

Cambridge International AS & A Level

CANDIDATE
NAME

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MATHEMATICS

9709/42

Paper 4 Mechanics

February/March 2020

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 **16** pages. Blank pages are indicated.

- 1** A lorry of mass 16 000 kg is travelling along a straight horizontal road. The engine of the lorry is working at constant power. The work done by the driving force in 10 s is 750 000 J.

(a) Find the power of the lorry's engine. [1]

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(b) There is a constant resistance force acting on the lorry of magnitude 2400 N.

Find the acceleration of the lorry at an instant when its speed is 25 m s^{-1} . [3]

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- 2 A particle P of mass 0.4 kg is on a rough horizontal floor. The coefficient of friction between P and the floor is μ . A force of magnitude 3 N is applied to P upwards at an angle α above the horizontal, where $\tan \alpha = \frac{3}{4}$. The particle is initially at rest and accelerates at 2 m s^{-2} .

(a) Find the time it takes for P to travel a distance of 1.44 m from its starting point. [2]

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(b) Find μ . [4]

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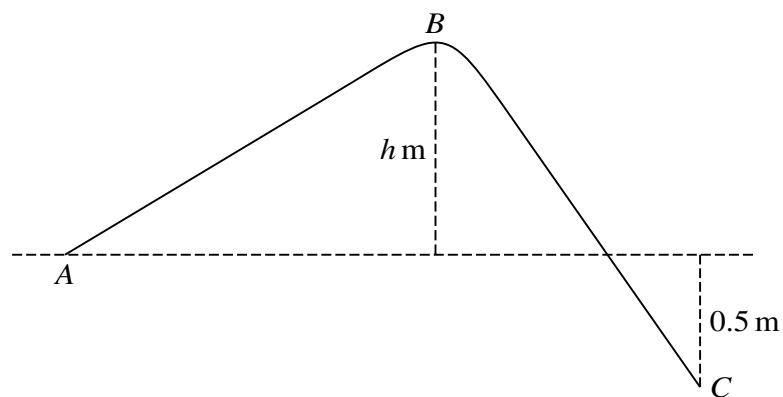
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The diagram shows the vertical cross-section of a surface. A , B and C are three points on the cross-section. The level of B is h m above the level of A . The level of C is 0.5 m below the level of A . A particle of mass 0.2 kg is projected up the slope from A with initial speed 5 m s^{-1} . The particle remains in contact with the surface as it travels from A to C .

- (a) Given that the particle reaches B with a speed of 3 m s^{-1} and that there is no resistance force, find h . [3]

[illegible]

- (b)** It is given instead that there is a resistance force and that the particle does 3.1 J of work against the resistance force as it travels from *A* to *C*.

Find the speed of the particle when it reaches C .

[3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 4 A cyclist travels along a straight road with constant acceleration. He passes through points A , B and C . The cyclist takes 2 seconds to travel along each of the sections AB and BC and passes through B with speed 4.5 m s^{-1} . The distance AB is $\frac{4}{5}$ of the distance BC .

(a) Find the acceleration of the cyclist.

[5]

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(b) Find AC .

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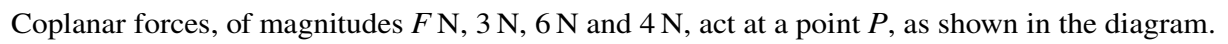
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- 6** On a straight horizontal test track, driverless vehicles (with no passengers) are being tested. A car of mass 1600 kg is towing a trailer of mass 700 kg along the track. The brakes are applied, resulting in a deceleration of 12 m s^{-2} . The braking force acts on the car only. In addition to the braking force there are constant resistance forces of 600 N on the car and of 200 N on the trailer.

(a) Find the magnitude of the force in the tow-bar. [2]

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(b) Find the braking force. [2]

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- (c) At the instant when the brakes are applied, the car has speed 22 m s^{-1} . At this instant the car is 17.5 m away from a stationary van, which is directly in front of the car.

Show that the car hits the van at a speed of 8 m s^{-1} . [2]

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- (d) After the collision, the van starts to move with speed 5 m s^{-1} and the car and trailer continue moving in the same direction with speed 2 m s^{-1} .

Find the mass of the van. [3]

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- 7 A particle moves in a straight line through the point O . The displacement of the particle from O at time t s is s m, where

$$s = t^2 - 3t + 2 \quad \text{for } 0 \leq t \leq 6,$$

$$s = \frac{24}{t} - \frac{t^2}{4} + 25 \quad \text{for } t \geq 6.$$

- (a) Find the value of t when the particle is instantaneously at rest during the first 6 seconds of its motion. [2]

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At $t = 6$, the particle hits a barrier at a point P and rebounds.

- (b) Find the velocity with which the particle arrives at P and also the velocity with which the particle leaves P . [3]

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