Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2002
Advanced Subsidiary Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION A) PA02
Unit 2 Mechanics and Molecular Kinetic Theory

Monday 14 January 2002 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a ruler.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- The paper carries 30% of the total marks for Physics Advanced Subsidiary and carries 15% of the total marks for Physics Advanced.
- A *Data Sheet* is provided on pages 3 and 4. You may wish to detach this perforated sheet at the start of the examination.
- You are expected to use a calculator where appropriate.
- In questions requiring description and explanation you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

- A perforated Data Sheet is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

TURN OVER FOR THE FIRST QUESTION

Answer **all** questions in the spaces provided.

1 (a) (i) Define acceleration.

.....

(ii) State why acceleration is a vector quantity.

.....

.....

(2 marks)

(b) State what feature of a velocity-time graph may be used to calculate

(i) acceleration,

.....

(ii) displacement.

.....

(2 marks)

(c) The graph in **Figure 1** shows how the displacement of a runner from a fixed point, along a straight track, varies with time.

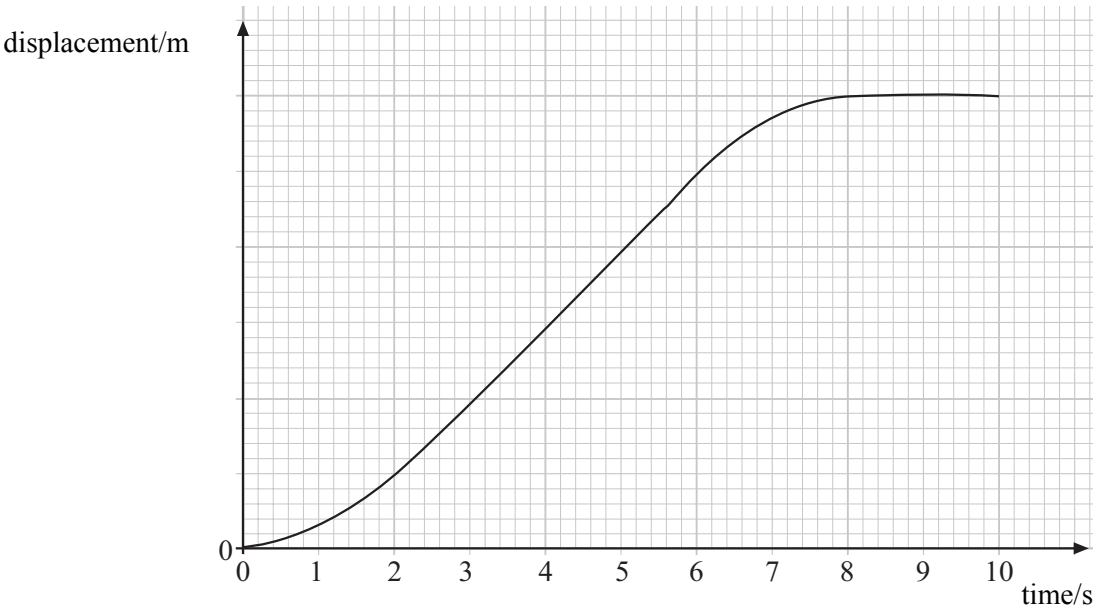

Figure 1

Without calculation, sketch on the grid in **Figure 2** a graph to show how the velocity of the same runner varies over the same period. The time scales are the same on both graphs.

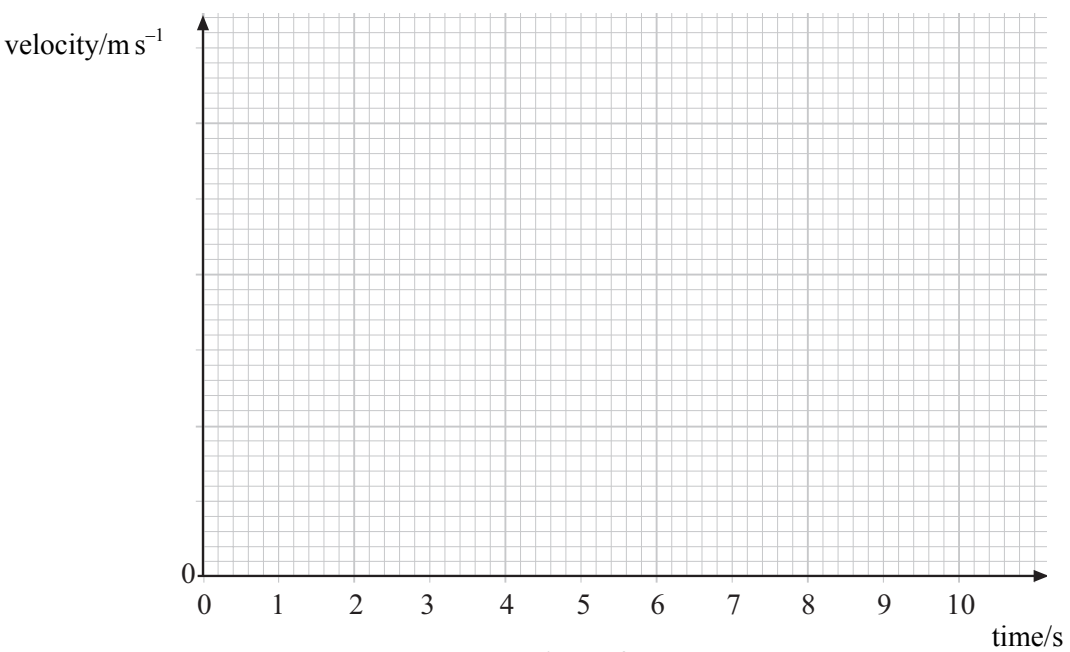

Figure 2

(4 marks)

2 The table gives the average kinetic energy of gas molecules at certain temperatures.

E_k/J × 10^{-21}	6.21	6.62	7.04	7.45	7.87	8.28
T/K	300	320	340	360	380	400

(a) On the grid provided, on the opposite page, plot a graph of E_k against T.

(i) Use your graph to determine the average kinetic energy of gas molecules at 350 K.

.....

(ii) Determine the gradient of your graph and hence calculate a value for the Boltzmann constant. Show all your working.

.....

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(8 marks)

(b) One of the assumptions of the kinetic theory is that collisions of gas molecules are elastic.

(i) State what is meant by an elastic collision.

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.....

(ii) State another assumption of the kinetic theory.

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(iii) Explain how the data in the table leads to the concept of absolute zero.

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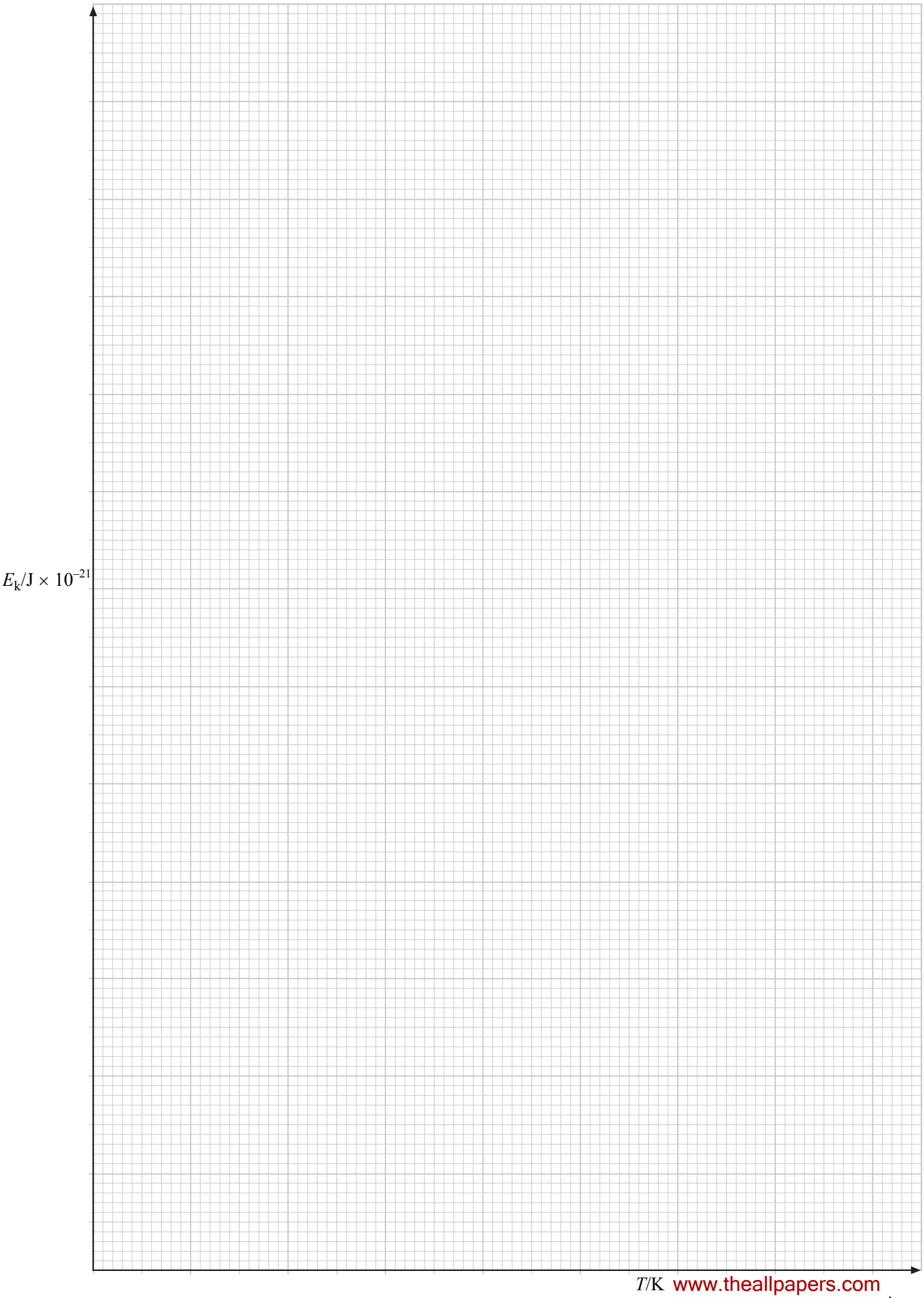
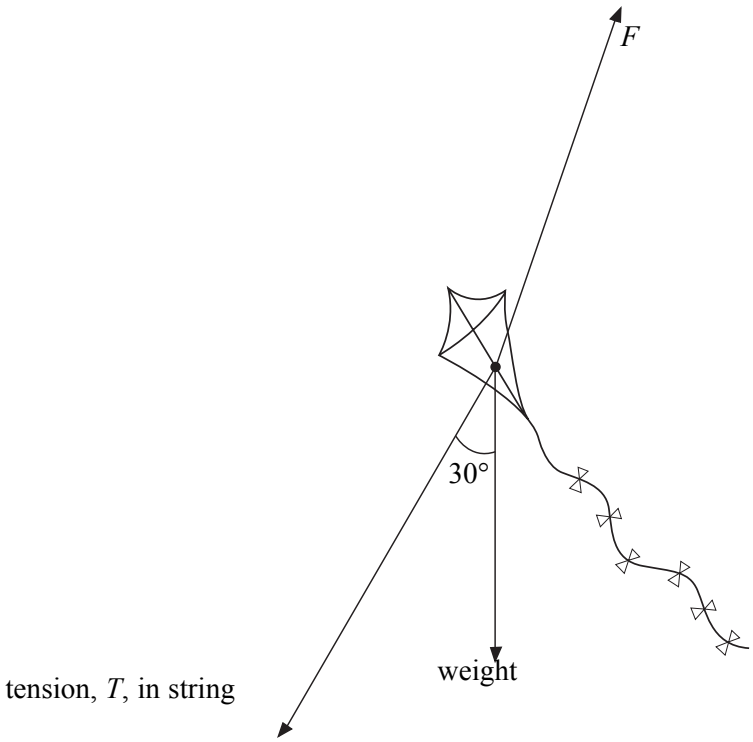
(4 marks)

12



3 The diagram shows the forces acting on a stationary kite. The force F is the force that the air exerts on the kite.



(a) Show on the diagram how force F can be resolved into horizontal and vertical components.

(2 marks)

(b) The magnitude of the tension, T, is 25 N.
Calculate

(i) the horizontal component of the tension,

.....

(ii) the vertical component of the tension.

.....

(2 marks)

(c) (i) Calculate the magnitude of the vertical component of F when the weight of the kite is 2.5 N.

.....

(ii) State the magnitude of the horizontal component of F.

.....

(iii) Hence calculate the magnitude of F.

.....

.....

(4 marks)

4 (a) State the principle of moments.

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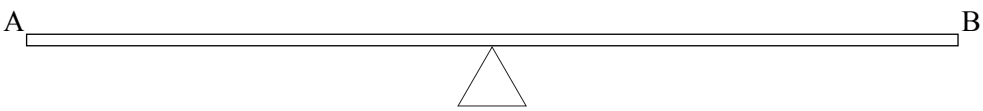
(2 marks)

(b) The diagram shows a uniform metre ruler, AB, freely pivoted at its centre of mass.



Explain what is meant by the centre of mass.

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(1 mark)

(c) A 1.0 N weight is placed on the ruler 0.30 m from the middle of the ruler towards A.

(i) Explain which way the pivot must be moved in order for equilibrium to be restored.

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(ii) Calculate the distance the pivot needs to be moved to restore equilibrium when the weight of the ruler is 0.50 N.

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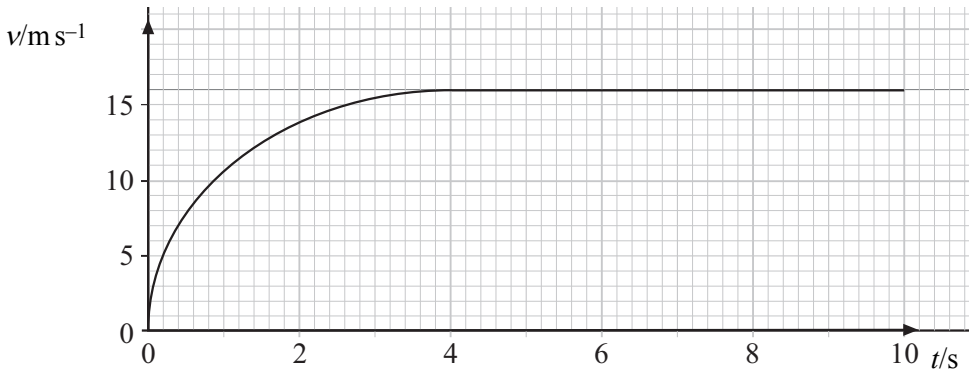
(5 marks)

5 The graph represents the motion of a car of mass 1.4×10^3 kg, travelling in a straight line.



(a) Describe, without calculation, how the *resultant* force acting on the car varies over this 10 second interval.

.....

.....

.....

.....

(2 marks)

(b) Calculate the maximum kinetic energy of the car.

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.....

(2 marks)

(c) At some time later, when the car is travelling at a steady speed of 30 m s^{-1}, the useful power developed by the engine is 20 kW. Calculate the driving force required to maintain this speed.

.....

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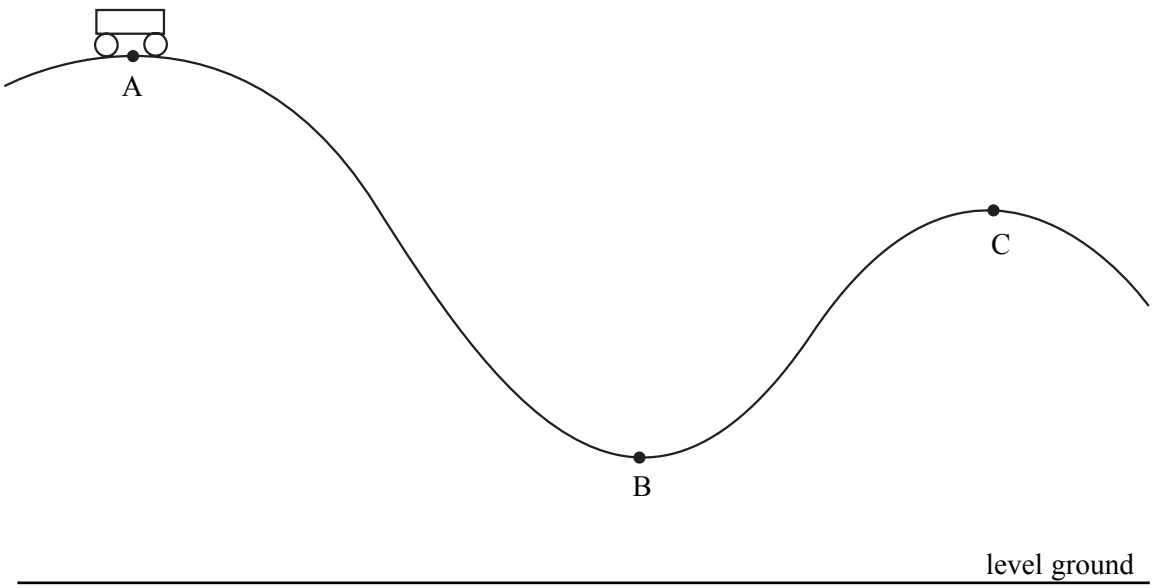
(2 marks)

6

6 The figure shows the track of a funfair ride.



Carriages are pulled up to the highest point, A, of the ride and then released so that they follow the path ABC.

(a) Point A is 18 m above the ground and point C is 12 m above the ground. Show that the maximum possible speed of the carriage at C is 11 m s^{-1}.

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(3 marks)

(b) The actual speed at C is less than 11m s^{-1}. Describe the energy changes that take place as the carriage moves from A to B to C.

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(4 marks)

7 A ball bearing is released into a tall cylinder of clear oil. The ball bearing initially accelerates but soon reaches terminal velocity.

(a) By considering the forces acting on the ball bearing, explain its motion.

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(3 marks)

(b) How would you demonstrate that the ball bearing had reached terminal velocity?

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(2 marks)

5

8 (a) A cricketer throws a ball vertically upwards so that the ball leaves his hands at a speed of $25\,m\,s^{-1}$. If air resistance can be neglected, calculate

(i) the maximum height reached by the ball,

.....

.....

(ii) the time taken to reach maximum height,

.....

.....

(iii) the speed of the ball when it is at 50% of the maximum height.

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(4 marks)

(b) When catching the ball, the cricketer moves his hands for a short distance in the direction of travel of the ball as it makes contact with his hands. Explain why this technique results in less force being exerted on the cricketer's hands.

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(2 marks)

6

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE