

10.5 Electric Potential

Name: _____ Class: _____ Date: _____

Total: 11 marks

Objective

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

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)

1 Worked examples

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

■ Electric potential

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

■ Work and potential difference

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

■ Field and potential

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

2 Practice

2.1 Find the potential 0.30 m from a $+6.0\ \mu\text{C}$ charge ($k = 8.99 \times 10^9$). [2]

2.2 State whether electric potential is a scalar or a vector quantity. [1]

2.3 Find the work needed to move a $+2.0\ \mu\text{C}$ charge through a potential difference of 100 V. [2]

3 Exam-style questions

3.1 Electric potential is [1]

- **A** potential energy per unit charge
 - **B** force per unit charge
 - **C** charge per unit energy
 - **D** field $\times$ distance only
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3.2 The electric field points in the direction of [1]

- **A** increasing potential
 - **B** decreasing potential
 - **C** zero potential
 - **D** constant potential
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3.3 A $+3.0\ \mu\text{C}$ charge sits at the origin.

(a) Find the potential 0.20 m from it. [3]

(b) Find the potential energy of a $+1.0\ \mu\text{C}$ charge placed there. [1]

4 Go further

- work through the **10.5 Electric Potential** lesson on the **Learn** page;
- read the **Electric Force, Field, and Potential** section of the AP Physics 2 handout on the **Know** page.

Solutions

2.1 $V = k \frac{q}{r} = 8.99 \times 10^9 \times \frac{6.0 \times 10^{-6}}{0.30} = 1.8 \times 10^5 \text{ V}.$

2.2 a scalar.

2.3 $W = q \Delta V = 2.0 \times 10^{-6} \times 100 = 2.0 \times 10^{-4} \text{ J}.$

3.1 A.

3.2 B.

3.3 (a) $V = 8.99 \times 10^9 \times \frac{3.0 \times 10^{-6}}{0.20} = 1.35 \times 10^5 \text{ V}.$ (b) $U = qV = (1.0 \times 10^{-6})(1.35 \times 10^5) = 0.135 \text{ J}.$