



Cambridge International AS & A Level

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FURTHER MATHEMATICS

9231/32

Paper 3 Further Mechanics

October/November 2024

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 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 [].

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[3]

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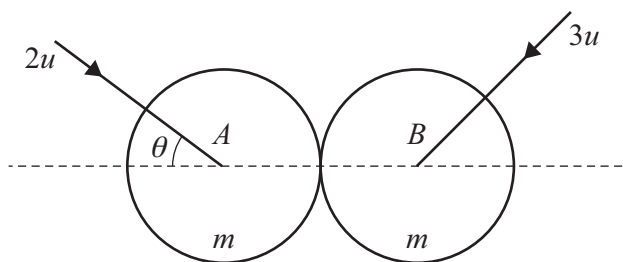
- 2 A particle P of mass m is attached to one end of a light elastic spring of natural length a and modulus of elasticity $5mg$. The other end of the spring is attached to a fixed point O . The spring hangs vertically with P below O . The particle P is pulled down vertically and released from rest when the length of the spring is $\frac{3}{2}a$.

Find the distance of P below O when P first comes to instantaneous rest. [4]

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3



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(b) Find the total loss of kinetic energy as a result of the collision.

[2]

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(c) Find, in degrees, the angle through which the direction of motion of A is deflected as a result of the collision.

[2]

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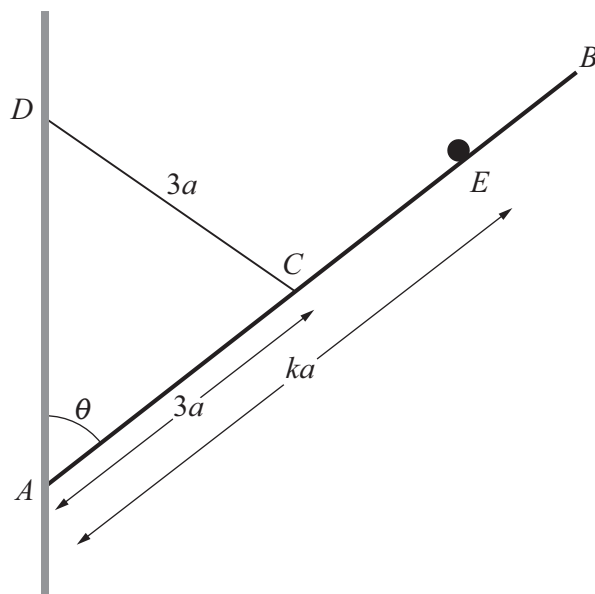
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4



The end A of a uniform rod AB of length $6a$ and weight W is in contact with a rough vertical wall. One end of a light inextensible string of length $3a$ is attached to the midpoint C of the rod. The other end of the string is attached to a point D on the wall, vertically above A . The rod is in equilibrium when the angle between the rod and the wall is θ , where $\tan \theta = \frac{3}{2}$. A particle of weight W is attached to the point E on the rod, where the distance AE is equal to ka ($3 < k < 6$) (see diagram). The rod and the string are in a vertical plane perpendicular to the wall. The coefficient of friction between the rod and the wall is $\frac{1}{3}$. The rod is about to slip down the wall.

- (a)** Find the value of k .

[5]

[illegible]

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- (b)** Find, in terms of W , the magnitude of the frictional force between the rod and the wall. [2]

[illegible]



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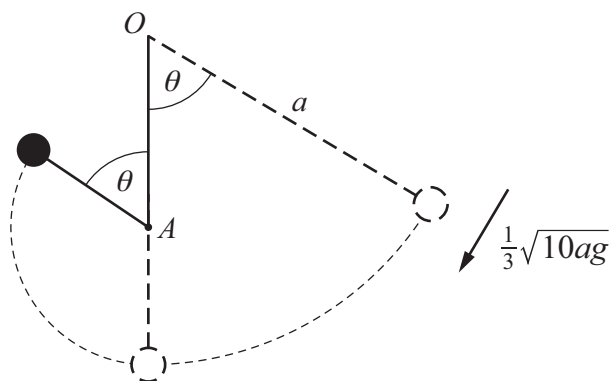
At the instant when P is moving horizontally, a particle Q is projected from O with speed V at an angle α above the horizontal. The particles P and Q reach the ground at the same point and at the same time.

(b) Express V^2 in the form kag , where k is a rational number. [6]

[illegible]



6



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 is held with the string taut and the string makes an angle θ with the downward vertical through O . The particle P is projected at right angles to the string with speed $\frac{1}{3}\sqrt{10ag}$ and begins to move downwards along a circular path. When the string is vertical, it strikes a small smooth peg at the point A which is vertically below O . The circular path and the point A are in the same vertical plane. After the string strikes the peg, the particle P begins to move in a vertical circle with centre A . When the string makes an angle θ with the upward vertical through A the string becomes slack (see diagram). The distance of A below O is $\frac{5}{9}a$.

- (a) Find the value of $\cos \theta$. [6]

[illegible]



- (b) Find the ratio of the tensions in the string immediately before and immediately after it strikes the peg. [4]





- (a) Find an expression for v in terms of t . [6]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for writing. The lines are evenly spaced across the entire page, providing a guide for letter height and placement. There is no text or other markings on the page.



The displacement of P from O at time t s is x m.

- (b)** Find an expression for v^2 in terms of x . [5]

[illegible]



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