OCR
Oxford Cambridge and RSA

Monday 20 June 2016 – Morning

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

* G 4 8 4 0 1 *

* 1 3 2 0 8 1 6 3 6 7 *

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. 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.
- 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 **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 A ball is held above level ground. It is then dropped from rest at time $t = 0$.
Fig. 1.1 shows the velocity v against time t graph for this ball bouncing vertically.
Ignore the effect of air resistance.

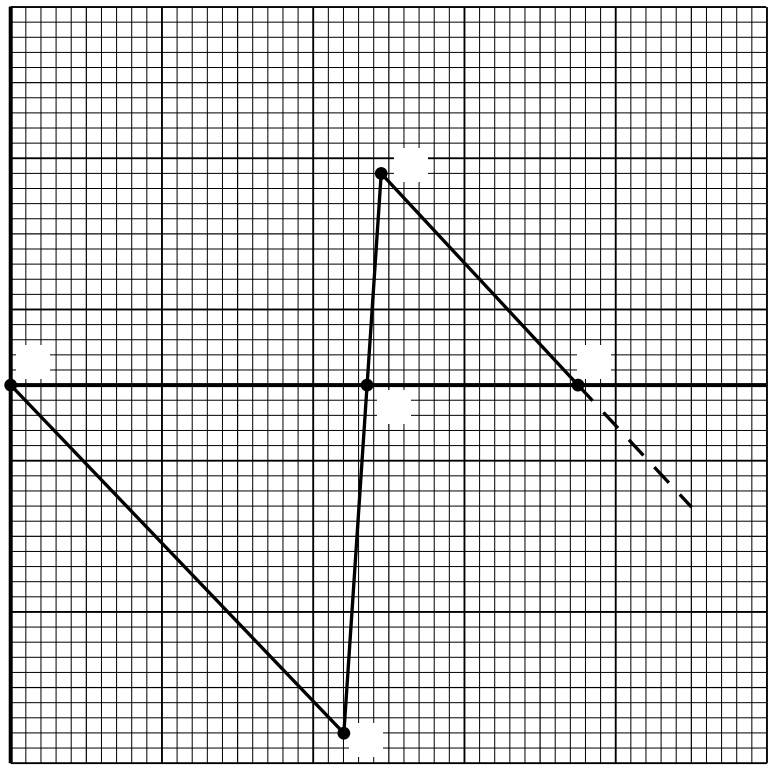

Fig. 1.1

(a) (i) Explain why the gradient of the line **DE** is the same as the gradient of the line **AB**.

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

.....

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

(ii) Explain why the area of triangle **ABC** is not the same as the area of triangle **CDE**.

.....

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.....

..... **[2]**

(b) The ball, of mass 0.13 kg, was dropped from an initial height of 1.7 m. It remained in contact with the ground for 75 ms while experiencing a mean upward force of 16 N.

Calculate

(i) the speed of the ball immediately before impact with the ground

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

(ii) the speed of the ball immediately at **D**

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

(iii) the maximum height reached after the first bounce.

height = ... m **[1]**

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

.....

.....

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

(b) Newton's third law suggests that forces always occur in pairs when two objects interact.

(i) State **two** ways in which the forces in such a pair are identical.

.....

.....

..... **[2]**

(ii) State **two** ways in which these forces are different.

.....

.....

..... **[2]**

(c) Fig. 2.1 shows a fireman using a hosepipe held at 55° to the horizontal. The cross-sectional area of the hosepipe nozzle is $3.3 \times 10^{-4}\,m^2$. Water is ejected from the nozzle at $25\,m\,s^{-1}$.

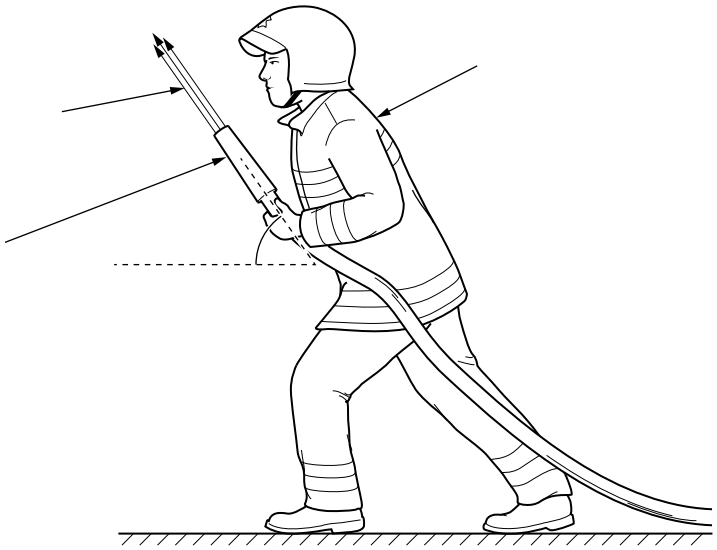

Fig. 2.1

(i) Show that the rate at which water is ejected from the nozzle is about $8.3\,kg\,s^{-1}$.

density of water = $1.0 \times 10^3\,kg\,m^{-3}$

[1]

(ii) The mass of the fireman is 92 kg. Determine the vertical component of the force exerted by the ground on the fireman's feet.

force = ... N **[3]**

3 **(a)** Fig. 3.1 shows a displacement against time graph of an object undergoing simple harmonic motion. Seven points, **A** to **G**, have been labelled on the graph.

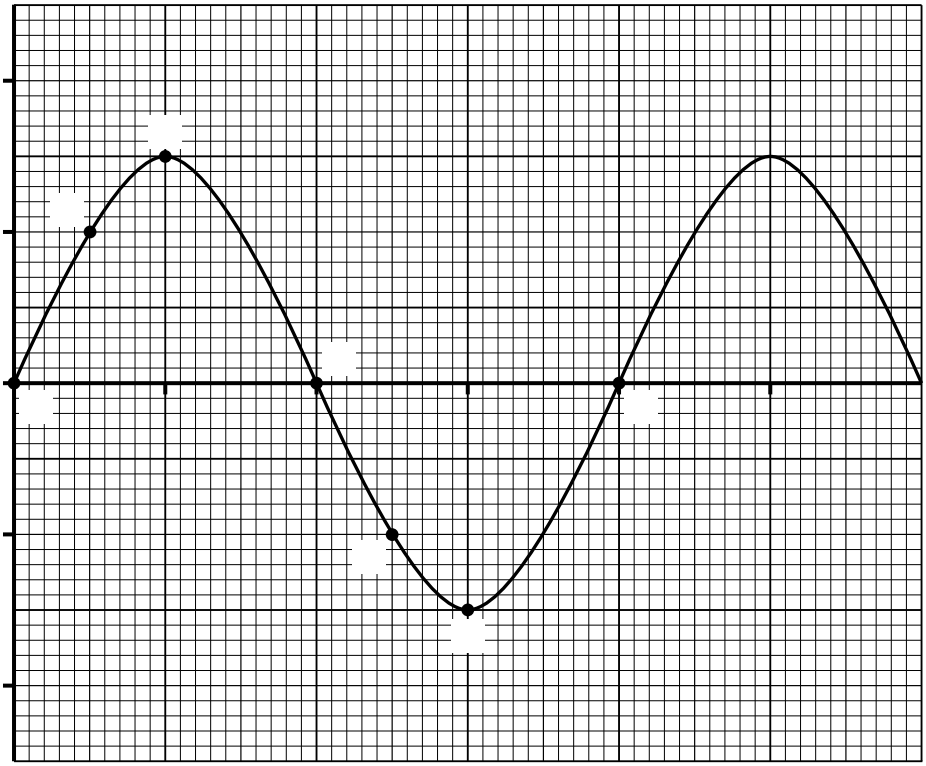

Fig. 3.1

(i) Write down two points that indicate when the object is at its amplitude position.

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

(ii) Write down a point which lags behind **D** by half a period.

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

(iii) Determine the phase difference, in radians, between points **B** and **F**.

phase difference = ... rad **[1]**

(b) Fig. 3.2 shows an airtrack glider of mass 0.45 kg held in equilibrium by two identical stretched springs. The glider is pulled 5.0 cm to the left. When released, it oscillates without friction. The springs are always in tension.

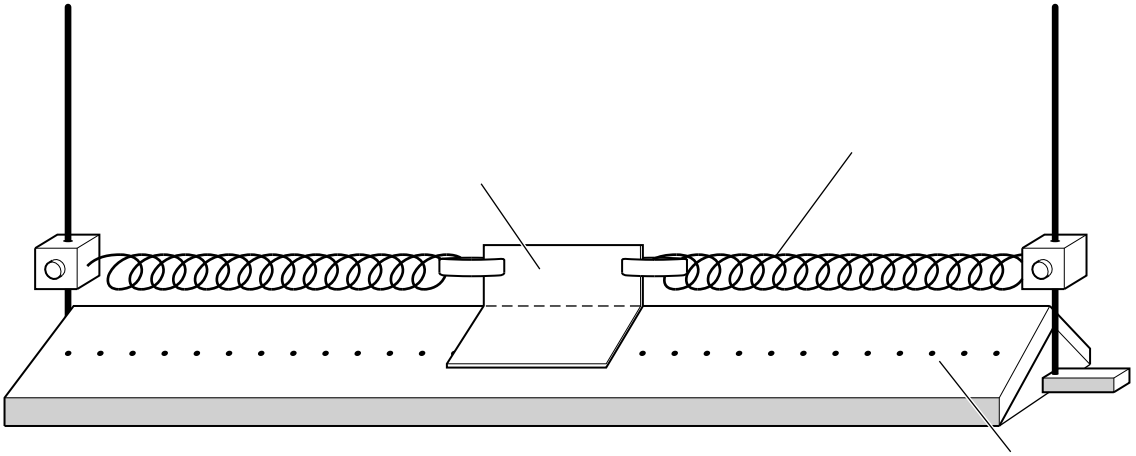

Fig. 3.2

The variation of elastic potential energy stored in the springs with displacement, *x*, of the glider is shown in Fig. 3.3.

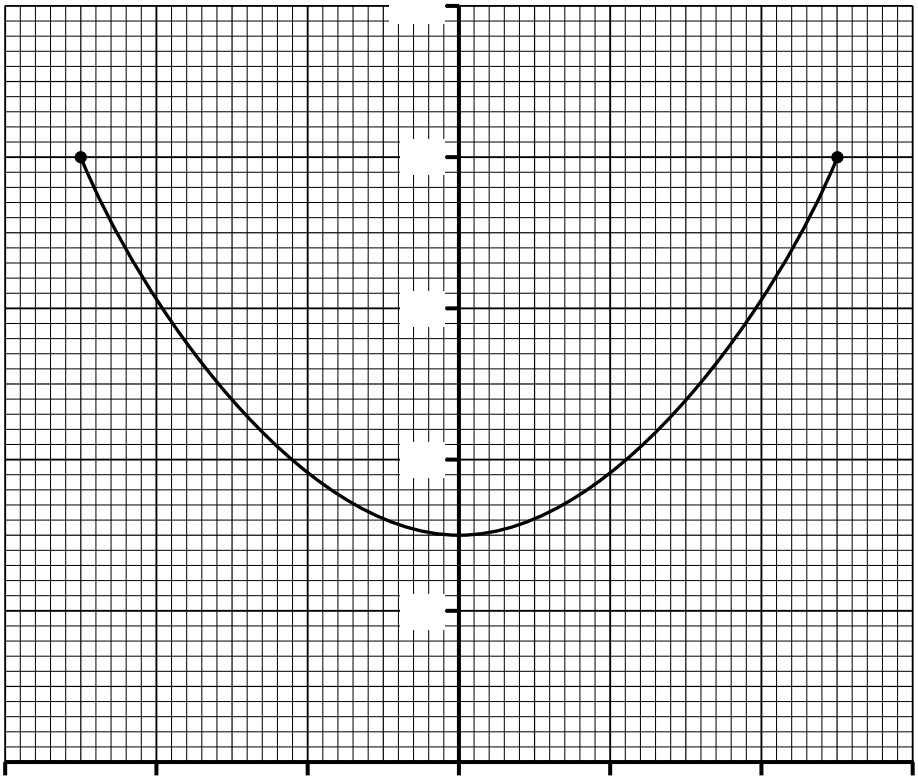

Fig. 3.3

(i) Draw on Fig. 3.3 a graph to show the variation of kinetic energy with displacement of the glider. **[2]**

(ii) Calculate the maximum speed of the glider.

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

(iii) Determine the period of the oscillations.

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

4 This question is about Mars and its two moons, Phobos and Deimos.

(a) Calculate

(i) the mass of Mars

gravitational field strength on the surface of Mars is $3.7\,N\,kg^{-1}$
radius of Mars is $3.4 \times 10^3\,km$

mass = ... kg **[2]**

(ii) the gravitational field strength at a height of 3.4×10^3 km **above** the surface of Mars.

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

(b) (i) State Kepler's third law.

.....

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

(ii) Phobos completes a circular orbit of mean radius 9.4×10^3 km in 7.7 hours. Deimos completes its orbit in 30 hours.
Calculate the mean radius of the orbit of Deimos.

mean radius = ... km **[2]**

(c) Recent observations of Phobos indicate that it is slowly spiralling towards the surface of Mars. State and explain how you would expect this to affect the speed of Phobos.

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

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Question 5 begins on page 12

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5 A binary star consists of two stars that orbit about their common centre of mass **C**, as shown in Fig. 5.1.

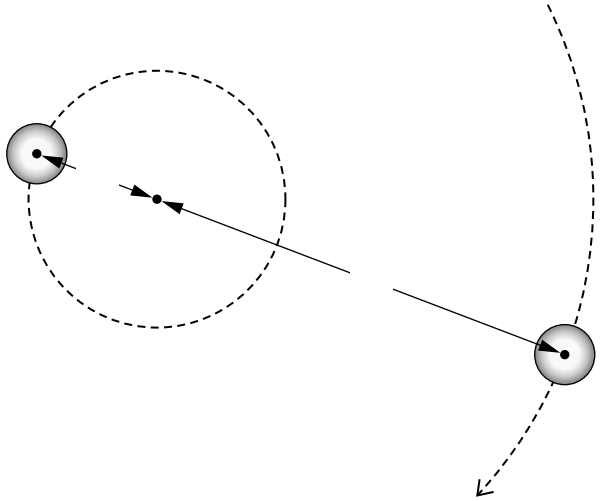

Fig. 5.1

The star $\mathbf{S_1}$ has mass M_1 and orbits in a circle of radius R_1. Star $\mathbf{S_2}$ has mass M_2 and a circular orbit of radius R_2. Both stars have the same orbital period T about **C**.

(a) Using the terms G, M_1, M_2, R_1, R_2 and T write an expression for

(i) the gravitational force F experienced by each star

[1]

(ii) the centripetal force F_1 acting on the star $\mathbf{S_1}$

[1]

(b) Use **(a)(ii)** to show that the ratio of the masses of the stars is given by the expression

$$\frac{M_1}{M_2} = \frac{R_2}{R_1}$$

[2]

(c) The ratio of the masses, M_1/M_2, is equal to 3.0 and the separation between the stars is 4.8×10^{12} m.
Calculate the radii R_1 and R_2.

R_1 = ... m

R_2 = ... m **[3]**

(d) The orbital period T of each star is 4.0 years.
Calculate the orbital speed of $\mathbf{S_1}$.

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

(e) Calculate the mass of $\mathbf{S_2}$.

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

6 Fig. 6.1 shows a tube containing small pellets of lead. When the tube is inverted the pellets of lead fall freely through a vertical height equal to the length of the tube. The pellets are warm after the tube has been inverted many times.

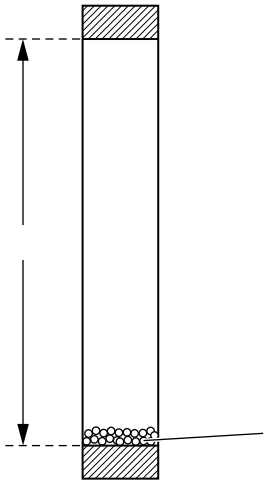

Fig. 6.1

(a) Describe the energy changes that take place to the lead pellets following one inversion of the tube.

.....

.....

..... **[2]**

(b) The tube is used in an experiment to determine the specific heat capacity of lead. The following results are obtained.

total mass of lead pellets = 0.025 kg
number of inversions = 50
length of tube = 1.2 m
change in temperature of the lead = 4.5 °C

Use this information to calculate the specific heat capacity of the lead.

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

(c) State **two** assumptions you have made in your calculation of the specific heat capacity.

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..... **[2]**

(d) State and explain the change, if any, you would expect to see in the temperature rise if the mass of the lead pellets is doubled.

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..... **[2]**

Question 7 begins on page 16

7 **(a)** Explain how the *internal energy* of an ideal gas is related to its temperature.

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

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..... **[2]**

(b) A weather balloon is designed to be inflated to a maximum volume of $1.4 \times 10^4\,m^3$. To launch the balloon it is partially inflated with 80 kg of helium at a pressure of 1.0×10^5 Pa and a temperature of 21 °C.

molar mass of helium = $0.004\,kg\,mol^{-1}$

(i) Calculate the volume of the partially inflated balloon.

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

(ii) To limit the maximum height that the balloon can reach, helium is allowed to leak out through a control valve.
Determine the number of moles of helium that need to escape for the weather balloon to reach its maximum volume when the pressure is 1.2×10^3 Pa and the temperature is –40 °C.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

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