

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 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]

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

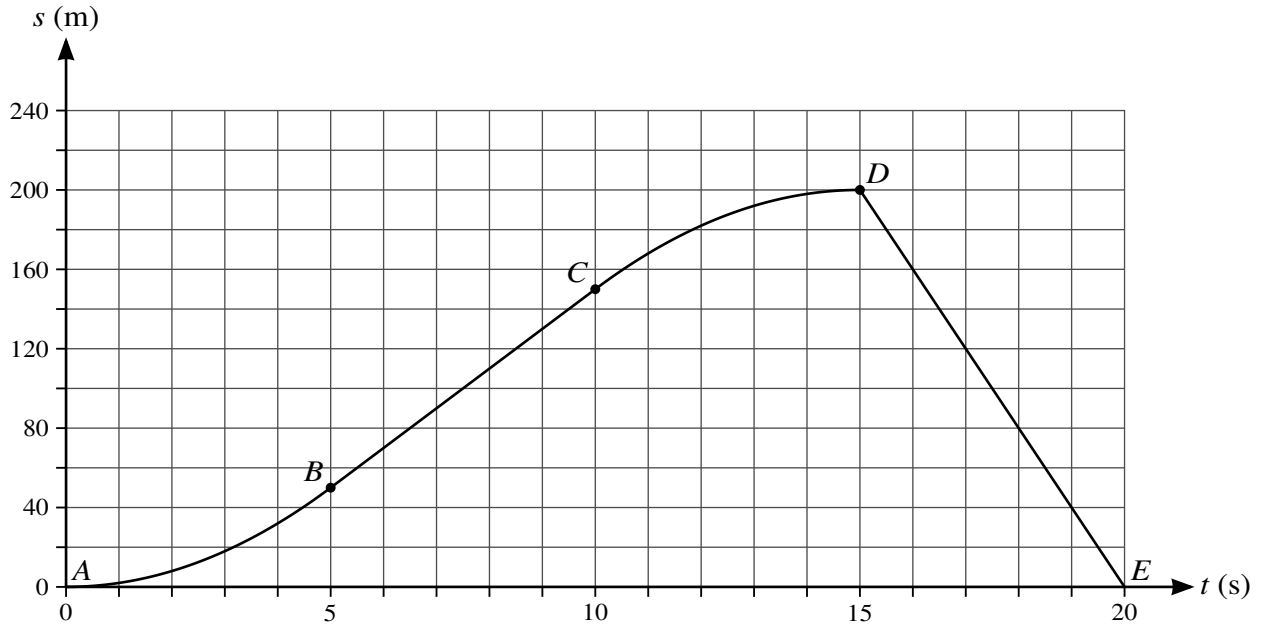
.....

.....

.....

.....

3



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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

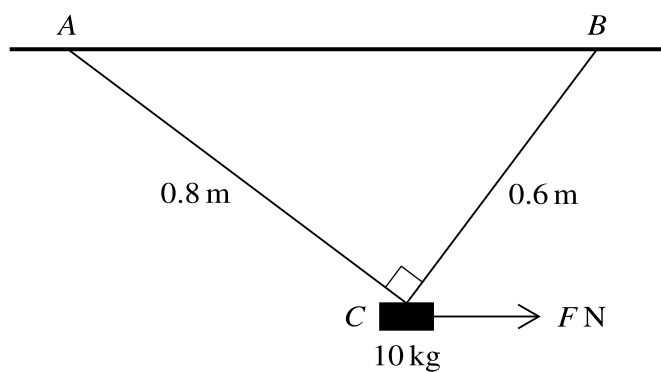
.....

.....

.....

.....

.....



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]

This image shows a full page of a document template designed for handwritten notes or essays. It features approximately 28 evenly spaced horizontal grey lines across the entire page, providing a guide for writing. The margins are consistent on all sides, and there are no pre-printed headers, footers, or other markings on the page.

[illegible]

- 5** A cyclist is riding along a straight horizontal road. The total mass of the cyclist and her bicycle is 70 kg. At an instant when the cyclist's speed is 4 m s^{-1} , her acceleration is 0.3 m s^{-2} . There is a constant resistance to motion of magnitude 30 N.

(a) Find the power developed by the cyclist.

[3]

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.

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 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]

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

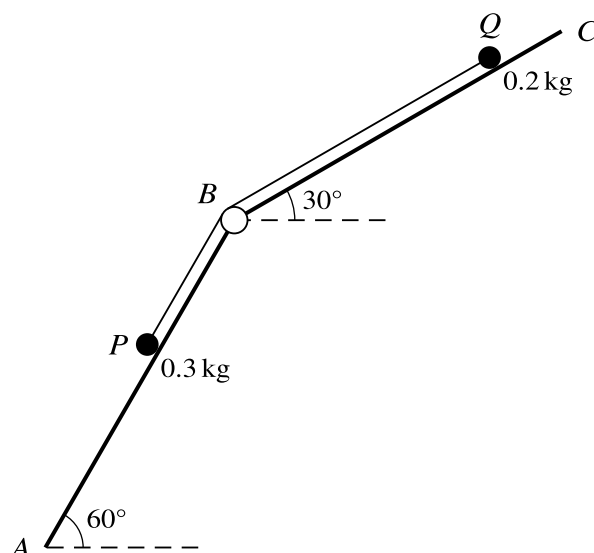
.....

.....

.....

.....

.....



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]

.....

.....

.....

.....

.....

.....

.....

- (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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 7** A particle P moves in a straight line through a point O . The velocity $v \text{ m s}^{-1}$ of P , at time $t \text{ s}$ after passing O , is given by

$$v = \frac{9}{4} + \frac{b}{(t+1)^2} - ct^2,$$

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]

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.

- (b) Given that the velocity of P is zero only at $t = 5$, find the distance travelled in the first 10 seconds of motion. [5]

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.

[illegible]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.