Objectives

1. Identify different elements and read resistors' values based on colour coding.
2. Use mustimeter (ammeter, voltmeter, ohmmeter).
3. Measure current, voltage, and resistance in serial and parallel connections.
4. Build circuits based on schematics and draw schematics of existing circuits.
5. Solder to a circuit board

Preparation work

This lab requires no preparation.

Part 1. Measure resistance

You are given three resistors. Look at colour bands and determine the resistance of each resistor based on colours. Now use multimeter HP 34401A to measure the value. For this connect probes to a resistor. Other ends of probes connect to the input HI port (top right) and grounding port (mid-right). Choose function **Ω 2W**.

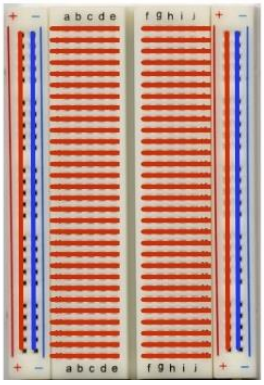
Probes with resistors

Measuring resistance with a multimeter

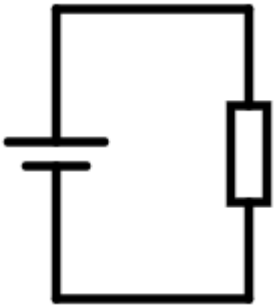
Nr	Colours	Value based on colour codes	Value based on multimeter
1			
2			
3			

Part 2. Build and measure a simple circuit

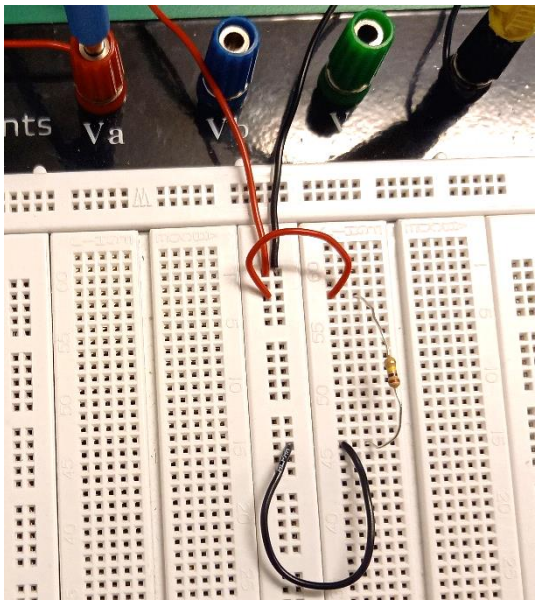
Build the following circuit using a breadboard. Remember that the holes are connected by following a certain rule. See the figure below. Also, make sure that all elements are connected properly (deep enough). Use DC power supplier to get 5V voltage. Connect wires to Channel 1 plus and minus ports, and other ends connect to the breadboard. Push PUSH(V) nob and then turn it left or right to change the voltage value. It is a good practice to connect a voltage source to vertical lines of holes. After, connect a resistor Nr 1 from the previous part using extra wires (do not use too long wires if not needed).



Breadboard connections



Circuit

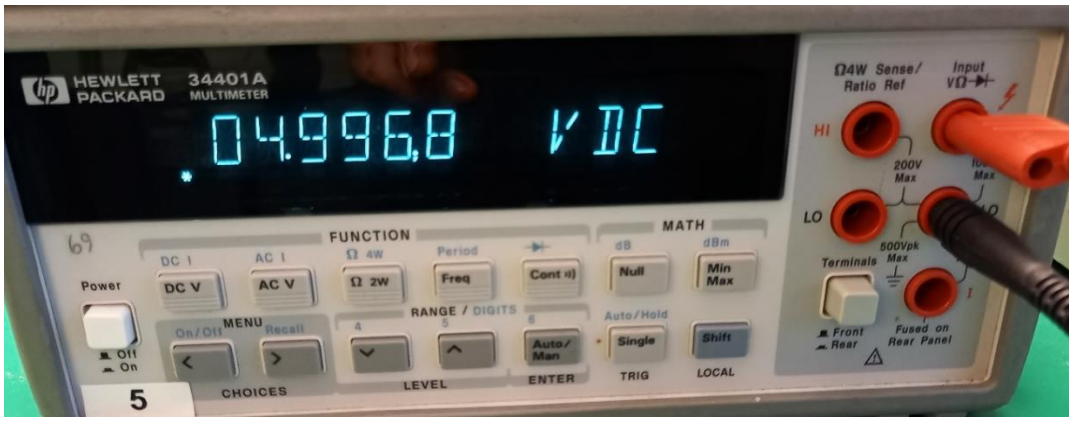


Circuit on a boardbpard

DC power supplier

Read the paragraph first. Once all element is connected, measure the resistance of the resistor. Remember that you cannot measure the resistance of elements that have active current, so disconnect the voltage source first! Record values.

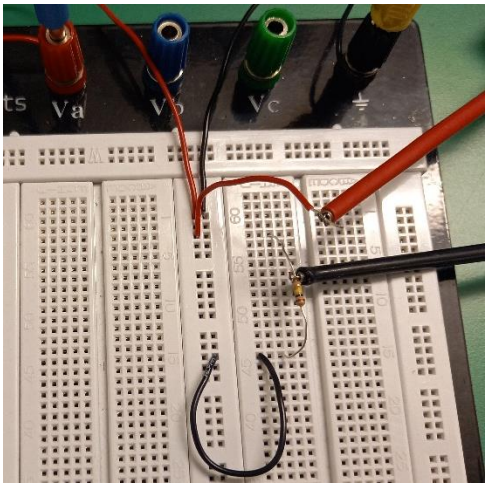
Read the paragraph first. Now connect the voltage source back and measure the voltage over the resistor. To do so, probes are connected in the same way as for measuring resistance, and function **DC V** is selected. Record values. The value may be negative. It means that the polarity was selected wrongly, however, the absolute value is still correct.



Measuring voltage with a multimeter

Read the paragraph first. Now measure a current that goes through the circuit. As the ammeter needs to be connected in series, disconnect from one side voltage source and the resistor. Add one probe to a disconnected voltage source and another probe to the resistor. In this way, the circuit is again connected via the ammeter. Change the end of probes to the current input port (bottom right) and the other one to the grounding port. Select function **DC I**. To do so, we need to press the first **Shift** and then DC V button, which has text **DC I** over it. Shift button allows to select function written in blue. Record values. It is possible that the value will be negative. It means that the polarity was selected wrongly, however the absolute value is still correct.

Measuring current with a multimeter



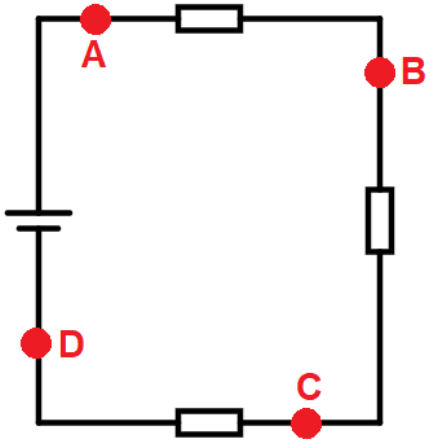
Probes for the current measure

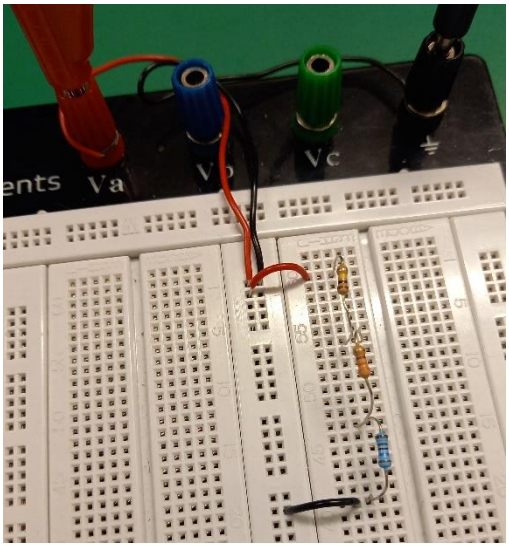
Additionally, calculate what is a current value using Ohm's law, knowing that V is 5v and R value based on colour codes.

	Resistance	Voltage	Current
Calculated		5V	
Measured			

Part 3. Serial and parallel connections

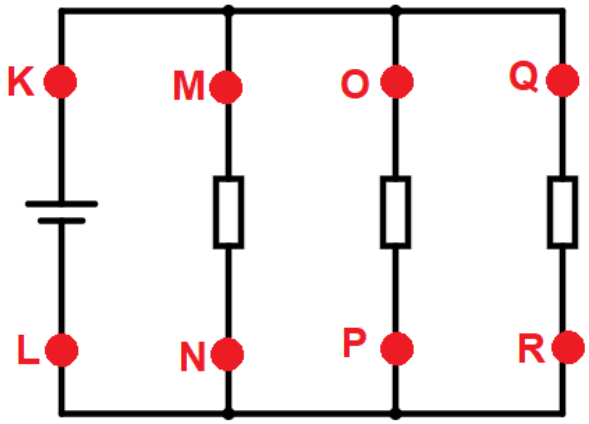
Build the following circuit using the breadboard in a similar way as in Part 2 with the resistors identified in Part 1. Fill in the missing information:

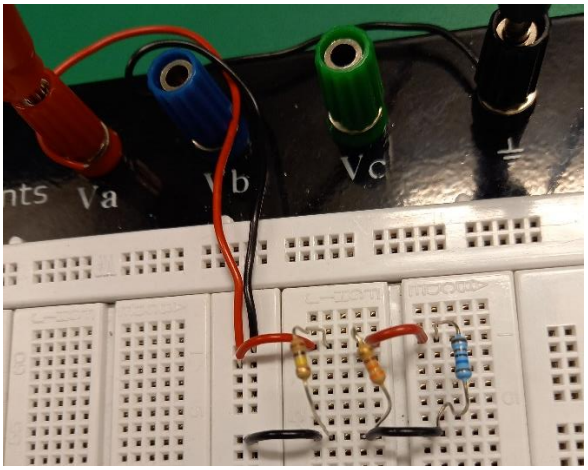




Series connection	
Calculate RT as a sum of all resistors	
Measure resistance between points A and D (remember to disconnect voltage source)	
Calculate IT as E/RT	
Measure current at point A	
Measure current at point B	
Measure current at point C	
Measure current at point D	
Calculate voltage between points A and B	
Calculate voltage between points B and C	
Calculate voltage between points C and D	
Measure voltage between points A and B	
Measure voltage between points B and C	
Measure voltage between points C and D	
Calculate the sum of voltages of all resistors	

Build the following circuit using the breadboard in a similar way as in Part 2 with the resistors identified in Part 1. Fill in the missing information:





Parallel connection	
Calculate RT as the sum of all resistors	
Measure resistance between points K and L (remember to disconnect voltage source)	
Calculate IT as E/RT	
Measure current at point K	
Measure current at point L	
Measure current at point M	
Measure current at point O	
Measure current at point Q	
Calculate the sum of currents of all resistors	
Calculate voltage between points M and N	
Calculate voltage between points O and P	
Calculate voltage between points Q and R	
Measure voltage between points M and N	
Measure voltage between points O and P	
Measure voltage between points Q and R	

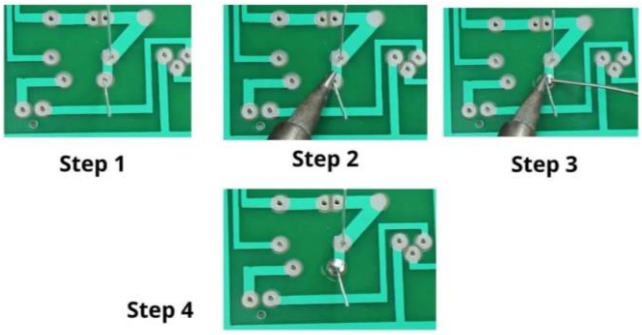
Part 4. Draw a schematic for a circuit

Look at the physical circuit on the breadboard provided to you. Identify all elements and draw schematics that represents this circuit.

Part 5. Soldering[1]

Soldering is the process of joining two or more electronic parts together by melting solder around the connection. Solder is a metal alloy and when it cools it creates a strong electrical bond between the parts. Even though soldering can create a permanent connection, it can also be reversed using a desoldering tool as described below.

To better explain how to solder, we're going to solder a resistor to a circuit board.



Step 1 mount the component: first, insert the cables from the resistor into the holes in the circuit board. Flip the board over and bend the cables outward at a 45°. This will help the component make a better joint with the copper pad and prevent it from falling out while soldering.

Step 2 heat the joint: turn your soldering iron on and if it has an adjustable heat control, set it to 330°C. At this point, touch the tip of the iron to the copper pad and the resistor lead at the same time. You need to hold the soldering iron in place for 3-4 seconds in order to heat the pad and the lead.

Step 3 apply solder to joint: keeping the soldering iron on top of the copper pad and lead, touch the connection with your solder. IMPORTANT Do not touch the solder directly with the tip of the iron. You want the joint hot enough to melt the solder when touched. If the joint is too cold, a bad connection is formed.

Step 4 snip the leads: remove the soldering iron and let the solder cool naturally. Do not blow on the solder as this can result in a bad joint. After cooling, you can cut the extra wire from the cables.

A proper solder joint is smooth, shiny, and looks like a volcano or cone shape. You want just enough solder to cover the entire joint but not too much so it becomes a ball or spills to a nearby lead or joint.

What Is desoldering?

In electronics, desoldering is the removal of solder and components from a circuit board for troubleshooting, repair, replacement, and salvage.

Desoldering is the process of melting the solder and removing the joints made between two materials. In electronics, it refers to the removal of electrical components from PCB for troubleshooting, repairing, replacing, and salvaging.

[1] based on https://www.engineeringchoice.com/soldering/

There is more than one method of desoldering. We will use a desoldering pump. A desoldering pump is basically a small, high-pressure vacuum pump. Before using the pump to suck the solder, you have to heat and melt the solder.

Here are the steps to use the desoldering pump to remove the solder:

- Use a soldering iron to heat the solder until it melts.
- Squeeze the bulb or press down the plunger of the desoldering pump and place it on the molten solder.
- Release the bulb to suck up the solder.
- Remove the desoldered components.
- Repeat the same steps until you remove the excess solder.