Exercise 2

1 A ball, mass 250 g, collides with a wall at a horizontal velocity of 12 $m \cdot s^{-1}$. The ball bounces back at a horizontal speed of 9 $m \cdot s^{-1}$ as shown in the diagram.

1.1 Calculate the change in momentum of the ball.

1.2 What is the impulse on the ball?

1.3 Calculate the force that the wall applies on the ball if the time of contact between the wall and the ball is 0,02 s.

2 A flower pot falls from the balcony of an apartment. The height from the balcony to the ground is 20 m, and the mass of the flower pot is 2 kg.

2.1 Calculate the speed with which the flower pot reaches the ground.

The ground is very muddy due to a lot of rain. The flowerpot falls into the mud and takes 0,6 s to come to rest.

2.2 Calculate the magnitude of the net force on the flowerpot when it falls into the mud.

2.3 What is the magnitude of the force of the mud on the flowerpot?

2.4 What difference would it make to the force exerted by the mud on the flowerpot, if the time it took to come to rest, increased? Explain your answer.

3 "The crumple zone of a car is structurally designed to compress when the car is involved in a head-on collision. Its purpose is to absorb some of the impact of the collision. A common misconception is that when the car crumples, the compressed parts crush the passengers of the car. The noticeable improvement in high speed collision test results during the past two decades, has proven the above assumption to be incorrect. Modern cars with crumple zones provide, on average, a lot more safety to passengers than older model cars without crumple zones."

3.1 By using the words impulse, momentum, time and force, explain why crumple zones provide protection to the passengers of a car during a collision. Give your answer in point form.

3.2 What other safety mechanism is used in cars to protect passengers during collisions?

3.3 Are there any similarities between crumple zones of cars and the foam-rubber mattresses used by high jumpers? If you think there are, explain the similarities between the two "safety mechanisms".

3.4 The word "inertia" is often used in discussions about safety mechanisms in cars. State Newton's law of inertia.

A car with a mass of 900 kg, collides with a wall while travelling at 100 $km \cdot h^{-1}$.

3.5 Convert 100 $km \cdot h^{-1}$ to $m \cdot s^{-1}$.

3.6 If the car does not have a crumple zone and it takes 0,25 s for the car to stop when it crashes into a wall, calculate the force of the wall on the car.

3.7 If the car does have a crumple zone, and it takes 0,75 s for it to stop when it hits the wall, calculate the force that the wall applies on the car.

3.8 What is the mathematical relationship between the time of contact Δt and the force F_{net} that is exerted on the car, assuming the change in momentum, Δp, remains the same.

4. Why are airbags built into cars as a safety device?

5. Why do you bend your knees as you land when you jump off a low wall?

6. Why do golf players follow through on their swing with a golf club?

7. Why do boxers wear boxing gloves?

8. Explain how Newton's second law in terms of acceleration (Fnet = ma) was derived from his second law in terms of momentum. Do this by using formulae.

9 A truck has a mass of 5 000 kg. The truck accelerates from rest to 25,2 $km \cdot h^{-1}$ in 30 seconds.

9.1 Convert 25,2 $km \cdot h^{-1}$ to $m \cdot s^{-1}$.

9.2 Determine the change in momentum of the truck.

9.3 Determine the force necessary to accelerate the truck.

10 Mlungisi drives in his car (800 kg) on the highway at 100 $km \cdot h^{-1}$. A dog runs across the road and Mlungisi hits the brakes. Within 3 seconds he reduces the speed to 20 $km \cdot h^{-1}$.

10.1 Convert 100 $km \cdot h^{-1}$ to $m \cdot s^{-1}$.

10.2 Convert 20 $km \cdot h^{-1}$ to $m \cdot s^{-1}$.

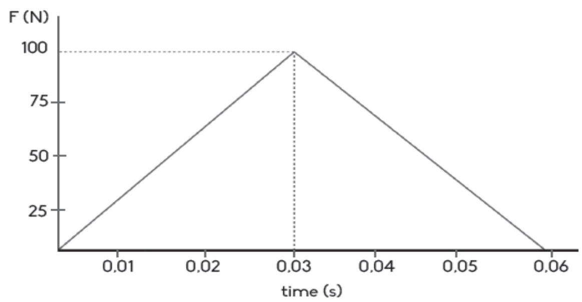
10.3 Determine the change in momentum.

10.4 Determine the force necessary to effect the change.

11. Wat is dieselfde eenheid as N·s? Verduidelik jou antwoord.

12. A tennis ball with mass 120 g is thrown against a wall at 11 $m \cdot s^{-1}$. The ball bounces back at 9 $m \cdot s^{-1}$. The ball was in contact with the wall for 0,01 seconds. Determine the average force of the wall on the ball. Choose right as positive.

13 During a hockey game Venitha hits a stationary hockey ball (200 g). The graph represents force against time:



13.1 Use the graph to determine the impulse of the ball.

13.2 At what velocity will the ball leave the hockey stick?

13.3 Venitha hits a softer ball (also 200 g). The ball leaves the hockey stick at the same velocity as in Question 13.2. How will the graph change?