Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8827910224

MATHEMATICS **9709/41**

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 $10\,\mathrm{m\,s^{-2}}$.
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 A crane is lifting a load of 1250 kg vertically at a constant speed $V\,\mathrm{m\,s^{-1}}$. Given that the power of the crane is a constant 20 kW, find the value of V. [2]

2 The total mass of a cyclist and her bicycle is 75 kg. The cyclist ascends a straight hill of length 0.7 km inclined at 1.5° to the horizontal. Her speed at the bottom of the hill is $10\,\text{m}\,\text{s}^{-1}$ and at the top it is $5\,\text{m}\,\text{s}^{-1}$. There is a resistance to motion, and the work done against this resistance as the cyclist ascends the hill is 2000 J. The cyclist exerts a constant force of magnitude F N in the direction of motion. Find F. [5]

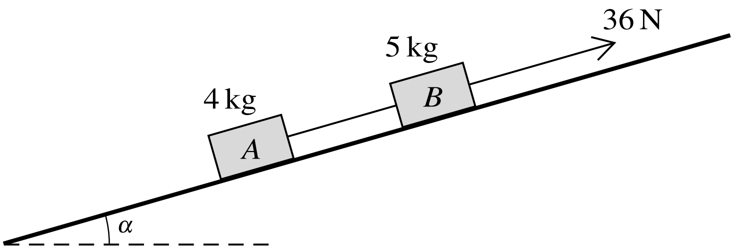
3 A block of mass 3 kg is at rest on a rough plane inclined at 60° to the horizontal. A force of magnitude 15 N acting up a line of greatest slope of the plane is just sufficient to prevent the block from sliding down the plane.

(i) Find the coefficient of friction between the block and the plane. [5]

The force of magnitude 15 N is now replaced by a force of magnitude X N acting up the line of greatest slope.

(ii) Find the greatest value of X for which the block does not move. [2]

4



Two blocks A and B of masses 4 kg and 5 kg respectively are joined by a light inextensible string. The blocks rest on a smooth plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{7}{24}$. The string is parallel to a line of greatest slope of the plane with B above A. A force of magnitude 36 N acts on B, parallel to a line of greatest slope of the plane (see diagram).

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

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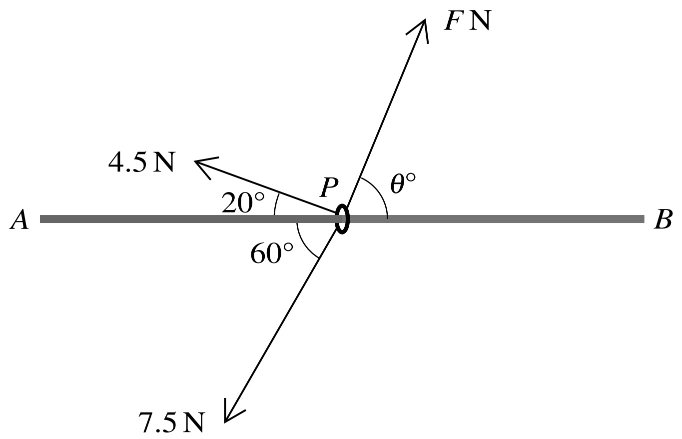
(ii) At a particular instant, the speed of the blocks is 1 m s^{-1}. Find the time, after this instant, that it takes for the blocks to travel 0.65 m. [2]

5



A small ring P is threaded on a fixed smooth horizontal rod AB. Three horizontal forces of magnitudes 4.5 N, 7.5 N and F N act on P (see diagram).

(i) Given that these three forces are in equilibrium, find the values of F and θ. [6]

(ii) It is given instead that the values of F and θ are 9.5 and 30 respectively, and the acceleration of the ring is $1.5\,\mathrm{m\,s^{-2}}$. Find the mass of the ring. [2]

6 A particle of mass 0.4 kg is released from rest at a height of 1.8 m above the surface of the water in a tank. There is no instantaneous change of speed when the particle enters the water. The water exerts an upward force of 5.6 N on the particle when it is in the water.

(i) Find the velocity of the particle at the instant when it reaches the surface of the water. [2]

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(ii) Find the time that it takes from the instant when the particle enters the water until it comes to instantaneous rest in the water. You may assume that the tank is deep enough so that the particle does not reach the bottom of the tank. [4]

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(iii) Sketch a velocity-time graph for the motion of the particle from the instant at which it is released until it comes to instantaneous rest in the water. [3]

7 A particle moves in a straight line, starting from rest at a point O, and comes to instantaneous rest at a point P. The velocity of the particle at time t s after leaving O is $v \text{ m s}^{-1}$, where

$$v = 0.6t^2 - 0.12t^3.$$

(i) Show that the distance OP is 6.25 m. [5]

On another occasion, the particle also moves in the same straight line. On this occasion, the displacement of the particle at time t s after leaving O is s m, where

$$s = kt^3 + ct^5.$$

It is given that the particle passes point P with velocity $1.25\ \text{m s}^{-1}$ at time $t = 5$.

(ii) Find the values of the constants k and c. [5]

(iii) Find the acceleration of the particle at time $t = 5$. [2]

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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