



Cambridge International AS & A Level

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FURTHER MATHEMATICS

9231/31

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 [].

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- 1** A particle P of mass 8 kg is moving in a straight horizontal line. At time $t\text{ s}$, P has displacement $x\text{ m}$ from a fixed point O on the line and velocity $v\text{ m s}^{-1}$. The only horizontal force acting on P has magnitude $(x^3 + 4x)\text{ N}$ and acts in the direction OP . When $t = 0$, $x = 0$ and $v = 1$.

- (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]

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.

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

[illegible]



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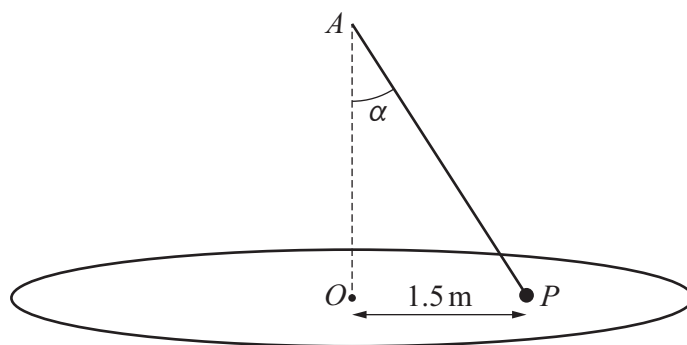
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(b) Given that P clears the wall, find the minimum distance from point O where P can land. [2]

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

[2]

[illegible]



(b) Find the number of revolutions per minute made by the disc and the particle P .

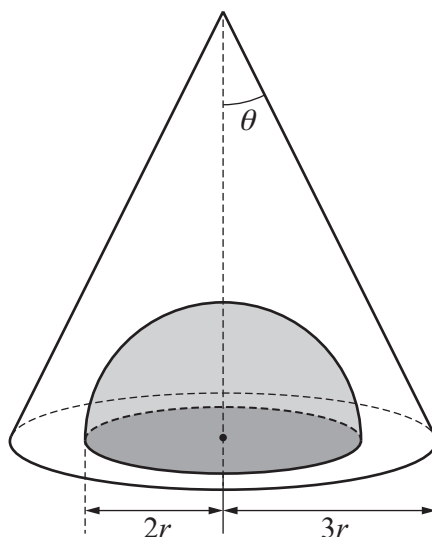
[5]

[illegible]



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An object is formed by removing a solid hemisphere, radius $2r$, from a uniform solid cone, radius $3r$ and semi-vertical angle θ , where $\tan \theta = \frac{1}{2}$. The axes of symmetry of the cone and the hemisphere coincide. The base of the cone and the base of the hemisphere are in the same plane as each other (see diagram).

- (a) Find, in terms of r , the distance of the centre of mass of the object from its base. [4]

[illegible]



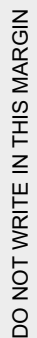
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The object is placed such that its circular base makes contact with a rough plane which is inclined to the horizontal at an angle α . The object is on the point of toppling. The plane is sufficiently rough to prevent sliding.

(b) Find the value of α .

[3]

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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.



- 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]

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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]

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[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]





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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