



CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

9231/32

October/November 2020

1 hour 30 minutes

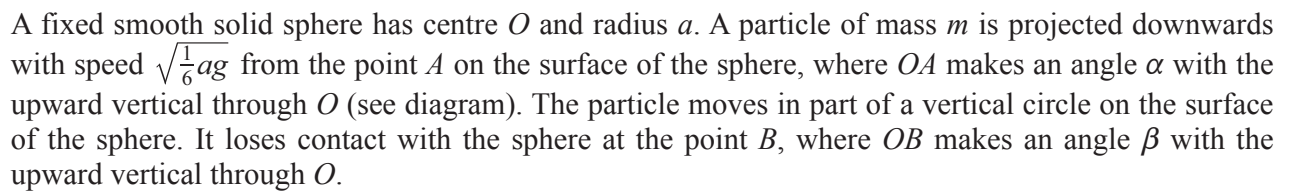
You will need: List of formulae (MF19)

- 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} .

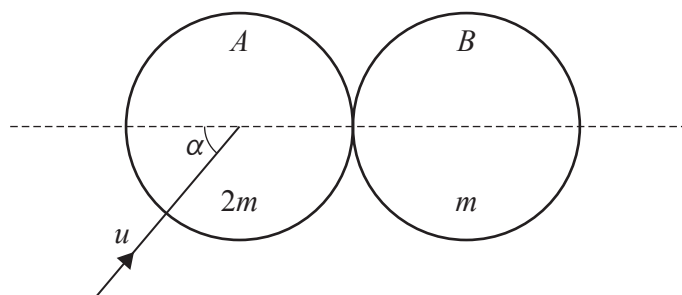
- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

DC (LK/SG) 187875/2
© UCLES 2020

[Turn over



This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



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.

- (a) Find the distance of the centre of mass of the object from the end of the cylinder that is not attached to the cone. [4]

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.

- (b)** Show that the object can rest in equilibrium with the curved surface of the cone in contact with a horizontal surface. [3]

[illegible]

- 4 A particle P of mass m is moving in a horizontal circle with angular speed ω on the smooth inner surface of a hemispherical shell of radius r . The angle between the vertical and the normal reaction of the surface on P is θ .

(a) Show that $\cos \theta = \frac{g}{\omega^2 r}$. [3]

[illegible]

The plane of the circular motion is at a height x above the lowest point of the shell. When the angular speed is doubled, the plane of the motion is at a height $4x$ above the lowest point of the shell.

(b) Find x in terms of r .

[4]

[illegible]

- 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 s are denoted by x m and y m respectively.

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

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

.....

.....

.....

.....

.....

.....

.....

.....

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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 6 One end of a light elastic string, of natural length a and modulus of elasticity k , is attached to a particle P of mass m . The other end of the string is attached to a fixed point Q . The particle P is projected vertically upwards from Q . When P is moving upwards and at a distance $\frac{4}{3}a$ directly above Q , it has a speed $\sqrt{2ga}$. At this point, its acceleration is $\frac{7}{3}g$ downwards.

Show that $k = 4mg$ and find in terms of a the greatest height above Q reached by P . [8]

[illegible]

- 7 A particle P of mass m kg moves in a horizontal straight line against a resistive force of magnitude mkv^2 N, where v ms⁻¹ is the speed of P after it has moved a distance x m and k is a positive constant. The initial speed of P is u ms⁻¹.

(a) Show that $x = \frac{1}{k} \ln 2$ when $v = \frac{1}{2}u$. [4]

[illegible]

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

[7]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed 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.

[illegible]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.