Exercise 10 – Momentum and Impulse

Past paper Homework Questions

1. Two trolleys travel towards each other in a straight line as shown.

The trolleys collide. After the collision the trolleys move as shown below.

What is the speed v of the 2·0 kg trolley after the collision?

A $1{\cdot}25\ \mathrm{m\,s^{-1}}$

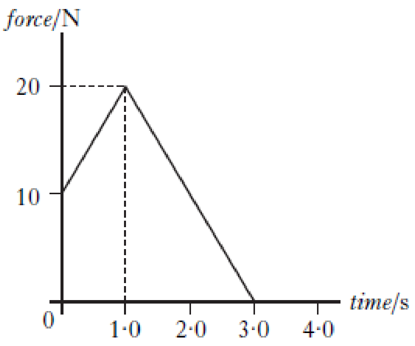
B $1{\cdot}75\ \mathrm{m\,s^{-1}}$

C $2{\cdot}0\ \mathrm{m\,s^{-1}}$

D $4{\cdot}0\ \mathrm{m\,s^{-1}}$

E $5{\cdot}0\ \mathrm{m\,s^{-1}}$

2. The graph shows the force acting on an object of mass 5·0 kg.



The change in the object's momentum is

A $7{\cdot}0\ \mathrm{kg\,m\,s^{-1}}$

B $30\ \mathrm{kg\,m\,s^{-1}}$

C $35\ \mathrm{kg\,m\,s^{-1}}$

D $60\ \mathrm{kg\,m\,s^{-1}}$

E $175\ \mathrm{kg\,m\,s^{-1}}$.

3. Momentum can be measured in

A $\mathrm{N\,kg^{-1}}$

B $\mathrm{N\,m}$

C $\mathrm{N\,m\,s^{-1}}$

D $\mathrm{kg\,m\,s^{-1}}$

E $\mathrm{kg\,m\,s^{-2}}$.

4. A cannon of mass 2000 kg fires a cannonball of mass 5·00 kg.

The cannonball leaves the cannon with a speed of $50{\cdot}0\ \mathrm{m\,s^{-1}}$.

The speed of the cannon immediately after firing is

A $0{\cdot}125\ \mathrm{m\,s^{-1}}$

B $8{\cdot}00\ \mathrm{m\,s^{-1}}$

C $39{\cdot}9\ \mathrm{m\,s^{-1}}$

D $40{\cdot}1\ \mathrm{m\,s^{-1}}$

E $200\ \mathrm{m\,s^{-1}}$.

5. A shell of mass 5·0 kg is travelling horizontally with a speed of $200\ \mathrm{m\,s^{-1}}$. It explodes into two parts. One part of mass 3·0 kg continues in the original direction with a speed of $100\ \mathrm{m\,s^{-1}}$.

The other part also continues in this same direction. Its speed is

A $150\ \mathrm{m\,s^{-1}}$

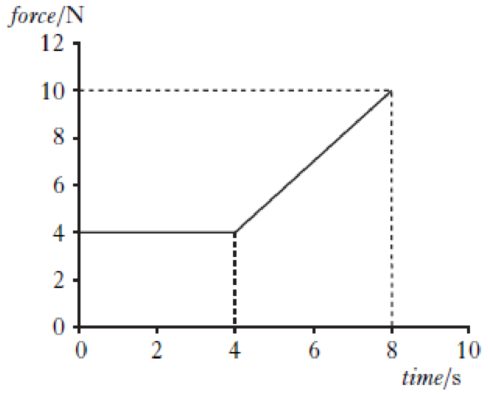
B $200\ \mathrm{m\,s^{-1}}$

C $300\ \mathrm{m\,s^{-1}}$

D $350\ \mathrm{m\,s^{-1}}$

E $700\ \mathrm{m\,s^{-1}}$.

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



The momentum gained by the object during this 8 seconds is

A $12\ \text{kg m s}^{-1}$

B $32\ \text{kg m s}^{-1}$

C $44\ \text{kg m s}^{-1}$

D $52\ \text{kg m s}^{-1}$

E $72\ \text{kg m s}^{-1}$.

7. A student makes the following statements about elastic and inelastic collisions.

I In an elastic collision kinetic energy is conserved but momentum is not conserved.

II In an inelastic collision both kinetic energy and momentum are conserved.

III In an inelastic collision momentum is conserved but kinetic energy is not conserved.

Which of the statements is/are correct?

A I only

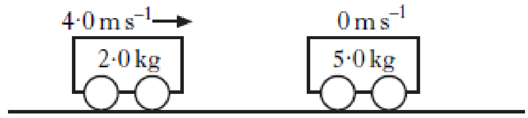
B II only

C III only

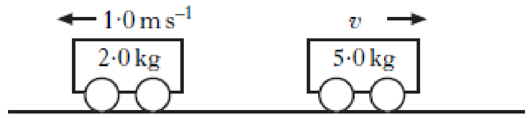
D I and II only

E I and III only

8. A 2·0 kg trolley travels in a straight line towards a stationary 5·0 kg trolley as shown.



The trolleys collide. After the collision the trolleys move as shown below.



What is the speed v of the 5·0 kg trolley after the collision?

A $0{\cdot}4\ \text{m s}^{-1}$

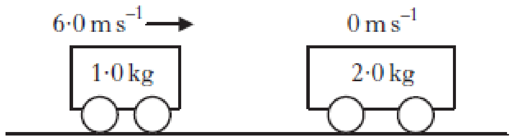
B $1{\cdot}2\ \text{m s}^{-1}$

C $2{\cdot}0\ \text{m s}^{-1}$

D $2{\cdot}2\ \text{m s}^{-1}$

E $3{\cdot}0\ \text{m s}^{-1}$

9. The diagram shows the masses and velocities of two trolleys just before they collide on a level bench.



After the collision, the trolleys move along the bench joined together.

How much kinetic energy is lost in this collision?

A 0 J

B 6·0 J

C 12 J

D 18 J

E 24 J

10. The momentum of a rock of mass 4 kg is $12\ \text{kg m s}^{-1}$.

The kinetic energy of the rock is

A 6 J

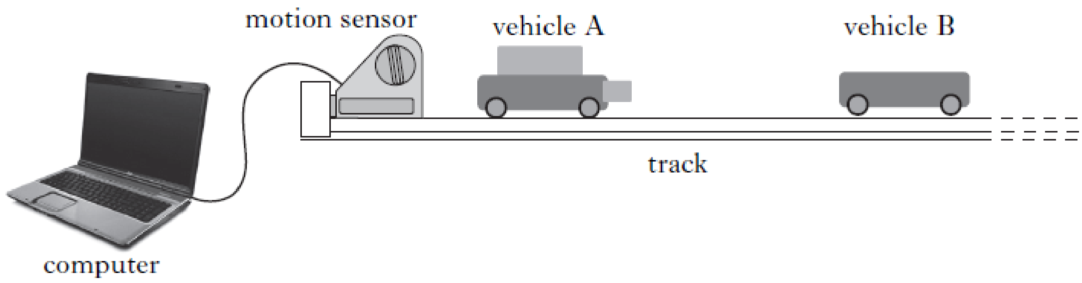
B 18 J

C 36 J

D 144 J

E 288 J.

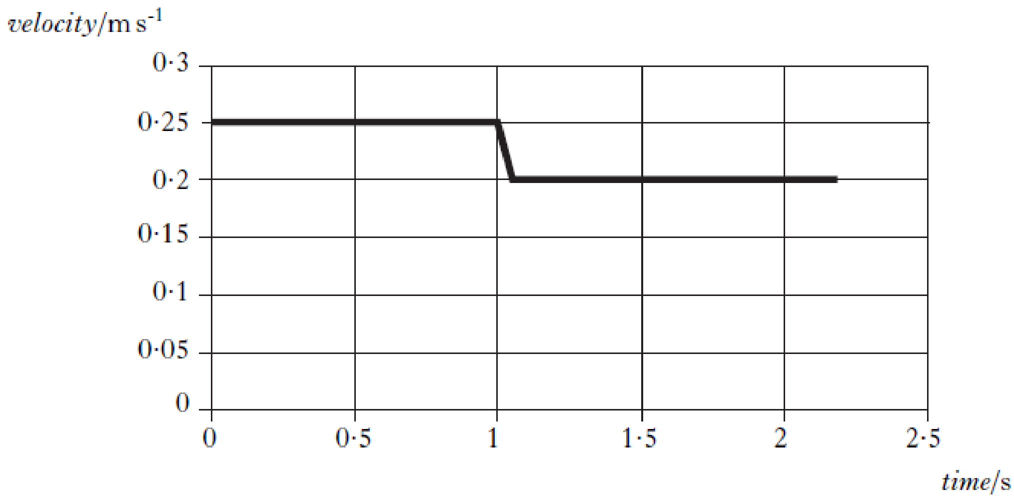
11. The apparatus shown is set up to investigate collisions between two vehicles on a track.



The mass of vehicle A is 0·22 kg and the mass of vehicle B is 0·16 kg.

The effects of friction are negligible.

(*a*) During one experiment the vehicles collide and stick together. The computer connected to the motion sensor displays the velocity-time graph for vehicle A.



(i) State the law of conservation of momentum. 2

(ii) Calculate the velocity of vehicle B before the collision. 3

(*b*) The same apparatus is used to carry out a second experiment.

In this experiment, vehicle B is stationary before the collision.

Vehicle A has the same velocity before the collision as in the first experiment.

After the collision, the two vehicles stick together.

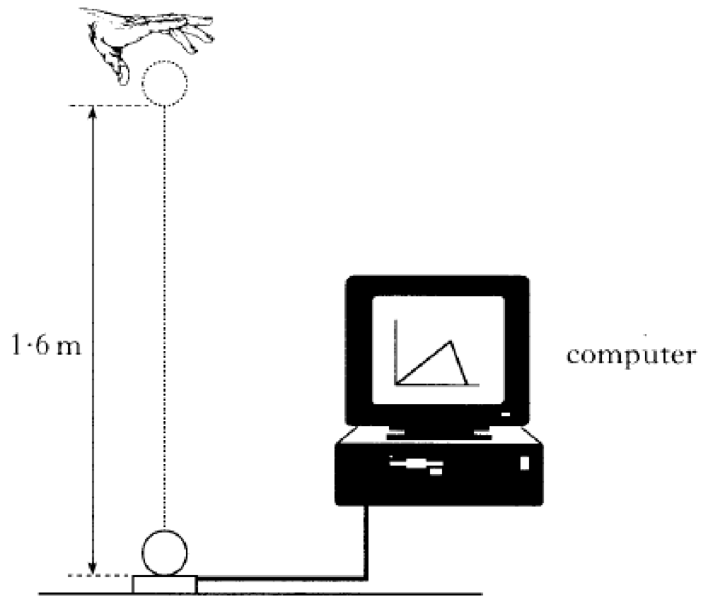
Is their combined velocity less than, equal to, or greater than that in the first collision?

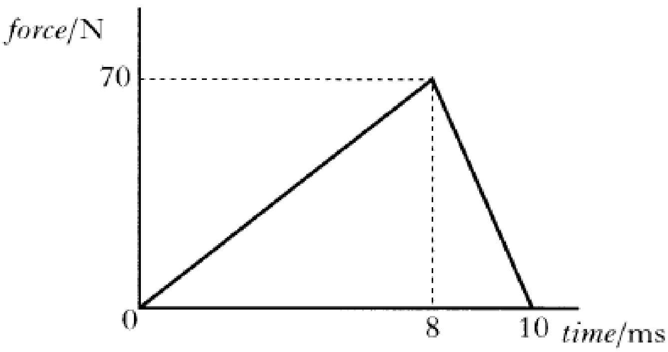
Justify your answer. 4

(9)

12.

A force sensor is used to investigate the impact of a ball as it bounces on a flat horizontal surface. The ball has a mass of 0·050 kg and is dropped vertically, from rest, through a height of 1·6 m as shown.





(i) Show by calculation that the magnitude of the impulse on the ball is 0·35 N s. 2

(ii) What is the magnitude and direction of the change in momentum of the ball? 2

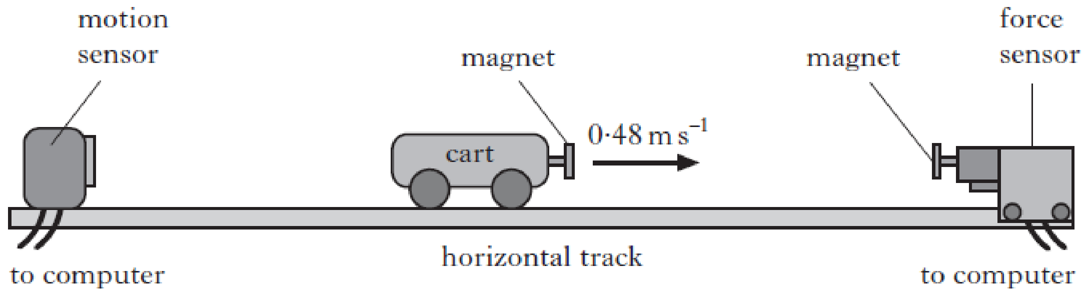
(iii) The ball is travelling at 5·6 m s^{-1} just before it hits the force sensor. Calculate the speed of the ball just as it leaves the force sensor. 3

(*b*) Another ball of identical size and mass, but made of a harder material, is dropped from rest and from the same height onto the same force sensor. Sketch the force-time graph shown above and, on the same axes, sketch another graph to show how the force on the harder ball varies with time.

Numerical values are not required but you must label the graphs clearly. 2

(9)

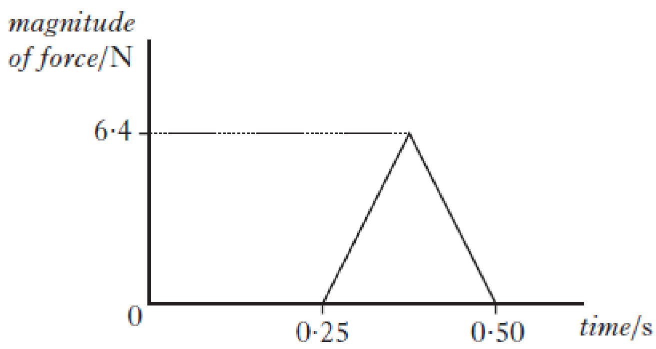
13. An experiment is set up to investigate the motion of a cart as it collides with a force sensor.



The cart moves along the horizontal track at $0{\cdot}48\ \mathrm{m\ s^{-1}}$ to the right.

As the cart approaches the force sensor, the magnets repel each other and exert a force on the cart.

The computer attached to the force sensor displays the following force-time graph for this collision.

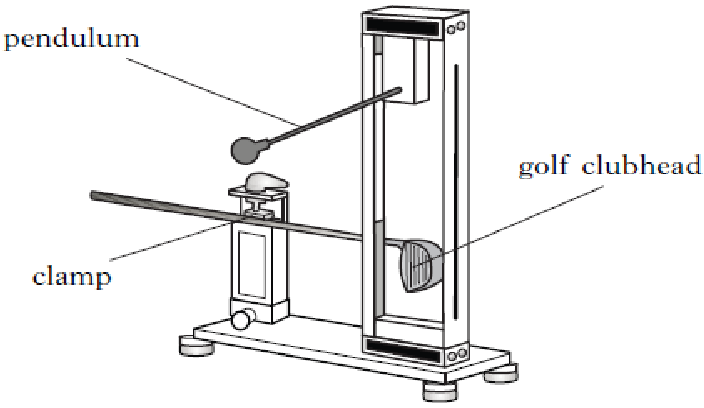


Calculate the magnitude of the impulse on the cart during the collision. 3

(3)

14. Golf clubs are tested to ensure they meet certain standards.

(*a*) In one test, a securely held clubhead is hit by a small steel pendulum. The time of contact between the clubhead and the pendulum is recorded.



The experiment is repeated several times.

The results are shown.

248 μs   259 μs   251 μs   263 μs   254 μs

(i) Calculate:

(A) the mean contact time between the clubhead and the pendulum; **1**

(B) the approximate absolute random uncertainty in this value. 1

(ii) In this test, the standard required is that the maximum value of the mean contact time must not be greater than 257 μs.

Does the club meet this standard?

You must justify your answer.

2

(*b*) In another test, a machine uses a club to hit a stationary golf ball.

The mass of the ball is $4 \cdot 5 \times 10^{-2}$ kg. The ball leaves the club with a speed of $50 \cdot 0\ \text{m s}^{-1}$. The time of contact between the club and ball is 450 μs.

(i) Calculate the average force exerted on the ball by the club. 3

(ii) The test is repeated using a different club and an identical ball. The machine applies the same average force on the ball but with a longer contact time.

What effect, if any, does this have on the speed of the ball as it leaves the club? 2

Justify your answer.

(9)

40 marks