

Cambridge International AS & A Level

CANDIDATE
NAME

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FURTHER MATHEMATICS

9231/32

Paper 3 Further Mechanics

May/June 2020

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 ms^{-2} .

INFORMATION

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

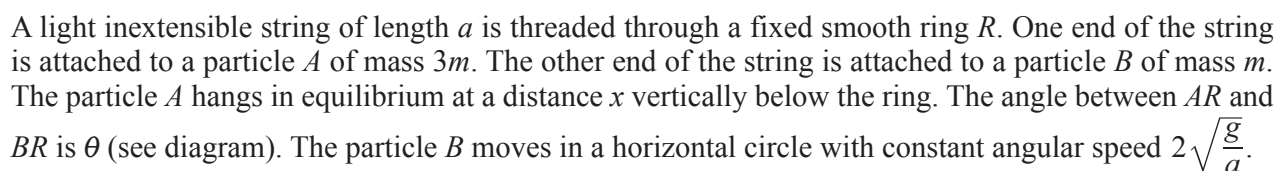
This document has **16** pages. Blank pages are indicated.

- 1 A particle P is projected with speed u at an angle of 30° above the horizontal from a point O on a horizontal plane and moves freely under gravity. The particle reaches its greatest height at time T after projection.

Find, in terms of u , the speed of P at time $\frac{2}{3}T$ after projection.

[5]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

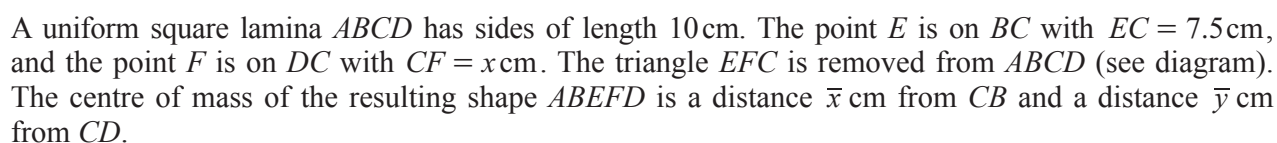
[illegible]

- 3** One end of a light elastic spring, of natural length a and modulus of elasticity $5mg$, is attached to a fixed point A . The other end of the spring is attached to a particle P of mass m . The spring hangs with P vertically below A . The particle P is released from rest in the position where the extension of the spring is $\frac{1}{2}a$.

(a) Show that the initial acceleration of P is $\frac{3}{2}g$ upwards. [3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook 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.

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- [illegible]

- [illegible]

- 5 A particle P is moving along a straight line with acceleration $3ku - kv$ where v is its velocity at time t , u is its initial velocity and k is a constant. The velocity and acceleration of P are both in the direction of increasing displacement from the initial position.

(a) Find the time taken for P to achieve a velocity of $2u$.

[3]

[illegible]

[illegible]

- 6 A particle P of mass m is moving with speed u on a fixed smooth horizontal surface. The particle strikes a fixed vertical barrier. At the instant of impact the direction of motion of P makes an angle α with the barrier. The coefficient of restitution between P and the barrier is e . As a result of the impact, the direction of motion of P is turned through 90° .

(a) Show that $\tan^2 \alpha = \frac{1}{e}$. [3]

[illegible]

The particle P loses two-thirds of its kinetic energy in the impact.

(b) Find the value of α and the value of e .

[5]

[illegible]

- 7 A hollow cylinder of radius a is fixed with its axis horizontal. A particle P , of mass m , moves in part of a vertical circle of radius a and centre O on the smooth inner surface of the cylinder. The speed of P when it is at the lowest point A of its motion is $\sqrt{\frac{7}{2}ga}$.

The particle P loses contact with the surface of the cylinder when OP makes an angle θ with the upward vertical through O .

- (a)** Show that $\theta = 60^\circ$. [5]

[illegible]

(b) Show that in its subsequent motion P strikes the cylinder at the point A .

[5]

[illegible]

[illegible]

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