Linear Momentum

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Dynamics
Sub Topic	Linear Momentum
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Two balls X and Y are supported by long strings, as shown in Fig. 3.1.

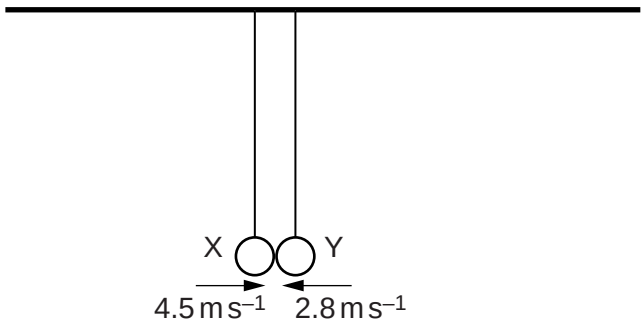

Fig. 3.1

The balls are each pulled back and pushed towards each other. When the balls collide at the position shown in Fig. 3.1, the strings are vertical. The balls rebound in opposite directions.

Fig. 3.2 shows data for X and Y during this collision.

ball	mass	velocity just before collision / m s^{-1}	velocity just after collision / m s^{-1}
X	50 g	+4.5	–1.8
Y	*M*	–2.8	+1.4

Fig. 3.2

The positive direction is horizontal and to the right.

(a) Use the conservation of linear momentum to determine the mass *M* of Y.

M = ... g [3]

(b) State and explain whether the collision is elastic.

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.....[1]

(c) Use Newton's second and third laws to explain why the magnitude of the change in momentum of each ball is the same.

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.....[3]

2 **(a)** A gas molecule has a mass of 6.64×10^{-27} kg and a speed of 1250 m s^{-1}. The molecule collides normally with a flat surface and rebounds with the same speed, as shown in Fig. 4.1.

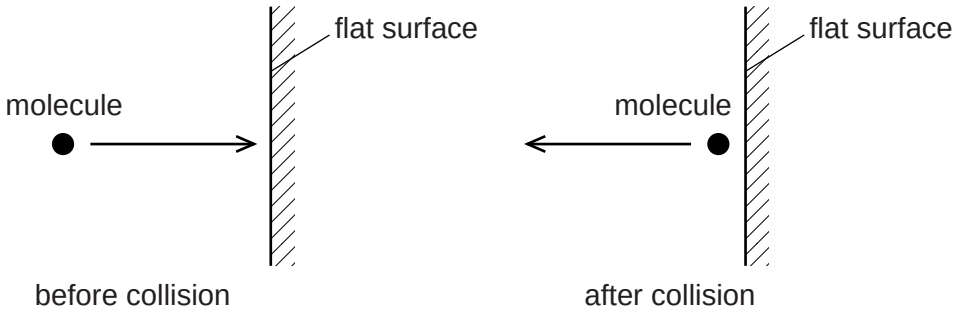

Fig. 4.1

Calculate the change in momentum of the molecule.

change in momentum = ... N s [2]

(b) **(i)** Use the kinetic model to explain the pressure exerted by gases.

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..... [3]

(ii) Explain the effect of an increase in density, at constant temperature, on the pressure of a gas.

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..... [1]

3 **(a)** State the principle of conservation of momentum.

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.....[2]

(b) A ball X and a ball Y are travelling along the same straight line in the same direction, as shown in Fig. 4.1.

Fig. 4.1

Ball X has mass 400 g and horizontal velocity 0.65 m s^{-1}.
Ball Y has mass 600 g and horizontal velocity 0.45 m s^{-1}.

Ball X catches up and collides with ball Y. After the collision, X has horizontal velocity 0.41 m s^{-1} and Y has horizontal velocity v, as shown in Fig. 4.2.

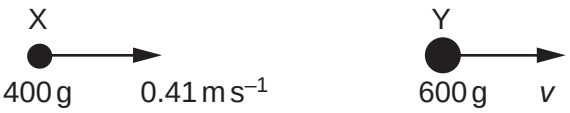

Fig. 4.2

Calculate

(i) the total initial momentum of the two balls,

momentum = ... N s [3]

(ii) the velocity v,

v = ... m s^{-1} [2]

(iii) the total initial kinetic energy of the two balls.

kinetic energy = ... J [3]

(c) Explain how you would check whether the collision is elastic.

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.....[1]

(d) Use Newton's third law to explain why, during the collision, the change in momentum of X is equal and opposite to the change in momentum of Y.

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.....[2]

4 **(a)** **(i)** State the principle of conservation of momentum.

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..... [2]

(ii) State the difference between an elastic and an inelastic collision.

..... [1]

(b) An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in Fig. 3.1.

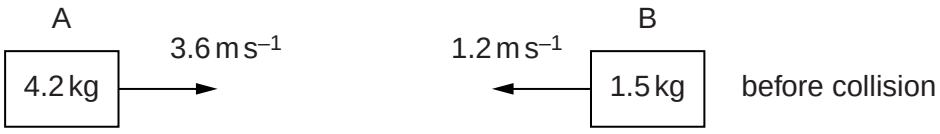

Fig. 3.1

Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.

The objects collide and then both move to the right, as shown in Fig. 3.2.

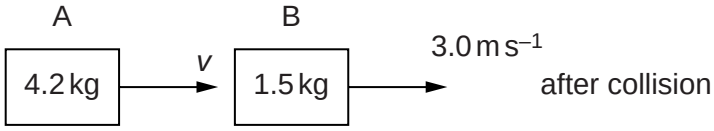

Fig. 3.2

Object A has velocity *v* and object B has velocity 3.0 m s^{-1}.

(i) Calculate the velocity *v* of object A after the collision.

velocity = ... m s^{-1} [3]

(ii) Determine whether the collision is elastic or inelastic.

[3]

5 A ball is thrown against a vertical wall. The path of the ball is shown in Fig. 3.1.

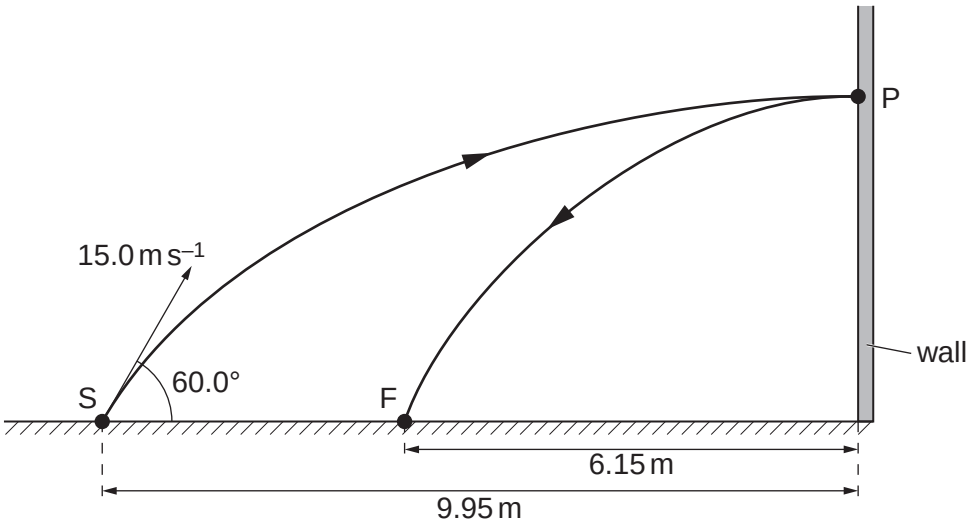

Fig. 3.1 (not to scale)

The ball is thrown from S with an initial velocity of 15.0 m s^{-1} at 60.0° to the horizontal. Assume that air resistance is negligible.

(a) For the ball at S, calculate

(i) its horizontal component of velocity,

horizontal component of velocity = ... m s^{-1} [1]

(ii) its vertical component of velocity.

vertical component of velocity = ... m s^{-1} [1]

(b) The horizontal distance from S to the wall is 9.95 m. The ball hits the wall at P with a velocity that is at right angles to the wall. The ball rebounds to a point F that is 6.15 m from the wall.

Using your answers in **(a)**,

(i) calculate the vertical height gained by the ball when it travels from S to P,

height = ... m [1]

(ii) show that the time taken for the ball to travel from S to P is 1.33 s,

[1]

(iii) show that the velocity of the ball immediately after rebounding from the wall is about 4.6 m s^{-1}.

[1]

(c) The mass of the ball is 60 × 10^{-3} kg.

(i) Calculate the change in momentum of the ball as it rebounds from the wall.

change in momentum = ... N s [2]

(ii) State and explain whether the collision is elastic or inelastic.

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..... [1]