

8.3 Electric Fields

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS electric field • test charge • point charges
• superposition

Objective

Build the skills to answer exam questions on **electric fields**.

You must be able to:

- define the **electric field** as force per unit charge, $\vec{E} = \frac{\vec{F}}{q}$
- calculate the field of a **point charge**, $E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$
- use **superposition** for several point charges
- find the force $\vec{F} = q\vec{E}$ on a charge in a field

1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later.

■ The electric field

$\vec{E} = \frac{\vec{F}}{q}$ – the force per unit **positive** test charge, in N C⁻¹.

■ Point charge

$E = k\frac{q}{r^2}$, pointing away from a positive charge and toward a negative one; add fields as vectors (superposition).

■ Force on a charge

$\vec{F} = q\vec{E}$. A positive charge feels a force **along** $\vec{E}$; a negative charge feels one **opposite** to $\vec{E}$.

2 Practice

2.1 Find the electric field 0.20 m from a $+5.0 \mu\text{C}$ charge ($k = 8.99 \times 10^9$). [2]

2.2 A $+2.0 \mu\text{C}$ charge sits in a field of 3000 N C^{-1} . Find the force on it. [2]

2.3 State the direction of the field around a negative point charge. [1]

3 Exam-style questions

3.1 The electric field is defined as [1]

- ☐ **A** qF
B F/q
C q/F
D qr^2

3.2 The force on a charge q in a field E is [1]

- ☐ **A** q/E
B qE
C E/q
D qE^2

3.3 A $+4.0 \mu\text{C}$ charge is at the origin.

(a) Find the electric field 0.30 m from it. [2]

(b) Find the force on a $-1.0 \mu\text{C}$ charge placed there, with direction. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- $E = k \frac{q}{r^2} = 8.99 \times 10^9 \times \frac{5.0 \times 10^{-6}}{(0.20)^2} = 1.1 \times 10^6 \text{ N C}^{-1}$

2.2

- $F = qE = (2.0 \times 10^{-6})(3000) = 6.0 \times 10^{-3} \text{ N}$

2.3

- radially inward, toward the charge

3.1 B

- F/q .

3.2 B

- qE .

3.3

(a)

- $E = 8.99 \times 10^9 \times \frac{4.0 \times 10^{-6}}{(0.30)^2} = 4.0 \times 10^5 \text{ N C}^{-1}$

(b)

- $F = qE = (1.0 \times 10^{-6})(4.0 \times 10^5) = 0.40 \text{ N}$, directed toward the $+4.0 \mu\text{C}$ charge (attractive)