## Impulse

Impulse is defined as the average force applied to an object during a given contact time.

$$\text{impulse} = Ft$$

Whenever an impulse is given to an object

.....

$$\text{impulse} = \text{change of momentum}$$

.....

## Impulse examples.

A 0.16 kg stationary snooker ball is given an average force of 8 N over a contact time of 0.3 s.

Calculate the impulse given to the snooker ball

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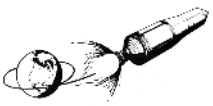
State the change in momentum of the ball

Determine the speed the snooker ball immediately after it was struck



A space rocket of mass 500 kg is travelling at 5 $ms^{-1}$. Its main rocket motor fires for 10 seconds giving an average force of 1,000 N.

Calculate the impulse given to the rocket

Determine the change of momentum of the rocket

Find the new speed of the rocket.

A 2,500 kg car travelling at 10 $ms^{-1}$ crashes into a tree and is brought to rest. The car is in contact with the tree during the collision for 0.8 s.

Calculate the change of momentum of the car.

What is the size and direction of the impulse given to the car from the tree.?

What is the size and direction of the force given to the car by the tree?

A rubber ball of mass 20 g is thrown towards a wall with a speed of 8 $ms^{-1}$ It then rebounds from the wall with a speed of 6 $ms^{-1}$.

The time of contact during the bounce is 0.1 s

Calculate the change of momentum of the ball.

State the impulse given to the ball.

Calculate the size of the force the ball gives to the wall.

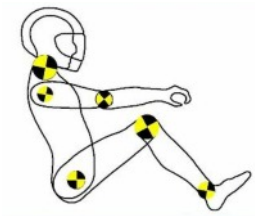
**What effect on the size the force on the wall if it is a softer ball?**

A tennis ball approaches a tennis player with a speed of 60 $ms^{-1}$

The player returns the ball. The tennis bat is in contact with the 57 g ball for ball for 6 milliseconds and the average force given to the ball is 100 N

Determine the velocity of the returning ball.

## The longer time it takes you to come to a halt the safer it is!



Car safety has vastly improved with the help of sophisticated dummies fitted out with accelerometer and force sensors.

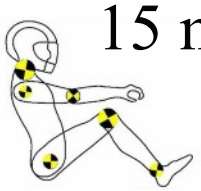
Data from crash tests have helped shape the safety of the car

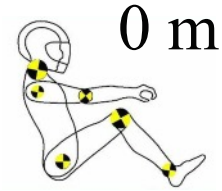
Seatbelts, air bags and crushable body work all help in making car crashes as safe as possible when a collision takes place.

How?

A driver of a car has a mass of 70 kg.

During a collision the driver`s speed goes from 15 $ms^{-1}$ to 0 $ms^{-1}$.



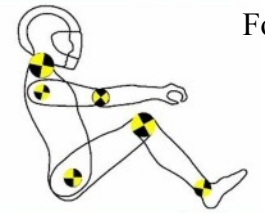

### Change of momentum

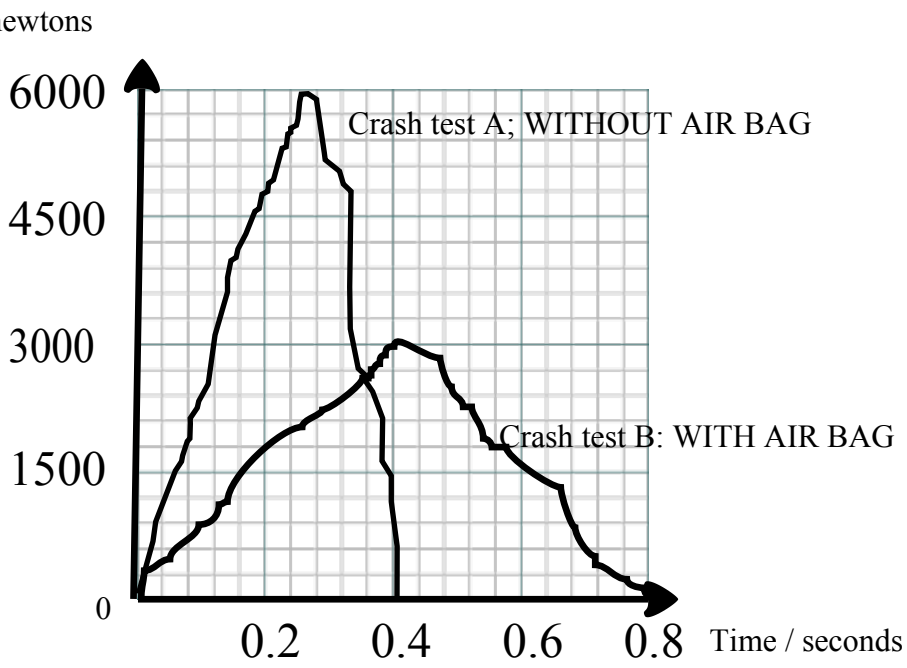
### Impulse
### Ft

Collision time = 0.4 s

Collision time = 0.8 s

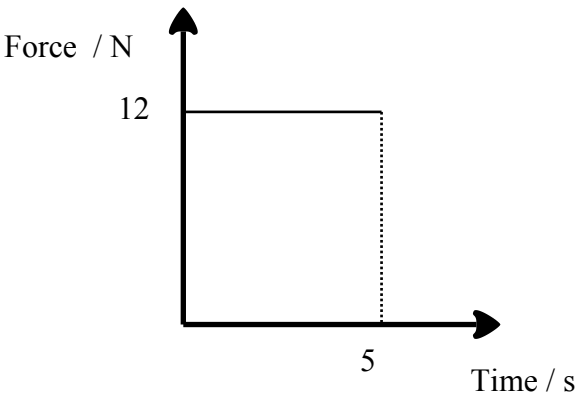
## Force time graphs from crash test dummy data.

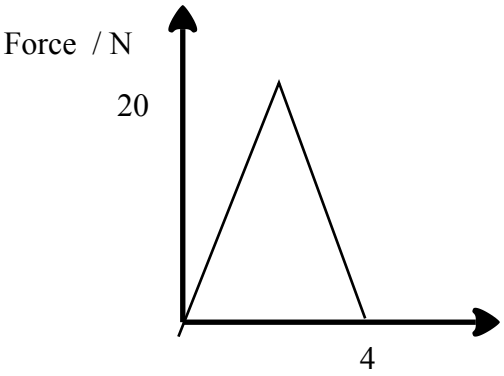


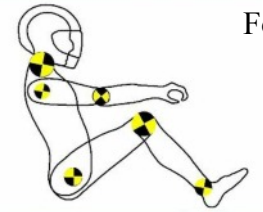


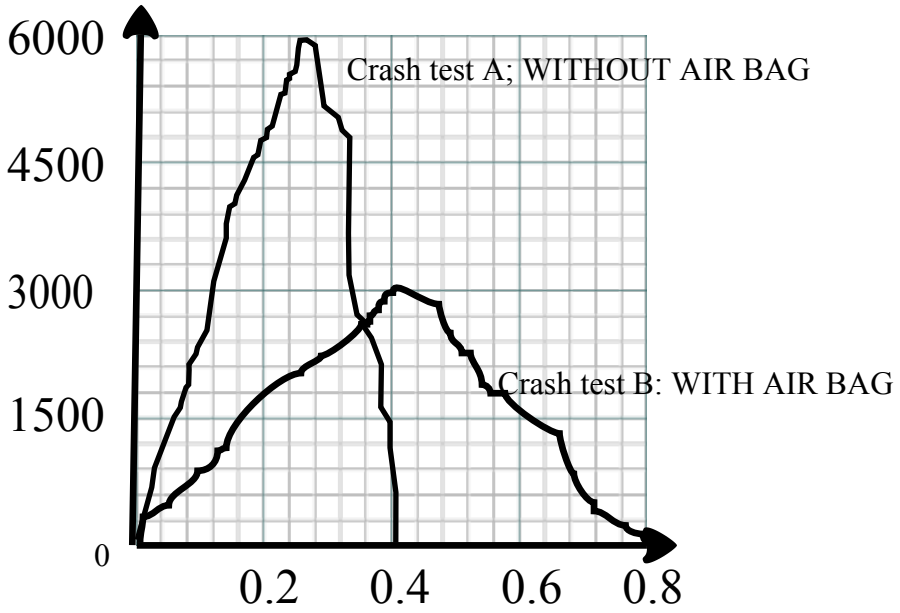

Observations from the data

## Area of a force time graph = IMPULSE = CHANGE OF MOMENTUM








Using the estimation that the graphs are approximately triangles, work out the change of momentum in each crash test.