Cambridge International AS & A Level

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CANDIDATE NAME

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3115764768

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **May/June 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 **14** printed pages and **2** blank pages.

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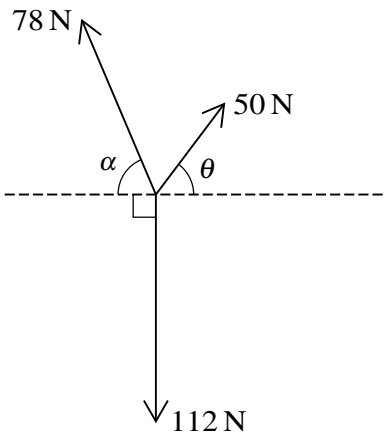
1



Given that $\tan\alpha = \frac{12}{5}$ and $\tan\theta = \frac{4}{3}$, show that the coplanar forces shown in the diagram are in equilibrium. [3]

2 A particle P is projected vertically upwards with speed $25\,\text{m}\,\text{s}^{-1}$ from a point 3 m above horizontal ground.

(i) Find the time taken for P to reach its greatest height. [2]

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(ii) Find the length of time for which P is higher than 23 m above the ground. [3]

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(iii) P is higher than h m above the ground for 1 second. Find h. [2]

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3 A lorry has mass 12 000 kg.

(i) The lorry moves at a constant speed of 5 m s^{-1} up a hill inclined at an angle of θ to the horizontal, where $\sin\theta = 0.08$. At this speed, the magnitude of the resistance to motion on the lorry is 1500 N. Show that the power of the lorry's engine is 55.5 kW. [3]

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When the speed of the lorry is v m s^{-1} the magnitude of the resistance to motion is kv^2 N, where k is a constant.

(ii) Show that $k = 60$. [1]

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(iii) The lorry now moves at a constant speed on a straight level road. Given that its engine is still working at 55.5 kW, find the lorry's speed. [3]

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4 A particle of mass 1.3 kg rests on a rough plane inclined at an angle θ to the horizontal, where $\tan\theta = \frac{12}{5}$. The coefficient of friction between the particle and the plane is μ.

(i) A force of magnitude 20 N parallel to a line of greatest slope of the plane is applied to the particle and the particle is on the point of moving up the plane. Show that $\mu = 1.6$. [4]

The force of magnitude 20 N is now removed.

(ii) Find the acceleration of the particle. [2]

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(iii) Find the work done against friction during the first 2 s of motion. [3]

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5 A particle P moves in a straight line from a fixed point O. The velocity v m s^{-1} of P at time t s is given by

$$v = t^2 - 8t + 12 \quad \text{for } 0 \leqslant t \leqslant 8.$$

(i) Find the minimum velocity of P. [3]

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(ii) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 8$. [7]

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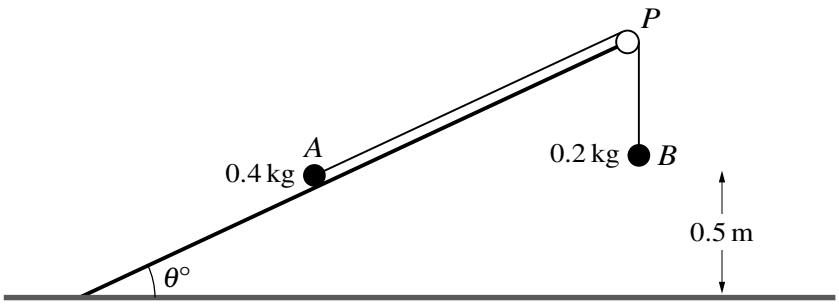

Two particles A and B, of masses 0.4 kg and 0.2 kg respectively, are connected by a light inextensible string. Particle A is held on a smooth plane inclined at an angle of $\theta°$ to the horizontal. The string passes over a small smooth pulley P fixed at the top of the plane, and B hangs freely 0.5 m above horizontal ground (see diagram). The particles are released from rest with both sections of the string taut.

(i) Given that the system is in equilibrium, find θ. [3]

(ii) It is given instead that $\theta = 20$. In the subsequent motion particle A does not reach P and B remains at rest after reaching the ground.

(a) Find the tension in the string and the acceleration of the system. [4]

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(b) Find the speed of A at the instant B reaches the ground. [2]

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[Question 6 continues on the next page.]

(c) Use an energy method to find the total distance A moves up the plane before coming to instantaneous rest. [5]

Additional Page

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