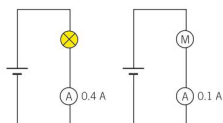


# 1.5 Resistance

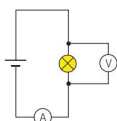
## Learning objectives

After this topic you will be able to:

- describe what is meant by resistance
- calculate the resistance of a component and of a circuit
- describe the difference between conductors and insulators in terms of resistance.



▲ The currents in these circuits are different, even though the cells are the same.



▲ You can use an ammeter and a voltmeter to find the resistance of a lamp.

### What's the resistance?

A bulb in a circuit has a current of 0.6 A through it and a potential difference of 12 V across it. Calculate the resistance of the bulb.

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The current in the wires connected to a television is much smaller than the current in the wires to a microwave. The reason for this is to do with resistance.



◀ Electrical devices have different currents through them.

### Different components, different current

Components do different jobs in an electric circuit. Each circuit component has a different **resistance**. This tells you how easy or difficult it is for the charges to pass through the component. Resistance is measured in **ohms**, which has the symbol  $\Omega$ .  $\Omega$  is a letter from the Greek alphabet.

The current depends on the push of the battery and also the resistance of the component. You can calculate the current using this equation:

$$\text{current (A)} = \frac{\text{potential difference (V)}}{\text{resistance } (\Omega)}$$

You can use the idea of resistance to explain why the current decreases as you add more bulbs in a series circuit. Adding more bulbs increases the resistance, so the current is less.

**A** State what is meant by resistance.

### Measuring resistance

You can use an equation to calculate the resistance of a component.

Here is the equation to calculate resistance:

$$\text{resistance } (\Omega) = \frac{\text{potential difference (V)}}{\text{current (A)}}$$

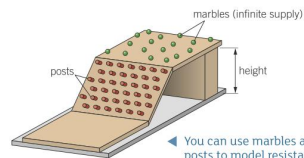
**B** State the unit of resistance.

For example, if you found that the current through a bulb was 0.2 A when the voltage across it was 6 V, you could work out the resistance:

$$\begin{aligned} \text{resistance} &= \frac{\text{potential difference}}{\text{current}} \\ &= \frac{6 \text{ V}}{0.2 \text{ A}} \\ &= 30 \Omega \end{aligned}$$

### What happens inside a wire?

You can use a model with marbles to show what happens inside a wire when a current flows. The charges that move in a wire are electrons.



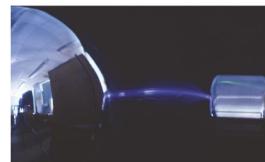
◀ You can use marbles and posts to model resistance.

The marbles behave like electrons. As they fall down the slope they collide with the posts. Inside a wire the moving electrons collide with the atoms of the wire. They transfer energy, and the wire gets hot.

### Conductors and insulators

Metals are good **conductors**. They have a very low resistance because they contain lots of electrons that can move. The resistance of a 10-m piece of copper wire is about 0.2  $\Omega$ .

Other materials such as plastics do not have many electrons that are free to move. The resistance of plastic objects is very high, over a thousand million million ohms. The air is usually an **insulator** but it can conduct if the potential difference is big enough. Insulators have a high resistance.



◀ A spark happens when the air conducts electricity.

### Fantastic Fact

Many people think that Thomas Edison invented the lightbulb. What he invented was the first lightbulb with a filament that didn't burn out when a current flowed in it.

### Key Words

resistance, ohms, conductor, insulator

### Summary Questions

- Copy and complete the sentences below.  
The current in a circuit depends on the \_\_\_\_\_ and the \_\_\_\_\_. The current will be bigger if the \_\_\_\_\_ is smaller. Inside a metal wire \_\_\_\_\_ collide with atoms and transfer \_\_\_\_\_ to them. \_\_\_\_\_ are materials that contain lots of charges that are free to move. \_\_\_\_\_ contain fewer charges that can move. (7 marks)
- In the circuit diagrams on the opposite page the cell has a potential difference of 3 V. Calculate the resistance of the motor and the lamp. (4 marks)
- Compare the resistance of conductors and insulators. (6 marks)

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