



**ADVANCED GCE**

**PHYSICS A**

The Newtonian World

**G484**

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	
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Centre number						Candidate number				
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**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.

2

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.

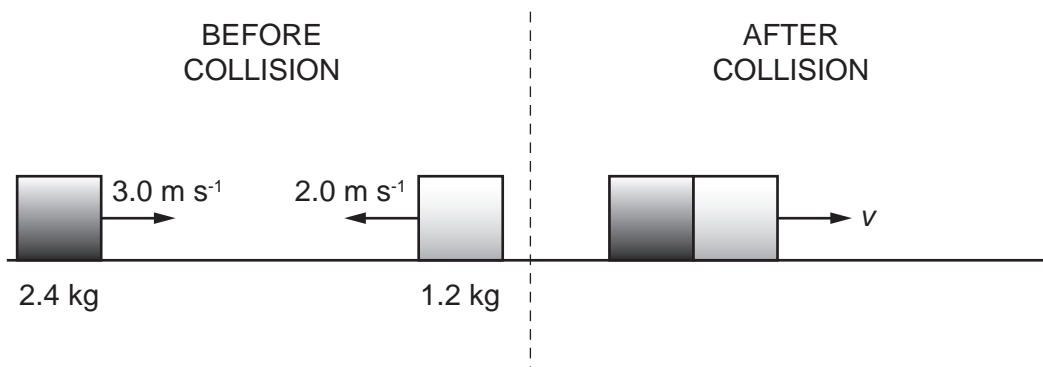


Fig. 1.1

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

1 Calculate the speed  $v$ .

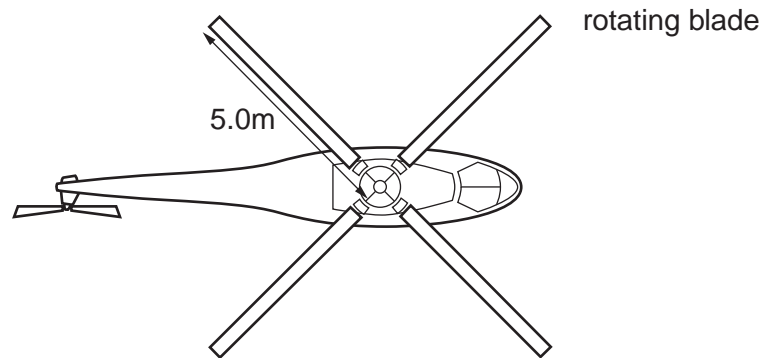
$v = \dots\dots\dots \text{ m s}^{-1}$  [2]

2 Show that this collision is inelastic.

[2]

3

(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  $12 \text{ m s}^{-1}$ . Assume that the descending air occupies a uniform cylinder of radius 5.0 m.

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

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

[2]

**4****(ii)** Calculate

- 1** the momentum of this mass of descending air

momentum = .....  $\text{kgms}^{-1}$  **[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]**

5

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

The mass  $M$  of the Earth is  $6.0 \times 10^{24} \text{ kg}$ .

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  $2.0 \times 10^7 \text{ m}$ . Calculate the speed of the satellite in this orbit.

speed = .....  $\text{m s}^{-1}$  [2]

[Total: 10]

6

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

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

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

cost = £ ..... [2]

(b) A large jug containing 2.0kg 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<sup>-1</sup> K<sup>-1</sup>.

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 = ..... Js<sup>-1</sup> [1]

## 7

(c) Another container full of milk is placed in a freezer and cooled from  $18^{\circ}\text{C}$  to  $-18^{\circ}\text{C}$ .

Assume that thermal energy is removed at a constant rate and that the freezing-point of milk is  $0^{\circ}\text{C}$ . The specific heat capacity of milk below  $0^{\circ}\text{C}$  is significantly less than its value above  $0^{\circ}\text{C}$ .

On Fig. 3.1 sketch a graph to show the variation with time of the temperature of the milk over the range  $18^{\circ}\text{C}$  to  $-18^{\circ}\text{C}$ . Numbers are not required on the time axis.



Fig. 3.1

[3]

[Total: 9]

8

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]

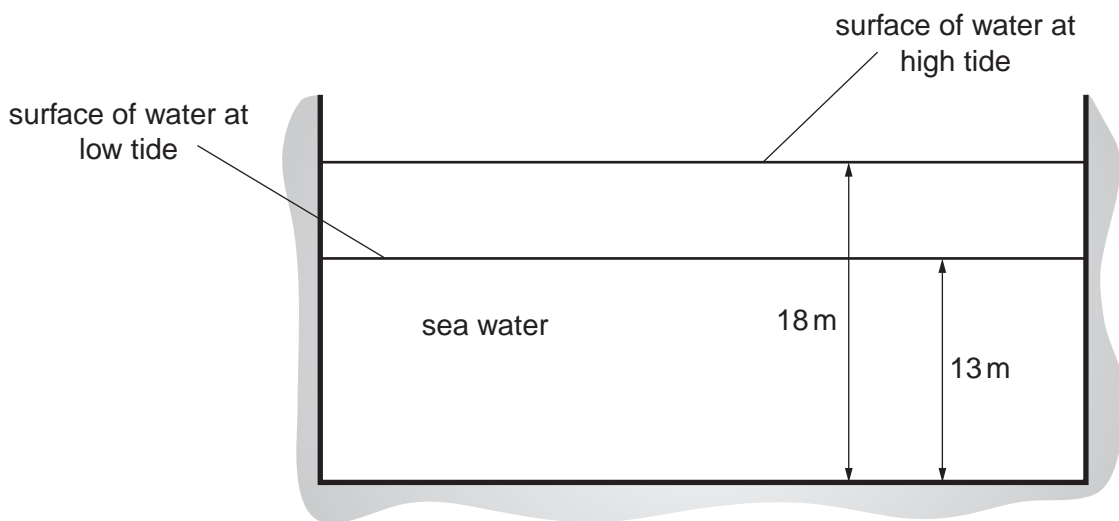
(ii) *frequency* and *angular frequency*.

.....

.....

..... [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.



**9**

(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 = .....  $\text{ms}^{-1}$  [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]

10

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  $0.0020 \text{ kg mol}^{-1}$  and  $0.032 \text{ kg mol}^{-1}$  respectively. The mean speed of hydrogen molecules at room temperature is  $1800 \text{ m s}^{-1}$ .

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

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

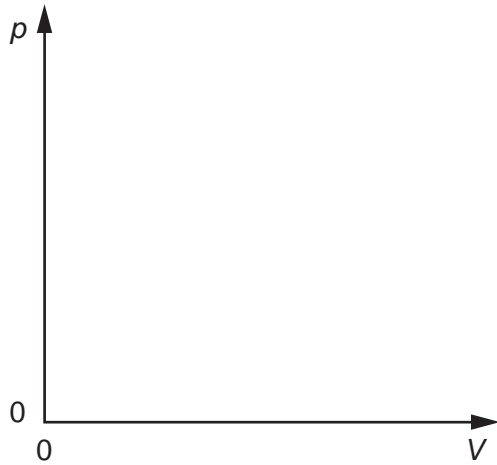


Fig. 6.1

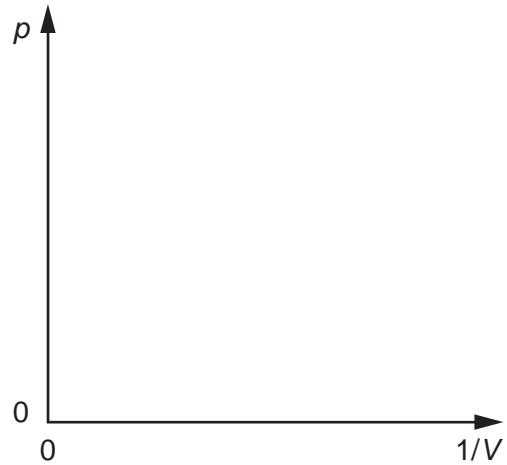


Fig. 6.2

Question 6 continues over the page.

## 12

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

(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  $4.5 \times 10^5\text{ Pa}$ , at the same temperature, because of leakage. Calculate the mass of nitrogen that has escaped.

mass = ..... kg [3]

[Total: 10]

**END OF QUESTION PAPER**



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