



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9231/32

May/June 2023

1 hour 30 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

- 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} .

- 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. Any blank pages are indicated.

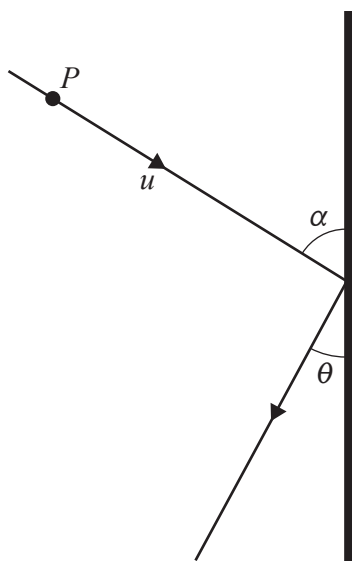
- 1** One end of a light elastic string, of natural length a and modulus of elasticity $3mg$, is attached to a fixed point O . The other end of the string is attached to a particle P of mass m . The string hangs with P vertically below O . The particle P is pulled vertically downwards so that the extension of the string is $2a$. The particle P is then released from rest.

- (a) Find the speed of P when it is at a distance $\frac{3}{4}a$ below O . [3]

[illegible]

- (b) Find the initial acceleration of P when it is released from rest. [2]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.



Find the value of e .

[5]

[illegible]

- 3 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 at the point A , where OA makes an angle θ with the downward vertical through O , and with the string taut. The particle P is projected perpendicular to OA in an upwards direction with speed u . It then starts to move along a circular path in a vertical plane. The string goes slack when P is at B , where angle AOB is 90° and the speed of P is $\sqrt{\frac{4}{5}ag}$.

- (a) Find the value of $\sin \theta$. [2]

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- (b) Find, in terms of m and g , the tension in the string when P is at A . [5]

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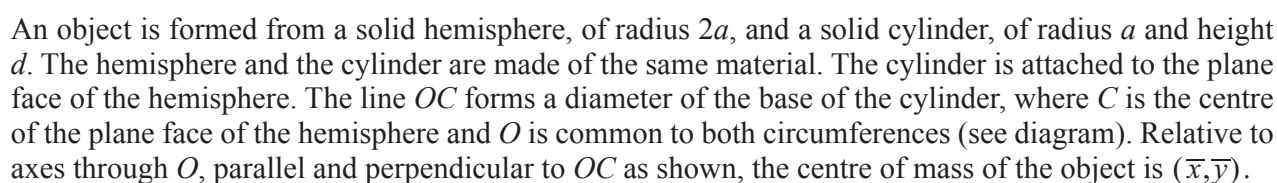
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- This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

The object is placed on a rough plane which is inclined to the horizontal at an angle θ where $\sin \theta = \frac{1}{6}$. The object is in equilibrium with CO horizontal, where CO lies in a vertical plane through a line of greatest slope.

(b) Find d in terms of a .

[3]

This image shows a full page of primary-ruled paper. It features approximately 20 horizontal dashed lines spaced evenly down the page, providing a guide for handwriting practice. The lines are thin and light gray, set against a plain white background. There are no margins, text, or other markings on the page.

- 5 A light elastic string of natural length a and modulus of elasticity λmg has one end attached to a fixed point O on a smooth horizontal surface. When a particle of mass m is attached to the free end of the string, it moves with speed v in a horizontal circle with centre O and radius x . When, instead, a particle of mass $2m$ is attached to the free end of the string, this particle moves with speed $\frac{1}{2}v$ in a horizontal circle with centre O and radius $\frac{3}{4}x$.

(a) Find x in terms of a .

[5]

[illegible]

(b) Given that $v = \sqrt{12ag}$, find the value of λ .

[2]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

- 6** A particle P moving in a straight line has displacement x m from a fixed point O on the line and velocity v m s⁻¹ at time t s. The acceleration of P , in m s⁻², is given by $6v\sqrt{v+9}$. When $t = 0$, $x = 2$ and $v = 72$.

(a) Find an expression for v in terms of x .

[4]

[illegible]

(b) Find an expression for x in terms of t .

[5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice 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.

- 7 At time ts , a particle P is projected with speed 40 ms^{-1} at an angle θ above the horizontal from a point O on a horizontal plane and moves freely under gravity. The greatest height achieved by P during its flight is $H \text{ m}$ and the corresponding time is $T \text{ s}$.

(a) Obtain expressions for H and T in terms of θ . [2]

During the time between $t = T$ and $t = 3$, P descends a distance $\frac{1}{4}H$.

(b) Find the value of θ . [4]

This image shows a full page of primary-ruled paper. It features multiple horizontal rows, each defined by two parallel dashed lines. The rows are evenly spaced and extend across the entire width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the paper.

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[illegible]

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