UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

MATHEMATICS **9709/51**

Paper 5 Mechanics 2 **(M2)** **October/November 2012**

1 hour 15 minutes

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

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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 $10\,\text{m}\,\text{s}^{-2}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

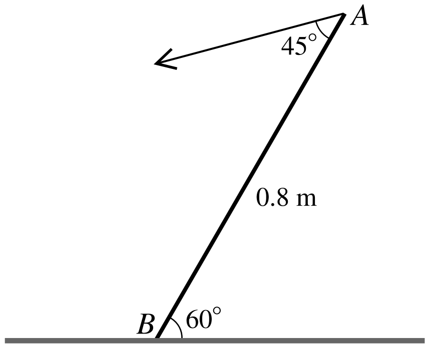
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

This document consists of **3** printed pages and **1** blank page.

UNIVERSITY of CAMBRIDGE International Examinations

1 ABC is a uniform semicircular arc with diameter $AC = 0.5$ m. The arc rotates abou through A and C with angular speed 2.4 rad s^{-1}. Calculate the speed of the centre of mass o

2



A uniform rod AB has weight 6 N and length 0.8 m. The rod rests in limiting equilibrium with B in contact with a rough horizontal surface and AB inclined at 60° to the horizontal. Equilibrium is maintained by a force, in the vertical plane containing AB, acting at A at an angle of 45° to AB (see diagram). Calculate

(i) the magnitude of the force applied at A, [3]

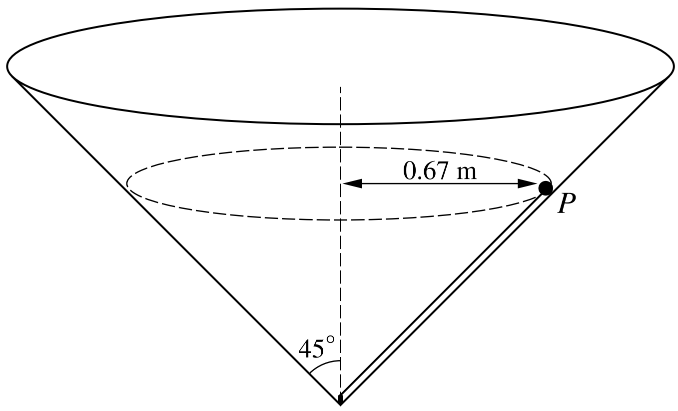
(ii) the least possible value of the coefficient of friction at B. [4]

3 A particle P of mass 0.2 kg is released from rest and falls vertically. At time t s after release P has speed $v \text{ m s}^{-1}$. A resisting force of magnitude $0.8v$ N acts on P.

(i) Show that the acceleration of P is $(10 - 4v) \text{ m s}^{-2}$. [2]

(ii) Find the value of v when $t = 0.6$. [5]

4



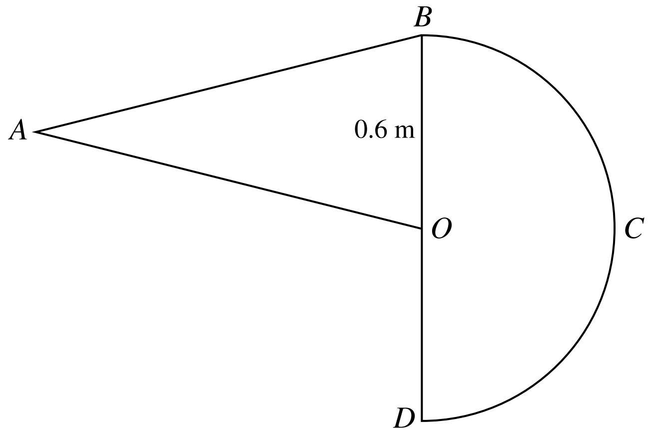
A particle P is moving inside a smooth hollow cone which has its vertex downwards and its axis vertical, and whose semi-vertical angle is 45°. A light inextensible string parallel to the surface of the cone connects P to the vertex. P moves with constant angular speed in a horizontal circle of radius 0.67 m (see diagram). The tension in the string is equal to the weight of P. Calculate the angular speed of P. [6]

5 A particle P is projected with speed $30\,\mathrm{m\,s^{-1}}$ at an angle of 60° above the horizontal from a point O on horizontal ground. For the instant when the speed of P is $17\,\mathrm{m\,s^{-1}}$ and increasing,

(i) show that the vertical component of the velocity of P is $8\,\mathrm{m\,s^{-1}}$ downwards,

(ii) calculate the distance of P from O. [5]

6



A uniform lamina $OABCD$ consists of a semicircle BCD with centre O and radius $0.6\,\mathrm{m}$ and an isosceles triangle OAB, joined along OB (see diagram). The triangle has area $0.36\,\mathrm{m}^2$ and $AB = AO$.

(i) Show that the centre of mass of the lamina lies on OB. [4]

(ii) Calculate the distance of the centre of mass of the lamina from O. [4]

7 A light elastic string has natural length 3 m and modulus of elasticity 45 N. A particle P of weight 6 N is attached to the mid-point of the string. The ends of the string are attached to fixed points A and B which lie in the same vertical line with A above B and $AB = 4\,\mathrm{m}$. The particle P is released from rest at the point 1.5 m vertically below A.

(i) Calculate the distance P moves after its release before first coming to instantaneous rest at a point vertically above B. (You may assume that at this point the part of the string joining P to B is slack.) [4]

(ii) Show that the greatest speed of P occurs when it is 2.1 m below A, and calculate this greatest speed. [5]

(iii) Calculate the greatest magnitude of the acceleration of P. [3]

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