Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	CANDIDATE NUMBER

5770334085

MATHEMATICS **9709/52**

Paper 5 Mechanics 2 **(M2)** **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

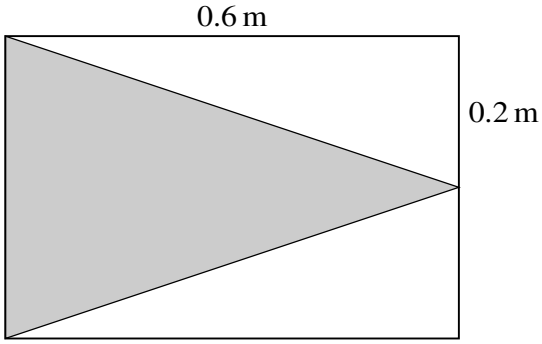
Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.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

This document consists of **13** printed pages and **3** blank pages.

1 A particle P of mass 0.2 kg is released from rest at a point O on a smooth horizontal surface. A horizontal force of magnitude te^{-v} N directed away from O acts on P, where v m s^{-1} is the velocity of P at time t s after release. Find the velocity of P when $t = 2$. [4]

2



A uniform solid cone has height 0.6 m and base radius 0.2 m. A uniform hollow cylinder, open at both ends, has the same dimensions. An object is made by putting the cone inside the cylinder so that the base of the cone coincides with one end of the cylinder (see diagram, which shows a cross-section). The total weight of the object is 60 N and its centre of mass is 0.25 m from the base of the cone. Calculate the weight of the cone. [3]

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3 A particle P of mass 0.4 kg is released from rest at a point O on a smooth plane inclined at 30° to the horizontal. P moves down the line of greatest slope through O. The velocity of P is v m s^{-1} when its displacement from O is x m. A retarding force of magnitude $0.2v^2$ N acts on P in the direction PO.

(i) Show that $v\dfrac{\mathrm{d}v}{\mathrm{d}x} = 5 - 0.5v^2$. [2]

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(ii) Express v in terms of x. [4]

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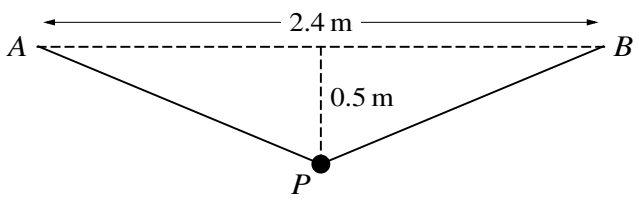

A light elastic string has natural length 2 m and modulus of elasticity 39 N. The ends of the string are attached to fixed points A and B which are at the same horizontal level and 2.4 m apart. A particle P of mass m kg is attached to the mid-point of the string and hangs in equilibrium at a point 0.5 m below AB (see diagram).

(i) Show that $m = 0.9$. [4]

P is projected vertically downwards from the equilibrium position, and comes to instantaneous rest at a point 1.6 m below AB.

(ii) Calculate the speed of projection of P. [5]

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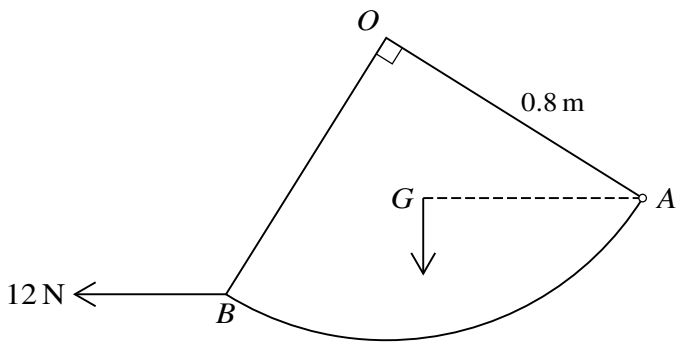

OAB is a uniform lamina in the shape of a quadrant of a circle with centre *O* and radius 0.8 m which has its centre of mass at *G*. The lamina is smoothly hinged at *A* to a fixed point and is free to rotate in a vertical plane. A horizontal force of magnitude 12 N acting in the plane of the lamina is applied to the lamina at *B*. The lamina is in equilibrium with *AG* horizontal (see diagram).

(i) Calculate the length *AG*. [3]

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(ii) Find the weight of the lamina. [5]

6 One end of a light elastic string of natural length 0.4 m and modulus of elasticity 8 N is attached to a fixed point O on a smooth horizontal plane. The other end of the string is attached to a particle P of mass 0.2 kg which moves on the plane in a circular path with centre O. The speed of P is v m s^{-1} and the extension of the string is x m.

(i) Given that $v = 2.5$, find x. [4]

It is given instead that the kinetic energy of P is twice the elastic potential energy stored in the string.

(ii) Form two simultaneous equations and hence find x and v. [5]

7 A small ball B is projected from a point O which is h m above a horizontal plane. At time 2 s after projection B has speed 18 m s^{-1} and is moving in the direction 30° above the horizontal.

(i) Find the initial speed and the angle of projection of B. [4]

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B has speed 38 m s^{-1} immediately before it strikes the plane.

(ii) Calculate h. [2]

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B bounces when it strikes the plane, and leaves the plane with speed $20\,\text{m}\,\text{s}^{-1}$ but with its horizontal component of velocity unchanged.

(iii) Find the total time which elapses between the initial projection of B and the instant when it strikes the plane for the second time. [5]

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