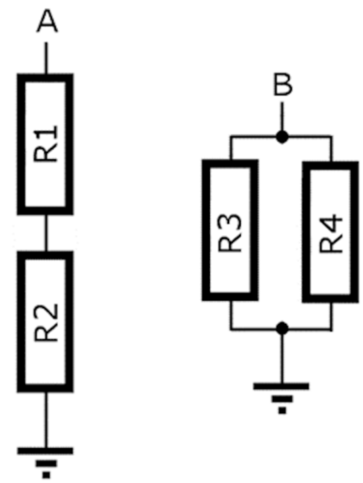
Series and Shunt Connections

Series means in-line. *Shunt* (a.k.a., parallel) means *side-by-side*.



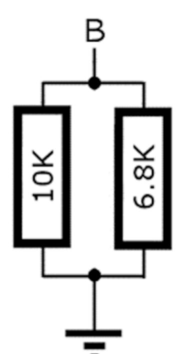
R1 and *R2* are connected in series, such that current flowing through the circuit has just one path. In this configuration, the resistor values just add. For example, if *R1* is 10K, and *R2* is 6.8K, the resistance from point *A* to ground will be 16.8K.

R3 and *R4* are connected in parallel; a shunt connection. In this case, current has two paths between ground and point B. In this connection, if the resistors are of equal value, the resistance from point *B* to ground will be half of whatever that value is, and an equal current will flow through each resistor. For example, if both resistors are 10K, the resistance from *B* to ground will be 5K.

If the resistors are not of equal value, then their parallel value will be somewhat less than the one of lowest value, and can be easily calculated:

$$R_t = \frac{R3 \times R4}{R3 + R4}$$

For example, assume that *R3* = 10K and *R4* is 6.8K …

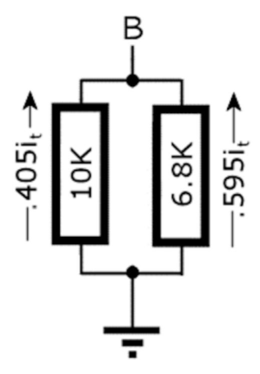


$$R_t = \frac{10K \times 6.8K}{10K + 6.8K} = \frac{68 \times 10^6}{16.8 \times 10^3} = 4.048K$$

The current flowing through this network will be determined by this effective resistance value, and will divide proportionately between the two resistors.

Pause for a moment, assign any arbitrary voltage value to point *B*, and see if you can figure out what the percentages will be.

Did you simply calculate the current through each resistor individually using Ohms law? If so, you found that about 60% of the total current will flow through the lower value resistor.



The resistance of a network comprised of multiple equal-value resistors in parallel is the value divided by the number of resistors. For example, four 10K resistors connected in parallel would have a net resistance of 2.5K.

When multiple resistors of unequal value are connected in parallel, the calculation is:

$$R_t = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + etc.}$$

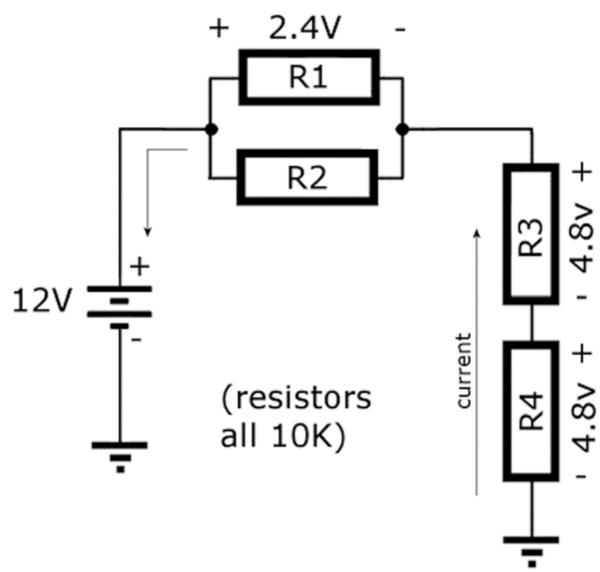
We could spend a lot of time doing exercises, calculating the effective resistance value of various series-parallel networks.

But this isn’t something that’s often encountered in the real world, so there’s really no need to concentrate on it. It’s sufficient that you know how to figure such things out should such a case ever happen to arise.

Voltage Drops

When current flows through a circuit, the voltage measured across that circuit will be equal to the voltage applied. The voltage measured across any segment of the circuit will be proportional to that segment’s resistance compared with the total resistance in the circuit and, by convention, is called a *voltage drop*.

That's just an expression. It does not infer that any voltage is lost. In fact, the total of all "voltage drops" around a circuit will be equal to the supply voltage.



You can use Ohms law to calculate the current in the above circuit, and then calculate the voltage across each resistor. In describing your result, you'd simply say things like, "The voltage drop across *R3* is 4.8-volts."

Kirchhoff’s Laws

In thinking about Ohm’s laws, two things occurred to the German physicist Gustav Kirchhoff …

… that *the algebraic sum of the currents at any junction of conductors is zero*, and …

… that *the algebraic sum of the EMFs and voltage drops around any closed circuit is always zero*.

These are known as Kirchhoff’s laws. If these seem rather obtuse, it’s only because they’re actually so obvious.

The first law states that the current flowing out of any point, such as the junction of *R1* and *R2* in the above illustration, is necessarily equal to the current flowing into it.

That seems quite obvious!

The second law states what we’ve already learned, that the algebraic sum of the applied voltage and all the voltage drops around the circuit is zero. Notice this is about the *algebraic sum*. If you observe the polarity marks, you'll see that those of the voltage drops are the reverse of (in opposition to) the polarity of the power source. Going around the circuit in a clockwise direction beginning at the battery …

$$12 + (-4.8) + (-4.8) + (-2.4) = 0$$

So? Who cares?

Can you think of any practical application for this information?

Neither could I. If you happen to think of anything, use the discussion board to let us know.

(I say that facetiously, of course.)

So, celebrations are in order once again, as we close out yet another section of the course!

Having familiarized ourselves with concepts associated with resistors, let's move on to inductors and capacitors.
