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Cambridge International AS & A Level

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CANDIDATE NAME

CENTRE NUMBER | | | | | |

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3733681574

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **October/November 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 crate of mass 500 kg is being pulled along rough horizontal ground by a horizontal rope attached to a winch. The winch produces a constant pulling force of 2500 N and the crate is moving at constant speed. Find the coefficient of friction between the crate and the ground. [3]

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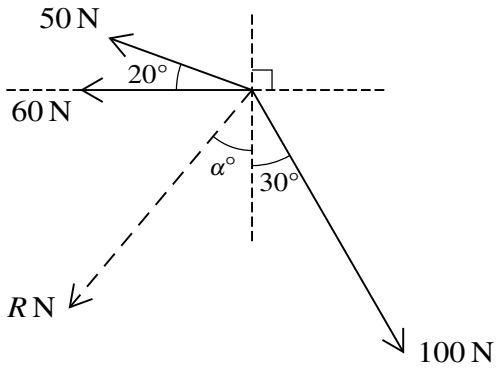
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2 A train of mass 150 000 kg ascends a straight slope inclined at $\alpha°$ to the horizontal with a constant driving force of 16 000 N. At a point A on the slope the speed of the train is $45\,\text{m s}^{-1}$. Point B on the slope is 500 m beyond A. At B the speed of the train is $42\,\text{m s}^{-1}$. There is a resistance force acting on the train and the train does 4×10^6 J of work against this resistance force between A and B. Find the value of α. [5]

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Three coplanar forces of magnitudes 50 N, 60 N and 100 N act at a point. The resultant of the forces has magnitude R N. The directions of these forces are shown in the diagram. Find the values of R and α. [6]

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4 A car travels along a straight road with constant acceleration. It passes through points P, Q, R and S. The times taken for the car to travel from P to Q, Q to R and R to S are each equal to 10 s. The distance QR is 1.5 times the distance PQ. At point Q the speed of the car is $20\,\text{m s}^{-1}$.

(i) Show that the acceleration of the car is $0.8\,\text{m s}^{-2}$. [3]

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(ii) Find the distance QS and hence find the average speed of the car between Q and S. [3]

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5 A cyclist is travelling along a straight horizontal road. The total mass of the cyclist and his bicycle is 80 kg. His power output is a constant 240 W. His acceleration when he is travelling at $6\,\text{m}\,\text{s}^{-1}$ is $0.3\,\text{m}\,\text{s}^{-2}$.

(i) Show that the resistance to the cyclist's motion is 16 N. [3]

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(ii) Find the steady speed that the cyclist can maintain if his power output and the resistance force are both unchanged. [2]

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(iii) The cyclist later ascends a straight hill inclined at 3° to the horizontal. His power output and the resistance force are still both unchanged. Find his acceleration when he is travelling at $4\,\text{m}\,\text{s}^{-1}$.
[3]

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6 Particle P travels in a straight line from A to B. The velocity of P at time t s after leaving A is denoted by v m s^{-1}, where

$$v = 0.04t^3 + ct^2 + kt.$$

P takes 5 s to travel from A to B and it reaches B with speed 10 m s^{-1}. The distance AB is 25 m.

(i) Find the values of the constants c and k. [6]

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(ii) Show that the acceleration of P is a minimum when $t = 2.5$. [3]

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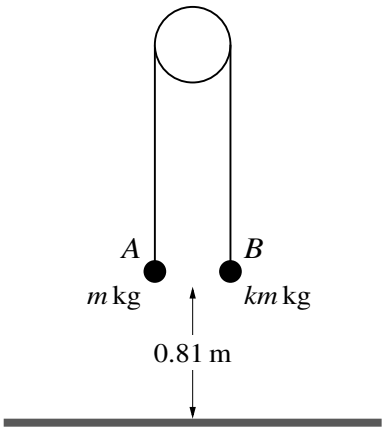
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Two particles A and B have masses m kg and km kg respectively, where $k > 1$. The particles are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley and the particles hang vertically below it. Both particles are at a height of 0.81 m above horizontal ground (see diagram). The system is released from rest and particle B reaches the ground 0.9 s later. The particle A does not reach the pulley in its subsequent motion.

(i) Find the value of k and show that the tension in the string before B reaches the ground is equal to $12m$ N. [7]

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At the instant when B reaches the ground, the string breaks.

(ii) Show that the speed of A when it reaches the ground is $5.97\ \text{m s}^{-1}$, correct to 3 significant figures, and find the time taken, after the string breaks, for A to reach the ground. [4]

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(iii) Sketch a velocity-time graph for the motion of particle A from the instant when the system is released until A reaches the ground. [2]

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Additional Page

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