

Introduction to Robotics

(A tutorial by *Technotutorz*)

This tutorial describes the basic electronic components and explores some software aspects used in all robot circuits. Most robots consist of four main parts: microprocessor (the brain), motors (for movement), sensors (to sense the environment) and batteries (as an energy source).

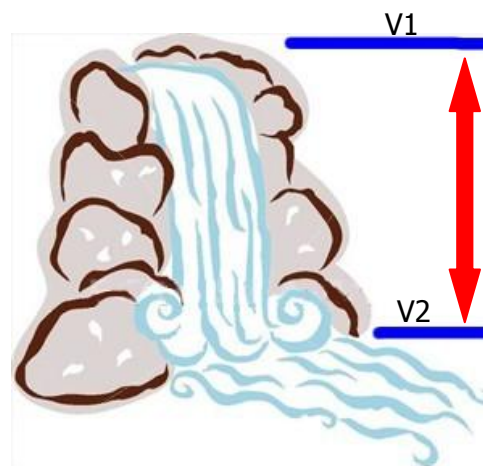
To understand how robots work we will systematically explore some of the general concepts and components used in electronics. The most important concepts are voltage, current and resistance and how they are influenced by various components or how voltage and current react differently with different components.

Voltage and Current

Voltage is the potential difference between two points in a circuit. An analogy can be a waterfall. The voltage difference is between V_1 and V_2 . V_1 is the highest voltage because the waterfall flows from V_1 to V_2 .

The analogy for current is the water that flows from the high voltage to a lower voltage.

Voltage (V) is measured in volts (V) and current (I) in Ampere (A).



Resistance

The next importance concept is resistance (R). The analogy in the waterfall example is how easy the water flows down the waterfall.

So, to limit the flow of current in an electronic circuit, we increase the resistance.

Resistance can be added to an electronic circuit by using resistors. Resistor values are measured in ohms (Ω).

Resistors have colour codes on them so that we know what value they are. Each colour has a different value and all the colours make up a specific ohm value.



Resistance can also be measured by using multimeters.

Multimeters are really important test instruments for anyone who wants to build electronic circuits. Most multimeters can measure units like current, voltage and resistance and others also measures capacitance, transistors, temperatures and frequency. You will learn more of these as you continue on your journey to learn more about electronics.

You will be given five resistors to firstly work out the resistance value using a colour chart and then measure the resistance with the multimeter.

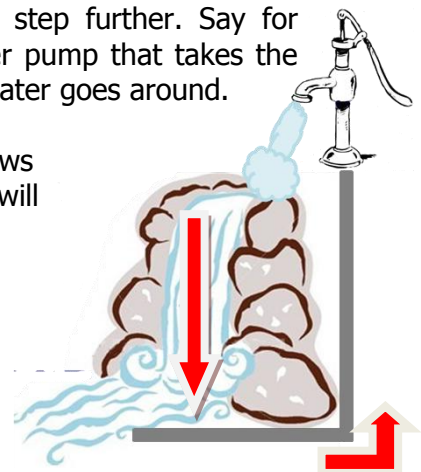
	Colour band	Calculate value using colour chart	Measure value using multimeter
1			
2			
3			
4			
5			

Why are the values different? _____

What is a circuit?

In electronics, this analogy with the waterfall can be taken one step further. Say for instance, this is the waterfall in your garden and you have a water pump that takes the water from the bottom pool back to the top. This ensures that the water goes around.

The same thing happens with current in an electronic circuit. It flows around a complete path otherwise the current doesn't flow. This will make more sense as we continue exploring basic components.



Ohm's Law

A very important relationship in electronics is the relationship between voltage, current and resistance. This relationship is called Ohm's law and it states that if there is a 1 volt voltage drop over a 1 ohm resistor that the current through the resistor will be 1 ampere. In the next section we will see how that is used.

Our first circuit

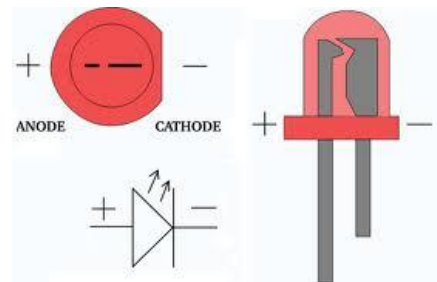
So far we have measured resistance and we know about Ohm's law. Let's see how we can use that to create our first circuit.

We will be using a bread board, a light emitting diode (LED), a resistor and a switch to show how an LED can be turned off and on.

What is a LED?

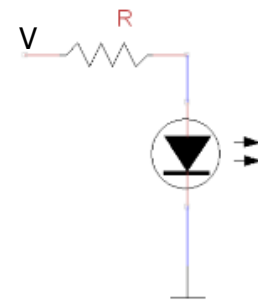
A LED is a component that glows brightly when current pass through it.

Current can only pass in one direction. Compared to our waterfall, current can only go down, the same way the water goes down the waterfall. The water can't go up the waterfall; it goes up through the pipe. That is why the LED symbol has a plus on one side. That shows the side with the higher potential (voltage).



Common colours are red, green, yellow, blue and white. LED's are often used for on/off indicators on electronic circuits, Christmas lights, flashlights, security lights, signs and display.

When LED's are used in electronic circuits it is important to add a resistor in series (in line) to limit the amount of current though the LED. Most LED's have a "safe" current range of about 10mA. The resistance of the LED is very low so if we put a voltage source over the LED with no extra resistance it will fail.

**Which resistor do we use?**

The value of the resistor depends on the voltage of the battery we are using. The battery is the energy source that we use to make everything work. Let's measure the value of the battery with the multimeter and write it below.

$$V_{\text{battery}} = \text{_____} \text{ V}$$

We can calculate the resistance value using Ohm's law. He was a very famous mathematician that found the relationship between voltage, current and resistance in 1827. This relationship is

$$V = I \times R$$

$$R = V/I$$

$$R = \frac{\text{_____}}{\text{_____}}$$

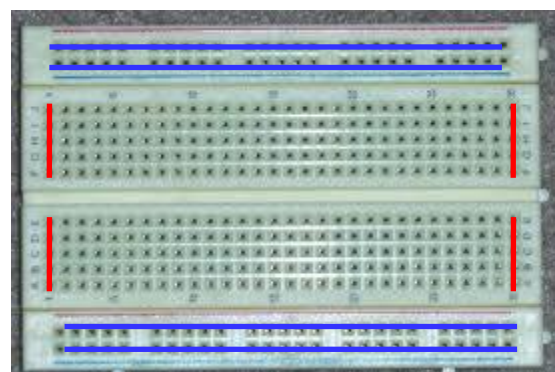
$$R = \text{_____} \Omega$$

We will choose a _____ Ω resistor.

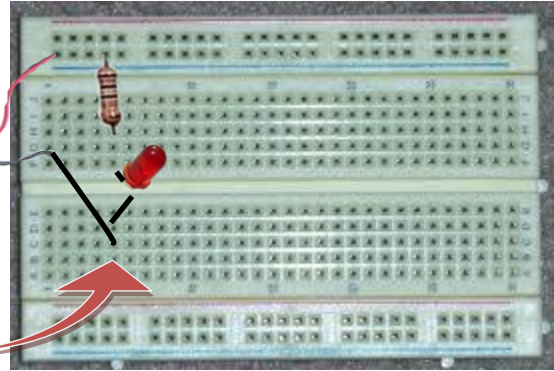
Building the circuit on the breadboard

A breadboard is a prototype base we use to create our circuit. The picture on the write shows which holes are connected. There are the four blue lines showing that all the holes under one line are connected.

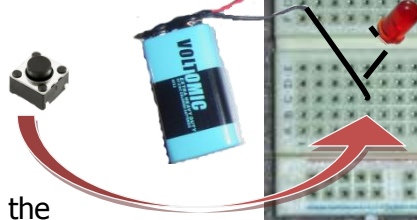
The red lines show that all the holes in the middle are connected vertically as shown.



Add the LED and resistor to the breadboard as shown. Push the legs into the holes. Then add the battery.



Add a switch in series to the negative line and use the switch to turn on the LED. Make sure the two pins that are normally connected are on the same side of the LED or battery.

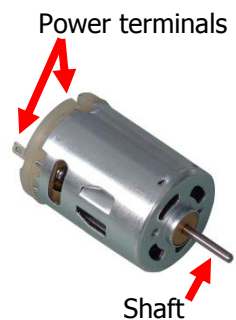


Challenge: Can you add all the LED's, using one resistor and turn them on one by one.

Motor movement

Being able to move is very important for a robot. It may be a robot that moves around a factory floor following a line or a robot hand, moving to put a box under a drill so that holes can be drilled.

In robotics we normally use Direct Current (DC) motors. The motors we use depend on a DC value, normally 5V. It will turn on when voltage is applied.



Connect the two DC motor power terminals to 5V from the battery. The positive lead of the battery goes to one terminal on the motor and the negative lead goes to the other terminal.

Observe the direction the shaft turns. If it is too fast you may need gears or reduce the voltage. What happens when you swop the battery leads on the terminals of the motor?

Connectors

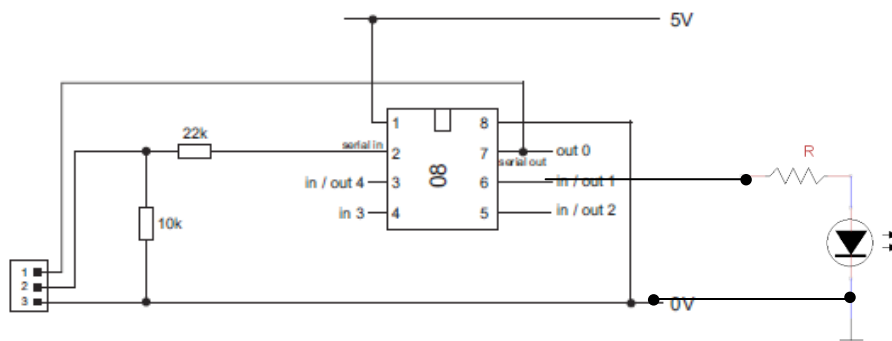
Connectors are use as a way to connect different parts of your electronic circuit. Connectors have a specified pin layout to ensure that both sides are connected to the correct point. One side is normally called the male and the other the female.

How many connectors can you identify on the circuits on the table?

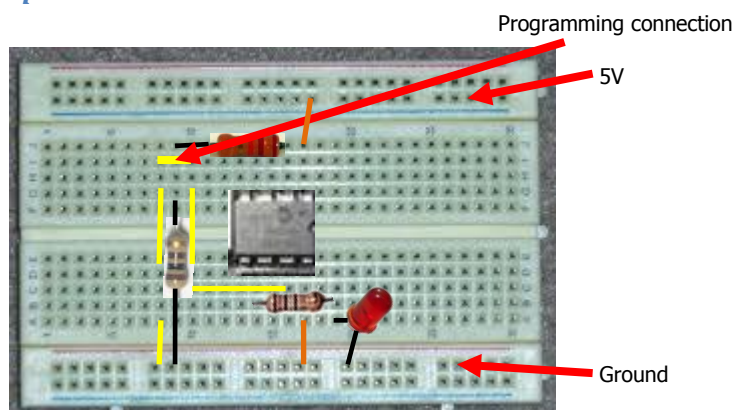
Microprocessors

Microprocessors are the brains of the robot but it needs a program to know what to do. For this exercise we are going to program a Picaxe microprocessor to turn a LED on, the same we have turned the LED on and off using the battery leads.

Connect the Picaxe chips to the LED and resistors as shown. The 22k and 10k resistors are required for the programming input.



Complete the breadboard as shown



Open Picaxe Programming Editor

Connect the USB to serial adapter to the USB port.
When asked choose PICAXE-08M.

Type the following code and program:

```
main:   high 1
        pause 1000
        low 1
        pause 1000
        goto main
```

