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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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9302293084

MATHEMATICS **9709/43**

Paper 4 Mechanics **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- Where a numerical value for the acceleration due to gravity (g) is needed, use $10\,\text{m}\,\text{s}^{-2}$.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.

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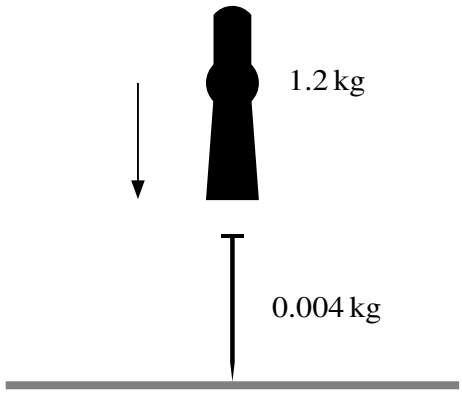
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1 A particle is projected vertically upwards from horizontal ground with a speed of $u\,\text{m}\,\text{s}^{-1}$. The particle has height s m above the ground at times 3 seconds and 4 seconds after projection.

Find the value of u and the value of s. [3]

2



A machine for driving a nail into a block of wood causes a hammerhead to drop vertically onto the top of a nail. The mass of the hammerhead is 1.2 kg and the mass of the nail is 0.004 kg (see diagram). The hammerhead hits the nail with speed v m s^{-1} and remains in contact with the nail after the impact. The combined hammerhead and nail move immediately after the impact with speed 40 m s^{-1}.

(a) Calculate v, giving your answer as an exact fraction. [2]

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(b) The nail is driven 4 cm into the wood.

Find the constant force resisting the motion. [3]

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3 A block of mass 8 kg slides down a rough plane inclined at 30° to the horizontal, starting from rest. The coefficient of friction between the block and the plane is μ. The block accelerates uniformly down the plane at $2.4\,\text{m}\,\text{s}^{-2}$.

(a) Draw a diagram showing the forces acting on the block. [1]

(b) Find the value of μ. [4]

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(c) Find the speed of the block after it has moved 3 m down the plane. [1]

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4 A car has mass 1600 kg.

(a) The car is moving along a straight horizontal road at a constant speed of $24\,\text{m}\,\text{s}^{-1}$ and is subject to a constant resistance of magnitude 480 N.

Find, in kW, the rate at which the engine of the car is working. [2]

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The car now moves down a hill inclined at an angle of θ to the horizontal, where $\sin\theta = 0.09$. The engine of the car is working at a constant rate of 12 kW. The speed of the car is $24\,\text{m}\,\text{s}^{-1}$ at the top of the hill. Ten seconds later the car has travelled 280 m down the hill and has speed $32\,\text{m}\,\text{s}^{-1}$.

(b) Given that the resistance is not constant, use an energy method to find the total work done against the resistance during the ten seconds. [5]

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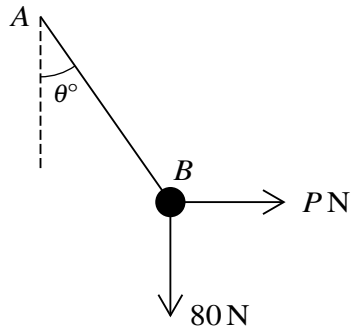
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5



A light string AB is fixed at A and has a particle of weight 80 N attached at B. A horizontal force of magnitude P N is applied at B such that the string makes an angle $\theta°$ to the vertical (see diagram).

(a) It is given that $P = 32$ and the system is in equilibrium.

Find the tension in the string and the value of θ. [4]

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(b) It is given instead that the tension in the string is 120 N and that the particle attached at B still has weight 80 N.

Find the value of P and the value of θ. [4]

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6 A particle moves in a straight line. At time t s, the acceleration, a m s^{-2}, of the particle is given by $a = 36 - 6t$. The velocity of the particle is 27 m s^{-1} when $t = 2$.

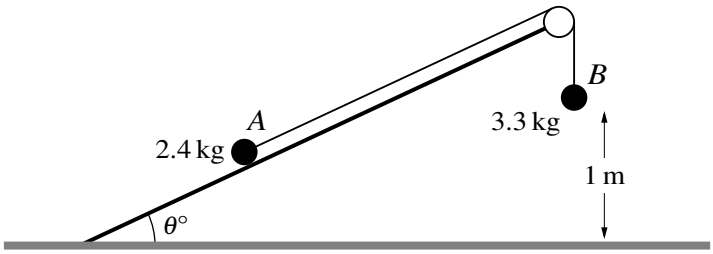
(a) Find the values of t when the particle is at instantaneous rest. [4]

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(b) Find the total distance the particle travels during the first 12 seconds. [4]

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7



Particles A and B, of masses 2.4 kg and 3.3 kg respectively, are connected by a light inextensible string that passes over a smooth pulley which is fixed to the top of a rough plane. The plane makes an angle of $\theta°$ with horizontal ground. Particle A is on the plane and the section of the string between A and the pulley is parallel to a line of greatest slope of the plane. Particle B hangs vertically below the pulley and is 1 m above the ground (see diagram). The coefficient of friction between the plane and A is μ.

(a) It is given that $\theta = 30$ and the system is in equilibrium with A on the point of moving directly up the plane.

Show that $\mu = 1.01$ correct to 3 significant figures. [5]

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(b) It is given instead that $\theta = 20$ and $\mu = 1.01$. The system is released from rest with the string taut.

Find the total distance travelled by A before coming to instantaneous rest. You may assume that A does not reach the pulley and that B remains at rest after it hits the ground. [8]

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Additional Page

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

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