Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MATHEMATICS **9709/42**

Paper 4 Mechanics **February/March 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 **16** pages. Any blank pages are indicated.

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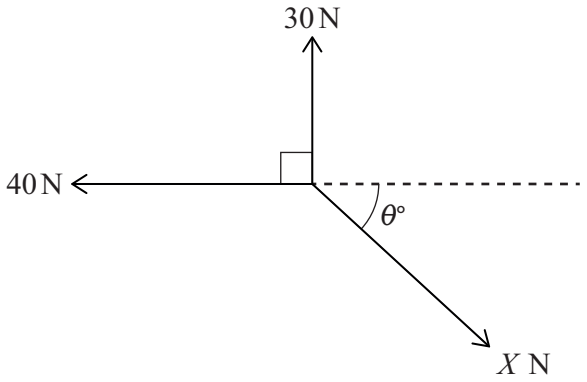

Three coplanar forces of magnitudes 40 N, 30 N and X N act at a point in the directions shown in the diagram.

Given that the forces are in equilibrium, find the values of θ and X. [4]

2 A cyclist is travelling along a straight horizontal road at a speed of $4\,\text{m s}^{-1}$ when she passes a point O. She accelerates at a constant rate for a distance of 42 m, reaching a speed of $V\,\text{m s}^{-1}$. She maintains the speed of $V\,\text{m s}^{-1}$ for 50 m and then decelerates at $2\,\text{m s}^{-2}$ before coming to rest. The distance travelled while decelerating is 16 m.

(a) Find the value of V. [2]

(b) Find the total time for which she is in motion from the instant that she passes O. [3]

3 An aeroplane is flying at a constant speed.

(a) The aeroplane is flying horizontally. The aeroplane's engines are producing a constant power of 5500 kW, and the aeroplane experiences a constant horizontal resistance force of 25 kN.

Find the speed of the aeroplane. [2]

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(b) The aeroplane then ascends 300 m in 50 s, while maintaining the same speed. The resistance force is no longer constant, and the work done against the resistance force in ascending the 300 m is 270 000 kJ. The mass of the aeroplane is 60 000 kg.

Find the average power of the aeroplane's engines. [4]

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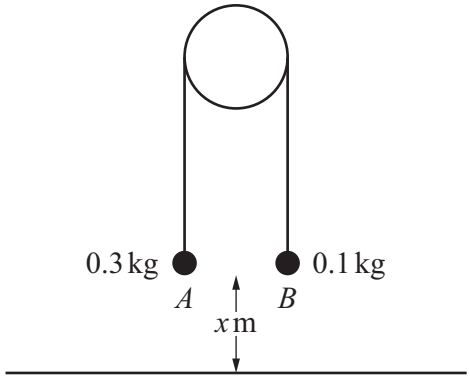

Two particles A and B have masses 0.3 kg and 0.1 kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley, and the particles hang vertically below the pulley. Both particles are initially at a height of x m above horizontal ground (see diagram). The system is released from rest.

(a) Find the tension in the string and the acceleration of the particles. [4]

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During the subsequent motion, B does **not** reach the pulley. When A reaches the ground, it comes to rest.

(b) Given that the greatest height of B above the ground is 1.2 m, find the value of x. [3]

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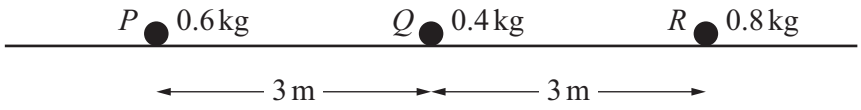

Three particles P, Q and R, of masses 0.6 kg, 0.4 kg and 0.8 kg respectively, are at rest in a straight line on a smooth horizontal plane. The distance from P to Q is 3 m, and the distance from Q to R is also 3 m (see diagram). P is projected directly towards Q with speed $3\,\text{m}\,\text{s}^{-1}$. After P and Q collide, P continues to move in the same direction with speed $1.5\,\text{m}\,\text{s}^{-1}$.

(a) Find the speed of Q after the collision. [2]

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In the subsequent collision between Q and R, these particles coalesce.

(b) Find the speed of the combined particle after this collision. [1]

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(c) Find the time that it takes from when P is initially projected until the instant at which P collides with the combined particle. [4]

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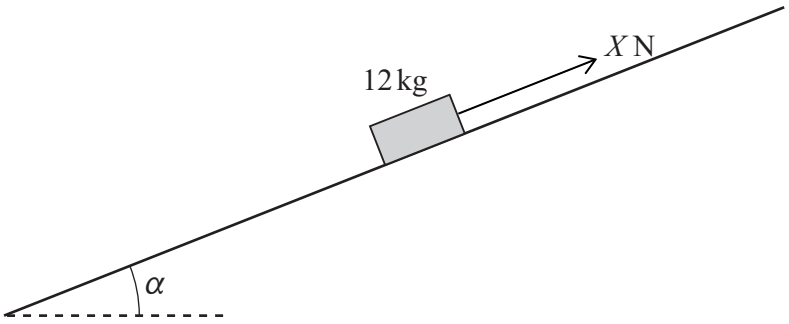

A block of mass 12 kg is placed on a rough plane inclined at an angle of α to the horizontal, where $\alpha = \tan^{-1}0.5$. A force of X N is applied to the block, directly up the plane (see diagram). The coefficient of friction between the block and the plane is μ.

(a) It is given that $\mu = 0.15$ and $X = 20$.

Find the time that it takes for the block to move 2 m down the plane from rest. [6]

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(b) It is given instead that $\mu \neq 0.15$ and that when $X = 10$, the block is on the point of moving **down** the plane.

Find the value of μ and the value of X for which the block is on the point of moving **up** the plane. [4]

7 A particle moves in a straight line. The velocity $v\,\text{m}\,\text{s}^{-1}$ of the particle $t\,\text{s}$ after leaving a fixed point O is given by $v = k(20 + pt - 6t^2)$, where k and p are constants. The acceleration of the particle at $t = 1$ is $42\,\text{m}\,\text{s}^{-2}$, and the displacement of the particle from O at $t = 1$ is 93 m.

(a) Show that $k = 3$ and $p = 26$. [6]

(b) Find the distance moved by the particle between the time at which its acceleration is zero and the time at which its velocity is zero. [5]

Additional page

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