



CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

9231/32

October/November 2021

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 (CE/FC) 199210/2
© UCLES 2021

[Turn over

- 1** A particle is projected with speed u at an angle α above the horizontal from a point O on a horizontal plane. The particle moves freely under gravity.

- (a)** Write down the horizontal and vertical components of the velocity of the particle at time T after projection. [2]

.....

.....

.....

.....

.....

At time T after projection, the direction of motion of the particle is perpendicular to the direction of projection.

- (b)** Express T in terms of u , g and α . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c)** Deduce that $T > \frac{u}{g}$. [1]

.....

.....

.....

.....

.....

.....

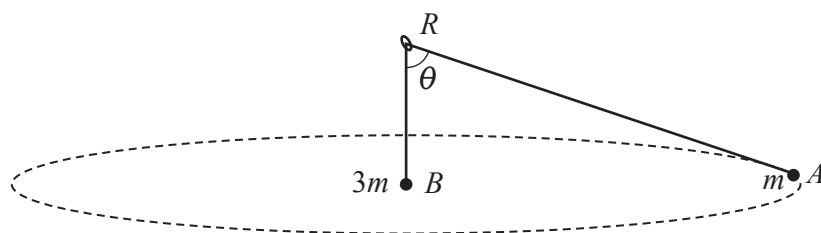
.....

- 2 A light spring AB has natural length a and modulus of elasticity $5mg$. The end A of the spring is attached to a fixed point on a smooth horizontal surface. A particle P of mass m is attached to the end B of the spring. The spring and particle P are at rest on the surface.

Another particle Q of mass km is moving with speed $\sqrt{4ga}$ along the horizontal surface towards P in the direction BA . The particles P and Q collide directly and coalesce. In the subsequent motion the greatest amount by which the spring is compressed is $\frac{1}{5}a$.

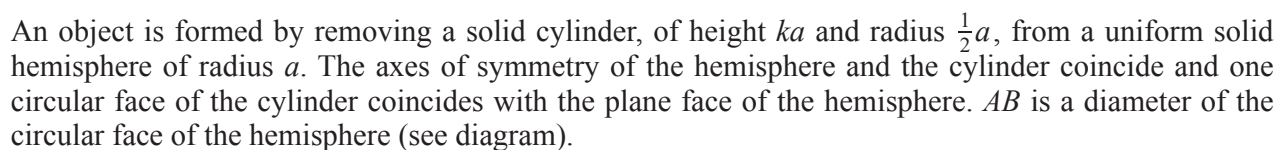
Find the value of k .

[6]



(a) Show that $\cos \theta = \frac{1}{3}$. [2]

This image shows a blank sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the width of the page. There is no handwriting or other markings on the paper.[illegible]



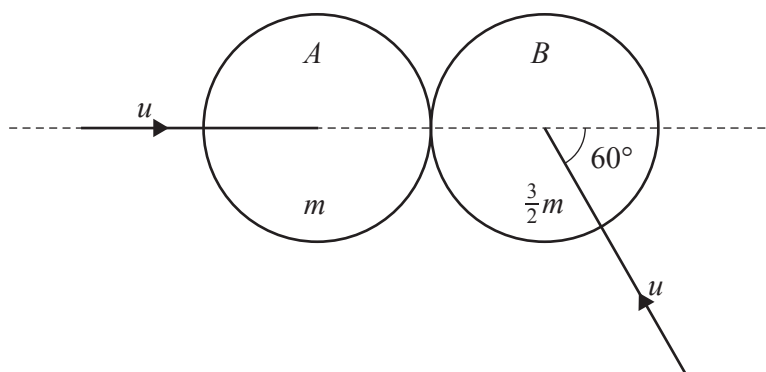
-
- This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

When the object is freely suspended from the point A , the line AB makes an angle θ with the downward vertical, where $\tan \theta = \frac{7}{18}$.

(b) Find the possible values of k .

[3]

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 width of the page. There are no margins, text, or other markings on the paper.



Two uniform smooth spheres A and B of equal radii have masses m and $\frac{3}{2}m$ respectively. The two spheres are each moving with speed u on a horizontal surface when they collide. Immediately before the collision A 's direction of motion is along the line of centres, and B 's direction of motion makes an angle of 60° with the line of centres (see diagram). The coefficient of restitution between the spheres is $\frac{2}{3}$.

- (a) Find the angle through which the direction of motion of B is deflected by the collision. [6]

[illegible]

- (b) Find the loss in the total kinetic energy of the system as a result of the collision. [3]

- 6** A particle P of mass 2 kg moves along a horizontal straight line. The point O is a fixed point on this line. At time $t\text{ s}$ the velocity of P is $v\text{ ms}^{-1}$ and the displacement of P from O is $x\text{ m}$.

A force of magnitude $\left(8x - \frac{128}{x^3}\right)$ N acts on P in the direction OP . When $t = 0$, $x = 8$ and $v = -15$.

- (a) Show that $v = -\frac{2}{x}(x^2 - 4)$. [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.

- 7 One end of a light inextensible string of length a is attached to a fixed point O . The other end of the string is attached to a particle P of mass m . The particle P is held vertically below O with the string taut and then projected horizontally. When the string makes an angle of 60° with the upward vertical, P becomes detached from the string. In its subsequent motion, P passes through the point A which is a distance a vertically above O .

- (a) The speed of P when it becomes detached from the string is V . Use the equation of the trajectory of a projectile to find V in terms of a and g . [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 practice. There are no margins, text, or other markings on the page.

Additional Page

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.