



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.
- 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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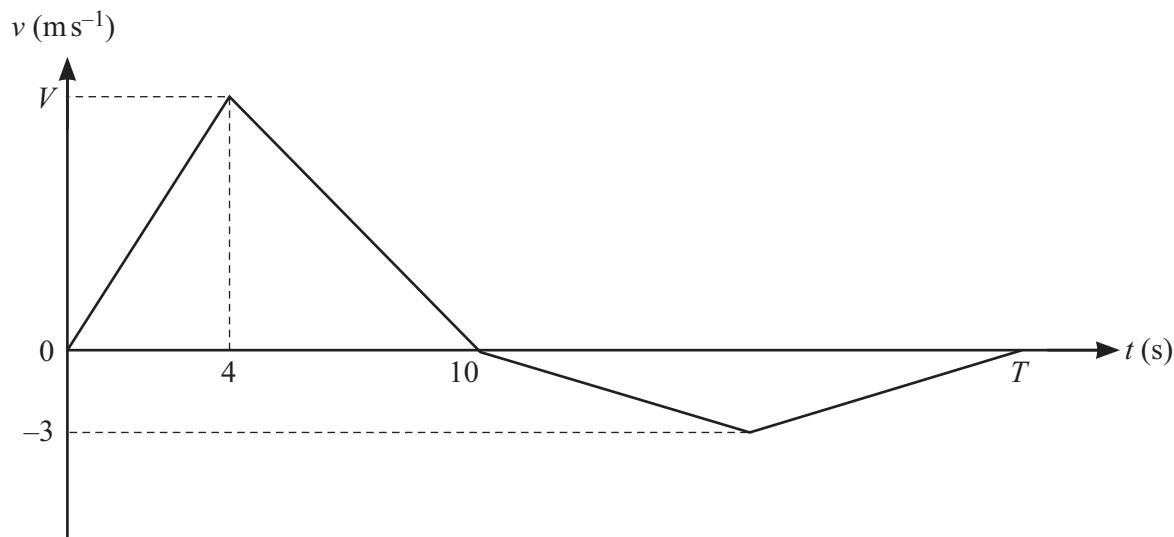


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The velocity of a particle moving in a straight line at time t seconds after leaving a fixed point O is $v \text{ ms}^{-1}$. The diagram shows a velocity-time graph which models the motion of the particle from $t = 0$ to $t = T$. The graph consists 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]

.....
.....
.....

(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]





2 A block of mass 20 kg is held at rest at the top of a plane inclined at 30° to the horizontal. The block is projected with speed 5 m s^{-1} down a line of greatest slope of the plane. There is a resistance force acting on the block. As the block moves 2 m down the plane from its point of projection, the work done against this resistance force is 50 J.

Find the speed of the block when it has moved 2 m down the plane.

[4]





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

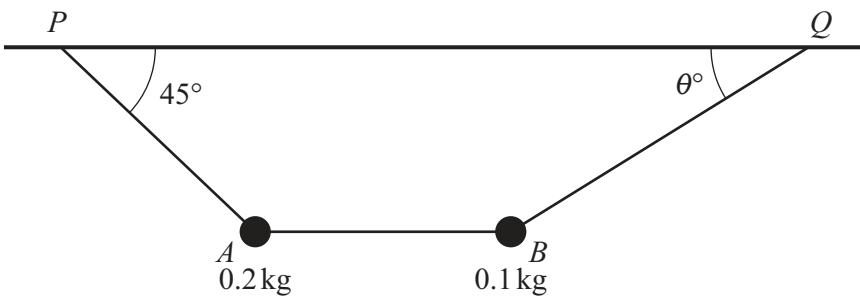
(a) Find the value of the constant resistance to motion acting on the cyclist.

[3]

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]





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]





(b) Find the value of θ and the tension in the string BQ .

[4]





5 Two particles, P and Q , of masses 2 kg and $m\text{ kg}$ respectively, are held at rest in the same vertical line. The heights of P and Q above horizontal ground are 1 m and 2 m respectively. P is projected vertically upwards with speed 2 m s^{-1} . At the same instant, Q is released from rest.

(a) Find the speed of each particle immediately before they collide.

[4]





(b) It is given that immediately after the collision the downward speed of Q is 3.5 m s^{-1} .

Find the speed of P at the instant that it reaches the ground.

[5]





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

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

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

(a) Find the velocity of P at $t = 1$.

[3]

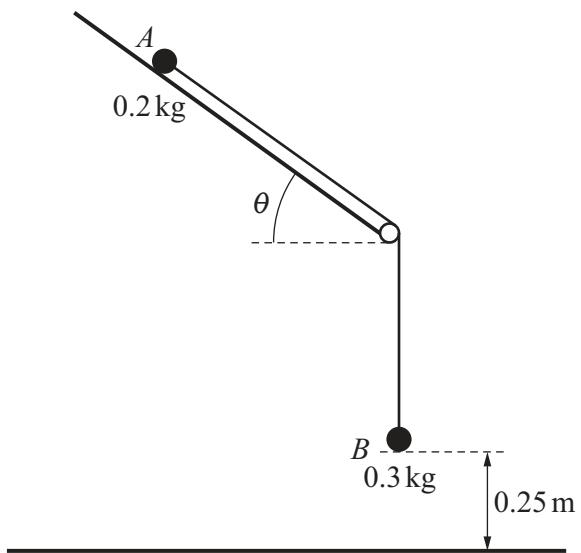
(b) Given that there is no change in the velocity of P when $t = 1$, find an expression for the velocity of P for $t > 1$. [3]

[3]



(c) Given that the velocity of P is positive for $t \leq 4$, find the total distance travelled between $t = 0$ and $t = 4$. [4]





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]





Additional page

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

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