

Cambridge International AS & A Level

CANDIDATE
NAME

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MATHEMATICS

9709/43

Paper 4 Mechanics

May/June 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.

- 1 Two particles P and Q , of masses 0.3 kg and 0.2 kg respectively, are at rest on a smooth horizontal plane. P is projected at a speed of 4 m s^{-1} directly towards Q . After P and Q collide, Q begins to move with a speed of 3 m s^{-1} .

(a) Find the speed of P after the collision.

[2]

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After the collision, Q moves directly towards a third particle R , of mass $m\text{ kg}$, which is at rest on the plane. The two particles Q and R coalesce on impact and move with a speed of 2 m s^{-1} .

(b) Find m .

[2]

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- 2 A particle P is projected vertically upwards from horizontal ground. P reaches a maximum height of 45 m. After reaching the ground, P comes to rest without rebounding.

(a) Find the speed at which P was projected. [2]

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(b) Find the total time for which the speed of P is at least 10 m s^{-1} . [3]

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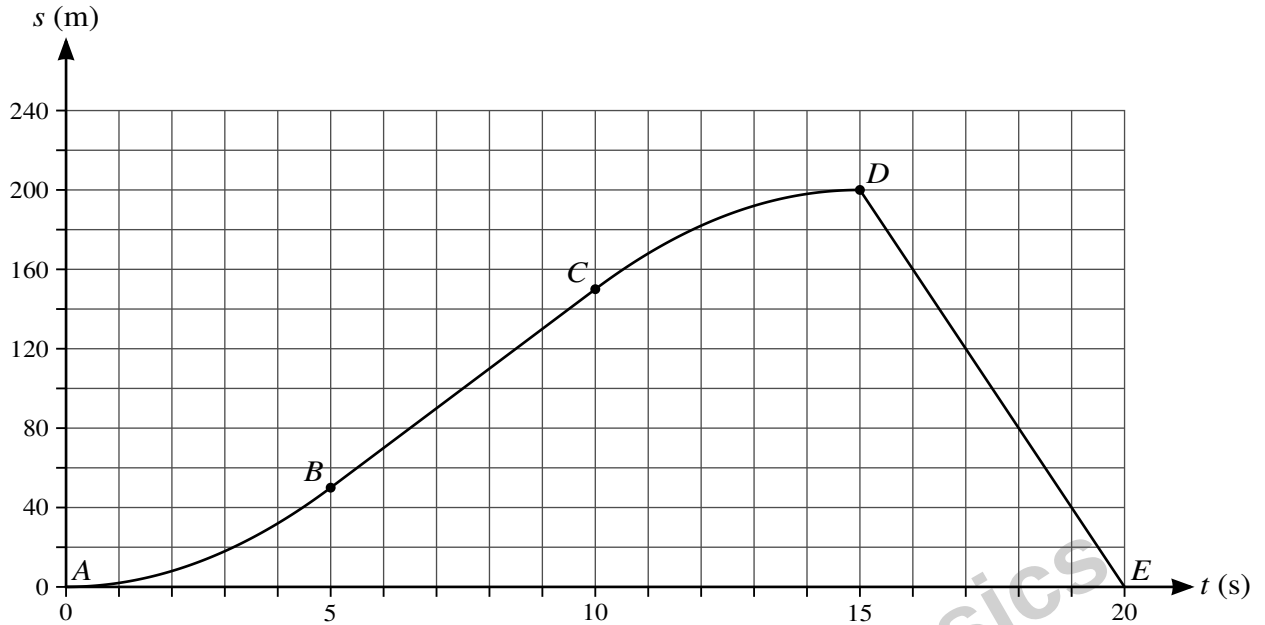
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The displacement of a particle moving in a straight line is s metres at time t seconds after leaving a fixed point O . The particle starts from rest and passes through points P , Q and R , at times $t = 5$, $t = 10$ and $t = 15$ respectively, and returns to O at time $t = 20$. The distances OP , OQ and OR are 50 m, 150 m and 200 m respectively.

The diagram shows a displacement-time graph which models the motion of the particle from $t = 0$ to $t = 20$. The graph consists of two curved segments AB and CD and two straight line segments BC and DE .

- (a) Find the speed of the particle between $t = 5$ and $t = 10$.

[1]

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- (b) Find the acceleration of the particle between $t = 0$ and $t = 5$, given that it is constant. [2]

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- (c) Find the average speed of the particle during its motion. [2]

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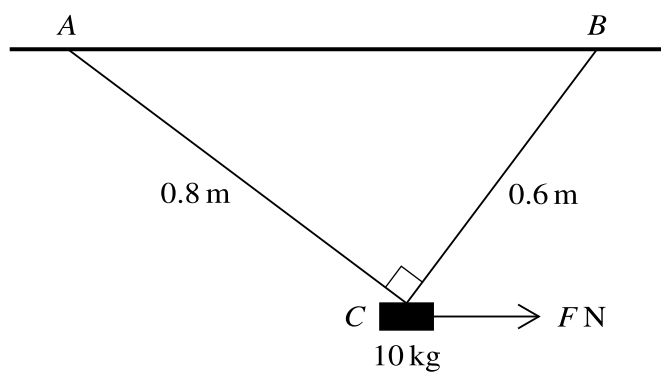
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The diagram shows a block of mass 10 kg suspended below a horizontal ceiling by two strings AC and BC , of lengths 0.8 m and 0.6 m respectively, attached to fixed points on the ceiling. Angle $ACB = 90^\circ$. There is a horizontal force of magnitude $F\text{ N}$ acting on the block. The block is in equilibrium.

- (a) In the case where $F = 20$, find the tensions in each of the strings. [5]

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- (a) Find the power developed by the cyclist.

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The cyclist comes to the top of a hill inclined at 5° to the horizontal. The cyclist stops pedalling and freewheels down the hill (so that the cyclist is no longer supplying any power). The magnitude of the resistance force remains at 30 N . Over a distance of $d\text{ m}$, the speed of the cyclist increases from 6 m s^{-1} to 12 m s^{-1} .

- (b) Find the change in kinetic energy. [2]

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- (c) Use an energy method to find d . [3]

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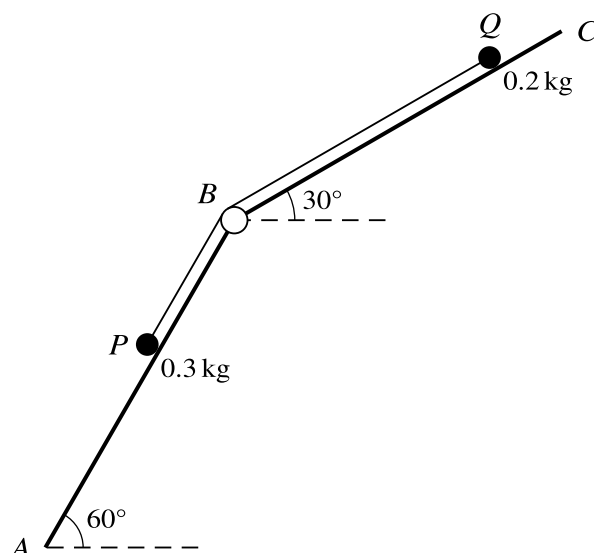
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Two particles P and Q , of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley at B which is attached to two inclined planes. P lies on a smooth plane AB which is inclined at 60° to the horizontal. Q lies on a plane BC which is inclined at 30° to the horizontal. The string is taut and the particles can move on lines of greatest slope of the two planes (see diagram).

- (a) It is given that the plane BC is smooth and that the particles are released from rest.

Find the tension in the string and the magnitude of the acceleration of the particles. [5]

[illegible]

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- (b) It is given instead that the plane BC is rough. A force of magnitude 3 N is applied to Q directly up the plane along a line of greatest slope of the plane.

Find the least value of the coefficient of friction between Q and the plane BC for which the particles remain at rest. [5]

- where b and c are positive constants. At $t = 5$, the velocity of P is zero and its acceleration is $-\frac{13}{12} \text{ m s}^{-2}$.

(a) Show that $b = 9$ and find the value of c . [5]

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