



Cambridge International AS & A Level

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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)

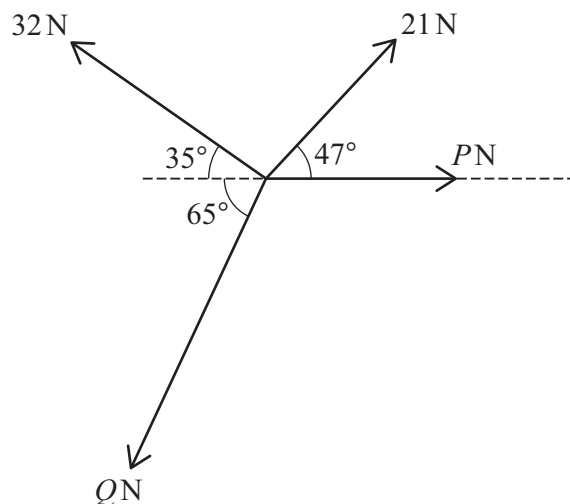
INSTRUCTIONS

- 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 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.



Coplanar forces of magnitudes PN , QN , 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]





- 2** An athlete runs along a straight horizontal road. The athlete starts from rest and accelerates at 0.5 ms^{-2} reaching a speed of $V \text{ ms}^{-1}$. The athlete maintains this speed of $V \text{ ms}^{-1}$ for T s before decelerating at 0.2 ms^{-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 ms^{-1} on a horizontal section of the road, the engine of the car is working at PW .

When the car is moving at a constant speed of 12 ms^{-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 PW .

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 ms^{-1} up the inclined section of the road with the engine working at 32 kW . [3]

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

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

[4]

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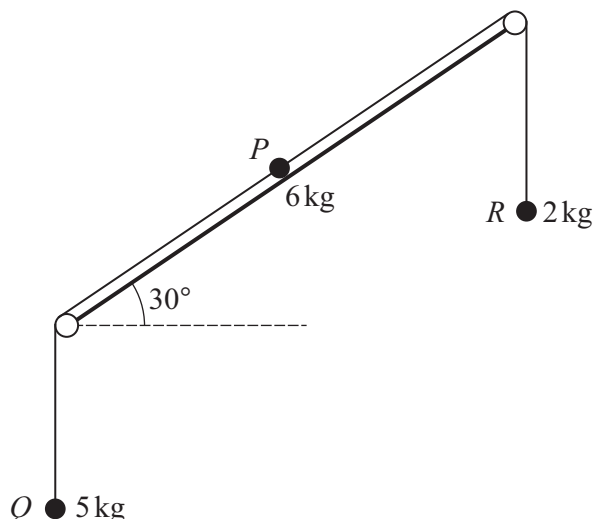




(b) Given instead that $k = 2.5$, find the total distance travelled by P in the interval $1 \leq t \leq 3$. [6]

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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]

(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]





- 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

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

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