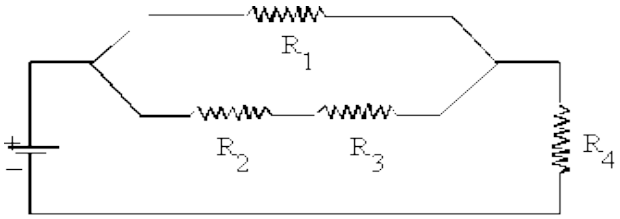
Electrical circuits exercises

Exercises collection obatained from: http://laurenhill.emsb.qc.ca/science/ansp32.html

1. An electric circuit is illustrated below:



$R_1 = 4\Omega$
$R_2 = 6\Omega$
$R_3 = 6\Omega$
$R_4 = 6\Omega$

What is the equivalent resistance of this circuit?

$R_2 + R_3 = R_{eq}$

$6 + 6 = 12\ \Omega$

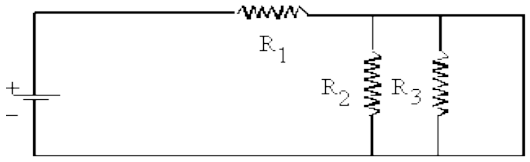
$1/R_p = 1/R_1 + 1/R_{eq}$

$1/R_p = 1/4 + 1/12$

$R_p = 3\ \Omega$

$R_t = R_{eq} + R_p = 3 + 6 = 9\ \Omega$

2. An electric circuit is illustrated below.



$R_1 = 15\Omega$
$I_1 = 2\ A$
$I_2 = 1.5\ A$
$V_2 = 90\ V$

What is the value of resistor R_3?

$I_1 = I_2 + I_3$ because I_1 is the total current in this case.

$2 = 1.5 + I_3$

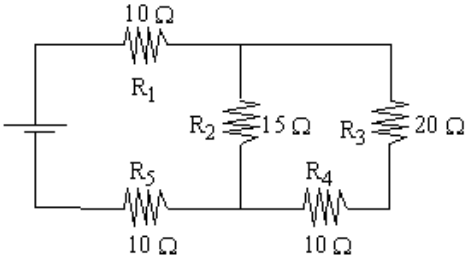
$I_3 = 0.5\ A$

If $V_2 = 90\ V$, then $V_3 = 90\ V$ because voltage is the same in parallel connection.

$R_3 = V_3/I_3 = 90/0.5 = 180\ \Omega$

3. Given this electric circuit:

Find the equivalent resistance, R_t.



R_4 and R_3 are in series so $R_{eq1} = R_4 + R_3 = 10 + 20 = 30\Omega$

R_2 and R_{eq1} are in a parallel connection, so:

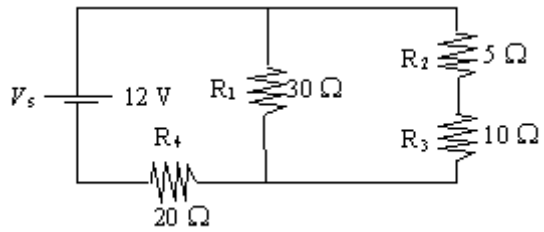
$1/R_{eq2} = 1/R_2 + 1/R_{eq1}$

$1/ R_{eq2} = 1/ 15 + 1/ 30$

$R_{eq2} = 10\ \Omega$

$R_t = R_5 + R_{eq2} + R_1 = 10 + 10 + 10 = 30\ \Omega$

4. A series-parallel electric circuit is illustrated below:



What is the voltage value across the terminals of resistor R_1?

First find total resistance:

$1/R_{eq} = 1/R_1 + 1/(R_2 + R_3)$

$1/R_{eq} = 1/30 + 1/(5 + 10) = 1/30 + 1/15 = 1/30 + 2/30 = 3/30 = 1/10$

$R_{eq} = 10\ \Omega$

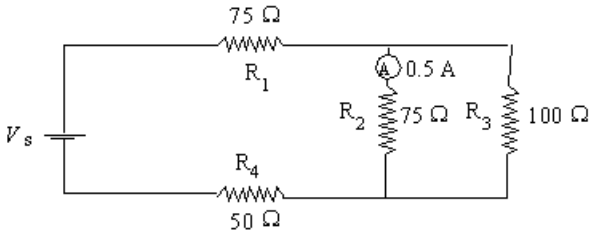
$R_t = R_4 + R_{eq} = 20 + 10 = 30\ \Omega$

$I_t = V/R = 12/30 = 0.40\ A$

$V_4 = IR_4 = 0.40 \times 20 = 8\ V$

$V_1 = V_t - V_4 = 12 - 8 = 4\ V$

5. A series-parallel electric is illustrated below.



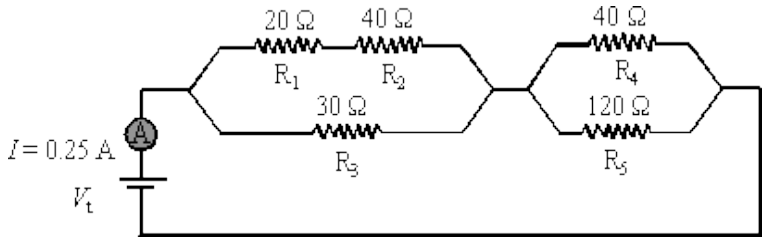
What is the intensity of the current flowing through the power source, I_s?

R_2 and R_3 experience the same voltage, so $V_2 = I_2R_2 = (0.5)75 = 37.5\ V$ and:

$I_3 = V_3/R_3 = 37.5/100 = 0.375A$

So total current = 0.5 + 0.375 = 0.875 A

6. The following electric circuit consists of a power supply, five resistors (R_1, R_2, R_3, R_4 and R_5) and an ammeter (Ⓐ) (An ammeter is a device used to measure the current value at a specific point in an electrical circuit.).



The ammeter reads 0.25 A.

a) What is the voltage (V_t) across the terminals of the power supply?

$1/ R_{eq1} = 1/(R_1 + R_2) + 1/R_3$

$1/ R_{eq1} = 1/(20 + 40) + 1/30$

$R_{eq1} = 20\ \Omega$

$1/ R_{eq2} = 1/R_4 + 1/R_5$

$1/ R_{eq2} = 1/40 + 1/120$

$R_{eq2} = 30\ \Omega$

$R_t = R_{eq1} + R_{eq2} = 20 + 30 = 50$ W.

$V_t = IR_t = 0.25 \times 50 =$ 12.5 V

b) What is the voltage across R_3?

$V_p = V_3 = I_t R_{eq1} = 0.25 \times 20 = 5V$

c) What is the potential difference across R_1?

$I_1 = V_p/(R_1+R_2) = 5/(20 + 40) = 0.0833A$

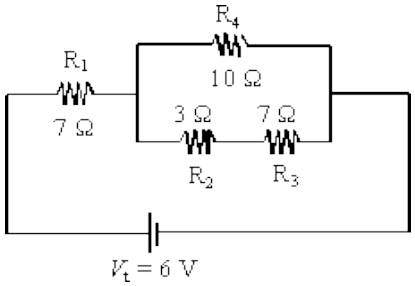
$V_1 = I_1R_1 = 0.0833 \times 20 = 1.67V$

d) What current flows through R_5?

$V_5 = V_t - V_3 = 12.5 - 5 = 7.5$ V

$I_5 = V_5/R_5 = 7.5/120 = 0.0625$ A

7. An electric circuit is illustrated below:



What is the value for the current flowing through resistors R_2 and R_3?

$R_{eq} = 1/R_4 + 1/(R_2 + R_3)$

$R_{eq} = 1/10 + 1/(3 + 7)$

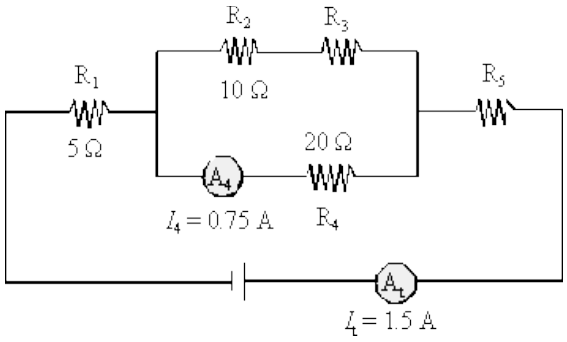
$R_{eq} = 5\ \Omega$

$R_t = R_1 + R_{eq} = 7 + 5 = 12\ \Omega$

$I_t = V_t/R_t = 6/12 = 0.5\ A$

Current flowing through R_2 and R_3 will be the same as what's on top (since R is the same), so it will be 0.5/2 = 0.25A

8. The following electric circuit consists of a power source, five resistors (R_1, R_2, R_3, R_4 and R_5) and two ammeters A_4 and A_t.



What is the voltage value across the terminals of resistor R_3?

R_2 and R_3 are receiving the same current (they are in series connection) and its value is 1.5 – 0.75 = 0.75 A (the difference betwwen A_t and A_4)

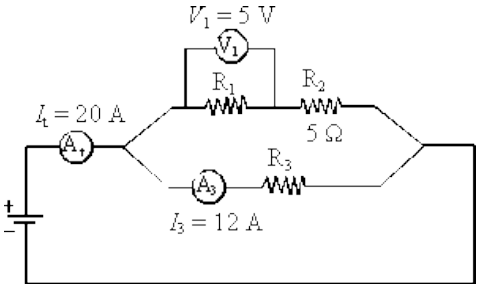
That means that current is the same in both braches. That implies that resistance has to be also the same in both branches ($R_2 + R_3 = R_4$).

So $R_3 = 20 - 10 = 10\ \Omega$

Now in order to calculate the voltage value across R_3:

$V_3 = I_3R_3 = 0{,}75 \times 10 = 7{,}5\ V$

9. The following circuit consists of a power source, two ammeters A_1 and A_3, a voltmeter V_1 and three resistors (R_1, R_2 and R_3). (A voltmeter is a devide used to measure voltage across two points in an electical circuit).



Total current I_t is 20 A, I_3 is 12 A. Voltage V_1 across the terminals of resistor R_1 is 5 V.

What is the resistance of resistor R_3?

$I_1 = I_t - I_3 = 20 - 12 = 8\ A = I_2$

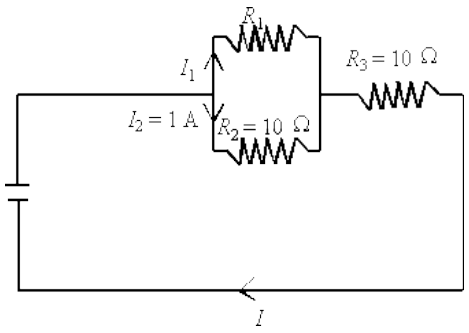
$V_2 = I_2R_2 = 8 \times 5 = 40\ V$

$V_1 + V_2 = V_3$

$5 + 40 = V_3 = 45$ V

$R_3 = V_3/I_3 = 45/12 = 3.75$ Ω

10. A power source with a voltage of 30 V is connected to the circuit shown below.



What is the current I across the circuit?

$V_2 = I_2R_2 = 1 \times 10 = 10$ V

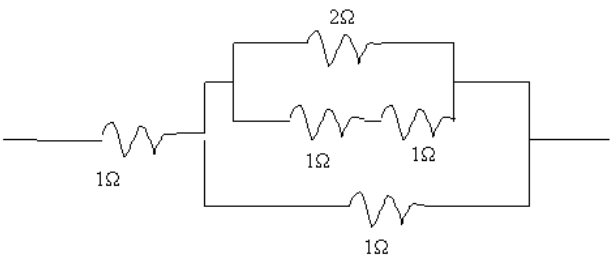
$V_3 = V_t - V_2 = 30 - 10 = 20$ V

$I_t = V_3/R_3 = 20/10 = 2$

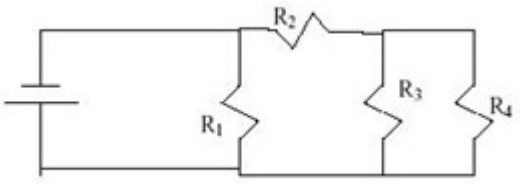
11. How can one 25 Ω and two 100 Ω resistors be connected so that their total resistance is 75 Ω?

Place the two 100 W resistors in parallel (so Req = 50 W)and put the new branch in series with the 25 W.

12. How can four 1.0 Ω resistors and one 2.0 Ω resistor be connected to give a combined resistance of 1.5 Ω?



13. Four identical resistors are connected as shown. If the total voltage is 12V, find the voltage across each resistor:



R_1 has the full 12V because It just connected in series with only the battery.

R_2 has twice the resistance of R_3 and R_4 combined (because R_3 and R_4 are in a parallel connection), so it will have twice the voltage. $12 = 2x + x$; $x = 4$ V.

Conclusion $V_2 = 2x = 8$V; V_3 and $V_4 = 4$V