CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPIC 4.2

FREE SAMPLE

Electrical Quantities

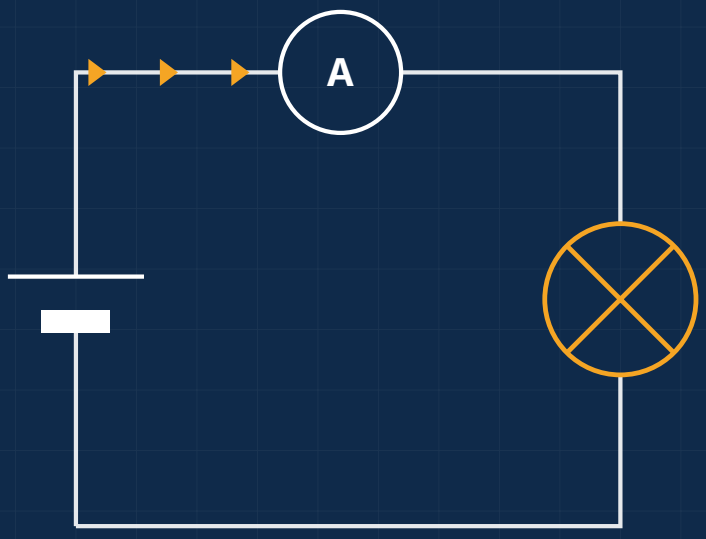
Free sample: knowledge organiser and Worksheet 1 with answers

Electric charge | Electric fields | Current | e.m.f. & p.d. | Resistance | I–V graphs

Power & kW h | Exam-style questions

$$V = IR$$

$$P = IV$$



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Free sample

Full pack: worksheets, exam paper, answers

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Knowledge organiser

ELECTRICAL QUANTITIES ON ONE PAGE

Electric charge

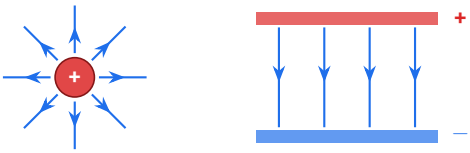
There are **positive** and **negative** charges. **Like charges repel; unlike charges attract.**

Charging by friction: only **electrons** (negative) move. The object that gains electrons becomes negative; the one that loses them becomes positive.

Conductors (metals, graphite) have **free electrons** that can move. **Insulators** (plastic, rubber, glass, dry wood) do not.

SUPPLEMENT Electric fields

Charge is measured in **coulombs (C)**. An **electric field** is a region where a charge feels a force. Field direction = direction of the force on a **positive** charge.



Current, e.m.f. and p.d.

Current is a flow of charge. In metals, **free electrons** move.

Ammeter: in **series**. **Voltmeter**: in **parallel**.

d.c. flows one way (cell); **a.c.** keeps reversing (mains).

e.m.f.: work done by the source per unit charge, around the whole circuit. **p.d.**: work done by a unit charge passing through a component. Both in **volts (V)**.

SUPPLEMENT Conventional current: $+ \rightarrow -$; electrons flow $- \rightarrow +$.

Equations

$R = \frac{V}{I}$ resistance (Ω)

$P = IV$ power (W)

$E = IVt$ energy (J)

SUPPLEMENT $I = \frac{Q}{t}$ current (A)

SUPPLEMENT $E = \frac{W}{Q}$ e.m.f. (V) (here E is e.m.f.)

SUPPLEMENT $V = \frac{W}{Q}$ p.d. (V)

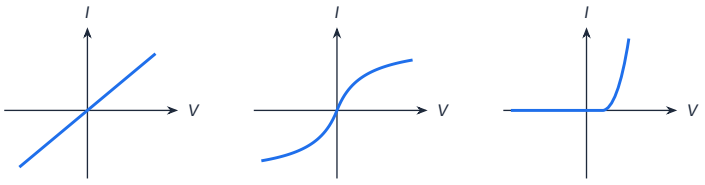
Resistance

Find R with an ammeter (current) and a voltmeter (p.d.): $R = V/I$. Take several readings and find the mean.

A **longer** wire has **more** resistance; a **thicker** wire has **less**.

SUPPLEMENT $R \propto L$ and $R \propto \frac{1}{A}$

SUPPLEMENT Current–voltage graphs



resistor | filament lamp | diode

Energy and the kilowatt-hour

A circuit transfers energy from the source (cell or mains) to the components, then to the surroundings.

1 kW h is the energy transferred by a **1 kW** appliance in **1 hour** (= 3.6 MJ).

energy (kW h) = power (kW) × time (h)

cost = energy (kW h) × price per kW h

Worked example

Question. A 2.0 kW heater is used for 3 hours a day for 30 days at 20 cents per kW h. Find the cost.

energy = $2.0 \times 3 \times 30 = 180$ kW h

cost = $180 \times 20 = 3600$ cents = **$36**

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Interactive simulations

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Explore the physics before (or after) you try the worksheets. Each simulation runs in any web browser on a phone, tablet or computer, with nothing to install. Scan the QR code, or click the link in the PDF.

Scan or click

4.2.4 RESISTANCE

Current–Voltage Graphs

Sweep the voltage across a resistor, a filament lamp and a diode and compare their I–V graphs.

Use with: Worksheet 3: Resistance

benfizikyapamiyorum.com/icdp/electricity-iv.html

Scan or click

4.2.4 RESISTANCE

Resistance of a Wire

Change the length, thickness and material of a wire and see how its resistance changes.

Use with: Worksheet 3: Resistance

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How to get the most from them Make a prediction first, then test it in the simulation. Change one thing at a time and note what happens to the readings. Each simulation ends with a quick *Check yourself* question.

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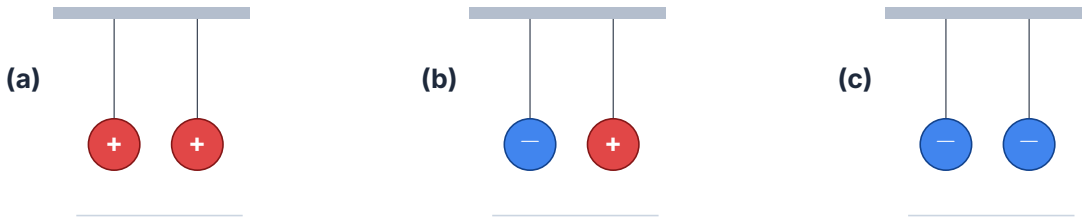
Electric charge

WORKSHEET 1
CORE SUPPLEMENT

You will: explain charging by friction in terms of electrons, tell conductors from insulators, and (Extended) describe electric fields and draw simple field patterns.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE Each pair of small charged spheres is about to be hung close together. For each pair, state whether the spheres **attract** or **repel**. [3]



2 CORE A polythene rod is rubbed with a woollen cloth. The rod becomes negatively charged.

(a) Explain, in terms of electrons, how the rod becomes negatively charged. [2]

.....

.....

(b) State the charge on the cloth after rubbing. Explain your answer. [2]

.....

.....

(c) A student says: *"The rod is negative because positive charges moved from the rod onto the cloth."* Explain why the student is wrong. [1]

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3 CORE A balloon is rubbed on a jumper. Describe a simple experiment to show that the balloon has become charged. [2]

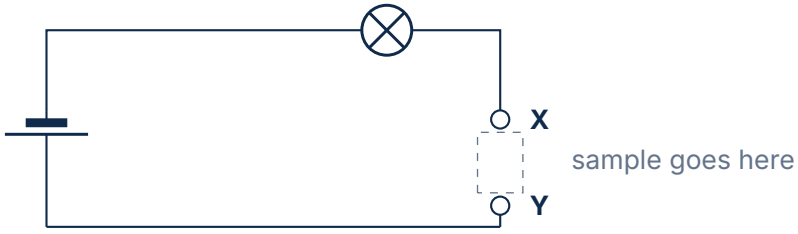
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4 CORE A student uses this circuit to test whether materials are electrical conductors or insulators. Each sample is connected between the terminals X and Y.



(a) Explain how the student can tell whether a sample is a conductor or an insulator. [2]

.....

.....

(b) Write **conductor** or **insulator** next to each material. [3]

copper	_____	plastic ruler	_____
pencil lead (graphite)	_____	dry wood	_____
aluminium foil	_____	rubber band	_____

5 CORE Use a simple electron model to explain why copper is a good electrical conductor but polythene is an insulator. [2]

.....

.....

Exam tip When objects are charged by friction, **only electrons move**. Never say that positive charges move: the protons stay in the nuclei of the atoms.

6 SUPPLEMENT This question is about electric charge and electric fields.

(a) State the unit of electric charge. [1]

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(b) State what is meant by an **electric field**. [1]

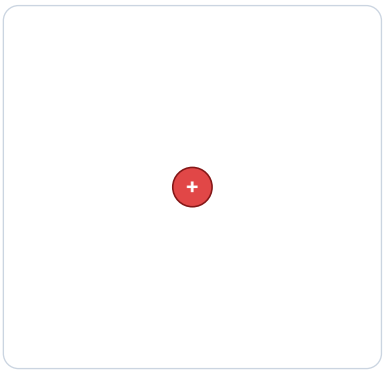
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(c) State how the direction of an electric field at a point is defined. [1]

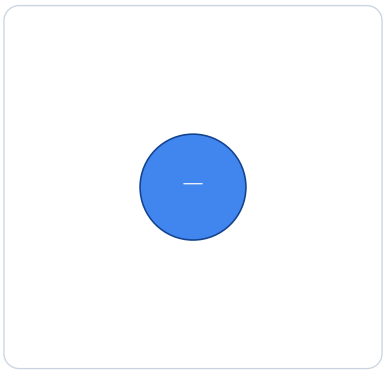
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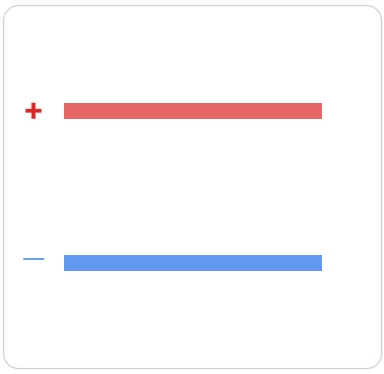
7 SUPPLEMENT Draw the electric field pattern in each diagram. Draw at least six field lines in (a) and (b), and show the direction of each line with an arrow. [6]



(a) a positive point charge



(b) a negatively charged conducting sphere



(c) two oppositely charged plates

8 SUPPLEMENT CHALLENGE A tiny oil drop is stationary between the plates in diagram (c) of Question 7.

(a) The drop has a negative charge. State the direction of the electric force on the drop. Explain your answer. [2]

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.....

(b) The drop is replaced by one with a positive charge. State what happens to the direction of the electric force. [1]

.....

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Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

Worksheet 1 – Electric charge

1 **(a)** repel B1 **(b)** attract B1 **(c)** repel B1

2 **(a)** Friction transfers electrons B1 from the cloth to the rod, so the rod has more electrons than protons. B1
(b) **Positive** B1; the cloth has lost electrons. B1
(c) Only electrons (negative charges) move when objects are charged by friction; the positive charges (protons) stay in the nuclei. B1

3 Any one valid experiment B1, with what is observed B1, e.g. hold the balloon near small pieces of paper: they are attracted to it; or hold it near a thin stream of water from a tap: the stream bends towards it; or bring it near the cap of a gold-leaf electroscope: the leaf rises.

4 **(a)** If the lamp lights, the sample is a conductor B1; if the lamp does not light, it is an insulator. B1
(b) conductors: **copper, graphite, aluminium**; insulators: **plastic ruler, dry wood, rubber band** B3 (all six correct: 3 marks; four or five correct: 2 marks; two or three correct: 1 mark)

5 Copper has free (delocalised) electrons that can move through the metal B1; in polythene the electrons are held in place (bound to atoms), so they cannot move to carry charge. B1

6 **(a)** **coulomb (C)** B1
(b) A region in which an electric charge experiences a force. B1
(c) The direction of the force on a positive charge at that point. B1

7 **(a)** Straight radial lines, evenly spaced around the charge B1, arrows pointing **outwards**. B1
(b) Straight radial lines meeting the surface at right angles B1, arrows pointing **inwards**, towards the sphere. B1
(c) Parallel, evenly spaced straight lines between the plates B1, arrows from the positive plate to the negative plate. B1

8 **(a)** **Upwards** (towards the positive plate) B1; the field points downwards and a negative charge feels a force opposite to the field direction (or: unlike charges attract). B1
(b) The force reverses: it is now downwards (in the direction of the field). B1

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Get the full pack

You have just used Worksheet 1. The full Electrical Quantities pack contains:

- **Worksheet 1:** Electric charge
- **Worksheet 2:** Current, e.m.f. and p.d.
- **Worksheet 3:** Resistance
- **Worksheet 4:** Electrical energy and power
- **Multiple-choice practice:** 10 Paper 1/2-style questions
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