



Cambridge International AS & A Level

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FURTHER MATHEMATICS

9231/33

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.

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- Given that $\tan \theta = \frac{4}{3}$, find ω in terms of a and g . [3]

[illegible]

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[3]

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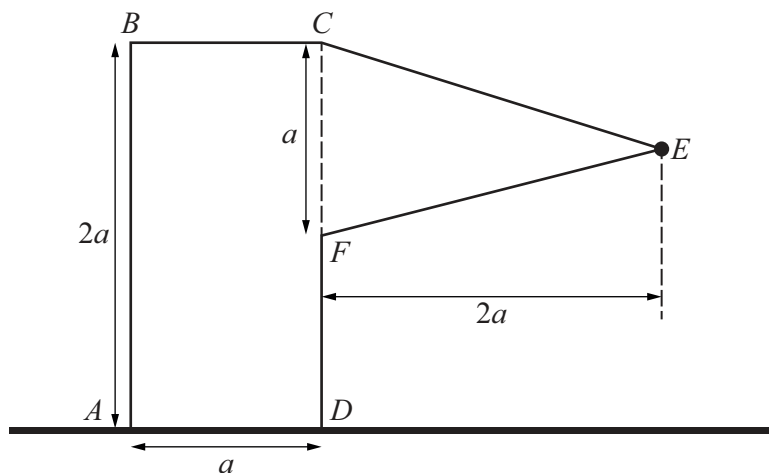
- (a) Show that the distance travelled by the ball when it is moving upwards is $x = \frac{1}{2k} \ln \left(\frac{g + kU^2}{g + kv^2} \right)$. [4]

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.



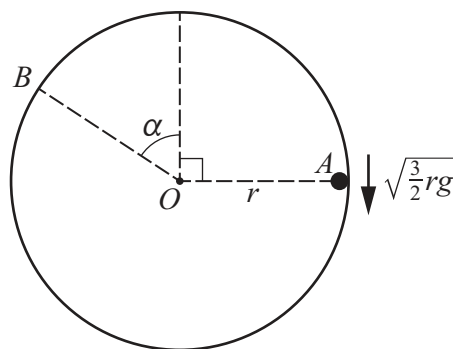
- [4]

[illegible]



Given that the object is on the point of toppling in its vertical plane about the vertex D , find the value of k . [4]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.



A hollow cylinder of radius r is fixed with its axis horizontal. Points A , B and O are in the same vertical plane perpendicular to the axis of the cylinder, with A and B on the smooth inner surface and O on the axis. OA and OB make angles 90° and α respectively with the upward vertical through O , with A and B on opposite sides of the vertical. A particle of mass m is projected vertically downwards from point A with speed $\sqrt{\frac{3}{2}rg}$ and moves in a vertical circle inside the cylinder (see diagram). The particle loses contact with the cylinder at point B .

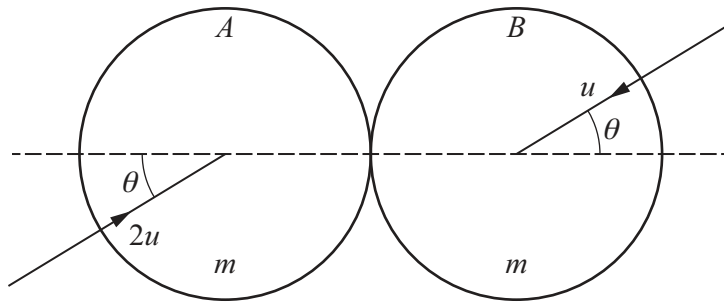
- (a)** Find the value of α .

[4]

[illegible]



This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.



Two identical uniform smooth spheres A and B , each with mass m , are moving on a horizontal surface with speeds $2u$ and u respectively when they collide. Immediately before the collision, the spheres are moving parallel to each other in opposite directions such that their directions of motion each make an angle θ with the line of centres (see diagram). As a result of the collision, B moves in a direction which is perpendicular to its initial direction of motion. The coefficient of restitution between the spheres is e .

- (a) Find an expression for $\tan \theta$ in terms of e . [6]

[illegible]



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As a result of the collision, A moves in a direction which is perpendicular to the line of centres.

(b) Find the value of θ . [2]

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At time T , the particle strikes a smooth horizontal plane at a point which is a horizontal distance D from O and a vertical distance H below O .

(c) Find the ratio $H : D$.

[4]

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After striking the horizontal plane, P rebounds with speed w . The coefficient of restitution between P and the plane is $\frac{2}{3}$.

(d) Find w in terms of U .

[3]

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