



Cambridge International AS & A Level

CANDIDATE
NAMECENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

FURTHER MATHEMATICS

9231/32

Paper 3 Further Mechanics

May/June 2025

1 hour 30 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.

* 0000800000002 *



2

BLANK PAGE





- (a) Find an expression for v in terms of x , giving your answer in the form $v = ax^2 + b$, where a and b are constants to be determined. [3]

[illegible]

- (b) Find an expression for x in terms of t . [2]

[illegible]

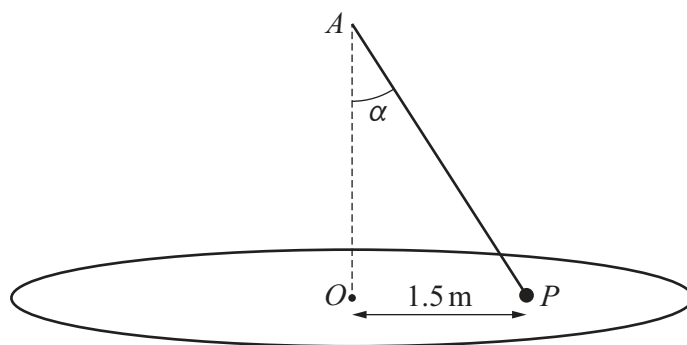
DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

[illegible]



A rough horizontal disc, centre O , rotates with constant angular speed $\omega \text{ rad s}^{-1}$. A particle P of mass 1.6 kg lies on the disc at a distance 1.5 m from O , and is attached to a point A vertically above O by a light elastic string. The string has natural length 2 m , modulus of elasticity 32 N and makes an angle α with the vertical OA (see diagram). Particle P moves in a horizontal circle also at a constant angular speed $\omega \text{ rad s}^{-1}$. Particle P is on the point of slipping in the direction OP . The coefficient of friction between the particle and the disc is 0.5 .

- (a)** Given that the tension in the string is 8 N, show that $\sin \alpha = 0.6$. [2]

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.



[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.



The object is placed such that its circular base makes contact with a rough plane which is inclined to the horizontal at an angle α . The object is on the point of toppling. The plane is sufficiently rough to prevent sliding.

(b) Find the value of α .

[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.

- DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN



- 6 Two uniform smooth spheres A and B of equal radii have masses $2m$ and m respectively. Sphere A is moving in a straight horizontal line with speed u , and sphere B is stationary. Sphere A collides directly with B , and they both then move in the same direction with speeds v_A and v_B respectively. After the collision, the kinetic energy of B is $\frac{9}{2}$ times the kinetic energy of A .

(a) Show that $v_B = \frac{6}{5}u$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

Sphere B then collides with a fixed vertical barrier. Immediately before the collision, the direction of motion of B makes an angle α with the barrier. Immediately after the collision, the direction of motion of B makes an angle β with the barrier. The coefficient of restitution between B and the barrier is $\frac{4}{5}$. As a result of the collision, the velocity of B is reduced to $\frac{12}{25}\sqrt{5}u$.

(b) Find the value of $\sin(\alpha + \beta)$. [6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

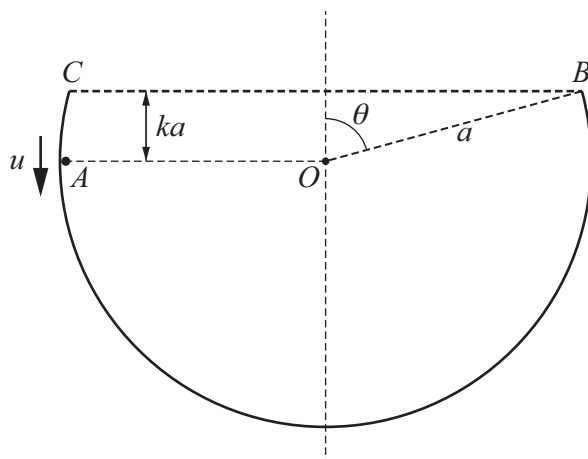
.....

.....

.....

.....





A fixed hollow sphere has radius a and centre O . The points A , B and C lie on the inner surface of the sphere with OA and BC horizontal. A portion of the sphere has been removed by a horizontal cut through points B and C at a vertical distance ka above the centre of the sphere, where k is a positive constant and $k < 1$. The points O , A , B and C all lie in the same vertical plane. OB makes an angle θ with the upward vertical through O (see diagram).

A particle P of mass m is free to move on the smooth inner surface of the sphere. The particle P is projected vertically downwards from A with speed u and begins to move in a vertical circle.

- (a)** In the case where $u = \sqrt{\frac{6}{5}ga}$, the reaction on P at B is half the reaction on P at A .

Find the value of k .

[5]

[illegible]



- (b) Find an expression for u , in terms of a and g , in the case that the particle just reaches B . [1]

- (c) Find an expression for u , in terms of a and g , in the case that the particle passes through B and in its subsequent motion reaches C . [4]



[illegible]

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.