



Cambridge International AS & A Level

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MATHEMATICS**9709/42**

Paper 4 Mechanics

October/November 2022**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.

Find the total mass of the cyclist and bicycle. [3]

[illegible]

3

2 A particle P of mass 0.4 kg is in limiting equilibrium on a plane inclined at 30° to the horizontal.

(a) Show that the coefficient of friction between the particle and the plane is $\frac{1}{3}\sqrt{3}$. [3]

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A force of magnitude 7.2 N is now applied to P directly up a line of greatest slope of the plane.

(b) Given that P starts from rest, find the time that it takes for P to move 1 m up the plane. [4]

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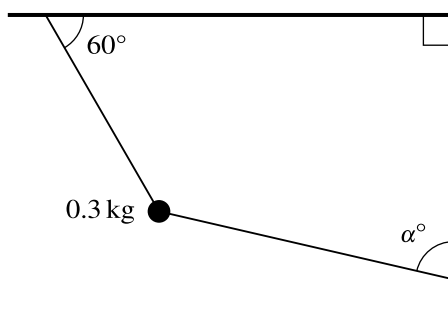
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A particle of mass 0.3 kg is held at rest by two light inextensible strings. One string is attached at an angle of 60° to a horizontal ceiling. The other string is attached at an angle α° to a vertical wall (see diagram). The tension in the string attached to the ceiling is 4 N.

Find the tension in the string which is attached to the wall and find the value of α . [6]

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- 4** A car of mass 1200 kg is travelling along a straight horizontal road AB . There is a constant resistance force of magnitude 500 N . When the car passes point A , it has a speed of 15 m s^{-1} and an acceleration of 0.8 m s^{-2} .

- (a)** Find the power of the car's engine at the point A . [3]

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The car continues to work with this power as it travels from A to B . The car takes 53 seconds to travel from A to B and the speed of the car at B is 32 m s^{-1} .

- (b)** Show that the distance AB is 1362.6 m . [3]

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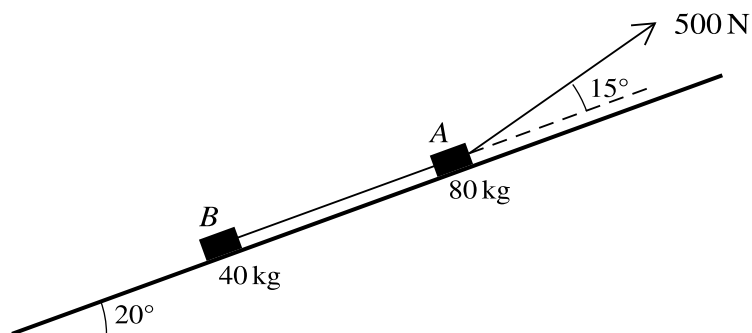
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A block A of mass 80 kg is connected by a light, inextensible rope to a block B of mass 40 kg . The rope joining the two blocks is taut and is parallel to a line of greatest slope of a plane which is inclined at an angle of 20° to the horizontal. A force of magnitude 500 N inclined at an angle of 15° above the same line of greatest slope acts on A (see diagram). The blocks move up the plane and there is a resistance force of 50 N on B , but no resistance force on A .

- (a) Find the acceleration of the blocks and the tension in the rope. [5]

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(b) Find the time that it takes for the blocks to reach a speed of 1.2 m s^{-1} from rest. [2]

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- 6 Three particles A , B and C of masses 0.3 kg , 0.4 kg and $m\text{ kg}$ respectively lie at rest in a straight line on a smooth horizontal plane. The distance between B and C is 2.1 m . A is projected directly towards B with speed 2 m s^{-1} . After A collides with B the speed of A is reduced to 0.6 m s^{-1} , still moving in the same direction.

- (a) Show that the speed of B after the collision is 1.05 m s^{-1} . [2]

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After the collision between A and B , B moves directly towards C . Particle B now collides with C . After this collision, the two particles coalesce and have a combined speed of 0.5 m s^{-1} .

- (b) Find m . [2]

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[illegible]

- 7 A particle P travels in a straight line, starting at rest from a point O . The acceleration of P at time t s after leaving O is denoted by $a \text{ m s}^{-2}$, where

$$\begin{aligned} a &= 0.3t^{\frac{1}{2}} && \text{for } 0 \leq t \leq 4, \\ a &= -kt^{-\frac{3}{2}} && \text{for } 4 < t \leq T, \end{aligned}$$

where k and T are constants.

- (a) Find the velocity of P at $t = 4$. [2]

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- (b) It is given that there is no change in the velocity of P at $t = 4$ and that the velocity of P at $t = 16$ is 0.3 m s^{-1} .

Show that $k = 2.6$ and find an expression, in terms of t , for the velocity of P for $4 \leq t \leq T$. [4]

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(c) Given that P comes to instantaneous rest at $t = T$, find the exact value of T . [2]

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(d) Find the total distance travelled between $t = 0$ and $t = T$. [4]

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