AQA · GCSE · PHYSICS • EXERCISE SHEET

2.8 Static electricity

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS electric field

Objective

Explain static charging by electron transfer, the attraction and repulsion rule, sparking, and the radial electric field of a charged sphere (physics only). Original questions for spec statement 4.2.5.

1 Key knowledge and worked examples

When two **insulating** materials are rubbed together, **electrons** (negative charge) transfer from one surface to the other:

- the material that **gains** electrons becomes **negatively charged**;
- the material that **loses** electrons keeps an **equal positive charge**.

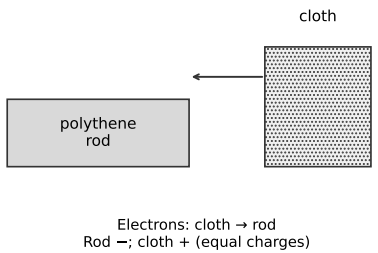
Only electrons move – the positive charges (nuclei) stay put. Charging by friction never creates charge; it separates it.

Charged objects exert forces **without contact** (a non-contact force):

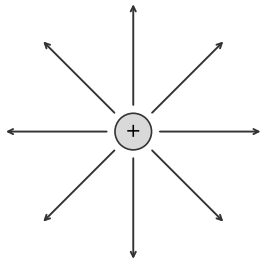
- **like charges repel; unlike charges attract.**

A **spark** jumps when the field between charged objects is strong enough to make air conduct – the charge suddenly flows across the gap.

Electric field : the region around a charged object where another charge feels a force. It is **strongest close to the object** and gets weaker with distance.



Electrons: cloth → rod
Rod −; cloth + (equal charges)



Positive sphere: arrows out
Field weaker further away

Electrons move; the field tells the force.

Drawing the field of an isolated charged sphere: straight **radial** arrows, pointing **away** from a positive charge (towards it for negative), drawn further apart as distance grows – showing the field getting weaker.

Worked example (explanation). A student rubs a balloon on hair and it sticks to a wall.

1. Rubbing transfers electrons from hair to balloon, so the balloon is negatively charged.
2. The charged balloon attracts **charges in the wall**: it slightly shifts bound charges in the insulating wall, leaving opposite charge nearer the balloon; the wall remains neutral overall.
3. Unlike charges attract, the nearer opposite charge experiences stronger attraction than the repulsion of the further like charge, pulling the balloon towards the wall.

Common credited points: sparking is caused by a large enough potential difference/pd between the charged object and a conductor; the concept of a field explains the non-contact force (the second charge feels a force because it sits in the first charge's field).

2 Practice

2.1 A polythene rod is rubbed with a dry cloth and becomes negatively charged. Explain, in terms of electrons, what happened to each object. [2]

2.2 Three rods are charged. Rod X repels rod Y; rod Y attracts rod Z. State what this shows about the charges on X and Z, and what happens when X meets Z if X is negative. [3]

2.3 Copy and complete: an electric field is a region where _____. State where the field of a charged sphere is strongest. [2]

3 Exam-style questions

3.1 A Van de Graaff generator's metal dome becomes negatively charged. A student touches the dome and their hair stands on end.

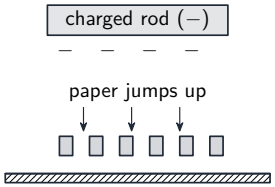
(a) Explain why the hair stands on end. [3]

(b) The dome's electric field is strongest at its most curved point. Use this to explain why a spark jumps to a nearby earthed conductor from a sharp point rather than a flat area. [2]

3.2 A charged rod is held just above small pieces of paper, which jump up to it although nothing touches them.

(a) Explain how the rod attracts neutral paper. [3]

(b) State and explain what happens to the force if the rod is moved further away. [2]



3.3 An aerial fitter works on a roof. The aerial cable comes close to an 11 000 V overhead line but does not touch it.

(a) Explain, using the idea of an electric field, why a spark could still jump from the line to the cable. [3]

(b) The fitter earths the cable before working. A student claims this makes sparks impossible and the fitter safe. Explain why the claim is false. [3]

Solutions

2.1 Electrons were transferred from the cloth to the rod; the rod gained electrons (negative charge) and the cloth lost the same number, leaving it positively charged.

2.2 X and Y have the **same** type of charge (like charges repel); Y and Z have **unlike** charges (attract); so Z is positive, and X (negative) would **attract** Z.

2.3 An electric field is a region where a (charged) object feels a (non-contact) force. Strongest close to the sphere's surface / close to the charged object.

3.1 (a) Electrons transfer onto the student from the dome, so the hair strands each carry the same (negative) charge; like charges repel; neighbouring strands push apart and rise – the hair stands on end. (b) The field is strongest at a sharp point (greatest curvature); there the air's breakdown happens first – the field is large enough to make air conduct, so the spark starts from the point.

3.2 (a) The charged rod's field affects the paper: it attracts the opposite charge within each neutral piece to the near side and repels like charge to the far side (induced charge separation); the nearer opposite charges feel a stronger attraction than the repulsion of the further like charges, so the paper is pulled to the rod. (b) The force decreases: the field weakens with distance from the rod, so the force on the paper's charges is smaller.

3.3 (a) The overhead line has an electric field around it; the cable sits inside that field, so charges in the cable feel a force and the cable's near side gains an induced opposite charge; if the field between line and cable is strong enough (about 11 kV across a small gap), air becomes conducting and a spark jumps without contact. (b) Earthing holds the cable near earth potential and gives a conducting path to earth; the overhead line remains at high potential relative to the cable, so a strong field can remain across the gap; air may still break down and a spark may carry current towards earth, so the stated action does not establish safety. Do not approach overhead lines or attempt this scenario.