OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2821**

PHYSICS A

Forces and Motion

THURSDAY 22 MAY 2008

Afternoon
Time: 1 hour

Candidates answer on the question paper
Additional materials (enclosed): None

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

CUP/T39860

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 60.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**19**	
2	**8**	
3	**5**	
4	**5**	
5	**9**	
6	**14**	
TOTAL	**60**	

This document consists of **14** printed pages and **2** blank pages.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

refractive index, $n = \frac{1}{\sin C}$

capacitors in series, $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

capacitor discharge, $x = x_0 e^{-t/CR}$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

radioactive decay, $x = x_0 e^{-\lambda t}$

$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$

critical density of matter in the Universe, $\rho_0 = \frac{3H_0^2}{8\pi G}$

relativity factor, $= \sqrt{(1 - \frac{v^2}{c^2})}$

current, $I = nAve$

nuclear radius, $r = r_0 A^{1/3}$

sound intensity level, $= 10 \lg \left(\frac{I}{I_0}\right)$

Answer **all** the questions.

1 **(a)** **(i)** State the difference between a scalar and a vector quantity.

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.....[1]

(ii) Underline the vector quantities in the list below.

acceleration density force kinetic energy power volume weight

[2]

(b) Fig. 1.1 shows the path of a ball that is thrown from point **A** to point **B**. The ball reaches its maximum height at point **H**.

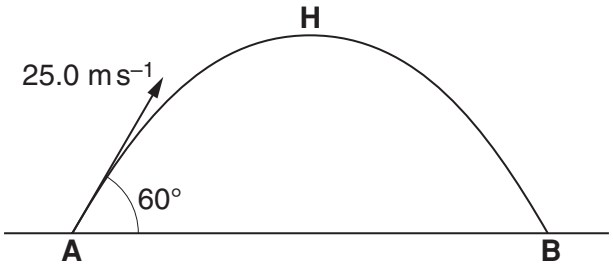

Fig. 1.1

The ball is thrown with an initial velocity of 25.0 m s^{-1} at 60° to the horizontal. Assume that there is no air resistance.

(i) **1** Show that the vertical component of the initial velocity is 21.7 m s^{-1}.

[1]

2 Calculate the time taken for the ball to reach point **H**.

time = ... s [2]

3 Calculate the displacement from **A** to **B**.

displacement = ... m [3]

(ii) For the path of the ball shown in Fig. 1.1, draw sketch graphs, with labelled axes but without numerical values, to show the variation of

1 the vertical component of the ball's velocity against time

[3]

2 the distance travelled along its path against time.

[2]

In this part of the question, one mark is available for the quality of written communication.

(iii) Assuming no air resistance, describe the forms of energy possessed by the ball at **A**, **H** and **B** and how the energy changes between these points.

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.....[4]

Quality of Written Communication [1]

[Total: 19]

2 (a) (i) State the conditions for a system to be in equilibrium.

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.....[2]

(ii) Define the *moment of a force*.

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.....[1]

(b) Fig. 2.1 shows a system for supporting a load.

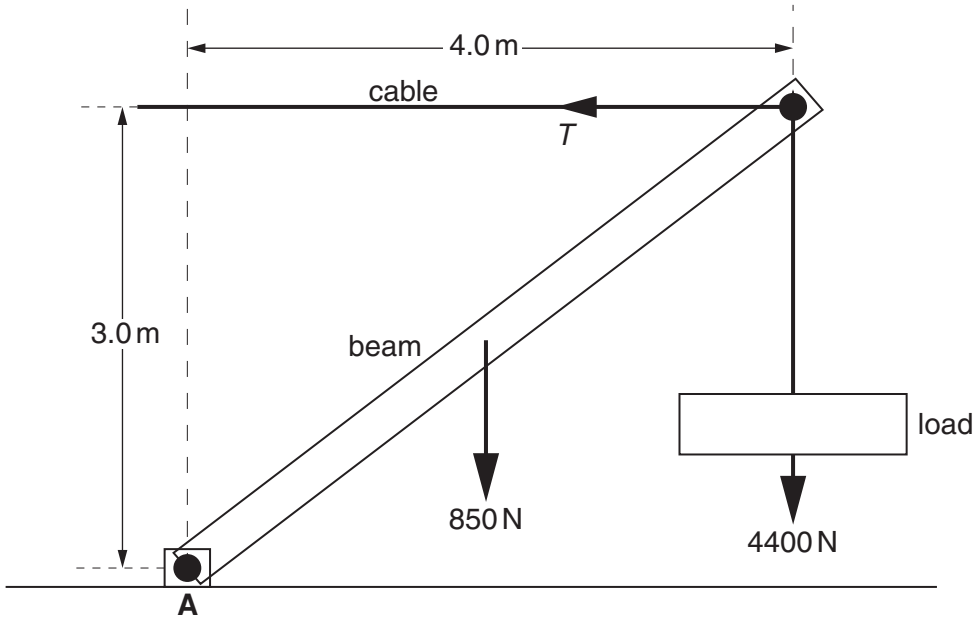

Fig. 2.1

The load of weight 4400 N is hanging from a uniform beam that is supported by a horizontal cable. The beam has a weight of 850 N and is hinged at **A**.

(i) Take moments about **A** and show that the tension *T* in the cable is 6400 N (to 2 significant figures).

[3]

(ii) State and explain what force, in addition to those shown, must act on the beam to keep it in equilibrium. You are not expected to calculate this force.
Draw this force on Fig. 2.1 and label it **F**.

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.....[2]

[Total: 8]

3 Fig. 3.1 shows a wall built with a material of average density 2500 kg m^{-3}.

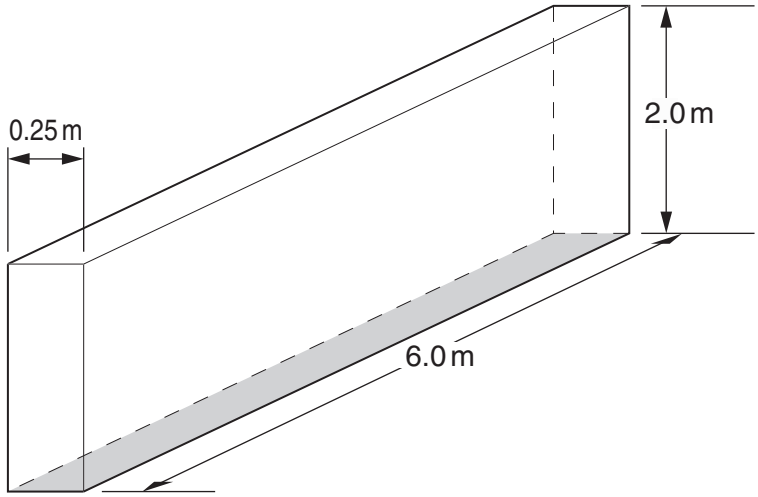

Fig. 3.1

The wall is 6.0 m long, 2.0 m high and 0.25 m wide.

(a) Calculate the mass of the wall.

mass = ... kg [2]

(b) Calculate the pressure the wall exerts on the ground.

pressure = ... Pa [3]

[Total: 5]

4 Fig. 4.1 shows a method used to knock down walls.

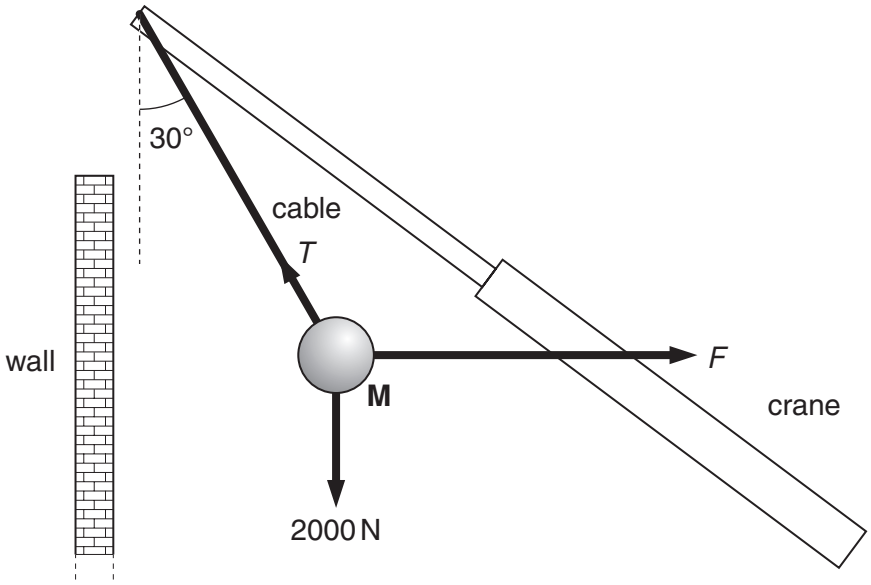

Fig. 4.1

M is a heavy steel ball suspended by a cable in which the tension is *T*. The ball is pulled to one side by a horizontal force *F* until the cable is at 30° to the vertical. It is then released so that it swings into the wall. The weight of the ball **M** is 2000 N.

(a) Determine the force *F* by using a triangle of forces **or** a scale diagram of the forces **or** by resolving forces.

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

(b) State and explain one change that could be made to this method to cause more damage to the wall.

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.....[2]

[Total: 5]

5 Fig. 5.1 shows a lorry travelling up a slope.

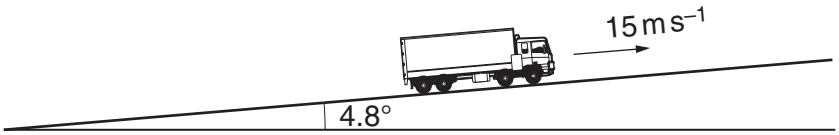

Fig. 5.1

The angle of the slope is 4.8° with the horizontal and the weight of the lorry is 2.4×10^5 N. A resistive force of 1.2×10^4 N down the slope acts on the lorry as it travels up the slope at a constant speed of $15\,m\,s^{-1}$.

(a) Show that the component of the weight of the lorry down the slope is 2.0×10^4 N.

[1]

(b) Calculate the rate at which the lorry does work against the resistive force.

rate of work done = ... J s^{-1} [2]

(c) Calculate the power developed by the lorry as it travels up the slope.

power = ... W [2]

(d) Calculate the rate of gain of potential energy of the lorry.

rate of gain of potential energy = ……. unit ……..….. [3]

(e) State and explain how the braking distance of the lorry up the slope compares with that on a horizontal road at the same speed.

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.....[1]

[Total: 9]

6 Fig. 6.1 shows the force *F* against extension *x* graph for a copper wire.

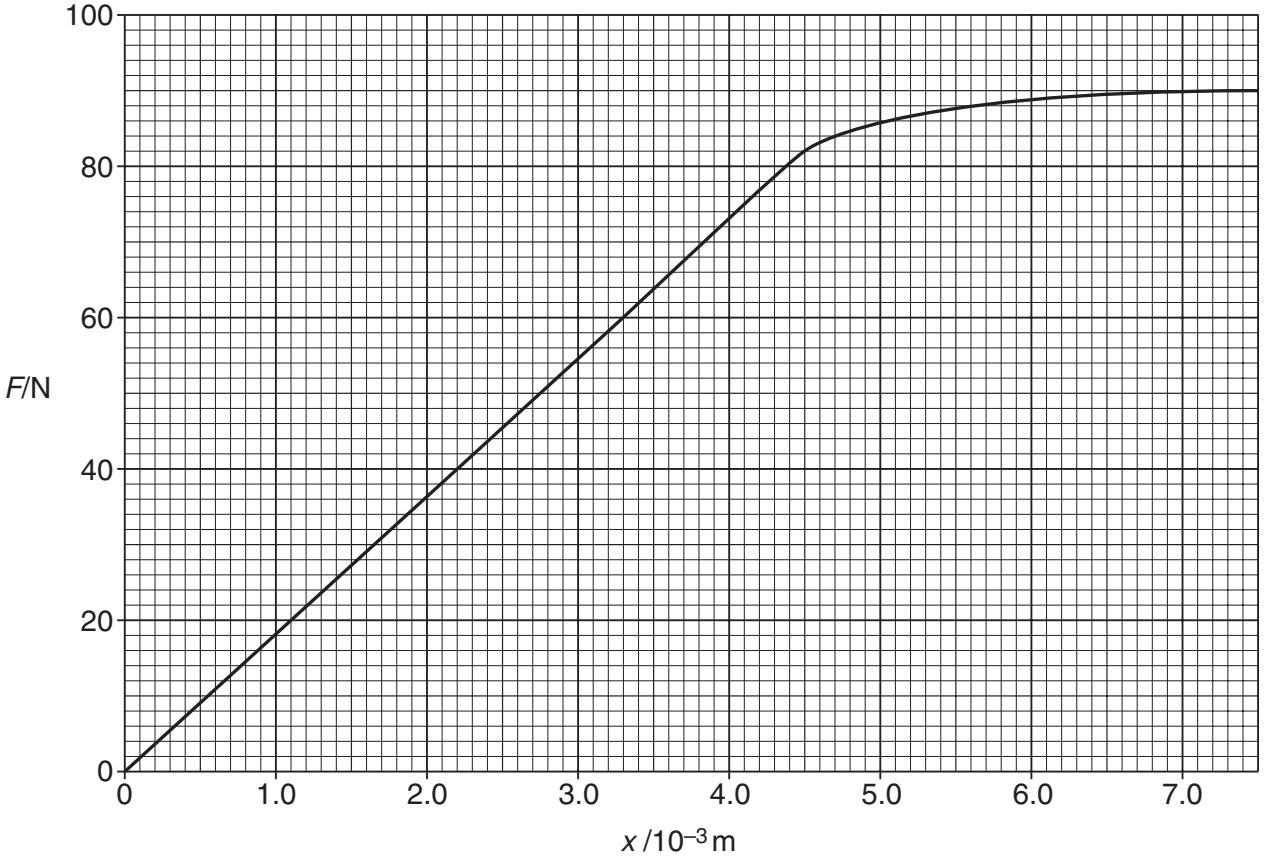

Fig. 6.1

(a) The original length of the wire was 4.0 m and its cross-sectional area $6.3 \times 10^{-7}\,m^2$. Use Fig. 6.1 to calculate

(i) the Young modulus of copper

Young modulus = ... Pa [4]

(ii) the strain energy stored in the wire when it is extended by a force of 80 N.

strain energy = ... J [2]

(b) The wire is now extended by a force of 90 N. Describe what happens to the extension of the wire when this force is removed.

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.....[1]

(c) In this part of the question, one mark is available for the quality of written communication.

Describe the behaviour and properties of the copper wire shown by Fig. 6.1 and compare with the behaviour and properties of a stretched glass fibre.

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Quality of Written Communication [1]

[Total: 14]

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