



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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- 1 A particle P of mass m is attached to one end of a light inextensible string of length a . The other end of the string is attached to a fixed point O . The particle moves in a horizontal circle with constant angular speed ω and with the string inclined at an angle of θ to the downward vertical.

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

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for practicing various letters and words. There is no text or other markings on the page.



- 2 A particle P of mass m is attached to one end of a light elastic string of natural length a and modulus of elasticity mg . The other end of the string is attached to a fixed point O on a rough plane inclined at an angle of 30° to the horizontal. The particle P is held at rest at point O before being released. The frictional force acting on P as it slides down the plane is $\frac{11}{30}mg$.

(a) Find, in terms of a , the distance that P moves down the plane before coming to rest. [5]

[illegible]



(b) It is given that P remains at rest in this new position.

Find, in terms of m and g , the magnitude of the frictional force in this position. [3]

[illegible]



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It is given that $k = 0.025$ and that $U = 20$.

- (b)** Find the time taken for the ball to reach its maximum height.

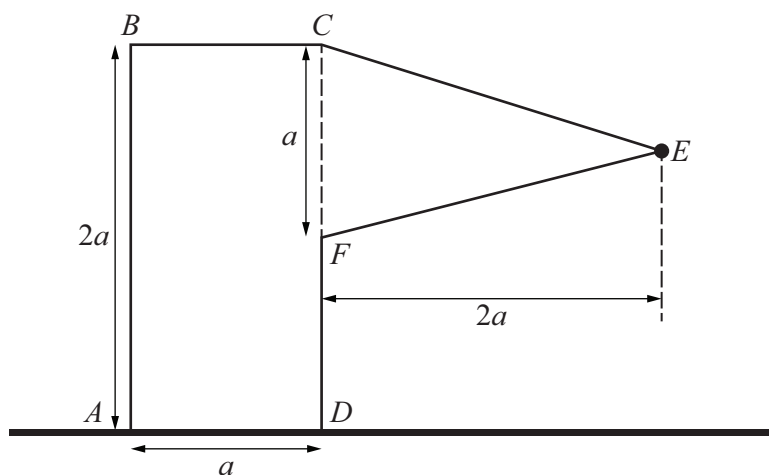
[4]

[illegible]



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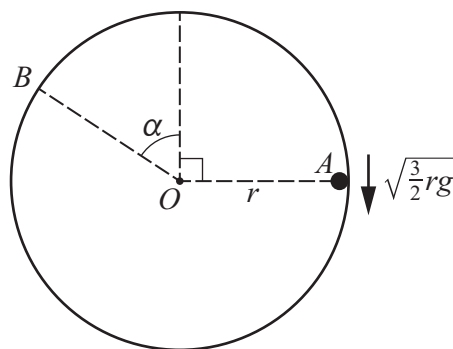
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A hollow cylinder of radius r is fixed with its axis horizontal. Points A , B and O are in the same vertical plane perpendicular to the axis of the cylinder, with A and B on the smooth inner surface and O on the axis. OA and OB make angles 90° and 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]



- (b)** In the subsequent motion find, in terms of r , the greatest height above O reached by the particle. [4]

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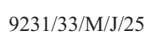
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At time T , the particle strikes a smooth horizontal plane at a point which is a horizontal distance D from O and a vertical distance H below O .

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

[illegible]

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