Exercise walk-through

Translational Kinetic Energy ▪ 3.1

eXercise

You must be able to

- define **kinetic energy 动能** $KE = \frac{1}{2}mv^2$
- explain that kinetic energy is a **scalar** that depends on the **square** of the speed
- state the **work-energy theorem 动能定理**: the net work equals the change in kinetic energy
- calculate the change in kinetic energy from a change in speed

Method — Kinetic energy

$KE = \frac{1}{2}mv^2$, a scalar measured in joules. Because it depends on v^2, **doubling** the speed gives **four times** the kinetic energy.

Method — The work-energy theorem

$W_{net} = \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$. Positive net work speeds an object up; negative net work slows it down.

Method — Example

A 2.0 kg cart speeds from 3.0 to 5.0 m s^{-1}:

$$\Delta KE = \frac{1}{2}(2.0)(5.0^2 - 3.0^2) = \frac{1}{2}(2.0)(16) = 16 \text{ J}.$$

Practice 2.1 ▪ 2 marks

Find the kinetic energy of a 0.50 kg ball moving at 6.0 m s^{-1}.

Solution 2.1

Method: Kinetic energy

Worked steps

$KE = \frac{1}{2}(0.50)(6.0)^2 = 9.0$ J **M1** **A1**.

Practice 2.2 ▪ 1 mark

State how the kinetic energy changes if the speed triples.

Solution 2.2

Method: Kinetic energy

Worked steps

it becomes **nine times** as large (3^2) B1.

Practice 2.3 ▪ 2 marks

A 1000 kg car slows from 20 m s^{-1} to rest. Find the net work done on it.

Solution 2.3

Method: The work-energy theorem

Worked steps

$W_{net} = \Delta KE = 0 - \frac{1}{2}(1000)(20)^2 = -2.0 \times 10^5$ J **M1** **A1**.

Practice 2.4 ▪ 1 mark

State the work-energy theorem in words.

Solution 2.4

Method: The work-energy theorem

Worked steps

The net work done on an object equals its change in kinetic energy **B1**.

Exam-style 3.1 ▪ 1 mark

The kinetic energy of an object depends on its speed as

A $KE \propto v$

B $KE \propto v^2$

C $KE \propto 1/v$

D $KE \propto \sqrt{v}$

Solution 3.1

Method: Kinetic energy

A $KE \propto v$

B $KE \propto v^2$ ✓

C $KE \propto 1/v$

D $KE \propto \sqrt{v}$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A net work of 40 J is done on a 2.0 kg object starting from rest. Its final speed is

- **A** 40 m s^{-1}
- **B** 20 m s^{-1}
- **C** 6.3 m s^{-1}
- **D** 4.5 m s^{-1}

Solution 3.2

Method: The work-energy theorem

A $40\ \mathrm{m\ s^{-1}}$

B $20\ \mathrm{m\ s^{-1}}$

C $6.3\ \mathrm{m\ s^{-1}}$ ✓

D $4.5\ \mathrm{m\ s^{-1}}$

Worked steps

C — $\frac{1}{2}(2.0)v^2 = 40 \Rightarrow v = \sqrt{40} = 6.3\ \mathrm{m\ s^{-1}}$.

Exam-style 3.3 ▪ 1 mark

A 0.20 kg hockey puck is pushed from rest and gains 9.0 J of kinetic energy.
(a) State its final kinetic energy.
(b) Find its final speed.

Solution 3.3

Method: Kinetic energy

Worked steps

(a) 9.0 J **B1**. (b) $\frac{1}{2}(0.20)v^2 = 9.0 \Rightarrow v = \sqrt{90} = 9.5$ m s^{-1} **M1** **A1**.