Static charge

4.2.5.1 · Electricity · revision notes

How rubbing two insulating materials together charges them by transferring electrons, how charged objects attract or repel, and how sparks are produced. This is in GCSE Physics only, not Combined Science. Expect 'explain' questions using electron transfer and short questions on like and unlike charges.

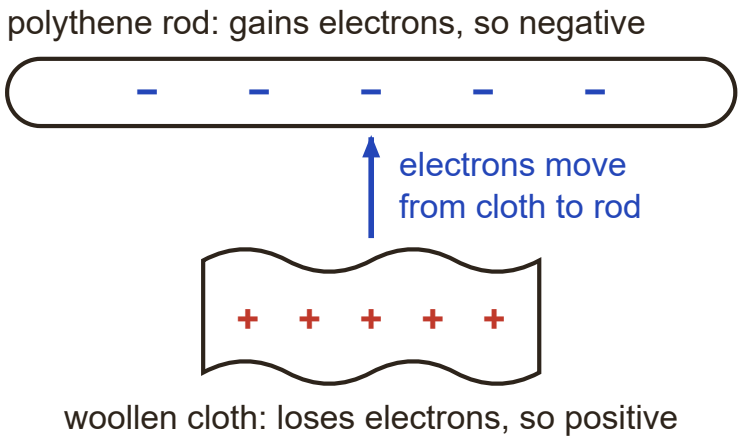
Key facts

- Rubbing insulating materials together transfers electrons
- Loses electrons → equal positive charge
- Like charges repel; unlike charges attract
- Large build-up of charge → spark to a nearby earthed conductor
- Gains electrons → negative charge
- Only electrons (negative charges) move
- Forces between charged objects are non-contact forces

Notes

Charging by rubbing

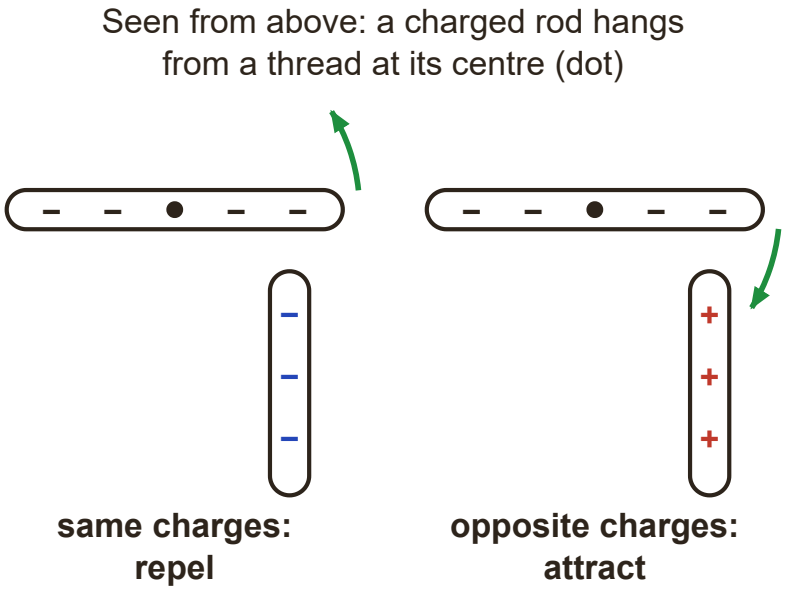
- When certain **insulating** materials are rubbed against each other, they become electrically charged.
- Negatively charged **electrons** are rubbed off one material and on to the other.
- The material that **gains** electrons becomes **negatively** charged.
- The material that **loses** electrons is left with an **equal positive** charge.
- Only electrons move. The positive charges (protons, in the nuclei of the atoms) stay where they are.
- Example: rubbing a polythene rod with a woollen cloth moves electrons from the cloth to the rod, so the rod becomes negative and the cloth becomes positive.



Only electrons move. The charges on the rod and the cloth are equal and opposite.

Forces between charged objects

- When two charged objects are brought close together, they exert a force on each other.
- Two objects with the **same** type of charge **repel**. Two objects with **different** types of charge **attract**.
- These forces are **non-contact forces**: they act without the objects touching.
- Evidence: hang a charged rod from a thread so it can turn freely. Bring another charged rod close to one end without touching it. The hanging rod turns away (repulsion) or turns towards it (attraction).



Like charges repel; unlike charges attract.

Sparking

- Rubbing can build up a large charge on an object, e.g. on you when your shoes rub on a nylon carpet.
- As the charge builds up, the potential difference between the object and a nearby earthed conductor (such as a metal tap) increases.
- When the pd is large enough, charge jumps across the gap through the air. This is a **spark**.
- Charge builds up only where it cannot flow away. If the object is joined to earth by a conductor (e.g. copper wire), electrons flow to earth, so no charge builds up and there is no spark.

How to answer each type of question

Explain how an object becomes charged — 2 to 3 marks — **Grade 5**

1. Say that rubbing transfers electrons.
2. Say which way the electrons move (from ... to ...).
3. Say that gaining electrons gives a negative charge, or losing electrons leaves a positive charge.

Example. A student rubs a polythene rod with a woollen cloth. The rod becomes negatively charged. Explain how the rod becomes negatively charged.

Model answer. Rubbing transfers electrons (1) from the cloth to the rod (1). The rod has gained electrons, which are negative, so it becomes negatively charged (1).

Explain the charge on the other material

2 marks | Grade 6

1. Say that this material lost electrons, so it is positive.
2. Say that the number of electrons lost equals the number gained by the other material, so the charges are equal in size.

Example. An acetate rod is rubbed with a cloth. The cloth becomes negatively charged.
Explain why the acetate rod has a positive charge that is equal in size to the charge on the cloth.

Model answer. Electrons moved from the rod to the cloth, so the rod has lost electrons and is left positively charged (1). The number of electrons lost by the rod equals the number gained by the cloth, so the charges are equal in size (1).

Predict and describe forces between charged objects

2 marks | Grade 5

1. Work out the sign of each charge.
2. Same sign: repel (move apart). Different signs: attract (move together).
3. Describe what you would see, e.g. the hanging rod turns away from the other rod.

Example. A negatively charged polythene rod hangs from a thread so that it can turn freely.
Describe what happens when each of these is brought close to one end, without touching:
(a) another negatively charged polythene rod
(b) a positively charged acetate rod.

Model answer.

(a) The hanging rod turns away / is repelled, because like charges repel (1)

(b) The hanging rod turns towards the acetate rod / is attracted, because unlike charges attract (1)

Explain how a spark is produced

3 marks | Grade 5

1. Rubbing transfers electrons, so charge builds up on the object.
2. The pd between the object and an earthed conductor increases.
3. When it is large enough, charge jumps across the air gap as a spark.

Example. A person walks across a nylon carpet and then reaches towards a metal tap. A small spark jumps between their finger and the tap.
Explain why.

Model answer. Rubbing between the shoes and the carpet transfers electrons, so charge builds up on the person (1). As the charge builds up, the potential difference between the person and the earthed tap increases (1). When the pd is large enough, charge (electrons) jumps across the gap through the air, which is the spark (1).

Don’t lose marks

- Saying positive charges (protons) move from one material to the other. Only electrons move.
- Saying a positively charged object 'gained protons'. It lost electrons.
- Writing 'friction makes it charged' without saying that electrons are transferred.
- Forgetting that the two materials end up with equal and opposite charges.

More tips

Memory tricks

- Only electrons move: 'negatives move, positives stay'.
- GAIN electrons = GAIN negative charge. LOSE electrons = left positive.
- Opposites attract, likes repel, just like the poles of magnets (but these are charges, not poles).

Exam technique

- Always use the word 'electrons' and say which way they move (from ... to ...).
- Give every charge a sign: 'positive' or 'negative', never just 'charged' or 'more charge'.
- For 'describe the evidence' questions, say what you see (turns towards / away) and that the objects do not touch.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State how like and unlike charges interact**
The same type of charge repels; different types of charge attract.

Grade 4 — **Describe charging by rubbing insulators**
Rubbing certain insulating materials together makes them electrically charged.

Grade 5 — **Explain charging using electron transfer**
Electrons move from one material to the other; the gainer becomes negative, the loser positive.

Grade 5 — **Describe evidence for forces between charges**
A charged rod hanging freely turns towards or away from another charged rod that is not touching it.

Grade 5 — **Describe how a spark is produced**
Charge builds up until the pd is large enough for charge to jump through the air to a nearby earthed conductor.

Grade 6 — **Explain why the two charges are equal**
The number of electrons gained by one material equals the number lost by the other.

Free notes, Full packs, practice papers and mock exams at chhetriacademy.com. Written for this site; not taken from past papers. Stuck? 1-to-1 tutoring with a free 30-minute trial lesson.