Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

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MATHEMATICS **9709/42**

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 particle moves in a straight line. The displacement of the particle at time t s is s m, where

$$s = t^3 - 6t^2 + 4t.$$

Find the velocity of the particle at the instant when its acceleration is zero. [4]

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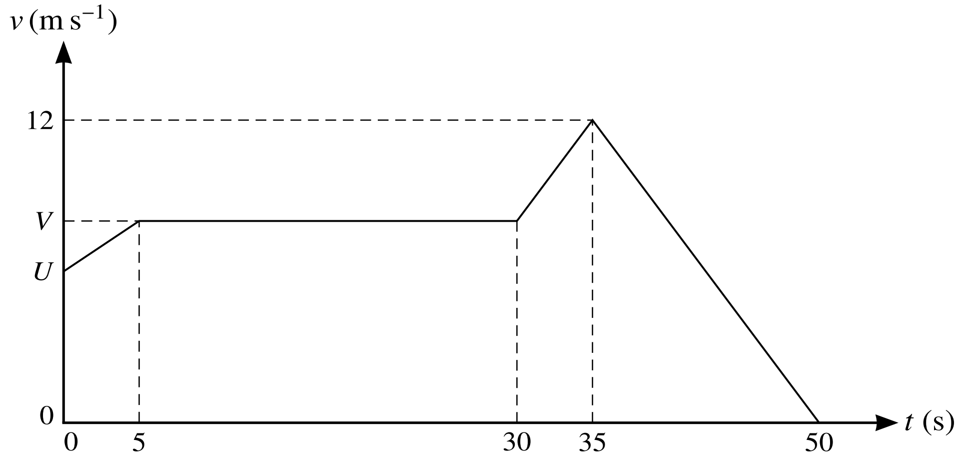

The diagram shows a velocity-time graph which models the motion of a tractor. The graph consists of four straight line segments. The tractor passes a point O at time $t = 0$ with speed $U\,\mathrm{m\,s^{-1}}$. The tractor accelerates to a speed of $V\,\mathrm{m\,s^{-1}}$ over a period of 5 s, and then travels at this speed for a further 25 s. The tractor then accelerates to a speed of $12\,\mathrm{m\,s^{-1}}$ over a period of 5 s. The tractor then decelerates to rest over a period of 15 s.

(i) Given that the acceleration of the tractor between $t = 30$ and $t = 35$ is $0.8\,\mathrm{m\,s^{-2}}$, find the value of V. [2]

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(ii) Given also that the total distance covered by the tractor in the 50 seconds of motion is 375 m, find the value of U. [3]

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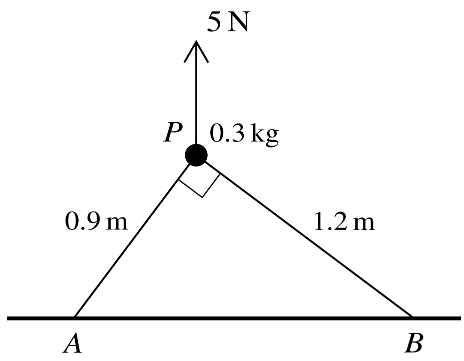

A particle P of mass 0.3 kg is held in equilibrium above a horizontal plane by a force of magnitude 5 N, acting vertically upwards. The particle is attached to two strings PA and PB of lengths 0.9 m and 1.2 m respectively. The points A and B lie on the plane and angle $APB = 90°$ (see diagram). Find the tension in each of the strings. [5]

4 A lorry of mass 25 000 kg travels along a straight horizontal road. There is a constant force of 3000 N resisting the motion.

(i) Find the power required to maintain a constant speed of $30\,\mathrm{m\,s^{-1}}$. [2]

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The lorry comes to a straight hill inclined at 2° to the horizontal. The driver switches off the engine of the lorry at the point A which is at the foot of the hill. Point B is further up the hill. The speeds of the lorry at A and B are $30\,\mathrm{m\,s^{-1}}$ and $25\,\mathrm{m\,s^{-1}}$ respectively. The resistance force is still 3000 N.

(ii) Use an energy method to find the height of B above the level of A. [5]

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5 Two particles A and B move in the same vertical line. Particle A is projected vertically upwards from the ground with speed $20\,\text{m}\,\text{s}^{-1}$. One second later particle B is dropped from rest from a height of 40 m.

(i) Find the height above the ground at which the two particles collide. [4]

(ii) Find the difference in the speeds of the two particles at the instant when the collision occurs. [3]

6 A block of mass 3 kg is initially at rest on a rough horizontal plane. A force of magnitude 6 N is applied to the block at an angle of θ above the horizontal, where $\cos\theta = \frac{24}{25}$. The force is applied for a period of 5 s, during which time the block moves a distance of 4.5 m.

(i) Find the magnitude of the frictional force on the block. [4]

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(ii) Show that the coefficient of friction between the block and the plane is 0.165, correct to 3 significant figures. [3]

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(iii) When the block has moved a distance of 4.5 m, the force of magnitude 6 N is removed and the block then decelerates to rest. Find the total time for which the block is in motion. [4]

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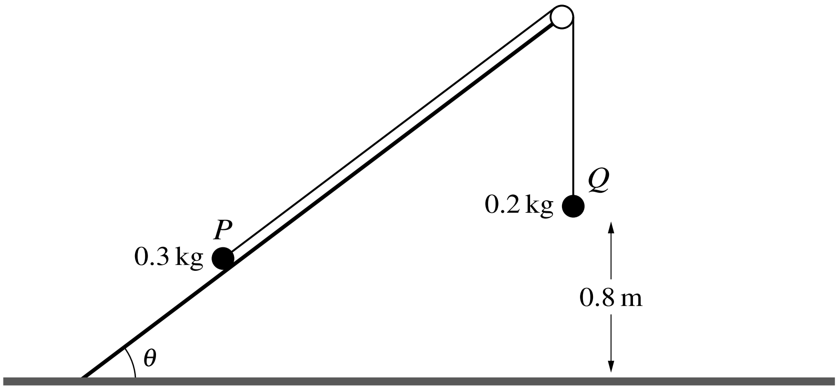

Two particles P and Q, of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley which is attached to the edge of a smooth plane. The plane is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{3}{5}$. P lies on the plane and Q hangs vertically below the pulley at a height of 0.8 m above the floor (see diagram). The string between P and the pulley is parallel to a line of greatest slope of the plane. P is released from rest and Q moves vertically downwards.

(i) Find the tension in the string and the magnitude of the acceleration of the particles. [5]

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Q hits the floor and does not bounce. It is given that P does not reach the pulley in the subsequent motion.

(ii) Find the time, from the instant at which P is released, for Q to reach the floor. [2]

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(iii) When Q hits the floor the string becomes slack. Find the time, from the instant at which P is released, for the string to become taut again. [4]

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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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