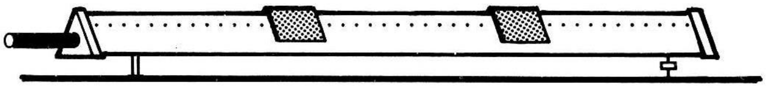
Key Area 3 - Collisions and Explosions

Multiple Choice Questions 1 → 10

1. The diagram below shows two vehicles, both of mass 0·2 kg, on a linear track. Vehicle P is moving at 5 ms^{-1} towards vehicle Q, which is at rest before the collision.

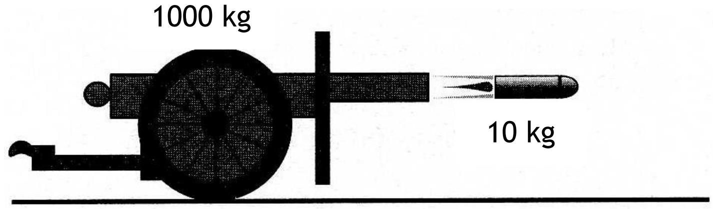


After colliding, the two vehicles move off separately to the right. Vehicle P moves with a speed of 2 ms^{-1} and vehicle Q moves with a speed of 3 ms^{-1}.

Identify which of the following correctly describes this collision.

	Momentum	Kinetic Energy	Type of Collision
A	lost	conserved	elastic
B	conserved	lost	elastic
C	conserved	conserved	elastic
D	lost	conserved	inelastic
E	conserved	lost	inelastic

2. A field-gun of mass 1000 kg fires a shell of mass 10 kg, with a velocity of 100 ms^{-1} East.



Calculate the velocity of the field-gun just after firing the shell.

A 0 ms^{-1}

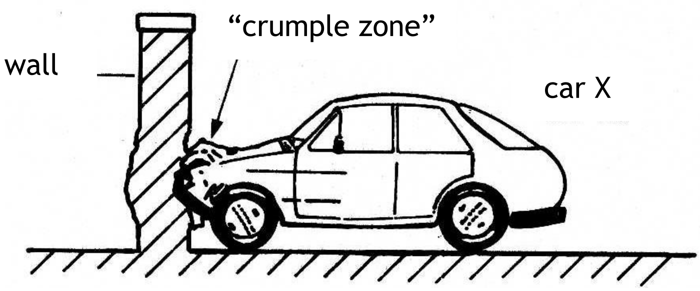
B 1 ms^{-1} East

C 1 ms^{-1} West

D 10 ms^{-1} East

E 10 ms^{-1} West

3. Car X is designed with a "crumple zone" so that the front of the car collapses during impact as shown in the diagram below.



A similar car, Y, of equal mass is built without a crumple zone. Both cars hit a wall at the same speed.

Comparing car X with car Y, identify which of the following statement is/are true during the collisions.

I the average force of car X is smaller.

II the time taken for car X to come to rest is greater.

III the change in momentum of car X is smaller.

A I only

B I and II only

C I and III only

D II and III only

E I, II and III

4. A shell of mass 5 kg is travelling horizontally with a speed of 200 ms^{-1} when it explodes into two parts. One part has a mass of 3 kg and it continues in the original direction the shell was moving in with a speed of 100 ms^{-1}.

The other part also continues in the same direction. Determine the speed of the second part.

A 150 ms^{-1}

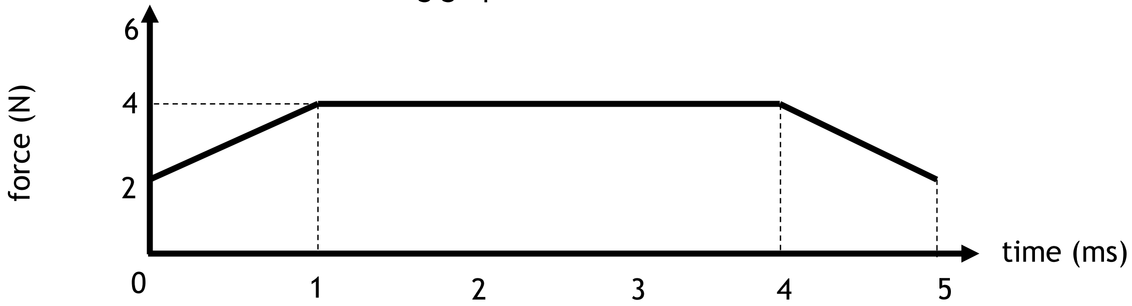
B 200 ms^{-1}

C 300 ms^{-1}

D 350 ms^{-1}

E 700 ms^{-1}

5. A force is applied to an object and causes the object to move in a straight line. The force varies with time as shown in the following graph.



Determine the total impulse given to the object by the force in this 5 ms time interval.

A 8×10^{-3} Ns

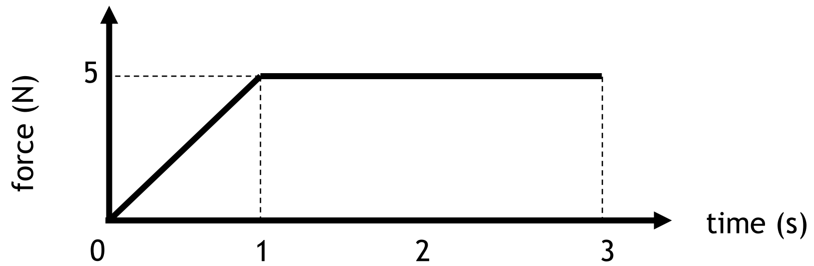
B 10×10^{-3} Ns

C 15×10^{-3} Ns

D 18×10^{-3} Ns

E 20×10^{-3} Ns

6. A model car of mass 3 kg is initially at rest. An unbalanced force acts on the model car, as shown in the following force-time graph.



Determine the momentum of the model car at a time of 3 seconds.

A 0·0 $kgms^{-1}$

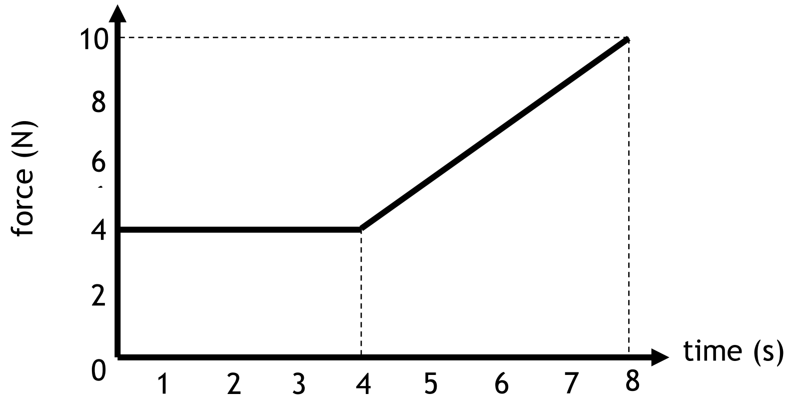
B 2·5 $kgms^{-1}$

C 5·0 $kgms^{-1}$

D 12·5 $kgms^{-1}$

E 15·0 $kgms^{-1}$

7. The graph below shows the force which acts on an object over a time interval of 8 seconds.



Calculate the momentum gained by the object during the 8 seconds.

A 12 Ns

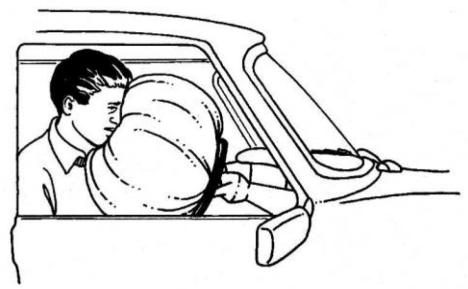
B 32 Ns

C 44 Ns

D 52 Ns

E 72 Ns

8. Many car manufacturers are now fitting airbags, which inflate automatically during an accident, as shown below.



Identify the method the airbag employs to protect the driver.

A Reducing the change of momentum per second, of the driver.

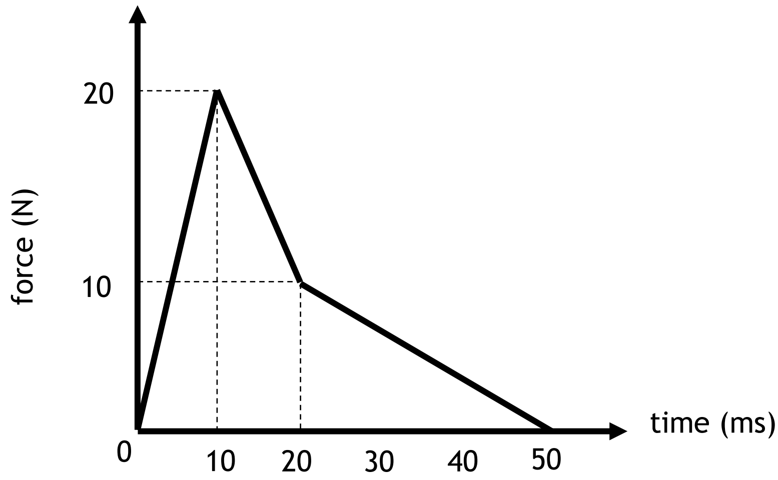
B Increasing the change of momentum per second, of the driver.

C Reducing the final velocity, of the driver.

D Reducing the total change in momentum, of the driver.

E Increasing the total change in momentum, of the driver.

9. The force acting on an object is measured and the results are stored in a computer. The force-time graph obtained from the computer is shown below.



Calculate the average force acting on the object during the 50 milliseconds.

A 15 N

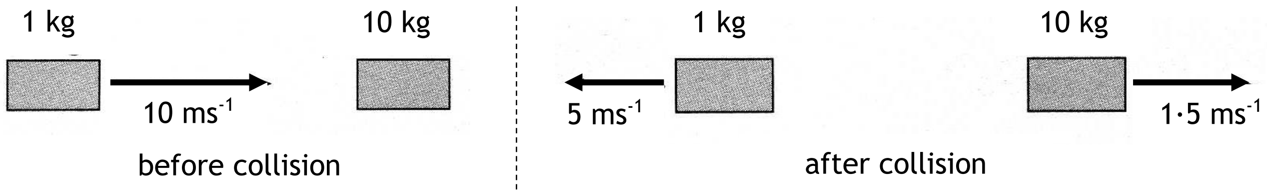
B 10 N

C 8 N

D 2·5 N

E 1 N

10. A block of mass 1 kg slides along a frictionless surface at 10 ms^{-1} and it collides with a stationary block of mass 10 kg. After the collision, the first block rebounds at 5 ms^{-1} and the other one moves off at 1.5 ms^{-1}.

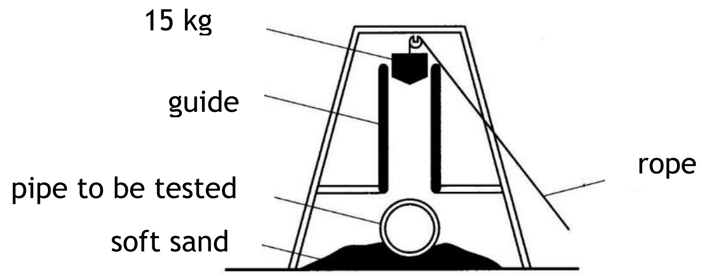


Identify which row in the table that correctly describes the collision.

	Momentum	Kinetic Energy	Type of Collision
A	conserved	conserved	elastic
B	conserved	not conserved	inelastic
C	conserved	not conserved	elastic
D	not conserved	not conserved	inelastic
E	not conserved	not conserved	elastic

Full Response Questions 11 → 14

11. The apparatus shown below is used to test concrete pipes.



When the rope is released, the 15 kg mass is dropped and falls freely through a distance of 2·0 m on to the pipe.

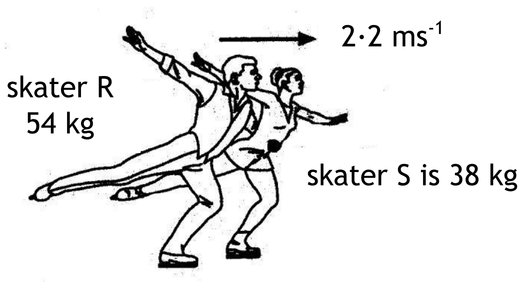
(a) In one test, the mass is dropped on to an uncovered pipe.

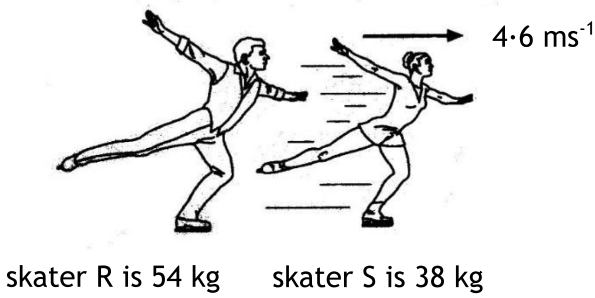
(i) Calculate the speed of the mass just before it hits the pipe.

(ii) When the 15 kg mass hits the pipe the mass is brought to rest in a time of 0·020 s.
Calculate the **size and direction** of the average unbalanced force on the **pipe**.

(b) The same 15 kg mass is now dropped through the same distance on to an identical pipe which is covered with a thick layer of soft material.
State the effect this layer has on the size of the average unbalanced force on the pipe.
You must justify your answer.

12. Two ice skaters are initially skating together, each with a velocity of 2·2 ms^{-1} to the right as shown in the left hand diagram.





Skater R now pushes skater S with an average force of 130 N for a short time. This force is in the same direction as their original velocity.
As a result, the velocity of skater S increases to 4·6 ms^{-1} to the right, as shown in the right hand diagram.

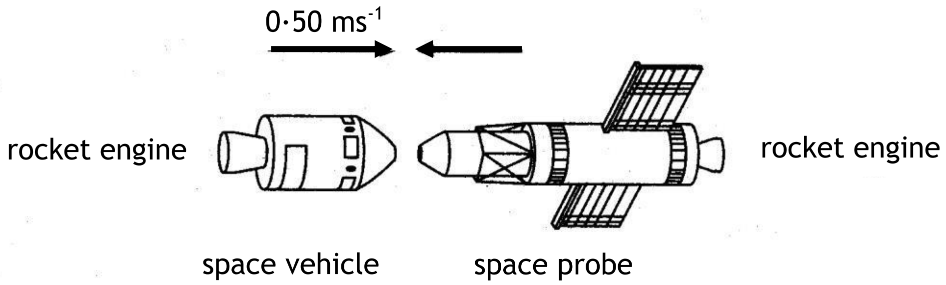
(a) Calculate the magnitude of the change in momentum of skater S.

(b) Calculate the time that skater R exerts the force on skater S.

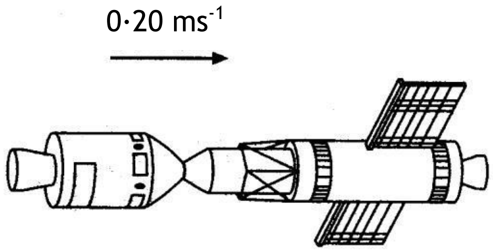
(c) Calculate the velocity of skater R immediately after pushing skater S.

(d) State whether this interaction between the skaters is elastic or inelastic.
You must justify your answer by an appropriate calculation.

13. A space vehicle of mass 2500 kg is moving with a constant speed of 0·50 ms^{-1} in the direction shown. It is about to dock with a space probe of mass 1500 kg which is moving with a constant speed in the opposite direction.



After the docking procedure, the space vehicle and the space probe move off together at 0·20 ms^{-1}, in the original direction in which the space vehicle was moving.



(a) Calculate the speed of the space probe before it docked with the space vehicle.

(b) The space vehicle has a rocket engine which produces a constant thrust of 1000 N. The space probe has a rocket engine which produces a constant thrust of 500 N.
The space vehicle and space probe are now brought to rest from their combined speed of 0·20 m s^{-1}.

(i) State which of the rocket engines was switched on to bring the vehicle and probe to rest.

(ii) Calculate the time for which this rocket engine was switched on. You must assume that a negligible mass of fuel was used during this time.