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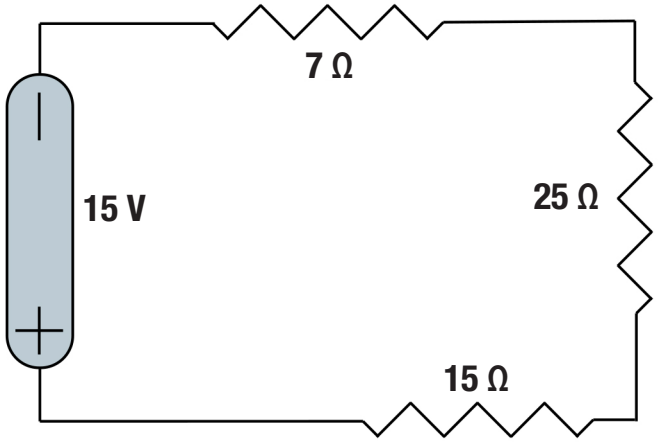
Unit 5G
Series Circuits
Practice Problems TEACHER

Work each of the following problems. SHOW ALL WORK.

1. For the illustrated series circuit, solve for the following:



a. total, equivalent resistance

$$R_{eq} = R_1 + R_2 + R_3$$
$$R_{eq} = 7\ \Omega + 25\ \Omega + 15\ \Omega$$
$$R_{eq} = 47\ \Omega$$

b. total current from the battery

$$V_{total} = I_{total} R_{eq}$$
$$I_{total} = \frac{V_{total}}{R_{eq}}$$
$$I_{total} = \frac{15\ V}{47\ \Omega}$$
$$I_{total} = 0.32\ A$$

c. voltage drop across each resistor

$$V_{7\Omega} = I_{total} R_{7\Omega}$$
$$V_{7\Omega} = (0.32\ A)(7\ \Omega)$$
$$V_{7\Omega} = 2.2\ V$$

$$V_{25\Omega} = I_{total} R_{25\Omega}$$
$$V_{25\Omega} = (0.32\ A)(25\ \Omega)$$
$$V_{25\Omega} = 8\ V$$

$$V_{15\Omega} = I_{total} R_{15\Omega}$$
$$V_{15\Omega} = (0.32\ A)(15\ \Omega)$$
$$V_{15\Omega} = 4.8\ V$$

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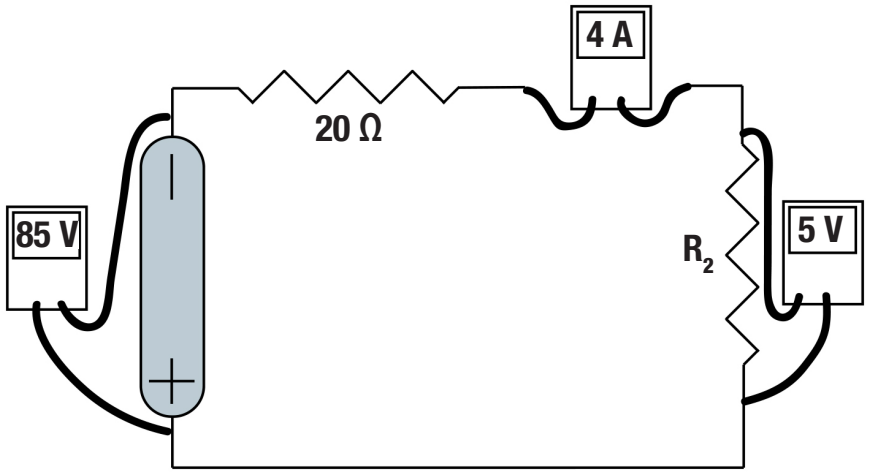
Work each of the following problems. SHOW ALL WORK.

2. **The circuit illustrated below has a power supply of unknown voltage and two resistors: one with a resistance of 20 Ω and the other of an unknown quantity. Using a voltmeter and multimeter, you make the following measurements:**



Calculate the following values:

a. voltage drop across the 20 Ω resistor

$$V_{total} = V_{20\Omega} + V_{R_2}$$
$$85\ V = V_{20\Omega} + 5\ V$$
$$V_{20\Omega} = 80\ V$$

b. current through R_2

$$I_{total} = I_{20\Omega} = I_{R_2} = 4\ A$$

c. resistance value of R_2

$$V_{R_2} = I_{R_2} R_{R_2}$$
$$R_{R_2} = \frac{V_{R_2}}{I_{R_2}}$$
$$R_{R_2} = \frac{5\ V}{4\ A}$$
$$R_{R_2} = 1.3\ \Omega$$

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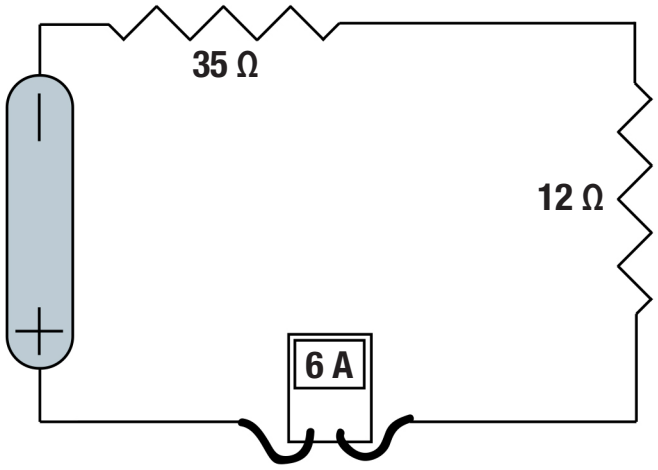
Work each of the following problems. SHOW ALL WORK.

3. The circuit illustrated below has two known resistors and an unknown power supply. Using an ammeter, you measure the current and calculate the following values:



$I_{total} = I_{35\Omega} = I_{12\Omega} = 6\ A$
$V_{35\Omega} = ?$
$V_{12\Omega} = ?$
$V_{total} = ?$

a. voltage drop across the 35 Ω resistor

$V_{35\Omega} = I_{35\Omega} R_{35\Omega}$
$V_{35\Omega} = (6\ A)(35\ \Omega)$
$V_{35\Omega} = 210\ V$

b. voltage drop across the 12 Ω resistor

$V = I_{12\Omega} R_{12\Omega}$
$V = (6\ A)(12\ \Omega)$
$V = 72\ V$

c. voltage supplied by the battery

$V_{total} = V_{35\Omega} + V_{12\Omega}$
$V_{total} = 210\ V + 72\ V$
$V_{total} = 282\ V$

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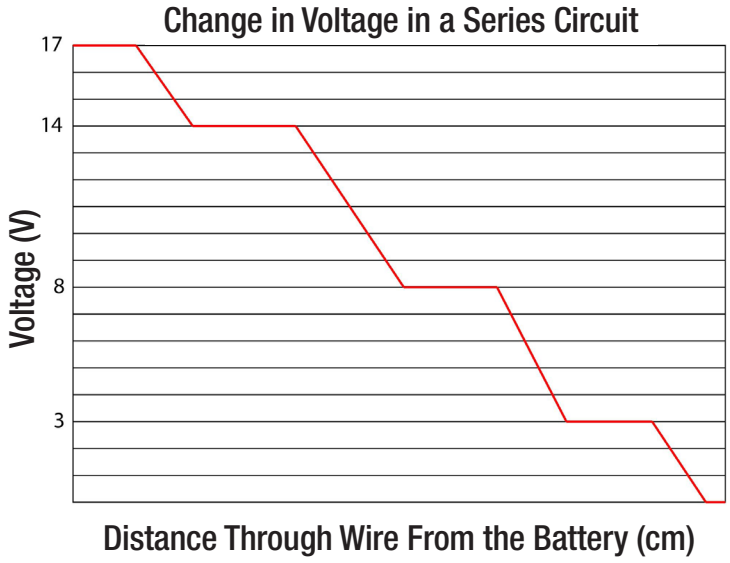
Work each of the following problems. SHOW ALL WORK.

4. The chart below shows how voltage changes across a series circuit. Assuming the circuit is ideal (no loss in the wires) and carries a current of 3 A, answer the following:



a. How many resistors are in the circuit? *4*

b. What are their values?

$R_1 = 3\,V / 3\,A = 1\,\Omega$

$R_2 = 6\,V / 3\,A = 2\,\Omega$

$R_3 = 5\,V / 3\,A = 1.7\,\Omega$

$R_4 = 3\,V / 3\,A = 1\,\Omega$

5. A series circuit has two 9 V batteries and four resistors with values of 10 Ω, 15 Ω, 6 Ω, and 117 Ω. What current runs through the circuit?

$V_{total} = 2(9\,V) = 18\,V$

$R_1 = 10\,\Omega$

$R_2 = 15\,\Omega$

$R_3 = 6\,\Omega$

$R_4 = 117\,\Omega$

For a series circuit:

$R_{eq} = R_1 + R_2 + R_3 + R_4$

$R_{eq} = (10\,\Omega + 15\,\Omega + 6\,\Omega + 117\,\Omega)$

$R_{eq} = 148\,\Omega$

$V_{total} = I_{total} R_{eq}$

$I_{total} = \frac{V_{total}}{R_{eq}}$

$I_{total} = \frac{18\,V}{148\,\Omega}$

$I_{total} = 0.12\,A$

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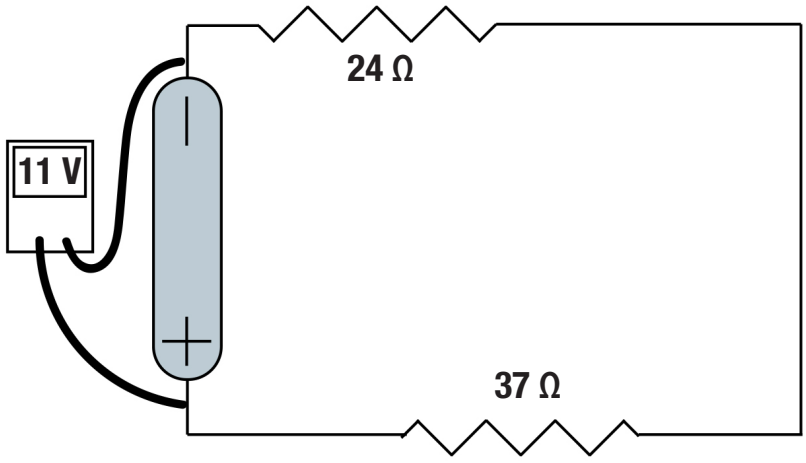
Work each of the following problems. SHOW ALL WORK.

6. Using the circuit illustrated below, solve for the following:



$V_{total} = 11V$
$R_{24\Omega} = 24\,\Omega$
$R_{37\Omega} = 37\,\Omega$
$I_{total} = ?$
$V_{24\Omega} = ?$
$V_{37\Omega} = ?$

a. total resistance

$$R_{eq} = R_{24\Omega} + R_{37\Omega}$$
$$R_{eq} = 24\,\Omega + 37\,\Omega$$
$$R_{eq} = 61\,\Omega$$

$$V_{total} = I_{total} R_{eq}$$
$$I_{total} = \frac{V_{total}}{R_{eq}}$$
$$I_{total} = \frac{11V}{61\,\Omega}$$
$$I_{total} = 0.18\,A$$

b. total current

For a series circuit: $I_{total} = I_{24\Omega} = I_{37\Omega}$

c. voltage drop across the 24 Ω resistor

$$V_{24\Omega} = I_{24\Omega} R_{24\Omega}$$
$$V_{24\Omega} = (0.18\,A)(24\,\Omega)$$
$$V_{24\Omega} = 4.3\,V$$

d. voltage drop across the 37 Ω resistor

$$V_{37\Omega} = I_{37\Omega} R_{24\Omega}$$
$$V_{37\Omega} = (0.18\,A)(37\,\Omega)$$
$$V_{37\Omega} = 6.7\,V$$

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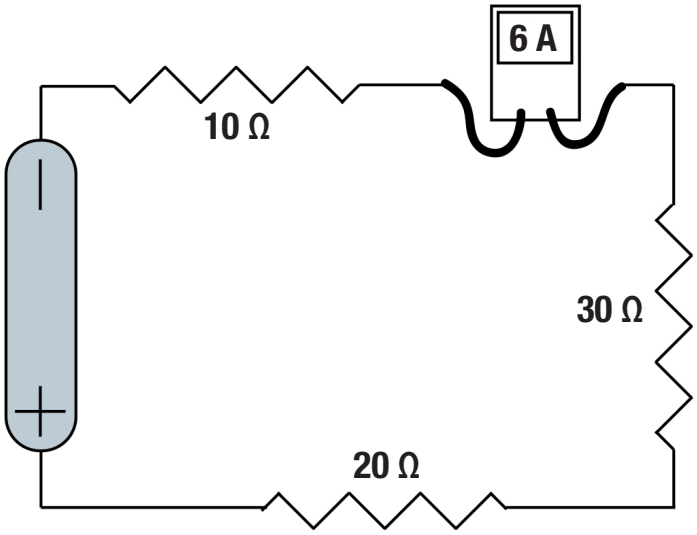
Work each of the following problems. SHOW ALL WORK.

7. What is the DC source voltage in this circuit?

$I_{total} = 6\ A$
$R_1 = 10\ \Omega$
$R_2 = 30\ \Omega$
$R_3 = 20\ \Omega$



$R_{eq} = R_1 + R_2 + R_3$
$R_{eq} = 10\ \Omega + 30\ \Omega + 20\ \Omega$
$R_{eq} = 60\ \Omega$

$V_{total} = I_{total} R_{eq}$
$V_{total} = (6\ A)(60\ \Omega)$
$V_{total} = 360\ V$

8. You are designing a circuit to power a nightlight and want to keep the light level as low as possible. The wire you use can handle up to 3 A of current; higher than that and the circuit will shut down automatically. If the power supply is 120 V, what is the fewest number of 2.3 Ω light bulbs you can put in series in the circuit without exceeding the maximum current?

$I_{total} = 3\ A$
$V_{total} = 120\ V$

$V_{total} = I_{total} R_{min}$

$$R_{min} = \frac{V_{total}}{I_{total}}$$

$$R_{min} = \frac{120\ V}{3\ A}$$

$R_{min} = 40\ \Omega$

$$17.4 = \frac{40\ \Omega}{2.3\ \Omega}$$

The fewest number of bulbs you can use without exceeding the 3 A current is 18.

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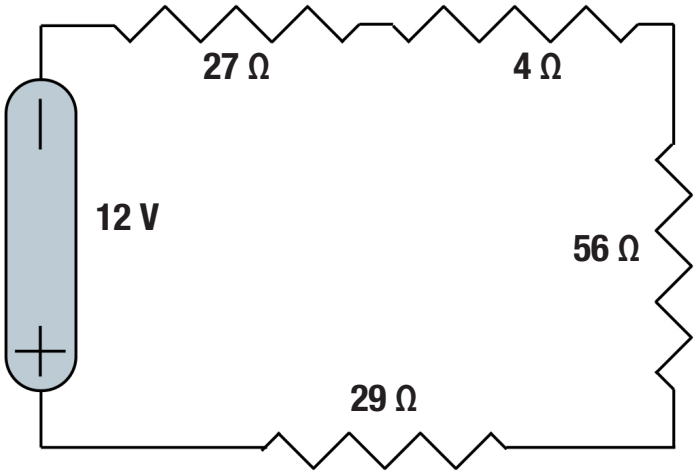
Work each of the following problems. SHOW ALL WORK.

9. What is the voltage across each of the resistors in the circuit illustrated below?



$V_{total} = 12\,V$
$R_{27\Omega} = 27\,\Omega$
$R_{4\Omega} = 4\,\Omega$
$R_{56\Omega} = 56\,\Omega$
$R_{29\Omega} = 29\,\Omega$
$V_{27\Omega} = ?$
$V_{4\Omega} = ?$
$V_{56\Omega} = ?$
$V_{29\Omega} = ?$

$R_{eq} = R_{27\Omega} + R_{4\Omega} + R_{56\Omega} + R_{29\Omega}$
$R_{eq} = (27\,\Omega + 4\,\Omega + 56\,\Omega + 29\,\Omega)$
$R_{eq} = 116\,\Omega$

$V_{total} = I_{total} R_{eq}$
$I_{total} = \dfrac{V_{total}}{R_{eq}}$
$I_{total} = \dfrac{12\,V}{116\,\Omega}$
$I_{total} = 0.10\,A$

$I_{total} = I_{27\Omega} = I_{4\Omega} = I_{56\Omega} = I_{29\Omega}$

$V_{27\Omega} = I_{27\Omega} R_{27\Omega}$
$V_{27\Omega} = (0.10\,A)(27\,\Omega)$
$V_{27\Omega} = 2.7\,V$

$V_{4\Omega} = I_{4\Omega} R_{4\Omega}$
$V_{4\Omega} = (0.10\,A)(4\,\Omega)$
$V_{4\Omega} = 0.4\,V$

$V_{56\Omega} = I_{56\Omega} R_{56\Omega}$
$V_{56\Omega} = (0.10\,A)(56\,\Omega)$
$V_{56\Omega} = 5.6\,V$

$V_{29\Omega} = I_{29\Omega} R_{29\Omega}$
$V_{29\Omega} = (0.10\,A)(29\,\Omega)$
$V_{29\Omega} = 2.9\,V$

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Work each of the following problems. SHOW ALL WORK.

10. Three identical 40 Ω light bulbs are arranged in series with a 15 V battery. If two more bulbs are added, how much does the current change? After the addition, will the bulbs be as bright as before or will they be dimmer?

$$R_1 = R_2 = R_3 = 40\,\Omega$$
$$V_{total} = 15\,V$$
$$I_{before} = ?$$
$$I_{after} = ?$$

$$R_{eq} = R_1 + R_2 + R_3$$
$$R_{eq} = 40\,\Omega + 40\,\Omega + 40\,\Omega$$
$$R_{eq} = 120\,\Omega$$

Before the two bulbs are added:

$$V_{total} = I_{before}\,R_{eq}$$
$$I_{before} = \frac{V_{total}}{R_{eq}}$$
$$I_{before} = \frac{15\,V}{120\,\Omega}$$
$$I_{before} = 0.13\,A$$

After the two bulbs are added:

$$R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5$$
$$R_{eq} = 40\,\Omega + 40\,\Omega + 40\,\Omega + 40\,\Omega + 40\,\Omega$$
$$R_{eq} = 200\,\Omega$$
$$I_{after} = \frac{15\,V}{200\,\Omega}$$
$$I_{after} = 0.08\,A$$

$$\Delta I = I_{after} - I_{before}$$
$$\Delta I = 0.08\,A - 0.13\,A$$
$$\Delta I = -0.05\,A$$

The current after the addition of the two bulbs is less than the current before.

Therefore, the bulbs will be dimmer since overall current has decreased in the circuit.

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