Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
June 2001
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Wednesday 6 June 2001 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.
- A *Data Sheet* is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

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.
- 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.
- Detach this sheet before you begin work.

The data sheet will replace this page

The data sheet will replace this page

1 (a) Collisions can be described as *elastic* or *inelastic*.
State what is meant by an inelastic collision.

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.....

(1 mark)

(b) A ball of mass 0.12 kg strikes a stationary cricket bat with a speed of 18 m s^{-1}. The ball is in contact with the bat for 0.14 s and returns along its original path with a speed of 15 m s^{-1}.

Calculate

(i) the momentum of the ball before the collision,

.....

.....

(ii) the momentum of the ball after the collision,

.....

.....

(iii) the total change of momentum of the ball,

.....

.....

(iv) the average force acting on the ball during contact with the bat,

.....

.....

(v) the kinetic energy lost by the ball as a result of the collision.

.....

.....

(6 marks)

— 7

2 (a) State **two** quantities which increase when the temperature of a given mass of gas is increased at constant volume.

(i) .....

(ii) .....

(2 marks)

(b) A car tyre of volume $1.0 \times 10^{-2}\,\text{m}^3$ contains air at a pressure of 300 kPa and a temperature of 290 K. The mass of one mole of air is 2.9×10^{-2} kg.

Assuming that the air behaves as an ideal gas, calculate

(i) *n*, the amount, in mol, of air,

.....

.....

(ii) the mass of the air,

.....

(iii) the density of the air.

.....

(5 marks)

(c) Air contains oxygen and nitrogen molecules. State, with a reason, whether the following are the same for oxygen and nitrogen molecules in air at a given temperature.

(i) The average kinetic energy per molecule

.....

.....

.....

(ii) The r.m.s. speed

.....

.....

.....

(4 marks)

11

3 The following data refer to a dishwasher.

power of heating element	2.5 kW
time to heat water	360 s
mass of water used	3.0 kg
initial temperature of water	20 °C
final temperature of water	60 °C

(a) Taking the specific heat capacity of water to be 4200 J kg^{-1} K^{-1}, calculate

(i) the energy provided by the heating element,

.....

.....

(ii) the energy required to heat the water.

.....

.....

.....

.....

(4 marks)

(b) Give **two** reasons why your answers in part (a) differ from each other.

.....

.....

.....

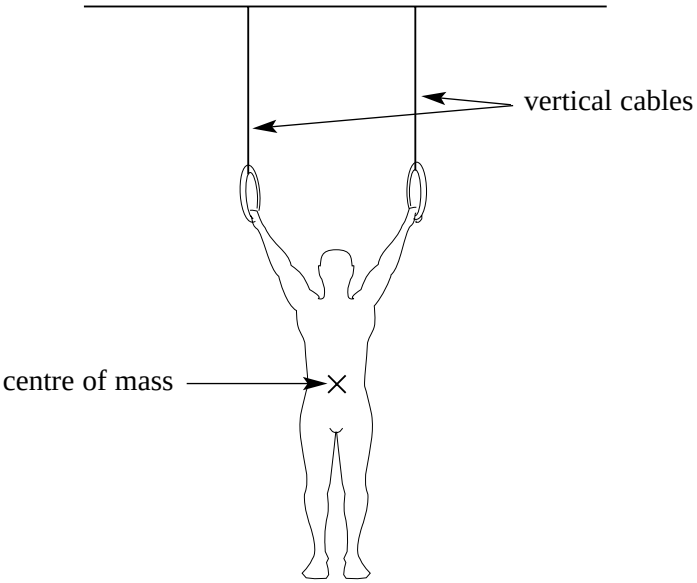
.....

(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

4 The diagram shows a gymnast of weight 720 N hanging centrally from two rings, each attached to cables which hang vertically.

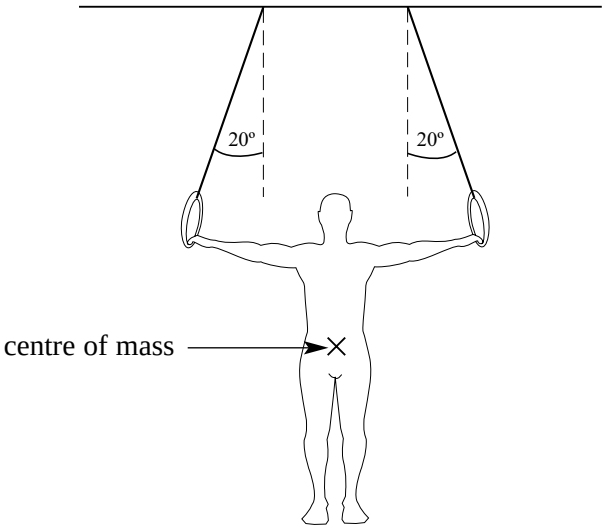


(a) State the tension in each cable.

.....

(1 mark)

(b) The diagram shows the gymnast after he has raised his body so that his centre of mass moves through a vertical distance of 0.60 m.



Calculate

(i) the increase in gravitational potential energy of the gymnast,

.....

.....

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(ii) the tension in each cable.

.....

.....

(3 marks)

(c) The gymnast now raises his legs so that they become horizontal,without raising the rest of his body. State and explain whether his gravitational potential energy is changed by this manoeuvre.

.....

.....

.....

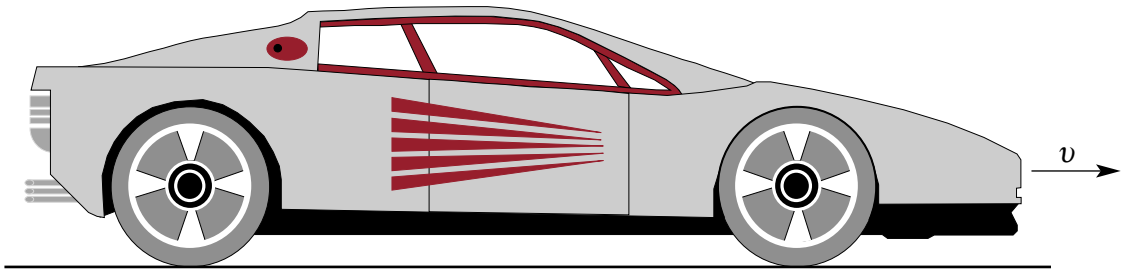
.....

(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

5 The diagram shows a car travelling at a constant velocity along a horizontal road.



(a) (i) Draw and label arrows on the diagram representing the forces acting on the car.

(ii) Referring to Newton's Laws of motion, explain why the car is travelling at constant velocity.

.....

.....

.....

.....

(5 marks)

(b) The car has an effective power output of 18 kW and is travelling at a constant velocity of 10 m s^{-1}. Show that the total resistive force acting is 1800 N.

.....

.....

.....

(1 mark)

(c) The total resistive force consists of two components. One of these is a constant frictional force of 250 N and the other is the force of air resistance, which is proportional to the square of the car's speed.

Calculate

(i) the force of air resistance when the car is travelling at 10 m s^{-1},

.....

.....

(ii) the force of air resistance when the car is travelling at $20\,m\,s^{-1}$,

.....

.....

(iii) the effective output power of the car required to maintain a constant speed of $20\,m\,s^{-1}$ on a horizontal road.

.....

.....

.....

(4 marks)

10

TURN OVER FOR THE NEXT QUESTION

6 (a) The torque of a couple is given by

$$\text{torque} = Fs\ .$$

(i) With the aid of a diagram explain what is meant by a couple. Label F and s on your diagram.

.....

.....

.....

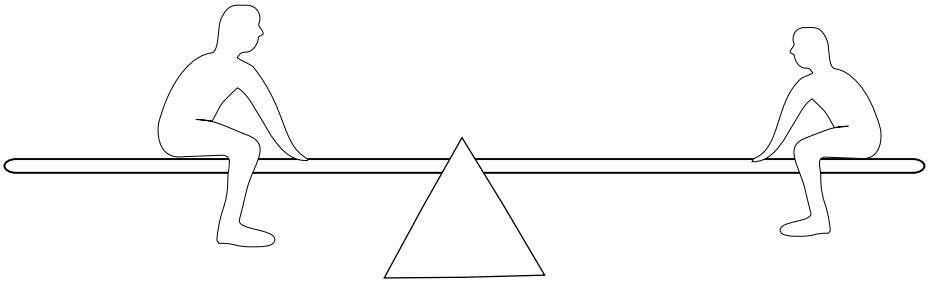
.....

(ii) State the unit for the torque of a couple.

.....

(4 marks)

(b) The see-saw shown in the diagram consists of a uniform beam freely pivoted at the centre of the beam. Two children sit opposite each other so that the see-saw is in equilibrium.



Explain why

(i) the see-saw is in equilibrium,

.....

.....

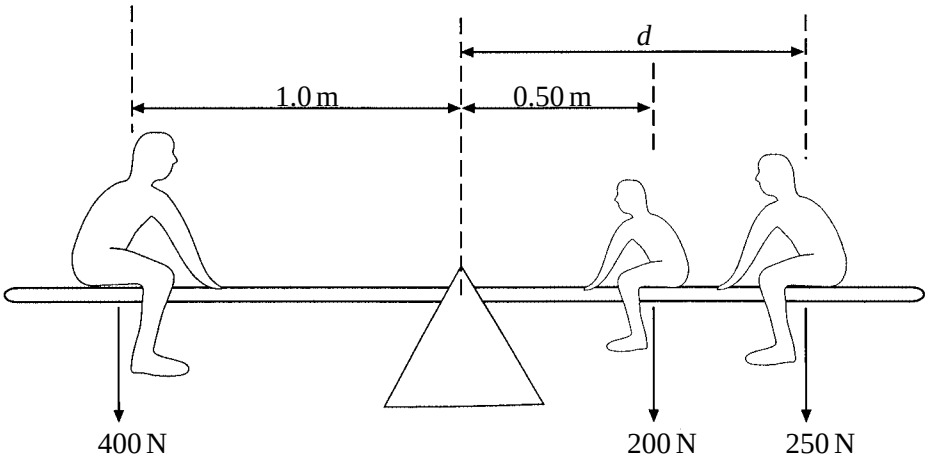
(ii) the weight of the beam does not affect equilibrium.

.....

.....

(3 marks)

(c) The diagram shows the see-saw with three children of weights 400 N, 250 N and 200 N sitting so that the see-saw is in equilibrium.



Calculate the distance, *d*.

.....

.....

.....

(2 marks)

9

7 Athlete A, competing in a 100 m race, crosses the finish line in a time of 10.2 s. At the start, the athlete accelerates uniformly to a top speed in 2.0 s and then remains at a constant speed for the remainder of the race.

(a) Calculate

(i) the average speed of the athlete over the full distance,

.....

.....

(ii) the maximum speed of the athlete if the acceleration were 5.4 m s^{-2},

.....

.....

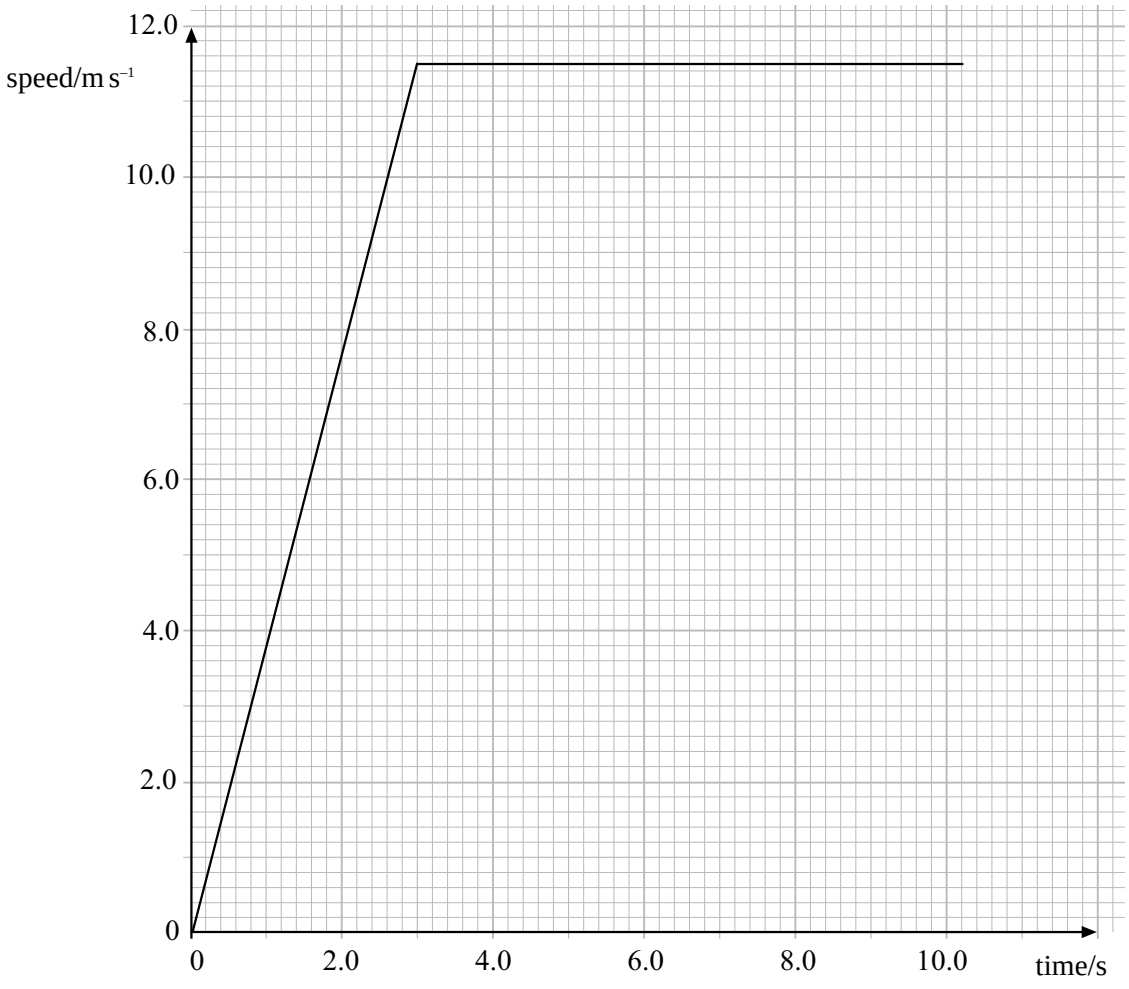
(iii) the distance travelled by the athlete whilst accelerating.

.....

.....

(4 marks)

(b) The graph is a speed time graph for athlete B in the same race.



On page 14, using the **same** axes, draw a speed time graph for athlete A.

(3 marks)

(c) Some time after the start of the race the two athletes are running at the same speed. Use your graph to determine

(i) the time at which this occurs,

.....

(ii) the distance covered by the athletes up to this time,

Athlete A: .....

.....

Athlete B: .....

.....

(iii) how far apart the athletes are at this time.

.....

(4 marks)

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END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE