

Cambridge International AS & A Level

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MATHEMATICS

9709/43

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 **16** pages. Any blank pages are indicated.

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- 1 A particle P is projected vertically upwards with speed $u \text{ m s}^{-1}$ from a point on the ground. P reaches its greatest height after 3 s.

(a) Find u . [1]

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(b) Find the greatest height of P above the ground. [2]

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- 2** A box of mass 5 kg is pulled at a constant speed of 1.8 m s^{-1} for 15 s up a rough plane inclined at an angle of 20° to the horizontal. The box moves along a line of greatest slope against a frictional force of 40 N. The force pulling the box is parallel to the line of greatest slope.

(a) Find the change in gravitational potential energy of the box. [2]

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(b) Find the work done by the pulling force. [2]

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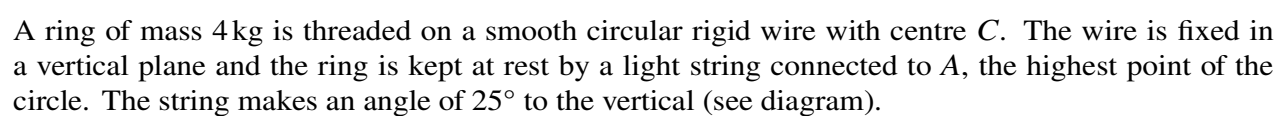
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This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, each set providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving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

- 4 A particle P travels in the positive direction along a straight line with constant acceleration. P travels a distance of 52 m during the 2nd second of its motion and a distance of 64 m during the 4th second of its motion.

(a) Find the initial speed and the acceleration of P .

[5]

[illegible]

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- (b) Find the distance travelled by P during the first 10 seconds of its motion. [2]

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- 5** Particles X and Y move in a straight line through points A and B . Particle X starts from rest at A and moves towards B . At the same instant, Y starts from rest at B .

At time t seconds after the particles start moving

- the acceleration of X in the direction AB is given by $(12t + 12) \text{ m s}^{-2}$,
- the acceleration of Y in the direction AB is given by $(24t - 8) \text{ m s}^{-2}$.

- (a)** It is given that the velocities of X and Y are equal when they collide.

Calculate the distance AB .

[6]

This image shows a single page 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.

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(b) It is given instead that $AB = 36$ m.

Verify that X and Y collide after 3 s.

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- 6** A car of mass 1750 kg is pulling a caravan of mass 500 kg. The car and the caravan are connected by a light rigid tow-bar. The resistances to the motion of the car and caravan are 650 N and 150 N respectively.

(a) The car and caravan are moving along a straight horizontal road at a constant speed of 24 m s^{-1} .

(i) Find the power of the car's engine. [2]

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(ii) The engine's power is now suddenly increased to 40 kW.

Find the instantaneous acceleration of the car and caravan and find the tension in the tow-bar. [5]

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- (b) The car and caravan now travel up a straight hill, inclined at an angle $\sin^{-1} 0.14$ to the horizontal, at a constant speed of $v \text{ m s}^{-1}$. The car's engine is working at 31 kW. The resistances to the motion of the car and caravan are unchanged.

Find v .

[3]

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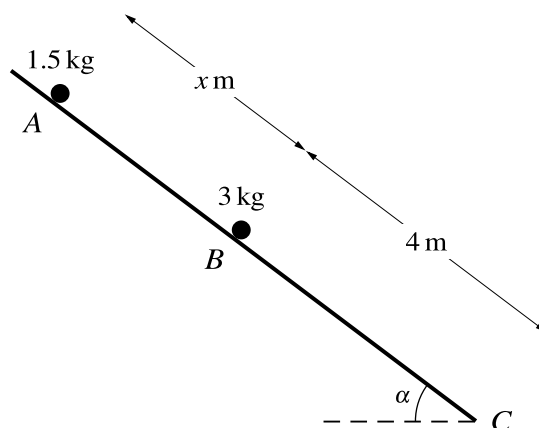
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Particles of masses 1.5 kg and 3 kg lie on a plane which is inclined at an angle of α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The section of the plane from A to B is smooth and the section of the plane from B to C is rough. The 1.5 kg particle is held at rest at A and the 3 kg particle is in limiting equilibrium at B . The distance AB is x m and the distance BC is 4 m (see diagram).

- (a) Show that the coefficient of friction between the particle at B and the plane is 0.75. [3]

[illegible]

The 1.5 kg particle is released from rest. In the subsequent motion the two particles collide and coalesce. The time taken for the combined particle to travel from B to C is 2 s. The coefficient of friction between the combined particle and the plane is still 0.75.

- (b) Find x . [6]

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- (c) Find the total loss of energy of the particles from the time the 1.5 kg particle is released until the combined particle reaches C . [3]

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