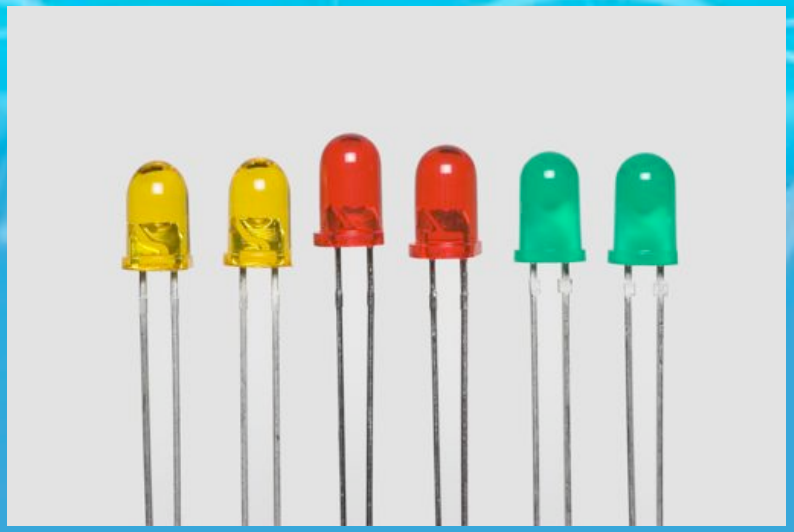
Standard Grade Physics
Unit 4 - Electronics

Some output devices convert electrical energy into light energy

Bulbs

Light emitting diodes (LEDs)



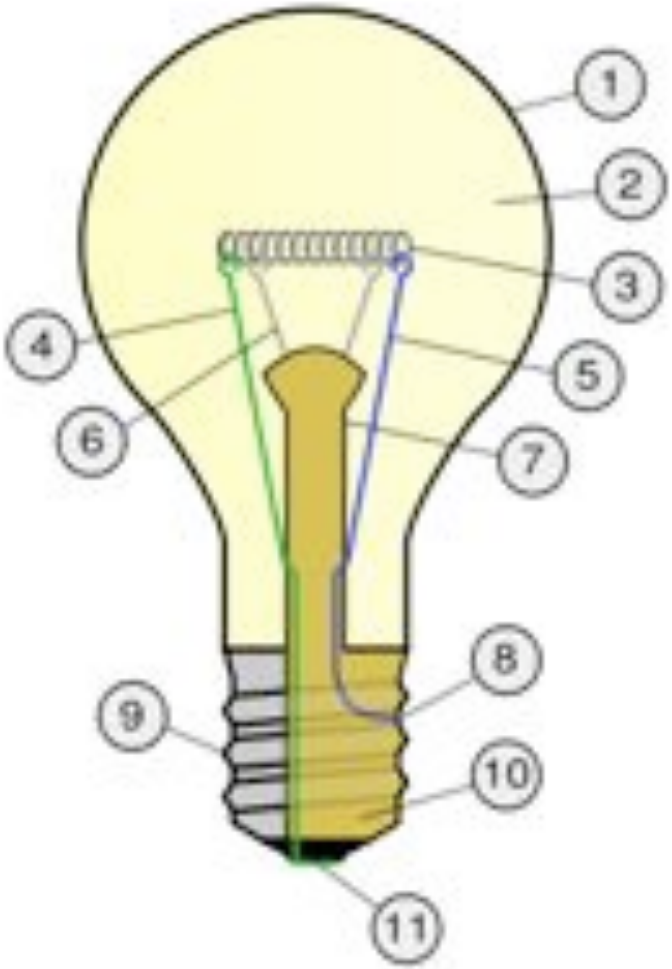
Experiment

Comparing bulbs and LEDs.

1. Wire up a bulb and LED separately.
2. Measure the current flowing in each device.
3. What happens when the voltage is changed?
4. What happens when the connections are reversed?
5. Examine the bulb and LED with a magnifying glass.

In your jotter:
Answer questions 3 & 4.
Write down any differences you notice between the bulb and LED, e.g. shape, light, size.

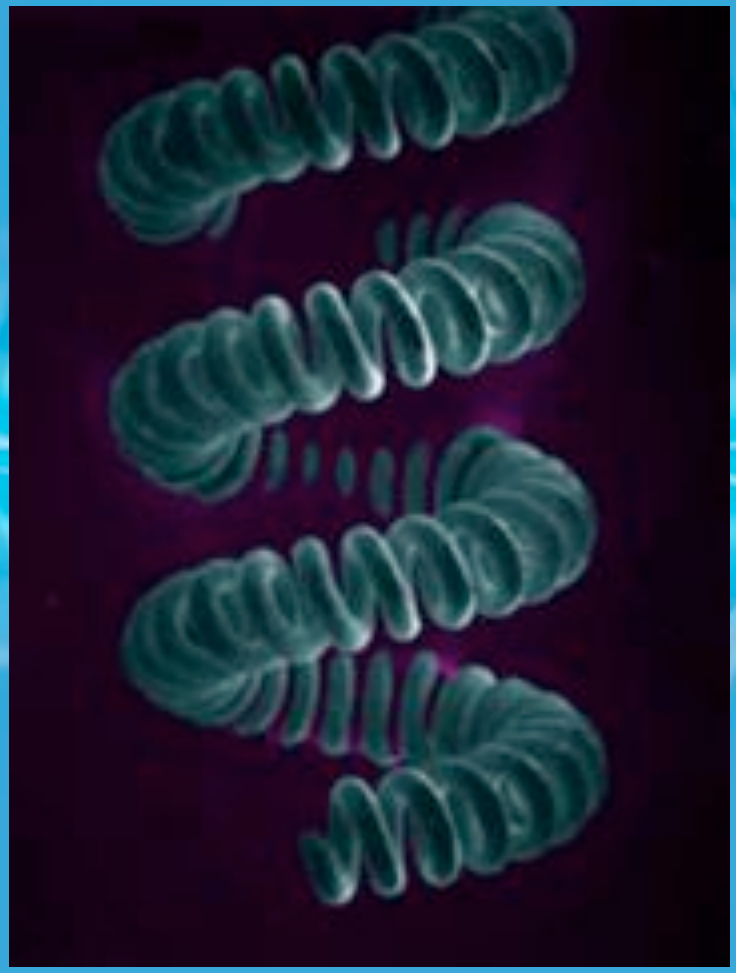
Filament Light Bulb



1. Glass bulb
2. Inert gas
3. Tungsten filament
4. Contact wire (goes to foot)
5. Contact wire (goes to base)
6. Support wires
7. Glass mount/support
8. Base contact wire
9. Screw threads
10. Insulation
11. Electrical foot contact

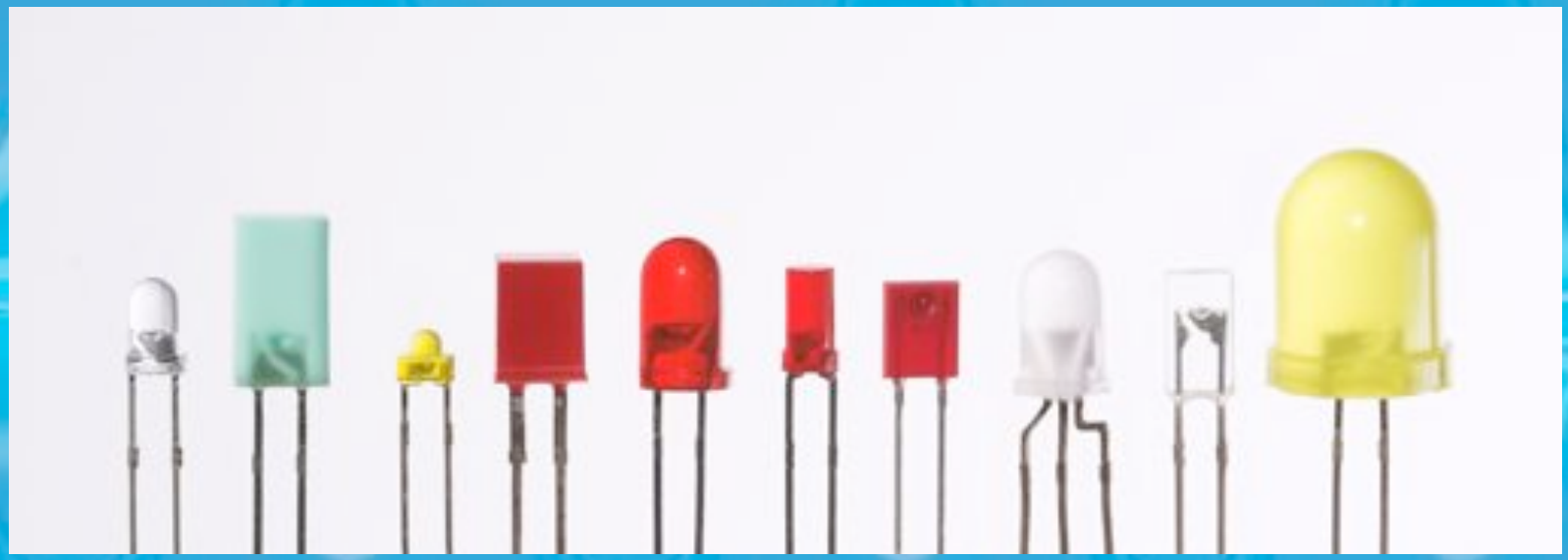
The Filament

This is an electron microscope image of the filament of a 60W bulb.



LEDs

LEDs are available in different shapes and sizes.



Comparison

Filament lamps

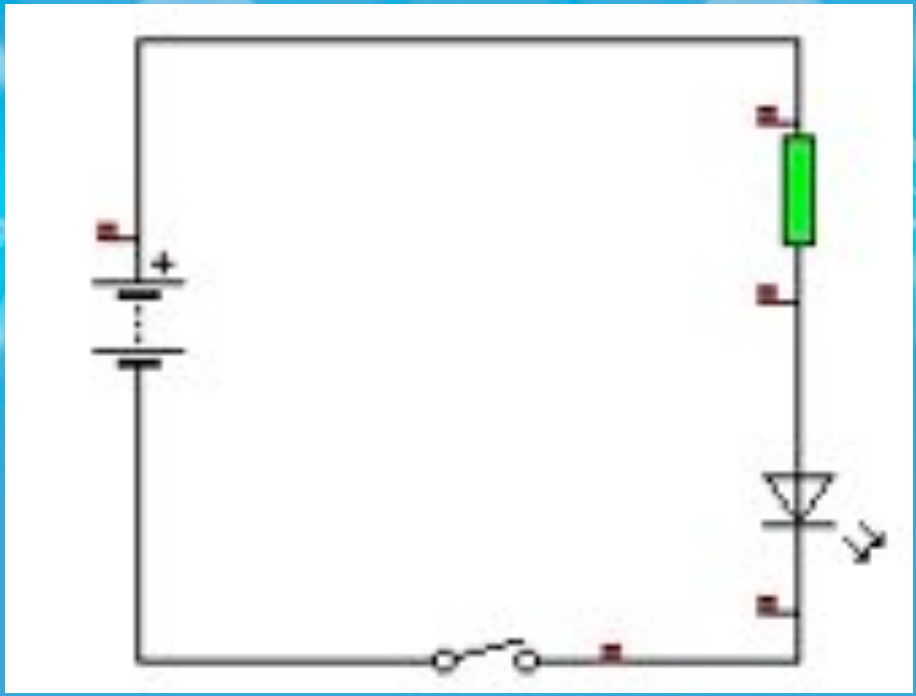
- Electric current is used to heat a filament until it emits light
- Light becomes brighter when current is increased
- No change when connections are reversed
- Can provide an analogue or digital output

LEDs

- Only a small current is required
- LED does not get hot
- Brightness can't be increased very much
- Does not work when connections are reversed
- Usually used as a digital output device

The problem with LEDs

LEDs require a series resistor to protect them from large currents that can cause damage.

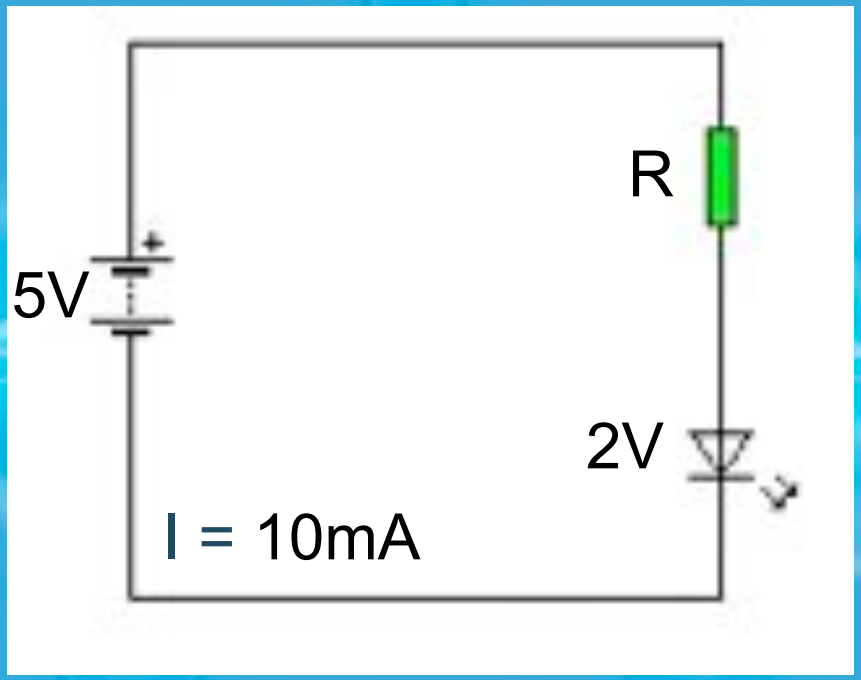


LED manufacturers provide information on the maximum safe operating voltage and current.

We can use this information to calculate the size of the series resistor.

Sample datasheet

How to calculate the series resistance

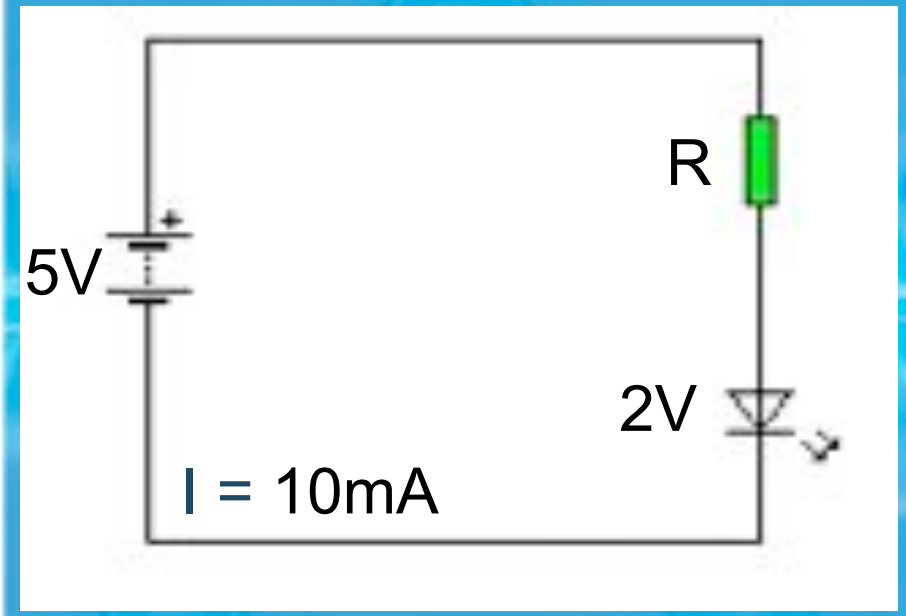


Example:

A manufacturer says the voltage drop across the LED must not exceed 2V and the maximum current allowed is 10 mA.

Calculation

First find V_R



$$V_{supply} = V_{LED} + V_R$$

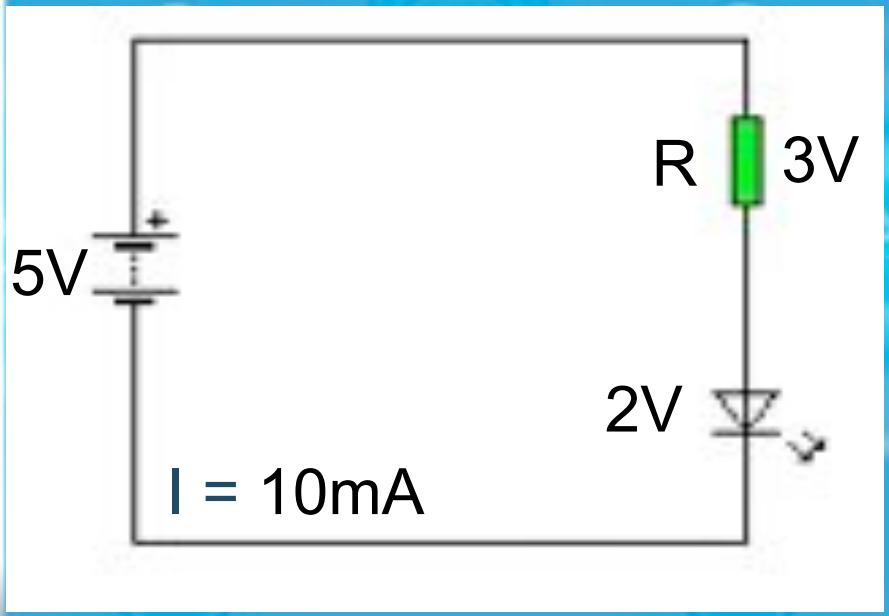
so

$$V_R = V_{supply} - V_{LED}$$

$$V_R = 5V - 2V$$

$$= 3V$$

Use **Ohm's Law** to find R



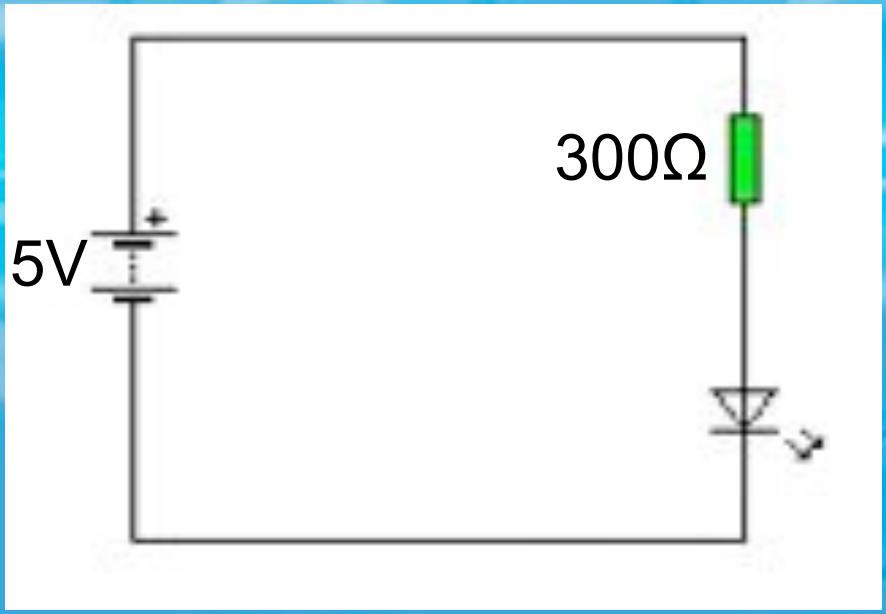
$$R = \frac{V_R}{\text{maximum current}}$$

$$= \frac{3V}{0.01A}$$

$$= 300\Omega$$

Solution

So our final LED circuit would look like this.



Try these examples.

1. An LED takes 10mA and 1.5V to work correctly.

(a)What value of series resistor is required if a 6V battery is used?

(b) Draw a circuit diagram showing how the resistor, LED and battery are connected.

Try these examples.

2. An LED requires 0.01A and 3.2V to work correctly.

(a)What protective resistor is required with a 9V supply?

(b) Calculate the resistance of the LED.

(c) Calculate the power rating of the LED.

State the most suitable output device.

a) A baby alarm system to allow parents to hear a crying baby in the next room.

b) A doorbell indicator for the deaf

c) A remotely controlled switch for an X-ray machine

d) A “power on” indicator for an electronic device such as a PC.

e) A display for a measuring instrument.

f) A remotely operated bolt for a fire door that allows smoke control doors to close in the event of a fire.

Input Devices

Input devices are the senses of an electronic system.

In electronic systems, the input device transforms other kinds of energy into electrical energy.

Microphone

What is the range of voltage amplitudes of the electrical signals produced by the microphone?

What energy transformation occurs in the microphone?

Other input devices

Thermocouple (Activity 9)
Use the thermocouple to measure the temperature of a Bunsen flame.

Thermistor (Activity 11)
Measure the resistance of the thermistor at different temperatures.

Other input devices

Solar Cell (Activity 10)
Investigate how the voltage produced by the cell varies.

Light Dependent Resistor – LDR (Activity 12)
Monitor the resistance of the LDR as the light reaching it is increased.