Solutions

Each answer shows the steps, then the **result**.

2.1

$$R_s = R_1 + R_2 = 6.0\ \Omega + 6.0\ \Omega = \mathbf{12}\ \Omega$$

2.2

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6.0\ \Omega} + \frac{1}{6.0\ \Omega} = \frac{2}{6.0\ \Omega}$$

- $R_p = \mathbf{3.0}\ \Omega$

2.3

- part of the emf is lost across the internal resistance:

$$V = \varepsilon - Ir = 12\ \text{V} - (2.0\ \text{A})(0.50\ \Omega)$$

- $V = \mathbf{11}\ \text{V}$

3.1 B

- the sum of the individual resistances.

3.2 B

- smaller.

3.3

(a)

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{3.0\ \Omega} + \frac{1}{6.0\ \Omega} = \frac{3}{6.0\ \Omega}$$

- $R_p = \mathbf{2.0}\ \Omega$

(b)

$$I = \frac{V}{R_p} = \frac{12\ \text{V}}{2.0\ \Omega}$$

- $I = \mathbf{6.0}\ \text{A}$

3.4

(a)

- parallel pair: reciprocals add, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$:

$$\frac{1}{R_p} = \frac{1}{6.0\ \Omega} + \frac{1}{12.0\ \Omega} = \frac{3}{12.0\ \Omega}, \quad R_p = 4.0\ \Omega$$

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- series with 4.0 Ω: $R_{\text{eq}} = 4.0\ \Omega + 4.0\ \Omega = \mathbf{8.0}\ \Omega$

(b)

- Ohm's law for the whole circuit, $I = \frac{\mathcal{E}}{R_{\text{eq}}}$:

$$I = \frac{\mathcal{E}}{R_{\text{eq}}} = \frac{12\ \text{V}}{8.0\ \Omega}$$

- $I = \mathbf{1.5}\ \text{A}$

(c)

- p.d. across the parallel pair, $V_p = IR_p$:

$$V_p = IR_p = (1.5\ \text{A})(4.0\ \Omega) = \mathbf{6.0}\ \text{V}$$

- current in the 6.0 Ω resistor, $I_1 = \frac{V_p}{R_1} = \frac{6.0\ \text{V}}{6.0\ \Omega} = \mathbf{1.0}\ \text{A}$

(d)

- it **increases**
- the voltmeter forms a third parallel path, lowering the parallel resistance (to 2.4 Ω) and so the total resistance; a lower total resistance draws more current from the battery