

CANDIDATE
NAME

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CENTRE
NUMBER

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FURTHER MATHEMATICS

9231/23

Paper 2

May/June 2019

3 hours

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF10)

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value is necessary, take the acceleration due to gravity to be 10 m s^{-2} .

The use of a calculator is expected, where appropriate.

Results obtained solely from a graphic calculator, without supporting working or reasoning, will not receive credit.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **23** printed pages and **1** blank page.



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(ii) Find the tension in the string when P is at B . [2]

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- (ii) Given that A and C are moving with equal speeds after these two collisions, find the value of e . [3]

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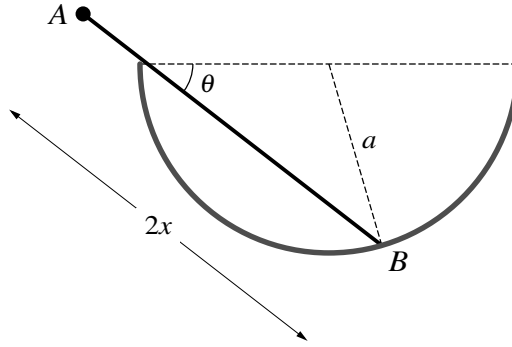
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5



A uniform rod AB of length $2x$ and weight W rests on the smooth rim of a fixed hemispherical bowl of radius a . The end B of the rod is in contact with the rough inner surface of the bowl. The coefficient of friction between the rod and the bowl at B is $\frac{1}{3}$. A particle of weight $\frac{1}{4}W$ is attached to the end A of the rod. The end B is about to slip upwards when AB is inclined at an angle θ to the horizontal, where $\tan \theta = \frac{3}{4}$ (see diagram).

- (i) By resolving parallel to the rod, show that the normal component of the reaction of the bowl on the rod at B is $\frac{3}{4}W$. [5]

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(ii) Find, in terms of W , the reaction between the rod and the smooth rim of the bowl. [4]

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(iii) Find x in terms of a . [3]

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6 The random variable T is the lifetime, in hours, of a randomly chosen battery of a particular type. It is given that T has a negative exponential distribution with mean 400 hours.

(i) Write down the probability density function of T . [1]

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(ii) Find the probability that a battery of this type has a lifetime that is less than 500 hours. [2]

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(iii) Find the median of the distribution. [3]

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7 A pair of fair coins is thrown repeatedly until a pair of tails is obtained. The number of throws taken is denoted by the random variable X .

(i) State the expected value of X . [1]

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(ii) Find the probability that exactly 3 throws are required to obtain a pair of tails. [2]

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(iii) Find the probability that fewer than 4 throws are required to obtain a pair of tails. [2]

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(iv) Find the least integer N such that the probability of obtaining a pair of tails in fewer than N throws is more than 0.95. [3]

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(ii) Find a 95% confidence interval for the population mean yield for plants grown in the new soil. [3]

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(ii) Test at the 5% significance level whether there is evidence of positive correlation between x and y . [4]

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(iii) Calculate an estimate of y when $x = 6.0$ and comment on the reliability of your estimate. [2]

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