



Cambridge International AS & A Level

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FURTHER MATHEMATICS

9231/33

Paper 3 Further Mechanics

October/November 2024

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 ms^{-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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[5]

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- 2** 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 P is held at the point A with the string taut. It is given that OA makes an angle θ with the downward vertical through O , where $\tan \theta = \frac{3}{4}$. The particle P is projected perpendicular to OA in an upwards direction with speed $\sqrt{5ag}$, and it starts to move along a circular path in a vertical plane. When P is at the point B , where angle AOB is a right angle, the tension in the string is T .

Find T in terms of m and g .

[5]

[illegible]



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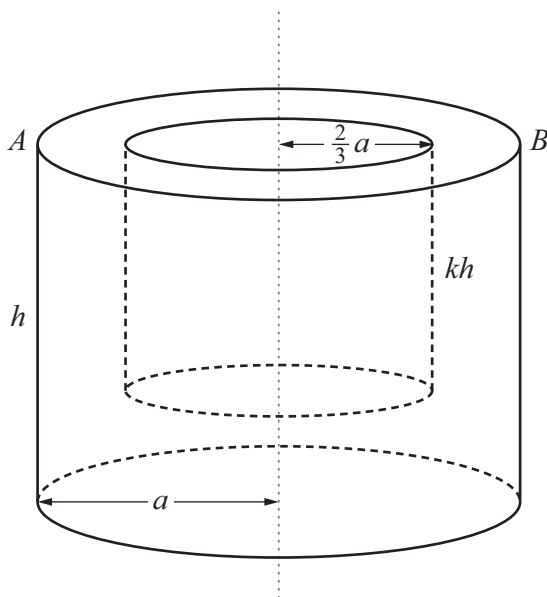
(b) Hence find the speed of P when it is 2 m below O .

[2]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



4



An object is formed by removing a cylinder of radius $\frac{2}{3}a$ and height kh ($k < 1$) from a uniform solid cylinder of radius a and height h . The vertical axes of symmetry of the two cylinders coincide. The upper faces of the two cylinders are in the same plane as each other. The points A and B are the opposite ends of a diameter of the upper face of the object (see diagram).

- (a) Find, in terms of h and k , the distance of the centre of mass of the object from AB . [4]

[illegible]



When the object is suspended from A , the angle between AB and the vertical is θ , where $\tan \theta = \frac{3}{2}$.

(b) Given that $h = \frac{8}{3}a$, find the possible values of k . [3]

[illegible]



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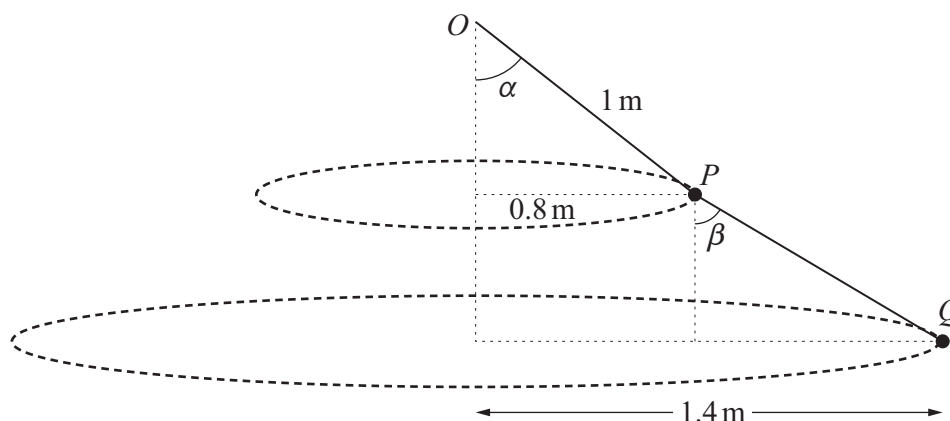
(b) Find the magnitude of F when $t = 3$.

[3]

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 writing. The lines are evenly spaced across the entire page, providing a guide for letter height and placement. There is no text or other markings on the page.



6



A particle P of mass 0.05 kg is attached to one end of a light inextensible string of length 1 m . The other end of the string is attached to a fixed point O . A particle Q of mass 0.04 kg is attached to one end of a second light inextensible string. The other end of this string is attached to P .

The particle P moves in a horizontal circle of radius 0.8 m with angular speed $\omega\text{ rad s}^{-1}$. The particle Q moves in a horizontal circle of radius 1.4 m also with angular speed $\omega\text{ rad s}^{-1}$. The centres of the circles are vertically below O , and O , P and Q are always in the same vertical plane. The strings OP and PQ remain at constant angles α and β respectively to the vertical (see diagram).

- (a) Find the tension in the string OP .

[3]

[illegible]



(b) Find the value of ω .

[3]

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(c) Find the value of β .

[2]

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In its subsequent motion, the greatest height reached by P above A is $\frac{3}{16}$ of the vertical height of A above the horizontal plane.

(b) Find the value of e .

[6]

[illegible]



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