Exercise walk-through

Electric Fields ▪ 10.3

eXercise

You must be able to

- define the **electric field 电场** as force per unit positive charge, $\vec{E} = \vec{F}/q$
- draw and interpret **field lines 电场线** (direction and density)
- calculate the field of a **point charge**, $E = k\frac{q}{r^2}$, and add fields as vectors
- describe the uniform field between parallel plates

Method — The electric field

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

Method — Field lines

Lines point **away** from positive and **toward** negative charge; where the lines are **denser**, the field is stronger.

Method — Point charge and parallel plates

$E = k\frac{q}{r^2}$ for a point charge. Between parallel plates the field is **uniform**, running from the $+$ plate to the $-$ plate.

Practice 2.1 ▪ 2 marks

A charge of 2.0×10^{-6} C feels a force of 0.10 N. Find the electric field there.

Solution 2.1

Method: The electric field

Worked steps

$$E = \frac{F}{q} = \frac{0.10}{2.0 \times 10^{-6}} = 5.0 \times 10^{4} \text{ N C}^{-1}$$ M1 A1.

Practice 2.2 ▪ 1 mark

State the direction of the field around a positive point charge.

Solution 2.2

Method: Field lines

Worked steps

radially outward, away from the charge B1.

Practice 2.3 ▪ 2 marks

Find the field 0.20 m from a $+4.0$ μC charge ($k = 8.99 \times 10^9$).

Solution 2.3

Worked steps

$$E = k\frac{q}{r^2} = 8.99 \times 10^9 \times \frac{4.0 \times 10^{-6}}{(0.20)^2} = 9.0 \times 10^5 \text{ N C}^{-1}$$ M1 A1.

Exam-style 3.1 ▪ 1 mark

The electric field is defined as

A force $\times$ charge

B force per unit charge

C charge per unit force

D charge $\times$ distance

Solution 3.1

A force × charge

B force per unit charge ✓

C charge per unit force

D charge × distance

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Field lines around a negative point charge point

A away from it

B toward it

C in circles around it

D there are none

Solution 3.2

Method: Field lines

A away from it

B toward it ✓

C in circles around it

D there are none

Worked steps

B.

Exam-style 3.3 ▪ 3 marks

A $+6.0\ \mu$C charge sits at the origin.
(a) Find the electric field 0.30 m from it.
(b) State the direction of the field.

Solution 3.3

Method: The electric field

Worked steps

(a) $E = 8.99 \times 10^9 \times \dfrac{6.0 \times 10^{-6}}{(0.30)^2} = 6.0 \times 10^5$ N C^{-1} M1 M1 A1. (b) away from the charge (radially outward) B1.