DFD

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 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 **12** pages. Any blank pages are indicated.

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1 A car of mass 1400 kg is travelling along a straight road against a constant resistance to motion of 600 N.

(a) The car travels along a horizontal section of the road. At an instant when the speed of the car is 20 $\mathrm{m\,s^{-1}}$, the acceleration of the car is 0.25 $\mathrm{m\,s^{-2}}$. Find the power developed by the car's engine at this instant. [2]

(b) The car later travels up a straight hill inclined at an angle α to the horizontal, where $\sin\alpha = 0.05$. The power developed by the engine is constant at 25 kW and the resistance to motion is 600 N. Find the steady speed at which the car travels up the hill. [3]

2 Two particles P and Q, of masses m kg and 2 kg respectively, are free to move in a straight line on a smooth horizontal plane. P and Q are moving directly towards each other with speeds $u\ \text{m s}^{-1}$ and $2u\ \text{m s}^{-1}$ respectively.

The particles collide. Immediately after the collision, the direction of motion of each particle is reversed, and the speed of P is $0.5u\ \text{m s}^{-1}$.

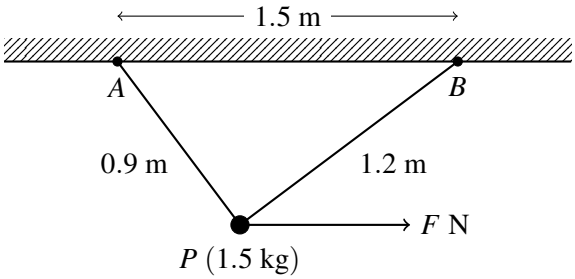
(a) Find, in terms of m and u, the speed of Q after the collision. [2]

(b) It is given that the kinetic energy of Q immediately after the collision is less than its kinetic energy immediately before the collision. Find the set of possible values of m. [3]

3 A particle P is projected vertically upwards from horizontal ground with speed 25 m s^{-1}. At the same instant, a second particle Q is dropped from a height of H m vertically above the point of projection of P.

The particles collide at the instant when particle P reaches its maximum height. Find the value of H and the time taken from the instant of projection to the collision. [5]

4



A particle P of mass 1.5 kg is suspended in equilibrium by two light inextensible strings AP and BP attached to two fixed points A and B on a horizontal ceiling. The distance AB is 1.5 m. The lengths of the strings AP and BP are 0.9 m and 1.2 m respectively. A horizontal force of magnitude F N is applied to P in the direction from A towards B (see diagram).

The tension in the string AP is twice the tension in the string BP. Find the value of F. [6]

5 A particle P moves in a straight line. At time t s after passing through a point O on the line, the displacement of P from O is s m, where $s = 0.1t^3 - 1.2t^2 + 4.5t$.

(a) Find the acceleration of P at the instants when P is instantaneously at rest. [4]

(b) Find the total distance travelled by P in the first 5 s of its motion. [4]

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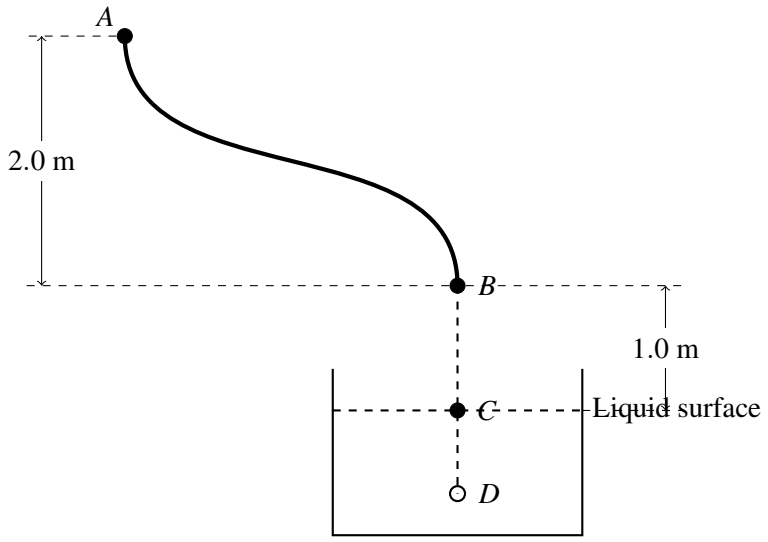

The diagram shows a particle of mass 0.4 kg released from rest at a point A on a rough curved track. The particle slides down the track and leaves it at point B, travelling vertically downwards. The point A is 2.0 m vertically above B.

The particle then falls freely and enters a liquid in a container at point C, which is 1.0 m vertically below B. The particle moves vertically downwards through the liquid and comes to instantaneous rest at a point D.

The work done against friction as the particle travels along the track from A to B is 4.8 J.

(a) Find the speed of the particle as it reaches C. [4]

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(b) It is given that the time taken for the particle to move through the liquid from C to D is equal to the time taken to fall freely from B to C. Find the distance CD. [3]

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(a) The liquid exerts a constant resisting force of R N on the particle. Use an energy method to find the value of R. [3]

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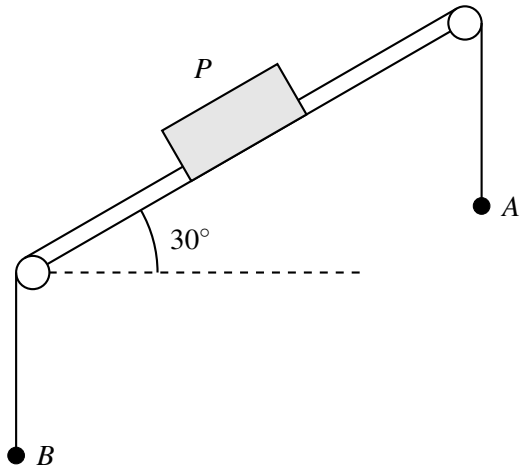

A particle P of mass 10 kg is placed on a rough plane inclined at an angle of 30° to the horizontal. Two light inextensible strings are attached to P. The strings pass over small smooth pulleys fixed at the top and bottom of the plane respectively. The non-vertical parts of the strings are parallel to a line of greatest slope of the plane.

Particles A and B, of masses m kg and 2 kg respectively, hang vertically at the ends of the strings. Particle A hangs from the pulley at the top of the plane, and B hangs from the pulley at the bottom (see diagram).

The coefficient of friction between P and the plane is $\frac{\sqrt{3}}{6}$.

(a) Given that $m = 12$ and the system is released from rest, find the acceleration of the system and the tension in the string attached to A. [5]

(a) Find the set of possible values of m for which the system remains at rest. [6]

Additional page

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

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