OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A

2821

Forces and Motion

Friday **10 JUNE 2005** Morning 1 hour

Candidates answer on the question paper.
Additional materials:
Electronic calculator
Ruler (cm/mm)
Protractor

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 provided 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	15	
2	14	
3	7	
4	6	
5	6	
6	12	
TOTAL	60	

This question paper consists of 15 printed pages and 1 blank page.

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,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
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,	$= 10 \lg \left(\frac{I}{I_0}\right)$

For Examiner's Use

Answer **all** the questions.

1 (a) (i) Define *velocity.*

....

....[1]

(ii) Define *acceleration.*

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....[1]

(b) During some car races, the cars often stop to refuel and change tyres.

(i) Suggest why a car stops to refuel rather than taking enough fuel at the start in order to complete the race without stopping.

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....[2]

(ii) Explain why the smooth tyres used in dry conditions are changed to those with a tread in wet weather.

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(c) Fig. 1.1 illustrates a racetrack near a refuelling station.

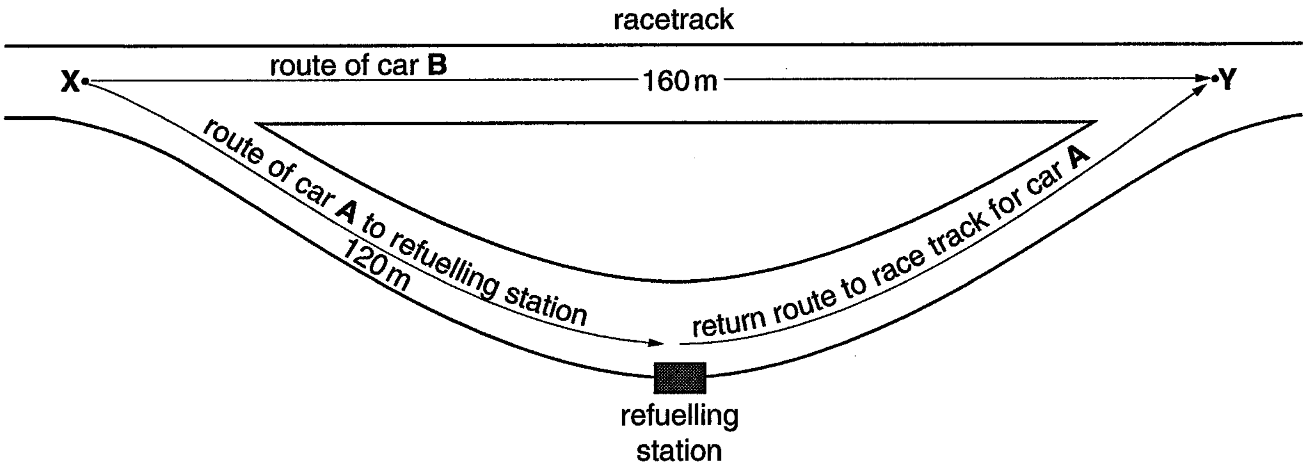

Fig. 1.1

The cars **A** and **B** are in a race and both have a speed of 80 m s^{-1}. Car **A** has a lead over car **B** of 17.0 s at **X** when **A** leaves the racetrack to refuel. Car **A** travels 120 m from **X** to the refuelling station.

Calculate the following values for car **A**, from the point where it leaves the racetrack until it comes to rest at the refuelling station. Assume the deceleration is constant.

(i) the average deceleration

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

(ii) the time taken

time = ... s [2]

(d) Car **A** refuels in 9.0 s and then takes 4.0 s to travel to **Y**. During the refuelling of car **A**, car **B** continues to travel at 80 m s^{-1}. Calculate the time difference between the cars **A** and **B** as car **A** arrives back on the racetrack at **Y**.

time = ... s [4]

[Total: 15]

For Examiner's Use

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

Fig. 2.1 shows the path of a ball after it is thrown from **T**. The ball reaches a maximum height at point **P** and then returns to the ground at **G**.

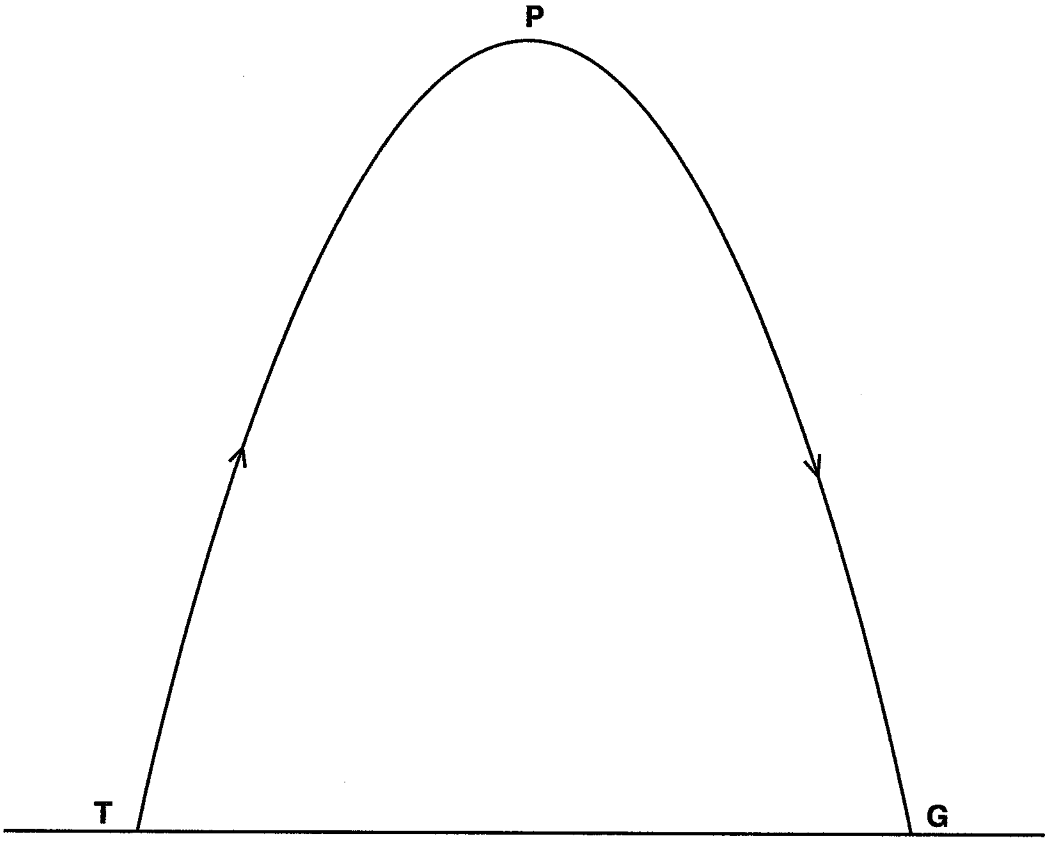

Fig. 2.1

(a) Assuming no air resistance, describe and explain how the vertical and horizontal components of the velocity of the ball change as it travels from **T** to **G**.

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For Examiner's Use

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....[5]

(b) Assuming no air resistance, describe the changes in the kinetic and potential energies of the ball as it travels from **T** to **G**.

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....[4]

(c) Describe how the motion of the ball is affected when air resistance is taken into consideration.

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....[3]

Quality of Written Communication [2]

[Total: 14]

3 A girl travels down a pulley-rope system that is set up in an adventure playground. Fig. 3.1 shows the girl at a point on her run where she has come to rest.

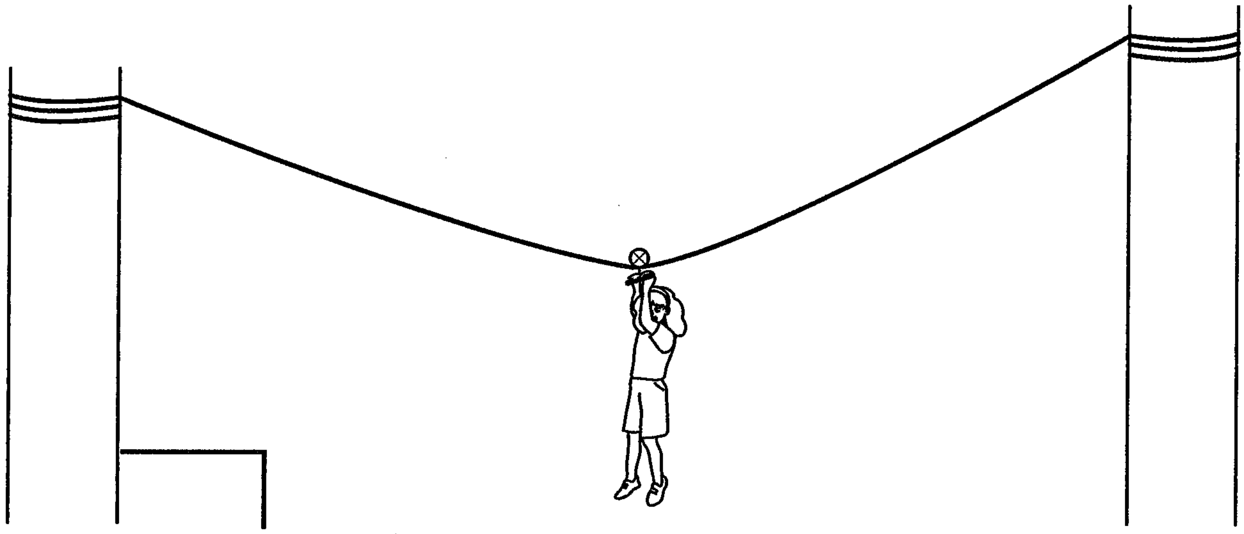

Fig. 3.1

The girl exerts a vertical force of 500 N on the pulley wheel. All the forces acting on the pulley wheel are shown in Fig. 3.2.

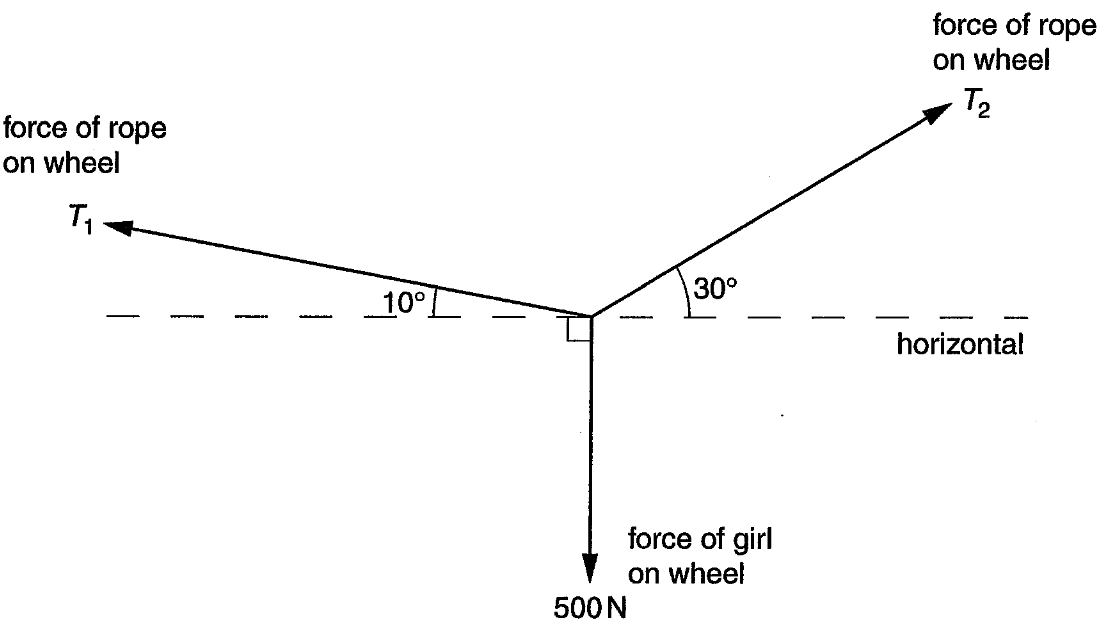

Fig. 3.2

(a) Explain why the vector sum of the three forces must be zero.

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....[1]

For Examiner's Use

(b) (i) Sketch a labelled vector triangle of the forces acting on the pulley wheel.

[3]

(ii) Determine by scale diagram or calculation the forces T_1 and T_2 the rope exerts on the pulley wheel.

[3]

[Total: 7]

For Examiner's Use

4 Fig. 4.1 shows a stationary oil drum floating in water.

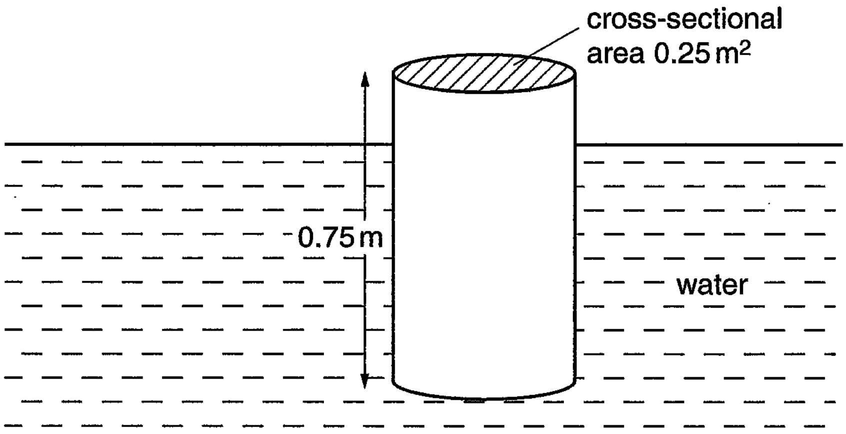

Fig. 4.1

The oil drum is 0.75 m long and has a cross-sectional area of 0.25 m^2. The air pressure above the oil drum is 1.0×10^5 Pa.

(a) Calculate the force acting on the top surface of the oil drum due to the external air pressure.

force = ... N [2]

(b) The average density of the oil drum and contents is 800 kg m^{-3}. Calculate the total weight of the oil drum and contents.

weight = ... N [3]

(c) Calculate the force acting upwards on the base of the drum.

force = ... N [1]

[Total: 6]

For Examiner's Use

5 Fig. 5.1 shows a crate resting on the flat bed of a moving lorry.

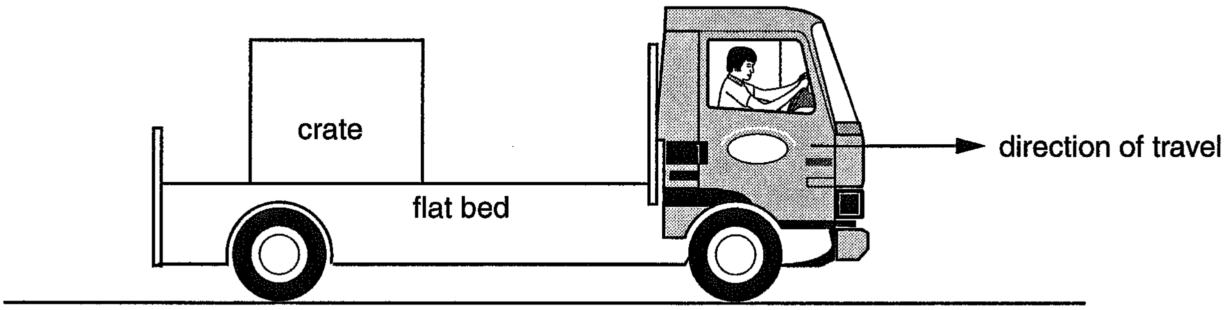

Fig. 5.1

(a) The lorry brakes and decelerates to rest.

(i) Describe and explain what happens to the crate if the flat bed of the lorry is smooth.

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....[2]

(ii) A rough flat bed allows the crate to stay in the same position on the lorry when the lorry brakes. Show on Fig. 5.1 (with an arrow **labelled F**) the direction of the force that must act on the crate to allow this. [1]

(b) Using your answers to **(a)** or otherwise explain how seat belts worn by rear seat passengers can reduce injuries when a car is involved in a head-on crash.

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....[3]

[Total: 6]

6 Fig. 6.1 shows a spring that is fixed at one end and is hanging vertically.

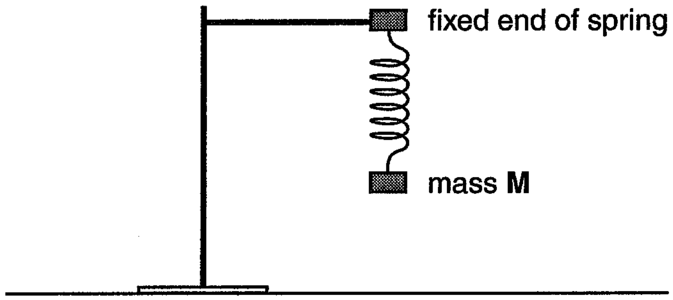

Fig. 6.1

A mass **M** has been placed on the free end of the spring and this has produced an extension of 250 mm. The weight of the mass **M** is 2.00 N.

Fig. 6.2 shows how the force F applied to the spring varies with extension x up to an extension of $x = 250$ mm.

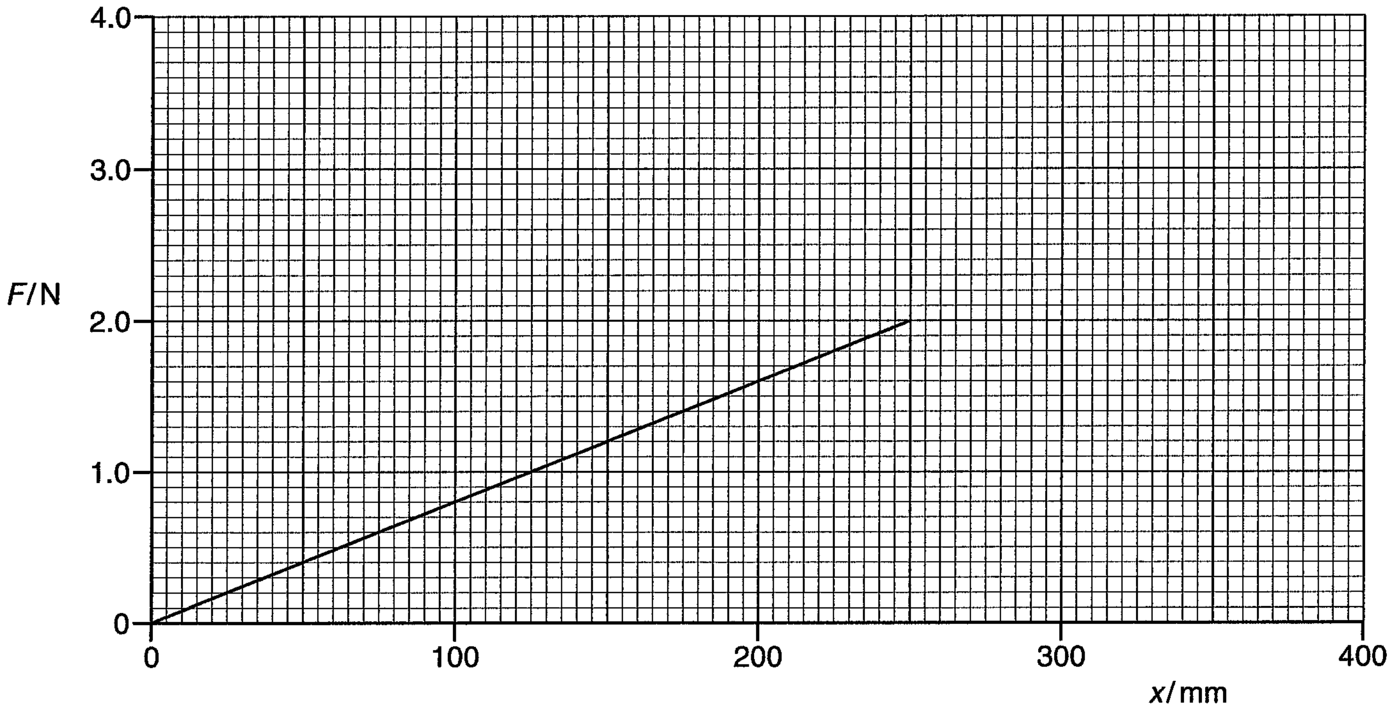

Fig. 6.2

For Examiner's Use

(a) **(i)** Calculate the spring constant of the spring.

spring constant = ... unit .... [3]

(ii) Calculate the strain energy in the spring when the extension is 250 mm.

strain energy = ... J [2]

(b) The mass **M** is pulled down a further 150 mm by a force *F* additional to its weight.

(i) Determine the force *F*.

F = ... N [1]

(ii) State any assumption made.

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....[1]

Question 6 continued on page 14

(c) The mass **M** is now released and it oscillates up and down. Fig. 6.3 shows the displacement *s* against time *t* for these oscillations.

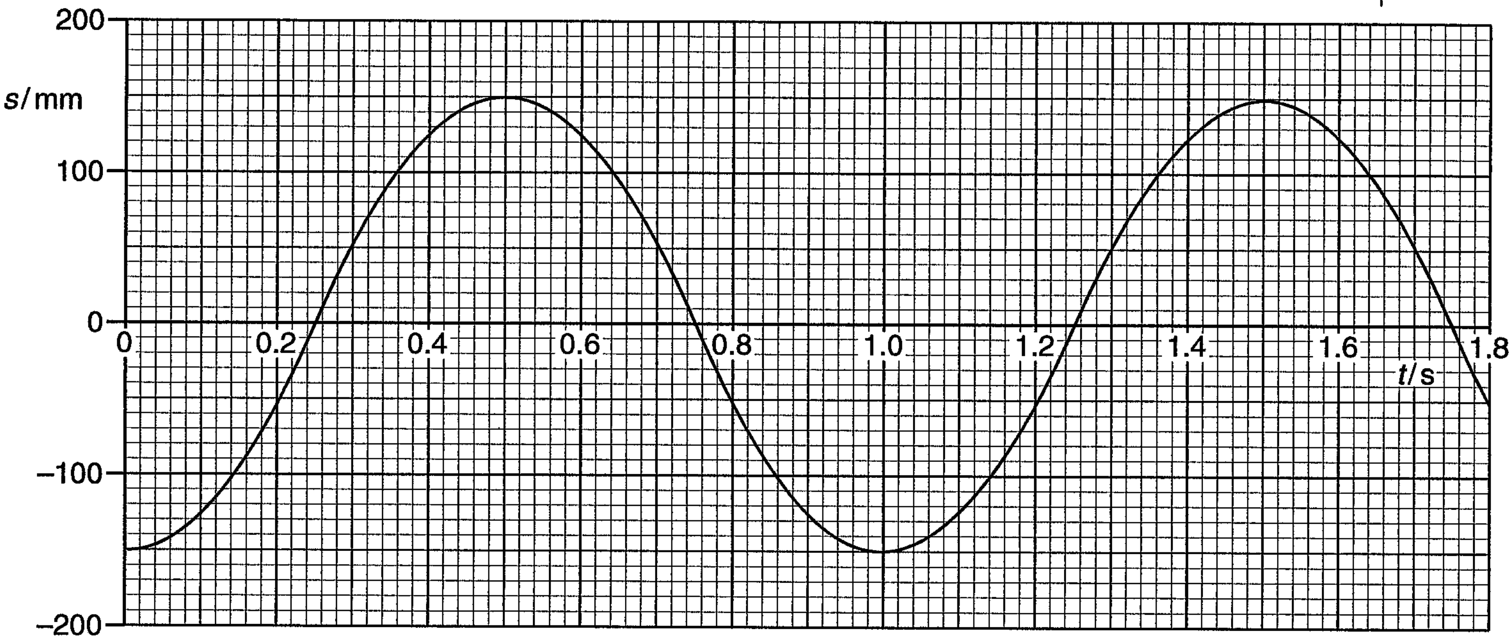

Fig. 6.3

(i) 1. Mark on Fig. 6.3 a time when the mass **M** has maximum downward velocity. Label this position V.

2. Use the graph to determine this maximum downward velocity of the mass.

maximum velocity = ... m s^{-1} [3]

(ii) 1. Mark on Fig. 6.3 a time when the mass **M** has maximum resultant force acting on it. Label this position with an X.

2. Explain your choice of position for X.

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....[2]

[Total: 12]

END OF QUESTION PAPER

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