AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

9.1 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 to assemble a charge configuration
- calculate the potential energy of two point charges, $U = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q_1 q_2}{r}$, with its sign
- find the total potential energy of a system by summing over all **pairs**
- relate the work done by the electric force to $W = -\Delta U$

1 Worked examples

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

■ Potential energy of a pair

$U = k\dfrac{q_1 q_2}{r}$ —**positive** for like charges, **negative** for unlike.

■ System of charges

Add U over every **distinct pair** of charges.

■ Work and a conservative force

The electric force is **conservative**, so $W = -\Delta U$ and the energy depends only on position.

2 Practice

2.1 Find the potential energy of a $+3.0\ \mu$C and a $-2.0\ \mu$C charge 0.40 m apart ($k = 8.99 \times 10^9$). [2]

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

2.3 The electric force does +6.0 J of work on a charge. State the change in its potential energy. [1]

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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 work done by the electric force equals [1]

- **A** $+\Delta U$
- **B** $-\Delta U$
- **C** ΔU^2
- **D** zero always

3.3 Three +2.0 μC charges sit at the corners of an equilateral triangle of side 0.30 m.

(a) Find the potential energy of **one** pair. [2]

(b) State the total potential energy of the system. [2]

4 Go further

- work through the **9.1 Electric Potential Energy** lesson on the **Learn** page;

- read the **Electric Potential** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

2.1 $U = k\dfrac{q_1 q_2}{r} = 8.99 \times 10^9 \times \dfrac{(3.0 \times 10^{-6})(-2.0 \times 10^{-6})}{0.40} = -0.13$ J.

2.2 positive.

2.3 $\Delta U = -6.0$ J.

3.1 **B**.

3.2 **B**.

3.3 (a) $U = k\dfrac{q^2}{r} = 8.99 \times 10^9 \times \dfrac{(2.0 \times 10^{-6})^2}{0.30} = 0.12$ J. (b) three identical pairs, so $U_{\text{total}} = 3 \times 0.12 = 0.36$ J.