Momentum 1

Have a go at the following exam questions.

OCR, G484, JANUARY 2011

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

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..... **[2]**

(ii) Explain what is meant by an *inelastic collision*.

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..... **[1]**

(iii) Fig. 1.1 shows the head-on-collision of two blocks on a frictionless surface.

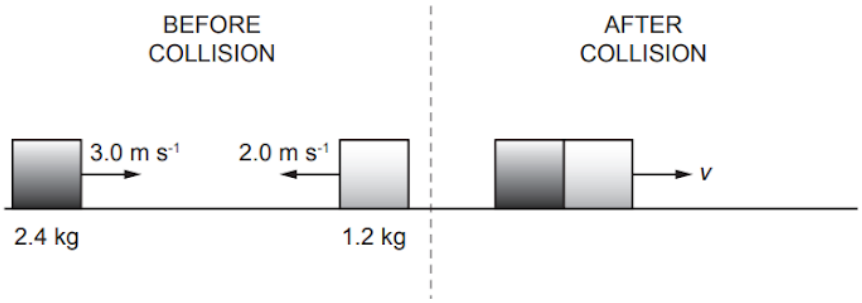

Fig. 1.1

Before the collision, the 2.4 kg block is moving to the right with a speed of 3.0 m s^{-1} and the 1.2 kg block is moving to the left at a speed of 2.0 m s^{-1}. During the collision the blocks stick together. Immediately after the collision the blocks have a common speed *v*.

1 Calculate the speed *v*.

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

2 Show that this collision is inelastic.

[2]

(b) Fig. 1.2 shows a helicopter viewed from above.

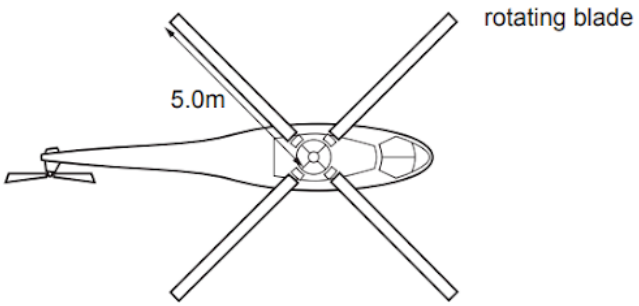

Fig. 1.2

The blades of the helicopter rotate in a circle of radius 5.0 m. When the helicopter is hovering, the blades propel air vertically downwards with a constant speed of 12 m s^{-1}. Assume that the descending air occupies a uniform cylinder of radius 5.0 m.

The density of air is 1.3 kg m^{-3}.

(i) Show that the mass of air propelled downwards in a time of 5.0 seconds is about 6000 kg.

[2]

(ii) Calculate

1 the momentum of this mass of descending air

momentum = ... $kg\,m\,s^{-1}$ **[1]**

2 the force provided by the rotating helicopter blades to propel this air downwards

force = ... N **[2]**

3 the mass of the hovering helicopter.

mass = ... kg **[1]**

[Total: 13]

3. *(a)* State Newton's second law of motion in terms of *momentum*. [2]

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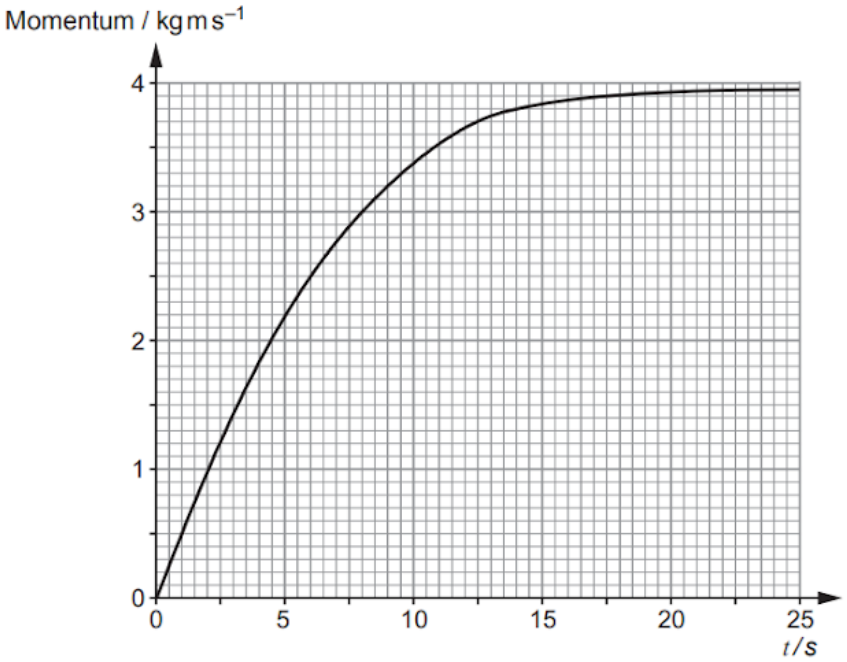
(b) A momentum-time graph is plotted below for an object of mass 0.050 kg dropped (at time $t = 0$) from the top of a high cliff.



(i) Show clearly that the resultant force on the object at $t = 10$ s is approximately 0.15 N. [3]

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(ii) Deduce the magnitude of the force of air resistance on the object at $t = 10$ s. [2]

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(iii) State the magnitude of the force of air resistance on the body when it has reached its terminal velocity. [1]

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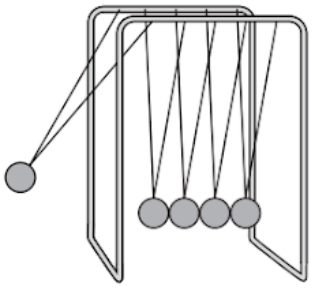
18 A student is using a 'Newton's Cradle'. This consists of a set of identical solid metal balls hanging by threads from a frame so that they are in contact with each other.

She initially pulls one ball to the side as shown.



She releases the ball, it collides with the nearest stationary ball and stops. The ball furthest to the right immediately moves away. The middle three balls remain stationary.

*(a) Explain what measurements the student would take and describe how she would use them to investigate whether momentum had been conserved in this event.

(4)

(b) The student makes the following observations:

- the ball on the right returns and collides with a similar result; this repeats itself a number of times
- after a while, the middle balls are also moving
- shortly afterwards, the balls all come to rest.

Discuss these observations in terms of energy.

(3)

(Total for Question 18 = 7 marks)