NAME _____ DATE _____ CLASS _____

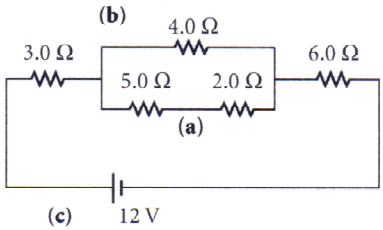
Holt Physics

Problem 20D

CURRENT IN AND POTENTIAL DIFFERENCE ACROSS A RESISTOR

PROBLEM

Determine the current in and the potential difference across the 5.0 Ω resistor in the circuit diagram at right.



SOLUTION

1. **Determine the equivalent resistance in the circuit.**

For group **(a)**: $R_{eq,a} = 5.0\ \Omega + 2.0\ \Omega = 7.0\ \Omega = R_2$

For group **(b)**: $\frac{1}{R_{eq,b}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4.0\ \Omega} + \frac{1}{7.0\ \Omega}$

$$\frac{1}{R_{eq,b}} = \frac{0.25}{1\ \Omega} + \frac{0.14}{1\ \Omega} = \frac{0.39}{1\ \Omega}$$

$$R_{eq,b} = 2.6\ \Omega$$

For group **(c)**: $R_{eq,c} = 3.0\ \Omega + 2.6\ \Omega + 6.0\ \Omega = 11.6\ \Omega$

2. **Calculate the total current in the circuit, which is the current in group (c).**

$$I = \frac{\Delta V_{tot}}{R_{eq}} = \frac{12.0\ \text{V}}{11.6\ \Omega} = 1.0\ \text{A}$$

3. **Determine a path from the equivalent resistance found in step 1 to the 5.0 Ω resistor.** Review the path taken to find the equivalent resistance and work backward through this path.

4. **Follow the path determined in step 3, and calculate the current in and the potential difference across each equivalent resistance.** Repeat this process until the desired values are found.

Regroup, evaluate, and calculate. The circuit's equivalent resistance is that of group **(c)**, as found in step **1** above. The resistors in group **(c)** are in series; therefore, the current in each resistor is the same as the current in the equivalent resistance, which equals 1.0 A. The potential difference across group **(b)**, which is represented by the 2.6 Ω resistor in group **(c)**, can be replaced with $\Delta V = IR$.

Given: $I = 1.0\ \text{A}$ $R = 2.6\ \Omega$

Unknown: $\Delta V = ?$

$$\Delta V = IR = (1.0\ \text{A})(2.6\ \Omega) = 2.6\ \text{V}$$

Regroup, evaluate, and calculate. Replace the center resistor with group **(b)**. The resistors in group **(b)** are in parallel; therefore, the potential difference across each resistor is the same as the potential difference across the 2.6 Ω equivalent resistance, which equals 2.6 V. The current in the 7.0 Ω resistor in group **(b)** can be calculated using $I = \Delta V/R$.

Given: $\Delta V = 2.6\ \text{V}$ $R = 7.0\ \Omega$

Unknown: $I = ?$

$$I = \frac{\Delta V}{R} = \frac{2.6\ \text{V}}{7.0\ \Omega} = 0.37\ \text{A}$$

Regroup, evaluate, and calculate. Replace the 7.0 Ω resistor with group **(a)**. The resistors in group **(a)** are in series; therefore, the current in each resistor is the same as the current in the 7.0 Ω equivalent resistance, which equals 0.37 A.

$$\boxed{I = 0.37\ \text{A}}$$

The potential difference across the 5.0 Ω resistor can be calculated using $\Delta V = IR$.

Given: $I = 0.37$ A $R = 5.0\ \Omega$

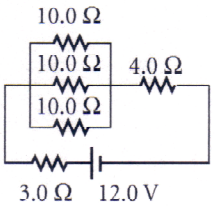
Unknown: $\Delta V = ?$

$$\Delta V = IR = (0.37\ \text{A})(5.0\ \Omega) = 1.85\ \text{V}$$

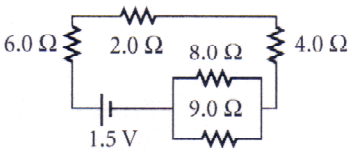
$$\boxed{\Delta V = 1.85\ \text{V}}$$

ADDITIONAL PRACTICE

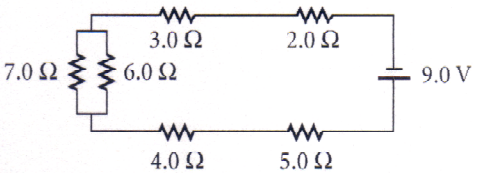
1. Determine the current in and the potential difference across the 4.0 Ω resistor in the circuit diagram at right.



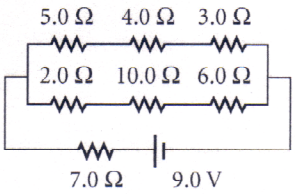
2. Determine the current in and the potential difference across the 9.0 Ω resistor in the circuit diagram at right.



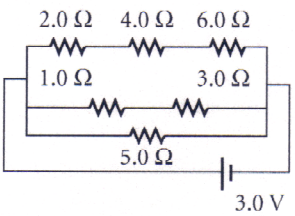
3. Determine the current in and the potential difference across the 6.0 Ω resistor in the circuit diagram at right.



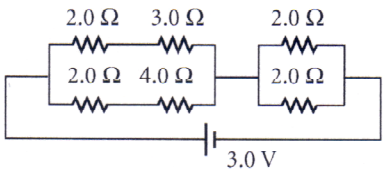
4. Determine the current in and the potential difference across the 10.0 Ω resistor in the circuit diagram at right.



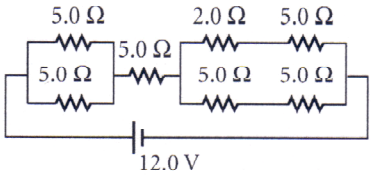
5. Determine the current in and the potential difference across the 4.0 Ω resistor in the circuit diagram at right.



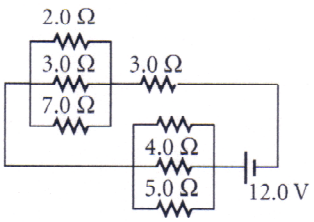
6. Determine the current in and the potential difference across the 3.0 Ω resistor in the circuit diagram at right.



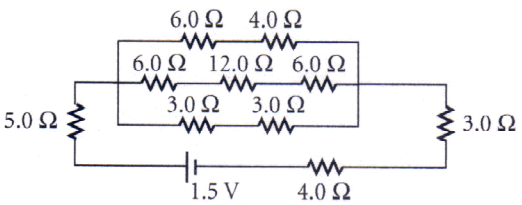
7. Determine the current in and the potential difference across the 2.0 Ω resistor in the circuit diagram at right.



8. Determine the current in and the potential difference across the 7.0 Ω resistor in the circuit diagram at right.



9. Determine the current in and the potential difference across the 12.0 Ω resistor in the circuit diagram at right.



10. Determine the current in and the potential difference across the 15.0 Ω resistor in the circuit diagram at right.