# Momentum 2

Have a go at the following exam questions.

## OCR, G484, JUNE 2010

**1** **(a)** A particular collision between two objects is *inelastic*. Place a tick (✓) at the end of each statement that applies to such a collision. **[2]**

| **Statement** | |
|---|---|
| The magnitude of the impulse on each object is the same. | |
| Kinetic energy and momentum for the objects are conserved. | |
| Total energy is conserved. | |
| After the collision, the objects have the same momentum. | |

**(b)** Fig. 1.1 shows a tennis ball before and after striking a wall at right angles.

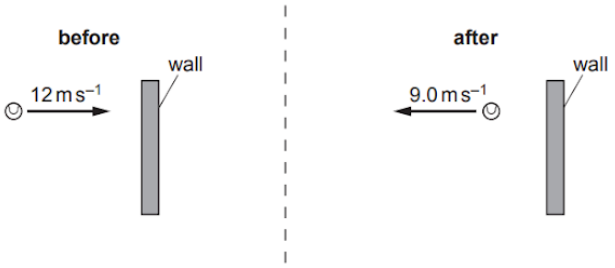


**Fig. 1.1**

The ball of mass 0.060 kg hits the wall at a speed of 12 m s$^{-1}$. The ball is in contact with the wall for 0.15 s. It rebounds with a speed of 9.0 m s$^{-1}$. Calculate

**(i)** the loss of kinetic energy during the collision

loss of kinetic energy = ...................................................... J **[2]**

**(ii)** the magnitude of the average force exerted on the ball by the wall

average force on ball = ...................................................... N **[2]**

**(iii)** the magnitude of the average force exerted on the wall by the ball during this collision.

average force on wall = ...................................................... N **[1]**

**17** (a) Explain what is meant by the principle of conservation of momentum.

(2)

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(b) The picture shows a toy car initially at rest with a piece of modelling clay attached to it.

A student carries out an experiment to find the speed of a pellet fired from an air rifle. The pellet is fired horizontally into the modelling clay. The pellet remains in the modelling clay as the car moves forward. The motion of the car is filmed for analysis.

The car travels a distance of 69 cm before coming to rest after a time of 1.3 s.

(i) Show that the speed of the car immediately after being struck by the pellet was about 1 m $s^{-1}$.

(2)

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(ii) State an assumption you made in order to apply the equation you used.

(1)

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(iii) Show that the speed of the pellet just before it collides with the car is about 120 m $s^{-1}$

mass of car and modelling clay = 97.31g
mass of pellet = 0.84 g

(3)

(c) The modelling clay is removed and is replaced by a metal plate of the same mass. The metal plate is fixed to the back of the car. The experiment is repeated but this time the pellet bounces backwards.

*(i) Explain why the speed of the toy car will now be greater than in the original experiment.

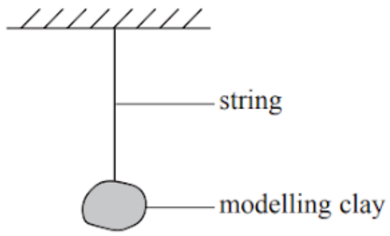
(3)

(ii) The film of this experiment shows that the pellet bounces back at an angle of 72° to the horizontal.

Explain why the car would move even faster if the pellet bounced directly backwards at the same speed.

(1)

(d) The student tests the result of the first experiment by firing a pellet into a pendulum with a bob made of modelling clay. She calculates the energy transferred.




The student's data and calculations are shown:

***Data***
*mass of pellet* = 0.84 g
*mass of pendulum and pellet* = 71.6 g
*change in vertical height of pendulum* = 22.6 cm

***Calculations***
*change in gravitational potential energy of pendulum and pellet*
$= 71.6 \times 10^{-3}\,\text{kg} \times 9.81\ \text{N kg}^{-1} \times 0.226\ \text{m} = 0.16\ \text{J}$
*therefore kinetic energy of pendulum and pellet immediately after collision* = 0.16 J
*therefore kinetic energy of pellet immediately before collision* = 0.16 J
*therefore speed of pellet before collision* = $19.5\ \text{m s}^{-1}$

There are no mathematical errors but her answer for the speed is too small.

State and explain which of the statements in the calculations are correct and which are not.

**(4)**

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**(Total for Question 17 = 16 marks)**

***12** In 2012 Neil Armstrong, the first man to step on the moon during the Apollo 11 lunar mission, died at the age of 82.

During this mission, a planned explosion caused the separation of the module in which Armstrong was travelling and the final-stage rocket. This explosion resulted in an increase in the speed of the module.

Discuss how the conservation of momentum and the conservation of energy apply to this situation.

(5)

**(Total for Question 12 = 5 marks)**