OCR
RECOGNISING ACHIEVEMENT

Thursday 12 January 2012 – Afternoon

AS GCE PHYSICS A

G481 Mechanics

Candidates answer on the Question Paper.

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

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

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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 **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Define *acceleration*.

.....

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

(b) A super-tanker cruising at an initial velocity of $6.0\,m\,s^{-1}$ takes 40 minutes (2400 s) to come to a stop. The super-tanker has a constant deceleration.

(i) Calculate the magnitude of the deceleration.

deceleration = ... $m\,s^{-2}$ **[3]**

(ii) Calculate the distance travelled in the 40 minutes it takes the tanker to stop.

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

(iii) On Fig. 1.1, sketch a graph to show the variation of distance *x* travelled by the super-tanker with time *t* as it decelerates to a stop.

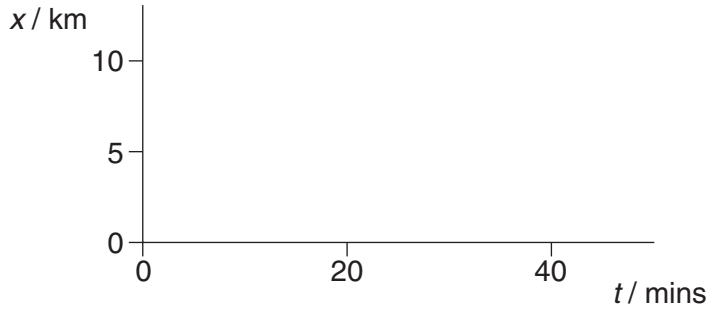


Fig. 1.1 **[2]**

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(c) A student repeats one of Galileo's classic experiments from the sixteenth century. Fig. 1.2 shows the arrangement of this experiment.

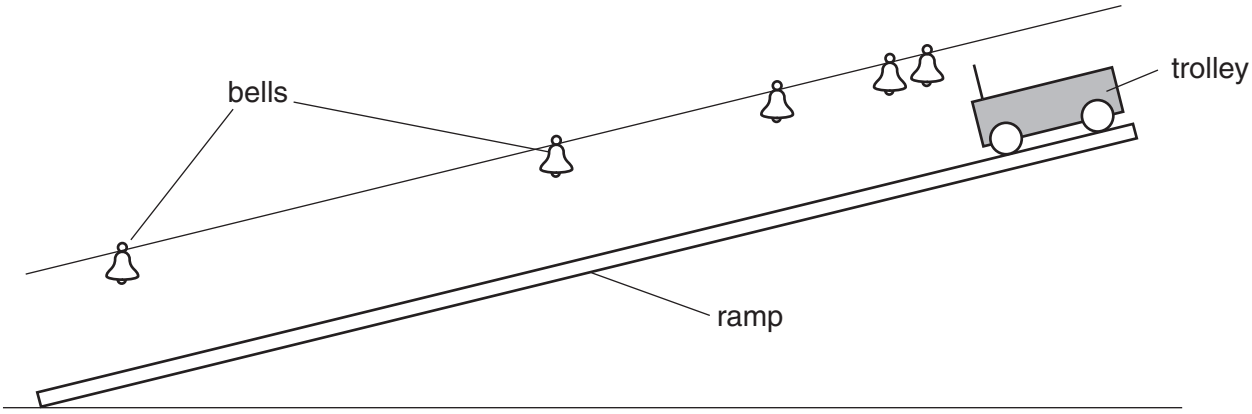


Fig. 1.2

A number of tiny bells are hung above a ramp. A trolley is released from rest from the top of the ramp. It rings each bell on its journey down the ramp. The procedure is repeated several times. The separations between the bells are adjusted until the time taken by the trolley to travel between successive bells is the **same**. This means that the bells ring at regular intervals. The distance between successive bells increases down the ramp.

(i) State what you can deduce about the motion of the trolley as it travels down the ramp.

.....

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

(ii) The positions of the bells are unchanged. The mass of the trolley is increased. This heavier trolley is released from rest from the top of the ramp. State and explain the observations made by the student for this trolley.

.....

.....

.....

.....

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

[Total: 11]

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2 **(a)** State the *principle of conservation of energy*.

.....

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

(b) Define *work done* by a force and state its unit.

definition .....

.....

.....

unit ..... **[3]**

(c) Fig. 2.1 shows a crater on the surface of the Earth.



Fig. 2.1

The crater was formed by a meteor impact about 50,000 years ago. The meteor was estimated to have a mass of 3.0×10^8 kg with an initial kinetic energy of 8.4×10^{16} J just before impact.

(i) State one major energy transformation that took place during the impact of the meteor with the Earth.

.....

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

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(ii) Show that the initial impact speed of the meteor was about $2.0 \times 10^4\,\text{m}\,\text{s}^{-1}$.

[2]

(iii) The crater is about 200 m deep. Estimate the average force acting on the meteor during the impact.

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

[Total: 10]

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3 Thinking and braking distances are important quantities when considering road safety.

(a) The driver of a car travelling at constant speed sees a hazard ahead at time $t = 0$. The reaction time of the driver is 0.5 s. On Fig. 3.1, sketch a graph of distance travelled by the car against time t during this interval of 0.5 s.

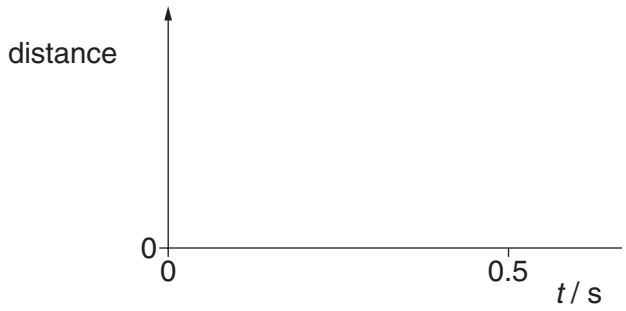


Fig. 3.1 **[1]**

(b) Explain the shape of your graph in Fig. 3.1.

.....

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

(c) Define *braking distance*.

.....

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

(d) Apart from the conditions of the tyres, brakes, road surface and weather, state two other factors that affect the **braking distance** of a car. For each factor, discuss how it affects the braking distance.

.....

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..... **[4]**

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(e) Describe and explain how seat belts reduce the forces on a driver during the impact in an accident.

.....

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.....

.....

.....

.....

..... **[3]**

[Total: 10]

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4 **(a)** Define *moment of a force*.

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

.....

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

(b) State the two conditions that apply when an object is in equilibrium.

1. .....

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

(c) Fig. 4.1 is a diagram of a human arm lifting an object.

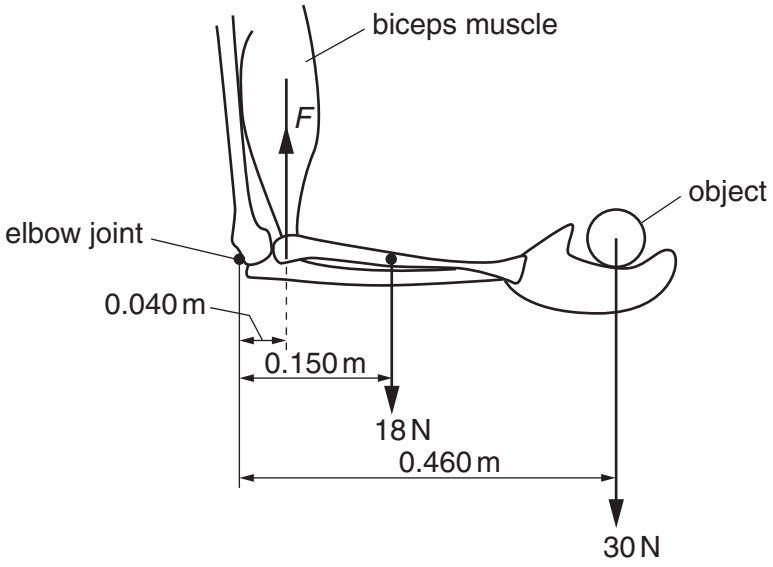


Fig. 4.1

The lower arm is horizontal and its centre of gravity is 0.150 m from the elbow joint. The weight of the lower arm is 18 N. The biceps muscle exerts a vertical force *F* on the arm. The horizontal distance between the elbow joint and the point of attachment of the muscle to the lower arm bone is 0.040 m. The weight of the object held in the hand is 30 N and its centre of gravity is 0.460 m from the elbow joint. The arm is in equilibrium.

(i) Define *centre of gravity.*

.....

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

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(ii) Calculate the total clockwise moment about the elbow joint.

total clockwise moment = ... N m **[2]**

(iii) As the lower arm is moved away from the body, the force *F* exerted by the biceps muscles acts at an angle θ to the vertical as shown in Fig. 4.2.

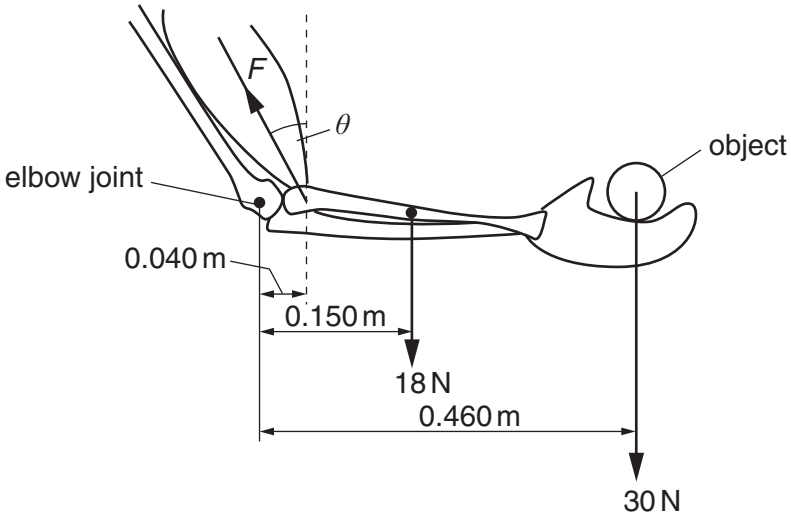


Fig. 4.2

The lower arm remains horizontal and in equilibrium. Describe and explain what happens to each of the following quantities as the angle θ is increased

1 the anticlockwise moment about the elbow joint

.....

.....

2 the magnitude of the force *F*.

.....

.....

.....

..... **[3]**

[Total: 9]

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5 Fig. 5.1 shows a person standing in a stationary lift.

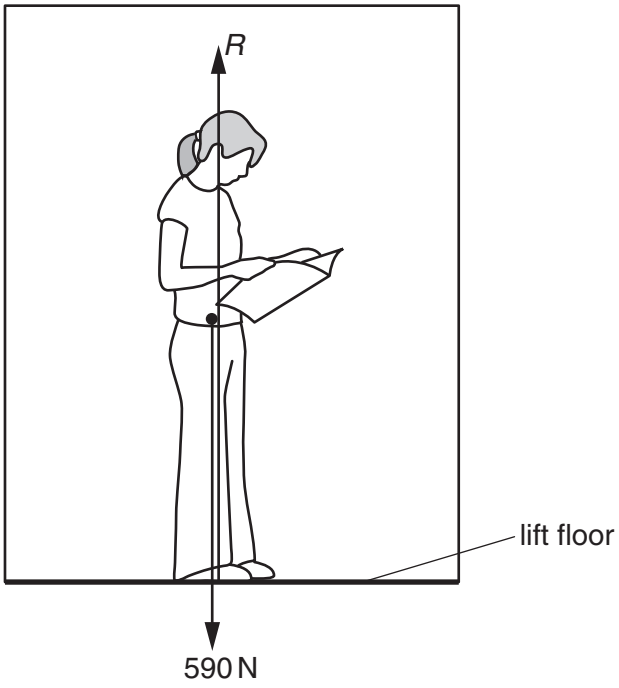


Fig. 5.1

There are only two forces acting on the person. The weight of the person is 590 N. The vertical contact force acting on the person from the floor of the lift is *R*.

(a) Show that the mass of the person is 60 kg.

[1]

(b) The lift starts from rest. It has a constant upward acceleration of 0.50 m s^{-2}. Calculate the magnitude of the contact force *R*.

R = ... N **[2]**

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(c) After a short period of acceleration, the lift travels upwards at a constant velocity. Explain why the force *R* is equal to the weight of the person when the lift travels at a constant velocity.

.....

.....

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

(d) State and explain how the force *R* changes at the instant the lift starts to decelerate.

.....

.....

.....

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

[Total: 6]

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6 **(a)** State *Hooke's law*.

.....

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

(b) Fig. 6.1 shows a force against extension graph for a spring.

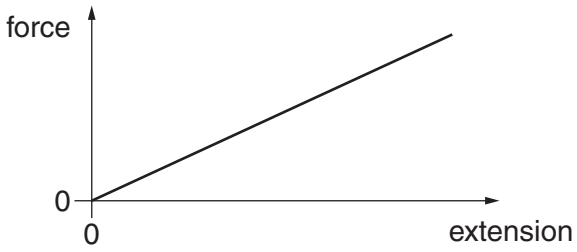


Fig. 6.1

Describe how such a force against extension graph can be used to determine

(i) the *force constant* of the spring

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

.....

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

(ii) the *work done* on the spring.

.....

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

(c) Two identical springs are connected end-to-end (series). The force constant of each spring is *k*. The free ends of the springs are pulled apart as shown in Fig. 6.2.

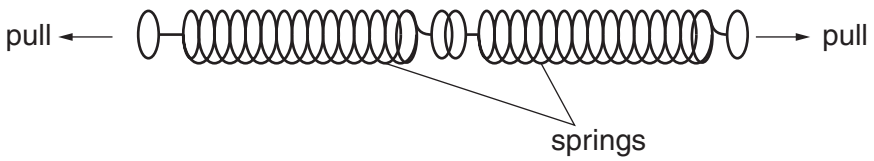


Fig. 6.2

Explain why the force constant of this combination of two springs in series is $\frac{k}{2}$.

.....

.....

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

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(d) (i) Define the *Young modulus* of a material and state the condition when it applies.

.....

.....

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

(ii) A guitar string has length 0.70 m and cross-sectional area 0.20 mm^2. A constant tension of 4.2 N is applied to the string causing a strain of 0.015. Calculate

1 the stress in the string

stress = ... Pa **[2]**

2 the Young modulus of the material of the string

Young modulus = ... Pa **[2]**

3 the elastic potential energy (stored energy) in the string.

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

[Total: 14]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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

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ADDITIONAL PAGE

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