OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS A 2821

Forces and Motion

Friday **31 MAY 2002** Afternoon 1 hour

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- 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	7	
2	10	
3	8	
4	9	
5	11	
6	13	
QWC	2	
TOTAL	60	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969

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

1 **(a)** Fig. 1.1 shows a skier being pulled up a slope at constant speed.

The tension in the wire pulls the skier with a force of 400 N that acts at 40° to the slope.

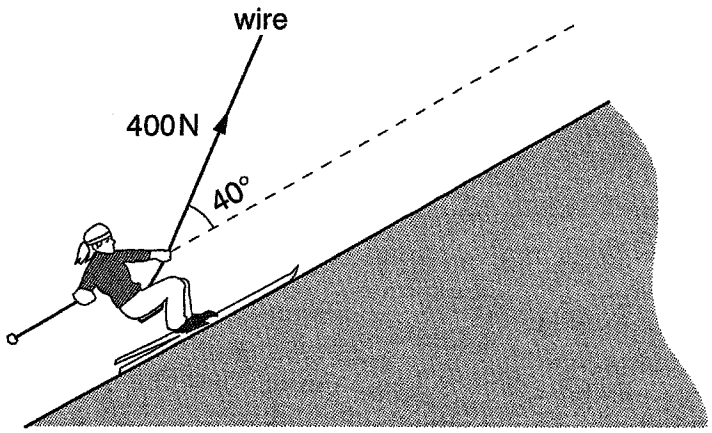

Fig. 1.1

(i) Explain with reference to the forces acting on the skier why he travels at constant speed.

.....

.....

..... [2]

(ii) Calculate the component of the tension in the wire

1. parallel to the slope

component = ... N

2. perpendicular to the slope.

component = ... N
[3]

(b) Describe **two** possible effects on the skier if the tension in the wire is suddenly increased.

.....

.....

.....

..... [2]

[Total: 7]

[Turn over

2 **(a)** **(i)** Explain what the *centre of gravity* of a body means.

.....

.....

(ii) Define *moment of a force* about a point.

.....

.....

[3]

(b) Fig. 2.1 shows an arrangement used to determine the approximate centre of gravity of a man. A uniform plank, of mass of 5.0 kg and length 2.00 m, is supported on a pivot at one end A while the other end B is supported on scales. The man lies horizontally on the plank with his feet level with end A. The man is 1.80 m tall and has a mass of 75 kg. The scales read 44 kg.

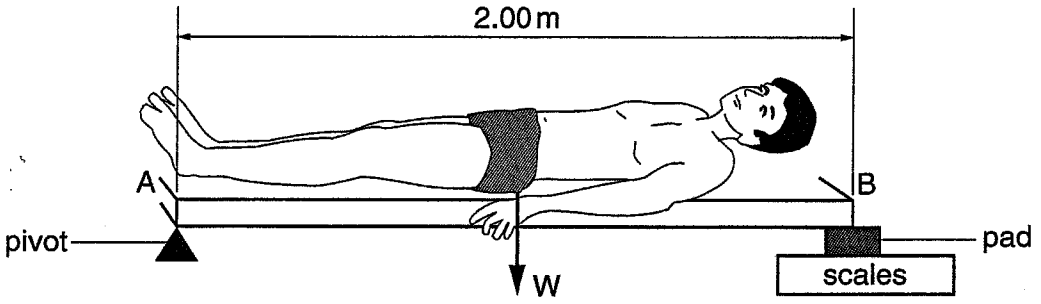

Fig. 2.1

The weight W, of the plank is shown.

(i) On Fig. 2.1 draw and label three other forces acting on the plank. [3]

(ii) Use the principle of moments to calculate the distance of the centre of gravity of the man from end A.

distance = ... m [4]

[Total: 10]

For Examiner's Use

3 **(a)** *In this question, two marks are available for the quality of written communication.*

An object falls vertically through a large distance from rest in air. Describe and explain the motion of the object as it descends in terms of the forces that act and its resulting acceleration.

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[6]

(b) Explain how a free-fall diver can increase the rate at which she descends through the air.

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..... [2]

[Total: 8]
Quality of Written Communication [2]

4 **(a)** **(i)** Define *pressure*.

.....

.....

.....

(ii) State the SI unit of pressure.

.....

[3]

(b) Fig. 4.1 shows the arrangement of the master cylinder and the slave cylinder for part of a braking system. The master cylinder piston, of surface area 8.0 cm^2, exerts a force of 28 N on the brake fluid when the driver presses the brake pedal.

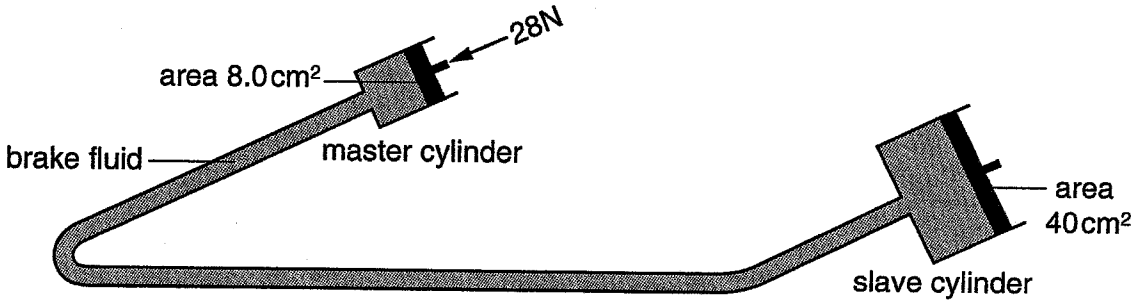

Fig. 4.1

(i) Calculate the pressure on the brake fluid produced by the master piston.

pressure = ... unit ..... [2]

This pressure is transmitted to the slave cylinder piston that has a surface area of 40 cm^2.

(ii) Calculate the force exerted on this piston.

force = ... N [2]

(iii) State **two** methods of increasing the force produced by the slave cylinder piston.

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..... [2]

[Total: 9]

(c) Discuss why the crumple zone of a car must deform plastically if it is to absorb a large quantity of energy.

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..... [3]

[Total: 11]

6 **(a)** Explain the following terms when associated with driving a car.

(i) thinking distance

.....

.....

(ii) braking distance.

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..... [2]

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

.....

..... [1]

(b) Fig. 5.1 shows a graph of force F against extension e for a metal in the form of a wire. The cross-sectional area of the wire is $1.80 \times 10^{-7}\,m^2$ and its length is 1.70 m.

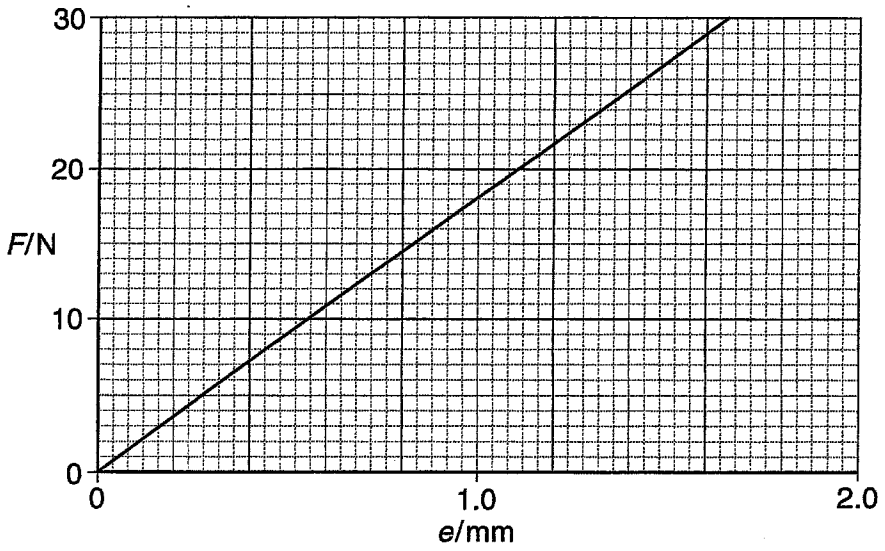

Fig. 5.1

(i) Calculate the Young modulus of the metal.

Young modulus = ... Pa [4]

(ii) Calculate the energy stored in the wire when it extended by 1.60 mm.

energy stored = ... J [3]

(b) Fig. 6.1 shows the variation with speed v of the thinking distance d for the driver of a car.

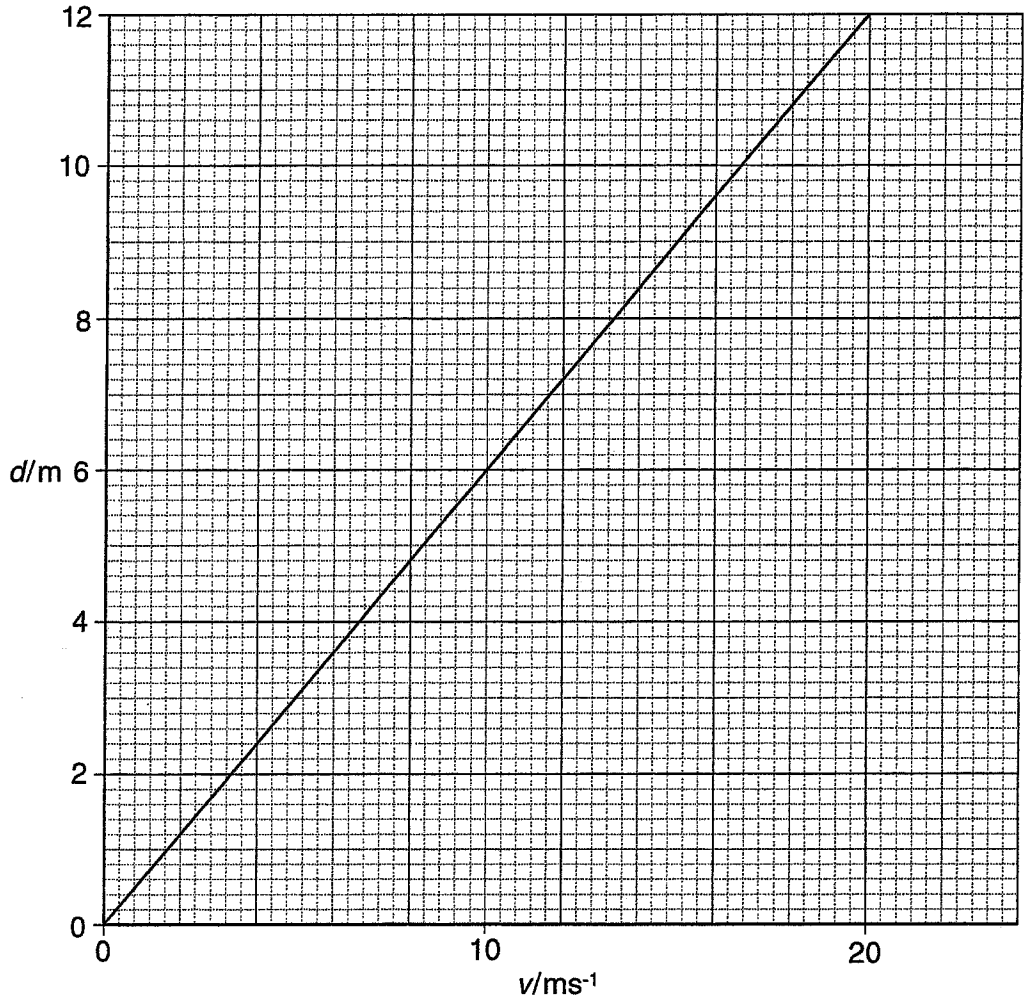

Fig. 6.1

(i) Explain why the graph is a straight line through the origin.

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..... [1]

(ii) Use the graph to determine the time taken for the driver to react when he is travelling at $16\,m\,s^{-1}$.

time taken = ... s [2]

(iii) The driver is travelling at $30\,m\,s^{-1}$ in a car which brakes with an acceleration of $-6.5\,m\,s^{-2}$. Calculate

1. the thinking distance

thinking distance = ... m

2. the overall stopping distance.

stopping distance = ... m
[5]

(c) Explain the effect of the road conditions and tyre tread on the stopping distance.

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..... [3]

[Total: 13]