

Understanding motion

AS Level

9702 AS Ch.6

Chapter 6: Momentum

Lesson 6.7

Sections 6.7

Goal: Link Newton's three laws to momentum, and explain conservation of momentum with the third law.

 force

01 The big picture

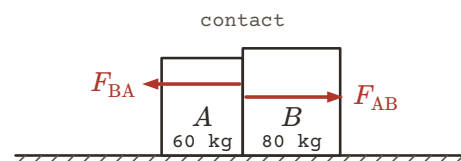
First law: an object stays at rest or at constant velocity unless a resultant force acts. Second law: the resultant force equals the rate of change of momentum. Third law: when A pushes on B, B pushes on A with an equal and opposite force of the same type.

In a collision the two forces of a third-law pair act for the same time, so the two changes in momentum are equal and opposite. That is why the total momentum is conserved.

Third-law pair [paraphrase]

Equal, opposite forces of the same type, acting on two different objects.

Fig. 1 · A third-law pair



Each skater pushes the other: 120 N on each, in opposite directions, for the same time.

02 Key equations

Second law

$$F = \frac{\Delta p}{\Delta t}$$

Third law

$$F_{AB} = -F_{BA}$$

So momentum is conserved

$$\Delta p_A = -\Delta p_B$$

Symbols and units

F_{AB} force on A by B N Δp change in momentum kg m s^{-1}

03 Sample problems with solutions

Sample 1 · Skaters push apart

Skaters A (60 kg) and B (80 kg) stand at rest and push apart with a force of 120 N for 0.50 s (Fig. 1). Find each skater's velocity and their total momentum.

Step 1. Equal and opposite forces for the same time:

$$\Delta p = F \Delta t = 120 \times 0.50 = 60 \text{ kg m s}^{-1} \text{ each}$$

Step 2. Velocities (A to the left, negative):

$$v_A = -\frac{60}{60} = -1.0 \text{ m s}^{-1}, \quad v_B = \frac{60}{80} = 0.75 \text{ m s}^{-1}$$

Answer: A: 1.0 m s^{-1} left; B: 0.75 m s^{-1} right; total momentum still zero

04 Practice problems

P1 State Newton's first law.

Answer: At rest or constant velocity unless a resultant force acts

P2 The Earth pulls a book down. What is the third-law partner of this force?

Answer: The book's gravitational pull on the Earth, upwards

P3 A rocket ejects 50 kg of gas per second at 2000 m s^{-1} . Find the thrust.

Answer: $1.0 \times 10^5 \text{ N}$

P4 Why are a book's weight and the table's push on it not a third-law pair?

Answer: They act on the same object and are different types

05 Other useful information

Common mistakes

- ✗ **Wrong:** Third-law forces cancel out.
- ✓ **Right:** They act on different objects, so they never cancel.

Exam tips

- For a third-law pair, swap the names: "force of A on B" ↔ "force of B on A".

What the syllabus asks

- 9702 topic 3: Newton's laws of motion; force and momentum. Coursebook 6.7.

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