Exercise walk-through

Electric Potential ▪ 10.5

eXercise

You must be able to

- define **electric potential 电势** (voltage) as potential energy per unit charge, $V = U/q$
- calculate the potential due to point charges, $V = k\frac{q}{r}$
- relate the **potential difference 电势差** to the work needed to move a charge
- connect the field to the potential (the field points toward decreasing potential)

Method — Electric potential

$V = \dfrac{U}{q}$, measured in volts — the potential energy per unit charge. For a point charge, $V = k\dfrac{q}{r}$, a **scalar** (just add potentials).

Method — Work and potential difference

$W = q\,\Delta V$ to move a charge q through a potential difference ΔV.

Method — Field and potential

The electric field points from **high** to **low** potential.

Practice 2.1 ▪ 2 marks

Find the potential 0.30 m from a $+6.0$ μC charge ($k = 8.99 \times 10^9$).

Solution 2.1

Worked steps

$$V = k\frac{q}{r} = 8.99 \times 10^{9} \times \frac{6.0 \times 10^{-6}}{0.30} = 1.8 \times 10^{5}\ \text{V}$$ M1 A1.

Practice 2.2 ▪ 1 mark

State whether electric potential is a scalar or a vector quantity.

Solution 2.2

Method: Electric potential

Worked steps

a scalar B1.

Practice 2.3 ▪ 2 marks

Find the work needed to move a $+2.0\ \mu$C charge through a potential difference of 100 V.

Solution 2.3

Method: Work and potential difference

Worked steps

$W = q\,\Delta V = 2.0 \times 10^{-6} \times 100 = 2.0 \times 10^{-4}$ J **M1** **A1**.

Exam-style 3.1 ▪ 1 mark

Electric potential is

A potential energy per unit charge

B force per unit charge

C charge per unit energy

D field $\times$ distance only

Solution 3.1

A potential energy per unit charge ✓

B force per unit charge

C charge per unit energy

D field $\times$ distance only

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

The electric field points in the direction of

A increasing potential

B decreasing potential

C zero potential

D constant potential

Solution 3.2

Method: Field and potential

A increasing potential

B decreasing potential ✓

C zero potential

D constant potential

Worked steps

B.

Exam-style 3.3 ▪ 3 marks

A $+3.0\ \mu$C charge sits at the origin.
(a) Find the potential 0.20 m from it.
(b) Find the potential energy of a $+1.0\ \mu$C charge placed there.

Solution 3.3

Method: Electric potential

Worked steps

(a) $V = 8.99 \times 10^9 \times \dfrac{3.0 \times 10^{-6}}{0.20} = 1.35 \times 10^5$ V **M1** **M1** **A1**. (b) $U = qV = (1.0 \times 10^{-6})(1.35 \times 10^5) = 0.135$ J **B1**.