Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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8796355118

MATHEMATICS **9709/52**

Paper 5 Mechanics 2 **(M2)** **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

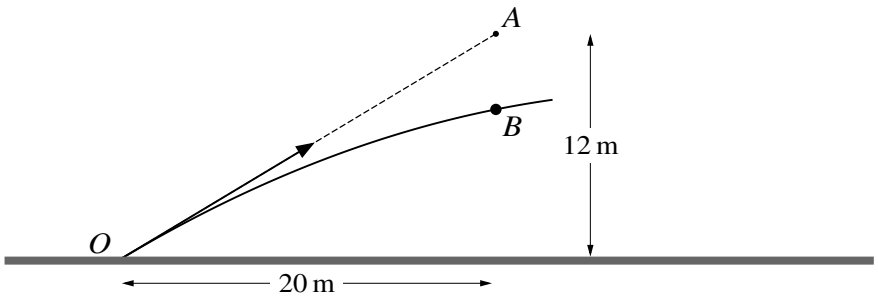
Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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 **14** printed pages and **2** blank pages.

1



A small ball B is projected from a point O on horizontal ground towards a point A 12 m above the ground. 0.9 s after projection B has travelled a horizontal distance of 20 m and is vertically below A (see diagram).

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

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(ii) Calculate the distance AB when B is vertically below A. [2]

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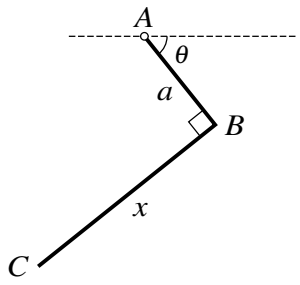
2 One end of a light elastic string is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.4 kg. The string has natural length 0.6 m and modulus of elasticity 24 N. The particle is released from rest at O. Find the two possible values of the distance OP for which the particle has speed $1.5\ \text{m s}^{-1}$. [6]

3



ABC is an object made from a uniform wire consisting of two straight portions AB and BC, in which $AB = a$, $BC = x$ and angle $ABC = 90°$. When the object is freely suspended from A and in equilibrium, the angle between AB and the horizontal is θ (see diagram).

(i) Show that $x^2 \tan\theta - 2ax - a^2 = 0$. [3]

(ii) Given that $\tan\theta = 1.25$, calculate the length of the wire in terms of a. [2]

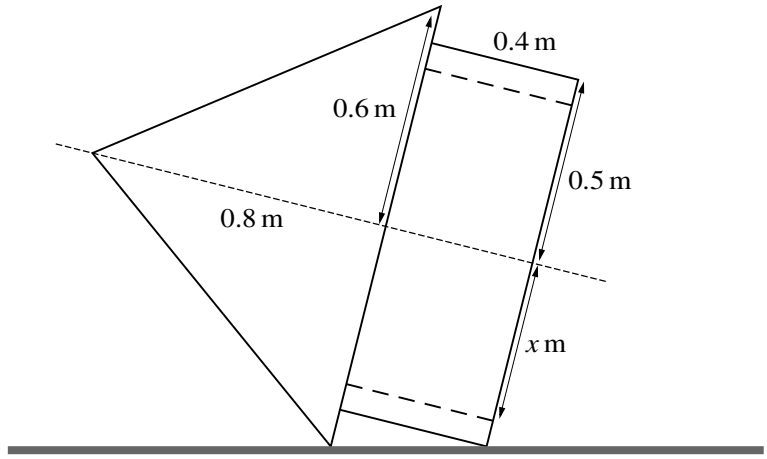
4 A particle P is projected from a point O on horizontal ground with initial speed $20\,\text{m s}^{-1}$ and angle of projection 30°. At the instant t s after projection, the horizontal and vertically upwards displacements of P from O are x m and y m respectively.

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

P is at the same height above the ground at two points which are a horizontal distance apart of 15 m.

(ii) Calculate this height. [3]

5



A uniform object is made by joining a solid cone of height 0.8 m and base radius 0.6 m and a cylinder. The cylinder has length 0.4 m and radius 0.5 m. The cylinder has a cylindrical hole of length 0.4 m and radius x m drilled through it along the axis of symmetry. A plane face of the cylinder is attached to the base of the cone so that the object has an axis of symmetry perpendicular to its base and passing through the vertex of the cone. The object is placed with points on the base of the cone and the base of the cylinder in contact with a horizontal surface (see diagram). The object is on the point of toppling.

(i) Show that the centre of mass of the object is 0.15 m from the base of the cone. [3]

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(ii) Find x. [4]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$.]

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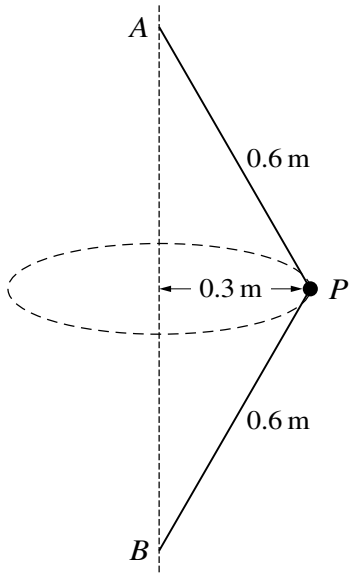

A particle P of mass 0.2 kg is attached to one end of a light inextensible string of length 0.6 m. The other end of the string is attached to a fixed point A. The particle P is also attached to one end of a second light inextensible string of length 0.6 m, the other end of which is attached to a fixed point B vertically below A. The particle moves in a horizontal circle of radius 0.3 m, which has its centre at the mid-point of AB, with both strings straight (see diagram).

(i) Calculate the least possible angular speed of P. [4]

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The string AP will break if its tension exceeds 8 N. The string BP will break if its tension exceeds 5 N.

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

7 A particle P of mass 0.2 kg is released from rest at a point O above horizontal ground. At time t s after its release the velocity of P is v m s^{-1} downwards. A vertically downwards force of magnitude $0.6t$ N acts on P. A vertically upwards force of magnitude $k\mathrm{e}^{-t}$ N, where k is a constant, also acts on P.

(i) Show that $\dfrac{\mathrm{d}v}{\mathrm{d}t} = 10 - 5k\mathrm{e}^{-t} + 3t$. [2]

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(ii) Find the greatest value of k for which P does not initially move upwards. [3]

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(iii) Given that $k = 1$, and that P strikes the ground when $t = 2$, find the height of O above the ground. [5]

Additional Page

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