10.7 Conservation of Electric Energy

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS conservation of energy • electric potential • electric potential energy • potential difference • capacitor

Objective

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

You must be able to:

- apply **conservation of energy** to a charge accelerated through a potential difference
- relate the kinetic energy gained to the work done by the field, $\Delta KE = q\,\Delta V$
- analyse energy transfers in systems of charges, fields, and capacitors

1 Key knowledge and worked examples

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

Energy from a potential difference

A charge q moved through a potential difference ΔV has work $q\,\Delta V$ done on it, so $\Delta KE = q\,\Delta V$ if nothing else acts.

Accelerating a charge

An electron accelerated through ΔV gains kinetic energy $e\,\Delta V$; setting this equal to $\frac{1}{2}mv^2$ gives its speed.

Example

A $+2.0\ \mu$C charge through 500 V: $\Delta KE = (2.0 \times 10^{-6})(500) = 1.0 \times 10^{-3}$ J.

2 Practice

2.1 A charge of 5.0×10^{-6} C moves through a potential difference of 200 V. Find the kinetic energy it gains. [2]

2.2 State the energy conversion when a charge accelerates through a potential difference. [1]

2.3 An electron ($q = 1.6 \times 10^{-19}$ C) is accelerated through 100 V. Find the kinetic energy it gains. [2]

3 Exam-style questions

3.1 A charge q accelerated through a potential difference ΔV gains kinetic energy [1]

- ☐ **A** $q\,\Delta V$
- **B** $q/\Delta V$
- **C** $\frac{1}{2}q\,\Delta V^2$
- **D** $\Delta V/q$

3.2 As a positive charge moves from high to low potential, its kinetic energy [1]

- ☐ **A** decreases
- **B** increases
- **C** stays constant
- **D** becomes zero

3.3 A proton ($q = 1.6 \times 10^{-19}$ C, $m = 1.67 \times 10^{-27}$ kg) is accelerated from rest through 1000 V.

(a) Find the kinetic energy it gains. [2]

(b) Find its final speed. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- $\Delta KE = q\,\Delta V = (5.0 \times 10^{-6})(200) = 1.0 \times 10^{-3}$ J

2.2

- electric potential energy is converted into kinetic energy

2.3

- $\Delta KE = (1.6 \times 10^{-19})(100) = 1.6 \times 10^{-17}$ J

3.1 A

- $q\,\Delta V$.

3.2 B

- increases.

3.3

(a)

- $\Delta KE = q\,\Delta V = (1.6 \times 10^{-19})(1000) = 1.6 \times 10^{-16}$ J

(b)

- $\frac{1}{2}mv^2 = 1.6 \times 10^{-16} \Rightarrow v = \sqrt{\dfrac{2(1.6 \times 10^{-16})}{1.67 \times 10^{-27}}} = 4.4 \times 10^5$ m s^{-1}