OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2821**

PHYSICS

Forces and Motion

FRIDAY 11 JANUARY 2008 Afternoon

Time: 1 hour

Candidates answer on the question paper.
Additional materials: Electronic calculator
Ruler
Protractor

CUP/T32369

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.
- Do **not** write outside the box bordering each page.
- 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	**9**	
2	**16**	
3	**8**	
4	**6**	
5	**12**	
6	**9**	
TOTAL	**60**	

This document consists of **16** printed 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 Fig. 1.1 shows part of an arrangement used to determine the acceleration of a metal plate that falls vertically.

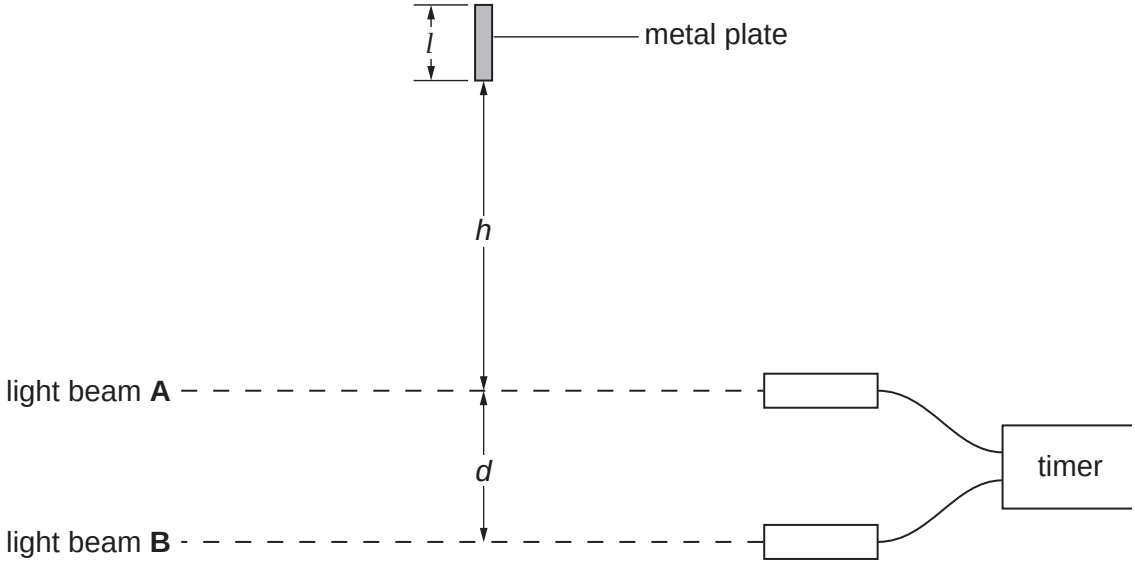

Fig. 1.1

The metal plate is released and falls a distance *h* of 0.500 m before breaking light beam **A**. The plate falls a further distance *d* before breaking a second light beam **B**.

(a) Assume the metal plate starts from rest and has an acceleration of 9.81 m s^{-2}.

(i) Show that the time taken for the plate to fall 0.500 m from rest is 0.319 s.

[2]

(ii) Calculate the average speed of the plate over the distance *h*.

average speed **=** ..... m s^{-1} [2]

(b) The length l of the plate is measured. This value is entered into the timer. When the plate breaks the light beams **A** and **B**, the timer records the average speed of the plate through each beam. The average speeds through light beams **A** and **B** are $3.05\,m\,s^{-1}$ and $3.75\,m\,s^{-1}$ respectively. The distance $d = 0.250\,m$.

(i) Calculate the acceleration of the plate as it falls distance d.

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

(ii) State and explain **two** reasons why the experimental value obtained for the acceleration of the plate in **(b)(i)** is not the same as the acceleration of free fall used in **(a)**.

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.....[3]

[Total: 9]

2 Fig. 2.1 shows the variation with time *t* of the velocity *v* of a lift travelling from ground level up to the viewing platform of a sky tower.

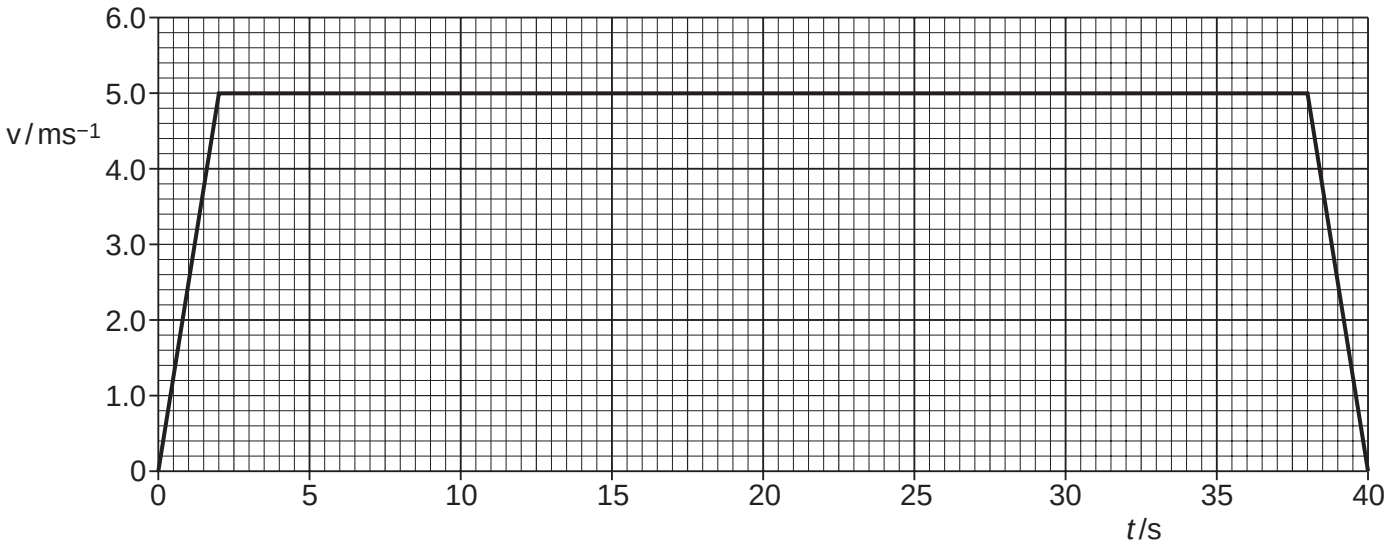

Fig. 2.1

(a) Use Fig. 2.1

(i) to calculate the initial acceleration of the lift

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

(ii) to show that the distance travelled by the lift is 190 m

[2]

(iii) to calculate the maximum kinetic energy of a passenger of mass 75 kg

kinetic energy = ... J [2]

(iv) to calculate the gain in potential energy of the passenger

potential energy = ... J [2]

(v) to calculate the average rate at which potential energy is gained by the passenger for this journey.

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

(b) The passenger exerts a pressure of 55 kPa on the floor of the lift when it is travelling at constant velocity.

(i) Calculate the area of contact between the passenger and the floor.

area = ... m^2 [2]

(ii) Without further calculation, state and explain how the values of the pressure exerted on the floor by the passenger during the two periods of acceleration of the lift differ from the value for constant velocity.

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.....[3]

[Total: 16]

3 **(a)** State the principle of moments.

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.....[1]

(b) Fig. 3.1 shows an arrangement used to demonstrate the principle of moments.

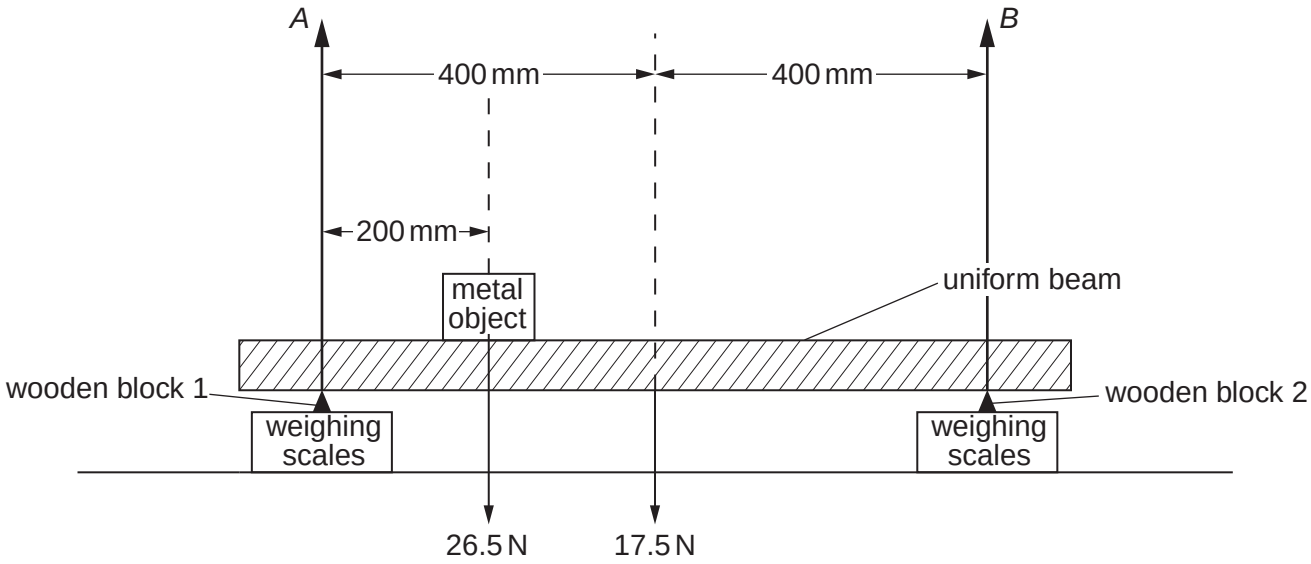

Fig. 3.1

A uniform beam is supported on the edges of two triangular shaped wooden blocks placed on two weighing scales. The weight of the beam is 17.5 N and the distance between the wooden blocks is 800 mm. A metal object of weight 26.5 N is placed 200 mm from one of the blocks. The blocks exert upward forces *A* and *B* on the beam.

(i) Calculate the force *B* by taking moments about wooden block 1.

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

(ii) State the sum of the two forces *A* and *B* and explain your answer.

sum = ... N

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.....[2]

(iii) Describe what happens to the forces *A* and *B* as the metal object is moved gradually to the centre of the beam.

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.....[2]

[Total: 8]

4 Fig. 4.1 shows a girl supported by two elastic ropes. She is in equilibrium. Her weight is 392 N.

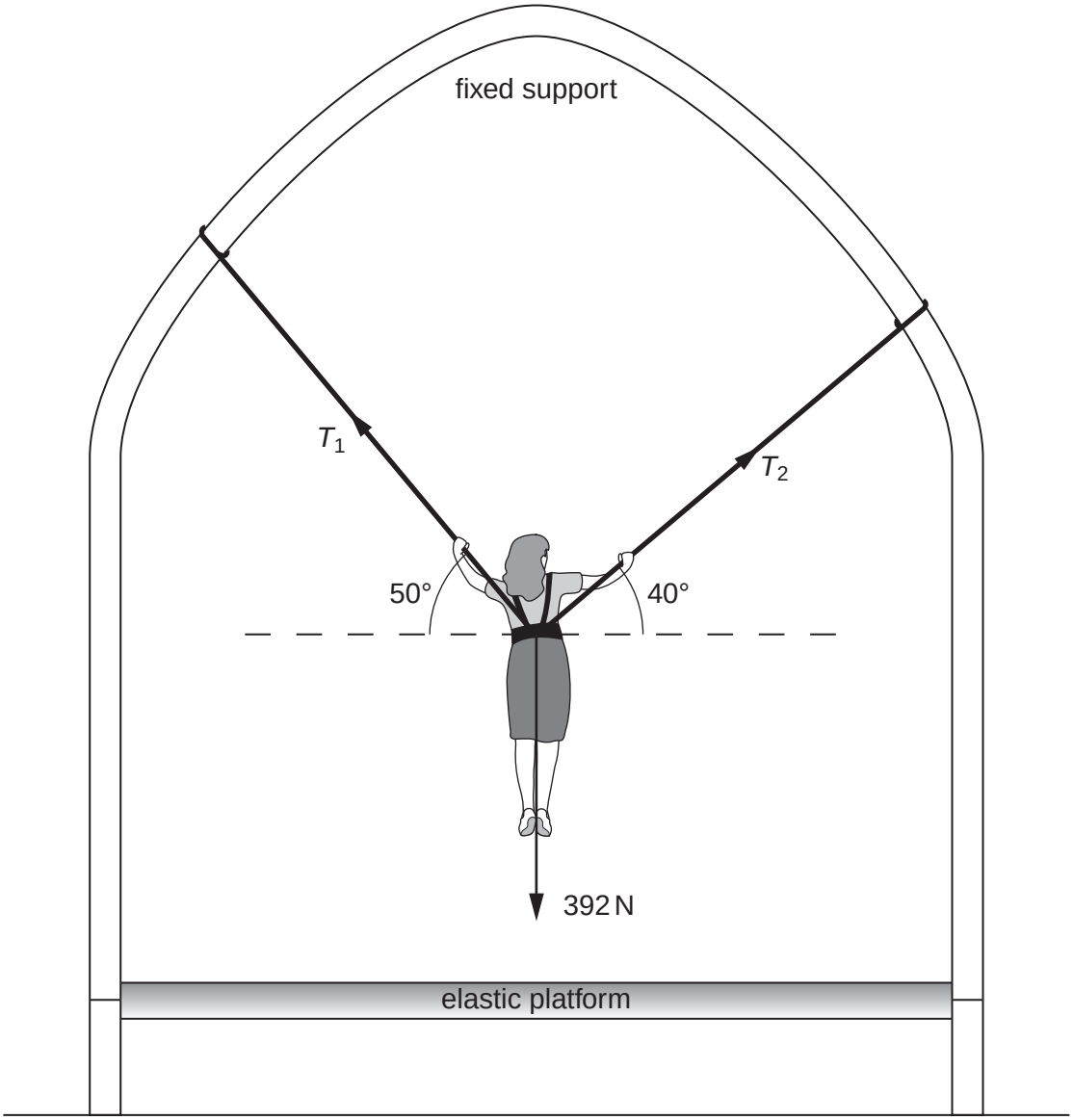

Fig. 4.1

(a) Determine the tensions T_1 and T_2 in the two ropes.

tension T_1 = ... N

tension T_2 = ... N [4]

(b) The girl is pulled vertically downwards so that the ropes stretch. She is then released. Discuss without further calculation whether the method you used in **(a)** could be used to determine the tensions in the ropes immediately after she is released.

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.....[2]

[Total: 6]

5 In this question, two marks are available for the quality of written communication.

This question is about an experiment to determine the Young modulus of a metal in the form of a wire.

(a) Describe, with the aid of a diagram, the **apparatus** you would use.

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(b) Describe how you would make the necessary **measurements**.

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(c) Describe how you would determine the Young modulus from your measurements.

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.....[4]

Quality of Written Communication [2]

[Total: 12]

6 **(a)** With reference to the driving of a car define the terms

(i) *thinking distance* .....

.....

(ii) *braking distance*. .....

.....[2]

(b) Fig. 6.1 shows a car travelling along a road that has a uniform downhill gradient.

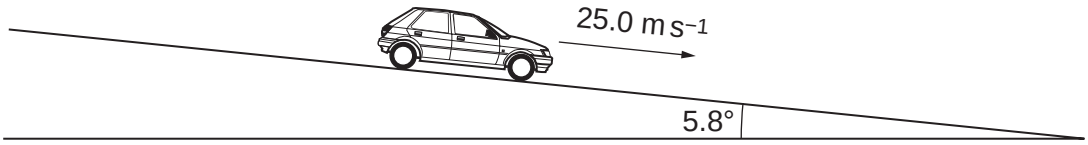

Fig. 6.1

The car has a total mass of 850 kg and is travelling at a constant speed of 25.0 m s^{-1}. The driver sees a hazard ahead and applies the brakes to stop the car. The reaction time of the driver is 0.62 s. When the brakes are applied the braking force is a constant 5520 N.

(i) Calculate the thinking distance.

thinking distance = ... m [2]

(ii) The angle of the road to the horizontal is 5.8°. Show that the deceleration with the brakes applied is 5.50 m s^{-2}.

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

(iii) Calculate the braking distance of the car.

braking distance = ... m [2]

[Total: 9]

END OF QUESTION PAPER

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