

Collisions in two dimensions

AS Level

9702 AS Ch.6

Chapter 6: Momentum

Lesson 6.5

Sections 6.5

Goal: Solve a glancing collision by conserving momentum in two perpendicular directions.

velocity

01 The big picture

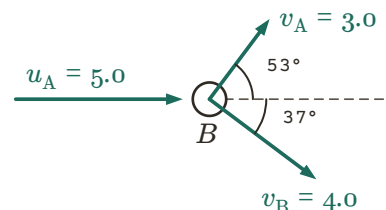
Momentum is a vector, so in a glancing collision it is conserved in every direction at once. Choose two perpendicular directions (x along the original motion, y across it) and conserve momentum in each separately.

Resolve each momentum into components with $\cos$ and $\sin$. If nothing was moving in the y direction before, the y -components after must cancel.

Glancing collision [paraphrase]

A collision that is not head-on: the objects move off at angles.

Fig. 1 · A glancing collision



A and B move off at angles; their y -momenta cancel and their x -momenta add up to A's momentum before.

02 Key equations

Along x

$$\sum p_x \text{ before} = \sum p_x \text{ after}$$

Along y

$$\sum p_y \text{ before} = \sum p_y \text{ after}$$

Components

$$p_x = p \cos \theta, \quad p_y = p \sin \theta$$

Symbols and units

p_x momentum along x kg m s^{-1} θ angle to the x direction $^\circ$

03 Sample problems with solutions

Sample 1 · A glancing collision

A 2.0 kg puck A at 5.0 m s⁻¹ hits an identical puck B at rest. A leaves at 3.0 m s⁻¹ at 53° to its first direction (Fig. 1). Find B's velocity.

Step 1. Along x (masses equal, so they cancel):

$$5.0 = 3.0 \cos 53^\circ + v_x \Rightarrow v_x = 3.2 \text{ m s}^{-1}$$

Step 2. Along y (zero before):

$$0 = 3.0 \sin 53^\circ + v_y \Rightarrow v_y = -2.4 \text{ m s}^{-1}$$

Step 3. Combine:

$$v = \sqrt{3.2^2 + 2.4^2} = 4.0 \text{ m s}^{-1}, \quad \theta = \tan^{-1} \frac{2.4}{3.2} = 37^\circ$$

Answer: 4.0 m s⁻¹ at 37° on the other side of the original direction

04 Practice problems

P1 In a two-dimensional collision, what is conserved separately?

Answer: Momentum in each of two perpendicular directions

P2 A 1.0 kg ball moving east at 4.0 m s⁻¹ sticks to a 1.0 kg ball moving north at 4.0 m s⁻¹. Find their velocity.

Answer: 2.8 m s⁻¹ north-east (45°)

P3 A 3.0 kg object at rest splits into three 1.0 kg pieces; two go east and north at 6.0 m s⁻¹. Find the third.

Answer: 8.5 m s⁻¹ south-west

P4 Is the collision in the sample elastic?

Answer: Yes: 25 J of kinetic energy before and after

05 Other useful information

Common mistakes

- ✗ **Wrong:** Add the speeds after: 3.0 + 4.0 = 5.0?
- ✓ **Right:** Add momentum components, never speeds.

Exam tips

- Draw the before and after momenta tip to tail: they close a triangle.

What the syllabus asks

- 9702 topic 3: conservation of momentum in one and two dimensions. Coursebook 6.5.

Explore: [Practice questions for this lesson](#)