OCR
RECOGNISING ACHIEVEMENT

Wednesday 16 January 2013 – Afternoon

A2 GCE PHYSICS A

G484/01 The Newtonian World

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator

Duration: 1 hour 15 minutes

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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- 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).
- 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 **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 **(a)** State, in words, Newton's second law of motion.

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

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.... **[2]**

(b) Fig. 1.1 shows the masses and velocities of two objects **A** and **B** moving directly towards each other. **A** and **B** stick together on impact and move with a common velocity *v*.

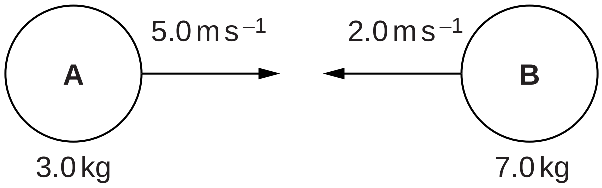

Fig. 1.1

(i) Determine the velocity *v*.

magnitude of velocity = ... $m\,s^{-1}$

direction = ...
[3]

(ii) Determine the impulse of the force experienced by the object **A** and state its direction.

impulse = ...N s

direction = ...
[2]

(iii) Explain, using Newton's third law of motion, the relationship between the impulse experienced by **A** and the impulse experienced by **B** during the impact.

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.... **[2]**

[Total: 9]

2 A satellite orbits the Earth in a circular path 800 km above the Earth's **surface**. At the orbit of the satellite the gravitational field strength is 7.7 N kg^{-1}. The radius of the Earth is 6400 km.

(a) Calculate

(i) the orbital speed of the satellite

orbital speed = ... m s^{-1} **[3]**

(ii) the period of the orbit of the satellite.

period = ... s **[2]**

(b) The orbit of the satellite passes over the Earth's poles.

(i) Show that the satellite makes about 14 orbits around the Earth in 24 hours.

[1]

(ii) The cameras on board the satellite continually photograph a strip of the Earth's surface, of width 3000 km, directly below the satellite. Determine, with an appropriate calculation, whether the satellite can photograph the whole of the Earth's surface in 24 hours. State your conclusion.

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.... **[3]**

(c) Suggest a practical use of such a satellite.

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.... **[1]**

[Total: 10]

3 **(a)** State, in words, Newton's law of gravitation.

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.... **[1]**

(b) Fig. 3.1 shows the circular orbits of two of Jupiter's moons: Adrastea, **A**, and Megaclite, **M**.

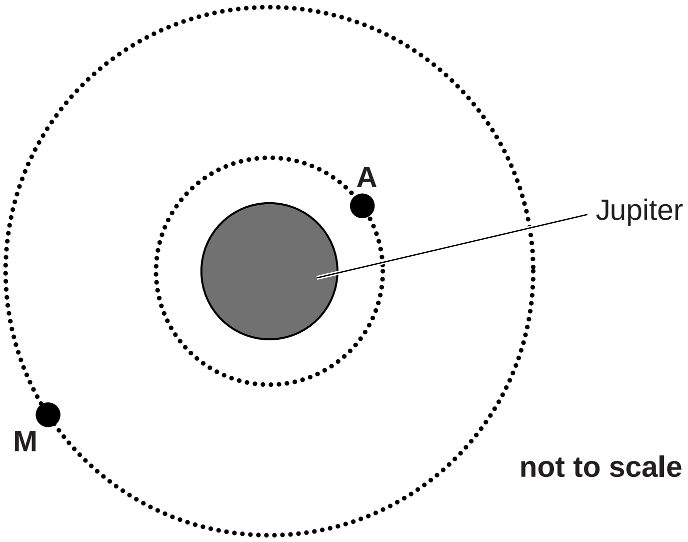

Fig. 3.1

Use the following data in the calculations below.

orbital radius of **A** = 1.3×10^{8} m
orbital period of **A** = 7.2 hours
gravitational field strength at orbit of **A** = 7.5 N kg^{-1}
orbital radius of **M** = 2.4×10^{10} m

Calculate

(i) the mass of Jupiter

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

(ii) the gravitational field strength at the orbit of **M**

gravitational field strength = ... $N\,kg^{-1}$ **[2]**

(iii) the orbital period of **M**.

orbital period = ... hours **[3]**

[Total: 9]

4 Fig. 4.1 shows slotted masses suspended from a spring. The spring is attached to a fixed support at its upper end.

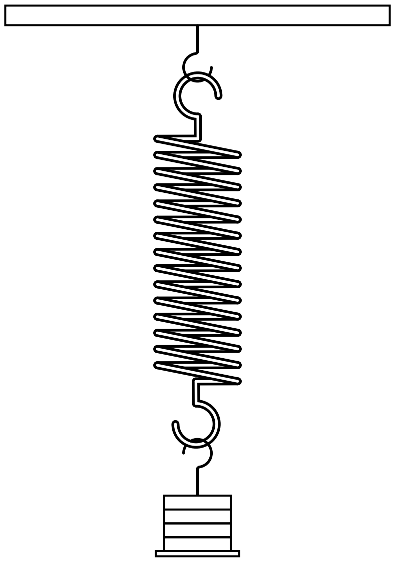

Fig. 4.1

When the masses are pulled down a short distance from the equilibrium position and released they oscillate vertically with simple harmonic motion. The frequency f of these oscillations depends on the mass m of the masses.
Two students make different predictions about the relationship between f and m.
One suggests f is proportional to $1/m$ and the other believes f is proportional to $1/\sqrt{m}$.

(a) Describe how you would test experimentally which prediction is correct.
Include in your answer:

- the measurements you would take, and
- how you would use these measurements to test each prediction.

You should also discuss ways of making the test as reliable as possible.

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.... **[4]**

(b) When the masses hanging on the spring are 400 g in total, they oscillate with an amplitude of 36 mm and a period of 1.2 s. Calculate

(i) the maximum kinetic energy of the masses

maximum kinetic energy = ... J **[3]**

(ii) the maximum acceleration of the masses.

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

(c) List the different types of energy involved in the oscillations of this mass-spring system. Describe the energy changes when the masses move from the lowest point of the oscillation to the highest point.

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

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.... **[4]**

[Total: 13]

5 **(a)** **(i)** The pressure *p* and volume *V* of a quantity of an ideal gas at absolute temperature *T* are related by the equations $pV = nRT$ and $pV = NkT$. In these equations identify the symbols *n* and *N*.

n ....

N.. **[1]**

(ii) Choose one of the equations in **(i)** and show how Boyle's law follows from it.

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.... **[2]**

(iii) Show that the product of *pV* has the same units as work done.

[1]

(b) The graph in Fig. 5.1 shows the variation of pressure, *p*, with the reciprocal of volume, 1/*V*, of 0.050 kg of oxygen behaving as an ideal gas.

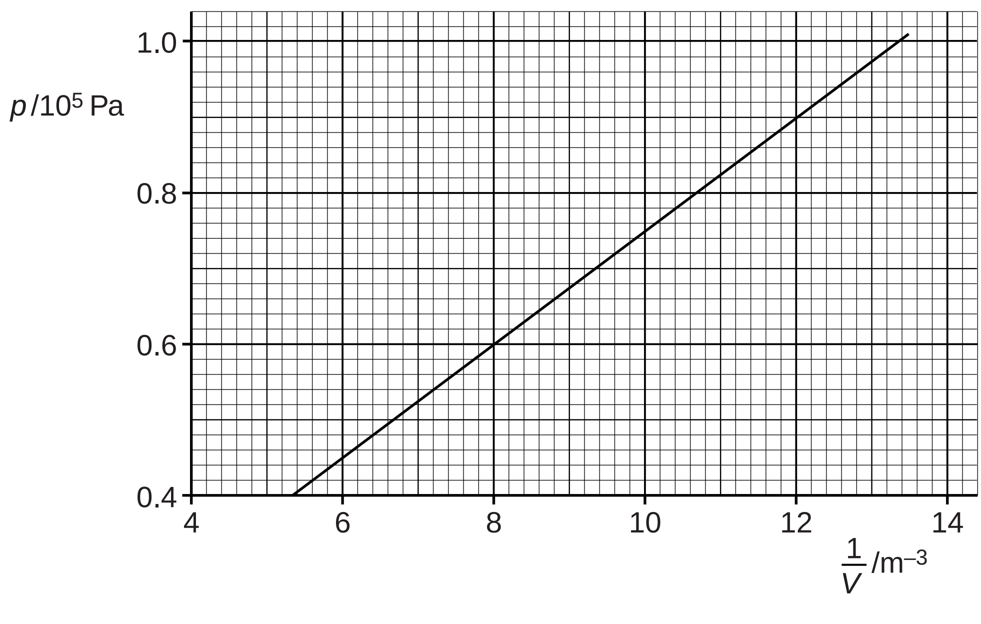

Fig. 5.1

(i) Use the graph to show that the variation of p with $\frac{1}{V}$ is taking place at constant temperature.

[2]

(ii) The molar mass of oxygen is 0.016 kg mol^{-1}. Calculate the temperature, in °C, of the oxygen in **(i)**.

temperature = ... °C **[3]**

[Total: 9]

6 (a) Describe

(i) the motion of atoms in a solid at a temperature well below its melting point

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.... **[1]**

(ii) the effect of a small increase in temperature on the motion of these atoms

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.... **[1]**

(iii) the effect on the internal energy and temperature of the solid when it melts.

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.... **[2]**

(b) Fig. 6.1 shows the apparatus used to determine the specific heat capacity of a metal. A block made of the metal is heated by an electrical heater that produces a constant power of 48 W. In order to reduce heat loss from the sides, top and bottom of the block, it is covered by a layer of insulating material.

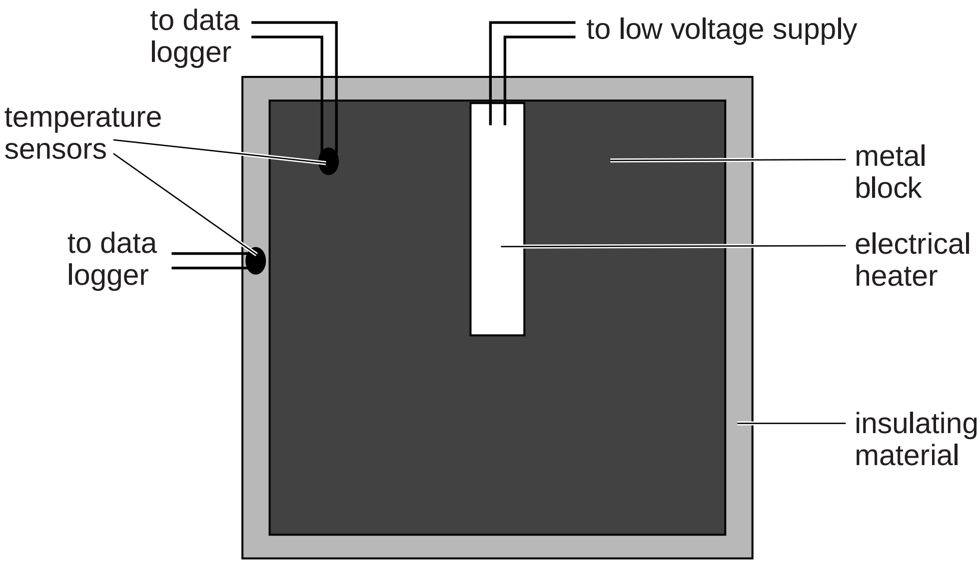

Fig. 6.1

Temperature sensors connected to a data logger show that the block and insulation are initially at the room temperature of 18 °C. The heater is switched on and after 720 seconds the sensors show that the temperature of the block is 54 °C and the average temperature of the insulating material is 38 °C.

(i) Use the information given above and the data shown below to determine the specific heat capacity of the metal block.

mass of metal block = 0.98 kg
power of heater = 48 W
specific heat capacity of the insulating material = 850 J kg^{-1} K^{-1}
mass of the insulating material = 0.027 kg

specific heat capacity = ... J kg^{-1} K^{-1} **[4]**

(ii) A second experiment is done without the insulating material and with the block again starting at 18 °C. Discuss whether the value of the specific heat capacity calculated from the second experiment is likely to be lower, the same or higher than the value calculated in **(i)**.

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.... **[2]**

[Total: 10]

END OF QUESTION PAPER