8.3 Electric Fields

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

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, $\vec{E} = \dfrac{\vec{F}}{q}$
- calculate the field of a **point charge**, $E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{r^2}$
- 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

$\vec{E} = \dfrac{\vec{F}}{q}$ —the force per unit **positive** test charge, in N C^{-1}.

Point charge

$E = k\dfrac{q}{r^2}$, 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 μC charge ($k = 8.99 \times 10^9$). [2]

2.2 A $+2.0\ \mu$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 $+4.0\ \mu$C charge is at the origin.

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

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

4 Go further

- work through the **8.3 Electric Fields** lesson on the **Learn** page;

- read the **Electrostatics** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

2.1 $E = k\dfrac{q}{r^2} = 8.99 \times 10^9 \times \dfrac{5.0 \times 10^{-6}}{(0.20)^2} = 1.1 \times 10^6$ N C^{-1}.

2.2 $F = qE = (2.0 \times 10^{-6})(3000) = 6.0 \times 10^{-3}$ N.

2.3 radially inward, toward the charge.

3.1 B.

3.2 B.

3.3 (a) $E = 8.99 \times 10^9 \times \dfrac{4.0 \times 10^{-6}}{(0.30)^2} = 4.0 \times 10^5$ N C^{-1}. (b) $F = qE = (1.0 \times 10^{-6})(4.0 \times 10^5) = 0.40$ N, directed toward the $+4.0$ μC charge (attractive).