2.3 Electrostatics (P)

Name: _____ Class: _____ Date: _____ **Total: 21 marks**

Objective

Build the skills to answer exam questions on **electric charge** : conductors and insulators, charging by friction, electron transfer, attraction and repulsion, and the uses and dangers of static electricity.

You must be able to:

- explain charging by friction in terms of electrons
- predict attraction and repulsion between charges
- explain the dangers of static charge and how earthing removes them
- explain a use of electrostatic charge

1 Key knowledge and worked examples

Static charge

idea	rule
charging by friction	rubbing two insulators moves electrons from one to the other
gaining or losing electrons	the object that gains electrons becomes negative; the one that loses them becomes positive
forces between charges	like charges repel; unlike charges attract
conductors and insulators	electrons move easily through conductors (metals), not through insulators (plastics)
earthing	a conducting path to earth lets charge flow away safely
charge and current	$Q = I \times t$

Worked example 1: charge. A current of 5.0 µA flows for 4.0 s. Find the charge.

1. Known: $I = 5.0 \times 10^{-6}$ A; $t = 4.0$ s.
2. Rule: $Q = It$.
3. Numbers: $5.0 \times 10^{-6} \times 4.0$.

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4. Result: 2.0×10^{-5} **C**.

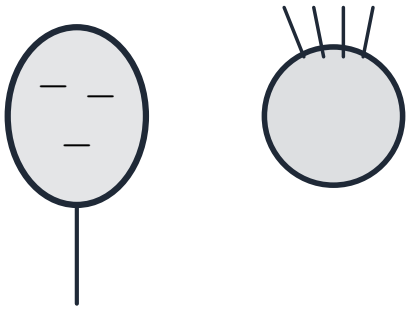
Worked example 2: electron transfer. An acetate rod becomes positive when rubbed with a cloth. Explain.

1. Known: the rod ends up positive.
2. Rule: losing electrons gives a positive charge.
3. Numbers: electrons move from the rod to the cloth.
4. Result: **rod positive, cloth negative, with equal amounts of charge**.

Answer shapes: only electrons move; positive charges never move in a solid.

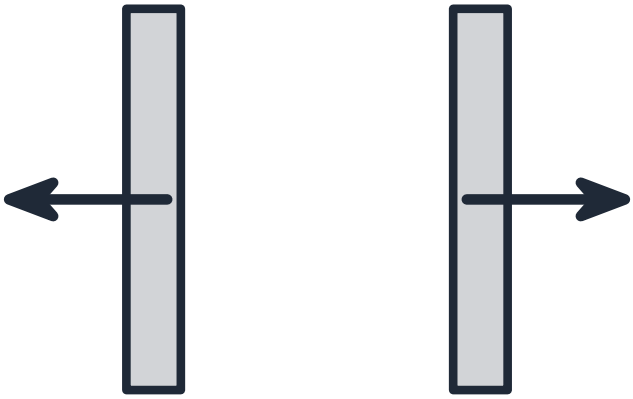
2 Practice

2.1 A balloon rubbed on hair becomes negatively charged. Explain why, and give the charge on the hair. [2]



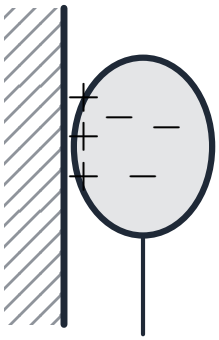
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2.2 Two charged rods are held close together and push each other away. What does this tell you about their charges? [2]



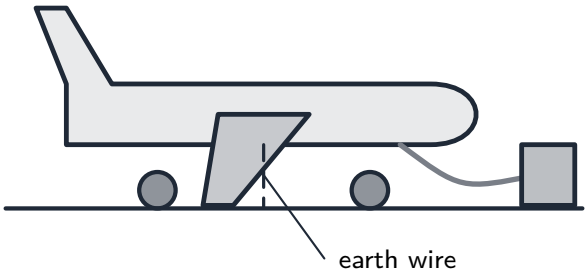
3 Exam-style questions

3.1 Explain why a negatively charged balloon sticks to an uncharged wall. [3]



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3.2 When an aircraft is refuelled, fuel rubbing against the pipe can charge the aircraft. A metal wire connects the aircraft to the ground during refuelling.



(a) During refuelling a current of 30 µA flows onto the aircraft for 120 s. Calculate the charge. [2]

(b) Explain why charge builds up on the aircraft, and why this is dangerous. [3]

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(c) Explain how the earth wire makes refuelling safe. [3]

(d) Car bodies are painted with an electrostatic spray. Explain how charging the paint and the car body gives a good, even coat with little waste. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- electrons move from the hair to the balloon
- the hair becomes positively charged

2.2

- they repel
- so they have the same type of charge (both positive or both negative)

3.1

- the balloon's negative charge repels electrons in the wall surface
- so the wall surface near the balloon becomes positive (induced charge)
- unlike charges attract, so the balloon sticks

3.2

(a) $30 \times 10^{-6} \times 120 = \mathbf{0.0036}$ C

(b) friction between the fuel and the pipe transfers electrons; the charge builds up because the aircraft is insulated from the ground by its tyres; a large charge can cause a spark that ignites the fuel vapour

(c) the wire is a conductor connected to earth; electrons flow through it to or from the earth as soon as charge builds up; so no large charge builds up and there is no spark

(d) points to include:

- the paint droplets are given the same charge as they leave the nozzle (K)
- like charges repel, so the droplets spread out into a fine, even spray (An)
- the car body is given the opposite charge (or earthed) (K)
- unlike charges attract, so the droplets are pulled onto the car (An)
- paint even reaches the back and hidden corners, giving an even coat (An)
- less paint misses the car, so there is less waste (App)

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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