

8.3 Electric Fields

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS electric field 电场 • test charge 检验电荷 • point charges 点电荷 • superposition 叠加

Objective

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

You must be able to:

- define the **electric field** 电场 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 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 $3000\ \text{N C}^{-1}$. 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 $0.30\ \text{m}$ from it. [2]

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

Solutions

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.

3.2 B.

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).