

Cambridge
International
A Level

Cambridge Assessment International Education
Cambridge International Advanced Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/52

Paper 5 Mechanics 2 **(M2)**

February/March 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use 10 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 50.

This document consists of **13** printed pages and **3** blank pages.



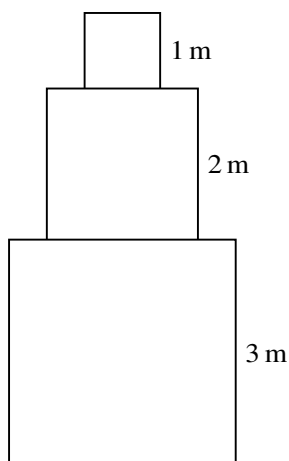
2

BLANK PAGE

- [illegible]

2

4



A uniform object is made by joining together three solid cubes with edges 3 m, 2 m and 1 m. The object has an axis of symmetry, with the cubes stacked vertically and the cube of edge 2 m between the other two cubes (see diagram).

- (i) Calculate the distance of the centre of mass of the object above the base of the largest cube. [3]

This image shows a full page of a worksheet designed for handwriting practice. It features 18 horizontal rows, each defined by two parallel dashed lines. The lines are evenly spaced and extend across the entire width of the page, providing a guide for letter height and placement. There is no text or other markings on the page.

The smallest cube is now removed from the object. It is replaced by a heavier uniform cube with 1 m edges which is made of a different material. The centre of mass of the object is now at the base of the 2 m cube.

- (ii) Find the ratio of the masses of the two cubes of edge 1 m. [3]

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.

3 A small ball is projected from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of the ball from O are x m and y m respectively, where $x = 4t$ and $y = 6t - 5t^2$.

(i) Find the equation of the trajectory of the ball. [2]

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Hence or otherwise calculate the angle of projection of the ball and its initial speed. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

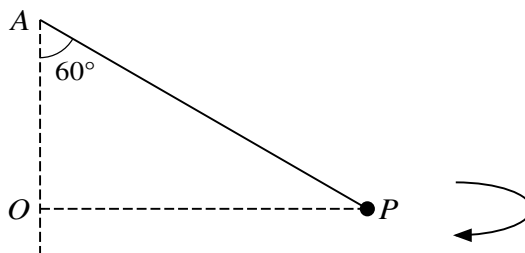
.....

.....

.....

.....

4



A particle P of mass 0.3 kg is attached to a fixed point A by a light elastic string of natural length 0.8 m and modulus of elasticity 16 N . The particle P moves in a horizontal circle which has centre O . It is given that AO is vertical and that angle OAP is 60° (see diagram). Calculate the speed of P . [6]

[illegible]

- 5** A particle P of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 24 N . The other end of the string is attached to a fixed point O . The particle P is released from rest at the point 0.4 m vertically below O .

(i) Find the greatest speed of P .

[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]

10

6

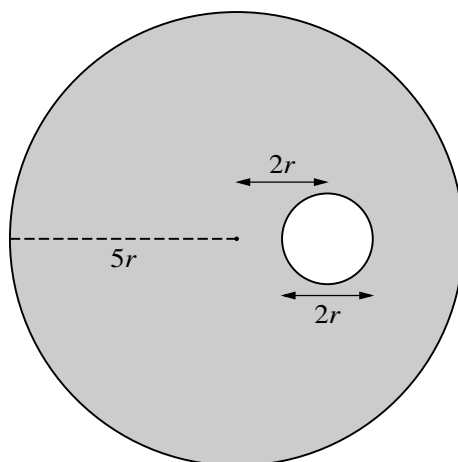


Fig. 1

Fig. 1 shows the cross-section of a solid cylinder through which a cylindrical hole has been drilled to make a uniform prism. The radius of the cylinder is $5r$ and the radius of the hole is r . The centre of the hole is a distance $2r$ from the centre of the cylinder.

- (i) Find, in terms of r , the distance of the centre of mass of the prism from the centre of the cylinder. [4]

[illegible]

11

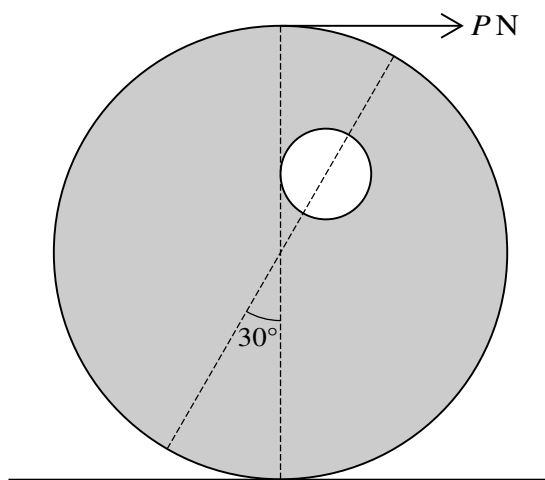


Fig. 2

The prism has weight WN and is placed with its curved surface on a rough horizontal plane. The axis of symmetry of the cross-section makes an angle of 30° with the vertical. A horizontal force of magnitude PN acting in the plane of the cross-section through the centre of mass is applied to the cylinder at the highest point of this cross-section (see Fig. 2). The prism rests in limiting equilibrium.

- (ii) Find the coefficient of friction between the prism and the plane. [4]

[illegible]

7 A particle P is projected horizontally from a point O on a rough horizontal surface. The coefficient of friction between the particle and the surface is 0.2. A horizontal force of magnitude $0.06t$ N directed away from O acts on P , where t s is the time after projection. P comes to rest when $t = 4$.

(i) The particle begins to move again when $t = 8$. Show that the mass of P is 0.24 kg. [2]

.....

.....

.....

.....

.....

.....

(ii) Show that, for $0 \leq t \leq 4$, $\frac{dv}{dt} = 0.25t - 2$, and find the speed of projection of P . [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(iii) Find the distance from O at which P comes to rest. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a single sheet of white paper with horizontal 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.

15

BLANK 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.