

Cambridge International AS & A Level

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

5 6 6 1 7 3 4 1 9 6

FURTHER MATHEMATICS

9231/32

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

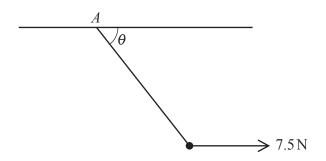
- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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 $10 \,\mathrm{m\,s^{-2}}$.

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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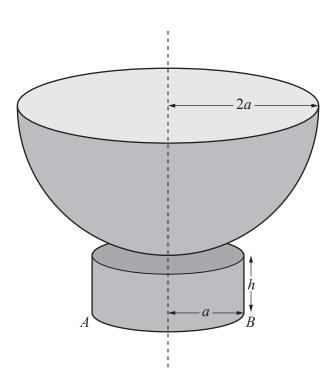


A particle of weight $10\,\mathrm{N}$ is attached to one end of a light elastic string. The other end of the string is attached to a fixed point A on a horizontal ceiling. A horizontal force of $7.5\,\mathrm{N}$ acts on the particle. In the equilibrium position, the string makes an angle θ with the ceiling (see diagram). The string has natural length $0.8\,\mathrm{m}$ and modulus of elasticity $50\,\mathrm{N}$.

(a)	Find the tension in the string.	[2]
<i>a</i> .		
(b)	Find the vertical distance between the particle and the ceiling.	[3]
		•••••

	and the downward vertical is equal to α , where $\cos \alpha = \frac{4}{5}$. The particle is projected from					
perpendicular to the string in an upwards direction, with a speed $\sqrt{3ga}$. It then moves along a path in a vertical plane. The string first goes slack when it makes an angle θ with the upward through O .						
Find the value of $\cos \theta$.						

A particle <i>P</i> is moving in a horizontal straight line. Initially <i>P</i> is at the point <i>O</i> on the line and is moving with velocity $25 \mathrm{ms^{-1}}$. At time <i>t</i> is after passing through <i>O</i> , the acceleration of <i>P</i> is $\frac{4000}{(5t+4)^3} \mathrm{ms^{-2}}$						
the direction I O . The displacement of I from O at time i is x in.						
Find an expression for x in terms of t .	[5]					



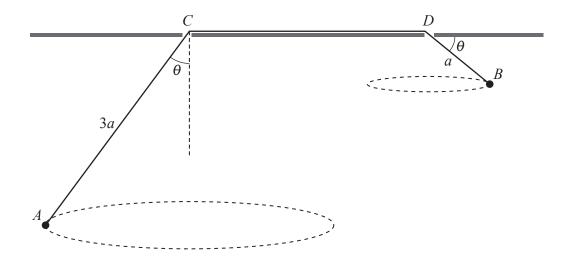
An object is composed of a hemispherical shell of radius 2a attached to a closed hollow circular cylinder of height h and base radius a. The hemispherical shell and the hollow cylinder are made of the same uniform material. The axes of symmetry of the shell and the cylinder coincide. AB is a diameter of the lower end of the cylinder (see diagram).

(a)	Find, in terms of a and h , an expression for the distance of the centre of mass of the object from AB . [4]						

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]



A light inextensible string AB passes through two small holes C and D in a smooth horizontal table where AC = 3a and DB = a. A particle of mass m is attached at the end A and moves in a horizontal circle with angular velocity ω . A particle of mass $\frac{3}{4}m$ is attached to the end B and moves in a horizontal circle with angular velocity B0. AC1 makes an angle B2 with the horizontal (see diagram).

and the value of k .	[7]
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rest	eres are on a horizontal surface. Sphere A is travelling with speed u towards sphere B which is at A . The spheres collide. Immediately before the collision, the direction of motion of A makes an angle A ith the line of centres. The coefficient of restitution between the spheres is $\frac{1}{2}$.						
(a)	Show that the speed of <i>B</i> after the collision is $\frac{3u\cos\alpha}{2(1+k)}$ and find also an expression for the speed of <i>A</i> along the line of centres after the collision, in terms of <i>k</i> , <i>u</i> and α . [4]						

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]

Particles P and Q are projected in the same vertical plane from a point O at the top of a cliff. The height of the cliff exceeds $50\,\mathrm{m}$. Both particles move freely under gravity. Particle P is projected with

roj	ection of particle P . The particles collide T s after the projection of particle Q .							
(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 $4uT = 21\sqrt{5}(T+1)$.							

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Find the horizonta	al and vertical displa	cements of the par	ticles from O when they	collide.
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Additional page

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