AP PHYSICS 1 • EXERCISE SHEET

3.1 Translational Kinetic Energy

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

KEY WORDS energy 能量 • kinetic energy 动能 • work 功 • work-energy theorem 动能定理 • joules 焦耳

Objective

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

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

1 Worked examples

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

■ 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.

■ 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.

■ Example

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

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

2 Practice

2.1 Find the kinetic energy of a 0.50 kg ball moving at 6.0 m s^{-1}. [2]

2.2 State how the kinetic energy changes if the speed triples. [1]

2.3 A 1000 kg car slows from 20 m s^{-1} to rest. Find the net work done on it. [2]

2.4 State the work-energy theorem in words. [1]

3 Exam-style questions

3.1 The kinetic energy of an object depends on its speed as [1]

- **A** $KE \propto v$
- **B** $KE \propto v^2$
- **C** $KE \propto 1/v$
- **D** $KE \propto \sqrt{v}$

3.2 A net work of 40 J is done on a 2.0 kg object starting from rest. Its final speed is [1]

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

3.3 A 0.20 kg hockey puck is pushed from rest and gains 9.0 J of kinetic energy.

(a) State its final kinetic energy. [1]

(b) Find its final speed. [2]

Solutions

2.1 $KE = \frac{1}{2}(0.50)(6.0)^2 = 9.0$ J.

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

2.3 $W_{net} = \Delta KE = 0 - \frac{1}{2}(1000)(20)^2 = -2.0 \times 10^5$ J.

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

3.1 B.

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

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