



**ADVANCED SUBSIDIARY GCE UNIT
PHYSICS A**

Forces and Motion

FRIDAY 12 JANUARY 2007

2821

Afternoon

Time: 1 hour

Additional materials: Electronic Calculator
Ruler (cm/mm)
Protractor



Candidate
Name

Centre
Number

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Candidate
Number

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INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate Number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- **WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.**

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	8	
2	9	
3	10	
4	12	
5	10	
6	11	
TOTAL	60	

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



Data

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



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,

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$

capacitors in parallel,

$$C = C_1 + C_2 + \dots$$

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,

$$= 10 \lg \left(\frac{I}{I_0} \right)$$



2 (a) Explain, with reference to a car, the quantities

(i) *braking force*

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

(ii) *braking distance.*

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

(b) A car of mass 1380 kg, travelling at 31.1 ms^{-1} , is brought to rest by the brakes in 48.2 m.

Calculate

(i) the initial kinetic energy of the car

kinetic energy = J [3]

(ii) the average deceleration of the car

deceleration = ms^{-2} [2]

(iii) the average braking force.

braking force = N [2]

[Total: 9]



(ii) the time taken for the mass to be raised through the height of 25 m

time = s [1]

(iii) the rate of gain of potential energy of the mass

rate of gain of potential energy = J s^{-1} [3]

(iv) the minimum output power of the motor used to raise the mass.

power = W [1]

[Total: 10]



4 (a) Define

(i) the *moment* of a force

.....
[2]

(ii) the *torque* of a couple.

.....
[1]

(b) Fig. 4.1 shows a uniform rectangular beam supported by two straps. The beam is in equilibrium.

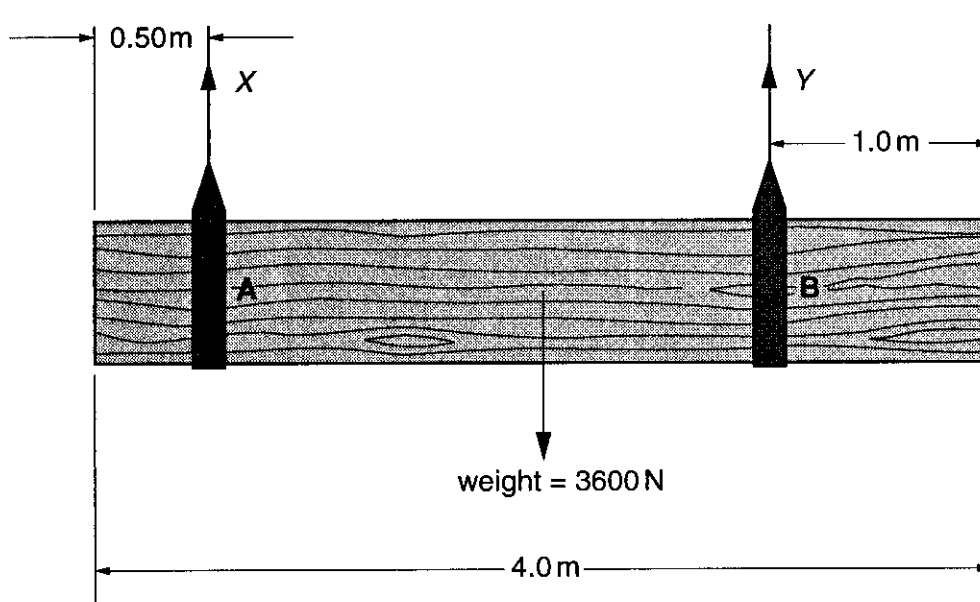


Fig. 4.1

The weight of the beam is 3600 N and its length is 4.0 m. The strap **A** is positioned 0.50 m from one end of the beam and the strap **B** is positioned 1.0 m from the other end.

(i) 1 Use the principle of moments to show that the upward force X at strap **A** is 1440 N.

[2]



2 Hence determine the force Y at the strap **B**.

force = N [2]

(ii) Discuss whether the forces X and Y provide a couple.

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

(iii) The area of strap **A** in contact with the underside of the beam is $2.3 \times 10^{-2} \text{m}^2$.
Calculate the average pressure exerted on the beam by strap **A**.

pressure = unit [3]

[Total: 12]



5 (a) Define the quantities

(i) *stress*

.....[1]

(ii) *strain*.

.....[1]

(b) The results given in Table 5.1 are obtained in an experiment to determine the Young modulus of a metal in the form of a wire. The wire is loaded in steps of 5.0N up to 25.0N and then unloaded.

	loading	unloading
load/N	extension/mm	extension/mm
0.0	0.00	0.00
5.0	0.24	0.24
10.0	0.47	0.48
15.0	0.71	0.71
20.0	0.96	0.95
25.0	1.20	1.20

Table 5.1

(i) Using the results in Table 5.1 and without plotting a graph, state and explain whether the deformation of the wire

1 is plastic or elastic

.....

[1]

2 obeys Hooke's law.

.....

[2]



(ii) Explain how the extension and length of the wire may be determined experimentally.

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

(iii) The wire tested is 1.72 m long and has a cross-sectional area of $1.80 \times 10^{-7} \text{ m}^2$. Use the extension value given in Table 5.1 for a load of 25.0 N to calculate the Young modulus of the metal of the wire.

Young modulus = Pa [3]

[Total: 10]



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