Topic 2: Electricity

Edexcel International GCSE Physics 4PH1 · Section 2 · statements 2.1–2.28P · sheets 2.1–2.3

From power station to lamp

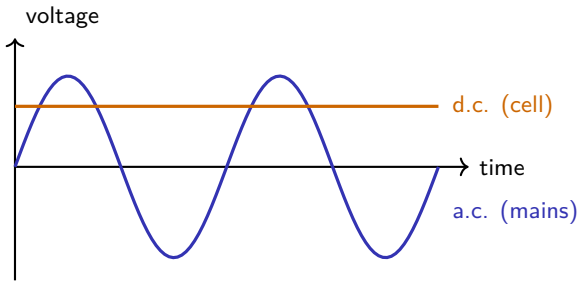
Sheet	What you learn
2.1	a.c. and d.c., insulation, **earthing**, fuses, $P = IV$, $E = IVt$
2.2	Series and parallel, $V = IR$, $Q = It$, $E = QV$, I–V graphs, LDRs, thermistors
2.3 (P)	Charging by friction, attraction and repulsion, dangers and uses

Use the evidence

Units to know: ampere (A), coulomb (C), joule (J), ohm (Ω), volt (V), watt (W).

exercises.lol exercises.com.cn

Alternating and direct current



a.c. goes below zero: the current reverses

Mains is a.c.: its direction keeps reversing. A cell gives d.c.: one direction only.

- a.c. reverses direction many times a second.
- d.c. flows in one direction only.

Earth wire and fuse work together

A fault connects the live wire to the metal casing.

↓

The earth wire is a low-resistance path: a large current flows.

↓

It melts the **fuse** (or trips the **circuit breaker**) in the live wire.

↓

The supply is cut before anyone touches the live casing.

> Double-insulated appliances have a plastic casing and need no earth wire.

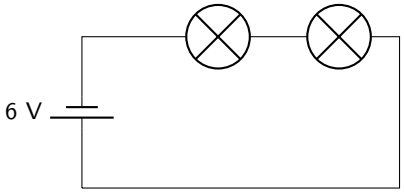
Worked example: choosing a fuse

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

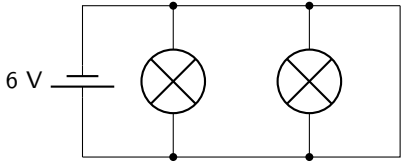
P in W, I in A, V in V, E in J, t in s

1. **Known** Heater: $P = 1150$ W on a $V = 230$ V supply. Fuses: 3 A, 5 A, 13 A.
2. **Equation** Power links current and voltage: $P = IV$, so $I = P/V$.
3. **Substitute** $I = 1150\ \text{W}/230\ \text{V} = 5.0$ A.
4. **Choose** The **fuse** must be above the working current: 13 A. A 5 A fuse would blow in normal use.

Series and parallel circuits



series: one loop



parallel: separate branches

Series

Same current everywhere; supply voltage shared.

$R = R_1 + R_2$. One lamp fails: all go out.

Parallel (house lighting)

Each branch gets the full voltage; currents add at junctions.

Lamps work and switch independently.

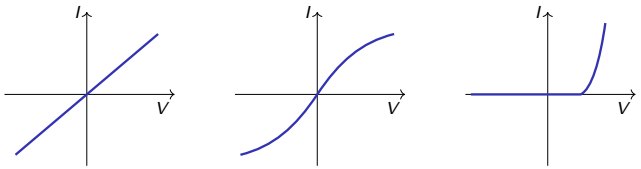
Current, charge and energy

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

Q in coulombs (C), t in seconds, voltage = energy per coulomb

1. **Known** Charger: $I = 2.0$ A, $V = 5.0$ V, for 30 minutes.
2. **Time** $t = 30 \times 60 = 1800$ s.
3. **Charge** $Q = It = 2.0\ \text{A} \times 1800\ \text{s} = 3600\ \text{C}$.
4. **Energy** $E = QV = 3600\ \text{C} \times 5.0\ \text{V} = 18\,000\ \text{J}$; check: $E = IVt$ gives the same.

Three I–V characteristics



Wire: straight line through the origin. Lamp: resistance rises as it heats. Diode: one direction only.

- Ohmic wire at constant temperature is a straight line.
- Lamp curves as it heats; diode conducts one way.

LDRs and thermistors as sensors

LDR

Resistance falls as light intensity rises.

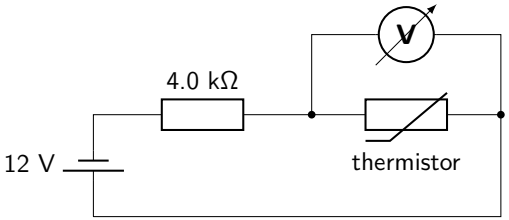
Use: street lights that switch on at dusk.

Thermistor

Resistance falls as temperature rises.

Use: temperature sensors and thermostats.

Worked example: a temperature sensor



Room	**Thermistor**	**Current** V/R_{total}	**Voltmeter** $= IR$
warm	2.0 kΩ	$12/6000 = 0.0020$ A	$0.0020 \times 2000 = 4.0$ V
cold	8.0 kΩ	$12/12\,000 = 0.0010$ A	$0.0010 \times 8000 = 8.0$ V

Your turn: 4 Ω and 6 Ω

Your turn

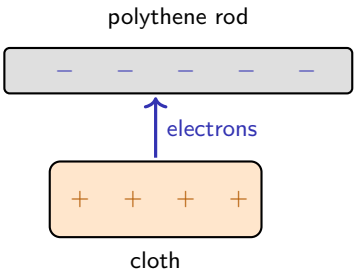
A 4 Ω and a 6 Ω resistor are connected to a 10 V supply.

A. In series, find the current and the voltage across each resistor.

B. In parallel, find each branch current and the total current.

C. Show the parallel combination is less than 4 Ω.

Charging by friction moves electrons



Polythene rod gains electrons: negative. Cloth loses electrons: equally positive.

- Only electrons move when insulators are rubbed.
- Unlike charges attract; like charges repel.

Static charge is dangerous and useful

Danger

Charge builds up while fuelling aircraft and tankers; a spark can ignite the vapour.

An earthed bonding wire drains the charge safely.

Uses

Photocopiers attract toner to charged areas of a drum.

Inkjet printers steer charged droplets with charged plates.

Six mistakes that cost marks

Mistake	**Correct idea**
Minutes in $Q = It$ or $E = IVt$	Always use seconds
A lamp uses up current	Series current is the same everywhere; energy is transferred
Adding parallel resistances	The pair is less than the smaller one
Fuse at or below working current	Pick the next rating above it
LDR resistance rises in light	Brighter or hotter means lower resistance
(P) Positive charges move	Only electrons are transferred

Check yourself

Your turn

Answer without notes, then check.

A. A 230 V kettle is rated 2.0 kW. Current and best fuse?

B. State two reasons domestic lighting is wired in parallel.

C. Define voltage in terms of energy and charge.

D. Charge passing when 2 A flows for 30 s?

E. (P) How does rubbing make a polythene rod negative?