Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 31 May 2002 Afternoon 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			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

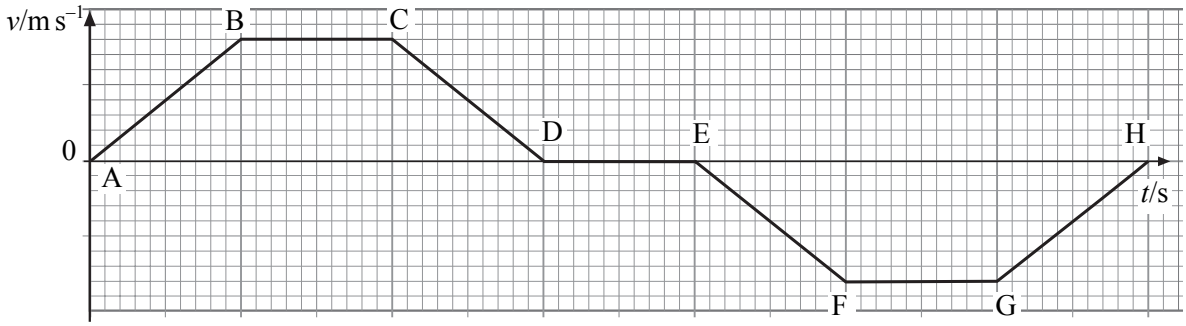
- A perforated Data Sheet is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

The data sheet will replace this page

The data sheet will replace this page

Answer **all** questions

1 The graph below shows how the velocity of a toy train moving in a straight line varies over a period of time.



(a) Describe the motion of the train in the following regions of the graph.

AB .....

BC .....

CD .....

DE .....

EF .....

(5 marks)

(b) What feature of the graph represents the displacement of the train?

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.....

(1 mark)

(c) Explain, with reference to the graph, why the distance travelled by the train is different from its displacement.

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(2 marks)

8

2 (a) The molecular theory model of an ideal gas leads to the derivation of the equation

$$pV = \tfrac{1}{3}Nm\overline{c^2}.$$

Explain what each symbol in the equation represents.

p .....

V .....

N .....

.....

m .....

.....

$\overline{c^2}$ .....

.....

(4 marks)

(b) One assumption used in the derivation of the equation stated in part (a) is that molecules are in a state of *random motion*.

(i) Explain what is meant by random motion.

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(ii) State **two** more assumptions used in this derivation.

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(3 marks)

(c) Describe how the motion of gas molecules can be used to explain the pressure exerted by a gas on the walls of its container.

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(4 marks)

11

TURN OVER FOR THE NEXT QUESTION

3 An electrical heater is used to heat a 1.0 kg block of metal, which is well lagged. The table shows how the temperature of the block increased with time.

temp/°C	20.1	23.0	26.9	30.0	33.1	36.9
time/s	0	60	120	180	240	300

(a) Plot a graph of temperature against time on the grid provided. *(3 marks)*

(b) Determine the gradient of the graph.

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(2 marks)

(c) The heater provides thermal energy at the rate of 48 W. Use your value for the gradient of the graph to determine a value for the specific heat capacity of the metal in the block.

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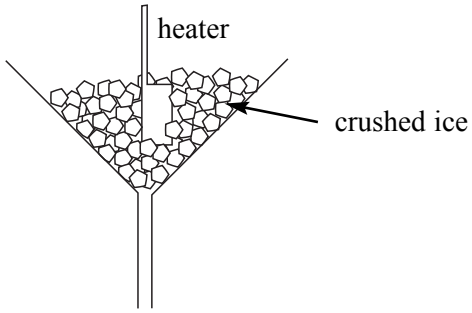
(2 marks)

(d) The heater in part (c) is placed in some crushed ice that has been placed in a funnel as shown.



The heater is switched on for 200 s and 32 g of ice are found to have melted during this time. Use this information to calculate a value for the specific latent heat of fusion for water, stating **one** assumption made.

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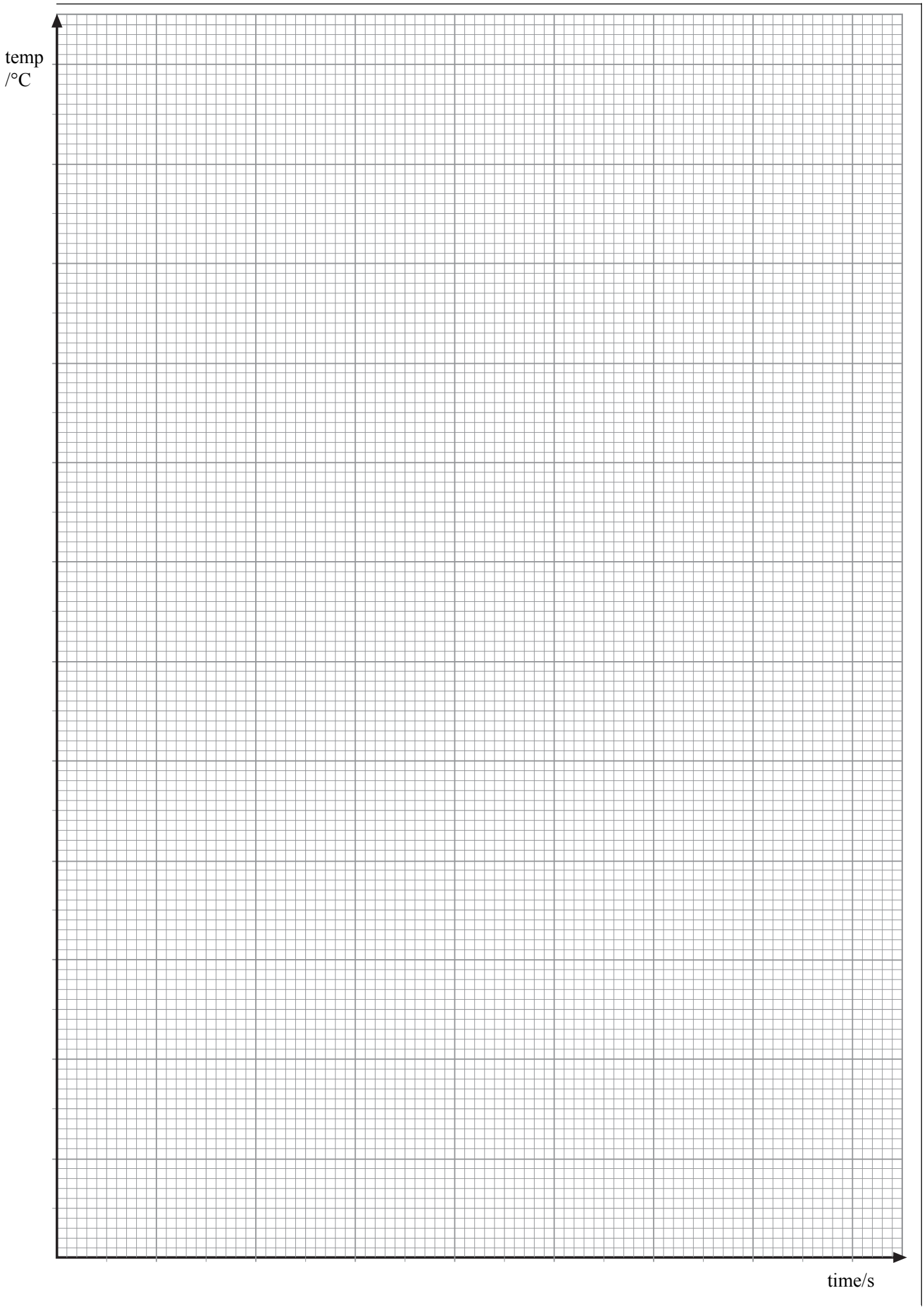
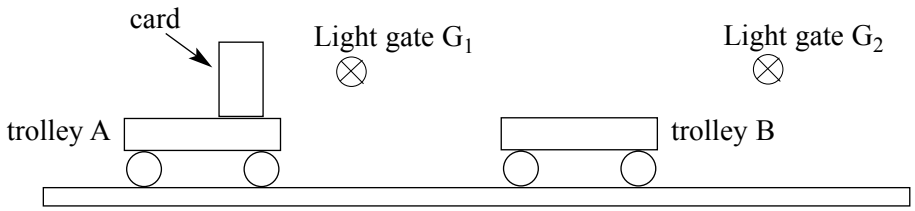
(3 marks)

10



4 The simplified diagram shows an experimental arrangement to investigate the collision of two trolleys.



In the experiment, trolley A is travelling at speed *v*. It collides with and sticks to, the initially stationary trolley B.

(a) State the measurements you would need to take so that you could determine the speed of

(i) trolley A before the collision,

.....

.....

(ii) trolleys A and B after the collision.

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(3 marks)

(b) Explain how you would verify that momentum was conserved in this collision, indicating what other measurements would be required.

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(2 marks)

(c) State and explain what you would do to minimise the effects of friction on the motion of the trolleys.

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(2 marks)

7

5 A car accelerates at a steady rate of 2.5 m s^{-2} along a straight, level road. The mass of the car is 1.3×10^3 kg.

(a) Calculate the magnitude of the resultant force acting on the car.

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(2 marks)

(b) When the accelerating car reaches a speed of 2.2 m s^{-1}, the total force opposing the motion of the car is 410 N.

Calculate

(i) the driving force provided by the wheels,

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(ii) the power delivered to the wheels of the car.

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(3 marks)

(c) Explain how the total force opposing the motion of the car is affected when it is travelling up a hill.

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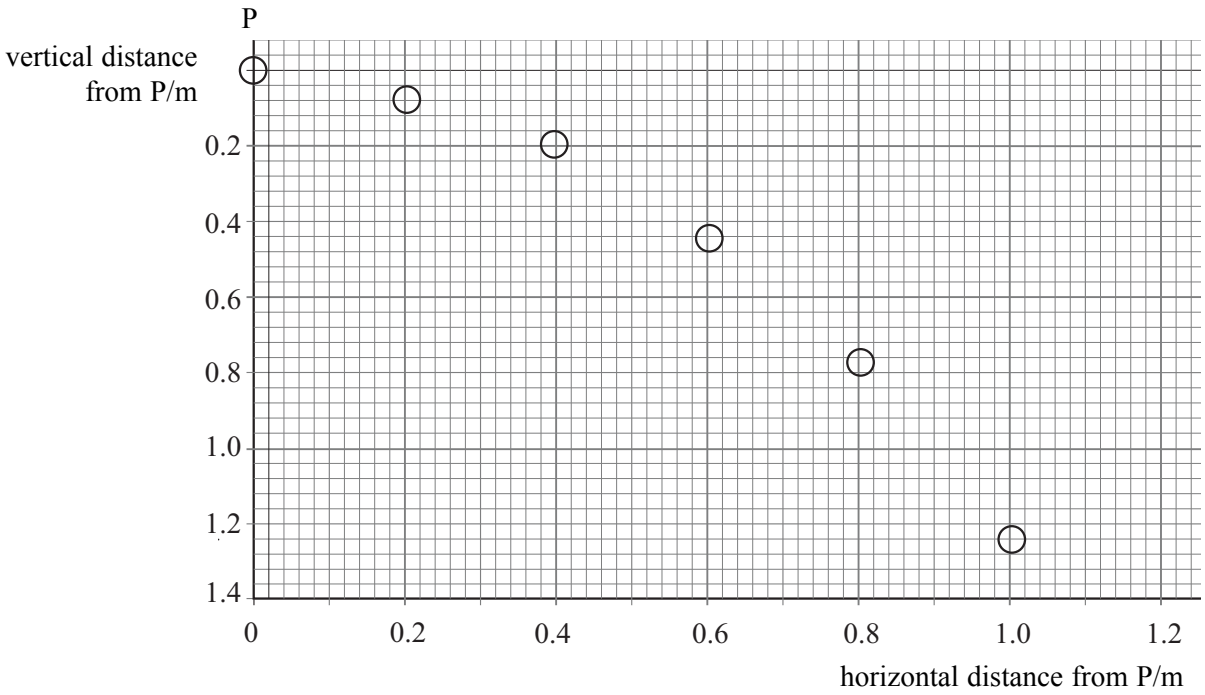
(1 mark)

6

TURN OVER FOR THE NEXT QUESTION

6 The graph shows how the position of a steel ball which has been projected horizontally from P changes with time. The position of the ball is shown at constant time intervals.



(a) Explain how the horizontal motion of the ball shows that air resistance is negligible.

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(2 marks)

(b) Explain the vertical motion of the ball.

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(2 marks)

(c) If air resistance were not negligible, describe how this would affect

(i) the horizontal motion of the ball,

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.....

(ii) the vertical motion of the ball.

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.....

(3 marks)

7

TURN OVER FOR THE NEXT QUESTION

7 (a) An egg of mass 5.8×10^{-2} kg is dropped from a height of 1.5 m onto a floor. Assuming air resistance is negligible, calculate for the egg

(i) the loss of potential energy,

.....

.....

(ii) the kinetic energy just before impact,

.....

(iii) the speed just before impact,

.....

.....

(iv) the momentum just before impact.

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(7 marks)

(b) On hitting the floor, the egg is brought to rest in a time of 0.010 s. Calculate the magnitude of the average decelerating force on the egg.

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(2 marks)

(c) The egg is now placed in a container that crumples on impact. Explain why this type of container makes it far less likely that the egg will break.

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(2 marks)

11

END OF QUESTIONS

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