Exercise walk-through

5.9
Momentum – HT only (4.5.7)

AQA · GCSE · Physics

Momentum (HT)

- **Momentum** is mass multiplied by velocity:
- p is **momentum** in kg m/s, m is mass in kg and v is velocity in m/s.
- Momentum is a **vector**.
- In a closed system, the total momentum before an event, such as a collision or an explosion, equals the total momentum after it.

$$p = mv$$

Exercises 2.1·2.2

2.1 A 0.16 kg ball moves at 25 m/s. Calculate its momentum. [2]



2.2 Two identical cars move at the same speed in opposite directions. Explain why their total momentum is zero. [2]



Exercises 2.1·2.2

2.1 A 0.16 kg ball moves at 25 m/s. Calculate its momentum. [2]



2.1

- $0.16 \times 25 = \mathbf{4.0}$ kg m/s

2.2 Two identical cars move at the same speed in opposite directions. Explain why their total momentum is zero. [2]



2.2

- momentum is a vector, so direction matters; the momenta are equal in size and opposite in direction, so they cancel

Exercises 2.3·3.1

2.3 Explain why a gymnast lands on a soft mat rather than a hard floor. [2]



3.1 A 4.0 kg rifle fires a 0.010 kg bullet at 400 m/s. Calculate the recoil speed of the rifle, and explain why it moves backwards. [3]



Exercises 2.3·3.1

2.3 Explain why a gymnast lands on a soft mat rather than a hard floor. [2]



2.3

- the mat increases the time taken to stop; so the rate of change of momentum, and the force on the gymnast, is smaller

3.1 A 4.0 kg rifle fires a 0.010 kg bullet at 400 m/s. Calculate the recoil speed of the rifle, and explain why it moves backwards. [3]



3.1

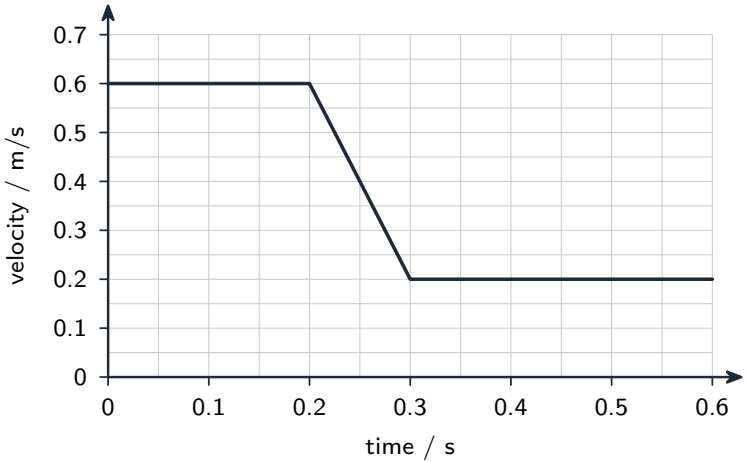
- momentum of the bullet $= 0.010 \times 400 = 4.0$ kg m/s
- the total momentum before is zero, so the rifle has 4.0 kg m/s backwards
- $v = 4.0 \div 4.0 = \mathbf{1.0}$ m/s

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Exercise 3.2 (a)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

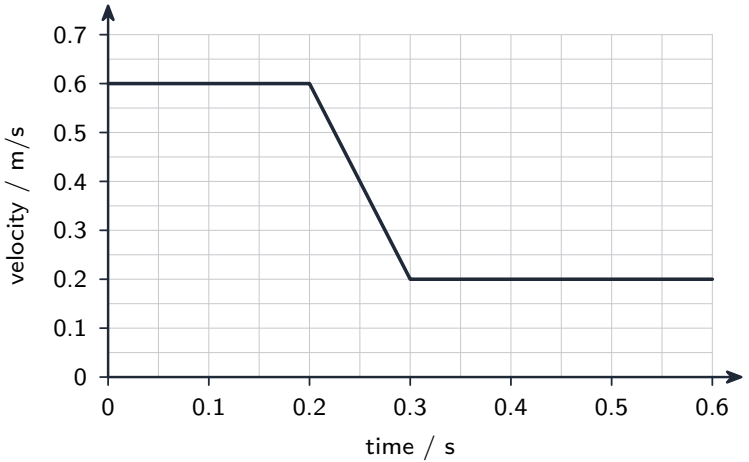
(a) Use the graph to find the velocity of trolley A before the collision. [2]



Exercise 3.2 (a)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(a) Use the graph to find the velocity of trolley A before the collision. [2]



(a) read the first flat part; **0.60** m/s

Exercise 3.2 (b)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(b) Calculate the momentum of A before the collision, and use it to show that the velocity after the collision is 0.20 m/s. [3]

Exercise 3.2 (b)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(b) Calculate the momentum of A before the collision, and use it to show that the velocity after the collision is 0.20 m/s. [3]

(b) $0.50 \times 0.60 = 0.30$ kg m/s; momentum after $= 0.30$ kg m/s with mass 1.5 kg; $0.30 \div 1.5 = \mathbf{0.20}$ m/s

Exercise 3.2 (c)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(c) Use the graph to find how long the collision lasts, and calculate the force on trolley A. [2]

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3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(c) Use the graph to find how long the collision lasts, and calculate the force on trolley A. [2]

(c) 0.10 s; $F = 0.50 \times 0.40 \div 0.10 = \mathbf{2.0}$ N

Exercise 3.2 (d)

3.2 Trolley A (0.50 kg) rolls into trolley B (1.0 kg), which is at rest. They stick together. The graph shows the velocity of trolley A.

(d) Explain how seat belts, air bags and crumple zones reduce the risk of injury in a car crash. Use the idea of momentum. [6]

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(d) Explain how seat belts, air bags and crumple zones reduce the risk of injury in a car crash. Use the idea of momentum. [6]

(d) points to include:

- in a crash the car and the people stop, so their momentum changes by a large amount
- force = change in momentum ÷ time taken
- crumple zones crush, so the car takes longer to stop
- seat belts stretch a little, so the person takes longer to stop
- air bags squash as the person hits them, which also increases the time
- a longer time means a smaller rate of change of momentum, so smaller forces on the people and less injury

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.