



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Advanced Level

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**MATHEMATICS**

**9709/05**

Paper 5 Mechanics 2 (M2)

**October/November 2007**

**1 hour 15 minutes**

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

\* 3 7 8 7 6 1 2 7 0 8 \*

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

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

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

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.

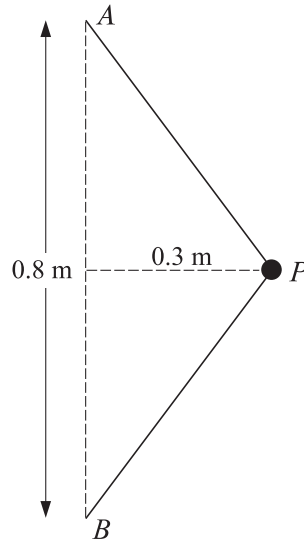
The total number of marks for this paper is 50.

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

This document consists of **5** printed pages and **3** blank pages.

2

1

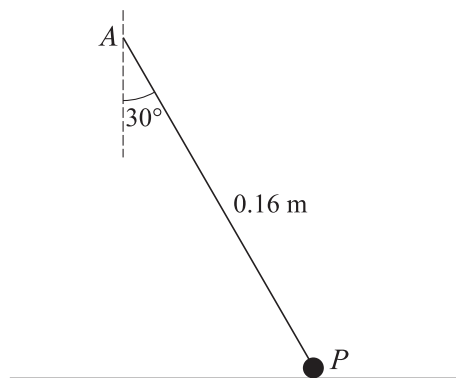


Each of two identical light elastic strings has natural length 0.25 m and modulus of elasticity 4 N. A particle  $P$  of mass 0.6 kg is attached to one end of each of the strings. The other ends of the strings are attached to fixed points  $A$  and  $B$  which are 0.8 m apart on a smooth horizontal table. The particle is held at rest on the table, at a point 0.3 m from  $AB$  for which  $AP = BP$  (see diagram).

(i) Find the tension in the strings. [2]

(ii) The particle is released. Find its initial acceleration. [3]

2



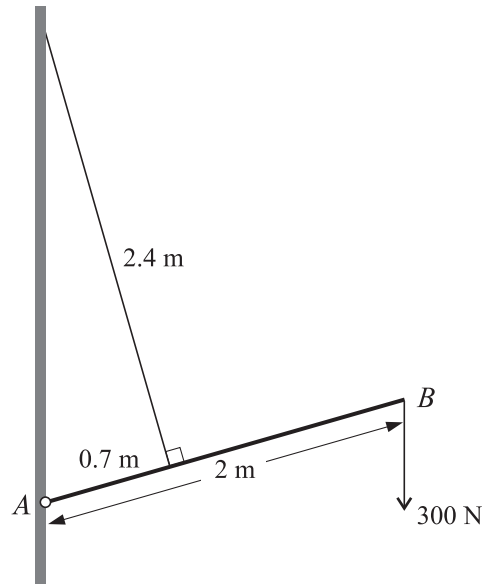
One end of a light inextensible string of length 0.16 m is attached to a fixed point  $A$  which is above a smooth horizontal table. A particle  $P$  of mass 0.4 kg is attached to the other end of the string.  $P$  moves on the table in a horizontal circle, with the string taut and making an angle of  $30^\circ$  with the downward vertical through  $A$  (see diagram).  $P$  moves with constant speed  $0.6 \text{ m s}^{-1}$ . Find

(i) the tension in the string, [3]

(ii) the force exerted by the table on  $P$ . [3]

3

3



A uniform beam  $AB$  has length 2 m and mass 10 kg. The beam is hinged at  $A$  to a fixed point on a vertical wall, and is held in a fixed position by a light inextensible string of length 2.4 m. One end of the string is attached to the beam at a point 0.7 m from  $A$ . The other end of the string is attached to the wall at a point vertically above the hinge. The string is at right angles to  $AB$ . The beam carries a load of weight 300 N at  $B$  (see diagram).

(i) Find the tension in the string. [4]

The components of the force exerted by the hinge on the beam are  $X$  N horizontally away from the wall and  $Y$  N vertically downwards.

(ii) Find the values of  $X$  and  $Y$ . [3]

4 A particle of mass 0.4 kg is released from rest and falls vertically. A resisting force of magnitude  $0.08v$  N acts upwards on the particle during its descent, where  $v$  m s<sup>-1</sup> is the velocity of the particle at time  $t$  s after its release.

(i) Show that the acceleration of the particle is  $(10 - 0.2v)$  m s<sup>-2</sup>. [2]

(ii) Find the velocity of the particle when  $t = 15$ . [5]

- 5 Each of two light elastic strings,  $S_1$  and  $S_2$ , has modulus of elasticity 16 N. The string  $S_1$  has natural length 0.4 m and the string  $S_2$  has natural length 0.5 m. One end of  $S_1$  is attached to a fixed point  $A$  on a smooth horizontal table and the other end is attached to a particle  $P$  of mass 0.5 kg. One end of  $S_2$  is attached to a fixed point  $B$  of the table and the other end is attached to  $P$ . The distance  $AB$  is 1.0 m. The particle  $P$  is held at  $A$  and then released from rest.
- (i) Find the speed of  $P$  at the instant that  $S_2$  becomes slack. [4]
- (ii) Find the greatest distance of  $P$  from  $A$  in the subsequent motion. [3]
- 6 A particle is projected from a point  $O$  at an angle of  $35^\circ$  above the horizontal. At time  $T$  s later the particle passes through a point  $A$  whose horizontal and vertically upward displacements from  $O$  are 8 m and 3 m respectively.
- (i) By using the equation of the particle's trajectory, or otherwise, find (in either order) the speed of projection of the particle from  $O$  and the value of  $T$ . [5]
- (ii) Find the angle between the direction of motion of the particle at  $A$  and the horizontal. [4]

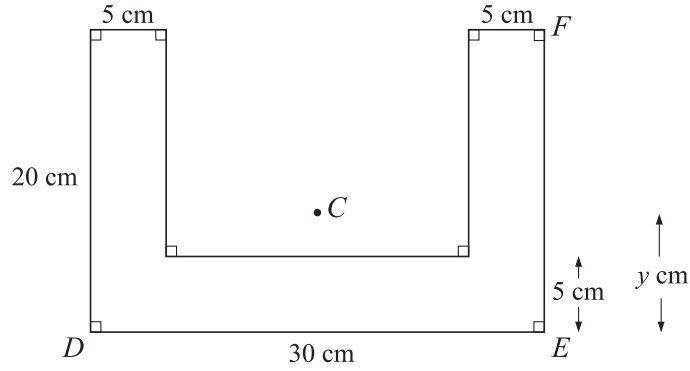


Fig. 1

Fig. 1 shows the cross-section of a uniform solid. The cross-section has the shape and dimensions shown. The centre of mass  $C$  of the solid lies in the plane of this cross-section. The distance of  $C$  from  $DE$  is  $y$  cm.

- (i) Find the value of  $y$ . [3]

The solid is placed on a rough plane. The coefficient of friction between the solid and the plane is  $\mu$ . The plane is tilted so that  $EF$  lies along a line of greatest slope.

- (ii)

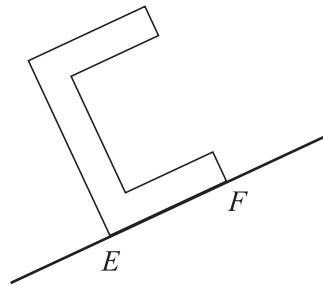


Fig. 2

The solid is placed so that  $F$  is higher up the plane than  $E$  (see Fig. 2). When the angle of inclination is sufficiently great the solid starts to topple (without sliding). Show that  $\mu > \frac{1}{2}$ . [3]

- (iii)

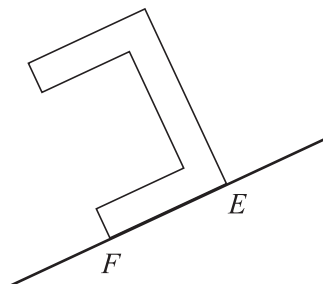


Fig. 3

The solid is now placed so that  $E$  is higher up the plane than  $F$  (see Fig. 3). When the angle of inclination is sufficiently great the solid starts to slide (without toppling). Show that  $\mu < \frac{5}{6}$ . [3]





