

Exercise walk-through

4.4

Elastic and Inelastic Collisions

AP Physics C: Mechanics

Elastic and inelastic collisions

Momentum is conserved in **every** collision;
kinetic energy is not:

- **elastic** – KE conserved (add it as a 2nd equation)
- **inelastic** – some KE lost
- **perfectly inelastic** –
they stick

Worked example (stick)

2 kg at 3 m/s hits a 4 kg at rest:

$$2(3) = 6v_f \Rightarrow v_f = 1 \text{ m/s}$$

KE : $9 \rightarrow 3 \text{ J}$; the lost 6 J became heat.

Where the kinetic energy goes

Elastic collision

Momentum conserved, and kinetic energy conserved as well. Two equations, so both final velocities can be found.

Inelastic collision

Momentum conserved; kinetic energy **decreases** – it becomes heat, sound and **deformation**.

Perfectly inelastic collision

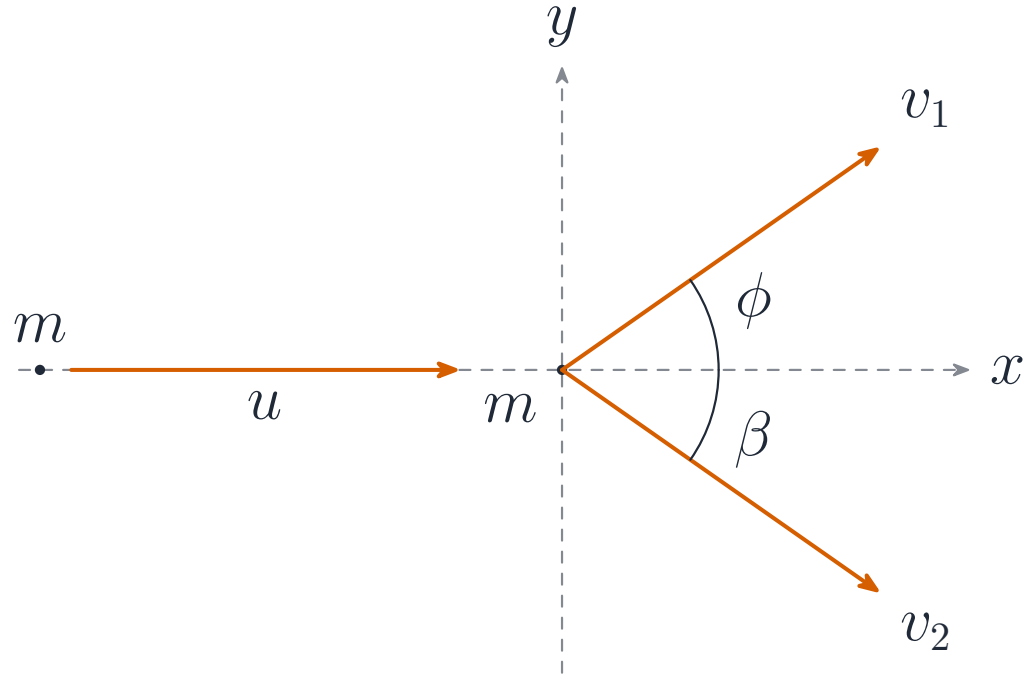
A **perfectly inelastic collision** is the largest possible loss: the objects stick together and share one velocity.

Explosions

Run the same algebra backwards. In an **explosion** the total momentum stays what it was – zero, if the body started at rest – so the pieces fly apart with equal and opposite momenta.

Momentum is conserved in every one of these. Kinetic energy is the question, never the assumption.

A glancing collision



A glancing collision, resolved along two perpendicular axes

Exam tips

- Impulse equals the momentum change: $\vec{J} = \int \vec{F} dt = \Delta\vec{p}$, and it is the area under a force–time graph.
- **Momentum is conserved** whenever the net external force is zero – always the go-to for collisions.
- Distinguish **elastic** (kinetic energy conserved) from **inelastic** (kinetic energy decreases) collisions; in a **perfectly inelastic** collision the objects stick and move with one velocity.
- Apply conservation to each component (x and y) separately in 2-D.
- Connect to center of mass: total momentum $= M\vec{v}_{cm}$.

Exercises 2.1-2.3

2.1 State what is conserved in **every** collision.

[1]

2.2 State the extra quantity conserved in an elastic collision.

[1]

2.3 In a perfectly inelastic collision, what do the objects do?

[1]

Exercises 2.1-2.3

2.1 State what is conserved in **every** collision. [1]

2.1

- Momentum
-

2.2 State the extra quantity conserved in an elastic collision. [1]

2.2

- Kinetic energy
-

2.3 In a perfectly inelastic collision, what do the objects do? [1]

2.3

- They stick together and move as one

Exercises 2.4·3.1

2.4 In an inelastic collision, where does the lost kinetic energy go? [1]

3.1 In an inelastic collision, which is conserved? [1]

☐

A kinetic energy only

B momentum only

C both momentum and kinetic energy

D neither

Exercises 2.4-3.1

2.4 In an inelastic collision, where does the lost kinetic energy go? [1]

2.4

- Into heat, sound, and deformation

3.1 In an inelastic collision, which is conserved? [1]

☐

A kinetic energy only

B momentum only

C both momentum and kinetic energy

D neither

3.1 B

- momentum only (kinetic energy is lost)

Exercise 3.2

3.2 Two balls collide and stick together. This collision is

[1]

☐

A elastic

B perfectly inelastic

C frictionless

D impossible

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3.2 Two balls collide and stick together. This collision is

[1]

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A elastic

B perfectly inelastic

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3.2 B

- sticking together is perfectly inelastic

Exercise 3.3 (a)

3.3 Before a collision the total KE is 50 J; after, it is 32 J.

(a) State whether the collision is elastic or inelastic.

[1]

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3.3 Before a collision the total KE is 50 J; after, it is 32 J.

(a) State whether the collision is elastic or inelastic.

[1]

(a)

- Inelastic (KE decreased)

Exercise 3.3 (b)

3.3 Before a collision the total KE is 50 J; after, it is 32 J.

(b) State how much kinetic energy was lost, and where it went.

[2]

Exercise 3.3 (b)

3.3 Before a collision the total KE is 50 J; after, it is 32 J.

(b) State how much kinetic energy was lost, and where it went.

[2]

(b)

- $50 - 32 = 18$ J lost, converted to heat/sound/deformation

Exercise 3.4 (a)

3.4 A 2 kg ball at 6 m s^{-1} hits a stationary 2 kg ball and they stick.

(a) Find the speed after (momentum conservation).

[2]

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(a)

- $2(6) = 12 = 4v \Rightarrow v = 3 \text{ m s}^{-1}$

Exercise 3.4 (b)

3.4 A 2 kg ball at 6 m s^{-1} hits a stationary 2 kg ball and they stick.

(b) Show that kinetic energy is not conserved.

[2]

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3.4 A 2 kg ball at 6 m s^{-1} hits a stationary 2 kg ball and they stick.

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[2]

(b)

- Before: $\frac{1}{2}(2)(6)^2 = 36 \text{ J}$; after: $\frac{1}{2}(4)(3)^2 = 18 \text{ J}$ – not conserved