Exercise walk-through

Translational Kinetic Energy ▪ 3.1

eXercise

You must be able to

- use **kinetic energy 动能**: $K = \frac{1}{2}mv^2$
- explain that K depends on the **square** of the speed
- find speed from kinetic energy, or kinetic energy from speed
- state that kinetic energy is a scalar (always positive or zero)

Method — The kinetic-energy formula

$$K = \tfrac{1}{2} m v^2.$$

A 4 kg mass at 3 m s^{-1} has $K = \tfrac{1}{2}(4)(3)^2 = 18$ J.

Method — The speed is squared

Because v is squared, doubling the speed multiplies the kinetic energy by four. Tripling the speed multiplies it by nine.

Method — Solving for speed

Rearrange: $v = \sqrt{2K/m}$. A 2 kg object with $K = 16$ J moves at $v = \sqrt{2(16)/2} = 4$ m s^{-1}.

Practice 2.1 ▪ 2 marks

A 2 kg ball moves at 5 m s^{-1}. Find its kinetic energy.

Solution 2.1

Method: The kinetic-energy formula

Worked steps

$K = \frac{1}{2}(2)(5)^2 = 25$ J M1 A1.

Practice 2.2 ▪ 1 mark

If a car's speed doubles, by what factor does its kinetic energy change?

Solution 2.2

Method: The speed is squared

Worked steps

Four times (speed is squared) B1.

Practice 2.3 ▪ 2 marks

A 6 kg object has $K = 12$ J. Find its speed.

Solution 2.3

Method: Solving for speed

Worked steps

$v = \sqrt{2K/m} = \sqrt{2(12)/6} = \sqrt{4} = 2$ m s^{-1} M1 A1.

Practice 2.4 ▪ 1 mark

Can kinetic energy be negative? Answer yes or no, with a reason.

Solution 2.4

Worked steps

No — mass and v^2 are never negative, so $K \geq 0$ B1.

Exam-style 3.1 ▪ 1 mark

Kinetic energy is given by

A mv

B $\frac{1}{2}mv^2$

C mgh

D $\frac{1}{2}kx^2$

Solution 3.1

A mv

B $\frac{1}{2}mv^2$ ✓

C mgh

D $\frac{1}{2}kx^2$

Worked steps

B — $K = \frac{1}{2}mv^2$.

Exam-style 3.2 ▪ 1 mark

Tripling an object's speed multiplies its kinetic energy by

A 3

B 6

C 9

D $1/3$

Solution 3.2

Method: The speed is squared

A 3

B 6

C 9 ✓

D 1/3

Worked steps

C — $K \propto v^2$, so $3^2 = 9$.

Exam-style 3.3 ▪ 2 marks

A 1500 kg car travels at 20 m s^{-1}.
(a) Find its kinetic energy.
(b) State its kinetic energy if the speed rises to 40 m s^{-1}.

Solution 3.3

Worked steps

(a) $K = \frac{1}{2}(1500)(20)^2 = 3.0 \times 10^5$ J M1 A1. (b) Four times larger, 1.2×10^6 J B1.

Exam-style 3.4 ▪ 2 marks

A 0.2 kg ball has 10 J of kinetic energy.
(a) Find its speed.
(b) State whether the direction of motion changes the kinetic energy.

Solution 3.4

Worked steps

(a) $v = \sqrt{2(10)/0.2} = \sqrt{100} = 10$ m s^{-1} M1 A1. (b) No — K is a scalar, independent of direction B1.