



Cambridge International AS & A Level

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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]

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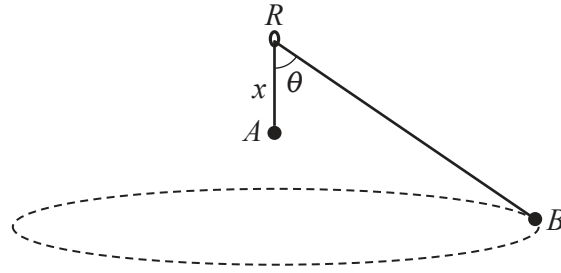
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A light inextensible string of length a is threaded through a fixed smooth ring R . One end of the string is attached to a particle A of mass $3m$. The other end of the string is attached to a particle B of mass m . The particle A hangs in equilibrium at a distance x vertically below the ring. The angle between AR and BR is θ (see diagram). The particle B moves in a horizontal circle with constant angular speed $2\sqrt{\frac{g}{a}}$.

Show that $\cos \theta = \frac{1}{3}$ and find x in terms of a . [5]

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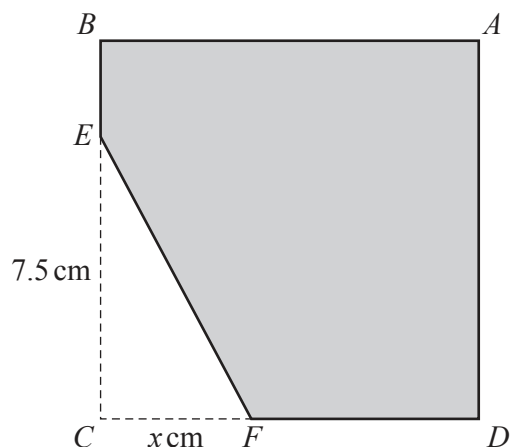
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4



A uniform square lamina $ABCD$ has sides of length 10 cm. The point E is on BC with $EC = 7.5$ cm, and the point F is on DC with $CF = x$ cm. The triangle EFC is removed from $ABCD$ (see diagram). The centre of mass of the resulting shape $ABEFD$ is a distance \bar{x} cm from CB and a distance \bar{y} cm from CD .

- (a) Show that $\bar{x} = \frac{400-x^2}{80-3x}$ and find a corresponding expression for \bar{y} . [4]

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(b) Find an expression for the displacement of P from its initial position when its velocity is $2u$. [5]

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- 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]

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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]

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- 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]

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Additional Page

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