# 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: $5.0 \times 10^{-6} \times 4.0$.
4. Result: $2.0 \times 10^{-5}$ **C**.

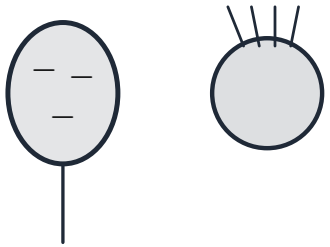
**Worked example 2: electron transfer.** An acetate rod becomes positive when rubbed with a cloth. Explain.

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**.

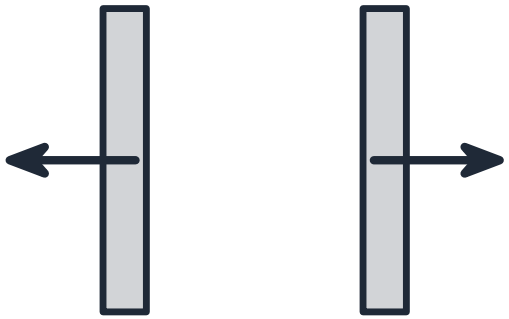
**Answer shapes:** only electrons move; positive charges never move in a solid.

## 2 Practice

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

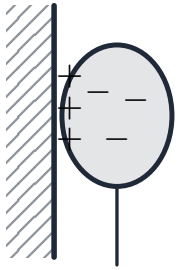


**2.2** Two charged rods are held close together and push each other away. What does this tell you about their charges? [2]

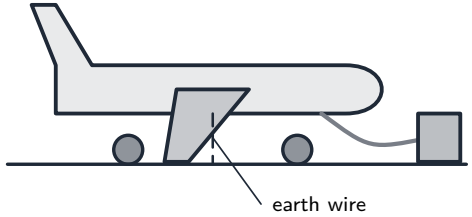


## 3 Exam-style questions

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



**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]

(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]

## 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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