OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A — 2821

Forces and Motion

Thursday **18 JANUARY 2001** Morning 1 hour 30 minutes

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

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	11	
2	13	
3	10	
4	12	
5	13	
6	14	
7	13	
QWC	4	
TOTAL	90	

This question paper consists of 12 printed pages.

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,	$1/C = 1/C_1 + 1/C_2 + \ldots$
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,	$x = x_0 e^{-\lambda t}$
	$\lambda t_{\frac{1}{2}} = 0.693$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
relativity factor,	$\gamma = \sqrt{\{1 - \frac{v^2}{c^2}\}}$
current,	$I = nAve$
nuclear radius,	$r = r_0 A^{1/3}$
sound intensity level,	$IL = 10 \lg \left(\frac{I}{I_0}\right)$

[Turn over

For Examiner's Use

1 **(a)** Distinguish between scalar and vector quantities.

....

....[2]

(b) Fig. 1.1 lists a number of physical quantities. Put a (✓) in the box next to the quantities that are vectors.

acceleration	
density	
energy	
momentum	
power	
velocity	

Fig. 1.1

[3]

(c) Fig. 1.2 shows a force of 6.0 N acting at 30° to the horizontal.

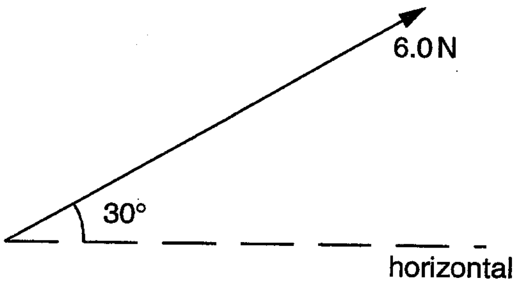

Fig. 1.2

Calculate the component of the force that acts

(i) horizontally,

horizontal component .... N

(ii) vertically.

vertical component .... N

[2]

For Examiner's Use

(d) Fig. 1.3 shows two strings supporting an object of weight 12 N. The tension in one of the strings is 6.0 N. The tension in the other string is *T*.

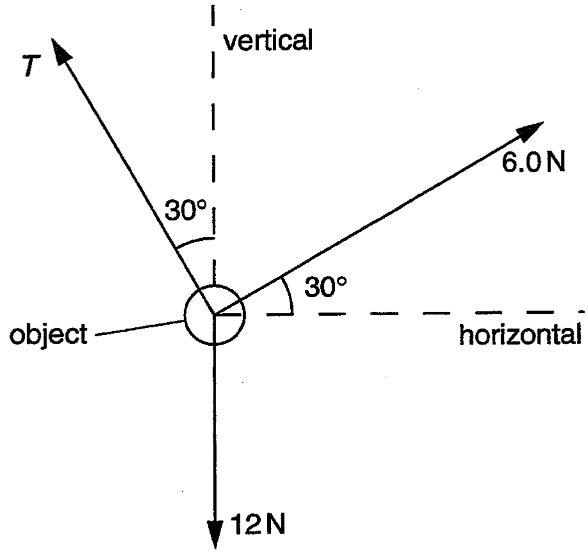

Fig. 1.3

(i) Calculate the magnitude of the vertical component of the tension *T* in order for the object to be in equilibrium.

vertical component .... N [2]

(ii) Hence calculate the magnitude of *T*.

magnitude of *T* .... N [2]

For Examiner's Use

2 **(a)** Define acceleration.

....

.... [2]

(b) Fig. 2.1 shows a graph of velocity v against time t for a train that stops at a station.

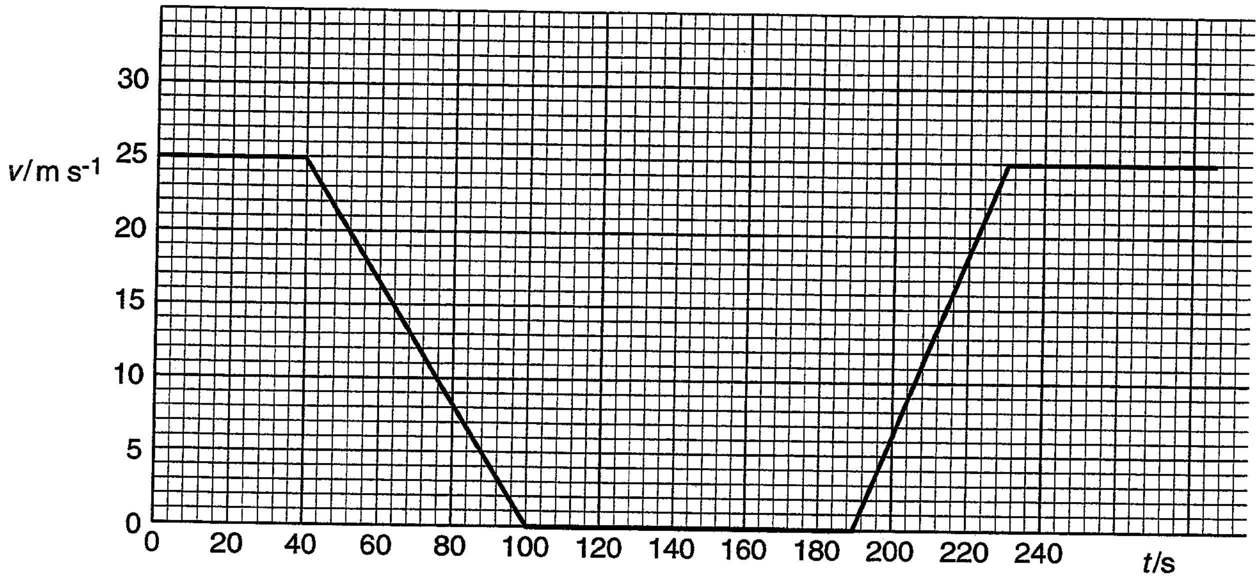

Fig. 2.1

(i) For the time interval t = 40 s to t = 100 s, calculate

1. the acceleration of the train,

acceleration .... m s^{-2}

2. the distance travelled by the train.

distance .... m

[5]

(ii) Calculate the distance travelled by the train during its acceleration from rest to 25 m s^{-1}.

distance .... m [2]

For Examiner's Use

(iii) Calculate the journey time that would be saved if the train did not stop at the station but continued at a constant speed of $25\,m\,s^{-1}$.

time saved .... s [4]

3 **(a)** Define density.

....

....[1]

(b) A paving slab has a mass of 45 kg and dimensions 50 mm × 600 mm × 600 mm.

(i) Calculate the density of the material from which it is made.

density .... unit .... [2]

(ii) Calculate the maximum pressure the slab could exert on the ground when resting on one of its surfaces.

maximum pressure .... Pa [4]

(iii) Twelve slabs, identical to that described in **(b)**, are to be stored on soft ground. Discuss whether less damage would be caused to the ground if the slabs were stored next to each other on their smallest surface or in one pile on their largest surface. (You will be awarded marks for the quality of written communication in this part of the question.)

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....

....[3]

For Examiner's Use

4 **(a)** In a downhill ski race the total distance between the start and the finish is 1800 m. The total vertical drop is 550 m. The weight of a skier (including his equipment) is 900 N and the time of his descent is 65 s.

(i) Calculate the average speed of the skier for the race.

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

(ii) Calculate the loss of gravitational potential energy of the skier.

loss of gravitational potential energy .... J [2]

(b) The average resistive force acting against the skier is 250 N.

(i) Calculate the work done against this resistive force.

work done .... J [2]

(ii) If the skier does no work, calculate

1. his kinetic energy as he passes the finish,

kinetic energy .... J [1]

2. his speed as he passes the finish.

speed .... m s^{-1} [3]

(iii) State whether in practice the final speed of the skier is likely to be greater or less than the value calculated in part **(ii) 2**. Explain your answer.

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....[2]

For Examiner's Use

5 **(a)** Define centre of gravity.

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....[2]

(b) Define moment of a force.

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....[2]

(c) Fig. 5.1 shows a student being weighed. The student, of mass 50 kg, stands 0.30 m from end A of a uniform plank of mass 8.0 kg and length 2.0 m. The plank is pivoted 0.50 m from end A, and an object of mass 5.0 kg is moved from end B until the plank balances.

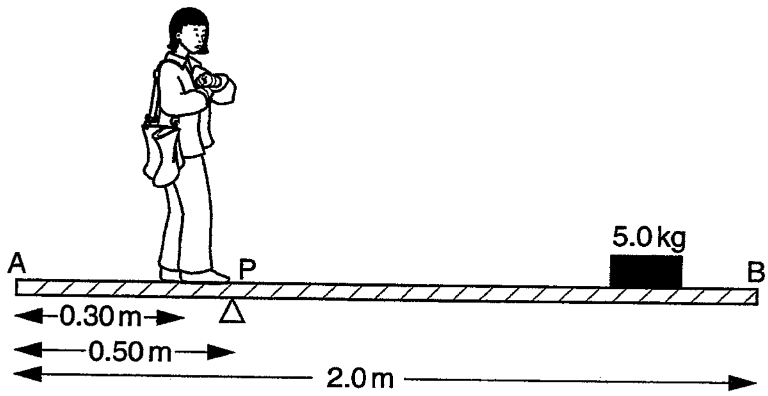

Fig. 5.1

(i) On Fig. 5.1, draw and label the forces acting on the plank. [2]

(ii) Show by using the principle of moments that the 5.0 kg mass must be placed 0.30 m from end B in order for the plank to balance.

[4]

(iii) The arrangement shown in Fig. 5.1 has a maximum mass that it can determine. Suggest **two** changes that can be made to the arrangement to increase this maximum possible mass. Explain your answers.

1. ....

....

2. ....

....[3]

6 (a) Define

(i) stress ....

....

(ii) strain ....

....[2]

(b) (i) Distinguish between elastic and plastic behaviour when materials are stretched.

....

....

....[2]

(ii) Define elastic limit.

....

....[2]

(c) (i) State the SI unit of the Young modulus.

unit ....

(ii) Describe, with the aid of a diagram, an experiment to determine the Young modulus of steel in the form of a wire. Explain how to use your readings to obtain the Young modulus. (You will be awarded marks for the quality of written communication in this part of the question.)

For Examiner's Use

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[8]

For Examiner's Use

7 **(a)** **(i)** (You will be awarded marks for quality of written communication in this question.)

Explain the terms thinking distance and braking distance when describing the stopping distance of a car.

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....[2]

(ii) Discuss the factors that affect the stopping distance of a car.

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....[6]

(b) When a car collides with an obstruction, an air bag may be triggered.

(i) Explain how the air bag may provide protection for the driver.

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....[3]

(ii) State and explain one other design feature of a car that may give protection to the driver in such circumstances.

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....[2]

Quality of Written Communication [4]