

Reading ammeters and voltmeters in circuits

Grade 7 science (Year 8 · Class 7) · Lesson

Quick answer: An ammeter measures electric current in amperes and is connected in series, in the loop. A voltmeter measures voltage in volts and is connected in parallel, across a component. In series the current is the same everywhere and voltages add up; in parallel the branch currents add up and every branch has the same voltage.

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What do current and voltage measure?

Electric circuits can seem mysterious because you cannot see what is moving. Two measurements describe what is going on: how much charge flows, and how hard the supply pushes it.

Definition

Electric current is the rate at which electric charge flows past a point in a circuit. It is measured in amperes (A) with an ammeter.

Definition

Voltage, also called potential difference, is the energy transferred to each unit of charge by a cell, or from the charge by a component. It is measured in volts (V) with a voltmeter.

Quantity	Symbol	Unit	Meter	How it is connected
Current	I	ampere (A)	Ammeter	In series (in the loop)
Voltage	V	volt (V)	Voltmeter	In parallel (across the part)

Small currents are often given in milliamperes. One ampere is 1000 milliamperes, so you divide by 1000 to change mA into A.

Formula

$$I \text{ (A)} = I \text{ (mA)} \div 1000$$

I is the current. A is the ampere and mA is the milliampere.

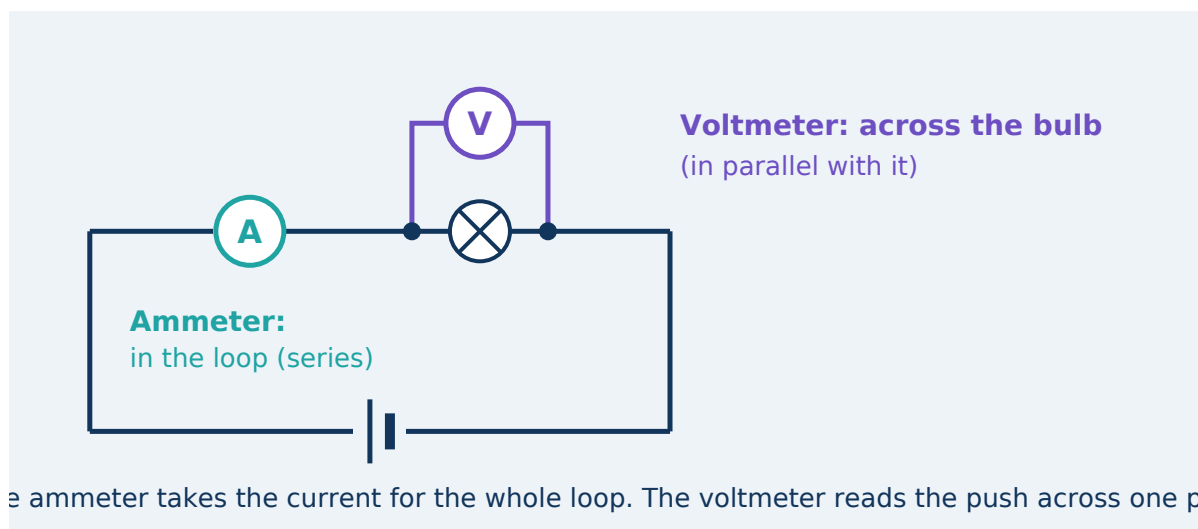
Worked example 1

Ayesha in Dhaka reads 250 mA on a meter in her phone charger circuit. Convert the reading to amperes.

$$I = 250 \text{ mA} \div 1000 = \mathbf{0.250 \text{ A.}}$$

How do you connect an ammeter and a voltmeter?

An ammeter must have the same current flowing through it as the part you are measuring, so you cut the circuit and put it in the loop, in series. A voltmeter measures the difference between two points, so you join it across the component, in parallel.



The ammeter takes the current for the whole loop. The voltmeter reads the push across one part of the loop.

The ammeter is in the loop. The voltmeter is across the bulb.

Common mistake

Never connect an ammeter across a component or across a cell. An ammeter has almost no resistance, so it makes a short circuit, and a large current can damage the meter or the cell. A voltmeter in series stops nearly all of the current.

What are the rules for current in series and parallel circuits?

Key law

In a series circuit the current is the same everywhere in the loop. In a parallel circuit the currents in the branches add up to the current in the main wire.

Formula

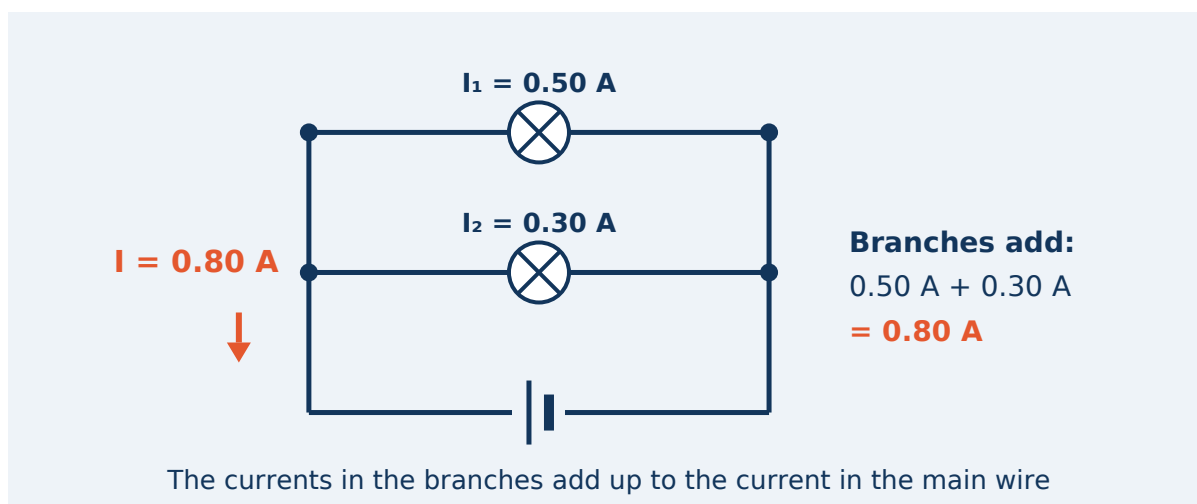
$$I = I_1 + I_2 + \dots$$

For a parallel circuit: I is the current in the main wire (A). I_1 , I_2 are the currents in the branches (A).

Worked example 2

Kofi in Accra measures 0.80 A in the main wire of a parallel circuit and 0.50 A in one branch. Calculate the current in the second branch.

$$I_2 = 0.80 \text{ A} - 0.50 \text{ A} = \mathbf{0.30 \text{ A.}}$$



At the junction the main current splits. The branch currents always add up to the main current.

What are the rules for voltage in series and parallel circuits?

Key law

In a series circuit the voltages across the components add up to the supply voltage. In a parallel circuit the voltage across each branch equals the supply voltage.

Formula

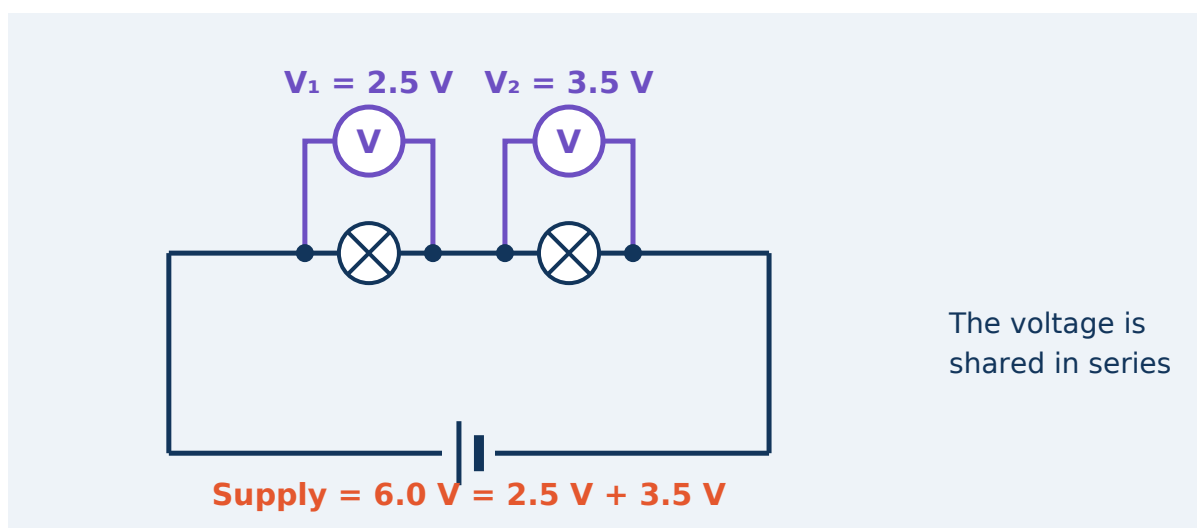
$$V = V_1 + V_2 + \dots$$

For a series circuit: V is the supply voltage (V). V_1 , V_2 are the voltages across the components (V).

Worked example 3

Mei in Singapore connects two bulbs in series to a 6.0 V supply. A voltmeter across the first bulb reads 2.5 V. Calculate the voltage across the second bulb.

$$V_2 = 6.0 \text{ V} - 2.5 \text{ V} = 3.5 \text{ V}.$$



In series the supply voltage is shared. The voltmeter readings add up to the supply voltage.

Quantity	Series circuit	Parallel circuit
Current	Same everywhere in the loop	Branch currents add up to the main current
Voltage	Shared between the components	Same across every branch

Lina's tip

Remember "A in line, V across": the ammeter goes in the line of the circuit and the voltmeter goes across the part you want to measure.

Key points to remember

- Current is measured in amperes (A) with an ammeter in series.
- Voltage is measured in volts (V) with a voltmeter in parallel.
- Series: same current everywhere; voltages add up to the supply.
- Parallel: branch currents add up ($I = I_1 + I_2$); same voltage across each branch.
- 1 A = 1000 mA, so divide by 1000 to change mA into A.

Reading ammeters and voltmeters in circuits: frequently asked questions

How do you connect an ammeter in a circuit?

Connect the ammeter in series, by breaking the circuit and putting it in the loop so that all the current to be measured passes through it. Never put an ammeter straight across a component or a cell.

How do you connect a voltmeter in a circuit?

Connect the voltmeter in parallel, with one lead on each side of the component. It measures the voltage across that component without being part of the main path.

What is the rule for current in a series circuit?

The current is the same at every point in a series circuit. The charge has only one path, and it is not used up by the components.

What is the rule for current in a parallel circuit?

The currents in the branches add up to the current in the main wire. For example, 0.50 A and 0.30 A in two branches give 0.80 A in the main wire.

How does voltage behave in series and parallel circuits?

In a series circuit the voltages across the components add up to the supply voltage. In a parallel circuit each branch has the same voltage as the supply.