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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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MATHEMATICS **9709/42**

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

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.

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1 A crate is being pushed in a straight line along a horizontal surface by a force of magnitude 25 N inclined at 20° above the horizontal. The crate moves a distance of 12 m in 8 seconds with constant speed.

(a) Find the constant speed of the crate. [1]

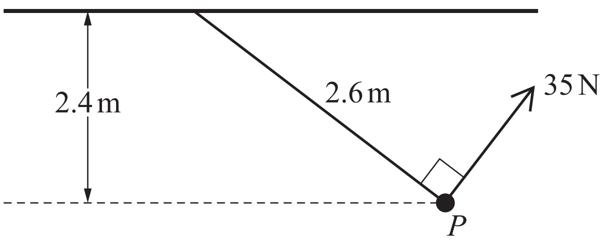
(b) Find the work done by the 25 N force. [2]

(c) Find the power at which the 25 N force is working. [1]

2 Two particles P and Q, of masses 0.2 kg and 0.1 kg respectively, are free to move in a straight line on a smooth horizontal plane. P is projected towards Q with speed $5\,\text{m}\,\text{s}^{-1}$. At the same instant, Q is projected away from P with speed $2\,\text{m}\,\text{s}^{-1}$. When P collides with Q, the particles coalesce.

Find the kinetic energy lost during the collision. [4]

3



A particle P of mass m kg is attached to one end of a light inextensible string of length 2.6 m. The other end of the string is attached to a fixed point on a horizontal ceiling, and the string is taut. The particle is held in equilibrium by a force of magnitude 35 N, acting in a vertical plane which is perpendicular to the ceiling and contains the string. The force acts in a direction perpendicular to the string (see diagram). The tension in the string is T N and the vertical distance of P from the ceiling is 2.4 m.

Find, in either order, the value of m and the value of T. [4]

4 A car is travelling along a straight horizontal road. The car passes through a point A, on the road travelling at a speed of $15\,\mathrm{m\,s^{-1}}$, and then accelerates uniformly at $0.4\,\mathrm{m\,s^{-2}}$ for 30 seconds. The car then moves at constant speed for $3T$ seconds, where $T < 30$. The car then decelerates uniformly at $0.2\,\mathrm{m\,s^{-2}}$ and after a further T seconds passes through a point B on the road.

(a) On the given axes, sketch a velocity-time graph for the motion of the car between points A and B. [2]

The distance from A to B is 2750 m.

(b) Find the value of T. [6]

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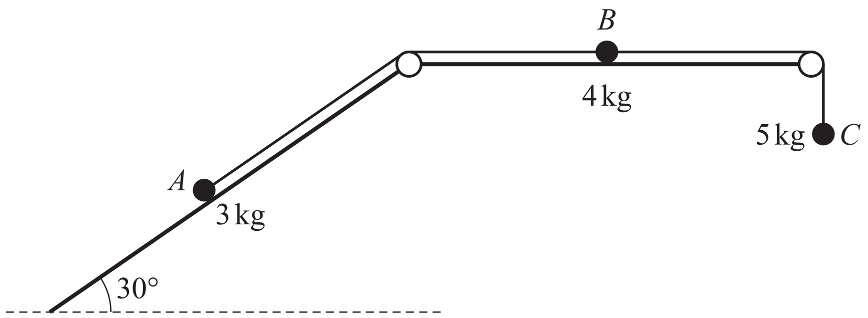
The car continues its journey from B, decelerating uniformly at $0.5\,\mathrm{m\,s^{-2}}$ until it comes to rest at a point C on the road.

(c) Find the total distance from A to C. [3]

5



One end of a light inextensible string is attached to a particle A of mass 3 kg. The other end of the string is attached to a particle B of mass 4 kg. Particle A is in contact with a rough plane inclined at 30° to the horizontal, and particle B is in contact with a smooth horizontal plane. A second light inextensible string is attached to B. The other end of this second string is attached to a particle C of mass 5 kg which hangs vertically.

Both strings are taut and pass over small smooth pulleys that are fixed at the ends of the horizontal plane. The part of the string from A to the pulley is parallel to a line of greatest slope of the inclined plane, and A, B and C are in the same vertical plane (see diagram).

The system is released from rest. In the subsequent motion, C moves vertically downwards with acceleration $2\,\text{m}\,\text{s}^{-2}$, and neither A nor B reach a pulley.

(a) Find the tensions in each of the strings. [3]

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(b) Find the coefficient of friction between A and the inclined plane. [4]

When the system has been in motion for 1.5 s, the string attached to A breaks.

(c) Find the total distance that A travels up the plane from the instant that the system is released from rest to the instant that A comes to instantaneous rest. [5]

6 A particle P moves in a straight line and passes through the point A at time $t = 0$. The velocity $v\,\mathrm{m\,s^{-1}}$ of P at time t seconds is given by

$$v = (2t+1)^{\frac{3}{2}} - 2t^2, \text{ where } 0 \leqslant t \leqslant 3.$$

(a) Find the maximum velocity of P in the interval $0 \leqslant t \leqslant 3$. [5]

It is given that in the interval $0 \leqslant t \leqslant 3$ the velocity of P is always positive.

(b) Find the distance of P from A at the instant when P is moving at this maximum velocity. [4]

7 A particle P of mass 3 kg is projected with a speed of $8\,\mathrm{m\,s^{-1}}$ up a line of greatest slope of a rough plane inclined at 30° to the horizontal. P is projected from a point A on the plane and comes to instantaneous rest at a point B on the plane. P then slides back down the plane. The coefficient of friction between P and the plane is $\frac{1}{12}\sqrt{3}$.

Using an energy method throughout, find the speed of P at the instant it returns to A. [6]

Additional page

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