



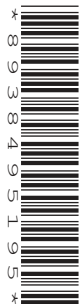
Cambridge International AS & A Level

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**FURTHER MATHEMATICS****9231/32**

Paper 3 Further Mechanics

October/November 2020**1 hour 30 minutes**

You must answer on the question paper.

You will need: List of formulae (MF19)

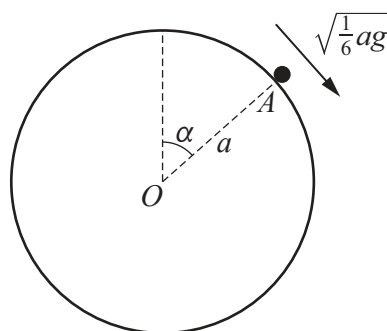
INSTRUCTIONS

- 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 [].

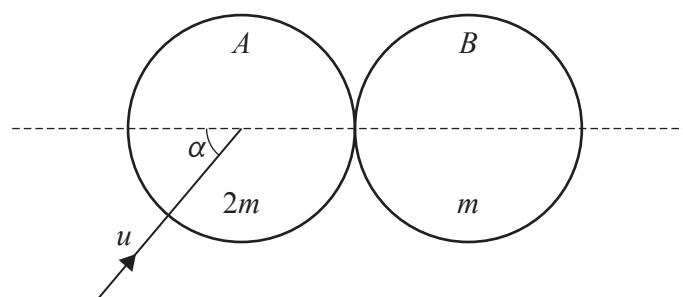
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Given that $\cos \alpha = \frac{2}{3}$, find the value of $\cos \beta$. [5]

[illegible]

2



Two uniform smooth spheres A and B of equal radii have masses $2m$ and m respectively. Sphere B is at rest on a smooth horizontal surface. Sphere A is moving on the surface with speed u and collides with B . Immediately before the collision, the direction of motion of A makes an angle α with the line of centres of the spheres, where $\tan \alpha = \frac{4}{3}$ (see diagram). The coefficient of restitution between the spheres is $\frac{1}{3}$.

Find the speed of A after the collision.

[5]

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.

- [illegible]

- (b)** Show that the object can rest in equilibrium with the curved surface of the cone in contact with a horizontal surface. [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 letter height. The entire page is otherwise blank, with no margins, text, or other markings.

(a) Show that $\cos \theta = \frac{g}{\omega^2 r}$. [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 writing practice. There is no text or other markings on the page.

[4]

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

5 A particle P is projected with speed $u\text{ ms}^{-1}$ at an angle of θ above the horizontal from a point O on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of P from O at a subsequent time $t\text{ s}$ are denoted by $x\text{ m}$ and $y\text{ m}$ respectively.

(a) Starting from the equation of the trajectory given in the List of formulae (MF19), show that

$$y = x \tan \theta - \frac{gx^2}{2u^2}(1 + \tan^2 \theta).$$

[1]

When $\theta = \tan^{-1} 2$, P passes through the point with coordinates $(10, 16)$.

(b) Show that there is no value of θ for which P can pass through the point with coordinates $(18, 30)$.
[6]

[illegible]

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.

[illegible]

- [illegible]

- $$\frac{1}{3k} \ln \left(\frac{A - ku^3}{B - ku^3} \right),$$

[7]

[illegible]

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 or typing. There are no margins, text, or other markings on the page.

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