Ohm's Law- Worksheet

After watching the introductory video, answer the question below:

What are the similarities and differences between water and current flow?

Part (A)

1. Draw a simple closed circuit diagram consisting of a lamp, battery and wires. Show the polarities of your closed circuit on the diagram.

2. Build a closed circuit from the components listed in step 1.

3. From the devices in front of you, try to identify a resistance, a voltammeter, an ammeter and a power supply. What is the function of each of these devices?

Devices	**Function**

4. Draw circuit diagram to connect the components listed in step 3 and show the polarities of each component in the closed circuit?

5. Try to connect the devices you identified in step 3 to form a closed electric circuit (note: The lamp's filament acts as a resistance so you deal with resistance as you would for a lamp).

6. After checking your circuit, turn the power supply on. By turning the power supply's knob you are increasing the potential difference to the circuit. Note the relation between current I that passes through the resistance R and the potential difference V across it?

7. Collect data that measures the current I that passes through the resistance R at specific potential difference V across it.

8. Draw a graph of *V* vs. *I*. What does the slope of the line represent?

9. The law that relates *V* with *I* is called Ohm′s law .Write the mathematical formula of this law.

10. Using what you have learned above, design a set-up to determine the value of the unknown resistance.

Part (B)

There are different methods to connect electrical components. Two of these methods are connecting in series and in parallel. Connecting in series means that the polarities of a component are connected to the opposite polarity of the second component. In connecting in parallel, the polarities of a component are connected to the same polarity of the other.

11. Connect the lamps in front of you once in series and once in parallel and draw a circuit diagram in each case.

Resistors in series connection	**Resistors in parallel connection**

12. Try to connect the resistance once in- series and once in- parallel and measure their equivalent resistance in each case, Test your results by using multimeter.

13. Complete the following sentences

a) --------------------- is a circuit connection in which resistors are arranged in a chain. The ----------- is the same through each resistor.
b) The equivalent resistance of resistors connected in series is given by the following formula ------------------.
c) ---------------------- is a circuit connection in which the resistors are arranged with their heads connected together, and their tails connected together. The ------------- across each resistor is the same.
d) The equivalent resistance of resistors connected in parallel is given by the following formula ---------------------.

Extend:

Why most devices used in homes, such as lamps and TV, are connected in parallel? (mention 2 reasons).

Ohm's Law

A resistor is a circuit element which dissipates electrical energy in the form of heat. All conductors (metals) have resistance, but the material used in most resistors is carbon-glass. Resistance manifests itself at the microscopic level as collisions between conduction electrons (those actually involved in carrying the current) and the atoms making up the resistive material. Resistance is actually determined by the geometry of the material, and the intrinsic property of a material which is the macroscopic manifestation of the collisions between the electrons and the atoms is called the *resistivity* of the material. The resistivity and the material geometry determine the resistance of the material, and the relationship for most geometries is:

$$R = \frac{\rho l}{A}$$

where ρ is the resistivity of the material, l is the length over which the current flows, and A is the cross sectional area through which the current flows. These are shown below in figure 1.

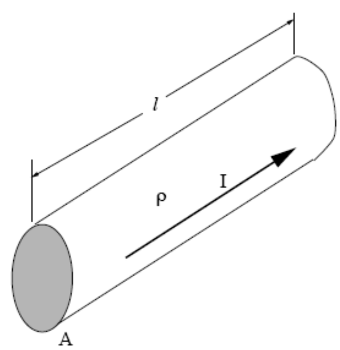

Figure 1: The geometry for the above equation.

Ohm's Law states the following:

$$R = \frac{V}{I}$$

where V is the voltage across the resistor in volts (V) and I is the current flowing through the resistor in amps (A). The units of resistance are then V/A = Ω, called ohms.

If the resistor is linear, then the ratio V / I is always the same and the resistance is a constant value. Then we may write

$$V = I R$$

which states that V and I are proportional with a constant of proportionality R. This is the linear form of Ohm's law, and the most famous form. All standard resistors follow this mathematical equation and are therefore technically *linear* resistors. Sometimes, for some materials or devices, this is not the case. Such devices are then termed *non-linear*.

When we build a circuit with resistors we can connect them in general in one of two ways: in series or in parallel. The way a resistor is sketched, and two resistors in series, are shown below.

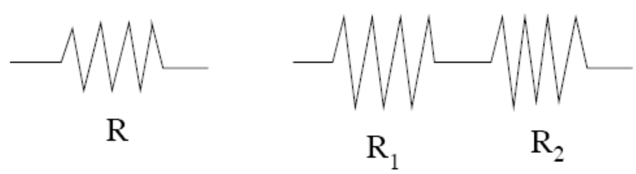

Figure 2: The schematic representation of a resistor (left) and two resistors in series (right).

Putting two resistors in series makes the net (equivalent) resistance the sum of the resistors:

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

or in general for many resistors

$$R_{eq} = R_1 + R_2 + R_3 + \cdots.. + + R_N$$

for a total of N resistors in series. For a parallel configuration, the resistors look like figure 3.

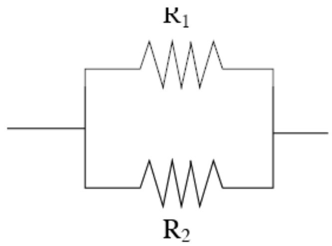

Figure 3: The schematic representation of two resistors in parallel.

The net resistance for the parallel resistors is given by the following expression

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

where R_{eq} will be less than either of the two resistances making up the parallel combination. For many resistors in parallel, the equation becomes

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_N}$$

and, once again, R_{eq} will be less than the smallest resistor in the combination.

Usually the circuit has a mixture of parallel and series resistors, and to find the equivalent resistance of the entire circuit one must add different sections in either series or parallel.

Voltmeters and Ammeters

Voltmeters measure the potential difference across some circuit element or elements. The voltmeter is placed in parallel with the element and since it has a very high resistance it does not draw any current from the circuit and therefore does not affect the circuit. The reading on the meter is the voltage drop between the two points where the meter leads are placed in the circuit. This is depicted in figure 4.

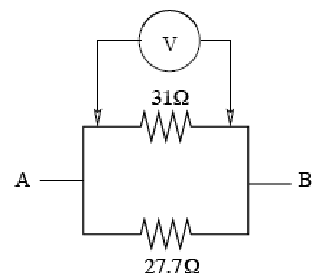

Figure 4: A voltmeter reading the potential difference across a resistor in a circuit.

Ammeters read the current passing through a particular branch of a circuit (i.e. a wire). The ammeter must be wired directly into the circuit in series where one wants to know the current. The resistance of the ammeter is very low (essentially zero) and therefore does not affect the circuit. This is depicted in figure 5.

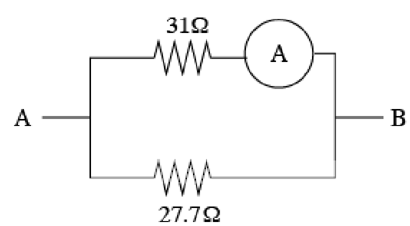

Figure 5: An ammeter reading the current through a wire in a circuit.