



Cambridge International AS & A Level

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FURTHER MATHEMATICS

9231/31

Paper 3 Further Mechanics

May/June 2022

1 hour 30 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

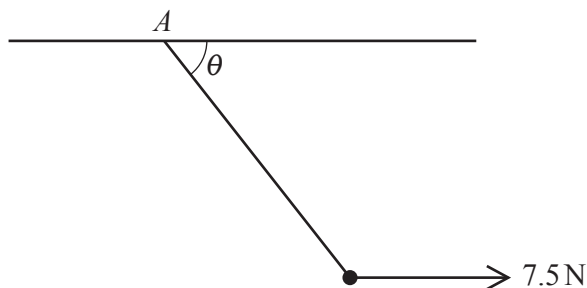
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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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(a) Find the tension in the string. [2]

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[illegible]

- 2 One end of a light inextensible string of length a is attached to a fixed point O . A particle of mass m is attached to the other end of the string. The particle is held at the point A with the string taut. The angle between OA and the downward vertical is equal to α , where $\cos \alpha = \frac{4}{5}$. The particle is projected from A , perpendicular to the string in an upwards direction, with a speed $\sqrt{3ga}$. It then moves along a circular path in a vertical plane. The string first goes slack when it makes an angle θ with the upward vertical through O .

Find the value of $\cos \theta$.

[5]

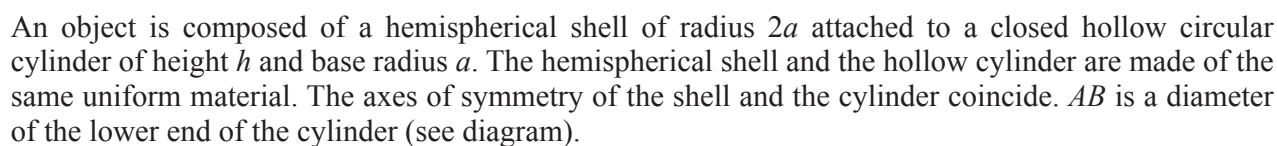
This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, providing a template for handwriting practice or general writing. There are no margins, text, or other markings on the page.

- 3 A particle P is moving in a horizontal straight line. Initially P is at the point O on the line and is moving with velocity 25 m s^{-1} . At time $t \text{ s}$ after passing through O , the acceleration of P is $\frac{4000}{(5t+4)^3} \text{ m s}^{-2}$ in the direction PO . The displacement of P from O at time t is $x \text{ m}$.

Find an expression for x in terms of t .

[5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

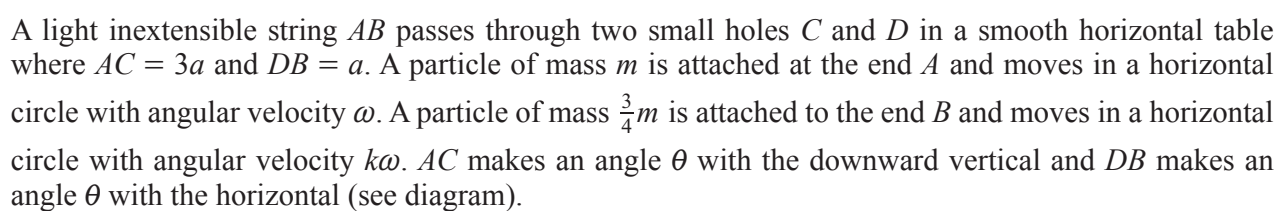


- [illegible]

The object is placed on a rough plane which is inclined to the horizontal at an angle θ , where $\tan \theta = \frac{2}{3}$. The object is in equilibrium with AB in contact with the plane and lying along a line of greatest slope of the plane.

- (b)** Find the set of possible values of h , in terms of a . [4]

[illegible]



[7]

[illegible]

- 6** Two uniform smooth spheres A and B of equal radii have masses m and km respectively. The two spheres are on a horizontal surface. Sphere A is travelling with speed u towards sphere B which is at rest. The spheres collide. Immediately before the collision, the direction of motion of A makes an angle α with the line of centres. The coefficient of restitution between the spheres is $\frac{1}{2}$.
- (a)** Show that the speed of B after the collision is $\frac{3u \cos \alpha}{2(1+k)}$ and find also an expression for the speed of A along the line of centres after the collision, in terms of k , u and α . [4]

[illegible]

After the collision, the kinetic energy of A is equal to the kinetic energy of B .

- (b)** Given that $\tan \alpha = \frac{2}{3}$, find the possible values of k . [5]

[illegible]

- (a) Write down expressions, in terms of T , for the horizontal displacements of P and Q from O when they collide and hence show that $4uT = 21\sqrt{5}(T+1)$. [4]

[illegible]

(b) Find the value of T .

[4]

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(c) Find the horizontal and vertical displacements of the particles from O when they collide.

[3]

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Additional page

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