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# Kirchhoff's Voltage Law



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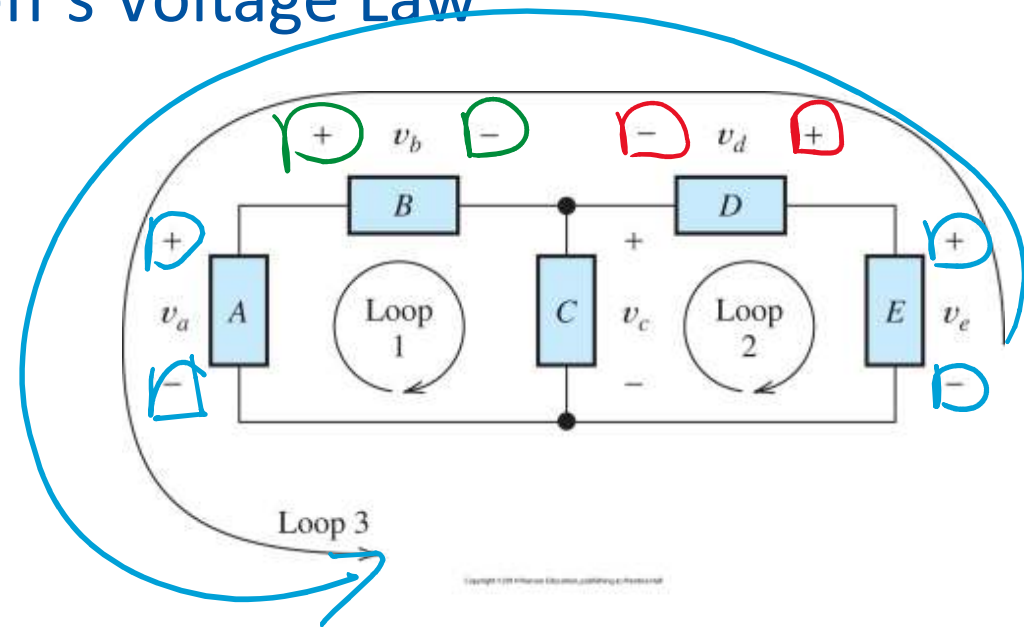
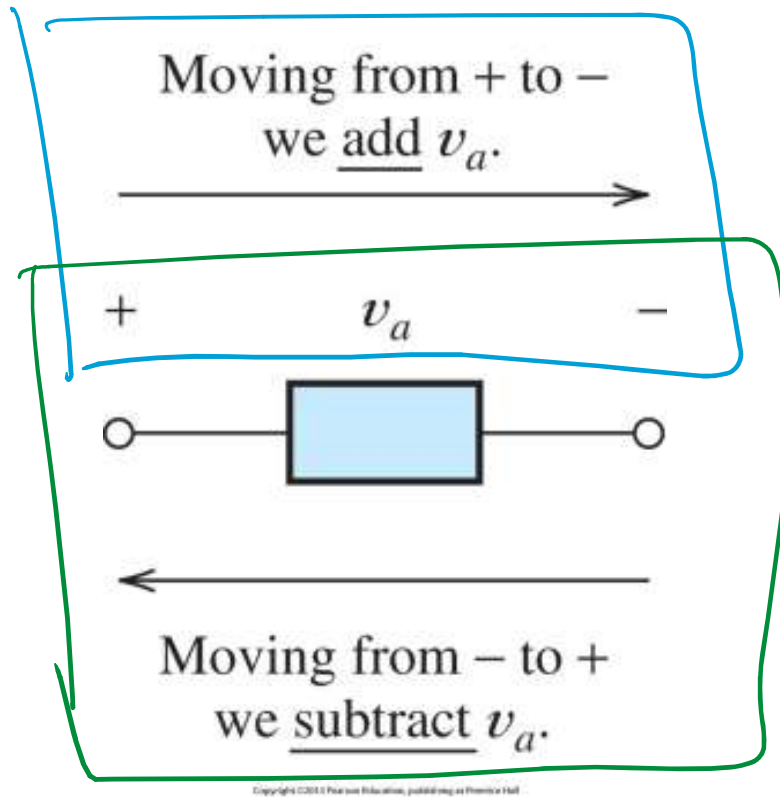
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# Kirchhoff's Voltage Law

The algebraic sum of the voltages equals zero for any closed path (loop) in an electrical circuit.

# Kirchhoff's Voltage Law



**Figure 1.24** Circuit used for illustration of Kirchhoff's voltage law.

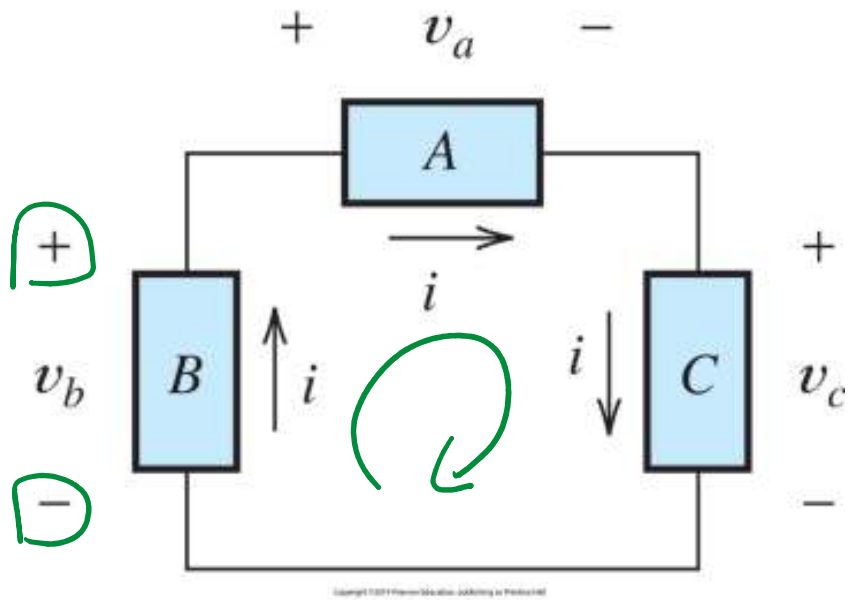
$$\text{Loop 1: } -v_a + v_b + v_c = 0$$

$$\text{Loop 2: } -v_c - v_d + v_e = 0$$

$$\text{Loop 3: } v_a - v_b + v_d - v_e = 0$$

**Figure 1.23** In applying KVL to a loop, voltages are added or subtracted depending on their reference polarities relative to the direction of travel around the loop.

# Kirchhoff's Voltage Law Related to Conservation of Energy



**Figure 1.25** In this circuit, conservation of energy requires that  $v_b = v_a + v_c$ .

Element A:

$$P_a = V_a i$$

Element B:

$$P_b = -V_b i$$

Element C:

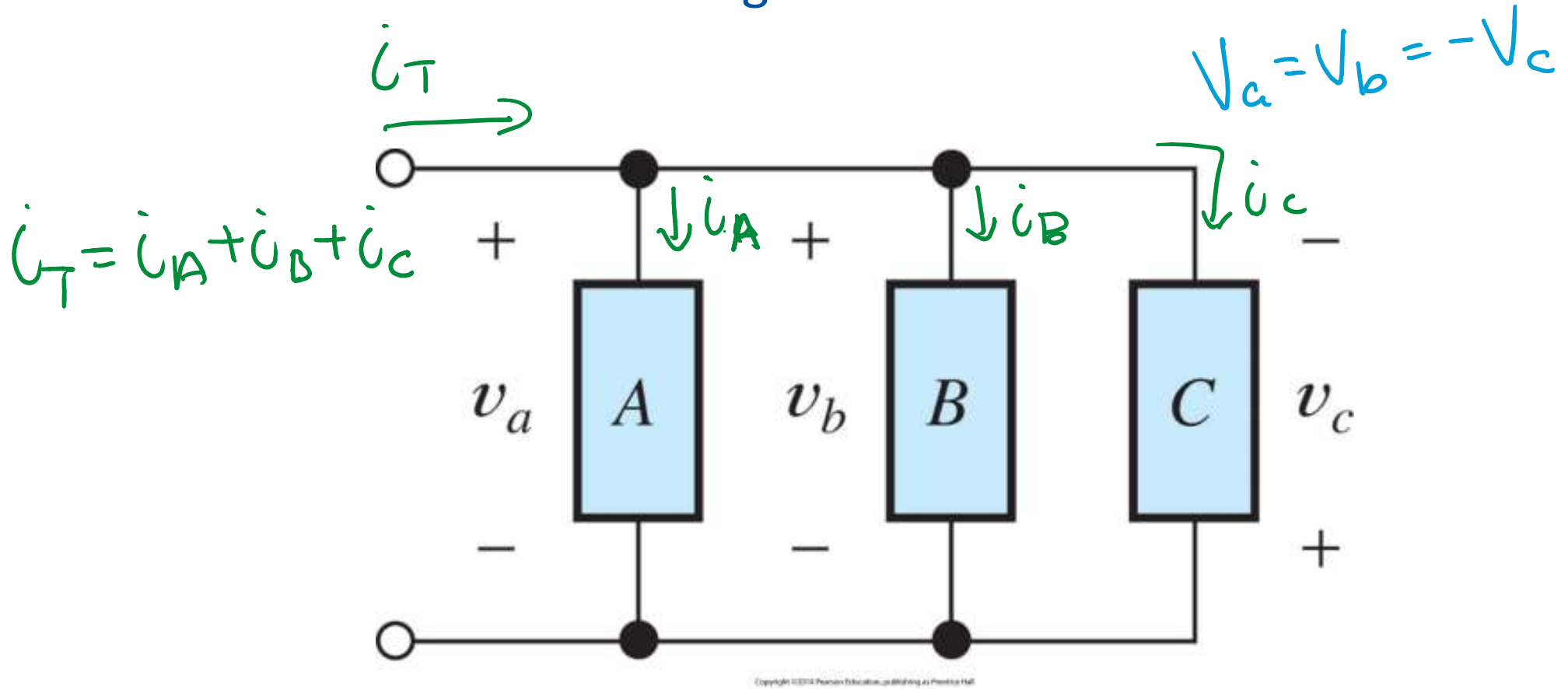
$$P_c = V_c i$$

$$P_a + P_b + P_c = 0$$

$$V_a i - V_b i + V_c i = 0$$

$$V_a - V_b + V_c = 0$$

## Kirchhoff's Voltage Law – Parallel Circuits

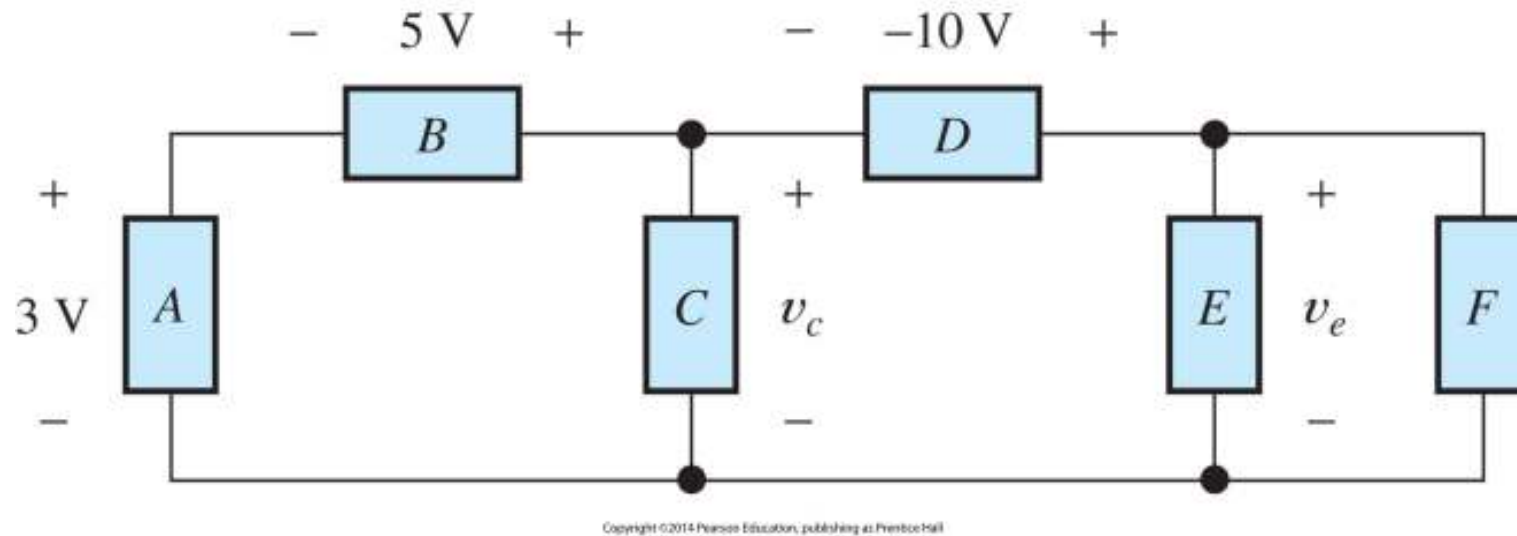


**Figure 1.27** For this circuit, we can show that  $v_a = v_b = -v_c$ .

Thus, the magnitudes and actual polarities of all three voltages are the same.

## Kirchhoff's Voltage Law - Example

Use repeated application of KVL to find the values of  $v_c$  and  $v_e$  for the circuit of figure 1.29.

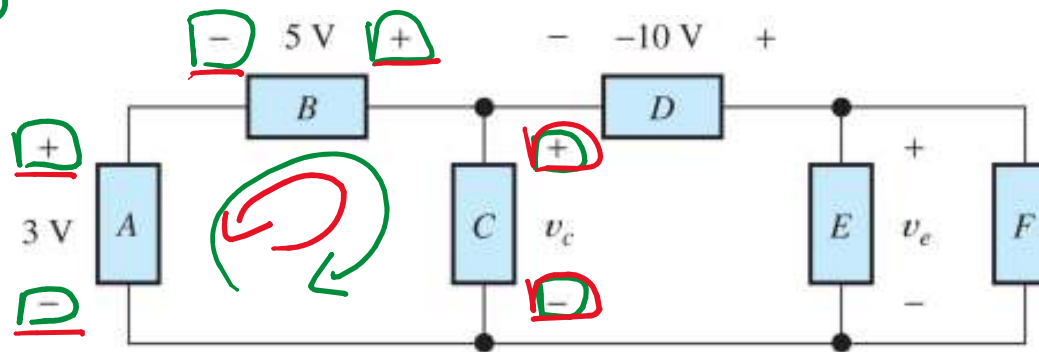


**Figure 1.29** Circuit for Exercises 1.9

# Kirchhoff's Voltage Law - Example

Find the values of  $v_c$

$$-3V - 5V + v_c = 0$$
$$v_c = 8V$$



$$-v_c + 5V + 3V = 0$$
$$v_c = 8V$$



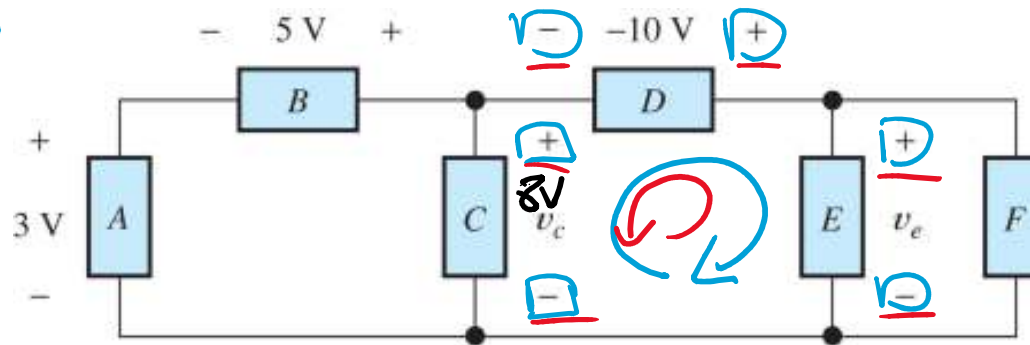
## Kirchhoff's Voltage Law - Example

Find the values of  $v_e$ . Where  $v_c$  is given as 8V

$$-v_c - (-10) + v_e = 0$$

$$-8V + 10V + v_e = 0$$

$$v_e = -2V$$



$$-v_e + (-10V) + 8V = 0$$

$$v_e = -2V$$



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