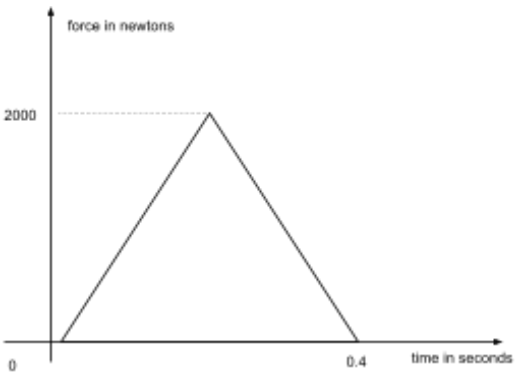
Our Dynamic Universe

Force time graphs

1) A force sensor collects data from a collision between a car and a wall. The data is downloaded from the sensor and displayed on a graph.

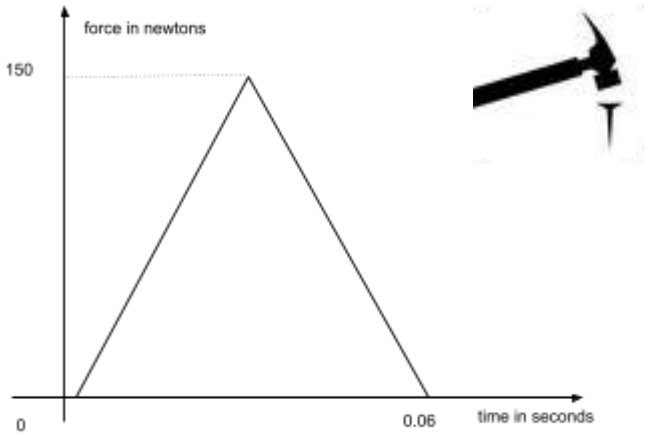


a) Calculate the size of the impulse received by the car from the wall.

b) State the size of the change of momentum of the car.

c) The car has a mass of 800 kg. Determine the speed it was travelling at before coming to rest at the wall.

2) An experiment is constructed to measure force applied over the time of a collision between a hammer and nail. The data is displayed on a force time graph.

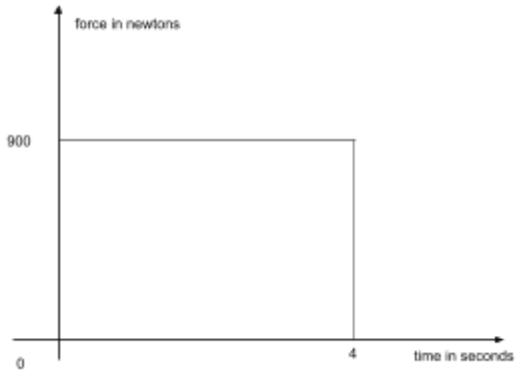


a) Calculate the size of the impulse received by the nail from the hammer.

b) State the size of the change of momentum of the nail.

c) The nail has a mass of 0.012 kg. Find the speed of the nail just after being struck by the hammer.

3) An object of mass 4 kg at rest is given a constant force over a given time as shown in the force time graph below.

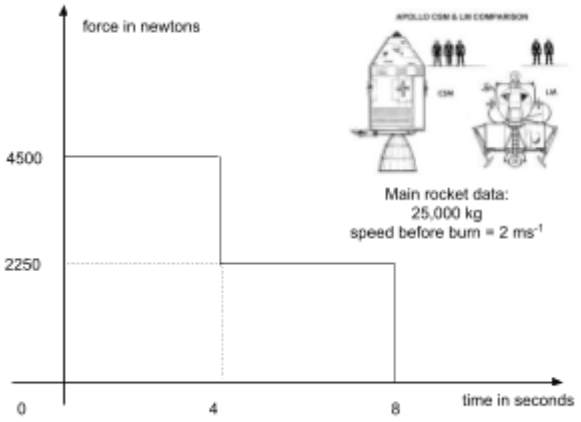


a) Calculate the change of momentum of the object.

b) State the impulse given to the object.

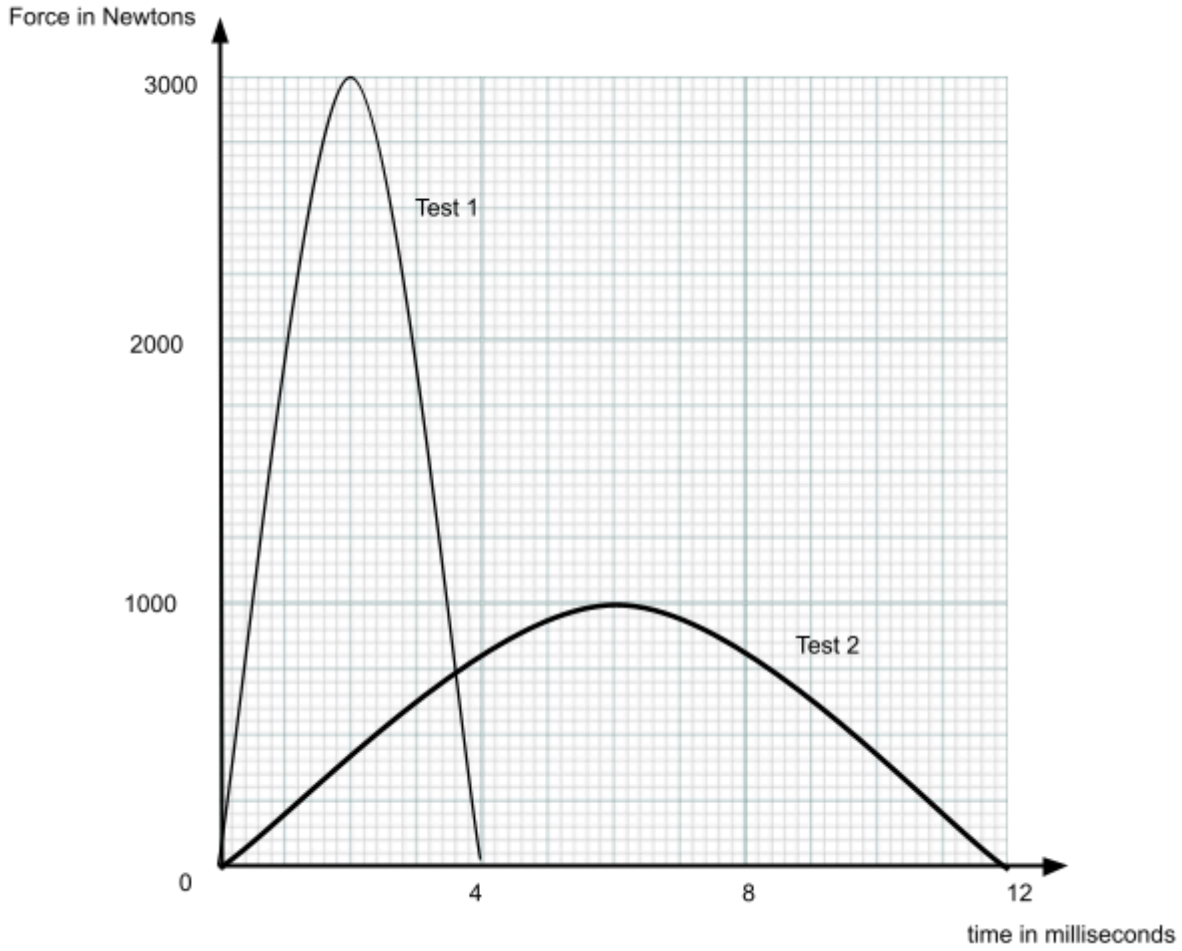
c) Determine the final speed of the object immediately after the force was applied to the object.

4) During the Apollo 11 Moon mission the spaceship`s main rocket engine was fired over a given time. The data from the rocket`s sensors is displayed on a screen at mission control.



a) Determine the impulse given to the spaceship by the thruster rocket.
b) State the change of momentum.
c) If the speed before the engine was fired (burn) was 2 ms^{-1} then find the speed of the space ship immediately after the engine was fired (or burned as they say in NASA)

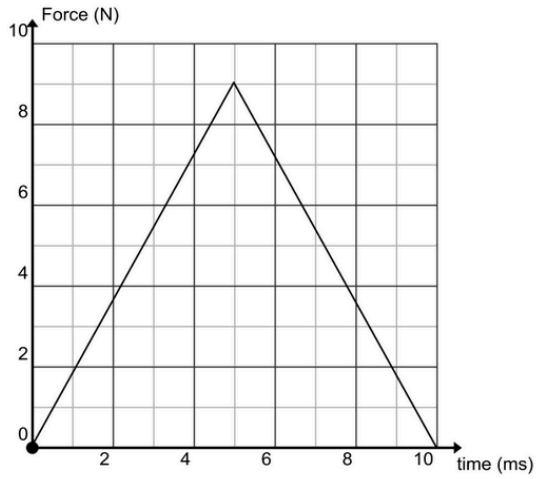
5) During a crash test with a new car a force time graph was downloaded from the data collected by the onboard computers.
The test consisted of two crashes: Test 1 with bumper made of material A and test 2 with a bumper of material B.
The graphs of the two collisions are shown below;



a) Both cars crash into the wall at exactly the same speed.
   i) Which test uses a more collapsible bumper? *Give a reason*.
   ii) Is the area of the graph of test 2 greater, smaller or just the same as the area of the graph of test 1. *Justify your answer.*

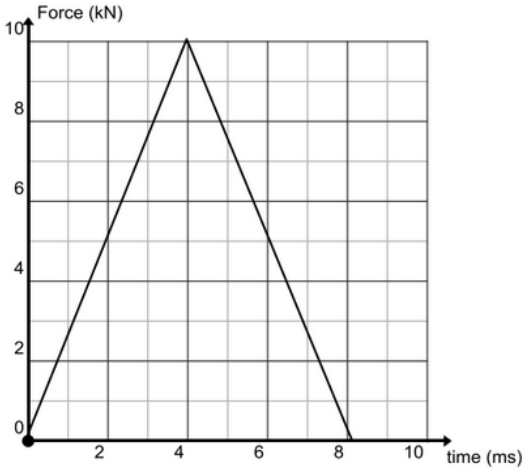
b) By considering the force time graph of each test to be approximately a triangle find the impulse the car received in test 1.
   i) If the test car has a mass 2000 kg then determine the change of momentum of the car assuming that it came to rest after crashing into the wall.
   ii) Find the speed of the car just before it crashed into the wall.

6) In an experiment to calculate the average force a snooker cue applies to a ball a special force sensor is attached to the snooker ball and the data of the size of the force over the time of contact is shown below:



a) Calculate the change of momentum of the snooker ball. [0.045 kg ms^{-1}]
b) Determine the speed of the snooker ball after it has been struck [0.09 ms^{-1}]
c) Find the magnitude of the average force given to the snooker ball. [4.5 N]
d) According to the graph, the maximum force given to the snooker ball.

7) During a test dummy crash investigation the data of the force acting on the dummy over a period of time is shown on the graph below:



a) Determine the impulse given to the crash test dummy. [40 Ns]
b) Calculate the average force given to the dummy [4000 N]
c) On a second test crash the car is fitted with an air bag which explodes on collision. Sketch a graph showing how the force time graph will look when the data is downloaded.
d) What can you say about the area of each graph obtained. *Justify your answer*.

Answers

1 a) 400 Ns
b) 400 kg ms^{-1}
c) 0.5 ms^{-1}

2 a) 4.5 Ns
b) 4.5 kg ms^{-1}
c) 375 ms^{-1}

3 a) 3600 kg ms^{-1}
b) 3600 Ns
c) 90 ms^{-1}

4 a) 27000 Ns
b) 27000 kg ms^{-1}
c) 3.08 ms^{-1}

5 a) i) test 2 longer collision time.
ii) same because same change of momentum
b) i) -6000 kg ms^{-1}
ii) 3 ms^{-1}