Impulse & Momentum

Unit 1
Mechanics &
Properties of Matter

1) A force of 20N acts on an object for 3 seconds.
   a) Calculate the impulse on the object.   [60Ns]
   b) Calculate the change of momentum of the object.   [60 kg ms^{-1}]

2) Copy and complete this sentence:
   The quantity called impulse is a measure of the force applied to an object over a given time and is measured in units --
   The quantity impulse is exactly equal to the change of -------- of the object and has units ---

3) A car of mass 1000 kg is moving with velocity 25 ms^{-1} when it applies its breaks for 4 seconds till it comes to a stop.
   a) Calculate the change in momentum of the car.   [-25000kgms^{-1}]
   b) What would be the impulse acting on the car   [-25000 Ns]
   c) Calculate the size of the average breaking force acting on the car.   [-6250N]

4) A basket ball player throws a 2kg ball with a velocity of 40 ms^{-1} from rest.
   The throw takes 0.8 seconds.
   a) Calculate the change of momentum of the ball.   [80 kgms^{-1}]
   b) Write down the impulse the ball received from the hand of the
      player.   [80Ns]
   c) Find the average force given to the ball by the player.   [100N]

5) A tennis player serves a ball from rest to a velocity of 45 ms^{-1}. The tennis ball has a mass of 56g and the bat was in contact with the ball for 0.004 seconds
   a) Calculate the change of momentum of the ball   [2.52 kgms^{-1}]
   b) What is the impulse received by the ball?
   c) Find the average force given to the ball by the bat.   [630N]

6) A boy of mass 40 kg lands on the ground with a velocity of 4 ms^1
   He is contact with the ground for a time of 0.8 seconds.

   a) Calculate the boy`s change of momentum as he lands
      on the ground.   [160kgms^{-1}]
   b) What impulse does his body receive from the ground?
   c) Calculate the force applied to the boy`s body from the ground?
                                                        [200N]
   d) The boy now skips on sand at the beach. Explain how this will
      affect the force he feels as he lands.

7) Read this passage from an article about car safety…..

   Modern cars are made as safe as they can be because it is easier to break speed
   laws but not the laws of physics!
   When you are involved in a car crash your momentum will be reduced to zero,
   that is you will come to a halt. The secret is to come to a halt over a longer time.
   This reduces the average force your body will experience. Cars have seatbelts
   that stretch and steering columns that compact when you body hits it. Crumple
   zones outside the car also help to reduce the forces you experience if you have
   the misfortune to come to a sudden unexpected stop.
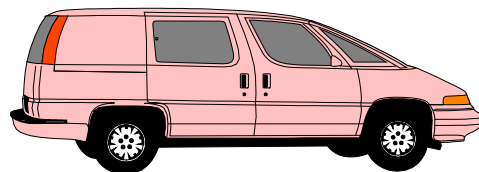
   a) A car is travelling at 15ms^{-1} when it crashes into a bollard.
      A 70 kg driver wearing a seatbelt comes to rest in a time of 0.1 seconds.
      Calculate the change of momentum of the driver and the force
      experienced by the driver.   [-1050 kgms^{-1} , -10500N]

   b) Without the safety devices the driver comes to rest in a tenth of this
      time. Now calculate the force the driver experiences now.

8) A hockey player strikes a puck of mass 0.05 kg with an average force of 600 Newtons. The hockey stick is in contact with the puck for 0.08 seconds.

    a) Calculate the impulse given to the puck from the hockey stick.   [48 Ns]

    b) What would be the change of momentum of the puck?

    c) Calculate the velocity that the puck would leave the hockey stick.   [960 ms^{-1}]

9) A lead weight of mass 10 kg is dropped to the ground and hits the ground with a velocity of 8 ms^{-1}. The block comes to a rest without bouncing in a time of 0.08 seconds.

    a) Calculate the **size** of the change in momentum.   [80 kgms^{-1}]

    b) What is size of the impulse on the weight?

    c) Calculate the average force experienced by the lead weight.   [1000 N]

    d) If the lead weight is dropped onto sand what effect will this have on the average force experienced by the lead weight. Justify your answer.

10) Explain using your knowledge of impulse and momentum these situations:

    a) When jumping of a wall you bend your legs to land.

    b) Crumple zones in a car.

    c) Training shoes with foam soles.

    d) A tennis player carries through her racquet when serving.

11) A baseball player catches a baseball of 250 g in his glove which was travelling at 15 ms^{-1} If the ball caught dead then

    a) find the change of momentum of the ball   [3.75kgms^{-1}]

    b) find the impulse the ball received from the player`s hand

    c) find the average force the ball received from the player`s hand if it was caught in a time of 0.5 seconds.   [7.5 N]