CAMBRIDGE
International Education

Cambridge International AS & A Level

FURTHER MATHEMATICS **9231/03**

Paper 3 Further Mechanics **For examination from 2027**

SPECIMEN PAPER **1 hour 30 minutes**

0123456789

You must answer on the printed answer booklet.

You will need: Printed answer booklet
List of formulae (MF19)

INSTRUCTIONS

- Answer all questions.
- Write your answers on the printed answer booklet. Follow the instructions on the front cover of the answer booklet.
- 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 $10\,\text{m}\,\text{s}^{-2}$.

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 **4** pages.

© Cambridge University Press & Assessment 2026

1 A child's toy consists of a uniform solid circular cone, of vertical height $3r$ and radius r, and a uniform solid hemisphere of radius r. The circular bases of the cone and the hemisphere are joined together so that they coincide. The cone and the hemisphere are made of the same material.

Show that the centre of mass of the toy is at a distance $\frac{27}{10}r$ from the vertex of the cone. [4]

2 A light elastic string has natural length a and modulus of elasticity $24mg$. One end of the string is attached to a fixed point A. The other end of the string is attached to a particle of mass $2m$.

(a) Find, in terms of a, the extension of the string when the particle hangs freely in equilibrium below A. [2]

(b) The particle is released from rest at A.

Find, in terms of a, the distance of the particle below A when it first comes to instantaneous rest. [6]

3 A particle P of mass m kg falls from rest under gravity. There is a resistive force of magnitude mkv^2 N, where $v\,\mathrm{m\,s^{-1}}$ is the speed of P after it has fallen a distance x m and k is a positive constant.

(a) By solving an appropriate differential equation, show that

$$v^2 = \frac{g}{k}\left(1 - \mathrm{e}^{-2kx}\right).$$ [7]

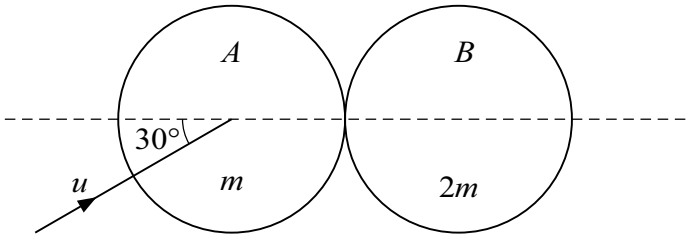
(b) It is now given that $k = 0.01$. The speed of P when x becomes large approaches $V\,\mathrm{m\,s^{-1}}$.

(i) Find the value of V correct to 2 decimal places. [1]

(ii) Hence, find how far P has fallen when its speed is $\frac{1}{2}V\,\mathrm{m\,s^{-1}}$. [2]

© Cambridge University Press & Assessment 2026

4

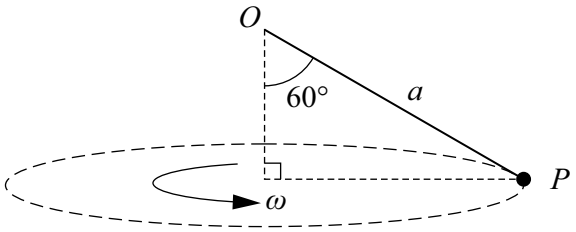


Two uniform smooth spheres A and B of equal radii have masses m and $2m$ respectively. Sphere B is at rest on a smooth horizontal surface. Sphere A is moving on the surface with speed u and collides with B. Immediately before the collision, the direction of motion makes an angle of 30° with the line of centres (see diagram). The coefficient of restitution between the spheres is e.

(a) Show that the speed of B after the collision is $\frac{\sqrt{3}}{6}u(1 + e)$ and find, in terms of u and e, the speed of A after the collision. [6]

(b) Given that $e = \frac{1}{3}$, find, in terms of m and u, the loss of kinetic energy as a result of the collision. [3]

5



(a) A particle P of mass m is attached to one end of a light inextensible string of length a. The other end of the string is attached to a fixed point O.

The particle P moves in a horizontal circle with a constant angular speed ω with the string inclined at 60° to the downward vertical through O (see diagram).

Show that $\omega^2 = \frac{2g}{a}$. [4]

(b) The particle now hangs at rest a distance a vertically below O. It is then projected horizontally so that it begins to move in a vertical circle with centre O. When the string makes an angle of 60° with the downward vertical through O, the angular speed of P is $\sqrt{\frac{2g}{a}}$. The string first goes slack when OP makes an angle θ with the upward vertical through O.

Find the value of $\cos\theta$. [6]

Question 6 is on the back page.

© Cambridge University Press & Assessment 2026

6 A particle P is projected with speed u at an angle α 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 are denoted by x and y respectively.

(a) Derive the equation of the trajectory of P in the form

$$y = x\tan\alpha - \frac{gx^2}{2u^2}\sec^2\alpha.$$ [3]

(b) The greatest height of P above the plane is denoted by H. When P is at a height of $\frac{3}{4}H$, it has travelled a horizontal distance d.

Given that $\tan\alpha = 2$, find, in terms of H, the two possible values of d. [6]

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 (Cambridge University Press & Assessment) 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.

Cambridge International Education is the name of our awarding body and a part of Cambridge University Press & Assessment, which is a department of the University of Cambridge.

© Cambridge University Press & Assessment 2026