Exercise walk-through

Conservation of Electric Energy ▪ 9.3

eXercise

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

Method — Energy from a potential difference

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

Method — The electron volt

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

Method — Final speed

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

Practice 2.1 ▪ 1 mark

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

Solution 2.1

Method: The electron volt

Worked steps

50 eV B1.

Practice 2.2 ▪ 2 marks

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

Solution 2.2

Method: The electron volt

Worked steps

$3.0 \times 1.6 \times 10^{-19} = 4.8 \times 10^{-19}$ J **M1** **A1**.

Practice 2.3 ▪ 2 marks

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

Solution 2.3

Method: The electron volt

Worked steps

$\Delta KE = q\,\Delta V = (2.0 \times 10^{-6})(300) = 6.0 \times 10^{-4}$ J M1 A1.

Exam-style 3.1 ▪ 1 mark

One electron volt equals

A 1 J

B 1.6×10^{-19} J

C 1 V

D 1 C

Solution 3.1

Method: The electron volt

A 1 J

B 1.6×10^{-19} J ✓

C 1 V

D 1 C

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A charge accelerated through a potential difference ΔV gains kinetic energy

A $q/\Delta V$

B $q\Delta V$

C $\Delta V/q$

D $\frac{1}{2}q\Delta V^2$

Solution 3.2

Method: Energy from a potential difference

A $q/\Delta V$

B $q\Delta V$ ✓

C $\Delta V/q$

D $\frac{1}{2}q\Delta V^2$

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

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.

(b) Find its final speed.

Solution 3.3

Method: The electron volt

Worked steps

(a) $\Delta KE = q\Delta V = (1.6 \times 10^{-19})(500) = 8.0 \times 10^{-17}$ J M1 A1. (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} M1 A1.