Candidate forename		Candidate surname	

Centre number						Candidate number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

G484

PHYSICS A

The Newtonian World

THURSDAY 27 JANUARY 2011: Afternoon
DURATION: 1 hour

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper.

OCR SUPPLIED MATERIALS:
Data, Formulae and Relationships Booklet

OTHER MATERIALS REQUIRED:
Electronic calculator

READ INSTRUCTIONS OVERLEAF

DC (AC/SW) 11MEP01225 41084/1

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**

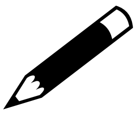
- **Use black ink. Pencil may be used for graphs and diagrams only.**

- **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.**

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.

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.

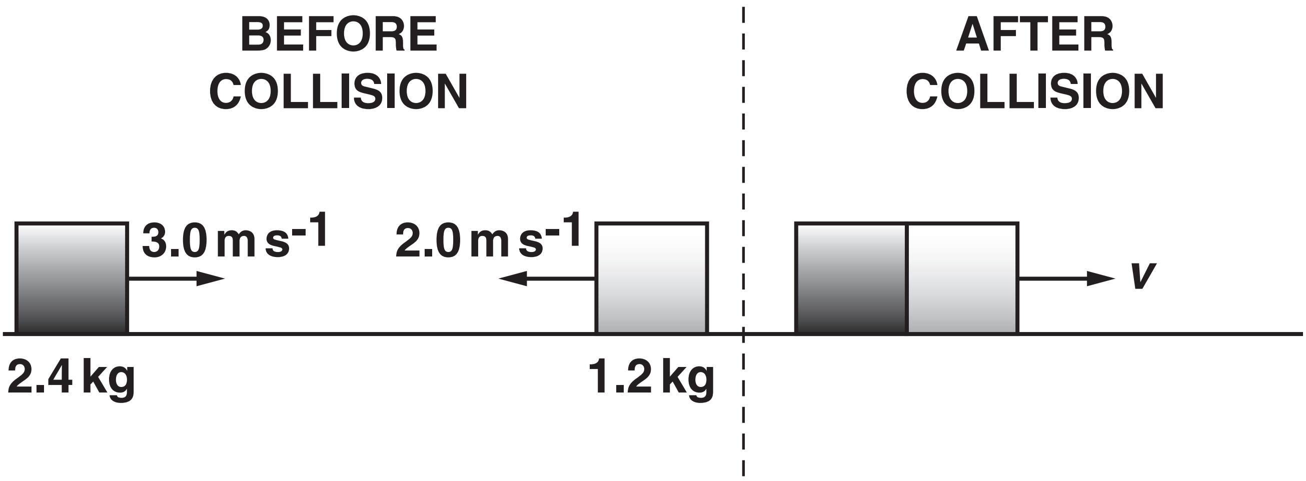


Fig. 1.1

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.

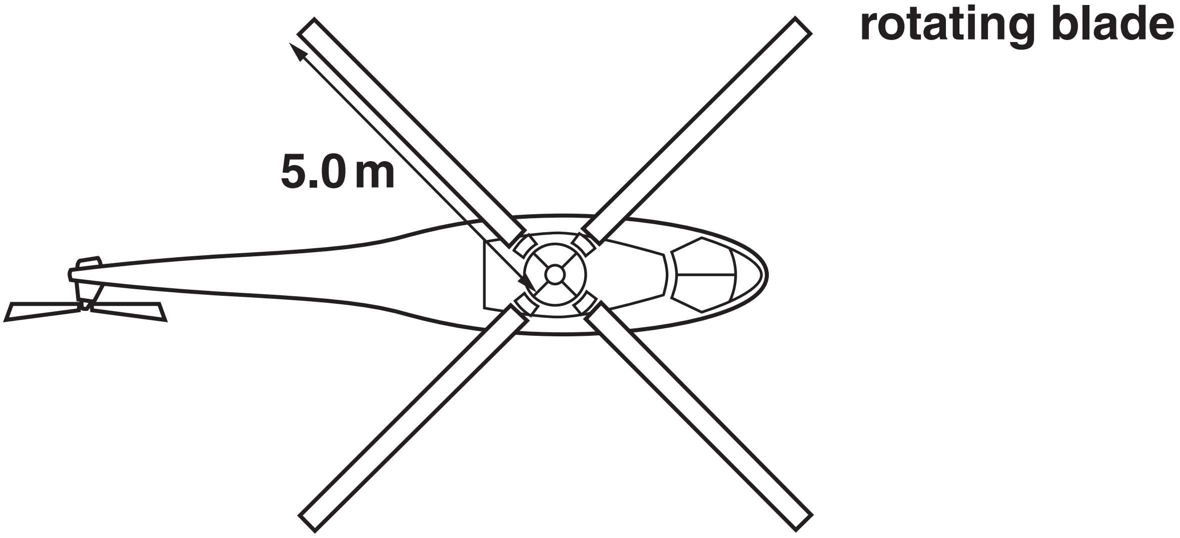


Fig. 1.2

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 $3700\,\text{m}\,\text{s}^{-1}$.

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.

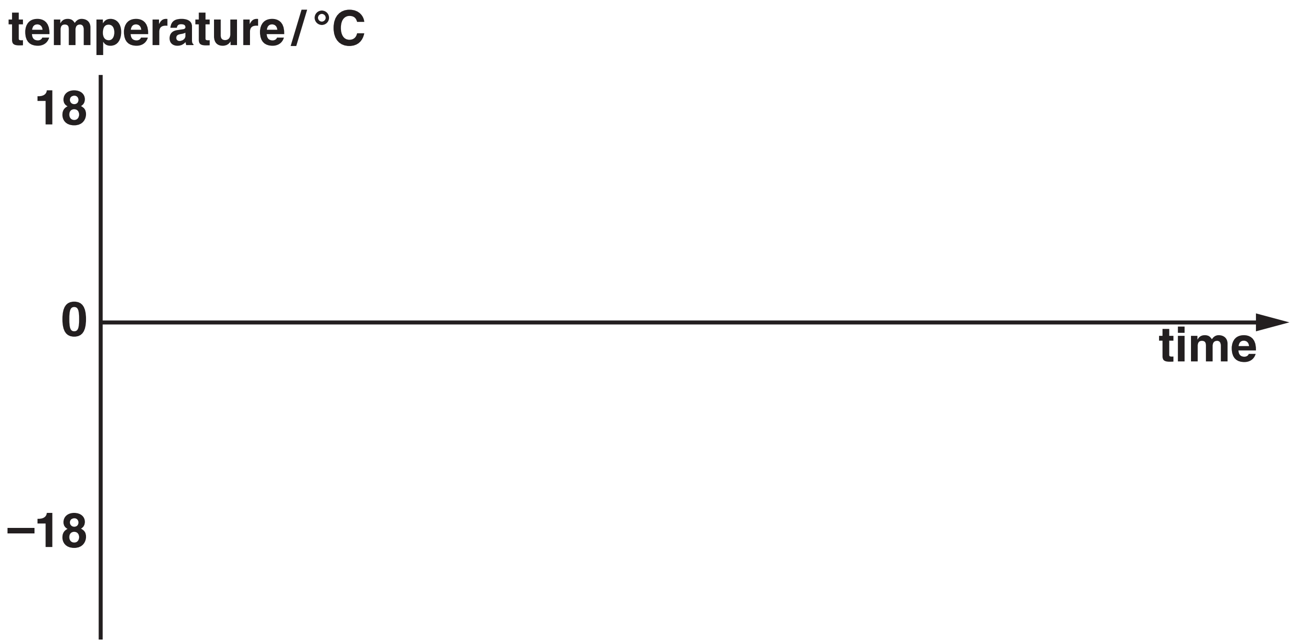


Fig. 3.1

[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.**

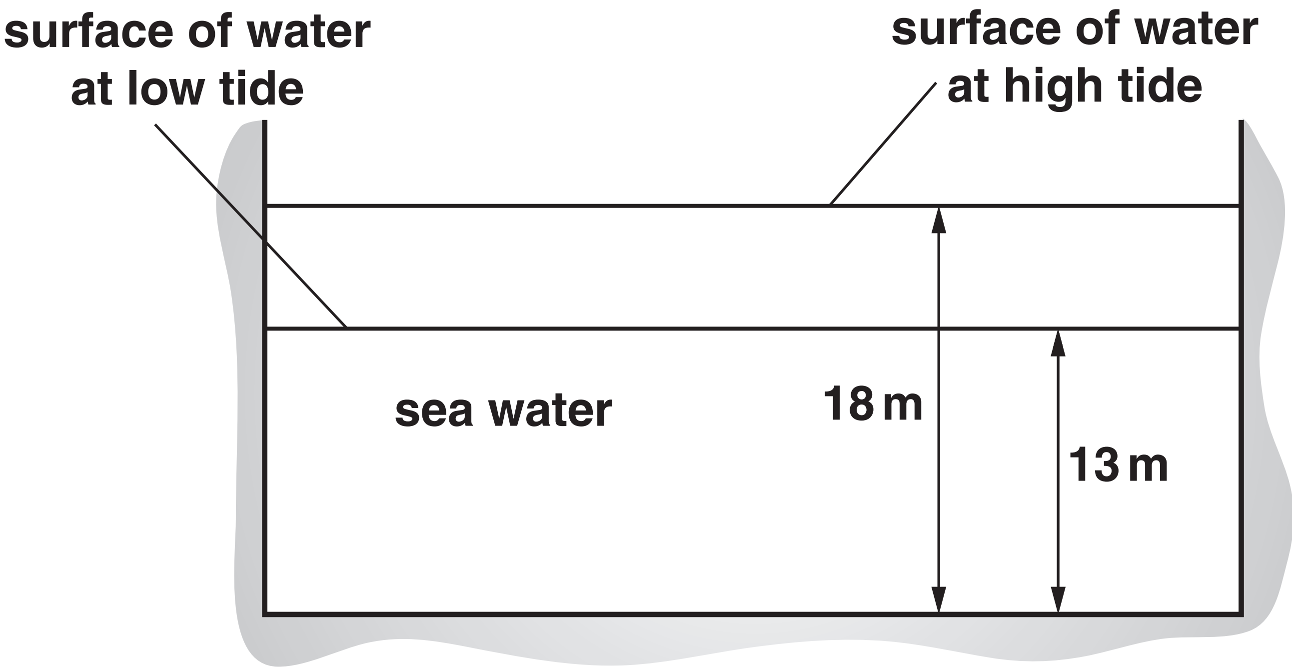


Fig. 4.1

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 kg mol^{-1} and 0.032 kg mol^{-1} respectively. The mean speed of hydrogen molecules at room temperature is 1800 m s^{-1}.**

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

mean speed = ____________________ m 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]

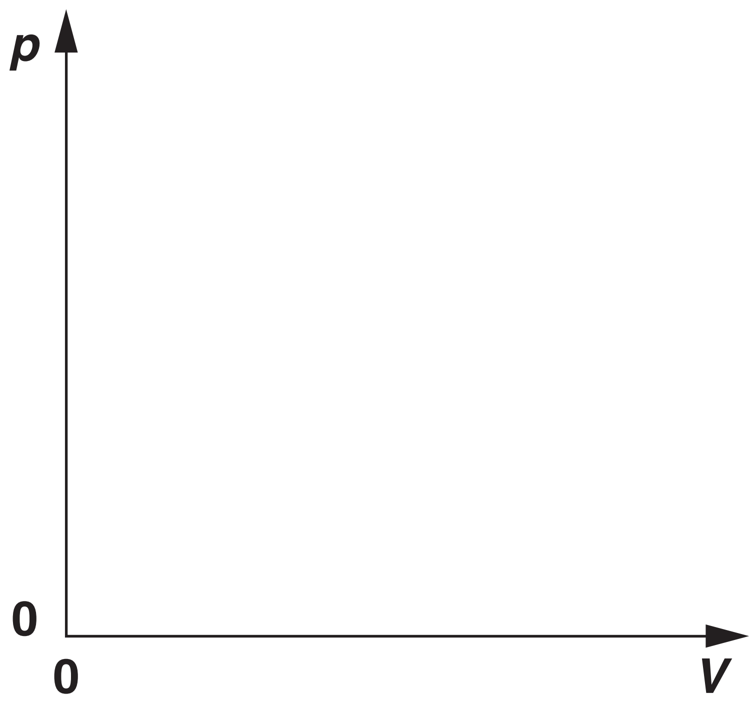


Fig. 6.1

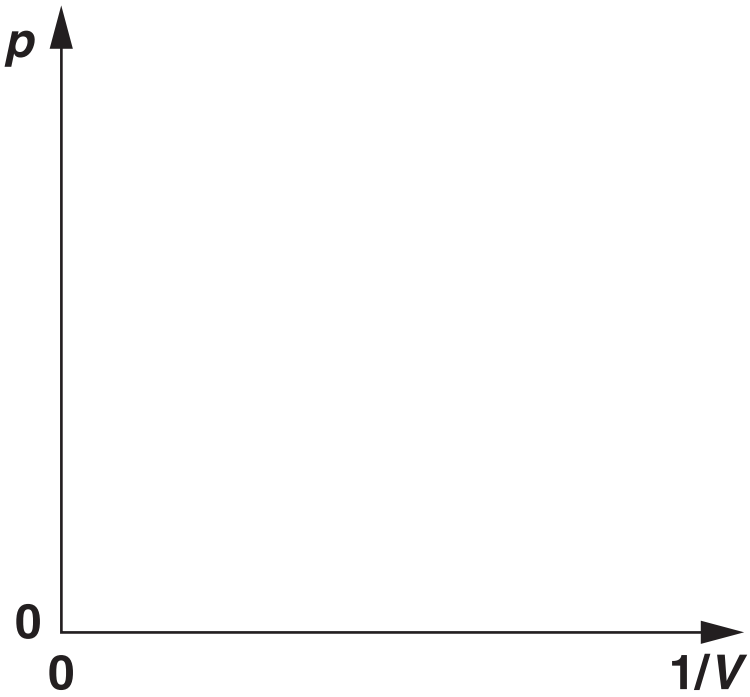


Fig. 6.2

(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