

10.4 Electric Potential Energy

Name: _____ Class: _____ Date: _____

Total: 10 marks

Objective

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

You must be able to:

- define **electric potential energy** 电势能 as the work done to assemble a charge configuration
- calculate the potential energy of two point charges, $U = k \frac{q_1 q_2}{r}$
- relate changes in potential energy to **work** done by the electric force
- apply **conservation of energy** to charges moving in a field

1 Worked examples

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

■ Potential energy of two charges

$U = k \frac{q_1 q_2}{r}$ —**positive** for like charges (they store energy as they are pushed together) and **negative** for unlike charges.

■ Work and energy

Work done by the field = $-\Delta U$. A charge released from rest gains kinetic energy equal to the drop in U .

■ Example

A $+1.0 \mu\text{C}$ and a $+2.0 \mu\text{C}$ charge 0.10 m apart: $U = 8.99 \times 10^9 \times \frac{(1.0 \times 10^{-6})(2.0 \times 10^{-6})}{0.10} = 0.18 \text{ J}$.

2 Practice

2.1 Find the electric potential energy of a $+2.0 \mu\text{C}$ and a $+3.0 \mu\text{C}$ charge 0.50 m apart ($k = 8.99 \times 10^9$). [2]

2.2 State the sign of the potential energy for two opposite charges. [1]

2.3 A charge is released and its potential energy falls by 5.0 J. State the kinetic energy it gains. [1]

3 Exam-style questions

3.1 The electric potential energy of two point charges is [1]

- **A** $k \frac{q_1 q_2}{r^2}$
 - **B** $k \frac{q_1 q_2}{r}$
 - **C** qE
 - **D** $\frac{1}{2}CV^2$
-

3.2 The electric potential energy of two unlike charges is [1]

- **A** positive
 - **B** negative
 - **C** zero
 - **D** infinite
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3.3 Two $+4.0 \mu\text{C}$ charges are held 0.20 m apart.

(a) Find the electric potential energy of the pair. [3]

(b) State what happens to this energy if the charges are released. [1]

4 Go further

- work through the **10.4 Electric Potential Energy** 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 $U = 8.99 \times 10^9 \times \frac{(2.0 \times 10^{-6})(3.0 \times 10^{-6})}{0.50} = 0.11 \text{ J}.$

2.2 negative.

2.3 5.0 J (energy is conserved).

3.1 B.

3.2 B.

3.3 (a) $U = 8.99 \times 10^9 \times \frac{(4.0 \times 10^{-6})^2}{0.20} = 0.72 \text{ J}.$ (b) it is converted into kinetic energy as the like charges fly apart.