

Cambridge International AS & A Level

CANDIDATE
NAME

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MATHEMATICS

9709/43

Paper 4 Mechanics

May/June 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 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.

- 1 Particles P of mass 0.4 kg and Q of mass 0.5 kg are free to move on a smooth horizontal plane. P and Q are moving directly towards each other with speeds 2.5 m s^{-1} and 1.5 m s^{-1} respectively. After P and Q collide, the speed of Q is twice the speed of P .

Find the two possible values of the speed of P after the collision.

[4]

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- 2 A cyclist is travelling along a straight horizontal road. She is working at a constant rate of 150 W. At an instant when her speed is 4 m s^{-1} , her acceleration is 0.25 m s^{-2} . The resistance to motion is 20 N.

(a) Find the total mass of the cyclist and her bicycle. [3]

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The cyclist comes to a straight hill inclined at an angle θ above the horizontal. She ascends the hill at constant speed 3 m s^{-1} . She continues to work at the same rate as before and the resistance force is unchanged.

(b) Find the value of θ . [2]

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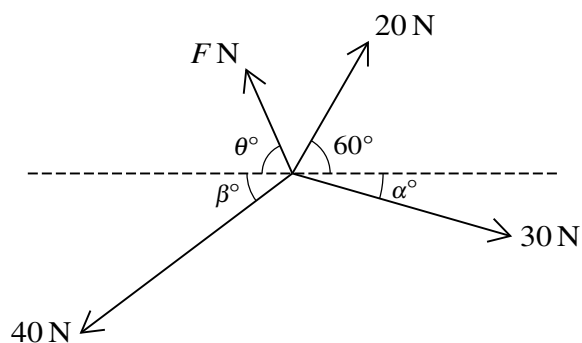
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Four coplanar forces act at a point. The magnitudes of the forces are 20 N, 30 N, 40 N and F N. The directions of the forces are as shown in the diagram, where $\sin \alpha^\circ = 0.28$ and $\sin \beta^\circ = 0.6$.

Given that the forces are in equilibrium, find F and θ . [6]

[illegible]

- 4 A particle is projected vertically upwards with speed $u \text{ m s}^{-1}$ from a point on horizontal ground. After 2 seconds, the height of the particle above the ground is 24 m.

(a) Show that $u = 22$. [2]

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- (b) The height of the particle above the ground is more than h m for a period of 3.6 s.

Find h . [4]

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- 5** A car of mass 1400 kg is towing a trailer of mass 500 kg down a straight hill inclined at an angle of 5° to the horizontal. The car and trailer are connected by a light rigid tow-bar. At the top of the hill the speed of the car and trailer is 20 m s^{-1} and at the bottom of the hill their speed is 30 m s^{-1} .
- (a)** It is given that as the car and trailer descend the hill, the engine of the car does 150 000 J of work, and there are no resistance forces.

Find the length of the hill.

[5]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** It is given instead that there is a resistance force of 100 N on the trailer, the length of the hill is 200 m, and the acceleration of the car and trailer is constant.

Find the tension in the tow-bar between the car and trailer.

[4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 6** A particle moves in a straight line and passes through the point A at time $t = 0$. The velocity of the particle at time t s after leaving A is $v \text{ m s}^{-1}$, where

$$v = 2t^2 - 5t + 3.$$

- (a)** Find the times at which the particle is instantaneously at rest. Hence or otherwise find the minimum velocity of the particle. [4]

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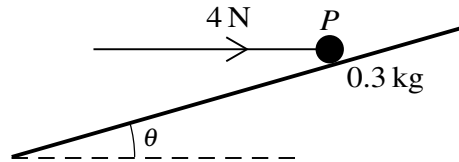
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- (b)** Sketch the velocity-time graph for the first 3 seconds of motion. [3]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

7



A particle P of mass 0.3 kg rests on a rough plane inclined at an angle θ to the horizontal, where $\sin \theta = \frac{7}{25}$. A horizontal force of magnitude 4 N , acting in the vertical plane containing a line of greatest slope of the plane, is applied to P (see diagram). The particle is on the point of sliding up the plane.

- (a) Show that the coefficient of friction between the particle and the plane is $\frac{3}{4}$. [4]

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The force acting horizontally is replaced by a force of magnitude 4 N acting up the plane parallel to a line of greatest slope.

- (b) Find the acceleration of P . [3]

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- (c) Starting with P at rest, the force of 4 N parallel to the plane acts for 3 seconds and is then removed.

Find the total distance travelled until P comes to instantaneous rest. [3]

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