Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
January 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 11 January 2008 1.30 pm to 2.30 pm

For this paper you must have:
- a calculator
- a ruler.

Time allowed: 1 hour

Instructions
- Use black ink or a black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- A *Data Sheet* is provided as a loose insert to this question paper.

Information
- The maximum mark for this paper is 50. This includes up to two marks for the Quality of Written Communication.
- The marks for questions are shown in brackets.
- Questions 3(a) and 4(a) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
Total (Column 1) →			
Total (Column 2) →			
Quality of Written Communication			
TOTAL			
Examiner's Initials			

Answer **all** questions.

1 (a) One of the assumptions of the kinetic theory of gases is that gas molecules move with random motion. State **two** other assumptions of the kinetic theory of gases.

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(2 marks)

(b) Explain why the average velocity of the gas molecules in a container is zero.

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(2 marks)

(c) The pressure a gas exerts on the walls of a container depends on the *mean square speed* of the molecules. Explain what is meant by mean square speed.

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(2 marks)

(d) Explain why the mean square speeds of the gas molecules of two different gases at the same temperature are **not** the same.

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(2 marks)

8

Turn over for the next question

2 (a) State the principle of moments for a body in equilibrium.

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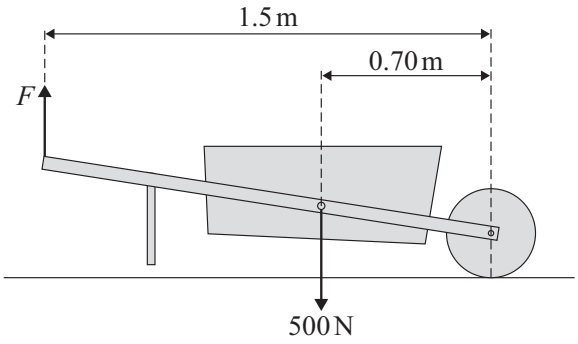
(2 marks)

(b) **Figure 1** shows a vertical force, *F*, being applied to raise a wheelbarrow which has a total weight of 500 N.

Figure 1



(i) On **Figure 1** draw an arrow to represent the position and direction of the force, *R*, exerted by the ground on the wheel.

(ii) Calculate the minimum value of the vertical force, *F*, needed to raise the legs of the wheelbarrow off the ground.

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(iii) Calculate the magnitude of *R* when the legs of the wheelbarrow have just left the ground.

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(5 marks)

7

3 A steady stream of water strikes a wall horizontally without rebounding and, as a result, exerts a force on the vertical wall.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer to Question 3(a).

(a) With reference to Newton's Laws of motion,

(i) state and explain why the momentum of the water changes as it strikes the wall,

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(ii) explain why the water exerts a constant force on the wall.

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(5 marks)

(b) Water arrives at the wall at a rate of $18\,\text{kg}\,\text{s}^{-1}$. It strikes the wall horizontally, at a speed of $7.2\,\text{m}\,\text{s}^{-1}$ without rebounding. Calculate

(i) the change in momentum of the water in **one** second,

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(ii) the force exerted by the water on the wall.

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(3 marks)

(c) State and explain the effect on the magnitude of the force if the water rebounds after striking the wall.

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(2 marks)

4 A dart is thrown horizontally at a speed of $8.0\,m\,s^{-1}$ towards the centre of a dartboard that is 2.0 m away. At the same instant that the dart is released, the support holding the dartboard fails and the dartboard falls freely, vertically downwards. The dart hits the dartboard in the centre before they both reach the ground.

(a) State and explain the motion of the dart and the dartboard, while the dart is in flight.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

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(4 marks)

(b) Calculate

(i) the time taken for the dart to hit the dartboard,

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(ii) the vertical component of the dart's velocity just before it strikes the dartboard,

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(iii) the magnitude and direction of the resultant velocity of the dart as it strikes the dartboard.

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(5 marks)

9

5 An aircraft accelerates horizontally from rest and takes off when its speed is $82\,m\,s^{-1}$. The mass of the aircraft is 5.6×10^4 kg and its engines provide a constant thrust of 1.9×10^5 N.

(a) Calculate

(i) the initial acceleration of the aircraft,

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(ii) the minimum length of runway required, assuming the acceleration is constant.

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(3 marks)

(b) In practice, the acceleration is unlikely to be constant. State a reason for this and explain what effect this will have on the minimum length of runway required.

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(2 marks)

(c) After taking off, the aircraft climbs at an angle of 22° to the ground. The thrust from the engines remains at 1.9×10^5 N. Calculate

(i) the horizontal component of the thrust,

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(ii) the vertical component of the thrust.

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(2 marks)

7

Turn over ▸

6 A car of mass 1200 kg is travelling at $12\,m\,s^{-1}$. When the brakes are applied the car comes uniformly to rest in 6.0 s.

(a) Calculate the kinetic energy lost by the car.

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(2 marks)

(b) Approximately 70% of the kinetic energy of the car is converted into thermal energy in the brakes of the car when coming to rest. The total mass of the brake components is 28 kg and their average specific heat capacity is $540\,J\,kg^{-1}\,K^{-1}$.

(i) Estimate the temperature rise of the brake components.

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(ii) State and explain where some of the remaining energy is likely to have been dissipated.

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(5 marks)

7

Quality of Written Communication *(2 marks)*

2

END OF QUESTIONS