Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MATHEMATICS **9709/43**

Paper 4 Mechanics **May/June 2025**

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 $10\,\text{m}\,\text{s}^{-2}$.

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 **12** pages.

[Turn over

1 Two particles P and Q, of masses 0.1 kg and 0.3 kg respectively, are at rest on a smooth horizontal plane. P is projected directly towards Q with speed $4u\,\text{m s}^{-1}$. At the same instant, Q is projected directly towards P with speed $u\,\text{m s}^{-1}$. After P and Q collide, P moves with speed $2\,\text{m s}^{-1}$ and Q moves with speed $4\,\text{m s}^{-1}$.

(a) Find the two possible values of u. [3]

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(b) Find the largest possible loss of kinetic energy in the collision. [2]

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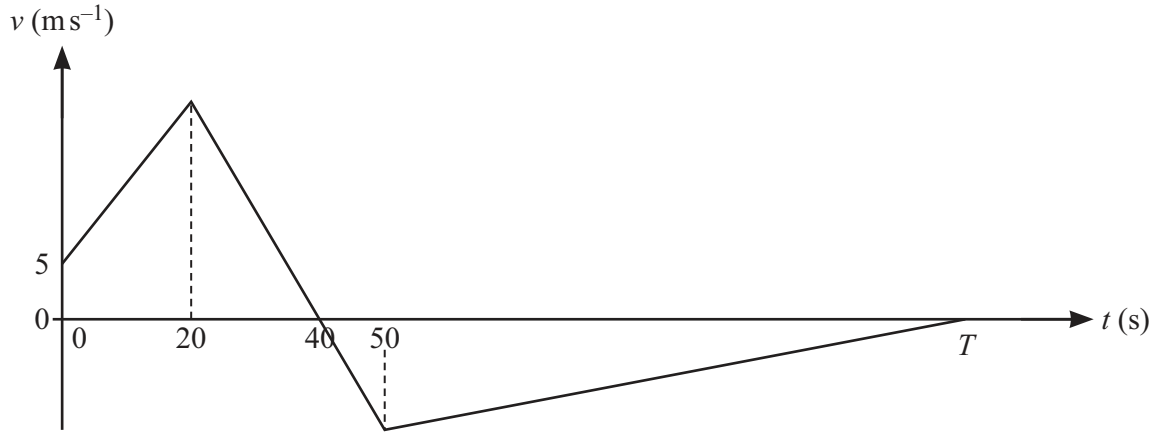
2 A van of mass 4500 kg is towing a trailer of mass 350 kg along a straight horizontal road. The van and trailer are connected by a light rigid tow-bar which is parallel to the road. There are resistance forces of XN on the van and 120 N on the trailer. The driving force produced by the van's engine is 2500 N. The tension in the tow-bar is TN, and the acceleration of the van is $0.4\,\text{m}\,\text{s}^{-2}$.

Find the value of X and the value of T. [4]

3



The diagram shows a velocity-time graph which models the motion of a particle. The graph consists of 3 straight line segments. The velocity of the particle at time t s after passing a fixed point O is v m s^{-1}. The particle leaves O with a velocity of 5 m s^{-1} and accelerates at 0.75 m s^{-2} for 20 s. The particle then decelerates for the next 30 s. At $t = 40$, the velocity of the particle is zero. After $t = 40$, the particle starts to travel back to O, coming to rest at O at time T s.

(a) Find the value of T. [5]

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(b) Find the acceleration of the particle from $t = 50$ to $t = T$. [2]

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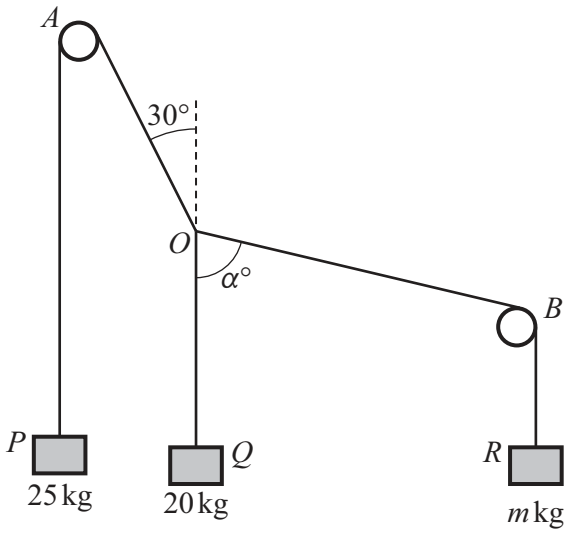


Three blocks P, Q and R, of masses 25 kg, 20 kg and m kg respectively, are held in equilibrium by three light inextensible strings OP, OQ and OR. The strings OP and OR both pass over small fixed smooth pulleys A and B respectively, with P and R hanging vertically below the pulleys. The block Q hangs vertically below the point O. The angle between OA and the vertical is 30° and the angle $BOQ = \alpha°$ (see diagram).

Find the value of m and the value of α. [6]

5 A van of mass 2500 kg travelling at speed $v\,\text{m s}^{-1}$ experiences a resistance force of kv^2 N. The constant power of the van's engine is 62.5 kW.

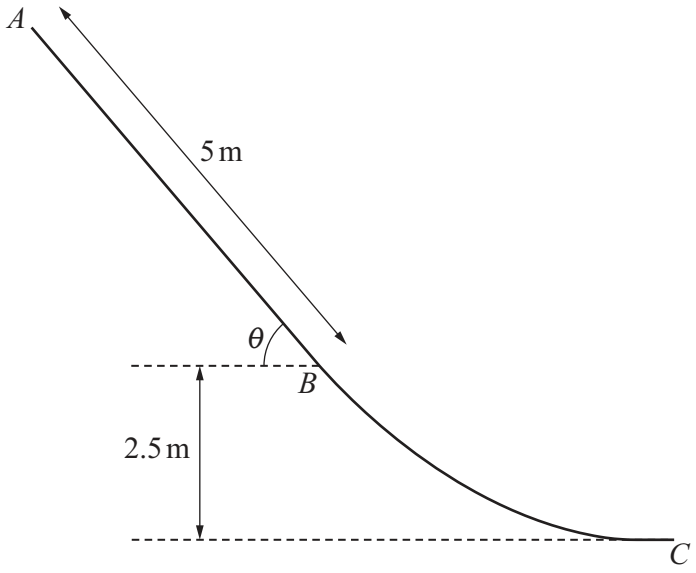
(a) The steady speed that the van could maintain when moving along a straight horizontal road is $50\,\text{m s}^{-1}$.

Show that $k = 0.5$, and find the acceleration of the van when its speed is $25\,\text{m s}^{-1}$ on this straight horizontal road. [4]

The van begins to ascend a hill inclined at an angle $\theta°$ to the horizontal. The van travels along a line of greatest slope of the hill. The speed of the van at the start of the hill is $20\,\text{m s}^{-1}$, and its acceleration is $5a\,\text{m s}^{-2}$. Later, on the same hill, the speed of the van is $30\,\text{m s}^{-1}$, and its acceleration is $a\,\text{m s}^{-2}$. The power of the van's engine remains at 62.5 kW, and the resistance force remains at $0.5v^2$ N.

(b) Find the value of a and the value of θ. [5]

6



The diagram shows the vertical cross-section ABC of a rough waterslide. The section AB is a straight line of length 5 m inclined at an angle of θ to the horizontal, where $\sin\theta = 0.8$. The point B is 2.5 m above the level of C. A man of mass 80 kg, modelled as a particle, slides down the waterslide, starting from rest at A. The coefficient of friction between the man and the straight section of the waterslide is 0.1.

(a) Find the speed of the man at B. [5]

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It is given that there is no change in the speed of the man when passing through B and that his speed at C is $11\,m\,s^{-1}$.

(b) Find the work done against the resistance force as the man moves from B to C. [4]

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7 A particle X moves in a straight line. The displacement of X from O at time t s after leaving O is s m, where $s = 0.3t^2 + 0.6t$ for $0 \leqslant t \leqslant 4$.

(a) Find the velocity of X at $t = 4$. [2]

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For $t > 4$, the acceleration of X at time t s after leaving O is $a\,\text{m s}^{-2}$, where $a = 0.3t^{\frac{1}{2}}$. There is no change in the velocity of X at $t = 4$. The velocity of X at $t = T$ is $14.2\,\text{m s}^{-1}$.

(b) (i) Find the value of T. [4]

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(ii) Find the total distance travelled by X between $t = 0$ and $t = T$. [4]

Additional page

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