Electric fields

4.2.5.2 · Electricity · revision notes

A charged object creates an electric field around it, and another charged object in that field experiences a force. You need to draw the field pattern of an isolated charged sphere and use the idea of an electric field to explain non-contact forces and sparking. This is in GCSE Physics only, not Combined Science.

Key facts

- A charged object creates an electric field around itself
- The field is strongest close to the object and weaker further away
- Field lines show the direction of the force on a small positive charge
- Very strong field → air ionised → lower resistance → charge flows → spark
- A second charged object in the field experiences a force
- Closer together → bigger force
- Isolated sphere: straight radial lines; outwards for positive, inwards for negative

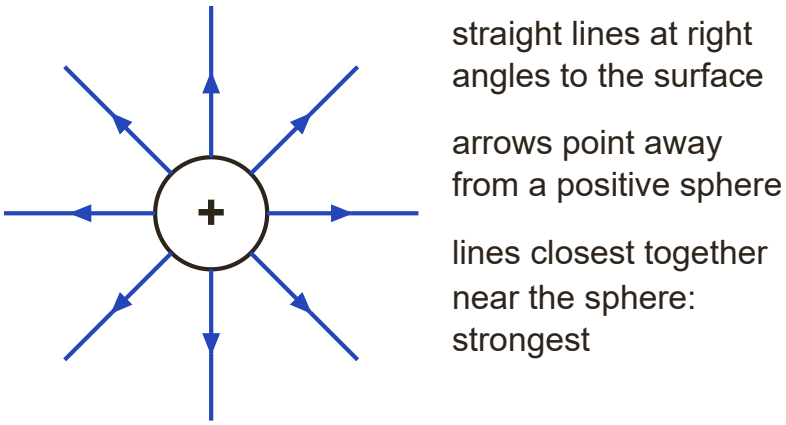
Notes

What an electric field is

- A charged object creates an **electric field** around itself.
- The electric field is the region where a second charged object **experiences a force**.
- The field is **strongest close** to the charged object. The further away from the object, the **weaker** the field.
- So the force between two charged objects gets **stronger as the distance between them decreases**.

Drawing the field of an isolated charged sphere

- Draw straight **field lines** going out from the surface of the sphere in all directions, evenly spaced, like the spokes of a wheel (radial lines).
- Each line meets the surface at right angles, as if it came from the centre of the sphere. Field lines never cross.
- The arrows show the direction of the force on a small **positive** charge placed in the field.
- **Positive** sphere: arrows point **away** from the sphere. **Negative** sphere: arrows point **towards** the sphere.
- The lines are closest together near the sphere, which shows the field is strongest there.



Positive sphere: radial lines, arrows outwards. For a negative sphere the arrows point inwards.

Using fields to explain forces and sparks

- Two charged objects are each in the other's electric field, so each experiences a force without touching: a **non-contact force**.
- Moving them closer puts each one in a stronger part of the other's field, so the force increases.
- Sparking: close to an object with a large charge, the electric field is very strong. A strong enough field pulls electrons off air particles: it **ionises** the air.
- Ionised air has a much lower resistance, so it conducts. Charge flows through it to a nearby earthed conductor as a spark.

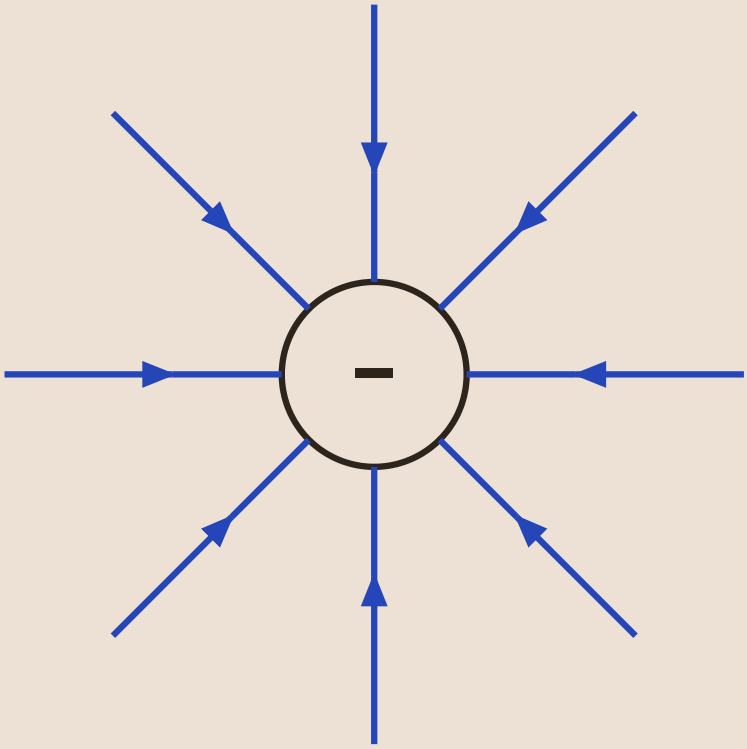
How to answer each type of question

Draw the electric field pattern 2 marks **Grade 5**

1. Use a ruler. Draw at least four evenly spaced straight lines starting at the surface of the sphere and pointing radially (as if from the centre).
2. Add an arrow on every line: away from a positive sphere, towards a negative sphere.

Example. Draw the electric field pattern around an isolated negatively charged sphere.

Model answer.



At least four straight, evenly spaced lines drawn radially from the surface of the sphere (1).

Arrows on the lines pointing towards the sphere (1).

Use the idea of an electric field to explain a force

2 marks | Grade 6

1. Say that the charged object creates an electric field around it.
2. Say that the second charged object is in this field, so it experiences a force.
3. Say whether it is attraction or repulsion if the charges are given.

Example. A small positively charged ball hangs near a large positively charged metal dome. The ball is pushed away from the dome, although they do not touch.
Use the idea of an electric field to explain why.

Model answer. The charged dome creates an electric field around it (1). The charged ball is in this field, so it experiences a force; the force is repulsive because both are positive (1).

Describe and explain how the force changes with distance

2 marks | Grade 5

1. Describe the change: closer → bigger force; further → smaller force.
2. Explain it with the field: the field is stronger closer to the charged object.

Example. A small charged ball is moved closer to a charged dome.
Describe and explain how the force on the ball changes.

Model answer. The force on the ball increases (1). The electric field is stronger closer to the dome (1).

Explain sparking using the electric field

3 marks | Grade 5

1. A large charge gives a very strong electric field close to the object.
2. The strong field ionises the air (removes electrons from air particles).
3. Charge can then flow through the air, which is the spark.

Example. A metal dome is given a large positive charge. When an earthed metal sphere is brought close to the dome, a spark jumps across the gap between them.
Use the idea of an electric field to explain why the spark is produced.

Model answer. There is a very strong electric field close to the highly charged dome / in the gap (1). The strong field ionises the air (electrons are pulled off air particles) (1). Charge can then flow through the air across the gap, producing the spark (1).

Don’t lose marks

- Drawing curved or crossing lines around a single sphere, or forgetting the arrows.
- Drawing arrows the wrong way: outwards is for a positive sphere, inwards for a negative sphere.
- Saying the field is the same strength everywhere, or strongest far from the object.
- Explaining a non-contact force without saying that the second object is in the first object's electric field.

More tips

Memory tricks

- The arrows show where a small positive charge would be pushed: away from +, towards −.
- An isolated charged sphere looks like the spokes of a bicycle wheel.
- Closer field lines = stronger field.

Exam technique

- When a question says 'use the idea of an electric field', the words 'electric field' and 'experiences a force' must appear in your answer.
- For field drawings, use a ruler and draw at least four evenly spaced lines with arrows.
- For sparking, build the chain: large charge → very strong field → air ionised → charge flows → spark.

What each grade needs

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

Grade 4 — **Describe what an electric field is**
The region around a charged object where another charged object experiences a force.

Grade 5 — **Describe how field strength changes with distance**
The field is strongest close to the charged object and weaker further away.

Grade 5 — **Draw the field of a charged sphere**
Straight radial lines: arrows point outwards for a positive sphere and inwards for a negative sphere.

Grade 5 — **Explain how the electrostatic force changes with distance**
Closer objects are in a stronger part of each other's field, so the force is bigger.

Grade 5 — **Explain sparking using electric fields**
A very strong field ionises the air, so charge can flow through the air as a spark.

Grade 6 — **Explain non-contact forces using fields**
Each charged object is in the other's electric field, so each experiences a force.

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