Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

9302293084

MATHEMATICS **9709/43**

Paper 4 Mechanics **October/November 2023**

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 $10\,\text{m}\,\text{s}^{-2}$.

INFORMATION

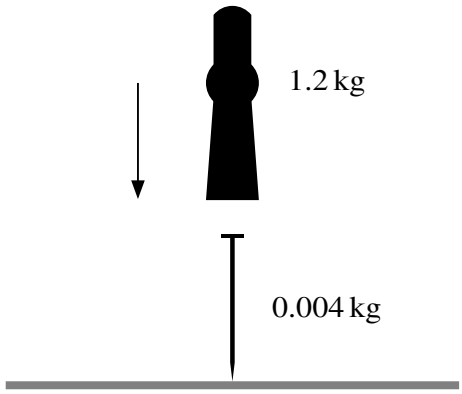
- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.

1 A particle is projected vertically upwards from horizontal ground with a speed of $u\,\text{m s}^{-1}$. The particle has height s m above the ground at times 3 seconds and 4 seconds after projection.

Find the value of u and the value of s. [3]

2



A machine for driving a nail into a block of wood causes a hammerhead to drop vertically onto the top of a nail. The mass of the hammerhead is 1.2 kg and the mass of the nail is 0.004 kg (see diagram). The hammerhead hits the nail with speed v m s^{-1} and remains in contact with the nail after the impact. The combined hammerhead and nail move immediately after the impact with speed 40 m s^{-1}.

(a) Calculate v, giving your answer as an exact fraction. [2]

.....

.....

.....

.....

(b) The nail is driven 4 cm into the wood.

Find the constant force resisting the motion. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3 A block of mass 8 kg slides down a rough plane inclined at 30° to the horizontal, starting from rest. The coefficient of friction between the block and the plane is μ. The block accelerates uniformly down the plane at $2.4\,\text{m}\,\text{s}^{-2}$.

(a) Draw a diagram showing the forces acting on the block. [1]

(b) Find the value of μ. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the speed of the block after it has moved 3 m down the plane. [1]

.....

.....

.....

.....

4 A car has mass 1600 kg.

(a) The car is moving along a straight horizontal road at a constant speed of $24\,\text{m}\,\text{s}^{-1}$ and is subject to a constant resistance of magnitude 480 N.

Find, in kW, the rate at which the engine of the car is working. [2]

.....

.....

.....

.....

The car now moves down a hill inclined at an angle of θ to the horizontal, where $\sin\theta = 0.09$. The engine of the car is working at a constant rate of 12 kW. The speed of the car is $24\,\text{m}\,\text{s}^{-1}$ at the top of the hill. Ten seconds later the car has travelled 280 m down the hill and has speed $32\,\text{m}\,\text{s}^{-1}$.

(b) Given that the resistance is not constant, use an energy method to find the total work done against the resistance during the ten seconds. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

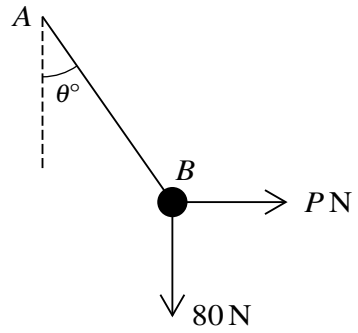
.....

.....

.....

.....

5



A light string AB is fixed at A and has a particle of weight 80 N attached at B. A horizontal force of magnitude P N is applied at B such that the string makes an angle $\theta°$ to the vertical (see diagram).

(a) It is given that $P = 32$ and the system is in equilibrium.

Find the tension in the string and the value of θ. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) It is given instead that the tension in the string is 120 N and that the particle attached at B still has weight 80 N.

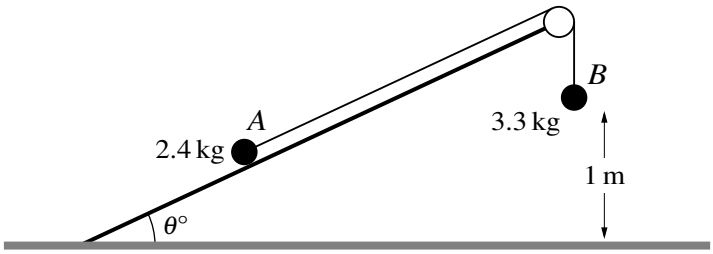
Find the value of P and the value of θ. [4]

6 A particle moves in a straight line. At time t s, the acceleration, $a\,\text{m s}^{-2}$, of the particle is given by $a = 36 - 6t$. The velocity of the particle is $27\,\text{m s}^{-1}$ when $t = 2$.

(a) Find the values of t when the particle is at instantaneous rest. [4]

(b) Find the total distance the particle travels during the first 12 seconds. [4]

7



Particles A and B, of masses 2.4 kg and 3.3 kg respectively, are connected by a light inextensible string that passes over a smooth pulley which is fixed to the top of a rough plane. The plane makes an angle of $\theta°$ with horizontal ground. Particle A is on the plane and the section of the string between A and the pulley is parallel to a line of greatest slope of the plane. Particle B hangs vertically below the pulley and is 1 m above the ground (see diagram). The coefficient of friction between the plane and A is μ.

(a) It is given that $\theta = 30$ and the system is in equilibrium with A on the point of moving directly up the plane.

Show that $\mu = 1.01$ correct to 3 significant figures. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) It is given instead that $\theta = 20$ and $\mu = 1.01$. The system is released from rest with the string taut.

Find the total distance travelled by A before coming to instantaneous rest. You may assume that A does not reach the pulley and that B remains at rest after it hits the ground. [8]

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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....