OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

PHYSICS A

G484

The Newtonian World

Candidates answer on the question paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet

Other materials required:
- Electronic calculator

Thursday 27 January 2011
Afternoon

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **12** pages. Any blank pages are indicated.

Answer **all** the questions.

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

....

....

.... **[2]**

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

....

.... **[1]**

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

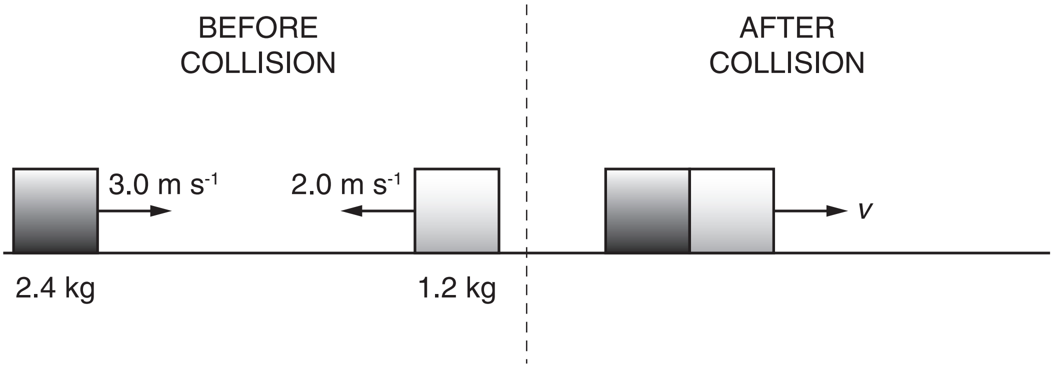

Fig. 1.1

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.

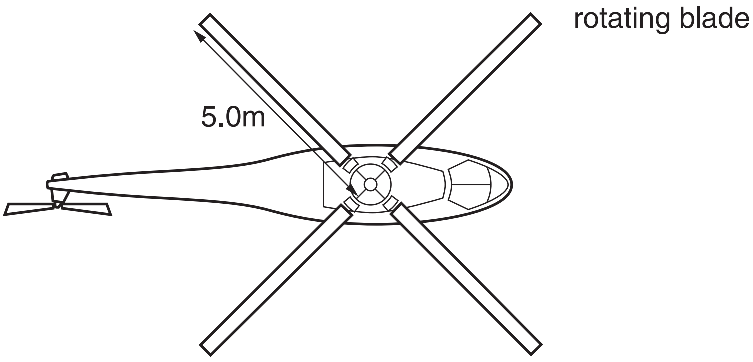

Fig. 1.2

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]

2 **(a)** **(i)** State, in terms of force, the conditions necessary for an object to move in a circular path at constant speed.

....

.... **[1]**

(ii) Explain why this object is accelerating. State the direction of the acceleration.

....

.... **[2]**

(b) A satellite moves in a circular orbit around the Earth at a constant speed of 3700 m s^{-1}.

The mass M of the Earth is 6.0×10^{24} kg.

Calculate the radius of this orbit.

radius = ... m **[4]**

(c) In order to move the satellite in **(b)** into a new smaller orbit, a decelerating force is applied for a brief period of time.

(i) Suggest how the decelerating force could be applied.

....

.... **[1]**

(ii) The radius of this new orbit is 2.0×10^{7} m. Calculate the speed of the satellite in this orbit.

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

[Total: 10]

3 **(a)** **(i)** Define the *kilowatt-hour*.

....

.... **[1]**

(ii) A domestic refrigerator works at a mean power of 70 W. Calculate the cost of running this refrigerator for one week at a cost of 12 p per kW h.

cost = £ .... **[2]**

(b) A large jug containing 2.0 kg of milk is placed in a refrigerator. The milk cools from 18 °C to 3.0 °C over a time period of 100 minutes. The specific heat capacity of milk is 3800 $J\,kg^{-1}\,K^{-1}$.

Calculate

(i) the thermal energy removed from the milk as it cools from 18 °C to 3 °C

energy removed = ... J **[2]**

(ii) the rate at which thermal energy is removed from the milk.

rate = ... $J\,s^{-1}$ **[1]**

(c) Another container full of milk is placed in a freezer and cooled from 18 °C to –18 °C.

Assume that thermal energy is removed at a constant rate and that the freezing-point of milk is 0 °C. The specific heat capacity of milk below 0 °C is significantly less than its value above 0 °C.

On Fig. 3.1 sketch a graph to show the variation with time of the temperature of the milk over the range 18 °C to –18 °C. Numbers are not required on the time axis.

Fig. 3.1 **[3]**

[Total: 9]

4 **(a)** For a body undergoing simple harmonic motion describe the difference between

(i) *displacement* and *amplitude*

In your answer, you should use appropriate technical terms spelled correctly.

....

....

.... **[2]**

(ii) *frequency* and *angular frequency*.

....

....

.... **[2]**

(b) A harbour, represented in Fig. 4.1, has vertical sides and a flat bottom. The surface of the water in the harbour is calm.

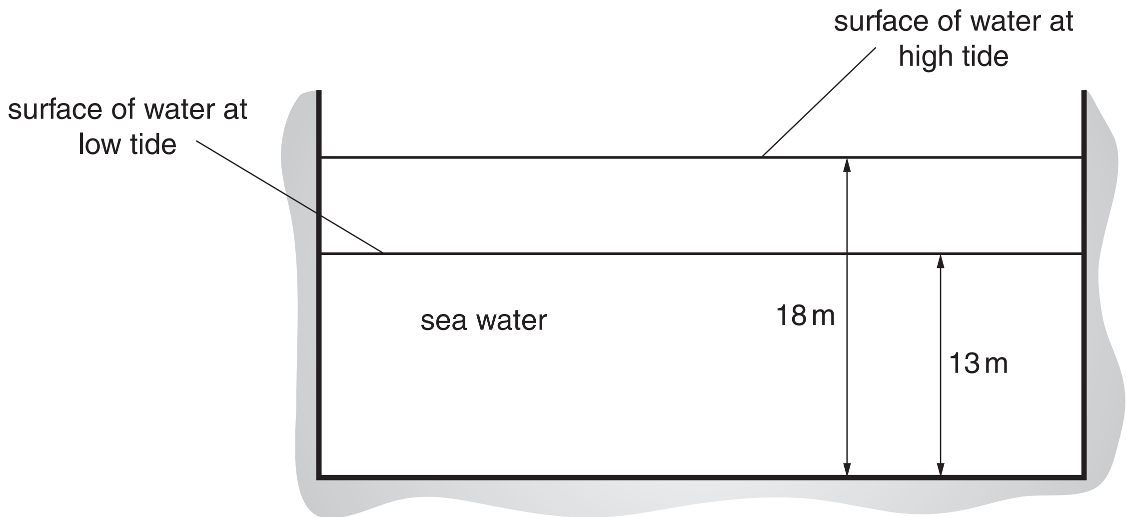

Fig. 4.1

The tide causes the surface of the water to perform simple harmonic motion with a period of 12.5 hours. The maximum depth of the water is 18 m and the minimum depth is 13 m.

(i) For the oscillation of the water surface, calculate

1 the amplitude

amplitude = ... m **[1]**

2 the frequency.

frequency = ... Hz **[2]**

(ii) Calculate the maximum vertical speed of the water surface.

maximum speed = ... $m\,s^{-1}$ **[2]**

(iii) Write an expression for the depth *d* in metres of water in the harbour in terms of time *t* in seconds.

[2]

[Total: 11]

5 **(a)** A student investigates Brownian motion by observing through a microscope smoke particles suspended in air.

(i) Describe the behaviour of the smoke particles as observed by the student.

In your answer, you should use appropriate technical terms spelled correctly.

....

.... **[1]**

(ii) State how the observations lead to conclusions about the nature and properties of the molecules of a gas.

....

....

....

....

....

....

....

.... **[3]**

(b) The molar masses of hydrogen and oxygen are $0.0020\,\text{kg}\,\text{mol}^{-1}$ and $0.032\,\text{kg}\,\text{mol}^{-1}$ respectively. The mean speed of hydrogen molecules at room temperature is $1800\,\text{m}\,\text{s}^{-1}$.

Calculate the mean speed of oxygen molecules at the same temperature.

mean speed = ... $\text{m}\,\text{s}^{-1}$ **[3]**

[Total: 7]

6 **(a)** **(i)** State Boyle's law.

....

.... **[2]**

(ii) For a gas which obeys Boyle's law, sketch

1 on Fig. 6.1 a graph of pressure p against volume V

2 on Fig. 6.2 a graph of p against $1/V$. **[3]**

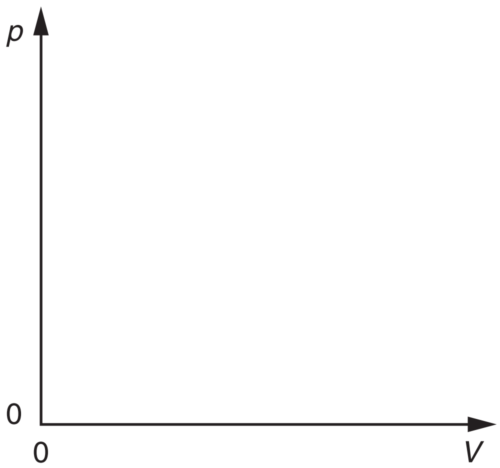

Fig. 6.1

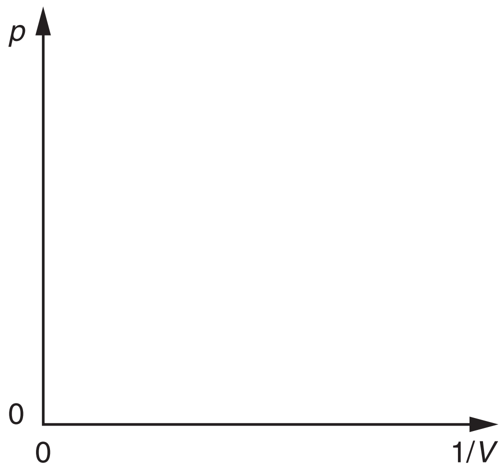

Fig. 6.2

Question 6 continues over the page.

(b) A cylinder of fixed volume 0.040 m^3 is filled with nitrogen gas at a pressure of 5.0×10^5 Pa and temperature 15 °C. The molar mass of nitrogen is 0.028 kg mol^{-1}.

(i) Calculate the number of moles of nitrogen in the cylinder.

number of moles = ... **[2]**

(ii) After a period of 100 days the pressure has fallen to 4.5×10^5 Pa, at the same temperature, because of leakage. Calculate the mass of nitrogen that has escaped.

mass = ... kg **[3]**

[Total: 10]

END OF QUESTION PAPER