

Charge, fields and sparks

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Full answers follow each problem in the same order. Check that you converted minutes to seconds and prefixes to base units, and that you describe charging as a movement of electrons, never protons.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P2, HS-PS2-4

Problem 1 Attract or repel

1. **Repel** (like charges).
2. **Attract** (unlike charges).
3. **Repel** (like charges).

Problem 2 Rubbing a rod

1. **Electrons**.
2. From the **cloth to the rod**.
3. **Positive**, because the cloth has lost electrons.

Problem 3 Charge from current

1. $Q = I \times t$.
2. $Q = 2.0 \times 5.0 = \mathbf{10\ C}$.

Problem 4 Milliamps and minutes

1. $250\ \text{mA} = 0.25\ \text{A}$ and $2.0\ \text{min} = 120\ \text{s}$.
2. $Q = 0.25 \times 120 = \mathbf{30\ C}$.

Problem 5 Conductor or insulator

Conductors: copper, steel, aluminium. **Insulators:** polythene, rubber, glass. Metals have free electrons; the others do not.

Problem 6 Add the arrows

1. **Towards** the negative charge.
2. Each arrowhead points **inwards**, towards the charge.
3. The lines spread out, so the field gets **weaker** with distance.

Problem 7 Counting electrons

1. $N = Q \div e$.
2. $N = 4.0 \times 10^{-9} \div 1.6 \times 10^{-19} = 2.5 \times 10^{10}$ **electrons**.

Problem 8 How long does it take

1. $t = Q \div I$.
2. $t = 36 \div 1.5 = 24$ **s**.

Problem 9 Current from charge

1. 3.0 min = 180 s.
2. $I = Q \div t = 90 \div 180 = 0.50$ **A**.

Problem 10 The balloon on the wall

1. **Negative**, because it gained electrons.
2. The balloon repels electrons in the wall surface, leaving the nearest part of the wall with a positive charge. Unlike charges attract, and the nearer positive charge is closer, so the force of attraction is stronger than the repulsion. The balloon is **attracted**.

Problem 11 Charging graph

1. **36 μC** .
2. Gradient = $48 \div 40 = 1.2$ **$\mu\text{C/s}$** .
3. It is the **current**, 1.2 μA , because current = charge $\div$ time.

Problem 12 Refuelling safely

1. Fuel flowing through the pipe rubs against the pipe and the lorry's surfaces, transferring electrons, so charge builds up.
2. The wire lets the charge **flow safely to the ground**, so no spark can ignite the petrol vapour.

Problem 13 Spray painting a bicycle frame

1. The droplets carry **like charges**, so they repel one another and spread out.
2. The charged droplets **induce the opposite charge** on the frame, so they are attracted and coat all sides, even the back.

Problem 14 Gold-leaf electroscope

1. The rod repels electrons in the cap, which travel down to the stem and leaf. Both then hold **extra negative charge**, so they repel and the leaf rises.

2. The electrons return to the cap and the leaf **falls** back, because the electroscope was never charged overall.

Problem 15 Spot the errors

1. **Electrons** move; protons stay in the nuclei.
2. Like charges **repel**; unlike charges attract.
3. $Q = I \times t = 5 \times 2 = \mathbf{10\ C}$, not 2.5 C (he divided instead of multiplying).

Problem 16 A lightning flash

1. $I = Q \div t = 6.0 \div 2.0 \times 10^{-4} = \mathbf{3.0 \times 10^4\ A}$.
2. $N = 6.0 \div 1.6 \times 10^{-19} = \mathbf{3.8 \times 10^{19}\ electrons}$.
3. The current and the energy released are millions of times larger, enough to heat air to thousands of degrees and kill.

Problem 17 Van de Graaff dome

1. $t = 50 \times 10^{-6} \div 2.5 \times 10^{-6} = \mathbf{20\ s}$.
2. $N \text{ per second} = 2.5 \times 10^{-6} \div 1.6 \times 10^{-19} = \mathbf{1.6 \times 10^{13}}$.
3. The spark carries the charge away through the air, so the dome discharges.

Problem 18 Electron between plates

1. **Upwards**, from the positive plate to the negative plate.
2. The electron is negative, so it feels a force **opposite to the field**, downward, towards the positive plate (it is also repelled by the negative plate).
3. A proton is positive, so it is pushed **up** to the negative plate, in the direction of the field.

Problem 19 Dust in a chimney

1. $Q = 20 \times 1.6 \times 10^{-19} = \mathbf{3.2 \times 10^{-18}\ C}$.
2. The particles are negative, so the plate is **positive**.
3. Opposite charges attract, so dust collects on the plate; tapping the plate shakes the dust into a hopper.

Problem 20 Rod and discharge

1. $Q = 5.0 \times 10^{10} \times 1.6 \times 10^{-19} = \mathbf{8.0 \times 10^{-9}\ C}$.
2. $I = 8.0 \times 10^{-9} \div 0.040 = \mathbf{2.0 \times 10^{-7}\ A}$ (0.20 μA).
3. The current is far too small to be felt or to harm a person.