Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 7 3 4 6 5 5 6 8 2 2 6 *

MATHEMATICS **9709/45**

Paper 4 Mechanics **October/November 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

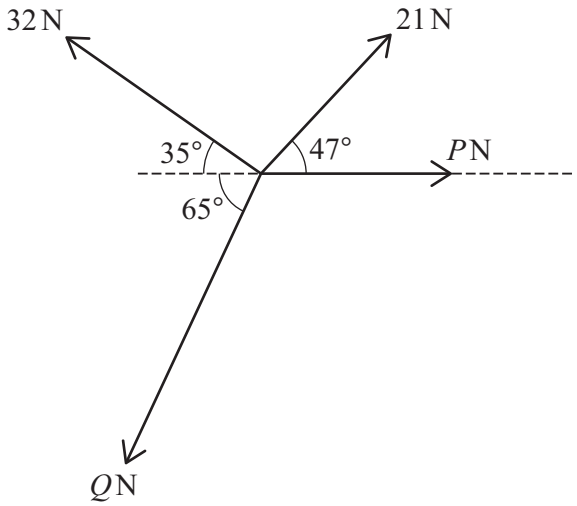
- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.

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Coplanar forces of magnitudes P N, Q N, 32 N and 21 N act at a point in the directions shown in the diagram. The forces are in equilibrium.

Find the value of P and the value of Q. [5]

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2 An athlete runs along a straight horizontal road. The athlete starts from rest and accelerates at $0.5\,\text{m s}^{-2}$ reaching a speed of $V\,\text{m s}^{-1}$. The athlete maintains this speed of $V\,\text{m s}^{-1}$ for Ts before decelerating at $0.2\,\text{m s}^{-2}$ back to rest. The athlete covers a total distance of 1350 m in 246 seconds.

(a) Sketch the velocity-time graph for the motion of the athlete. [1]



(b) Find T in terms of V, and hence show that $7V^2 - 492V + 2700 = 0$. [4]

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(c) Find the value of V, giving a justification for your answer. [2]

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3 A car of mass 800 kg is moving on a straight road.

When the car is moving at a constant speed of $20\,\text{m}\,\text{s}^{-1}$ on a horizontal section of the road, the engine of the car is working at P W.

When the car is moving at a constant speed of $12\,\text{m}\,\text{s}^{-1}$ up a section of the road inclined at $\sin^{-1} 0.15$ to the horizontal, the engine of the car is also working at P W.

On both sections of the road there is a constant force of magnitude R N resisting the motion of the car.

(a) Find the value of R and the value of P. [5]

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(b) Find the acceleration of the car when it is moving at $10\,\text{m}\,\text{s}^{-1}$ up the inclined section of the road with the engine working at 32 kW. [3]

4 A particle P moves in a straight line. At time t s after leaving a point O on the line, the acceleration $a\,\text{m s}^{-2}$ of P is given by $a = kt - 3$, where k is a positive constant. At time $t = 0$, the velocity of P is $1\,\text{m s}^{-1}$.

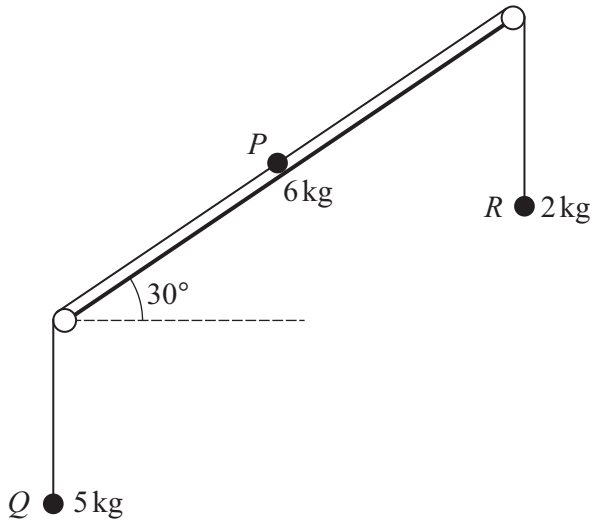
(a) Given that P is never at instantaneous rest, show that $k > 4.5$. [4]

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(b) Given instead that $k = 2.5$, find the total distance travelled by P in the interval $1 \leqslant t \leqslant 3$. [6]

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The diagram shows a particle P of mass 6 kg on a rough plane inclined at an angle of 30° to the horizontal. Two light inextensible strings are attached to P. The strings pass over small smooth pulleys, which are fixed at the ends of the plane. The non-vertical parts of the string are parallel to a line of greatest slope of the plane. Particles Q and R, of masses 5 kg and 2 kg respectively, hang vertically at the ends of the strings.

Both strings are taut, and the system is released from rest.

It is given that the tension in the string attached to Q is twice the tension in the string attached to R.

(a) Find, in terms of g, the tension in each of the strings and the magnitude of the acceleration of the particles. [5]

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(b) Find the coefficient of friction between P and the plane. [5]

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(c) It is given that when the system is released from rest, P is at the midpoint of the plane. In the subsequent motion, R does not reach the pulley at the top of the plane, and P takes 1.5 s to reach the pulley at the bottom of the plane.

Find the total length of the plane. [2]

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6 Two particles A and B of masses km and m respectively, where k and m are constants, are free to move in a straight line on a smooth horizontal plane. Particle A is projected towards B with speed $2u$ and at the same instant B is projected towards A with speed u.

The particles collide. After the collision the speed of A is u and both particles move in the same direction as A's original motion.

It is given that 35% of the total kinetic energy is lost in the collision. Find, in terms of u, the speed of B after the collision. [8]

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Additional page

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