ADVANCED SUBSIDIARY GCE

PHYSICS A

G481

Mechanics

Candidates answer on the question paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet

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

Tuesday 24 May 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 **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 **(a)** The areas under the graphs below are physical quantities.

(i) Fig. 1.1 shows a force against extension graph for a rubber band.

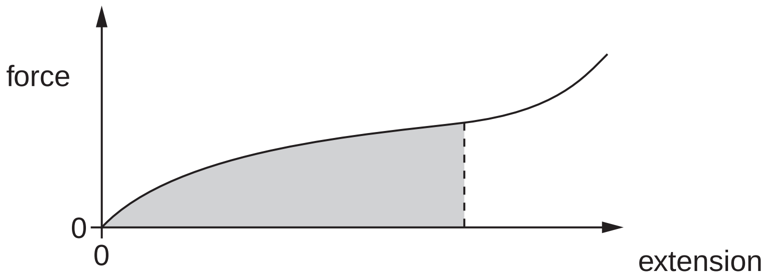

Fig. 1.1

State the quantity represented by the area under the force against extension graph.

.... **[1]**

(ii) Fig. 1.2 shows the velocity against time graph for an accelerating car.

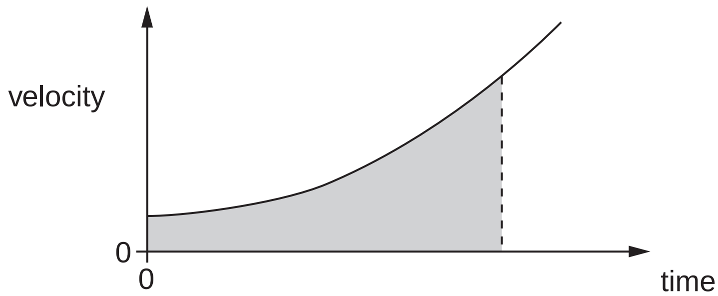

Fig. 1.2

State the quantity represented by the area under the velocity against time graph.

.... **[1]**

(b) State two quantities in physics that have the **same** unit of newton metre (N m).

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

quantity 2 .... **[1]**

[Total: 4]

2 **(a)** Define *density*.

....

.... **[1]**

(b) Fig. 2.1 shows the variation of density of the Earth with **depth** from the surface.

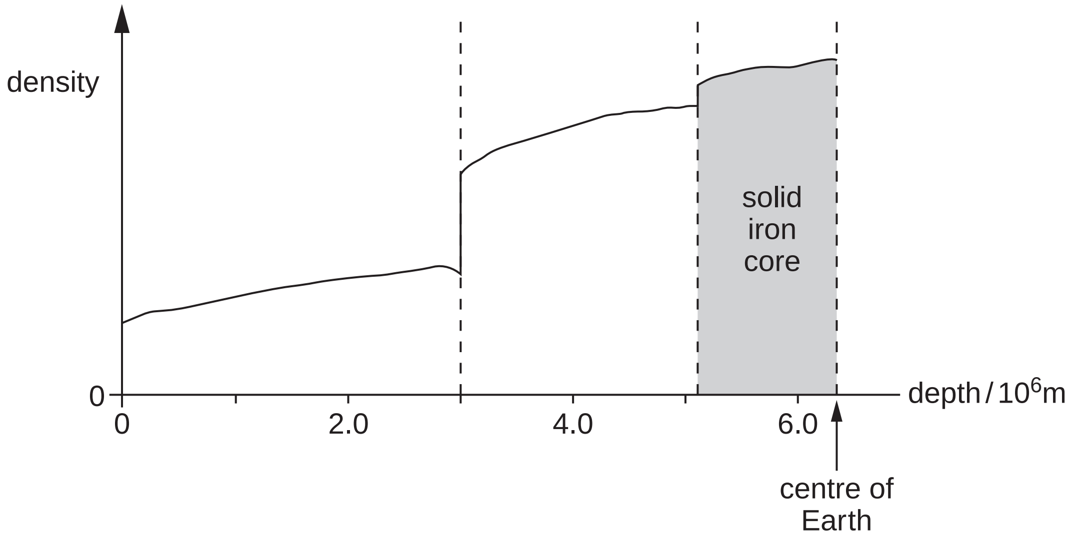

Fig. 2.1

(i) Suggest how Fig. 2.1 shows that the Earth consists of a number of distinct layers.

....

.... **[1]**

(ii) Geophysicists believe that the central core of the Earth is solid iron. This central core is surrounded by a layer of molten metal. The central core starts at a **depth** of 5.1×10^6 m. The solid iron core accounts for 18% of the mass of the Earth. The mass of the Earth is 6.0×10^{24} kg and its radius is 6.4×10^6 m. Calculate the mean density of the central core of the Earth.

volume of a sphere = $\frac{4}{3}\pi r^3$

density = ... kg m^{-3} **[3]**

[Total: 5]

3 **(a)** Define a *vector* quantity and give one example.

....

.... **[2]**

(b) Fig. 3.1 shows a force F at an angle of 30° to the horizontal direction.

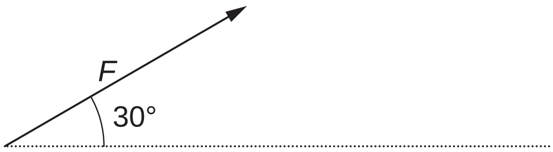

Fig. 3.1

(i) The **horizontal component** of the force F is 7.0 N. Calculate the magnitude of the force F.

F = ... N **[2]**

(ii) The force F moves an object in the horizontal direction. In a time of 4.2 s, the object moves a horizontal distance of 5.0 m. Calculate

1 the work done by the force

work done = ... J **[2]**

2 the rate of work done by the force.

rate of work done = ... W **[1]**

(c) Fig. 3.2 shows the forces acting on a stage light of weight 120 N held stationary by two separate cables.

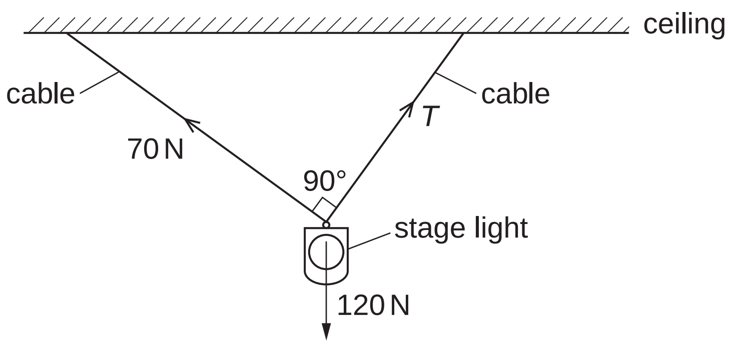

Fig. 3.2

The angle between the two cables is 90°. One cable has tension 70 N and the other has tension *T*.

(i) State the magnitude and the direction of the **resultant** of the tensions in the two cables.

magnitude ....

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

(ii) Sketch a labelled vector triangle for the forces acting on the stage light. Hence, determine the magnitude of the tension *T*.

T = ... N **[4]**

[Total: 13]

4 **(a)** State two factors that affect the magnitude of the drag force acting on an object falling through air.

1. ....

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

(b) Fig. 4.1 shows a skydiver of total mass 75 kg falling vertically towards the ground.

Fig. 4.1

The air resistance, or drag force, D in newtons (N) acting on the skydiver falling through the air is given by the equation

$$D = 0.3v^2$$

where v is the speed in $m\,s^{-1}$ of the skydiver.

(i) On Fig. 4.1, draw arrows to represent the weight (labelled W) and drag force (labelled D). **[1]**

(ii) Calculate the weight of the skydiver.

weight = ... N **[1]**

(iii) At a particular instant, the speed of the skydiver is 20 m s^{-1}. Calculate the instantaneous acceleration of the skydiver.

acceleration = ... m s^{-2} **[3]**

(iv) State the relationship between the forces *W* and *D* when the skydiver reaches terminal velocity.

....

.... **[1]**

(v) Determine the terminal velocity of the skydiver.

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

[Total: 10]

5 **(a)** A student conducts an experiment to estimate the acceleration *g* of free fall by dropping a heavy metal ball from a high wall into a sandpit below. Describe how this student can estimate the acceleration *g* of free fall. Your description should include:

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to estimate *g*
- an explanation of why the value for *g* is only an estimate

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

[7]

(b) The global positioning system (GPS) is used to locate accurately the position of cars on the Earth's surface.

(i) Name the electromagnetic waves used by GPS.

.... **[1]**

(ii) Explain how GPS determines the distance between the car and satellite.

....

....

....

.... **[2]**

(iii) Briefly describe how the distances from two or more satellites are used to locate the position of a car.

....

....

....

.... **[2]**

[Total: 12]

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

....

....

.... **[1]**

(b) Fig. 6.1 shows a glider on a horizontal frictionless track.

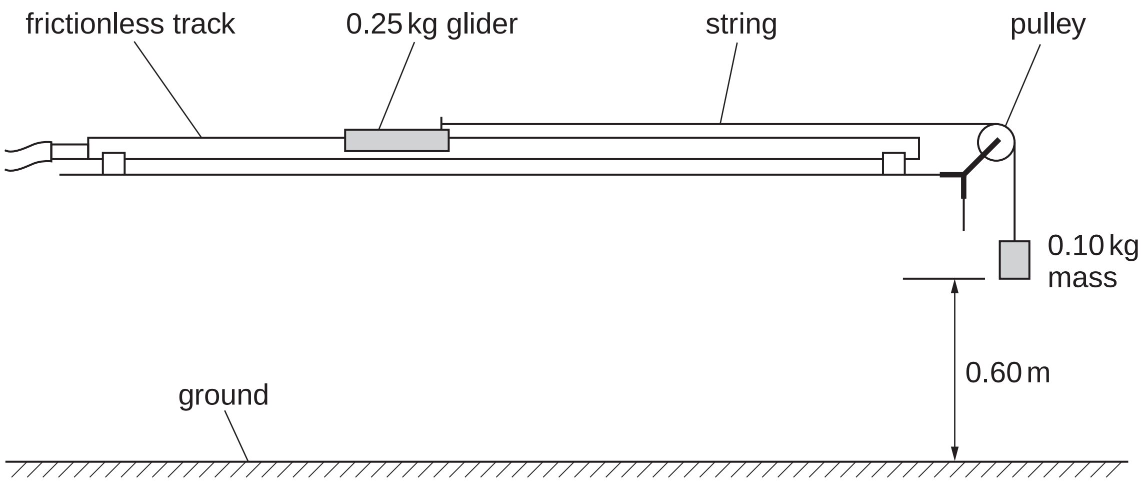

Fig. 6.1

The mass of the glider is 0.25 kg. One end of a string is fixed to the glider and the other end to a 0.10 kg mass. The 0.10 kg mass is held stationary at a height of 0.60 m from the ground. The pulley is more than 0.60 m away from the front of the glider. When the 0.10 kg mass is released, the glider has a constant acceleration of 2.8 m s^{-2} towards the pulley. The 0.10 kg mass instantaneously comes to rest when it hits the ground.

(i) Calculate the loss in potential energy of the 0.10 kg mass as it falls through the distance of 0.60 m.

loss in potential energy = ... J **[1]**

(ii) The glider starts from rest. Show that the velocity of the **glider** after travelling a distance of 0.60 m is about 1.8 m s^{-1}.

[2]

(iii) Calculate the kinetic energy of the **glider** at this velocity of 1.8 m s^{-1}.

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

(iv) Explain why the answer to **(b)(iii)** is not the same as **(b)(i)**.

....

.... **[1]**

[Total: 7]

7 **(a)** Atoms in a solid are held in position by electrical forces. These electrical forces can be represented by an imaginary 'interatomic spring' between neighbouring atoms, see Fig. 7.1.

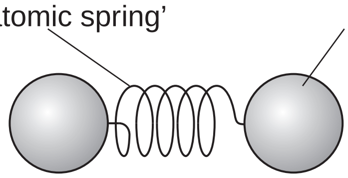

Fig. 7.1

The interatomic spring obeys *Hooke's law* and has a *force constant* just as a normal spring in the laboratory. Researchers in America have recently managed to determine the force experienced by an individual atom of cobalt when the atoms are squeezed together. The researchers found that a force of 210 pN changed the separation between a pair of atoms by a distance of 0.16 nm.

(i) State *Hooke's law*.

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

....

....

.... **[1]**

(ii) Calculate the force constant of the interatomic spring for a pair of cobalt atoms.

force constant = ... $N\,m^{-1}$ **[3]**

(b) Fig. 7.2 shows a stress against strain graph for a metal wire up to its breaking point.

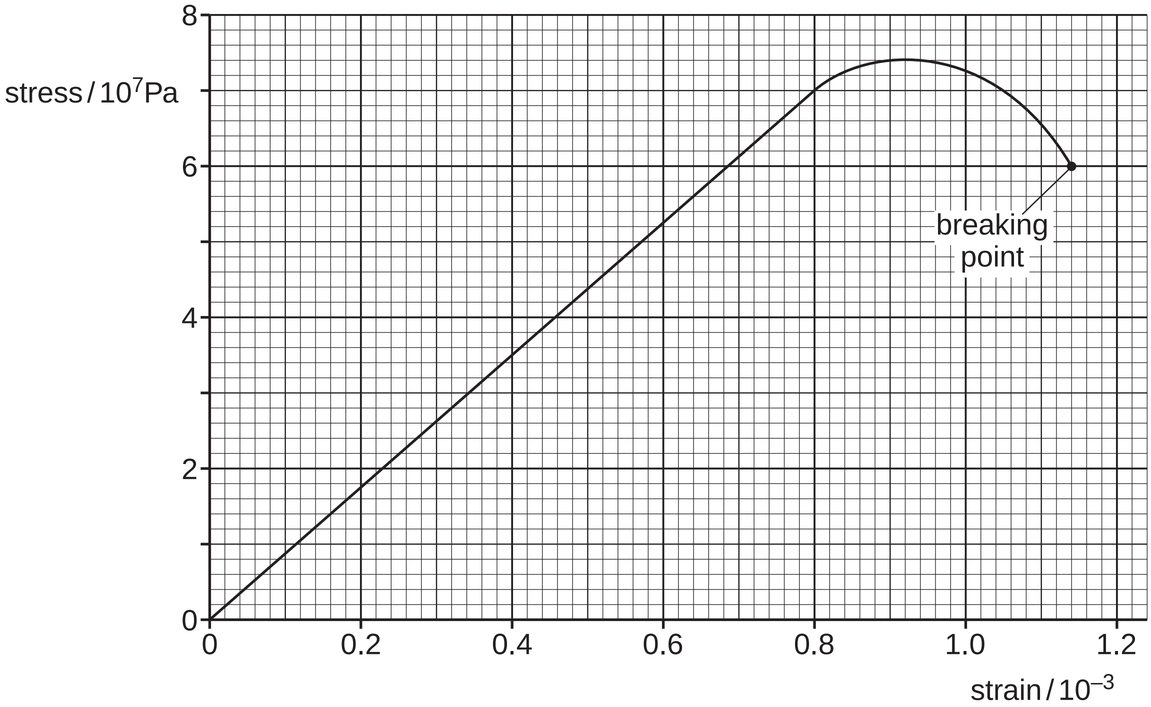

Fig. 7.2

(i) Use the graph to determine the Young modulus of the metal.

Young modulus = ... unit ....**[3]**

(ii) The wire breaks when a force of 19 N is applied. Use the graph to determine the cross-sectional area of the wire at the breaking point.

area = ... m^2 **[2]**

[Total: 9]

END OF QUESTION PAPER