AP PHYSICS C: MECHANICS • EXERCISE SHEET

3.1 Translational Kinetic Energy

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS kinetic energy 动能 • scalar 标量 • work 功

Objective

Build the skills to answer exam questions on **translational kinetic energy**.

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)

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The kinetic-energy formula

$$K = \tfrac{1}{2}mv^2.$$

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

■ The speed is squared

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

■ 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}.

2 Practice

Now apply the methods above.

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

2.2 If a car's speed doubles, by what factor does its kinetic energy change? [1]

2.3 A 6 kg object has $K = 12$ J. Find its speed. [2]

2.4 Can kinetic energy be negative? Answer yes or no, with a reason. [1]

3 Exam-style questions

3.1 Kinetic energy is given by [1]

- **A** mv
- **B** $\frac{1}{2}mv^2$
- **C** mgh
- **D** $\frac{1}{2}kx^2$

3.2 Tripling an object's speed multiplies its kinetic energy by [1]

- **A** 3
- **B** 6
- **C** 9
- **D** 1/3

3.3 A 1500 kg car travels at 20 m s^{-1}.

(a) Find its kinetic energy. [2]

(b) State its kinetic energy if the speed rises to 40 m s^{-1}. [1]

3.4 A 0.2 kg ball has 10 J of kinetic energy.

(a) Find its speed. [2]

(b) State whether the direction of motion changes the kinetic energy. [1]

Solutions

2.1 $K = \frac{1}{2}(2)(5)^2 = 25$ J.

2.2 Four times (speed is squared).

2.3 $v = \sqrt{2K/m} = \sqrt{2(12)/6} = \sqrt{4} = 2$ m s^{-1}.

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

3.1 B — $K = \frac{1}{2}mv^2$.

3.2 C — $K \propto v^2$, so $3^2 = 9$.

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

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