AP PHYSICS 2 • EXERCISE SHEET

10.4 Electric Potential Energy

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS electric potential 电势 • electric potential energy 电势能

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

2 Practice

2.1 Find the electric potential energy of a $+2.0\ \mu$C and a $+3.0\ \mu$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

3.3 Two +4.0 μC 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]

Solutions

2.1 $U = 8.99 \times 10^9 \times \dfrac{(2.0 \times 10^{-6})(3.0 \times 10^{-6})}{0.50} = 0.11$ J.

2.2 negative.

2.3 5.0 J (energy is conserved).

3.1 **B**.

3.2 **B**.

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