* stays same so *V* decreases if *C* increases



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

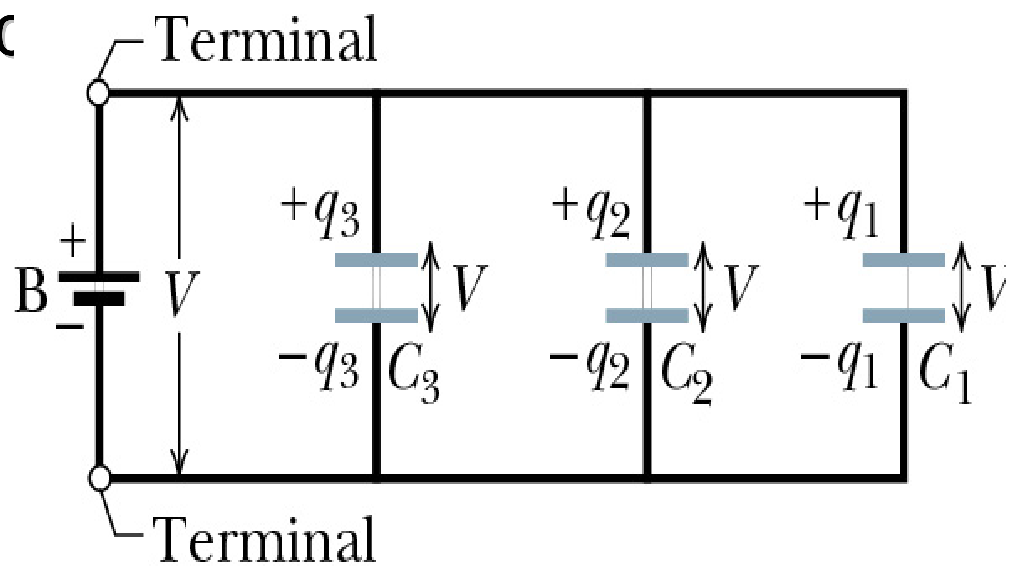
$$V = \frac{q}{C}$$

Capacitance

- What if we have more than one capacitor in a circuit?
  - Replace combination with an equivalent capacitance C_{eq}
- Two basic combinations
  - Parallel
  - Series

Capacitance (Fig. 26-7)

- Capacitors in parallel
- Capacitors are directly wired together at eac plate and *V* applied across the group of plates



- *V* is same across all capacitors

$$V_1 = V_2 = V_3 = V$$

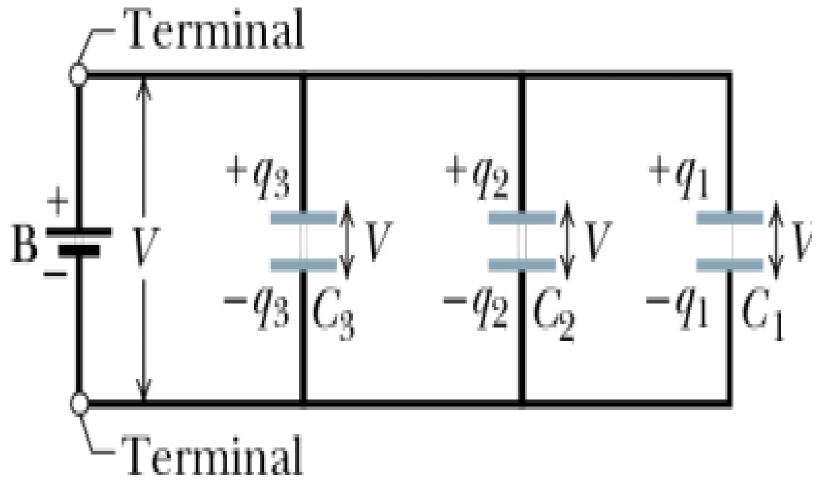
Capacitance (Fig. 26-7)

- Capacitors in parallel
- Total q stored on capacitors is sum of the charges of all capacitors

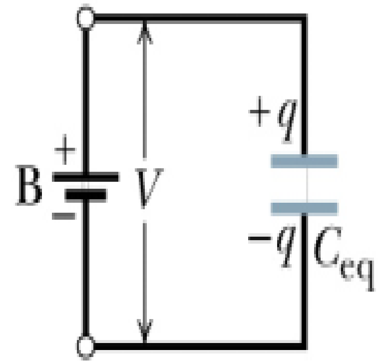
$$q = q_1 + q_2 + q_3$$

- C_{eq} has total charge q and same V as original capacitors

$$C_{eq} = \frac{q}{V}$$



(a)



(b)

Capacitance (Fig. 26-7)

- Capacitors in parallel

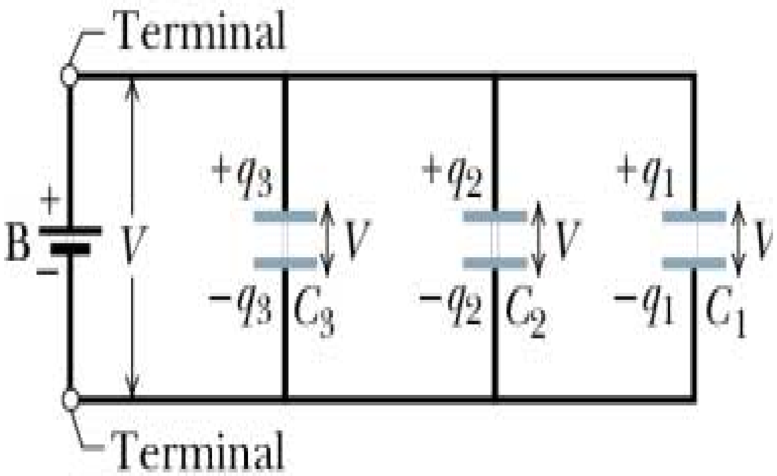
$$q = q_1 + q_2 + q_3$$

$$q_1 = C_1 V \quad q_2 = C_2 V \quad q_3 = C_3 V$$

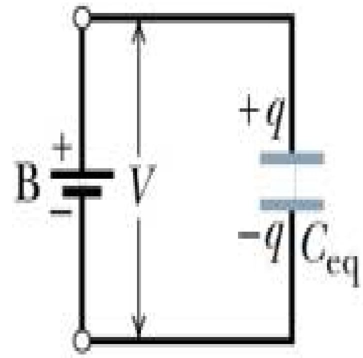
$$q = (C_1 + C_2 + C_3)V$$

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

$$C_{eq} = \sum_i^n C_i$$



(a)



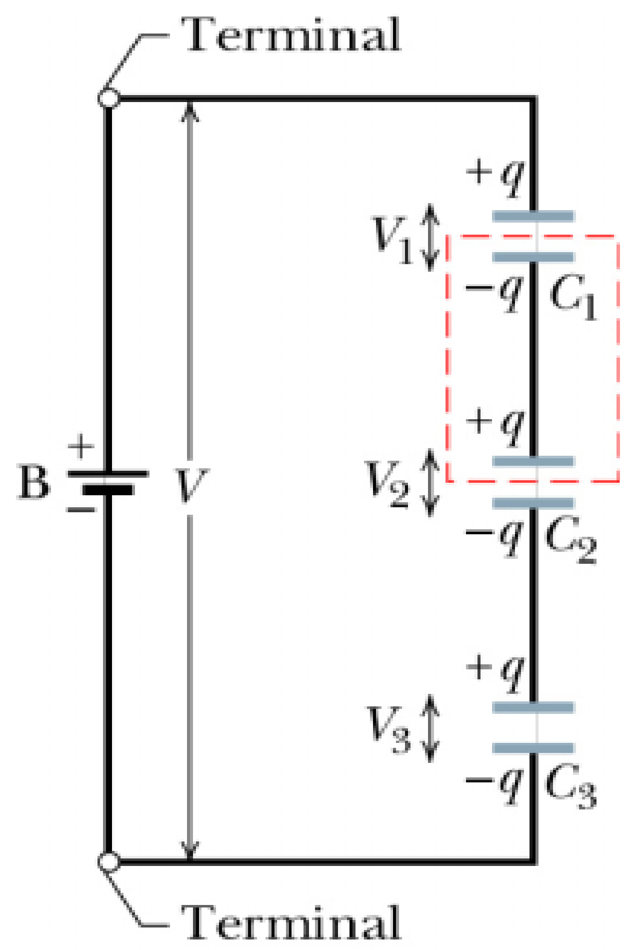
(b)

Capacitance (Fig. 26-8)

- Capacitors in series
- Capacitors are wired one after the other and V is applied across the two ends of the series
- Capacitors have identical q

$$q_1 = q_2 = q_3 = q$$

- Battery produces q only on top and bottom plates, induced q on other plates



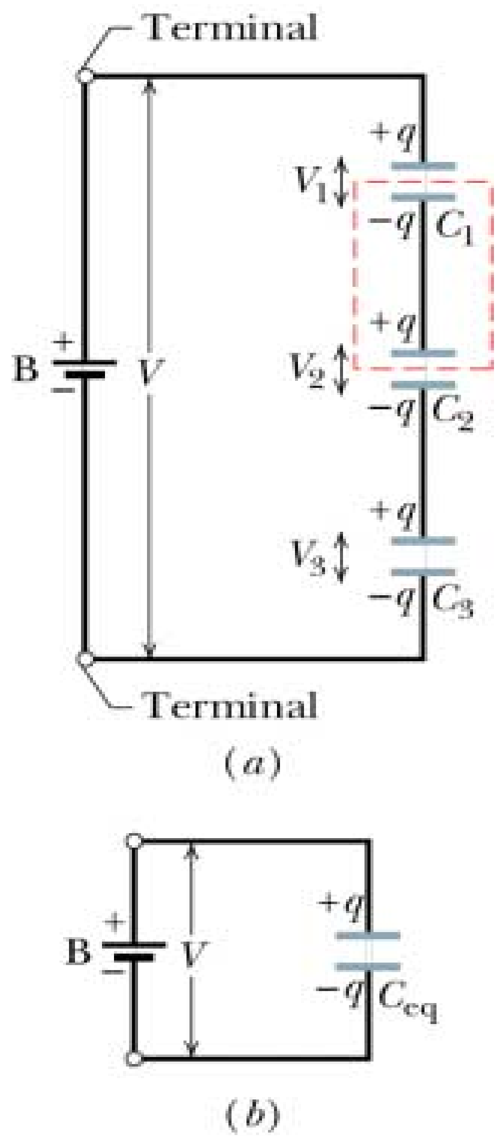
Capacitance (Fig. 26-8)

- Capacitors in series
- Sum of *V* across all capacitors is equal to applied *V*

$$V = V_1 + V_2 + V_3$$

- C_{eq} has same *q* and total *V* as original capacitors

$$C_{eq} = \frac{q}{V}$$



Capacitance (Fig. 26-8)

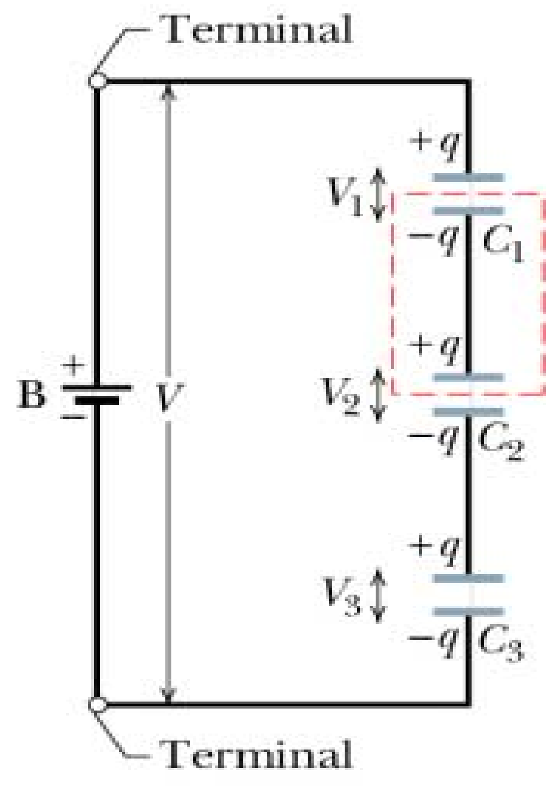
- Capacitors in series

$$V = V_1 + V_2 + V_3$$

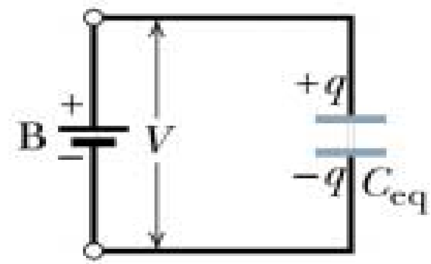
$$V_1 = \frac{q}{C_1} \qquad V_2 = \frac{q}{C_2} \qquad V_3 = \frac{q}{C_3}$$

$$V = q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\frac{1}{C_{eq}} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$



(a)



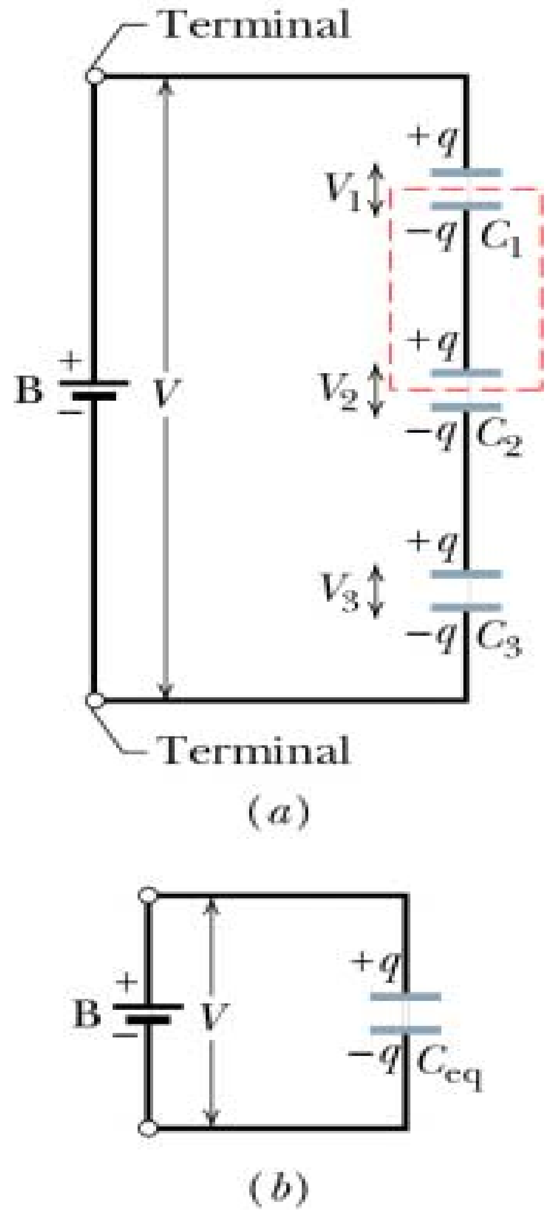
(b)

Capacitance (Fig. 26-8)

- Capacitors in series
- Charge can only be shifted from one capacitor to another.

$$\frac{1}{C_{eq}} = \sum_{i}^{n} \frac{1}{C_i}$$

- C_{eq} is always less than smallest capacitance



Capacitance

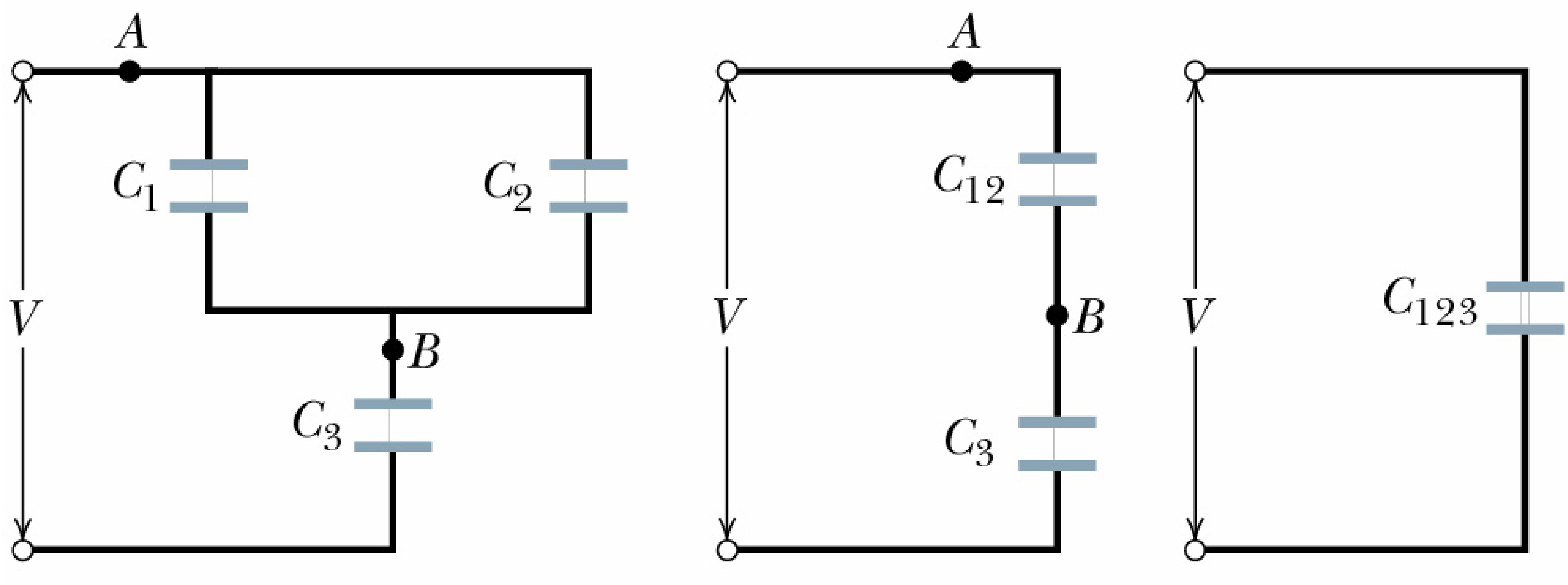
- Capacitors in parallel
  - *V* across each is equal
  - Total *q* is sum
  - Multiple paths for *q*

$$C_{eq} = \sum_{i}^{n} C_i$$

- Capacitors in series
  - *q* is equal on each
  - Total *V* is sum
  - One path for *q*

$$\frac{1}{C_{eq}} = \sum_{i}^{n} \frac{1}{C_i}$$

Capacitance (Fig. 26-9)

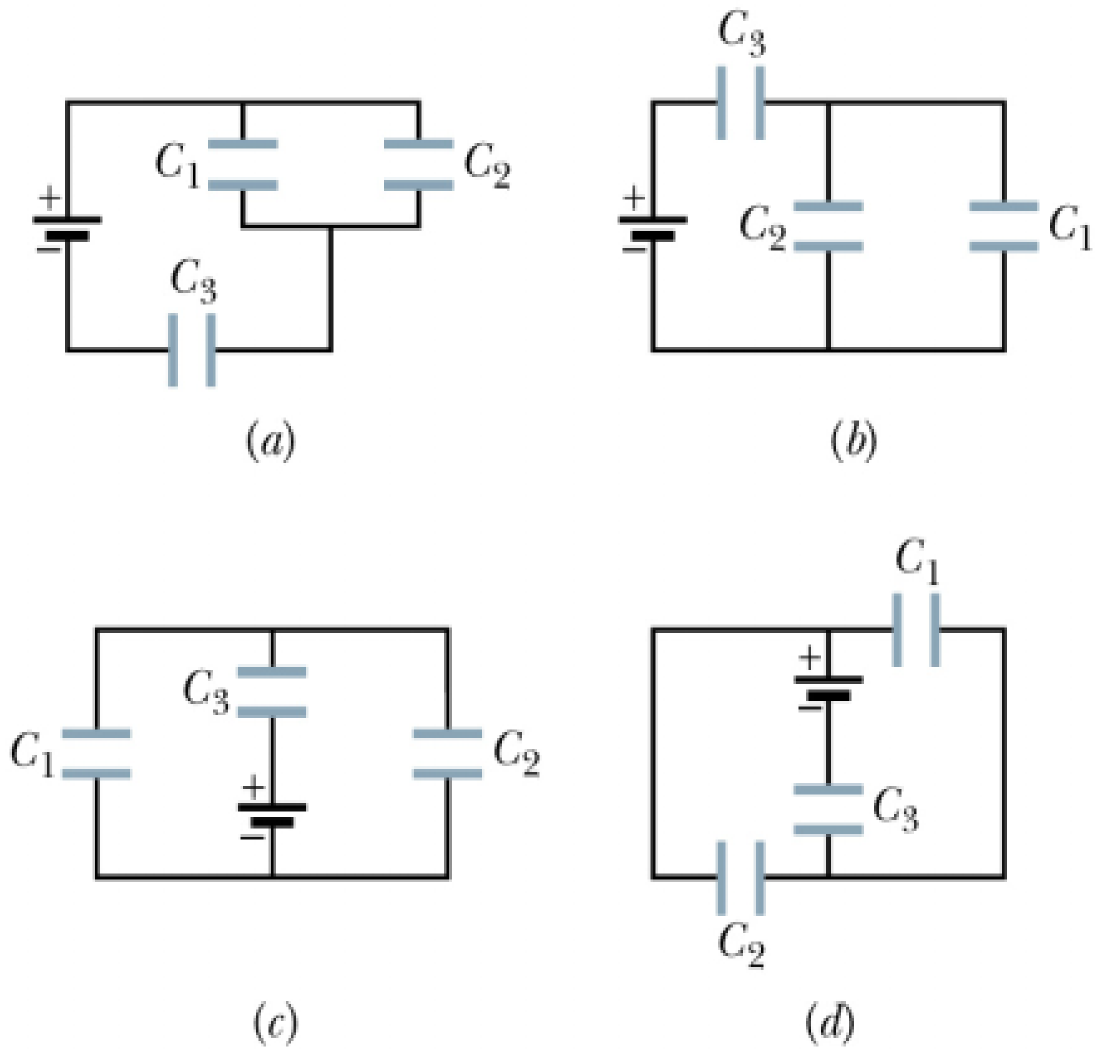


C1=12μ, C2=5.3μF, C3=4.5μF, V=12.5V

What is the charge on C1?

Capacitance (Question #4)

These are all the same



Capacitance (Checkpoint #3)

- A battery with *V* stores total charge *q* on two identical capacitors
- a) What is *V* across and *q* on either capacitor if they are in parallel?
- *V* is same for each and equal to *V* of battery.
- Total charge conserved and $q = q_1 + q_2$
  - BUT $q_1 = q_2$ SO $q_{cap} = \frac{q}{2}$

Capacitance (Checkpoint #3)

- A battery with V stores charge q on two identical capacitors
- b) What is V across and q on either capacitor if they are in series?
  - q is same for each
  - V is sum of V across capacitors

$$V = V_1 + V_2$$

- BUT $V_1 = V_2$ SO $V_{cap} = \frac{V}{2}$