

Exercise walk-through

Linear Momentum ■ 4.1

eXercise

You must be able to

- calculate **momentum** 动量: $\vec{p} = m\vec{v}$
- treat momentum as a vector (direction matters)
- find momentum from mass and velocity, or velocity from momentum
- state the unit of momentum (kg m s^{-1})

Method — Momentum is mass times velocity

$$\vec{p} = m\vec{v}.$$

A 3 kg ball at 4 m s^{-1} has $p = 3 \times 4 = 12 \text{ kg m s}^{-1}$.

Method — Momentum is a vector

Its direction is the direction of the velocity. Taking right as positive, a 2 kg ball moving left at 5 m s^{-1} has $p = -10 \text{ kg m s}^{-1}$.

Method — Comparing momenta

A heavy slow object can have the same momentum as a light fast one: 10 kg at 2 m s^{-1} and 2 kg at 10 m s^{-1} both have $p = 20 \text{ kg m s}^{-1}$.

Practice 2.1 ■ 2 marks

A 5 kg object moves at 3 m s^{-1} . Find its momentum.

Solution 2.1

Method: Comparing momenta

Worked steps

$$p = mv = 5 \times 3 = 15 \text{ kg m s}^{-1} \quad \text{M1 A1}.$$

Practice 2.2 ■ 1 mark

State the unit of momentum.

Solution 2.2

Worked steps

 kg m s^{-1} **B1**.

Practice 2.3 ■ 2 marks

Taking right as positive, find the momentum of a 2 kg ball moving left at 6 m s^{-1} .

Solution 2.3

Method: Momentum is a vector

Worked steps

$$p = 2 \times (-6) = -12 \text{ kg m s}^{-1} \quad \text{M1} \quad \text{A1}.$$

Practice 2.4 ■ 2 marks

An object has momentum 24 kg m s^{-1} and mass 4 kg . Find its speed.

Solution 2.4

Worked steps

$$v = p/m = 24/4 = 6 \text{ m s}^{-1} \quad \text{M1 A1}.$$

Exam-style 3.1 ■ 1 mark

Momentum is calculated as

A $\frac{1}{2}mv^2$

B mv

C ma

D Fd

Solution 3.1

A $\frac{1}{2}mv^2$

B mv



C ma

D Fd

Worked steps

B — $p = mv$.

Exam-style 3.2 ■ 1 mark

Which quantity is a vector?

A mass

B speed

C momentum

D kinetic energy

Solution 3.2

A mass

B speed

C momentum



D kinetic energy

Worked steps

C — momentum is a vector.

Exam-style 3.3 ■ 2 marks

A 1200 kg car moves east at 15 m s^{-1} .

- (a) Find its momentum.
- (b) State the direction of the momentum.

Solution 3.3

Method: Momentum is a vector

Worked steps

(a) $p = 1200 \times 15 = 1.8 \times 10^4 \text{ kg m s}^{-1}$ **M1** **A1**. (b) East **B1**.

Exam-style 3.4 ■ 2 marks

Object A: 8 kg at 3 m s^{-1} . Object B: 2 kg at 12 m s^{-1} .

- (a) Find each momentum.
- (b) State which has the greater momentum.

Solution 3.4

Method: Comparing momenta

Worked steps

(a) A: 24 kg m s^{-1} ; B: 24 kg m s^{-1} **M1** **A1**. (b) Equal **B1**.