



Cambridge International AS & A Level

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MATHEMATICS**9709/41**

Paper 4 Mechanics

October/November 2024**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.
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- 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} .

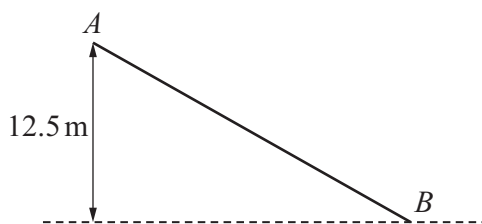
INFORMATION

- 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.



2



(a) Given that the plane is smooth, use an energy method to find the speed of the particle at B . [2]

[illegible]

- Find the value of F . [3]

[illegible]

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- 4 A bus travels between two stops, A and B . The bus starts from rest at A and accelerates at a constant rate of $a \text{ m s}^{-2}$ until it reaches a speed of 16 m s^{-1} . It then travels at this constant speed before decelerating at a constant rate of $0.75a \text{ m s}^{-2}$, coming to rest at B . The total time for the journey is 240 s .

(a) Sketch the velocity-time graph for the bus's journey from A to B .

[1]



- (b) Find an expression, in terms of a , for the length of time that the bus is travelling with constant speed. [2]

- (c) Given that the distance from A to B is 3000 m, find the value of a .

[3]

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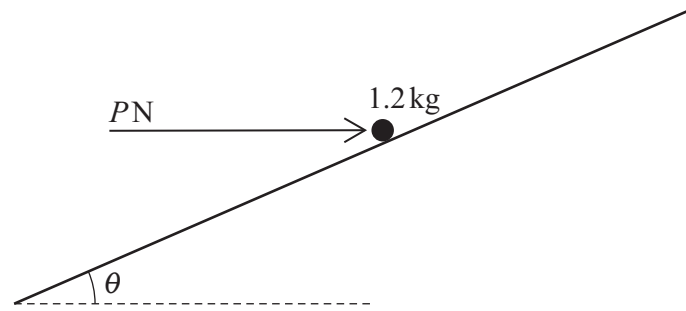
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[5]

This image shows a full page of white paper with horizontal dotted 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.



A particle of mass 1.2 kg is placed on a rough plane which is inclined at an angle θ to the horizontal, where $\sin \theta = \frac{7}{25}$. The particle is kept in equilibrium by a horizontal force of magnitude $P \text{ N}$ acting in a vertical plane containing a line of greatest slope (see diagram). The coefficient of friction between the particle and the plane is 0.15 .

Find the least possible value of P .

[6]

[illegible]

[illegible]



- 7 A car has mass 1200 kg. When the car is travelling at a speed of $v \text{ m s}^{-1}$, there is a resistive force of magnitude $k v \text{ N}$. The maximum power of the car's engine is 92.16 kW.

(a) The car travels along a straight level road.

- (i) The car has a greatest possible constant speed of 48 m s^{-1} .

Show that $k = 40$.

[1]

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- (ii) At an instant when its speed is 45 m s^{-1} , find the greatest possible acceleration of the car. [3]

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Find the greatest possible speed of the car going up the hill. [4]

[illegible]

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This image shows a full page of a document template designed for handwriting practice or general note-taking. It consists of approximately 28 evenly spaced horizontal dotted lines across the entire width of the page. The background is plain white, and there are no margins, headers, footers, or other markings present.

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[illegible]



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Cambridge International AS & A Level

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MATHEMATICS**9709/42**

Paper 4 Mechanics

October/November 2024**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.
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- 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} .

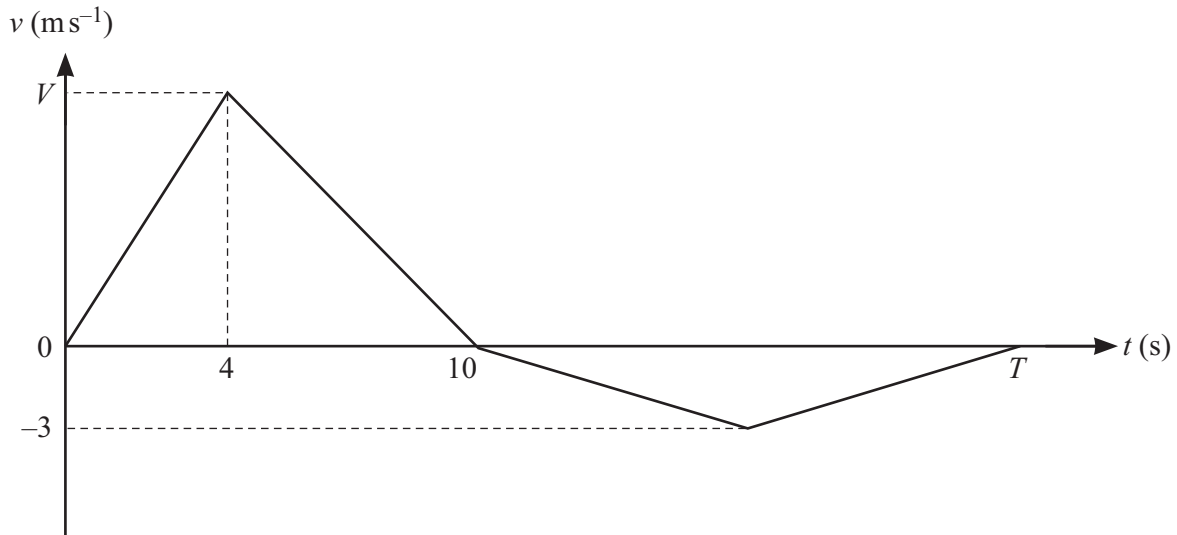
INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

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1



The velocity of a particle moving in a straight line at time t seconds after leaving a fixed point O is $v \text{ ms}^{-1}$. The diagram shows a velocity-time graph which models the motion of the particle from $t = 0$ to $t = T$. The graph consists of four straight line segments. The particle accelerates from rest to a speed of $V \text{ ms}^{-1}$ over a period of 4 s, and then decelerates at $\frac{5}{3} \text{ ms}^{-2}$ to instantaneous rest over a period of 6 s. The particle then travels back towards O , reaching a maximum speed of 3 ms^{-1} before coming to rest at time $t = T$.

- (a) Find the value of V . [2]

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- (b) Given that the total distance travelled by the particle from $t = 0$ to $t = T$ is 68 m, find the value of T . [3]

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- 3 A cyclist is riding along a straight horizontal road. The total mass of the cyclist and his bicycle is 90 kg. The power exerted by the cyclist is 250 W. At an instant when the cyclist's speed is 5 ms^{-1} , his acceleration is 0.1 ms^{-2} .

(a) Find the value of the constant resistance to motion acting on the cyclist. [3]

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The cyclist comes to the bottom of a hill inclined at 2° to the horizontal.

(b) Given that the power and resistance to motion are unchanged, find the steady speed which the cyclist could maintain when riding up the hill. [2]

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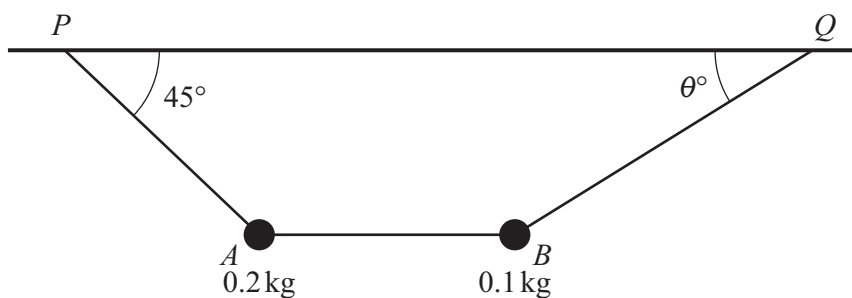
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4



The diagram shows two particles, A and B , of masses 0.2 kg and 0.1 kg respectively. The particles are suspended below a horizontal ceiling by two strings, AP and BQ , attached to fixed points P and Q on the ceiling. The particles are connected by a horizontal string, AB . Angle $APQ = 45^\circ$ and $BQP = \theta^\circ$. Each string is light and inextensible. The particles are in equilibrium.

- (a) Find the value of the tension in the string AB . [2]

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[4]

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- (a)** Find the speed of each particle immediately before they collide. [4]

This image shows a full page of white paper with horizontal dotted 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.



[5]

[illegible]



- 6 A particle, P , travels in a straight line, starting from a point O with velocity 6 m s^{-1} . The acceleration of P at time t s after leaving O is $a \text{ m s}^{-2}$, where

$$a = -1.5t^{\frac{1}{2}} \quad \text{for } 0 \leq t \leq 1,$$

$$a = 1.5t^{\frac{1}{2}} - 3t^{-\frac{1}{2}} \quad \text{for } t > 1.$$

- (a) Find the velocity of P at $t = 1$. [3]

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- (b) Given that there is no change in the velocity of P when $t = 1$, find an expression for the velocity of P for $t > 1$. [3]

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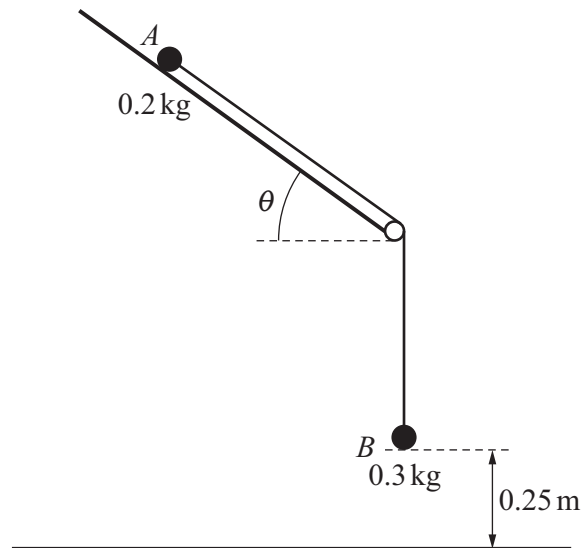
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This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.



Two particles, A and B , of masses 0.2 kg and 0.3 kg respectively, are attached to the ends of a light inextensible string. The string passes over a small fixed smooth pulley which is attached to the bottom of a rough plane inclined at an angle θ to the horizontal where $\sin \theta = 0.6$. Particle A lies on the plane, and particle B hangs vertically below the pulley, 0.25 m above horizontal ground. The string between A and the pulley is parallel to a line of greatest slope of the plane (see diagram). The coefficient of friction between A and the plane is 1.125 . Particle A is released from rest.

- (a) Find the tension in the string and the magnitude of the acceleration of the particles. [7]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook 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.



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(b) When B reaches the ground, it comes to rest.

Find the total distance that A travels down the plane from when it is released until it comes to rest.
You may assume that A does not reach the pulley. [4]

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Cambridge International AS & A Level

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MATHEMATICS**9709/43**

Paper 4 Mechanics

October/November 2024**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.
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INFORMATION

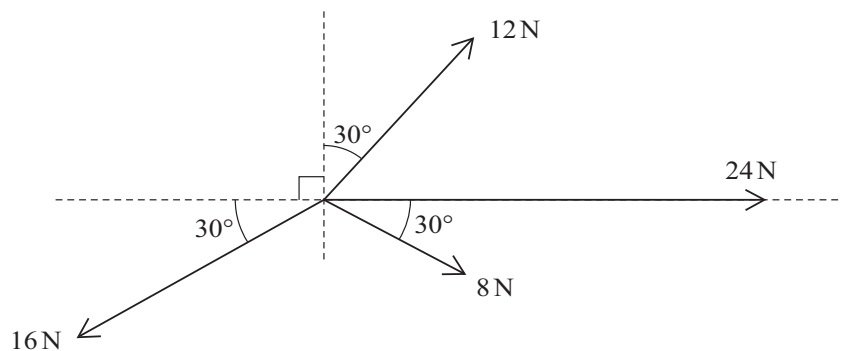
- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

This document has **12** pages. Any blank pages are indicated.



- Find the value of m .

[illegible]



Coplanar forces of magnitudes 16 N, 12 N, 24 N and 8 N act at a point in the directions shown in the diagram.

Find the magnitude and direction of the single additional force acting at the same point which will produce equilibrium. [6]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.



- 3 A car of mass 1600 kg travels up a slope inclined at an angle of $\sin^{-1} 0.08$ to the horizontal. There is a constant resistance of magnitude 240 N acting on the car.

- (a) It is given that the car travels at a constant speed of 32 m s^{-1} .

Find the power of the engine of the car.

[3]

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- (b) Find the acceleration of the car when its speed is 24 m s^{-1} and the engine is working at 95% of the power found in (a). [3]

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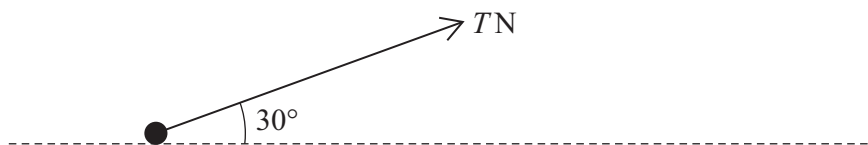
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A particle of mass 12 kg is going to be pulled across a rough horizontal plane by a light inextensible string. The string is at an angle of 30° above the plane and has tension $T\text{ N}$ (see diagram). The coefficient of friction between the particle and the plane is 0.5 .

- (a) Given that the particle is on the point of moving, find the value of T . [5]

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- (b) Given instead that the particle is accelerating at 0.2 m s^{-2} , find the value of T . [3]

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- 6 A particle moves in a straight line. It starts from rest, at time $t = 0$, and accelerates at $0.6t \text{ m s}^{-2}$ for 4 s, reaching a speed of $V \text{ m s}^{-1}$. The particle then travels at $V \text{ m s}^{-1}$ for 11 s, and finally slows down, with constant deceleration, stopping after a further 5 s.

(a) Show that $V = 4.8$. [1]

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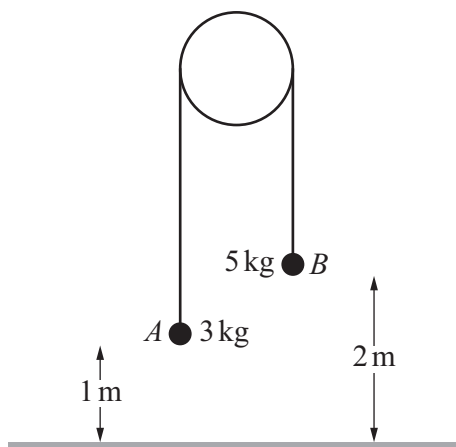
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(b) Sketch a velocity-time graph for the motion. [3]





Two particles, A and B , of masses 3 kg and 5 kg respectively, are connected by a light inextensible string that passes over a fixed smooth pulley. The particles are held with the string taut and its straight parts vertical. Particle A is 1 m above a horizontal plane, and particle B is 2 m above the plane (see diagram).

The particles are released from rest. In the subsequent motion, A does not reach the pulley, and after B reaches the plane it remains in contact with the plane.

- (a) Find the tension in the string and the time taken for B to reach the plane. [6]

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(b) Find the time for which A is at least 3.25 m above the plane. [4]



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