Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

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3141176339

MATHEMATICS **9709/42**

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.

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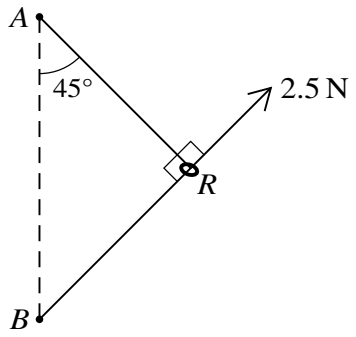

A smooth ring R of mass m kg is threaded on a light inextensible string ARB. The ends of the string are attached to fixed points A and B with A vertically above B. The string is taut and angle $ARB = 90°$. The angle between the part AR of the string and the vertical is 45°. The ring is held in equilibrium in this position by a force of magnitude 2.5 N, acting on the ring in the direction BR (see diagram). Calculate the tension in the string and the mass of the ring. [4]

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2 A block of mass 5 kg is being pulled by a rope up a rough plane inclined at 6° to the horizontal. The rope is parallel to a line of greatest slope of the plane and the block is moving at constant speed. The coefficient of friction between the block and the plane is 0.3. Find the tension in the rope. [4]

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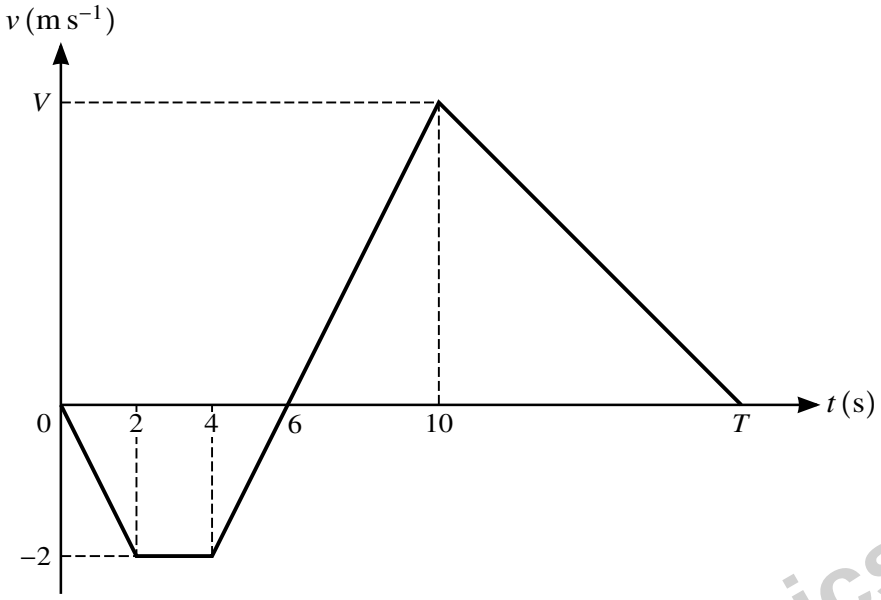

The velocity of a particle moving in a straight line is v m s^{-1} at time t seconds. The diagram shows a velocity-time graph which models the motion of the particle from $t = 0$ to $t = T$. The graph consists of four straight line segments. The particle reaches its maximum velocity V m s^{-1} at $t = 10$.

(i) Find the acceleration of the particle during the first 2 seconds. [1]

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(ii) Find the value of V. [2]

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At $t = 6$, the particle is instantaneously at rest at the point A. At $t = T$, the particle comes to rest at the point B. At $t = 0$ the particle starts from rest at a point one third of the way from A to B.

(iii) Find the distance AB and hence find the value of T. [4]

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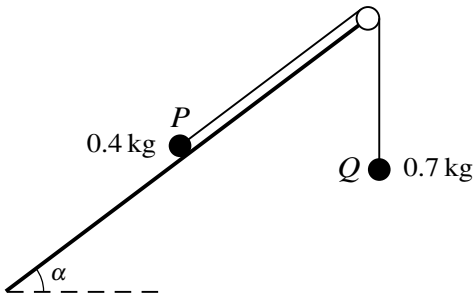

Two particles P and Q, of masses 0.4 kg and 0.7 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley which is attached to the edge of a rough plane. The coefficient of friction between P and the plane is 0.5. The plane is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. Particle P lies on the plane and particle Q hangs vertically. The string between P and the pulley is parallel to a line of greatest slope of the plane (see diagram). A force of magnitude X N, acting directly down the plane, is applied to P.

(i) Show that the greatest value of X for which P remains stationary is 6.2. [4]

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(ii) Given instead that $X = 0.8$, find the acceleration of P. [4]

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5 A particle moves in a straight line starting from a point O with initial velocity $1\ \text{m s}^{-1}$. The acceleration of the particle at time t s after leaving O is $a\ \text{m s}^{-2}$, where

$$a = 1.2t^{\frac{1}{2}} - 0.6t.$$

(i) At time T s after leaving O the particle reaches its maximum velocity. Find the value of T. [2]

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(ii) Find the velocity of the particle when its acceleration is maximum (you do not need to verify that the acceleration is a maximum rather than a minimum). [6]

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6 A car of mass 1200 kg is driving along a straight horizontal road at a constant speed of 15 m s^{-1}. There is a constant resistance to motion of 350 N.

(i) Find the power of the car's engine. [1]

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The car comes to a hill inclined at 1° to the horizontal, still travelling at 15 m s^{-1}.

(ii) The car starts to descend the hill with reduced power and with an acceleration of 0.12 m s^{-2}. Given that there is no change in the resistance force, find the new power of the car's engine at the instant when it starts to descend the hill. [3]

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(iii) When the car is travelling at $20\,\text{m}\,\text{s}^{-1}$ down the hill, the power is cut off and the car gradually slows down. Assuming that the resistance force remains 350 N, find the distance travelled from the moment when the power is cut off until the speed of the car is reduced to $18\,\text{m}\,\text{s}^{-1}$. [4]

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7 A particle of mass 0.3 kg is released from rest above a tank containing water. The particle falls vertically, taking 0.8 s to reach the water surface. There is no instantaneous change of speed when the particle enters the water. The depth of water in the tank is 1.25 m. The water exerts a force on the particle resisting its motion. The work done against this resistance force from the instant that the particle enters the water until it reaches the bottom of the tank is 1.2 J.

(i) Use an energy method to find the speed of the particle when it reaches the bottom of the tank. [4]

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When the particle reaches the bottom of the tank, it bounces back vertically upwards with initial speed $7\,\text{m}\,\text{s}^{-1}$. As the particle rises through the water, it experiences a constant resistance force of 1.8 N. The particle comes to instantaneous rest t seconds after it bounces on the bottom of the tank.

(ii) Find the value of t. [7]

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Additional Page

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