

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

**MATHEMATICS**

**9709/04**

Paper 4 Mechanics 1 (M1)

May/June 2003

**1 hour 15 minutes**

Additional materials: Answer Booklet/Paper  
Graph paper  
List of Formulae (MF9)

**READ THESE INSTRUCTIONS FIRST**

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.  
Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen on both sides of the paper.  
You may use a soft pencil for any diagrams or graphs.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

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  $10 \text{ m s}^{-2}$ .

At the end of the examination, fasten all your work securely together.

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.

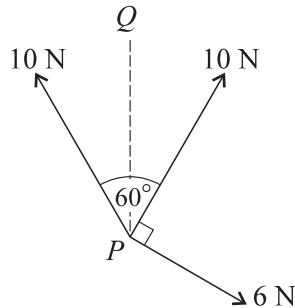
You are reminded of the need for clear presentation in your answers.

This document consists of 4 printed pages.



- 1 A crate of mass 800 kg is lifted vertically, at constant speed, by the cable of a crane. Find
- (i) the tension in the cable, [1]
  - (ii) the power applied to the crate in increasing the height by 20 m in 50 s. [3]

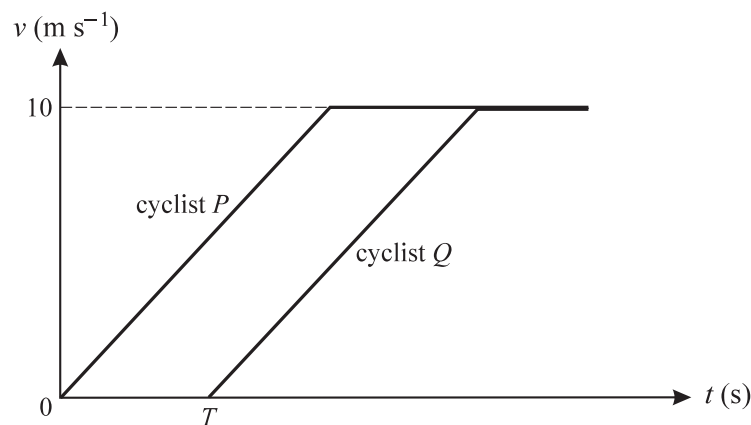
2



Three coplanar forces of magnitudes 10 N, 10 N and 6 N act at a point  $P$  in the directions shown in the diagram.  $PQ$  is the bisector of the angle between the two forces of magnitude 10 N.

- (i) Find the component of the resultant of the three forces
  - (a) in the direction of  $PQ$ , [2]
  - (b) in the direction perpendicular to  $PQ$ . [1]
- (ii) Find the magnitude of the resultant of the three forces. [2]

3



The diagram shows the velocity-time graphs for the motion of two cyclists  $P$  and  $Q$ , who travel in the same direction along a straight path. Both cyclists start from rest at the same point  $O$  and both accelerate at  $2 \text{ m s}^{-2}$  up to a speed of  $10 \text{ m s}^{-1}$ . Both then continue at a constant speed of  $10 \text{ m s}^{-1}$ .  $Q$  starts his journey  $T$  seconds after  $P$ .

- (i) Show in a sketch of the diagram the region whose area represents the displacement of  $P$ , from  $O$ , at the instant when  $Q$  starts. [1]

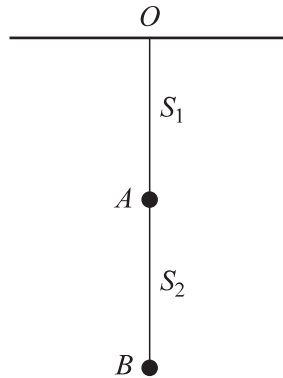
Given that  $P$  has travelled 16 m at the instant when  $Q$  starts, find

- (ii) the value of  $T$ , [3]
- (iii) the distance between  $P$  and  $Q$  when  $Q$ 's speed reaches  $10 \text{ m s}^{-1}$ . [2]

- 4 A particle moves in a straight line. Its displacement  $t$  seconds after leaving the fixed point  $O$  is  $x$  metres, where  $x = \frac{1}{2}t^2 + \frac{1}{30}t^3$ . Find

- (i) the speed of the particle when  $t = 10$ , [3]  
 (ii) the value of  $t$  for which the acceleration of the particle is twice its initial acceleration. [3]

5



$S_1$  and  $S_2$  are light inextensible strings, and  $A$  and  $B$  are particles each of mass  $0.2$  kg. Particle  $A$  is suspended from a fixed point  $O$  by the string  $S_1$ , and particle  $B$  is suspended from  $A$  by the string  $S_2$ . The particles hang in equilibrium as shown in the diagram.

- (i) Find the tensions in  $S_1$  and  $S_2$ . [3]

The string  $S_1$  is cut and the particles fall. The air resistance acting on  $A$  is  $0.4$  N and the air resistance acting on  $B$  is  $0.2$  N.

- (ii) Find the acceleration of the particles and the tension in  $S_2$ . [5]

- 6 A small block of mass  $0.15$  kg moves on a horizontal surface. The coefficient of friction between the block and the surface is  $0.025$ .

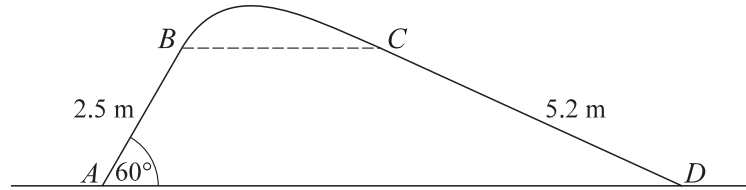
- (i) Find the frictional force acting on the block. [2]  
 (ii) Show that the deceleration of the block is  $0.25 \text{ m s}^{-2}$ . [2]

The block is struck from a point  $A$  on the surface and,  $4$  s later, it hits a boundary board at a point  $B$ . The initial speed of the block is  $5.5 \text{ m s}^{-1}$ .

- (iii) Find the distance  $AB$ . [2]

The block rebounds from the board with a speed of  $3.5 \text{ m s}^{-1}$  and moves along the line  $BA$ . Find

- (iv) the speed with which the block passes through  $A$ , [2]  
 (v) the total distance moved by the block, from the instant when it was struck at  $A$  until the instant when it comes to rest. [2]



The diagram shows a vertical cross-section  $ABCD$  of a surface. The parts  $AB$  and  $CD$  are straight and have lengths 2.5 m and 5.2 m respectively.  $AD$  is horizontal, and  $AB$  is inclined at  $60^\circ$  to the horizontal. The points  $B$  and  $C$  are at the same height above  $AD$ . The parts of the surface containing  $AB$  and  $BC$  are smooth. A particle  $P$  is given a velocity of  $8 \text{ m s}^{-1}$  at  $A$ , in the direction  $AB$ , and it subsequently reaches  $D$ . The particle does not lose contact with the surface during this motion.

- (i) Find the speed of  $P$  at  $B$ . [4]
- (ii) Show that the maximum height of the cross-section, above  $AD$ , is less than 3.2 m. [2]
- (iii) State briefly why  $P$ 's speed at  $C$  is the same as its speed at  $B$ . [1]
- (iv) The frictional force acting on the particle as it travels from  $C$  to  $D$  is 1.4 N. Given that the mass of  $P$  is 0.4 kg, find the speed with which  $P$  reaches  $D$ . [4]