

# Electricity

Pearson Edexcel · International GCSE · Physics

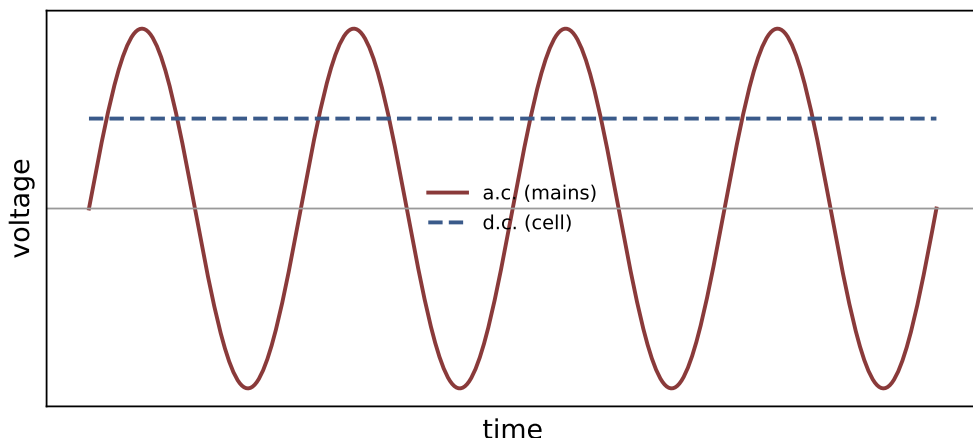
## The energy you cannot see

Press a switch and a room lights. Between the power station and the lamp stands everything in this section: how domestic wiring keeps you safe, how voltage drives current through circuits, and – (P) – how electrons rubbed from one surface to another make charges that attract, repel and sometimes spark.

**Edexcel International GCSE Physics 4PH1, Section 2** (statements 2.1–2.28P). Units: ampere (A), coulomb (C), joule (J), ohm ( $\Omega$ ), volt (V), watt (W). P-suffixed statements are the Physics-only extension, assessed on Paper 2P.

## Mains electricity

Mains electricity is **alternating current (a.c.)** – direction reverses many times a second; a cell gives **direct current (d.c.)** – one direction only.



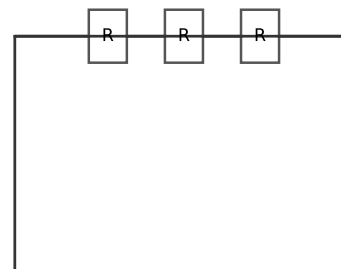
**Safety:** insulation on wires; **double insulation** (plastic casing, no earth needed); **earthing** (a low-resistance path so a fault current blows the fuse); **fuses** and **circuit breakers** (melt or trip on excess current, protecting wiring and people). Current in a resistor transfers electrical energy to **thermal** energy – the point of kettles and heaters, and the reason fuse ratings matter:

$$P = I \times V \quad E = I \times V \times t$$

**Worked check (fuse choice).** A 230 V, 1.15 kW heater draws  $I = P/V = 1150/230 = 5$  A – fit a 13 A fuse (next standard rating above the current); a 3 A fuse would blow in normal use.

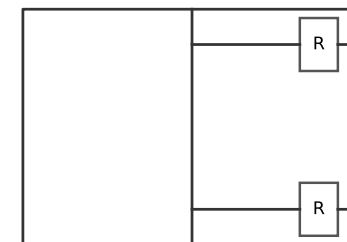
## Circuits

series: one loop, same current



one loop: same current everywhere; voltages add

parallel: branches, same voltage



voltage the same on each branch; currents add

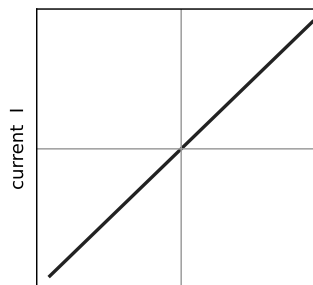
**Series** suits chains (switches, ammeters, fairy lights) – the same current everywhere, voltages add, and one failure breaks all. **Parallel** suits domestic lighting – each lamp gets the full supply voltage, works independently, and currents add at junctions (**charge is conserved at a junction**).

$$V = I \times R \quad Q = I \times t \quad E = Q \times V$$

Current is a **flow of negatively charged electrons** in metals. Voltage is the **energy transferred per unit charge** ( $1 \text{ V} = 1 \text{ J/C}$ ). Two resistors in series:  $R = R_1 + R_2$ ; in parallel the combined resistance is less than either alone.

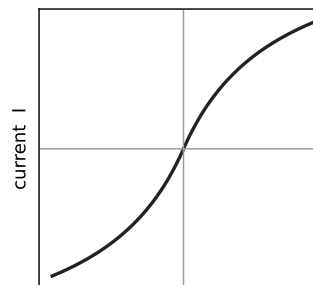
**I–V characteristics** : a wire gives a straight line through the origin (constant resistance); a filament lamp curves as heating raises its resistance; a diode conducts in one direction only. **LDRs:** resistance falls as light rises. **Thermistors:** resistance falls as temperature rises (or rises as it cools – used in temperature sensors). Lamps and LEDs indicate current.

wire:  $I \propto V$  (straight line)



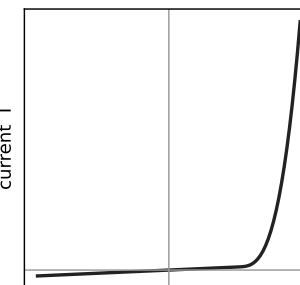
voltage V

filament lamp: curve flattens



voltage V

diode: one direction only



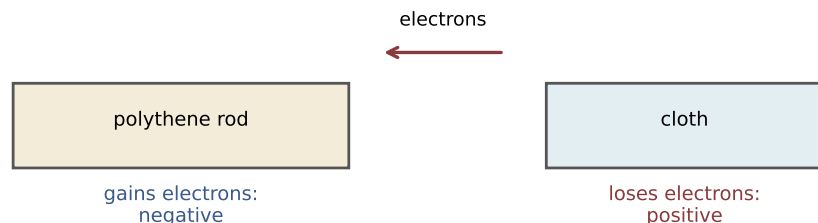
voltage V

**Worked check.** Two resistors,  $4 \Omega$  and  $6 \Omega$ , in series across 10 V: total  $10 \Omega$ ,

$I = 10/10 = 1 \text{ A}$ ; voltages 4 V and 6 V. In parallel across 10 V: each branch draws  $10/4 = 2.5 \text{ A}$  and  $10/6 \approx 1.67 \text{ A}$  – total  $\approx 4.17 \text{ A}$ , equivalent resistance  $\approx 2.4 \Omega$  (less than either).

## Electric charge (P)

**Conductors** (metals) let charge flow; **insulators** (plastics) do not.



only electrons move; the charges are equal and opposite

Rubbing an insulator transfers **electrons**: the loser becomes **positive**, the gainer **negative** – never protons moving. **Unlike charges attract; like charges repel.** A charged rod attracts tiny uncharged paper because it **induces** charge separation. Dangers: sparks while fuelling aircraft and tankers – earthed bonds drain charge safely. Uses: photocopiers and inkjet printers steer charged toner or droplets.

## Check yourself

1. State the difference between a.c. and d.c. and give one source of each.
2. Explain how earthing and a fuse work together to protect a user.
3. A 230 V kettle is rated 2.0 kW. Calculate the current and the best fuse.
4. State two reasons domestic lighting is wired in parallel.
5. State the I–V shapes for a wire, a filament lamp and a diode.
6. What happens to an LDR's resistance in bright light?
7. Define voltage in terms of energy and charge.
8. Calculate the charge passing when 2 A flows for 30 s.
9. (P) Explain how rubbing a polythene rod with a cloth makes it negative.
10. (P) Give one danger and one use of electrostatic charge.

Answers: 1 a.c. reverses direction repeatedly – the mains; d.c. flows one way – a cell or battery; 2 the earth wire gives a low-resistance path, so the large fault current flows to earth and melts the fuse, cutting off the supply before a user can touch the live casing; 3  $I = 2000/230 = 8.7 \text{ A}$  – a 13 A fuse; 4 each lamp receives the full mains voltage; one lamp failing leaves the others working (and switches control

lamps independently); 5 straight line through the origin; S-shaped curve (gradient falls as it heats); zero until a forward threshold then steep (one direction); 6 it falls; 7 voltage is the energy transferred per unit charge (1 volt = 1 joule per coulomb); 8  $Q = 2 \times 30 = 60 \text{ C}$ ; 9 (P) friction transfers electrons from the cloth to the rod – the rod gains electrons and becomes negative, the cloth positive; 10 (P) danger – sparking while fuelling aircraft/tankers; use – photocopier or inkjet printer.