OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A 2821

Forces and Motion

Wednesday **12 JANUARY 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	10	
2	10	
3	13	
4	10	
5	17	
TOTAL	60	

This question paper consists of 14 printed pages and 2 blank 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,	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$
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 **(a)** The following is a list of scalar and vector quantities.

acceleration, density, displacement, energy, power, speed, time, weight.

In the blank spaces provided in Fig. 1.1, list the quantities as either scalars or vectors. [4]

scalar	vector

Fig. 1.1

(b) Fig. 1.2 shows the path of a ball as it is passed between three players. Player **A** passes a ball to player **B**. When player **B** receives the ball, she immediately passes the ball to player **C**. The distances for each pass are shown on Fig. 1.2.

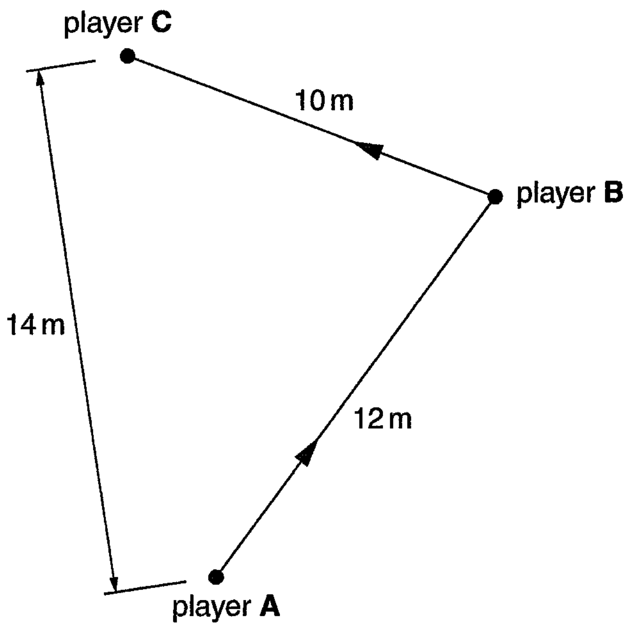

Fig. 1.2

The ball takes 2.4 s to travel from player **A** to player **C**.

(i) Calculate, for the total journey of the ball

1. the average speed of the ball

average speed = ... $m\,s^{-1}$ [2]

2. the magnitude of the average velocity of the ball.

average velocity = ... $m\,s^{-1}$ [2]

(ii) Explain why the values for the **average speed** and **average velocity** are different.

....

....

....

....[2]

[Total: 10]

2 **(a)** State the **two** conditions necessary for a system to be in equilibrium.

1. ....

....

2. ....

....[2]

(b) Fig. 2.1 shows a painter's plank resting on two supports **A** and **B**.

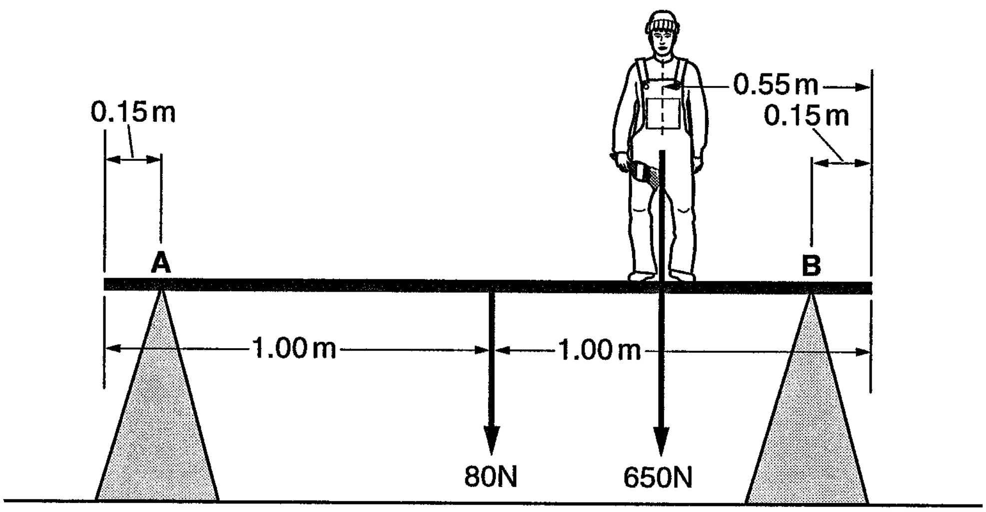

Fig. 2.1

The plank is uniform, has a weight 80 N and length 2.00 m. A painter of weight 650 N stands 0.55 m from one end.

(i) Show that the force acting on the plank at the support **B** is approximately 540 N by taking moments of all the forces about the support at **A**.

[3]

(ii) Calculate the force acting on the plank at support **A**.

force at **A** = ... N [2]

For Examiner's Use

(iii) Describe and explain what happens to the forces on the plank at **A** and **B** if the painter moves towards the support at **A**. Quantitative values are not required.

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....[3]

[Total: 10]

For Examiner's Use

3 (a) Define *acceleration*.

....

.... [1]

(b) Fig. 3.1 shows the velocity v of a ball against time t as it falls vertically from rest to when it hits the ground at **A**.

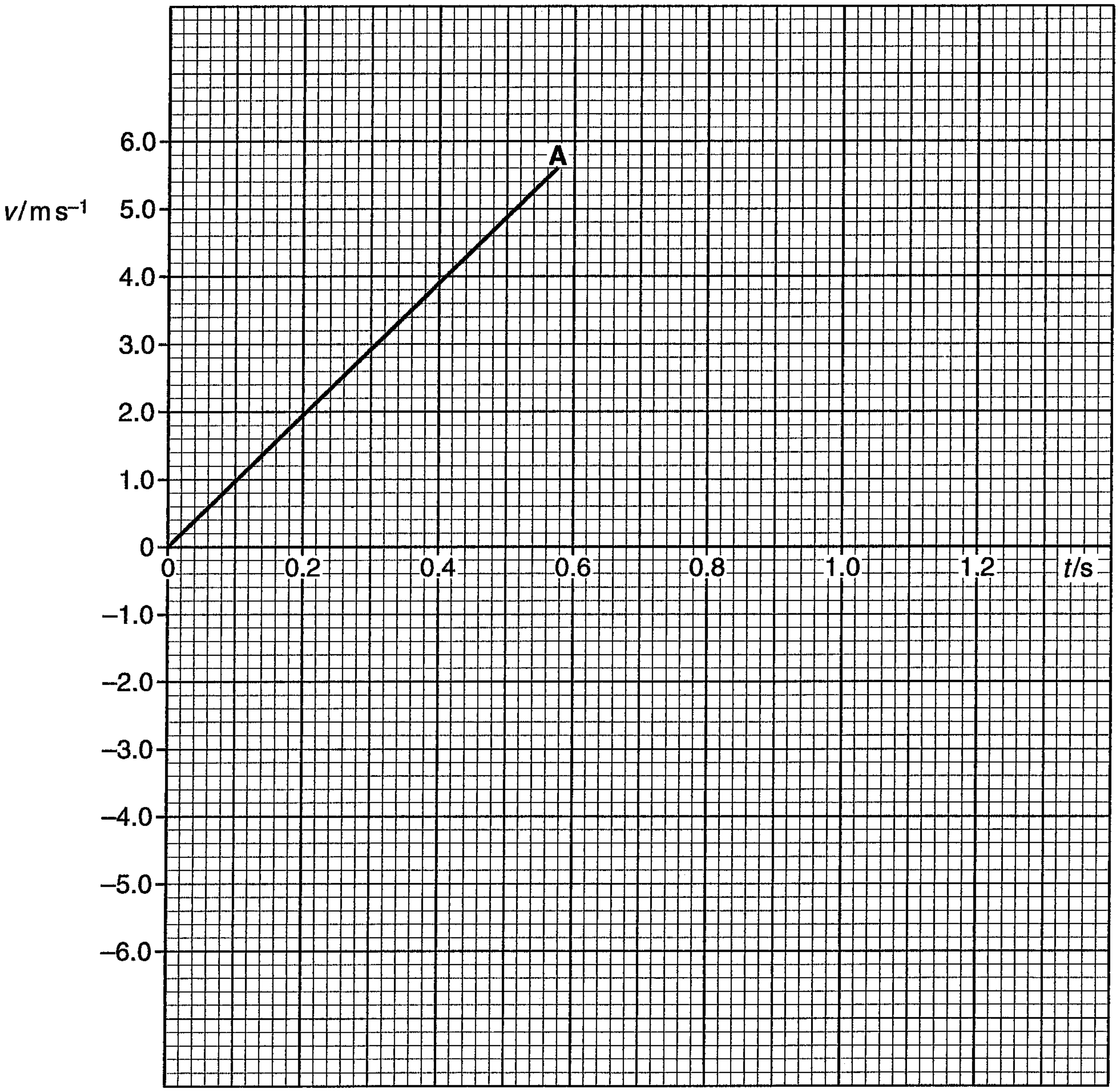

Fig. 3.1

Use Fig. 3.1 to show the distance that the ball falls is approximately 1.6 m.

[2]

For Examiner's Use

(c) The ball is in contact with the ground for 20 ms and then rebounds vertically with an initial upwards velocity of 5.1 m s^{-1}.

(i) Calculate the acceleration of the ball as it rebounds while in contact with the ground.

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

(ii) Sketch on Fig. 3.1 the velocity against time graph for the ball after it has bounced off the ground until it reaches its maximum height. [3]

(d) The ball has a mass of 0.025 kg and rebounds to a height of 1.3 m.

(i) Calculate the loss in the potential energy of the ball from the initial point of release at 1.6 m to when it reaches 1.3 m.

loss in potential energy .... unit .... [3]

(ii) Explain the loss in the potential energy.

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....[1]

[Total: 13]

4 (a) (i) Define *work done*.

....

....[1]

(ii) Define the *watt*.

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....[1]

(b) The braking distance x of a car depends on its initial kinetic energy E_k. Fig. 4.1 shows the relationship between E_k and x.

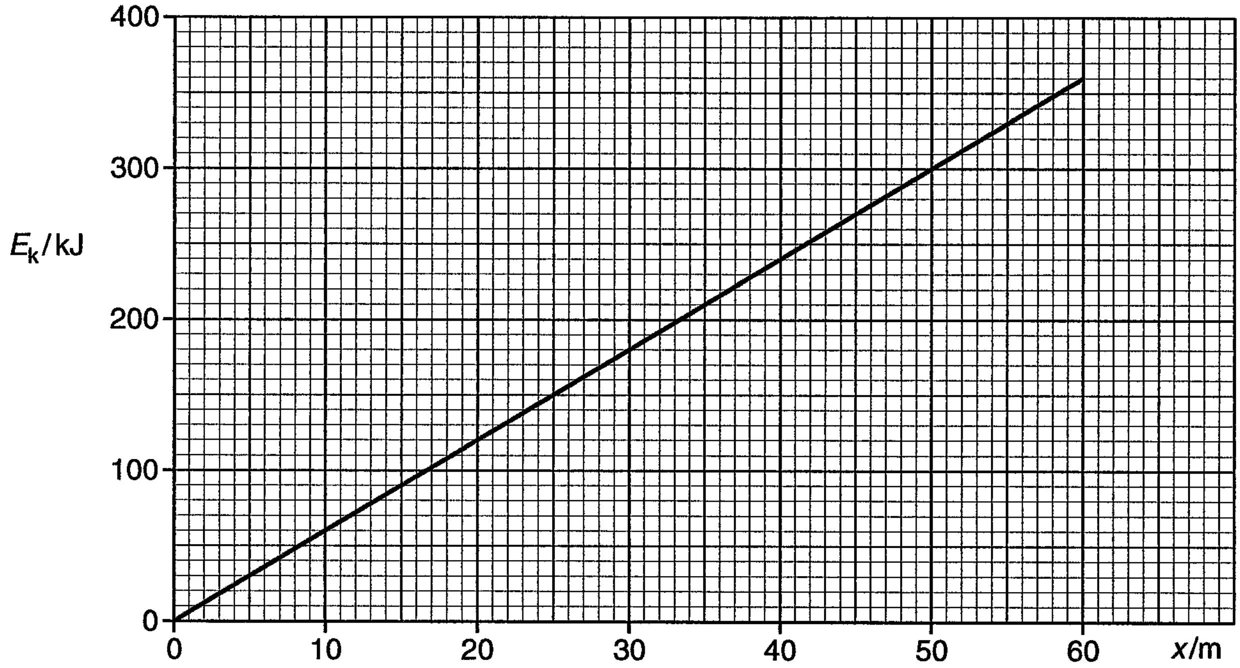

Fig. 4.1

(i) Calculate the gradient of the graph.

gradient = ... $J\,m^{-1}$ [2]

(ii) Explain why the gradient of the graph is equal to the braking force acting on the car.

....

....

....[2]

For Examiner's Use

(iii) The car has a mass of 800 kg. Calculate the deceleration of the car when braking.

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

(iv) The car is loaded so that the total mass is 1200 kg. Describe and explain how the braking distance changes for the same braking force and initial velocity.

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....[2]

[Total: 10]

For Examiner's Use

5 (a) (i) Define *strain*.

....

....

(ii) Define *stress*.

....

....
[2]

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

Describe an experiment to determine the Young modulus of a metal in the form of a wire.

Your description should include

- a labelled diagram of the apparatus
- the measurements to be taken
- an explanation of how the equipment is used to obtain the measurements
- an explanation of how the measurements would be used to determine the Young modulus.

diagram of the apparatus

[3]

For Examiner's Use

measurements to be taken

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how the equipment is used to obtain the measurements

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....[4]

determination of the Young modulus

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....[4]

Quality of Written Communication [2]

END OF QUESTION PAPER [Total: 17]

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