1.4 Series and parallel

Learning objectives

After this topic you will be able to:

- describe the difference between series and parallel circuits
- describe how current and potential difference vary in series and parallel circuits.

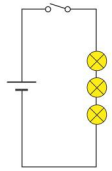
▲ Modern Christmas lights stay on if one bulb blows.

Christmas lights make a great display. In old sets of lights, if one of the bulbs broke they would all go out.

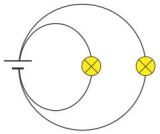
Two types of circuit

The old type of Christmas lights were connected in **series**. All the bulbs formed one loop, including the battery and the switch.

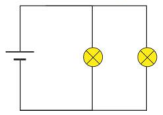
There is another type of circuit called a **parallel** circuit. In a parallel circuit there is more than one loop or branch. Parallel circuits are sometimes called 'branching circuits'.



▲ In a series circuit there is only one loop.



▲ This is a parallel circuit because there is more than one loop...



▲ ...which you can also draw like this.

Parallel circuits are very useful because if one bulb breaks, the other lights stay on. You can control each lamp separately in a parallel circuit by adding a switch to each branch. Each bulb is independent of the others.

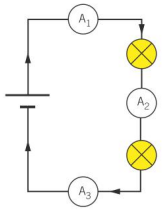
A State two differences between series and parallel circuits.

What happens to the current?

Series circuits

In the circuit opposite, the ammeters A_1, A_2, and A_3 all show the same reading. In a series circuit the current is the same everywhere.

If you add components to a series circuit the current will get smaller.



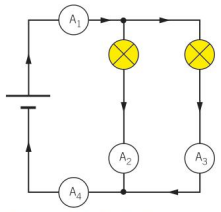
▲ In a series circuit, the reading on all the ammeters is the same.

Parallel circuits

A parallel circuit has more than one loop. In the circuit at the top of the next page, the current in each branch is the same. The ammeters A_2 and A_3 show the same reading.

The ammeters A_1 and A_4 measure the total current. The currents in all the branches of a parallel circuit add together to make the total current. Here the total current is double the current in each branch.

If you add another branch to a parallel circuit the current in the other branches stays the same but the total current increases.



▲ In a parallel circuit, the current in all the branches adds to the total current.

B State what happens to the total current as you add more branches in a parallel circuit.

Modelling circuits – part 3

You can use the rope model when you are thinking about different types of circuit. In the rope model:

Series circuits

- The rope moves at the same speed everywhere.
- As more people hold the rope, the rope moves more slowly.

Parallel circuits

- There are more loops of rope.
- All the loops are driven by the same 'battery' person.

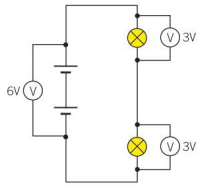
What happens to the potential difference?

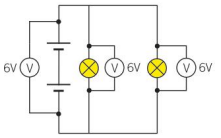
Series circuits

The potential difference across each component *adds up to* the potential difference across the battery.

Parallel circuits

The potential difference across each component *is the same as* the potential difference across the battery.





Current issues

In a circuit with a single cell and a single bulb, the current is 0.2 A. Calculate the current if you add another bulb in series with the first bulb. Explain your answer.

Key Words

series, parallel

Fantastic Fact

A family in Australia holds the world record for Christmas tree lights. Their display contained over 330 000 separate lights.

Summary Questions

1 Copy the sentences below, choosing the correct **bold** words.

A series circuit has **more than one/one** loop. A parallel circuit has **more than one/one** loop. If a bulb in a **parallel/series** circuit breaks the rest of the bulbs stay on. If a bulb in a **parallel/series** circuit breaks the rest of the bulbs go out. *(4 marks)*

2 State what happens to the total current as you add more bulbs in a parallel circuit. *(1 mark)*

3 Compare the readings on ammeters and voltmeters when you connect them in series and parallel circuits. *(6 marks)*