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

Monday 27 June 2011
Morning

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. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- 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.

DC (CW/DJ) 26181/4

Answer **all** the questions.

1 **(a)** **(i)** State Newton's first law of motion.

....

....

.... **[1]**

(ii) Define the *newton*.

....

.... **[1]**

(b) A jet plane on the deck of an aircraft carrier is accelerated before take-off using a catapult. The mass of the plane is 3.2×10^4 kg and it is accelerated from rest to a velocity of $55\,\mathrm{m\,s^{-1}}$ in a time of 2.2 s. Calculate

(i) the mean acceleration of the plane

mean acceleration = ... $\mathrm{m\,s^{-2}}$ **[2]**

(ii) the distance over which the acceleration takes place

distance = ... m **[2]**

(iii) the mean force producing the acceleration.

mean force = ... N **[1]**

(c) The jet plane describes a **horizontal** circle of radius 870 m flying at a constant speed of 120 m s^{-1}.

(i) State the direction of the resultant horizontal force acting on the plane.

.... **[1]**

(ii) Calculate the magnitude of this horizontal force.

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

(d) By changing the velocity of the plane it can be made to fly in a **vertical** circle of radius 1500 m. At a particular point in the vertical circle, the contact force between the pilot and his seat may be zero and the pilot experiences "weightlessness".

(i) State and explain at what point in the circle this weightlessness may occur.

....

....

....

.... **[2]**

(ii) Calculate the speed of the plane at which weightlessness occurs.

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

[Total: 14]

2 **(a)** Fig. 2.1 shows a mass attached to the end of a spring. The mass is pulled down and then released. The mass performs vertical simple harmonic motion.

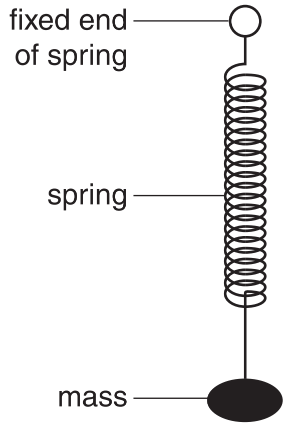

Fig. 2.1

(i) Define *simple harmonic motion*.

....

....

....

.... **[2]**

(ii) Mark the following statements about the oscillating mass-spring system as *true* or *false*. **[2]**

statement	**true/false**
The period of oscillation is constant.	
The net force on the mass is equal to its weight.	
The acceleration of the mass is a maximum at the mid-point of the oscillations.	
The velocity of the mass is proportional to the displacement.	

(b) A student wishes to investigate whether the period of oscillation of a simple pendulum is constant for all angles of swing. Describe how the student should carry out the investigation. Include the following in your description:

- a sketch of the apparatus with angle of swing labelled
- details of how the measurements would be made
- how these results would be used to form a conclusion
- the major difficulty likely to be encountered and how this might be overcome.

Sketch:

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... **[5]**

[Total: 9]

3 **(a)** Define *gravitational field strength*.

....

.... **[1]**

(b) The table shows, in modern units, information that was known to physicists at the time of Isaac Newton.

position	distance r from centre of the Earth / km	gravitational field strength g due to the Earth / $N\,kg^{-1}$
surface of Earth	6.4×10^3	9.8
Moon's orbit	3.8×10^5	2.7×10^{-3}

Use the information provided in the table to

(i) state a relationship between the gravitational field strength g and the distance r and verify this relationship

....

.... **[3]**

(ii) show that the mass of the Earth is about 6×10^{24} kg

[2]

(iii) determine the mean density of the Earth.

density = ... $kg\,m^{-3}$ **[2]**

[Total: 8]

4 **(a)** *In your answer you should use appropriate technical terms spelled correctly.*

State the terms used to describe the thermal energy required to change

(i) a solid into a liquid at a constant temperature

.... **[1]**

(ii) a liquid into a gas at a constant temperature.

.... **[1]**

(b) Most households waste energy by overfilling electric kettles. Assume that, on average, 0.80 kg of water per household per day is unnecessarily boiled.

(i) Estimate the energy required when 0.80 kg of water, initially at 18 °C, is heated in an electric kettle. The kettle switches off automatically when the water is boiling steadily at 100 °C. The specific heat capacity of water is 4200 $J\,kg^{-1}\,K^{-1}$.

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

(ii) State and explain **two** different reasons why the actual quantity of energy required to warm the water to 100 °C is greater than the estimate in **(i)**.

1. ....

....

2. ....

.... **[2]**

(iii) Calculate, in kW h, the average annual energy wasted per household by boiling too much water.

energy = ...kW h **[2]**

[Total: 8]

5 **(a)** One assumption required for the development of the kinetic model of a gas is that molecules undergo perfectly elastic collisions with the walls of their containing vessel and with each other.

(i) Explain what is meant by a *perfectly elastic collision*.

....

.... **[1]**

(ii) State **three** other assumptions of the kinetic theory of gases.

1. ....

....

2. ....

....

3. ....

.... **[3]**

(b) Fig. 5.1 shows a cubical box of side length 0.20 m. The box contains one molecule of mass 4.8×10^{-26} kg moving with a constant speed of $500\,\mathrm{m\,s^{-1}}$. The molecule collides elastically at right angles with the opposite faces **X** and **Y** of the box.

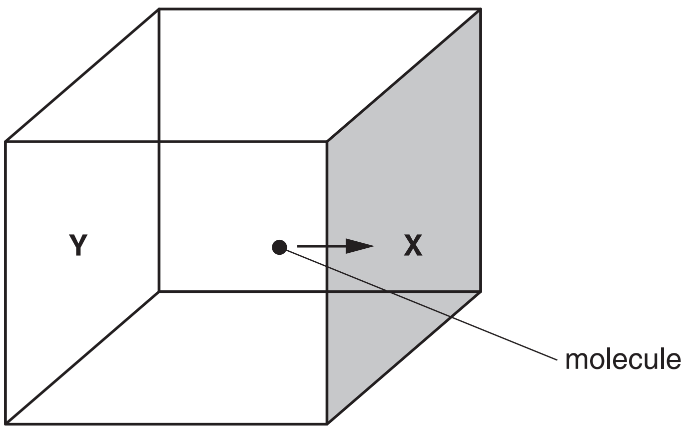

Fig. 5.1

(i) Calculate the change of momentum each time the molecule collides with face **X**.

change of momentum = ... $\mathrm{kg\,m\,s^{-1}}$ **[2]**

(ii) Calculate the number of collisions made by the molecule with face **X** in 1.0 s.

number = ... **[1]**

(iii) Calculate the mean force exerted on the molecule by face **X**.

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

(iv) Hence state the force exerted on face **X** by the molecule. Justify your answer.

....

.... **[1]**

(c) The single molecule in the box in **(b)** is replaced by 3 moles of air at atmospheric pressure.

(i) Calculate the number of air molecules in the box.

number = ... **[1]**

(ii) Suggest why the pressure exerted by the air on each of the six faces of the box is the same.

....

.... **[1]**

(iii) The temperature of the air inside the box is increased. Explain in terms of the **motion** of the air molecules how the pressure exerted by the air will change.

....

....

.... **[2]**

[Total: 14]

6 **(a)** **(i)** A container has **1 mole** of an ideal gas. The volume of the container is V cubic metres (m^3) and the gas exerts pressure p pascal (Pa). On Fig. 6.1, show the relationship between the product pV and the absolute temperature T of the gas. **[1]**

Fig. 6.1

(ii) State the value of the gradient of this graph.

.... **[1]**

(b) The volume of 1.5 moles of an ideal gas at −40 °C is 2.4×10^{-2} m^3. The gas is now heated at constant pressure p. Calculate

(i) the new volume of the gas at a temperature of 250 °C

volume = ... m^3 **[3]**

(ii) the value of the pressure p.

p = ... Pa **[2]**

[Total: 7]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

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