Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

4362225277

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **October/November 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 **13** printed pages and **3** blank pages.

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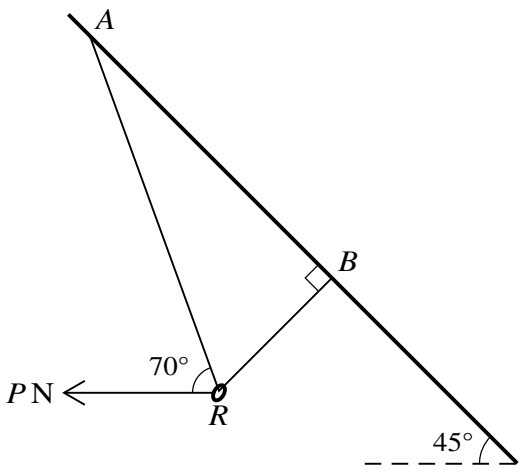

A small smooth ring R of mass 0.2 kg is threaded onto a light inextensible string ARB. The two ends of the string are attached to points A and B on a sloping roof inclined at 45° to the horizontal. A horizontal force of magnitude P N, acting in the plane ARB, is applied to the ring. The section BR of the string is perpendicular to the roof and the section AR of the string is inclined at 70° to the horizontal (see diagram). The system is in equilibrium. Find the tension in the string and the value of P. [4]

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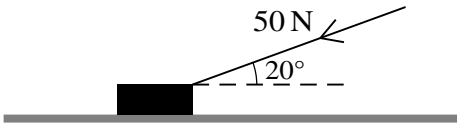

A block is pushed along a horizontal floor by a force of magnitude 50 N which acts at an angle of 20° to the horizontal (see diagram). The coefficient of friction between the block and the floor is 0.3. Given that the speed of the block is constant, find the mass of the block. [5]

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3 A particle of mass 1.2 kg moves in a straight line AB. It is projected with speed $7.5\,\mathrm{m\,s^{-1}}$ from A towards B and experiences a resistance force. The work done against this resistance force in moving from A to B is 25 J.

(i) Given that AB is horizontal, find the speed of the particle at B. [2]

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(ii) It is given instead that AB is inclined at 30° below the horizontal and that the speed of the particle at B is $9\,\mathrm{m\,s^{-1}}$. The work done against the resistance force remains the same. Find the distance AB. [3]

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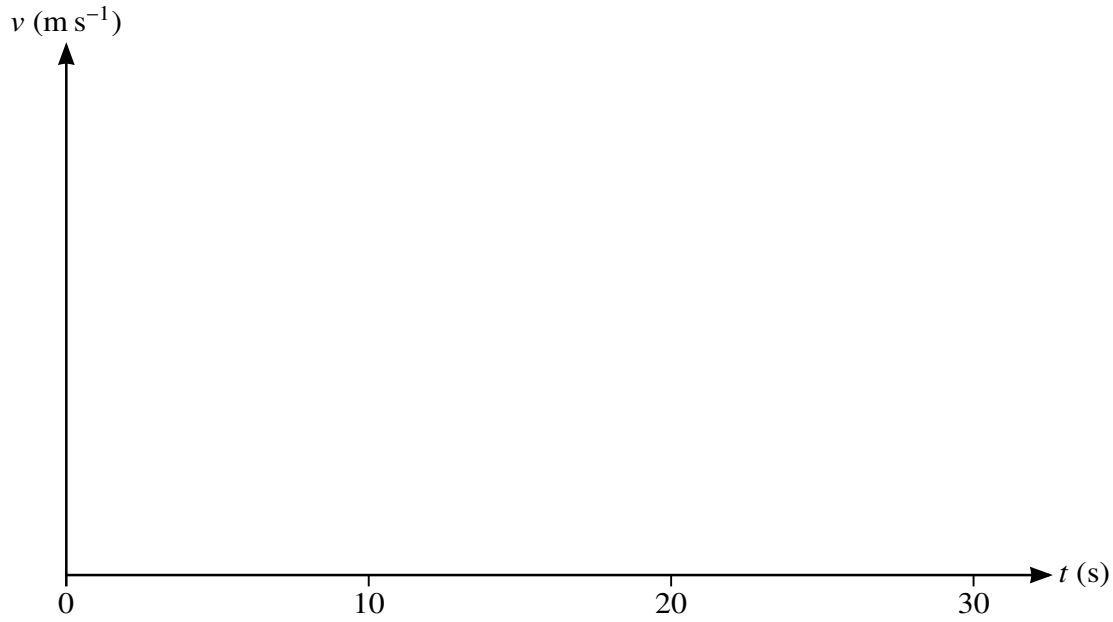
4 A runner sets off from a point P at time $t = 0$, where t is in seconds. The runner starts from rest and accelerates at $1.2\,\mathrm{m\,s^{-2}}$ for 5 s. For the next 12 s the runner moves at constant speed before decelerating uniformly over a period of 3 s, coming to rest at Q. A cyclist sets off from P at time $t = 10$ and accelerates uniformly for 10 s, before immediately decelerating uniformly to rest at Q at time $t = 30$.

(i) Sketch the velocity-time graph for the runner and show that the distance PQ is 96 m. [4]



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(ii) Find the magnitude of the acceleration of the cyclist. [3]

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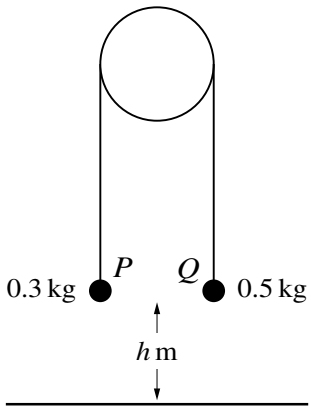

Two particles P and Q, of masses 0.3 kg and 0.5 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley with the particles hanging freely below it. Q is held at rest with the string taut at a height of h m above a horizontal floor (see diagram). Q is now released and both particles start to move. The pulley is sufficiently high so that P does not reach it at any stage. The time taken for Q to reach the floor is 0.6 s.

(i) Find the acceleration of Q before it reaches the floor and hence find the value of h. [6]

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Q remains at rest when it reaches the floor, and P continues to move upwards.

(ii) Find the velocity of P at the instant when Q reaches the floor and the total time taken from the instant at which Q is released until the string becomes taut again. [3]

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6 A van of mass 3200 kg travels along a horizontal road. The power of the van's engine is constant and equal to 36 kW, and there is a constant resistance to motion acting on the van.

(i) When the speed of the van is $20\,\mathrm{m\,s^{-1}}$, its acceleration is $0.2\,\mathrm{m\,s^{-2}}$. Find the resistance force. [3]

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When the van is travelling at $30\,\mathrm{m\,s^{-1}}$, it begins to ascend a hill inclined at 1.5° to the horizontal. The power is increased and the resistance force is still equal to the value found in part **(i)**.

(ii) Find the power required to maintain this speed of $30\,\mathrm{m\,s^{-1}}$. [3]

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(iii) The engine is now stopped, with the van still travelling at $30\,\mathrm{m\,s^{-1}}$, and the van decelerates to rest. Find the distance the van moves up the hill from the point at which the engine is stopped until it comes to rest. [4]

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7 A particle moves in a straight line. The particle is initially at rest at a point O on the line. At time t s after leaving O, the acceleration a m s^{-2} of the particle is given by $a = 25 - t^2$ for $0 \leqslant t \leqslant 9$.

(i) Find the maximum velocity of the particle in this time period. [4]

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(ii) Find the total distance travelled until the maximum velocity is reached. [2]

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The acceleration of the particle for $t > 9$ is given by $a = -3t^{-\frac{1}{2}}$.

(iii) Find the velocity of the particle when $t = 25$. [4]

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Additional Page

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