



Momentum

Contextual questions

- 1 An object with a mass of 6,8 kg moves at 7,4 m·s⁻¹ north-east.
 - 1.1 Calculate the momentum of the object.
 - 1.2 The object is brought to a standstill within 0,4 s. Calculate the impulse exerted.
 - 1.3 Calculate the average force exerted in 0,4 s.

- 2 A force of 9,6 N south is exerted for 0,24 s on a rock with mass 0,13 kg. Calculate the velocity of the rock after 0,24 s if it was initially at rest.

- 3 Two objects collide head-to-head and are stuck together. Object A has a mass of 34 kg and moves at a velocity of 5,4 m·s⁻¹ while object B has a mass of 14,6 kg and moves at a velocity of 8,4 m·s⁻¹ in the opposite direction. Calculate the velocity of the system after the collision.

- 4 A waitress at a roadside café wears rollerskates. She is carrying a tray with a large order. She has a mass of 55 kg and moves at a speed of 2,4 m·s⁻¹. The tray's mass is 4,8 kg. A thug grabs the tray out of her hands. She does not change direction. Calculate the waitress's velocity directly after the theft of the tray. Assume that the tray's horizontal velocity is zero, directly after it is grabbed.

- 5 An object with a mass of 58 kg moves straight east at 2,3 m·s⁻¹. It collides from behind against a second object with a mass of 41,5 kg which is also moving east at 1,9 m·s⁻¹. After the collision, the object with mass 58 kg moves at 1,3 m·s⁻¹ in the opposite direction. Calculate the velocity of the other object.

- 6 Calculate the change in momentum as caused by a 65 N force exerted to the right on an object for 15 s.

- 7 A train moves at a velocity of 15 m·s⁻¹ north. The mass of the train is 6×10^3 ton. What is the velocity at which a car with mass 2 200 kg should move to have the same momentum?

- 8 A force is exerted to the left on an object with mass 8 kg. The velocity of the object increases uniformly from 2,5 m·s⁻¹ to 8,5 m·s⁻¹ in a time of 7 s.
Calculate the:
 - 8.1 change in momentum of the object.
 - 8.2 impulse exerted on the object.
 - 8.3 net force exerted on the object.

- 9 The driver of a car, mass 2,3 ton, moving at 12 m·s⁻¹ north accelerates until the velocity is 28 m·s⁻¹ north in 15 s.
Calculate the:
 - 9.1 change in momentum of the car.
 - 9.2 impulse that is exerted on the car.
 - 9.3 net force exerted on the car.



10. For how long should a 45 N force be exerted on a mass of 420 kg to change the velocity of the mass from $8,4 \text{ m}\cdot\text{s}^{-1}$ north to $11,6 \text{ m}\cdot\text{s}^{-1}$ north?
11. A skater with mass 68 kg moves at $5,2 \text{ m}\cdot\text{s}^{-1}$ south. It takes him 9,6 s to stop.
- 11.1 Calculate the magnitude and direction of the net force that stops the skater.
- 11.2 If the skater had stopped in 3 s, will the net force become larger, smaller or remain the same? Motivate your answer.
- 11.3 How will the impulse exerted on the skater change if the time changes to 3 s? Motivate your answer.
12. A golf player hits a 45 g golf ball from the tee so that the velocity is $28 \text{ m}\cdot\text{s}^{-1}$ north. The golf club is in contact with the ball for 0,009 s.
- 12.1 What is the change in momentum of the ball during the hit?
- 12.2 Calculate the impulse exerted on the ball.
- 12.3 Determine the force exerted on the ball.
- 12.4 Determine the force exerted on the club by the ball.
13. A tennis ball with mass 280 g moves at $4,3 \text{ m}\cdot\text{s}^{-1}$ west and bounces against a wall. After the bounce the ball moves at $2,8 \text{ m}\cdot\text{s}^{-1}$ east. The ball is in contact with the wall for 0,003 s.
- 13.1 Calculate the change in momentum of the ball.
- 13.2 Calculate the force exerted by the wall on the ball.
- 13.3 Calculate the force exerted by the ball on the wall.
14. A volleyball ball is hit in such a way that the incoming velocity of $4,6 \text{ m}\cdot\text{s}^{-1}$ changes to an outgoing velocity of $16,5 \text{ m}\cdot\text{s}^{-1}$. If the mass of the ball is 0,6 kg, calculate the impulse that is experienced by the ball.
15. Adri and Mbali have identical masses of 45 kg. The girls stand on a 1 m high wall along the netball court and jump down from the wall at the same time.
- 15.1 What are the girls' velocity just as they hit the ground?
- 15.2 What is each girl's momentum just before they hit the ground?
- 15.3 The impact with the ground causes the girls to stop. How great is the impulse that each girl experiences?
- 15.4 Adri bends her knees when she comes into contact with the ground and stops over a time of 1,1 s while Mbali stops in 0,21 s because she does not bend her knees. Which girl experiences the greatest stopping force? Explain your answer.
16. A 2,8 kg gun is loaded with a 12 g bullet which is fired at a velocity of $610 \text{ m}\cdot\text{s}^{-1}$ south.
- 16.1 Calculate the recoil velocity of the gun.
- 16.2 If the explosion exerts a force on the bullet for 0,03 s, calculate the average force exerted.
17. Object A with mass 12,3 kg moves at $25,4 \text{ m}\cdot\text{s}^{-1}$ west and has an inelastic collision with object B which has a mass of 36 kg and velocity of $36,4 \text{ m}\cdot\text{s}^{-1}$ east. The objects stick together after the collision.
- 17.1 Calculate the velocity of the combined objects after the collision.
- 17.2 Calculate the change in momentum of A.
- 17.3 Calculate the change in momentum of B.