

# Cambridge International AS & A Level

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## MATHEMATICS

9709/42

## Paper 4 Mechanics

February/March 2021

**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  $10 \text{ m s}^{-2}$ .

## 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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- 1** Two particles  $P$  and  $Q$  of masses  $0.2\text{ kg}$  and  $0.3\text{ kg}$  respectively are free to move in a horizontal straight line on a smooth horizontal plane.  $P$  is projected towards  $Q$  with speed  $0.5\text{ m s}^{-1}$ . At the same instant  $Q$  is projected towards  $P$  with speed  $1\text{ m s}^{-1}$ .  $Q$  comes to rest in the resulting collision.

Find the speed of  $P$  after the collision.

[3]

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AHEAD

- 2 A car of mass 1400 kg is travelling at constant speed up a straight hill inclined at  $\alpha$  to the horizontal, where  $\sin \alpha = 0.1$ . There is a constant resistance force of magnitude 600 N. The power of the car's engine is 22 500 W.

(a) Show that the speed of the car is  $11.25 \text{ m s}^{-1}$ . [3]

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The car, moving with speed  $11.25 \text{ m s}^{-1}$ , comes to a section of the hill which is inclined at  $2^\circ$  to the horizontal.

(b) Given that the power and resistance force do not change, find the initial acceleration of the car up this section of the hill. [3]

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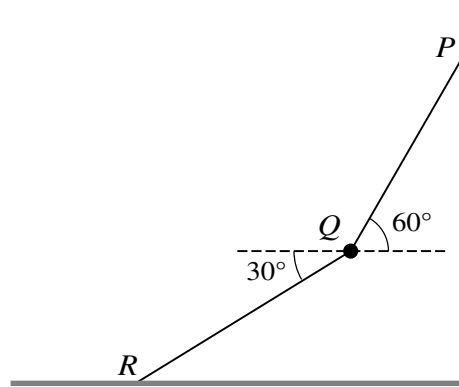
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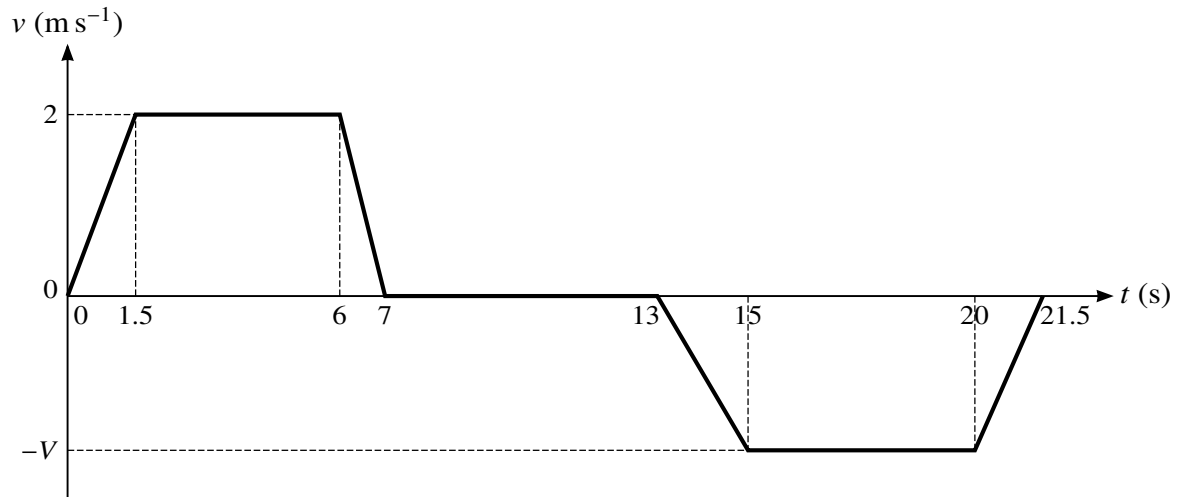
A particle  $Q$  of mass  $0.2 \text{ kg}$  is held in equilibrium by two light inextensible strings  $PQ$  and  $QR$ .  $P$  is a fixed point on a vertical wall and  $R$  is a fixed point on a horizontal floor. The angles which strings  $PQ$  and  $QR$  make with the horizontal are  $60^\circ$  and  $30^\circ$  respectively (see diagram).

Find the tensions in the two strings.

[5]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. In the bottom right corner, there is a small, partially visible circular logo. The logo has a blue border and contains the word "AHEAD" in white capital letters. Below the text, there is a red circular element, possibly a stylized letter or symbol. The rest of the page is empty.

4



An elevator moves vertically, supported by a cable. The diagram shows a velocity-time graph which models the motion of the elevator. The graph consists of 7 straight line segments.

The elevator accelerates upwards from rest to a speed of  $2 \text{ m s}^{-1}$  over a period of 1.5 s and then travels at this speed for 4.5 s, before decelerating to rest over a period of 1 s.

The elevator then remains at rest for 6 s, before accelerating to a speed of  $V \text{ m s}^{-1}$  downwards over a period of 2 s. The elevator travels at this speed for a period of 5 s, before decelerating to rest over a period of 1.5 s.

- (a) Find the acceleration of the elevator during the first 1.5 s. [1]

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- (b) Given that the elevator starts and finishes its journey on the ground floor, find  $V$ . [2]

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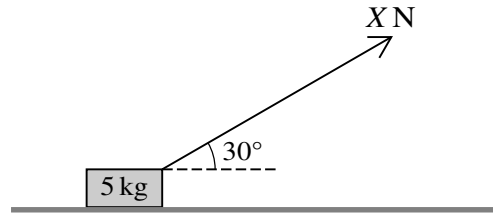
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- (c) The combined weight of the elevator and passengers on its upward journey is 1500 kg. Assuming that there is no resistance to motion, find the tension in the elevator cable on its upward journey when the elevator is decelerating. [3]

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A block of mass 5 kg is being pulled along a rough horizontal floor by a force of magnitude  $X$  N acting at  $30^\circ$  above the horizontal (see diagram). The block starts from rest and travels 2 m in the first 5 s of its motion.

- (a) Find the acceleration of the block. [2]

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- (b) Given that the coefficient of friction between the block and the floor is 0.4, find  $X$ . [4]

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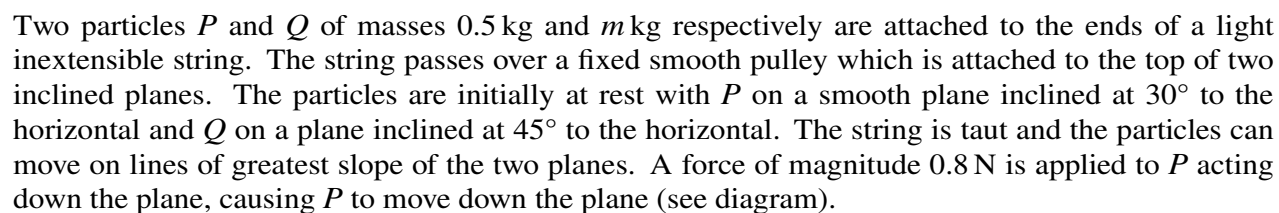
(c) Find the value of the coefficient of friction between the block and this part of the floor. [3]

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- 6** A particle moves in a straight line. It starts from rest from a fixed point  $O$  on the line. Its velocity at time  $t$  s after leaving  $O$  is  $v$  m s<sup>-1</sup>, where  $v = t^2 - 8t^{\frac{3}{2}} + 10t$ .
- (a)** Find the displacement of the particle from  $O$  when  $t = 1$ . [4]

This image shows a blank sheet of white paper designed for handwriting practice. It features multiple sets of horizontal lines. Each set consists of a solid top line, a dashed middle line, and a solid bottom line, providing a guide for letter height and placement. At the very top, there is a header section with a dotted line for a name or date. At the bottom right, there is a small purple circular logo containing the word "HEARST". The rest of the page is filled with the repeating pattern of solid-top, dashed-middle, and solid-bottom lines.

AHEAD



- Find the tension in the string.

[5]

[illegible]

[5]

AHEAD



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