

10.7 Conservation of Electric Energy

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS conservation of energy 能量守恒 • electric potential 电势
• electric potential energy 电势能 • potential difference 电压 • capacitor 电容器

Objective

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

You must be able to:

- apply **conservation of energy** 能量守恒 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 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 $+2.0 \mu\text{C}$ 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

2.1 $\Delta KE = q \Delta V = (5.0 \times 10^{-6})(200) = 1.0 \times 10^{-3} \text{ J}.$

2.2 electric potential energy is converted into kinetic energy.

2.3 $\Delta KE = (1.6 \times 10^{-19})(100) = 1.6 \times 10^{-17} \text{ J}.$

3.1 A.

3.2 B.

3.3 (a) $\Delta KE = q \Delta V = (1.6 \times 10^{-19})(1000) = 1.6 \times 10^{-16} \text{ J}.$ (b) $\frac{1}{2}mv^2 = 1.6 \times 10^{-16} \Rightarrow$

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