Cambridge International A Level

Cambridge Assessment International Education
Cambridge International Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

MATHEMATICS **9709/52**

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.

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1 A small ball is projected from a point O on horizontal ground at an angle of 30° above the horizontal. At time t s after projection the vertically upwards displacement of the ball from O is $(14t - kt^2)$ m, where k is a constant.

(i) State the value of k. [1]

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(ii) Show that the initial speed of the ball is 28 m s^{-1}. [2]

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(iii) Find the horizontal displacement of the ball from O when $t = 3$. [2]

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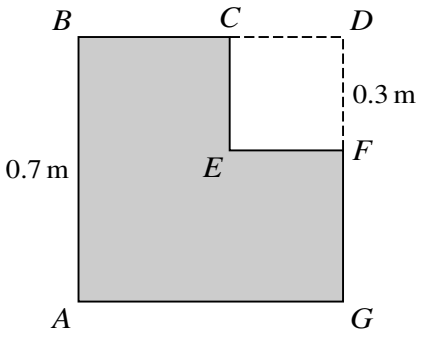

A uniform lamina $ABCEFG$ is formed from a square $ABDG$ by removing a smaller square $CDFE$ from one corner. $AB = 0.7$ m and $DF = 0.3$ m (see diagram). Find the distance of the centre of mass of the lamina from A. [4]

3 A particle P of mass 0.4 kg is attached to a fixed point A by a light inextensible string of length 0.5 m. The point A is 0.3 m above a smooth horizontal surface. The particle P moves in a horizontal circle on the surface with constant angular speed 5 rad s^{-1}.

(i) Calculate the tension in the string. [3]

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(ii) Find the magnitude of the force exerted by the surface on P. [2]

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4 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point 0.8 m vertically below O. When the extension of the string is x m, the downwards velocity of P is v m s^{-1} and a force of magnitude $25x^2$ N opposes the motion of P.

(i) Show that, when P is moving downwards, $v\frac{\mathrm{d}v}{\mathrm{d}x} = 10 - 40x - 50x^2$. [2]

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(ii) For the instant when P has its greatest downwards speed, find the kinetic energy of P and the elastic potential energy stored in the string. [6]

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5 A light elastic string has natural length a m and modulus of elasticity λ N. When the length of the string is 1.6 m the tension is 4 N. When the length of the string is 2 m the tension is 6 N.

(i) Find the values of a and λ. [5]

One end of the string is attached to a fixed point O on a smooth horizontal surface. The other end of the string is attached to a particle P of mass 0.2 kg. The particle P moves with constant speed on the surface in a circle with centre O and radius 1.9 m.

(ii) Find the speed of P. [3]

6 A particle is projected with speed $15\,\text{m s}^{-1}$ at an angle of $\theta°$ above the horizontal. At the instant 4 s after projection the speed of the particle is $30\,\text{m s}^{-1}$.

(i) Find θ. [4]

(ii) Show that at the instant 4 s after projection the particle is 33.75 m below the level of the point of projection and find the direction of motion at this instant. [4]

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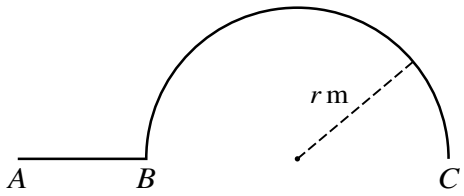

Fig. 1

Fig. 1 shows an object made from a uniform wire of length 0.8 m. The object consists of a straight part AB, and a semicircular part BC such that A, B and C lie in the same straight line. The radius of the semicircle is r m and the centre of mass of the object is 0.1 m from line ABC.

(i) Show that $r = 0.2$. [3]

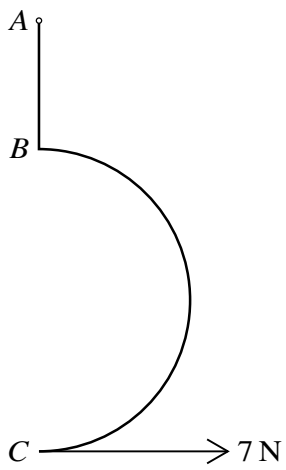

Fig. 2

The object is freely suspended at A and a horizontal force of magnitude 7 N is applied to the object at C so that the object is in equilibrium with ABC vertical (see Fig. 2).

(ii) Calculate the weight of the object. [3]

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[Question 7(iii) is printed on the next page.]

The 7 N force is removed and the object hangs in equilibrium with ABC at an angle of $\theta°$ with the vertical.

(iii) Find θ. [6]

Additional Page

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