Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6303252032

MATHEMATICS **9709/41**

Paper 4 Mechanics **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- Where a numerical value for the acceleration due to gravity (g) is needed, use $10\,\mathrm{m\,s^{-2}}$.

INFORMATION
- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

1 A particle of mass 1.6 kg is projected with a speed of $20\,\mathrm{m\,s^{-1}}$ up a line of greatest slope of a smooth plane inclined at α to the horizontal, where $\tan\alpha = \frac{3}{4}$.

Use an energy method to find the distance the particle moves up the plane before coming to instantaneous rest. [3]

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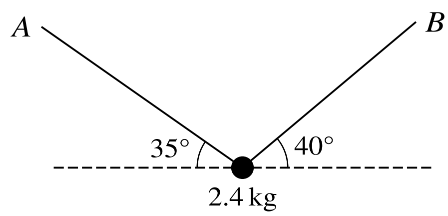
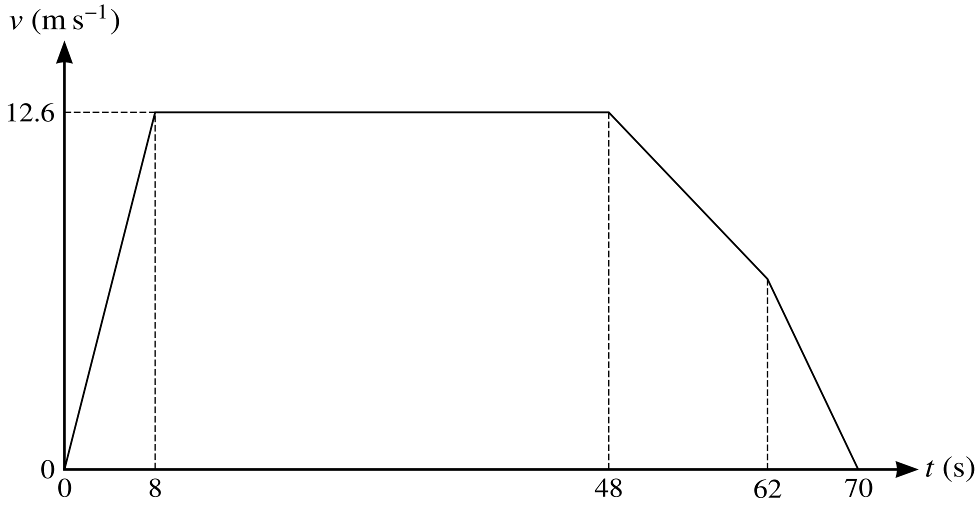


A particle of mass 2.4 kg is held in equilibrium by two light inextensible strings, one of which is attached to point A and the other attached to point B. The strings make angles of 35° and 40° with the horizontal (see diagram).

Find the tension in each of the two strings. [5]

3



The diagram shows the velocity-time graph for the motion of a bus. The bus starts from rest and accelerates uniformly for 8 seconds until it reaches a speed of $12.6\,\text{m}\,\text{s}^{-1}$. The bus maintains this speed for 40 seconds. It then decelerates uniformly in two stages. Between 48 and 62 seconds the bus decelerates at $a\,\text{m}\,\text{s}^{-2}$ and between 62 and 70 seconds it decelerates at $2a\,\text{m}\,\text{s}^{-2}$ until coming to rest.

(a) Find the distance covered by the bus in the first 8 seconds. [1]

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(b) Find the value of a. [3]

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(c) Find the average speed of the bus for the whole journey. [4]

4 Two particles P and Q, of masses 6 kg and 2 kg respectively, lie at rest 12.5 m apart on a rough horizontal plane. The coefficient of friction between each particle and the plane is 0.4. Particle P is projected towards Q with speed $20\,\mathrm{m\,s^{-1}}$.

(a) Show that the speed of P immediately before the collision with Q is $10\sqrt{3}\,\mathrm{m\,s^{-1}}$. [3]

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In the collision P and Q coalesce to form particle R.

(b) Find the loss of kinetic energy due to the collision. [4]

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The coefficient of friction between R and the plane is 0.4.

(c) Find the distance travelled by particle R before coming to rest. [2]

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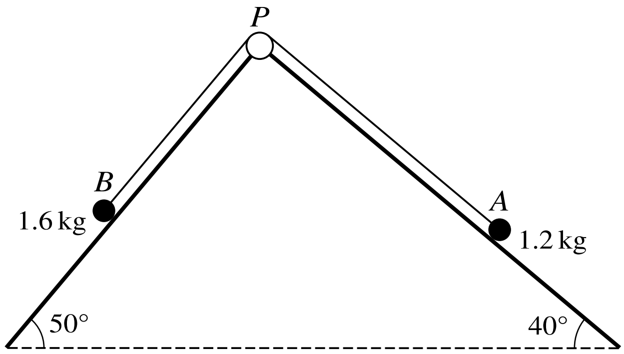

The diagram shows a particle A, of mass 1.2 kg, which lies on a plane inclined at an angle of 40° to the horizontal and a particle B, of mass 1.6 kg, which lies on a plane inclined at an angle of 50° to the horizontal. The particles are connected by a light inextensible string which passes over a small smooth pulley P fixed at the top of the planes. The parts AP and BP of the string are taut and parallel to lines of greatest slope of the respective planes. The two planes are rough, with the same coefficient of friction, μ, between the particles and the planes.

Find the value of μ for which the system is in limiting equilibrium. [7]

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6 A car of mass 1300 kg is moving on a straight road.

(a) On a horizontal section of the road, the car has a constant speed of $30\,\mathrm{m\,s^{-1}}$ and there is a constant force of 650 N resisting the motion.

(i) Calculate, in kW, the power developed by the engine of the car. [2]

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(ii) Given that this power is suddenly increased **by** 9 kW, find the instantaneous acceleration of the car. [3]

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(b) On a section of the road inclined at $\sin^{-1} 0.08$ to the horizontal, the resistance to the motion of the car is $(1000 + 20v)$ N when the speed of the car is $v \text{ m s}^{-1}$. The car travels downwards along this section of the road at constant speed with the engine working at 11.5 kW.

Find this constant speed. [4]

7 A particle moves in a straight line starting from a point O before coming to instantaneous rest at a point X. At time t s after leaving O, the velocity $v\,\mathrm{m\,s^{-1}}$ of the particle is given by

$$v = 7.2t^2 \qquad 0 \leqslant t \leqslant 2,$$
$$v = 30.6 - 0.9t \qquad 2 \leqslant t \leqslant 8,$$
$$v = \frac{1600}{t^2} + kt \qquad 8 \leqslant t,$$

where k is a constant. It is given that there is no instantaneous change in velocity at $t = 8$.

Find the distance OX. [9]

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Additional Page

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