9.3 Conservation of Electric Energy

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

Objective

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

You must be able to:

- relate the change in a charge's **kinetic energy** to $W = q\,\Delta V$
- apply **conservation of energy** 能量守恒 to a charge moving through a potential difference
- define and use the **electron volt** 电子伏特 (eV)
- find the final **speed** of a charge accelerated through a potential difference

1 Worked examples

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

■ **Energy from a potential difference**

$\Delta KE = q\,\Delta V$: the field does work $q\,\Delta V$ on a charge that falls through ΔV.

■ **The electron volt**

1 eV is the energy an electron gains through 1 V: $1\text{ eV} = 1.6 \times 10^{-19}$ J.

■ **Final speed**

Set $\frac{1}{2}mv^2 = q\,\Delta V$ and solve for v.

2 Practice

2.1 An electron moves through a potential difference of 50 V. State the energy it gains, in eV. [1]

2.2 Convert 3.0 eV to joules ($e = 1.6 \times 10^{-19}$ C). [2]

2.3 A $+2.0\ \mu$C charge moves through 300 V. Find the energy it gains, in joules. [2]

3 Exam-style questions

3.1 One electron volt equals [1]

- **A** 1 J
- **B** 1.6×10^{-19} J
- **C** 1 V
- **D** 1 C

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

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

3.3 A proton ($m = 1.67 \times 10^{-27}$ kg, $q = 1.6 \times 10^{-19}$ C) accelerates from rest through 500 V.

(a) Find its kinetic energy in joules. [2]

(b) Find its final speed. [2]

4 Go further

- work through the **9.3 Conservation of Electric 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 50 eV.

2.2 $3.0 \times 1.6 \times 10^{-19} = 4.8 \times 10^{-19}$ J.

2.3 $\Delta KE = q\,\Delta V = (2.0 \times 10^{-6})(300) = 6.0 \times 10^{-4}$ J.

3.1 B.

3.2 B.

3.3 (a) $\Delta KE = q\,\Delta V = (1.6 \times 10^{-19})(500) = 8.0 \times 10^{-17}$ J. (b) $\frac{1}{2}mv^2 = 8.0 \times 10^{-17} \Rightarrow v = \sqrt{\dfrac{2(8.0 \times 10^{-17})}{1.67 \times 10^{-27}}} = 3.1 \times 10^5$ m s^{-1}.