GradeMax

Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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9849593396

MATHEMATICS **9709/42**

Paper 4 Mechanics 1 **(M1)** **May/June 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 **11** printed pages and **1** blank page.

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1 One end of a light inextensible string is attached to a block. The string makes an angle of $\theta°$ with the horizontal. The tension in the string is 20 N. The string pulls the block along a horizontal surface at a constant speed of 1.5 m s^{-1} for 12 s. The work done by the tension in the string is 50 J. Find θ. [3]

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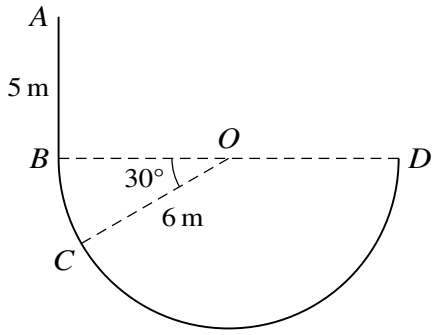
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2



The diagram shows a wire $ABCD$ consisting of a straight part AB of length 5 m and a part BCD in the shape of a semicircle of radius 6 m and centre O. The diameter BD of the semicircle is horizontal and AB is vertical. A small ring is threaded onto the wire and slides along the wire. The ring starts from rest at A. The part AB of the wire is rough, and the ring accelerates at a constant rate of 2.5 m s^{-2} between A and B.

(i) Show that the speed of the ring as it reaches B is 5 m s^{-1}. [1]

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The part BCD of the wire is smooth. The mass of the ring is 0.2 kg.

(ii) (a) Find the speed of the ring at C, where angle $BOC = 30°$. [4]

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(b) Find the greatest speed of the ring. [2]

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[Turn over

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3 A particle A moves in a straight line with constant speed $10\,\text{m s}^{-1}$. Two seconds after A passes a point O on the line, a particle B passes through O, moving along the line in the same direction as A. Particle B has speed $16\,\text{m s}^{-1}$ at O and has a constant deceleration of $2\,\text{m s}^{-2}$.

(i) Find expressions, in terms of t, for the displacement from O of each particle t s after B passes through O. [3]

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(ii) Find the distance between the particles when B comes to instantaneous rest. [3]

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(iii) Find the minimum distance between the particles. [3]

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4 A car of mass 1200 kg is moving on a straight road against a constant force of 850 N resisting the motion.

(i) On a part of the road that is horizontal, the car moves with a constant speed of $42\,\text{m}\,\text{s}^{-1}$.

(a) Calculate, in kW, the power developed by the engine of the car. [2]

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(b) Given that this power is suddenly increased by 6 kW, find the instantaneous acceleration of the car. [3]

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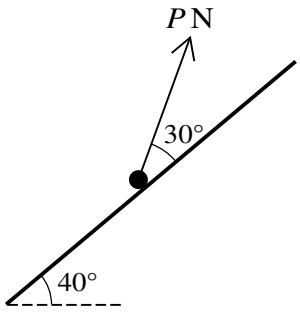
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(ii) On a part of the road that is inclined at $\theta°$ to the horizontal, the car moves up the hill at a constant speed of $24\,\text{m}\,\text{s}^{-1}$, with the engine working at 80 kW. Find θ. [4]

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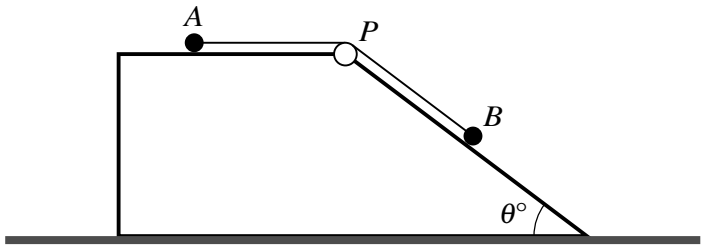


A particle of mass 0.12 kg is placed on a plane which is inclined at an angle of 40° to the horizontal. The particle is kept in equilibrium by a force of magnitude P N acting up the plane at an angle of 30° above a line of greatest slope, as shown in the diagram. The coefficient of friction between the particle and the plane is 0.32. Find the set of possible values of P. [8]

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The diagram shows a fixed block with a horizontal top surface and a surface which is inclined at an angle of $\theta°$ to the horizontal, where $\sin\theta = \frac{3}{5}$. A particle A of mass 0.3 kg rests on the horizontal surface and is attached to one end of a light inextensible string. The string passes over a small smooth pulley P fixed at the edge of the block. The other end of the string is attached to a particle B of mass 1.5 kg which rests on the sloping surface of the block. The system is released from rest with the string taut.

(i) Given that the block is smooth, find the acceleration of particle A and the tension in the string. [5]

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(ii) It is given instead that the block is rough. The coefficient of friction between A and the block is μ and the coefficient of friction between B and the block is also μ. In the first 3 seconds of the motion, A does not reach P and B does not reach the bottom of the sloping surface. The speed of the particles after 3 s is $5\,\text{m}\,\text{s}^{-1}$. Find the acceleration of particle A and the value of μ. [9]

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