



# Cambridge International AS & A Level

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## MATHEMATICS

9709/45

Paper 4 Mechanics

May/June 2026

1 hour 15 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

### INSTRUCTIONS

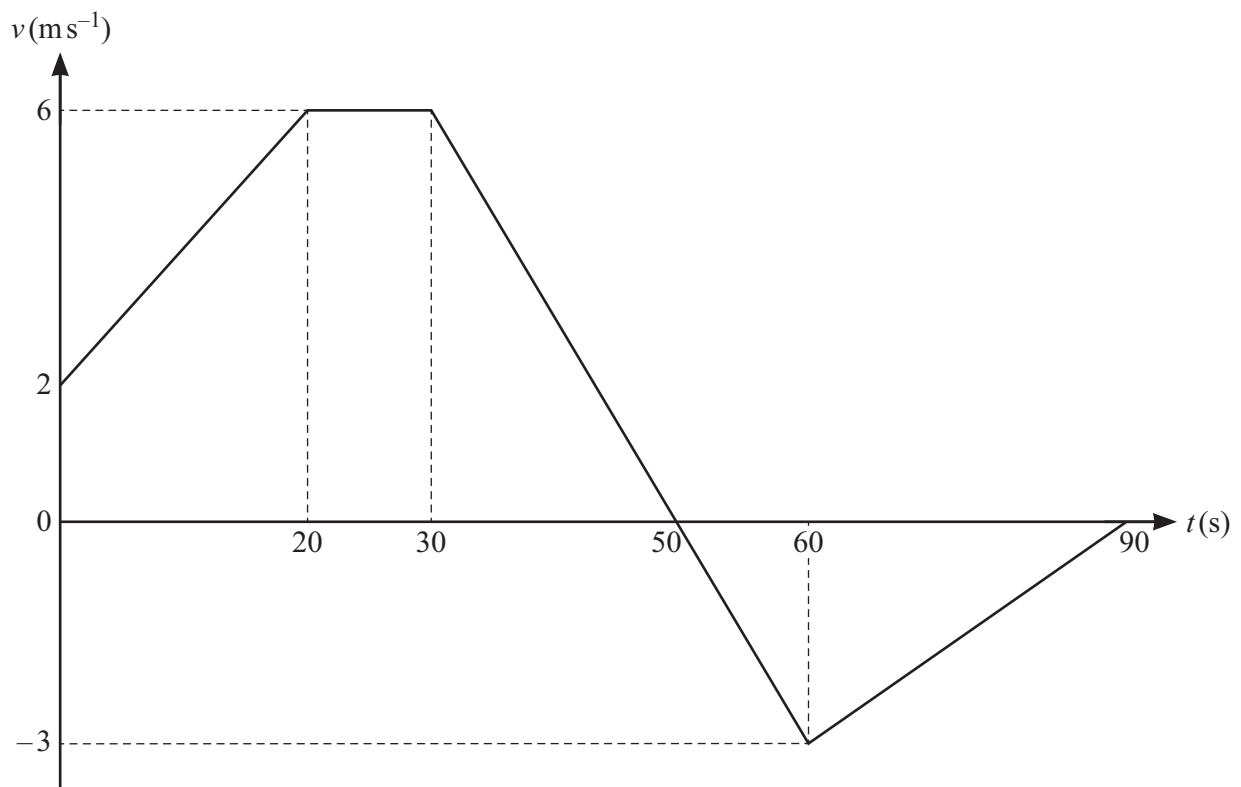
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- 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  $10 \text{ m s}^{-2}$ .

### 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



The diagram shows the velocity-time graph of the motion of an athlete who is running in a straight line. The athlete's velocity  $t$  seconds after passing a fixed point  $O$  is  $v \text{ m s}^{-1}$ . The graph consists of 4 straight line segments. The athlete is at point  $P$  at time  $t = 90$ .

- (a) Find the distance  $OP$ . [2]

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- (b) Find the total distance which the athlete runs in the 90s after passing  $O$ . [1]

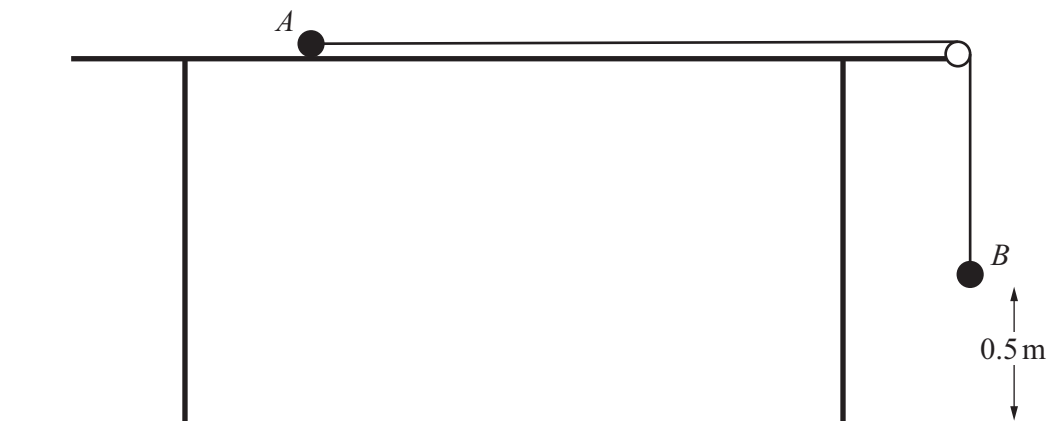
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A particle  $A$  of mass  $0.6\text{ kg}$  rests on a smooth horizontal table and is attached to one end of a light inextensible string. The string passes over a small smooth pulley fixed at the edge of the table. The other end of the string is attached to a particle  $B$  of mass  $0.4\text{ kg}$  which hangs freely below the pulley. The system is released from rest with the string taut and with  $B$  at a height of  $0.5\text{ m}$  above horizontal ground (see diagram).

- (a) Find the tension in the string and the magnitude of the acceleration of  $B$ . [4]

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- (b) Find the time that it takes for  $B$  to reach the ground after the system is released. You should assume that  $A$  does not reach the pulley before  $B$  reaches the ground. [2]

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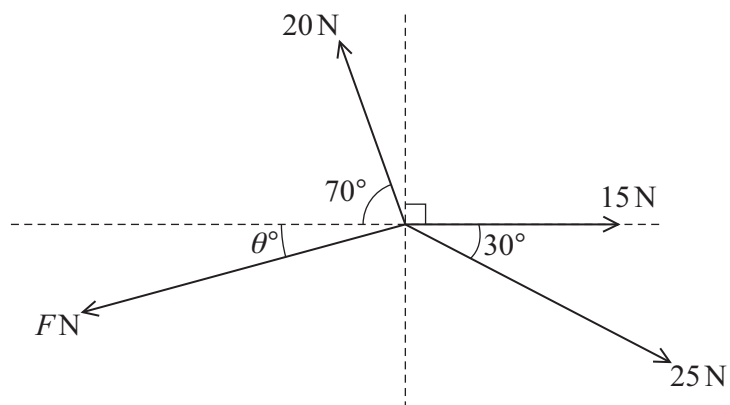
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Four coplanar forces of magnitudes 20 N, 15 N, 25 N and  $F$  N act at a point in the directions shown in the diagram.

Given that the four forces are in equilibrium, find the value of  $F$  and the value of  $\theta$ . [6]

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.

- 4 A car of mass 1200 kg is travelling along a straight horizontal road. There is a constant resistance force of magnitude  $R$  N acting on the car. Points  $A$ ,  $B$  and  $C$  are on the road in that order.

- (a) The car takes 70 s to travel from  $A$  to  $B$  at constant speed. The distance  $AB$  is 1400 m. The power produced by the car's engine is 15 kW.

Find the value of  $R$ .

[3]

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- (b) At  $B$ , the power produced by the car's engine is increased to 25 kW. The car travels a distance of 500 m from  $B$  to  $C$ . The speed of the car at  $C$  is  $40 \text{ ms}^{-1}$  and the value of  $R$  is unchanged.

Find the time that the car takes to travel from  $B$  to  $C$ .

[4]

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- 5 A particle moves in a straight line through two points  $O$  and  $A$ . The particle starts from  $A$  and initially moves away from  $O$ . The velocity of the particle  $t$  seconds after leaving  $A$  is  $v \text{ m s}^{-1}$ , where  $v = 6t - t^{\frac{3}{2}}$ .

**(a)** Given that the particle is 700 m from  $O$  when  $t = 25$ , find the distance  $OA$ .

[4]

This image shows a full page of a worksheet designed for handwriting practice. It consists of multiple rows of horizontal dashed lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

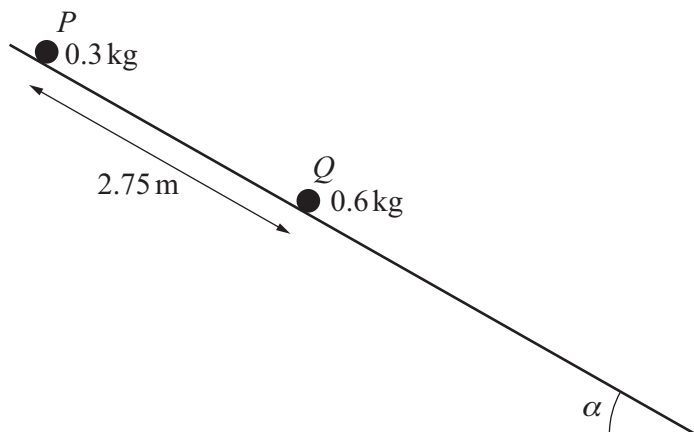


- (b)** Given that  $t > 0$ , find the distance travelled by the particle between the time at which its acceleration is zero and the time at which its velocity is zero.

[6]

[illegible]

6



Particles  $P$  and  $Q$  have masses  $0.3 \text{ kg}$  and  $0.6 \text{ kg}$  respectively. The particles are held at rest at a distance of  $2.75 \text{ m}$  apart on a line of greatest slope of a rough plane inclined at angle  $\alpha$  to the horizontal, where  $\sin \alpha = 0.28$  (see diagram). The coefficient of friction between each particle and the plane is  $0.5$ .

Particles  $P$  and  $Q$  are then released.

- (a) Show that neither particle moves. [3]

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Particle  $P$  is now projected directly towards  $Q$  with speed  $6 \text{ m s}^{-1}$ .

- (b) Find the speed of  $P$  immediately before it collides with  $Q$ . [4]

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- (c) Immediately after the collision,  $P$  begins to move with speed  $1 \text{ m s}^{-1}$  up the plane.

Find the distance between the two particles when they both come to rest after the collision. [5]





- 7 A cyclist travels along a straight horizontal road with constant acceleration  $a \text{ ms}^{-2}$ . She passes through points  $A, B, C$  and  $D$ . The distances  $AB$  and  $CD$  are 50 m and 100 m respectively. The times that she takes to travel from  $A$  to  $B$ , from  $B$  to  $C$  and from  $C$  to  $D$  are all 10 s.

Find, in either order, the value of  $a$  and the increase in the speed of the cyclist between  $A$  and  $D$ . [6]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dotted lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.



9709/45/M/J/26



[illegible]

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