AP PHYSICS 1 • EXERCISE SHEET

4.4 Elastic and Inelastic Collisions

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

KEY WORDS elastic collision 弹性碰撞 • inelastic collision 非弹性碰撞 • perfectly inelastic collision 完全非弹性碰撞 • collisions 碰撞 • conserved 守恒

Objective

Build the skills to answer exam questions on **elastic and inelastic collisions**.

You must be able to:

- distinguish an **elastic collision** 弹性碰撞 (kinetic energy conserved) from an **inelastic collision** 非弹性碰撞
- describe a **perfectly inelastic collision** 完全非弹性碰撞 (objects stick and move with a common velocity)
- apply **conservation of momentum** to find final velocities
- check whether **kinetic energy** is conserved

1 Worked examples

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

■ **Momentum is always conserved; energy is not**

In **every** collision (no external force), momentum is conserved. Kinetic energy is conserved only in an **elastic** collision; in an inelastic one, some becomes thermal energy.

■ **Perfectly inelastic collision**

The objects stick: $m_1u_1 + m_2u_2 = (m_1 + m_2)v$.

■ **Example**

A 2.0 kg cart at 3.0 m s^{-1} sticks to a stationary 2.0 kg cart: $v = \dfrac{2.0(3.0)}{4.0} = 1.5$ m s^{-1}.
KE before = 9.0 J, after = $\frac{1}{2}(4.0)(1.5)^2 = 4.5$ J $\rightarrow$ 4.5 J lost to heat (inelastic).

2 Practice

2.1 State what is conserved in (a) an elastic collision and (b) an inelastic collision. [2]

2.2 A 1.0 kg ball at 6.0 m s^{-1} strikes a stationary 2.0 kg ball and they stick together. Find their common speed. [2]

2.3 For the collision in 2.2, find the kinetic energy lost. [2]

3 Exam-style questions

3.1 In a perfectly inelastic collision, the objects [1]

- **A** bounce apart
- **B** stick together
- **C** conserve kinetic energy
- **D** reverse direction

3.2 Kinetic energy is conserved in [1]

- **A** all collisions
- **B** elastic collisions only
- **C** inelastic collisions only
- **D** explosions only

3.3 A 0.50 kg cart at 4.0 m s^{-1} hits a stationary 0.50 kg cart, and they move off together.

(a) Find their common velocity. [2]

(b) By calculating the kinetic energy before and after, state whether the collision is elastic. [2]

Solutions

2.1 (a) both momentum and kinetic energy; (b) momentum only.

2.2 $1.0(6.0) = (1.0 + 2.0)v \Rightarrow v = 2.0$ m s^{-1}.

2.3 KE before $= \frac{1}{2}(1.0)(6.0)^2 = 18$ J; after $= \frac{1}{2}(3.0)(2.0)^2 = 6.0$ J; lost $= 12$ J.

3.1 B.

3.2 B.

3.3 (a) $0.50(4.0) = (1.0)v \Rightarrow v = 2.0$ m s^{-1}. (b) KE before $= \frac{1}{2}(0.50)(4.0)^2 = 4.0$ J; after $= \frac{1}{2}(1.0)(2.0)^2 = 2.0$ J; not conserved, so it is **inelastic**.