A-LEVEL PHYSICS • EXERCISE SHEET

18.4 Electric field of a point charge

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

Build the skills to answer exam questions on the **electric field of a point charge**.

You must be able to:

- use $E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$
- compare electric and gravitational fields

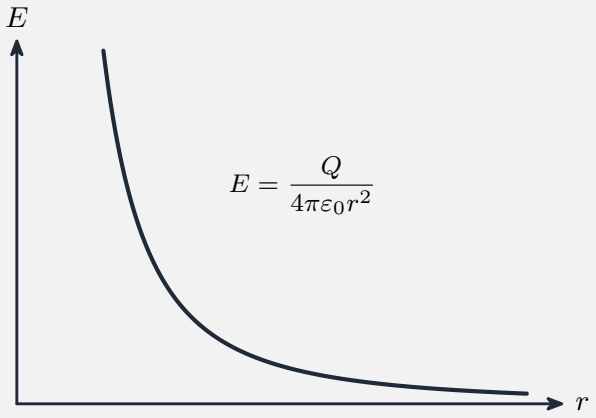
1 Worked examples

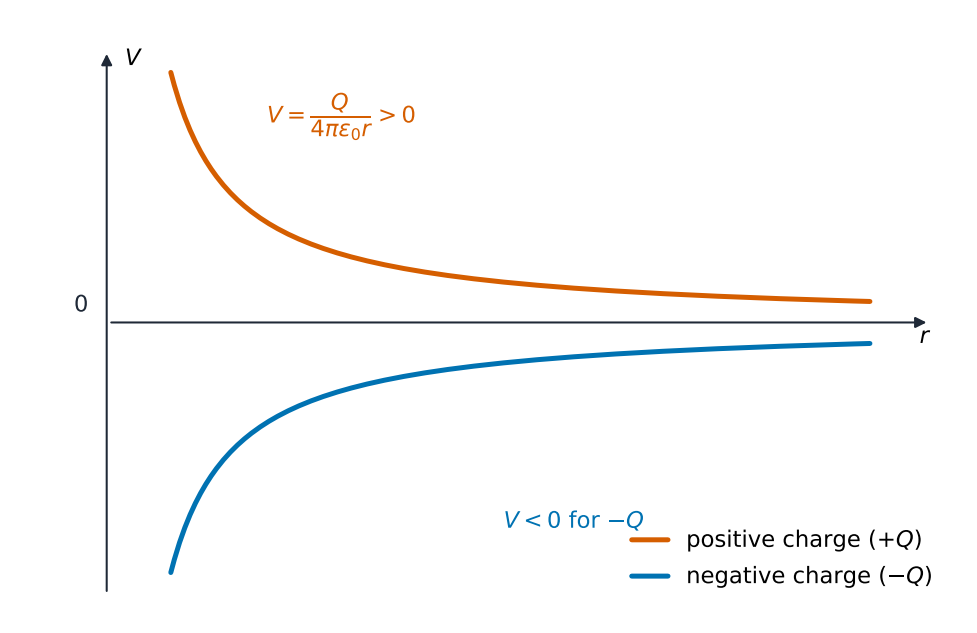
Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ **Field of a point charge**

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}.$$

It points **out** from a positive charge and **in** to a negative one, and falls as an **inverse square**:





The radial field of a point charge

This is just like the **gravitational** field $g = GM/r^2$ —except gravity is **always attractive**, while the electric field can be attractive or repulsive.

2 Practice

Now apply the methods above.

2.1 Write the equation for the field strength E due to a **point charge**. [1]

2.2 State how E varies with distance r from a point charge. [1]

2.3 Find the field strength at 0.10 m from a +5.0 nC point charge. ($\frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9$.) [2]

3 Exam-style questions

3.1 Both the electric field of a point charge and the gravitational field of a point mass vary with distance as: [1]

- **A** $1/r$
- **B** $1/r^2$
- **C** r
- **D** r^2

3.2 Calculate the electric field strength at 2.0 cm from a point charge of +8.0 nC. [3]

3.3 State **one** similarity and **one** difference between an electric field and a gravitational field. [2]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **18.4 Electric field of a point charge** past-paper sheet in the Library, or try these in **Practice mode**:

- 9702/44 N25 —Q5 (field of a charged sphere)
- 9702/41 J25 —Q2 (point-charge field)
- 9702/44 J25 —Q5 (electric field, structured)
- 9702/43 J25 —Q2 (field and force)

Solutions

2.1 $E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$.

2.2 $E \propto 1/r^2$ (inverse-square).

2.3 $E = \dfrac{(9.0\times10^{9})(5.0\times10^{-9})}{(0.10)^2} = 4.5\times10^{3}\ \text{N C}^{-1}$.

3.1 B —$1/r^2$.

3.2 $E = \dfrac{(9.0\times10^{9})(8.0\times10^{-9})}{(0.020)^2} = 1.8\times10^{5}\ \text{N C}^{-1}$.

3.3 Similarity: both follow an **inverse-square** law (radial field around a point source). Difference: the electric force can be **attractive or repulsive**, but gravity is **always attractive**.