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**MATHEMATICS**

**9709/52**

Paper 5 Mechanics 2 **(M2)**

**February/March 2018**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

**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 for the acceleration due to gravity is needed, use  $10 \text{ m s}^{-2}$ .

The use of an electronic calculator is expected, where appropriate.

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.

The total number of marks for this paper is 50.

This document consists of **15** printed pages and **1** blank page.



**BLANK PAGE**

- [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 2** An object is projected with speed  $15 \text{ m s}^{-1}$  at an angle of  $35^\circ$  above the horizontal from a point on horizontal ground. Find the speed and direction of motion of the object at time 2 s after the instant of projection. [5]

[illegible]

- 3 A small ball  $B$  is connected to one end of a light elastic string of natural length  $0.4\text{ m}$  and modulus of elasticity  $12\text{ N}$ . The other end of the string is attached to a fixed point  $A$ . The ball is projected with speed  $1\text{ m s}^{-1}$  vertically downwards from a position  $0.4\text{ m}$  vertically below  $A$ , and reaches its greatest speed at the point  $0.7\text{ m}$  below  $A$ .

(i) Show that the mass of  $B$  is  $0.9\text{ kg}$ .

[2]

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(ii) Calculate the greatest speed of  $B$ .

[4]

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- 4 A particle  $P$  is projected from a point  $O$  on horizontal ground. At the instant  $t$  s after projection, the horizontal and vertically upwards displacements of  $P$  from  $O$  are  $x$  m and  $y$  m respectively. The equation of the trajectory of  $P$  is  $y = 3x - 0.05x^2$ .

(i) Find the angle of projection and the initial speed of  $P$ . [3]

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(ii) Find the coordinates of  $P$  at the instant when  $OP$  makes an angle of  $45^\circ$  with the horizontal. [2]

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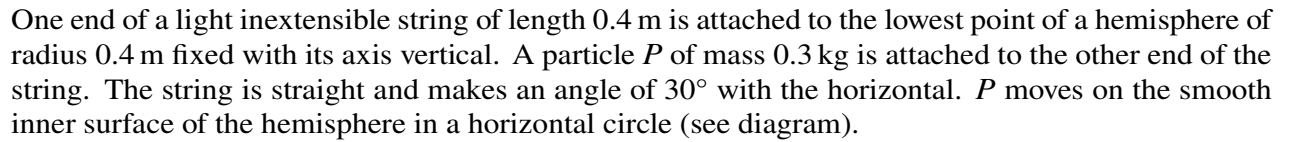
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- (iii) For the instant when  $P$  is at its greatest height above the ground, calculate this height and the corresponding value of  $t$ . [4]

[illegible]

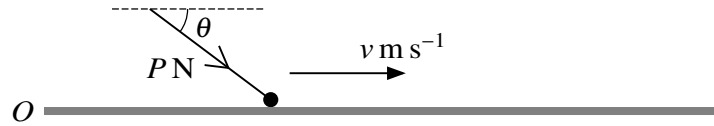


- [illegible]

- (ii) Given that the greatest possible tension in the string is 5 N, calculate the greatest possible speed of  $P$ . [4]

This image shows a full page of white paper with horizontal dotted 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.

6



A small object of mass  $0.2\text{ kg}$  rests at a point  $O$  on a rough horizontal surface. The coefficient of friction between the object and the surface is  $0.5$ . A force of magnitude  $P\text{ N}$  acting at an angle  $\theta$  below the horizontal is applied to the object. The velocity of the object is  $v\text{ m s}^{-1}$  away from  $O$  at time  $t\text{ s}$  after the force begins to act (see diagram). It is given that  $\tan \theta = \frac{3}{4}$  and that  $P = 0.4t$  for  $0 \leq t \leq 8$ .

- (i) Find the value of  $t$  when the object starts to move. [3]

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- (ii) Show that, when the force is acting and the object is in motion,  $\frac{dv}{dt} = t - 5$ . [2]

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(iii) Find the distance travelled by the object after  $t = 8$  before it comes to rest. [5]

[illegible]



(i) Show that  $r = 0.214$ , correct to 3 significant figures.

[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 entire width of the page. There are no margins, text, or other markings present.



The lamina is held in equilibrium with  $AD$  horizontal by a force of magnitude  $15\text{ N}$  acting in the plane of the lamina applied at  $D$ . The line of action of this force makes an angle of  $60^\circ$  with the vertical (see Fig. 2).

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- 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 entire width of the page. There are no margins, text, or other markings present.



[illegible]

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