UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

MATHEMATICS **9709/52**

Paper 5 Mechanics 2 **(M2)** **May/June 2011**

1 hour 15 minutes

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

* 3 4 2 3 1 2 3 4 9 4 *

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.

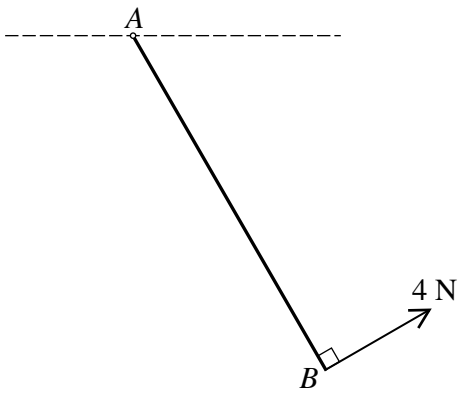
Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
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.

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1



A uniform rod AB of weight 16 N is freely hinged at A to a fixed point. A force of magnitude 4 N acting perpendicular to the rod is applied at B (see diagram). Given that the rod is in equilibrium,

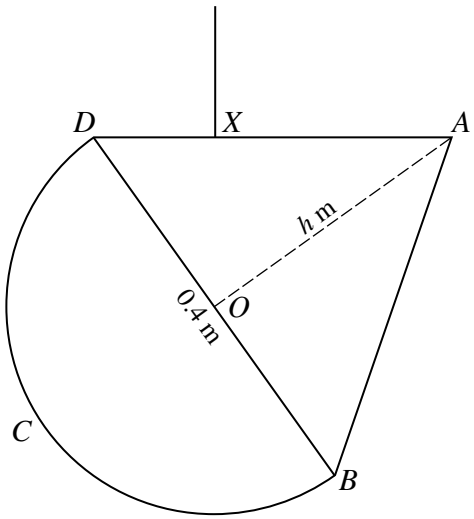
(i) calculate the angle the rod makes with the horizontal, [2]

(ii) find the magnitude and direction of the force exerted on the rod at A. [4]

2 A uniform lamina $ABCD$ consists of a semicircle BCD with centre O and diameter 0.4 m, and an isosceles triangle ABD with base BD = 0.4 m and perpendicular height h m. The centre of mass of the lamina is at O.

(i) Find the value of h. [4]

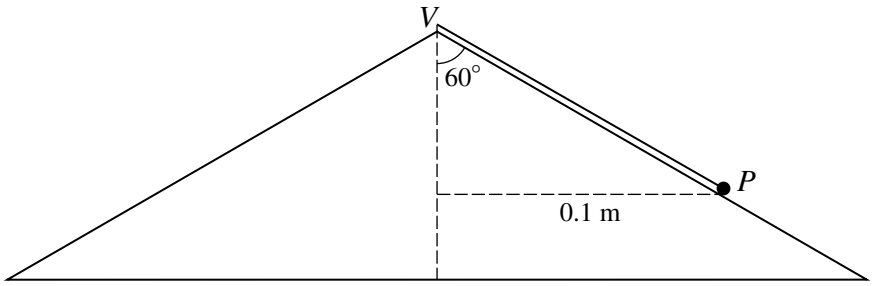
(ii)



The lamina is suspended from a vertical string attached to a point X on the side AD of the triangle (see diagram). Given the lamina is in equilibrium with AD horizontal, calculate XD. [3]

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3



A particle P of mass 0.5 kg is attached to the vertex V of a fixed solid cone by a light inextensible string. P lies on the smooth curved surface of the cone and moves in a horizontal circle of radius 0.1 m with centre on the axis of the cone. The cone has semi-vertical angle 60° (see diagram).

(i) Calculate the speed of P, given that the tension in the string and the contact force between the cone and P have the same magnitude. [4]

(ii) Calculate the greatest angular speed at which P can move on the surface of the cone. [4]

4 One end of a light elastic string of natural length 0.5 m and modulus of elasticity 12 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.24 kg. P is projected vertically upwards with speed 3 m s^{-1} from a position 0.8 m vertically below O.

(i) Calculate the speed of the particle when it is moving upwards with zero acceleration. [5]

(ii) Show that the particle moves 0.6 m while it is moving upwards with constant acceleration. [4]

5 A particle P of mass 0.4 kg moves in a straight line on a horizontal surface and has velocity v m s^{-1} at time t s. A horizontal force of magnitude $k\sqrt{v}$ N opposes the motion of P. When $t = 0$, $v = 9$ and when $t = 2$, $v = 4$.

(i) Express $\dfrac{\mathrm{d}v}{\mathrm{d}t}$ in terms of k and v, and hence show that $v = \frac{1}{4}(t - 6)^2$. [5]

(ii) Find the distance travelled by P in the first 3 seconds of its motion. [4]

6 A particle P is projected with speed 26 m s^{-1} at an angle of 30° below the horizontal, from a point O which is 80 m above horizontal ground.

(i) Calculate the distance from O of the particle 2.3 s after projection. [4]

(ii) Find the horizontal distance travelled by P before it reaches the ground. [3]

(iii) Calculate the speed and direction of motion of P immediately before it reaches the ground. [4]

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