Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

9889194789 8

MATHEMATICS **9709/42**

Paper 4 Mechanics **October/November 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 **12** pages.

[Turn over

1 A cyclist is riding a bicycle along a straight horizontal road AB of length 50 m. The cyclist starts from rest at A and reaches a speed of $6\,\text{m}\,\text{s}^{-1}$ at B. The cyclist produces a constant driving force of magnitude 100 N. There is a resistance force, and the work done against the resistance force from A to B is 3560 J.

Find the total mass of the cyclist and bicycle. [3]

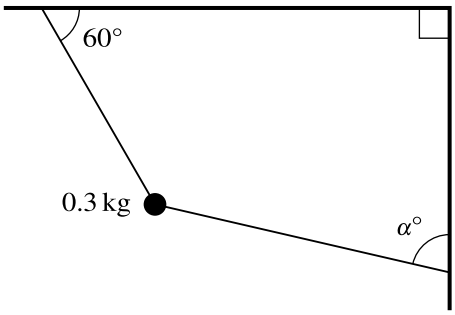
2 A particle P of mass 0.4 kg is in limiting equilibrium on a plane inclined at 30° to the horizontal.

(a) Show that the coefficient of friction between the particle and the plane is $\frac{1}{3}\sqrt{3}$. [3]

A force of magnitude 7.2 N is now applied to P directly up a line of greatest slope of the plane.

(b) Given that P starts from rest, find the time that it takes for P to move 1 m up the plane. [4]

3



A particle of mass 0.3 kg is held at rest by two light inextensible strings. One string is attached at an angle of 60° to a horizontal ceiling. The other string is attached at an angle $\alpha°$ to a vertical wall (see diagram). The tension in the string attached to the ceiling is 4 N.

Find the tension in the string which is attached to the wall and find the value of α. [6]

4 A car of mass 1200 kg is travelling along a straight horizontal road AB. There is a constant resistance force of magnitude 500 N. When the car passes point A, it has a speed of $15\,\text{m s}^{-1}$ and an acceleration of $0.8\,\text{m s}^{-2}$.

(a) Find the power of the car's engine at the point A. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The car continues to work with this power as it travels from A to B. The car takes 53 seconds to travel from A to B and the speed of the car at B is $32\,\text{m s}^{-1}$.

(b) Show that the distance AB is 1362.6 m. [3]

.....

.....

.....

.....

.....

.....

.....

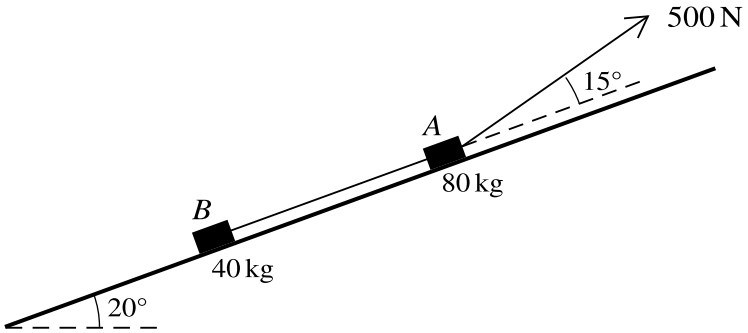
.....

.....

.....

.....

5



A block A of mass 80 kg is connected by a light, inextensible rope to a block B of mass 40 kg. The rope joining the two blocks is taut and is parallel to a line of greatest slope of a plane which is inclined at an angle of 20° to the horizontal. A force of magnitude 500 N inclined at an angle of 15° above the same line of greatest slope acts on A (see diagram). The blocks move up the plane and there is a resistance force of 50 N on B, but no resistance force on A.

(a) Find the acceleration of the blocks and the tension in the rope. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the time that it takes for the blocks to reach a speed of $1.2\,\text{m}\,\text{s}^{-1}$ from rest. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6 Three particles A, B and C of masses 0.3 kg, 0.4 kg and m kg respectively lie at rest in a straight line on a smooth horizontal plane. The distance between B and C is 2.1 m. A is projected directly towards B with speed $2\,\text{m}\,\text{s}^{-1}$. After A collides with B the speed of A is reduced to $0.6\,\text{m}\,\text{s}^{-1}$, still moving in the same direction.

(a) Show that the speed of B after the collision is $1.05\,\text{m}\,\text{s}^{-1}$. [2]

.....

.....

.....

.....

.....

.....

After the collision between A and B, B moves directly towards C. Particle B now collides with C. After this collision, the two particles coalesce and have a combined speed of $0.5\,\text{m}\,\text{s}^{-1}$.

(b) Find m. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the time that it takes, from the instant when B and C collide, until A collides with the combined particle. [5]

7 A particle P travels in a straight line, starting at rest from a point O. The acceleration of P at time t s after leaving O is denoted by a m s^{-2}, where

$$a = 0.3t^{\frac{1}{2}} \quad \text{for } 0 \leqslant t \leqslant 4,$$
$$a = -kt^{-\frac{3}{2}} \quad \text{for } 4 < t \leqslant T,$$

where k and T are constants.

(a) Find the velocity of P at $t = 4$. [2]

.....

.....

.....

.....

.....

.....

.....

(b) It is given that there is no change in the velocity of P at $t = 4$ and that the velocity of P at $t = 16$ is 0.3 m s^{-1}.

Show that $k = 2.6$ and find an expression, in terms of t, for the velocity of P for $4 \leqslant t \leqslant T$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Given that P comes to instantaneous rest at $t = T$, find the exact value of T. [2]

.....

.....

.....

.....

.....

.....

.....

(d) Find the total distance travelled between $t = 0$ and $t = T$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Additional Page

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....