PHYS 1P22/92
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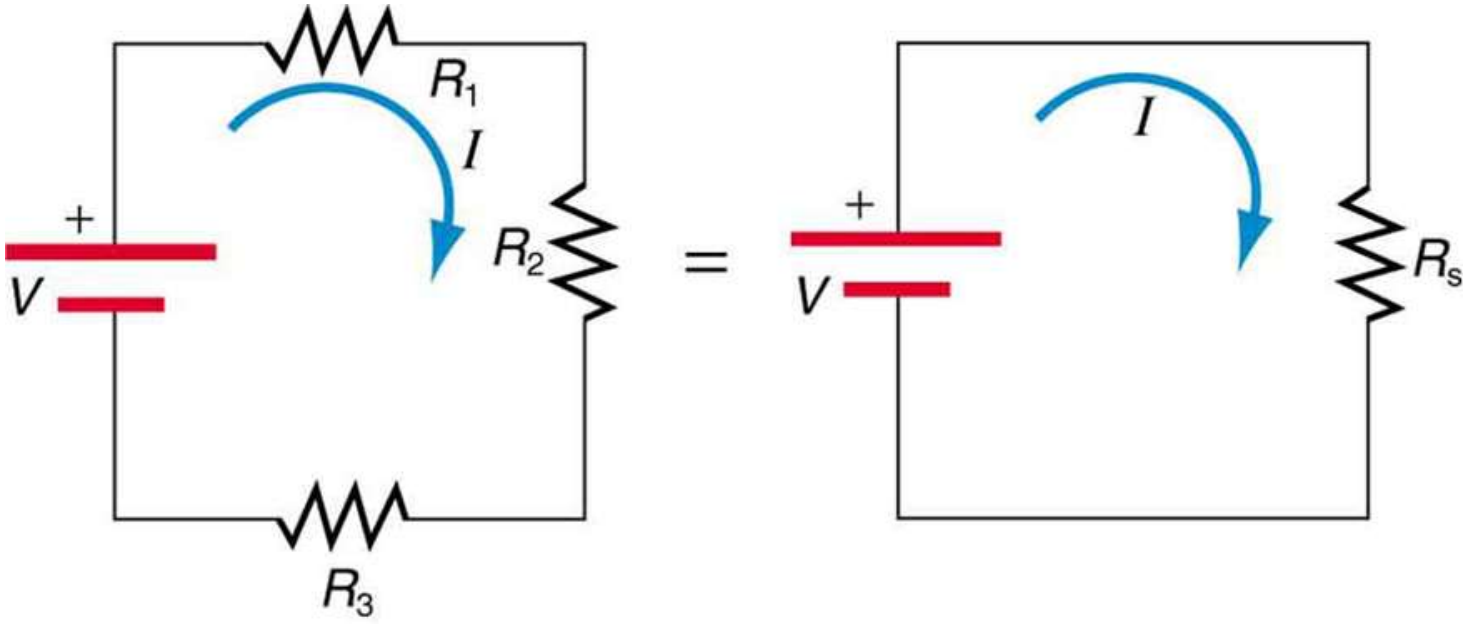
21. Circuits & DC Instruments

21.1 Resistors in Series and Parallel

Series

From conservation of energy: potential energy is qV, so $\sum_i qV_i$ must be conserved.



$$V = IR$$

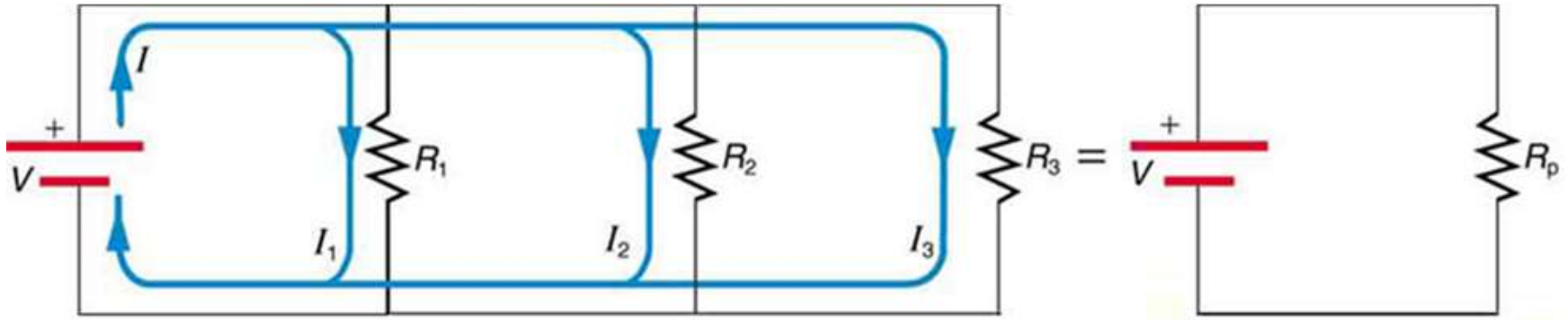
$$V_S = V_1 + V_2 + V_3 = \sum_i V_i$$

$$IR_S = IR_1 + IR_2 + IR_3 = I\sum_i R_i$$

$$R_S = R_1 + R_2 + R_3 = \sum_i R_i$$

Note: each R_i gets same I but different V_i.

Parallel



$$I = \frac{V}{R}$$

$$\downarrow$$

$$I_P = I_1 + I_2 + I_3 = \sum_i I_i$$

$$\downarrow$$

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} = V\sum_i \frac{1}{R_i}$$

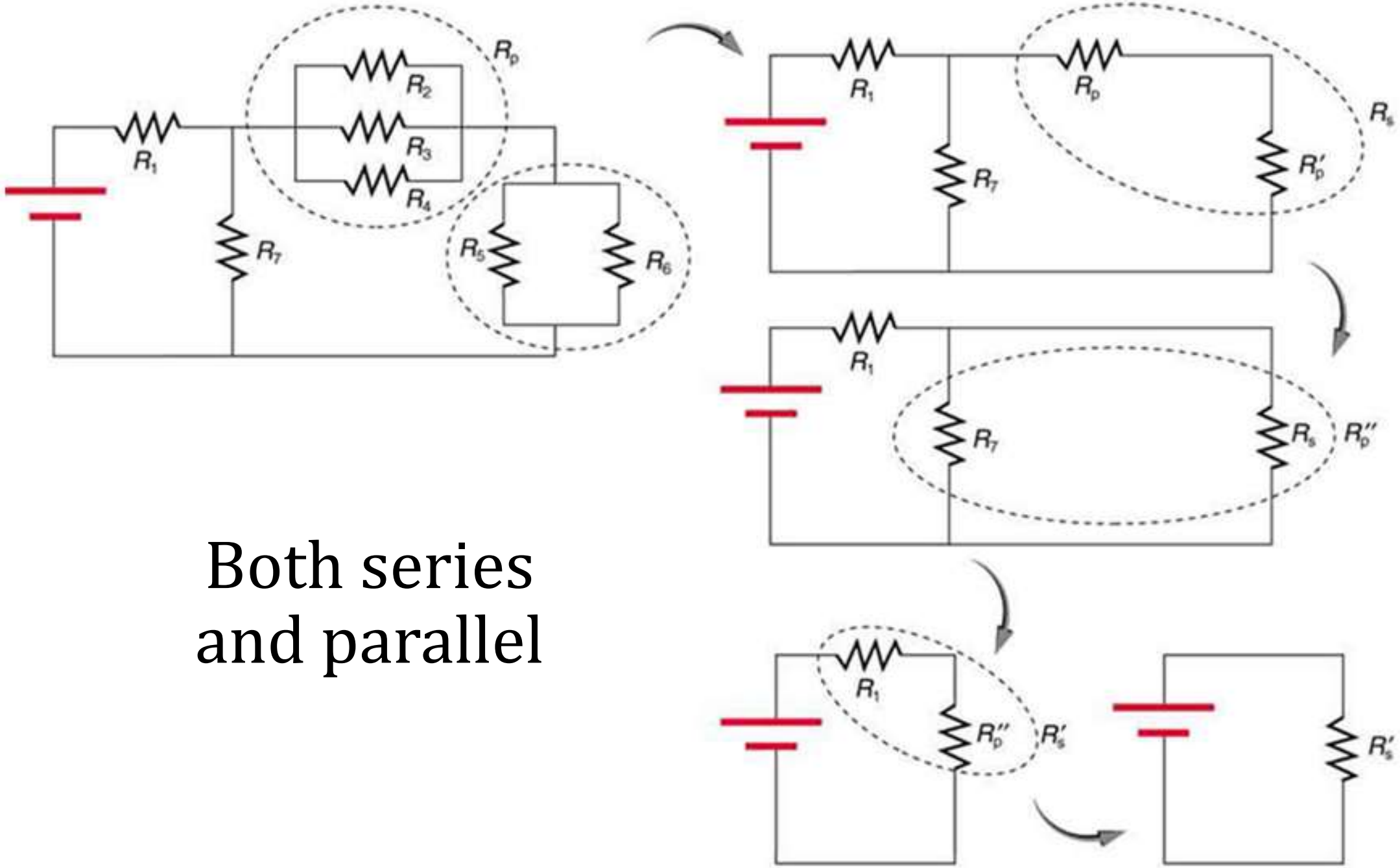
$$\rightarrow$$

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \sum_i \frac{1}{R_i}$$

$$\uparrow$$

$$R_P = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\sum_i \frac{1}{R_i}}$$

Note: each R_i gets same V but different I_i.



Both series and parallel

Capacitors vs. resistors

- Opposite relations:

$$\frac{1}{C_S} = \sum_i \frac{1}{C_i} \qquad C_P = \sum_i C_i$$

vs.

$$R_S = \sum_i R_i \qquad \frac{1}{R_P} = \sum_i \frac{1}{R_i}$$

(This is the only section we will learn from this chapter.)