Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MATHEMATICS **9709/42**

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. Any blank pages are indicated.

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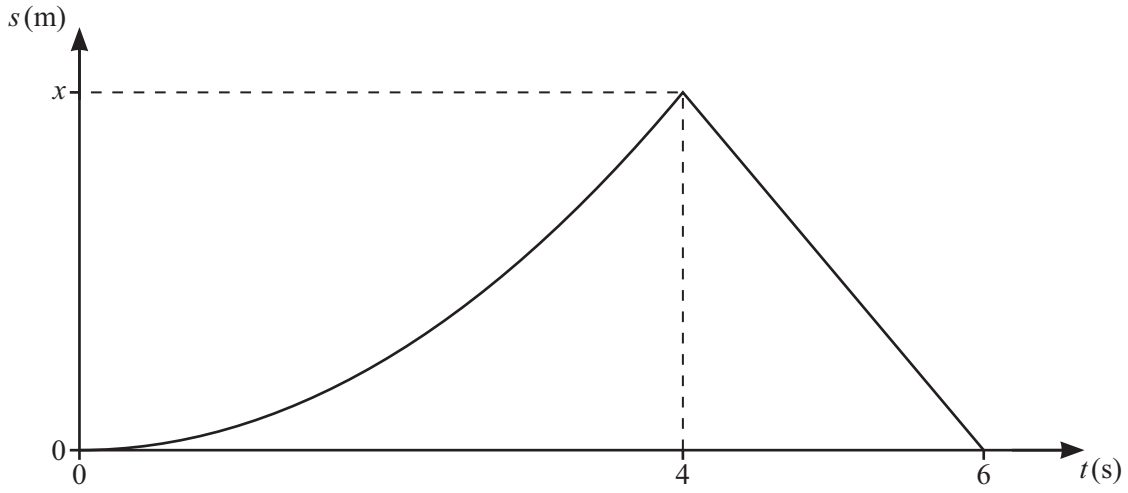

The diagram shows the displacement-time graph for the motion of a particle. The particle starts from rest at a point O and travels with constant acceleration $a\,\text{m}\,\text{s}^{-2}$, taking 4 s to move a distance of x m. The particle then returns to O with constant speed of $40\,\text{m}\,\text{s}^{-1}$, over a period of 2 s.

Find the value of x and the value of a. [3]

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2 A railway locomotive of mass 240 000 kg is towing a coach of mass 36 000 kg down a hill inclined at an angle of $\sin^{-1} 0.04$ to the horizontal. The driving force produced by the locomotive is 450 000 N and there are resistances to motion of 120 000 N on the locomotive and 15 000 N on the coach. The coupling between the locomotive and the coach is light, rigid and parallel to the hill.

Find the acceleration of the locomotive and the tension in the coupling. [5]

3 A car of mass 1400 kg travelling on a straight horizontal road accelerates uniformly from a speed of $15\,m\,s^{-1}$ to $20\,m\,s^{-1}$ over a distance of 175 m.

(a) Find the time taken to travel the 175 m. [2]

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There is a constant resistance force of 800 N to the motion of the car.

(b) (i) Use an energy method throughout to find the average power of the car's engine as the speed increases from $15\,m\,s^{-1}$ to $20\,m\,s^{-1}$. [4]

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(ii) Find the steady speed that the car could maintain on the horizontal road if the engine is working at the power found in **(b)(i)**. [2]

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4 A particle P of mass 0.1 kg is projected vertically upwards with speed $30\,\text{m}\,\text{s}^{-1}$ from horizontal ground. At the same instant a particle Q of mass 0.4 kg is projected vertically upwards with speed $10\,\text{m}\,\text{s}^{-1}$ from a height of 15 m above the ground. P and Q move in the same vertical line.

(a) Find the height above the ground at which P and Q collide. [4]

When P and Q collide, they coalesce.

(b) Find the speed of the combined particle at the instant that it reaches the ground. [5]

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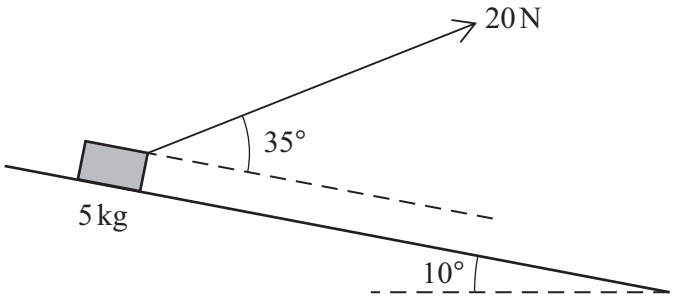

A block of mass 5 kg is being pulled straight down a line of greatest slope of a rough plane by a force of magnitude 20 N. The plane is inclined at an angle of 10° to the horizontal and the 20 N force acts at an angle of 35° above the line of greatest slope of the plane (see diagram). The coefficient of friction between the block and the plane is 0.4. The speed of the block when it passes a point O is $2\,\text{m}\,\text{s}^{-1}$.

Find the speed of the block when it has moved 3 m down the plane from O. [6]

6 A particle starts from rest at a point O. The acceleration of the particle at time t s after leaving O is a m s^{-2}, where

$$a = 2(t+1)^{-\frac{1}{2}} - 1 \text{ for } t \geqslant 0.$$

Find the distance that the particle travels from O until the time at which its acceleration is zero. [8]

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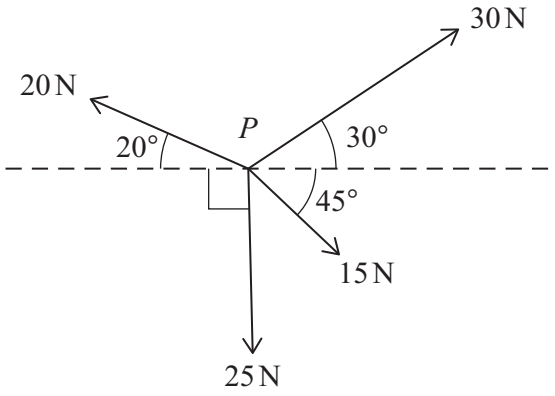

Fig. 7.1

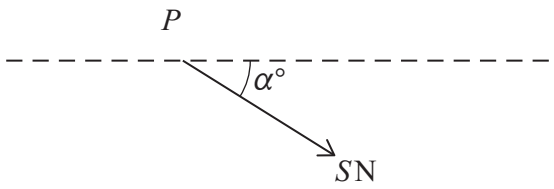

Fig. 7.2

Four coplanar forces of magnitudes 20 N, 30 N, 15 N and 25 N act at a point P in the directions shown in Fig. 7.1. The forces act in a vertical plane. The resultant of these forces has magnitude S N and acts at an angle $\alpha°$ below the horizontal as shown in Fig. 7.2.

(a) Find the value of S and the value of α. [6]

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A small ring of mass 0.6 kg is threaded on a rough straight horizontal wire. The four forces shown in Fig. 7.1 act on the ring and are in the same vertical plane as the wire. The ring starts from rest and takes 3 s to travel a distance of 2 m along the wire.

(b) Find the coefficient of friction between the ring and the wire. [5]

Additional page

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