



Cambridge International AS & A Level

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MATHEMATICS

9709/41

Paper 4 Mechanics

May/June 2025

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.
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- Do **not** write on any bar codes.
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- 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.

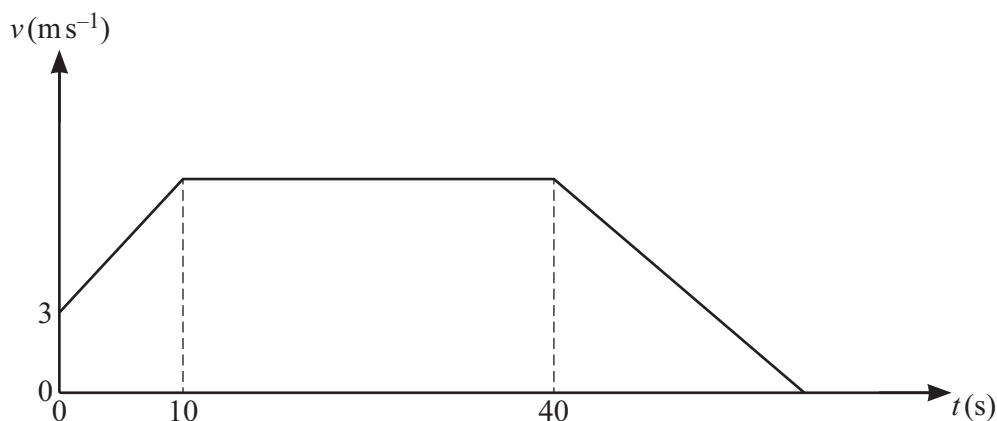
- Find the tension in the rope.

[illegible]



Find the value of P and the value of Q . [4]

This image shows a full page of a notebook or worksheet template. It consists of approximately 20 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for handwriting practice. The background is plain white, and there are no margins, titles, or other markings present.



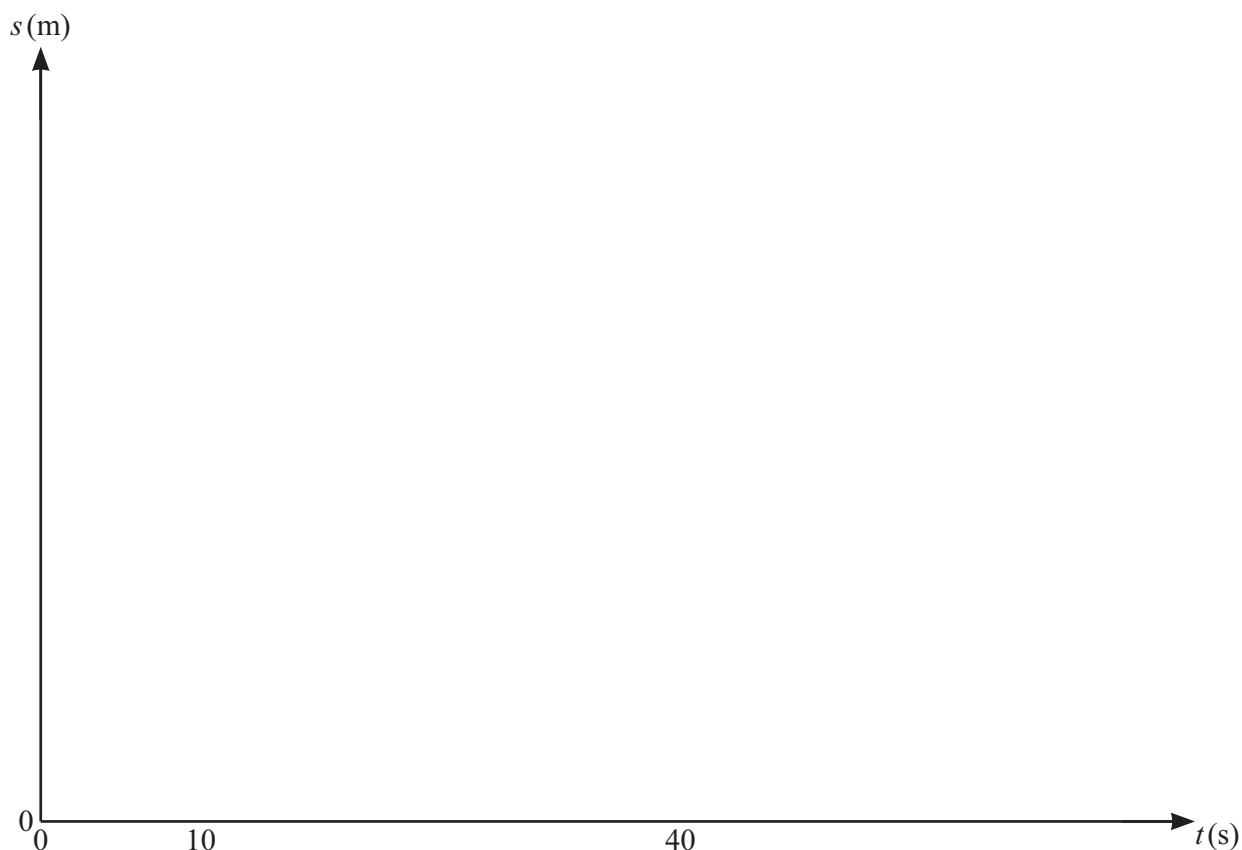
(a) Find the total time taken for the journey from O to P .

[3]

[illegible]



- (b) On the given axes, sketch a displacement-time graph for the cyclist's journey from O to P , showing on your graph the distances travelled after 10 s and 40 s. [4]



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4 A lorry of mass 18 000 kg is travelling along a straight road.

(a) On a horizontal section of the road, the power of the lorry's engine is constant. There is a constant resistance to motion of 1600 N.

(i) The steady speed which the lorry can maintain with the engine working at power PW is 30 m s^{-1} .

Find the value of P . [1]

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(ii) At an instant when the speed of the lorry is 16 m s^{-1} , its engine is working at a power of 40 kW.

Find the acceleration of the lorry at this instant. [2]

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(b) When the lorry has reached a speed of 20 m s^{-1} , it begins to ascend a section of road inclined at an angle α° to the horizontal. The engine now works at a power of 120 kW. There is no change in the lorry's speed as it ascends the hill. The constant resistance to motion remains 1600 N.

Find the value of α . [3]

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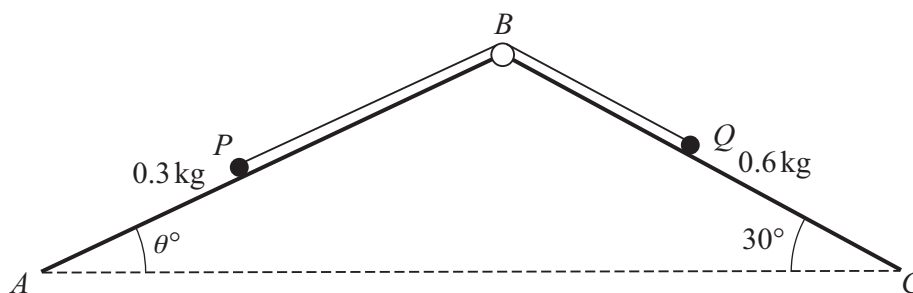


- (a) Find the value of m and the value of u . [3]

[illegible]

(b) Find the value of v and the value of w . [4]

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. There are no margins, text, or other markings on the paper.



(a) It is given that the plane BC is smooth.

[5]

[illegible]

- Use an energy method to find the speed of Q when it has moved 2 m down the plane. [4]

[illegible]

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- This image shows a full page of primary-ruled paper. It features approximately 20 horizontal dotted lines spaced evenly down the page, providing a guide for handwriting practice. The paper is otherwise blank, with no margins, text, or other markings.



(b) When the velocity of Y is -9.6 ms^{-1} , show that the displacement of X from O is equal to the displacement of Y from P . [7]

[illegible]

[illegible]

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MATHEMATICS**9709/42**

Paper 4 Mechanics

May/June 2025**1 hour 15 minutes**

You must answer on the question paper.

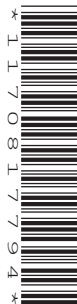
You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
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INFORMATION

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This document has **16** pages. Any blank pages are indicated.



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- 1 A crate is being pushed in a straight line along a horizontal surface by a force of magnitude 25 N inclined at 20° above the horizontal. The crate moves a distance of 12 m in 8 seconds with constant speed.

(a) Find the constant speed of the crate. [1]

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(b) Find the work done by the 25 N force. [2]

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(c) Find the power at which the 25 N force is working. [1]

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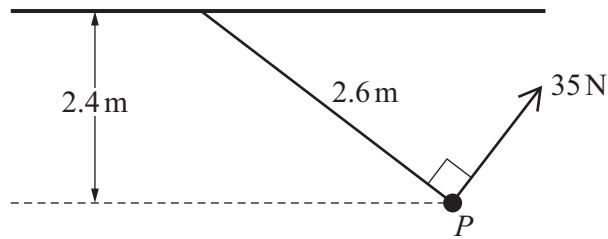


- 2 Two particles P and Q , of masses 0.2 kg and 0.1 kg respectively, are free to move in a straight line on a smooth horizontal plane. P is projected towards Q with speed 5 ms^{-1} . At the same instant, Q is projected away from P with speed 2 ms^{-1} . When P collides with Q , the particles coalesce.

Find the kinetic energy lost during the collision.

[4]

[illegible]



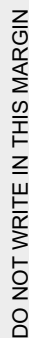
A particle P of mass m kg is attached to one end of a light inextensible string of length 2.6 m. The other end of the string is attached to a fixed point on a horizontal ceiling, and the string is taut. The particle is held in equilibrium by a force of magnitude 35 N, acting in a vertical plane which is perpendicular to the ceiling and contains the string. The force acts in a direction perpendicular to the string (see diagram). The tension in the string is T N and the vertical distance of P from the ceiling is 2.4 m.

Find, in either order, the value of m and the value of T . [4]

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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The car continues its journey from *B*, decelerating uniformly at 0.5 m s^{-2} until it comes to rest at a point *C* on the road.

(c) Find the total distance from *A* to *C*. [3]

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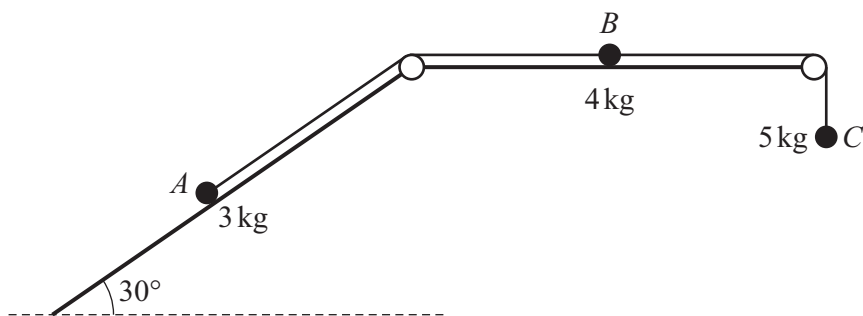
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One end of a light inextensible string is attached to a particle A of mass 3 kg . The other end of the string is attached to a particle B of mass 4 kg . Particle A is in contact with a rough plane inclined at 30° to the horizontal, and particle B is in contact with a smooth horizontal plane. A second light inextensible string is attached to B . The other end of this second string is attached to a particle C of mass 5 kg which hangs vertically.

Both strings are taut and pass over small smooth pulleys that are fixed at the ends of the horizontal plane. The part of the string from A to the pulley is parallel to a line of greatest slope of the inclined plane, and A , B and C are in the same vertical plane (see diagram).

The system is released from rest. In the subsequent motion, C moves vertically downwards with acceleration 2 ms^{-2} , and neither A nor B reach a pulley.

- (a) Find the tensions in each of the strings. [3]

[illegible]



[4]

[illegible]

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(b) Find the distance of P from A at the instant when P is moving at this maximum velocity. [4]

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- Using an energy method throughout, find the speed of P at the instant it returns to A . [6]

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Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.

[illegible]







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MATHEMATICS**9709/43**

Paper 4 Mechanics

May/June 2025**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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- 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.
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This document has **12** pages.



- 1 Two particles P and Q , of masses 0.1 kg and 0.3 kg respectively, are at rest on a smooth horizontal plane. P is projected directly towards Q with speed $4u \text{ ms}^{-1}$. At the same instant, Q is projected directly towards P with speed $u \text{ ms}^{-1}$. After P and Q collide, P moves with speed 2 ms^{-1} and Q moves with speed 4 ms^{-1} .

(a) Find the two possible values of u .

[3]

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(b) Find the largest possible loss of kinetic energy in the collision.

[2]

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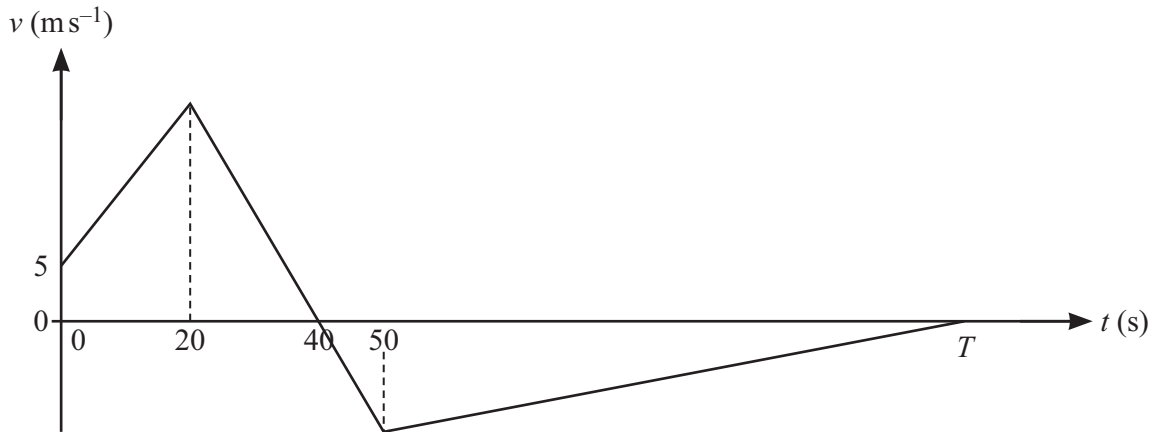




- Find the value of X and the value of T . [4]

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The diagram shows a velocity-time graph which models the motion of a particle. The graph consists of 3 straight line segments. The velocity of the particle at time t s after passing a fixed point O is $v \text{ ms}^{-1}$. The particle leaves O with a velocity of 5 ms^{-1} and accelerates at 0.75 ms^{-2} for 20 s. The particle then decelerates for the next 30 s. At $t = 40$, the velocity of the particle is zero. After $t = 40$, the particle starts to travel back to O , coming to rest at O at time T s.

(a) Find the value of T .

[5]

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(b) Find the acceleration of the particle from $t = 50$ to $t = T$.

[2]

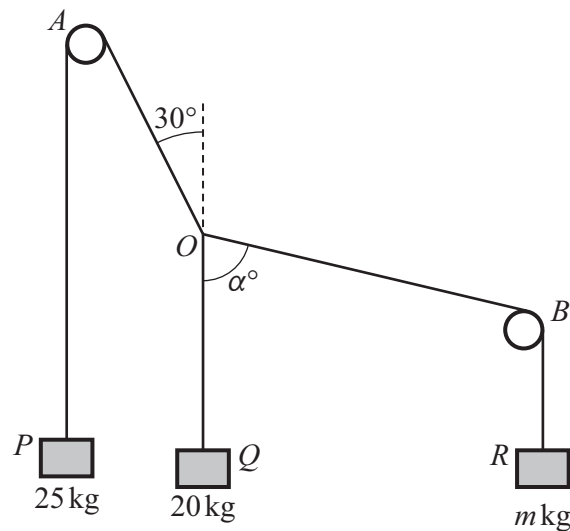
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Three blocks P , Q and R , of masses 25 kg, 20 kg and m kg respectively, are held in equilibrium by three light inextensible strings OP , OQ and OR . The strings OP and OR both pass over small fixed smooth pulleys A and B respectively, with P and R hanging vertically below the pulleys. The block Q hangs vertically below the point O . The angle between OA and the vertical is 30° and the angle $BOQ = \alpha^\circ$ (see diagram).

Find the value of m and the value of α .

[6]

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- Show that $k = 0.5$, and find the acceleration of the van when its speed is 25 ms^{-1} on this straight horizontal road. [4]

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(b) Find the value of a and the value of θ . [5]

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It is given that there is no change in the speed of the man when passing through B and that his speed at C is 11 ms^{-1} .

- (b)** Find the work done against the resistance force as the man moves from B to C . [4]

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[illegible]



[4]

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[illegible]

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MATHEMATICS**9709/45**

Paper 4 Mechanics

May/June 2025**1 hour 15 minutes**

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- Find the work done by the pulling force.

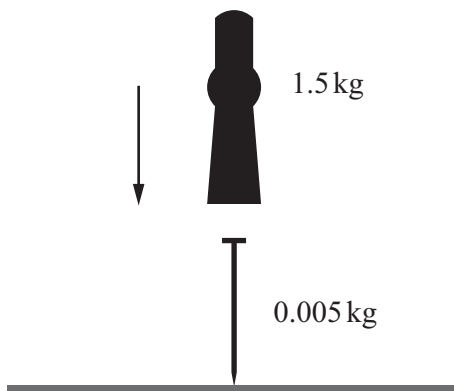
[4]

[illegible]



2

4



A machine for driving a nail into a block of wood causes a hammerhead to drop vertically onto the top of the nail. The mass of the hammerhead is 1.5 kg and the mass of the nail is 0.005 kg (see diagram). The hammerhead hits the nail with speed 32 m s^{-1} and remains in contact with the nail after the impact.

- (a) Calculate the speed with which the combined hammerhead and nail move immediately after the impact. Give your answer correct to 3 decimal places. [2]

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There is a constant force resisting the motion of magnitude 25 000 N.

- (b) Calculate the distance the nail is driven into the wood. [3]

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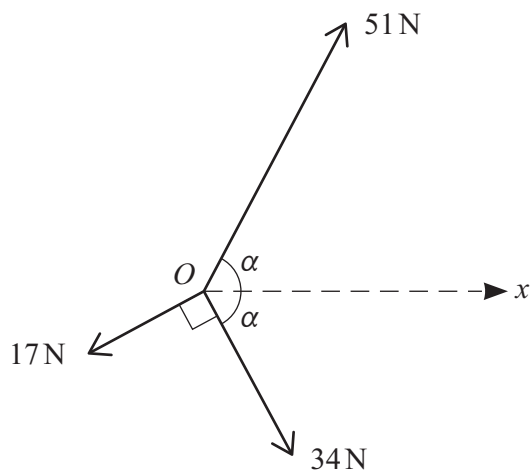
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- Find the value of T and hence find the distance moved by the train while travelling at the constant speed of 30 ms^{-1} . [5]

[illegible]



Coplanar forces of magnitudes 17 N, 51 N and 34 N act at a point O in the directions shown in the diagram, where $\tan \alpha = \frac{15}{8}$.

- (a) Find the magnitude and direction of the resultant of the three forces. [6]

[illegible]



The force of magnitude 51 N is replaced by a force of magnitude P N acting in the same direction. The resultant of the three forces now acts in the positive x -direction.

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- (a) It is given that there is a constant resistance to motion. The engine of the car is working at 24 kW while the car is travelling at a constant speed of 32 m s^{-1} . The power is now increased to 28 kW.

Find the acceleration of the car at the instant it is travelling at a speed of 36 ms^{-1} . [4]

[illegible]

Find this constant speed.

[3]



- 6 A particle P moves in a straight line starting from a point O . At time t s after leaving O , the velocity, $v \text{ m s}^{-1}$, of P is given by $v = (15 - 2t)^2$.

- (a) Find the values of t when the velocity of P is 100 m s^{-1} . [2]

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- (b) Show that there is a particular value of t for which the velocity and acceleration of the particle are both zero. [3]

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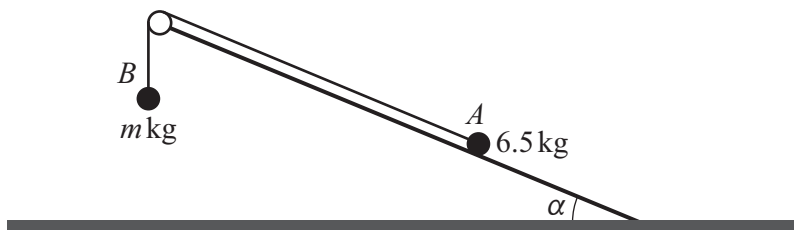
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[illegible]



(a) Given that the system is in equilibrium, find the set of possible values of m . [7]

[illegible]



Use an energy method to find the speed of the particles when each particle has moved 0.6 m. You may assume that this occurs before A reaches the pulley or B reaches the ground. [5]

[illegible]

[illegible]





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