Cambridge International A Level

Cambridge Assessment International Education
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6032091752

MATHEMATICS **9709/51**

Paper 5 Mechanics 2 **(M2)** **May/June 2019**

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 in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
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.

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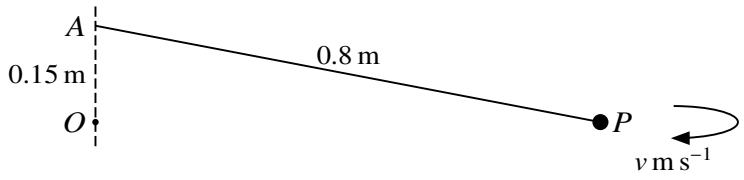
1



A particle P of mass 0.3 kg is attached to a fixed point A by a light inextensible string of length 0.8 m. The fixed point O is 0.15 m vertically below A. The particle P moves with constant speed v m s^{-1} in a horizontal circle with centre O (see diagram).

(i) Show that the tension in the string is 16 N. [2]

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(ii) Find the value of v. [3]

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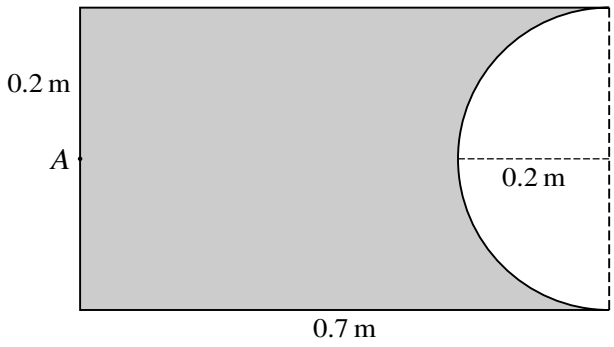
[Turn over

2 A particle is projected with speed V m s^{-1} at an angle of $\theta°$ above the horizontal. At the instant 4 s after projection the speed of the particle is 16 m s^{-1} and its direction of motion is 30° above the horizontal. Find V and θ. [5]

3



The diagram shows the cross-section through the centre of mass of a uniform solid object. The object is a cylinder of radius 0.2 m and length 0.7 m, from which a hemisphere of radius 0.2 m has been removed at one end. The point A is the centre of the plane face at the other end of the object. Find the distance of the centre of mass of the object from A. [5]

[The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

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4 A small ball is projected with speed $25\ \text{m s}^{-1}$ at an angle of 30° above the horizontal from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of the ball from O are x m and y m respectively.

(i) Express x and y in terms of t and hence find the equation of the trajectory of the ball. [4]

(ii) Find x for the position of the ball when its path makes an angle of 15° below the horizontal. [4]

5 A particle P of mass 0.4 kg is attached to one end of a light elastic string of natural length 0.5 m and modulus of elasticity 6 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point $(0.5 + x)$ m vertically below O. The particle P comes to instantaneous rest at O.

(i) Find x. [3]

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(ii) Find the greatest speed of P. [5]

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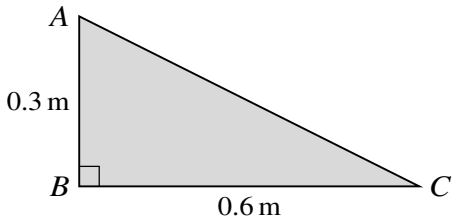

ABC is a uniform lamina in the form of a triangle with $AB = 0.3$ m, $BC = 0.6$ m and a right angle at B (see diagram).

(i) State the distances of the centre of mass of the lamina from AB and from BC. [2]

Distance from AB.....

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Distance from BC .....

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The lamina is freely suspended at B and hangs in equilibrium.

(ii) Find the angle between AB and the horizontal. [2]

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A force of magnitude 12 N is applied along the edge AC of the lamina in the direction from A towards C. The lamina, still suspended at B, is now in equilibrium with AB vertical.

(iii) Calculate the weight of the lamina. [3]

7 A particle P of mass 0.5 kg is attached to a fixed point O by a light elastic string of natural length 1 m and modulus of elasticity 16 N. The particle P is projected vertically upwards from O with speed $6\,\text{m s}^{-1}$. A resisting force of magnitude $0.1x^2$ N acts on P when P has displacement x m above O. After projection the upwards velocity of P is $v\,\text{m s}^{-1}$.

(i) Show that, before the string becomes taut, $v\dfrac{\mathrm{d}v}{\mathrm{d}x} = -10 - 0.2x^2$. [2]

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(ii) Find the velocity of P at the instant the string becomes taut. [4]

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(iii) Find an expression for the acceleration of P while it is moving upwards after the string becomes taut. [2]

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(iv) Verify that P comes to instantaneous rest before the extension of the string is 0.5 m. [4]

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Additional Page

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