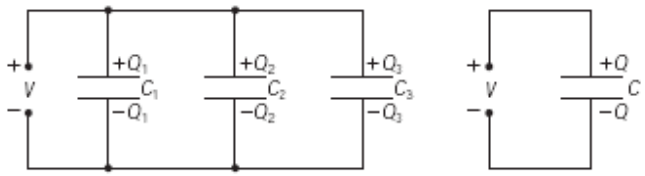
26.3 Combination of capacitors:

Two or more capacitors often are combined in electric circuits.

Parallel Combination:

Two capacitors connected as shown in Figure are known as a *parallel combination* of capacitors. The figure shows a circuit diagram for this combination of capacitors. The left plates of the capacitors are connected by a conducting wire to the positive terminal of the battery and are therefore both at the same electric potential as the positive terminal. Likewise, the right plates are connected to the negative terminal and are therefore both at the same potential as the negative terminal. Thus, the individual potential differences across capacitors connected in parallel are all the same and are equal to the potential difference applied across the combination.



$V=V_1=V_2=V_3$

$q= q_1 + q_2 +q_3$

$$CV = C_1V + C_2V + C_3V$$

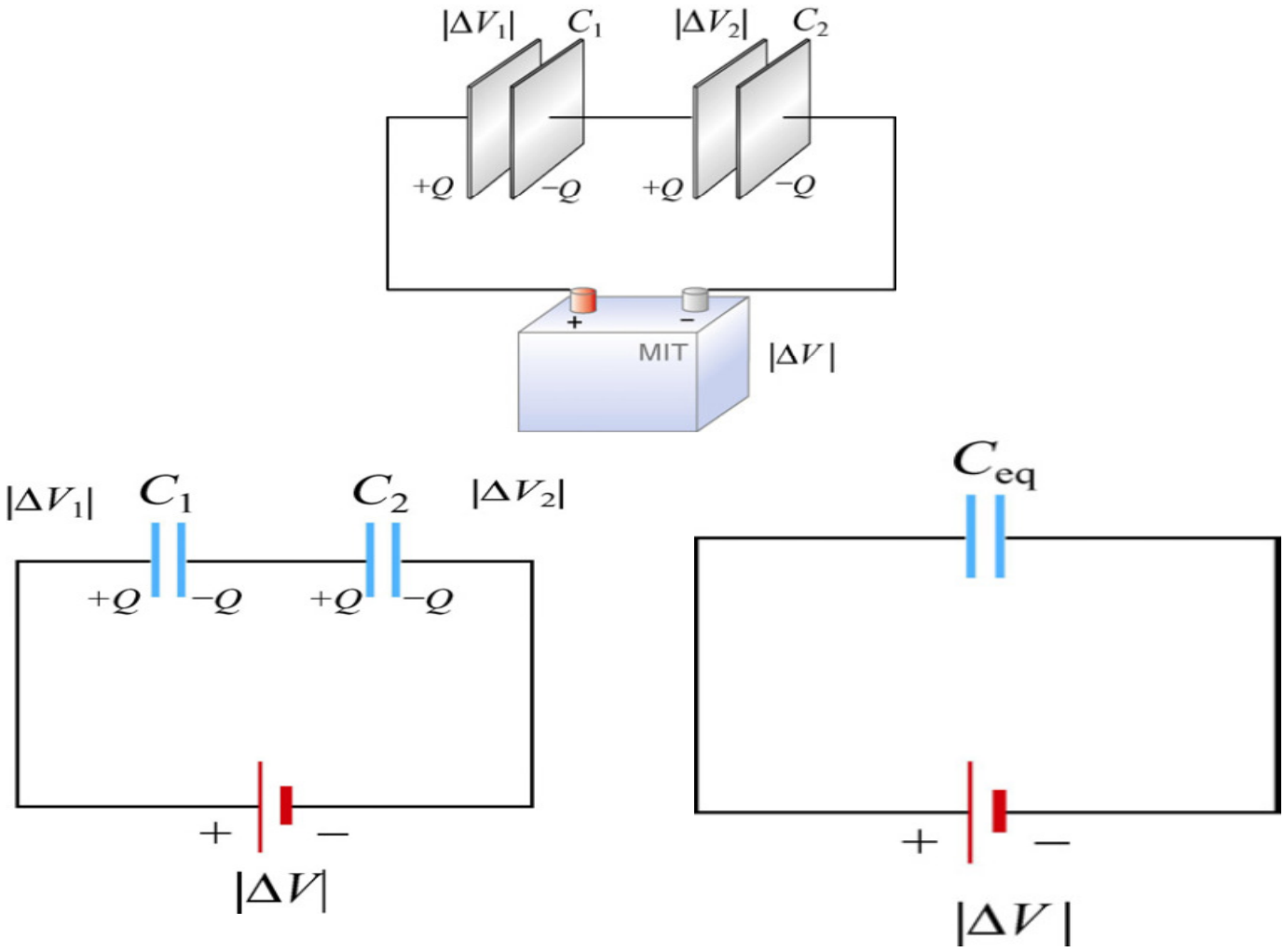
$$CV = (C_1 + C_2 + C_3)V$$

$$C = (C_1 + C_2 + C_3)$$

For ensemble of capacitors:

$$C = \sum_{i=1}^{n} C_1 + C_2 + ... + C_n$$

Series Combination:



Suppose three initially uncharged capacitors C_1 and C_2 are connected in series, as shown in the figure above. A potential difference ΔV is then applied across both capacitors. The left plate of capacitor 1 is connected to the positive terminal of the battery and becomes positively charged with a charge $+Q$, while the right plate of capacitor 2 is connected to the negative terminal and becomes negatively charged with charge $-Q$ as electrons flow in. What about the inner plates? They

were initially uncharged; now the outside plates each attract an equal and opposite charge. So the right plate of capacitor 1 will acquire a charge $-Q$ and the left plate of capacitor $+Q$.

We see that the total potential difference is simply the sum of the two individual potential differences:

$$V = V_1 + V_2$$

$$q = q_1 = q_2$$

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

$$V = V_1 + V_2$$

$$\frac{q}{C} = \frac{q}{C_1} + \frac{q}{C_2}$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

For ensemble of capacitors:

$$\frac{1}{C} = \sum_{i=1}^{n} \frac{1}{C_1} + \frac{1}{C_1} \ldots\ldots\ldots\ldots\ldots + \frac{1}{C_n}$$

Examples: