Exercise walk-through

Elastic and Inelastic Collisions ▪ 4.4

eXercise

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

Method — 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.

Method — Perfectly inelastic collision

The objects stick: $m_1 u_1 + m_2 u_2 = (m_1 + m_2)v$.

Method — 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).

Practice 2.1 ▪ 2 marks

State what is conserved in (a) an elastic collision and (b) an inelastic collision.

Solution 2.1

Method: Momentum is always conserved; energy is not

Worked steps

(a) both momentum and kinetic energy B1; (b) momentum only B1.

Practice 2.2 ▪ 2 marks

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.

Solution 2.2

Method: Example

Worked steps

$1.0(6.0) = (1.0 + 2.0)v \Rightarrow v = 2.0$ m s^{-1} M1 A1.

Practice 2.3 ▪ 2 marks

For the collision in 2.2, find the kinetic energy lost.

Solution 2.3

Method: Momentum is always conserved; energy is not

Worked steps

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 M1 A1.

Exam-style 3.1 ▪ 1 mark

In a perfectly inelastic collision, the objects

A bounce apart

B stick together

C conserve kinetic energy

D reverse direction

Solution 3.1

Method: Perfectly inelastic collision

A bounce apart

B stick together ✓

C conserve kinetic energy

D reverse direction

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Kinetic energy is conserved in

A all collisions

B elastic collisions only

C inelastic collisions only

D explosions only

Solution 3.2

Method: Momentum is always conserved; energy is not

A all collisions

B elastic collisions only ✓

C inelastic collisions only

D explosions only

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

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

Solution 3.3

Method: Example

Worked steps

(a) $0.50(4.0) = (1.0)v \Rightarrow v = 2.0$ m s^{-1} M1 A1. (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** M1 A1.