

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
**General Certificate of Education Advanced Subsidiary Level**

**MATHEMATICS**

**8709/4**

**PAPER 4 Mechanics 1 (M1)**

**OCTOBER/NOVEMBER SESSION 2001**

1 hour 15 minutes

Additional materials:

Answer paper  
Graph paper  
List of Formulae (MF9)

**TIME** 1 hour 15 minutes

**INSTRUCTIONS TO CANDIDATES**

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **all** the questions.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use  $10 \text{ m s}^{-2}$ .

**INFORMATION FOR CANDIDATES**

The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 50.

Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

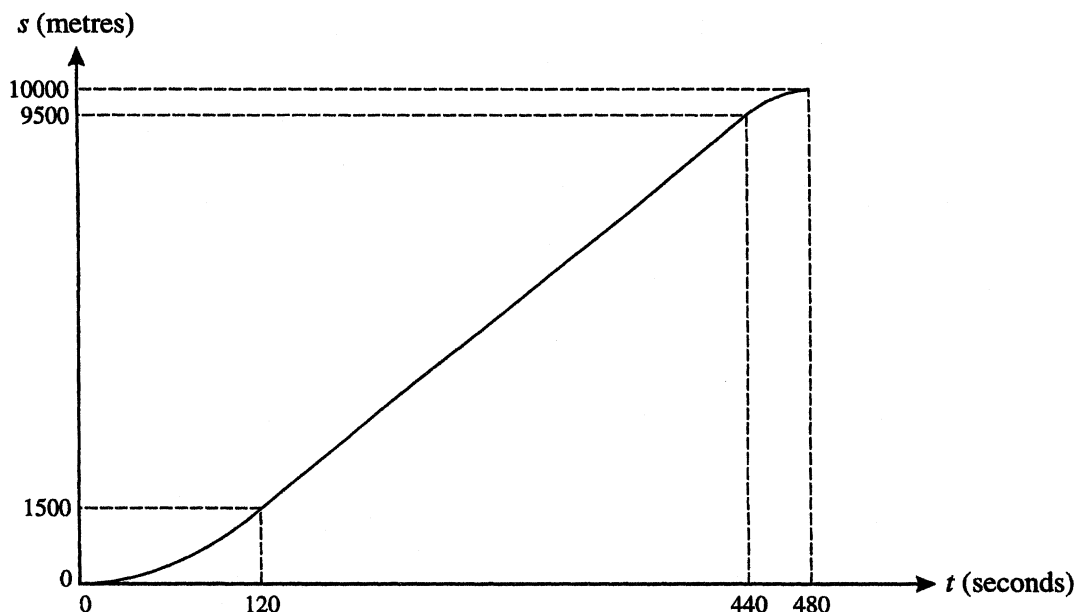
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**This question paper consists of 4 printed pages.**



- 1 A man pushes a shopping trolley in a straight line along horizontal ground. He exerts a force on the trolley of magnitude 30 N, acting downwards at  $10^\circ$  to the horizontal. Find the work done by the force in moving the trolley a distance of 80 m. [3]

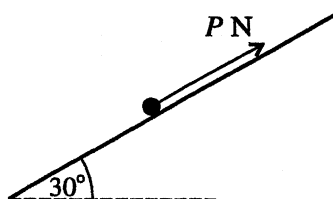
2



A train starts from rest at a station and travels in a straight line until it comes to rest again at the next station. The displacement-time graph above refers to the journey.

- (i) The speed of the train is constant from  $t = 120$  to  $t = 440$ . Find this speed. [2]
- (ii) Given that the acceleration of the train is constant from  $t = 0$  to  $t = 120$  and from  $t = 440$  to  $t = 480$ , make a sketch of the velocity-time graph for the journey, showing the maximum speed of the train. [3]

3



The diagram shows a particle of mass 0.5 kg resting on a rough plane inclined at  $30^\circ$  to the horizontal. The coefficient of friction between the particle and the plane is 0.4. A force of magnitude  $P$  N, acting directly up the plane, is just sufficient to prevent the particle sliding down the plane. Find the value of  $P$ . [6]

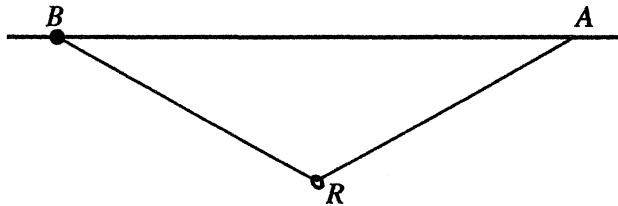
- 4 A particle travels in a straight line from a point  $A$  to a point  $B$ . Its velocity  $t$  seconds after leaving  $A$  is  $v \text{ m s}^{-1}$ , where

$$v = 4t - 0.04t^3.$$

Given that the distance  $AB$  is 100 m, find

- (i) the value of  $t$  when the particle reaches  $B$ , [5]  
 (ii) whether the particle is speeding up or slowing down at the instant that it reaches  $B$ . [3]

5

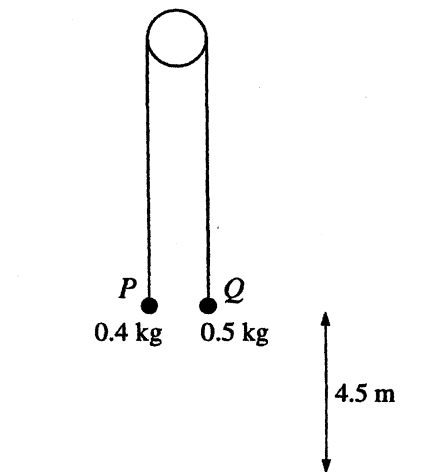


A small ring  $R$ , of mass 0.5 kg, is threaded on a light inextensible string, one end of which is attached to a fixed point  $A$ . A small bead  $B$  of mass 0.3 kg is attached to the other end of the string, and is threaded on a fixed rough horizontal rod which passes through  $A$  (see diagram). The ring is smooth and the system is in equilibrium.

- (i) State the relationship between the tension in  $AR$  and the tension in  $BR$ . [1]  
 (ii) Show that angle  $RAB$  is equal to angle  $RBA$ . [1]  
 (iii) Given that angle  $ARB$  is  $120^\circ$ , find the normal and frictional components of the contact force between  $B$  and the rod. [6]

**QUESTION 6 IS PRINTED OVERLEAF**

6



Particle  $P$  of mass  $0.4\text{ kg}$  and particle  $Q$  of mass  $0.5\text{ kg}$  are attached to the ends of a long light inextensible string which passes over a smooth pulley. The system is released from rest with both particles at a height of  $4.5\text{ m}$  above the ground (see diagram). The particles move vertically and  $Q$  does not rebound when it hits the ground. Find

- (i) the acceleration of  $Q$  before it hits the ground, [4]
- (ii) the time taken from the instant that  $Q$  hits the ground until  $P$  reaches its maximum height, [3]
- (iii) the total distance travelled by  $P$  while  $Q$  remains at rest on the ground. [2]
- 7 (i) A car  $C$  of mass  $1200\text{ kg}$  climbs a hill of length  $500\text{ m}$  at a constant speed. The hill is inclined at an angle of  $6^\circ$  to the horizontal. The driving force exerted by  $C$ 's engine has magnitude  $1800\text{ N}$ . Find the work done against the resistance to the motion of  $C$ , as it climbs from the bottom of the hill to the top. [4]
- (ii) Another car  $D$ , also of mass  $1200\text{ kg}$ , climbs the same hill with increasing speed. The speed at the bottom is  $8\text{ m s}^{-1}$  and the speed at the top is  $20\text{ m s}^{-1}$ . Assuming the resistance to the motion of  $D$  is constant and has magnitude  $700\text{ N}$ , find the work done by  $D$ 's engine as  $D$  climbs from the bottom of the hill to the top. [4]
- (iii) The driving force exerted by  $D$ 's engine is 4 times as great when  $D$  is at the top of the hill as it is when  $D$  is at the bottom. Find the ratio of the power developed by  $D$ 's engine at the top of the hill to the power developed at the bottom. [3]