



**Surname** \_\_\_\_\_

**Forename(s)** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**I declare this is my own work.**

**A-level**

**FURTHER MATHEMATICS**

**Paper 3 Mechanics**

**7367/3M**

**Friday 7 June 2024 Afternoon**

**Time allowed: 2 hours**

**At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.**

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## **MATERIALS**

- You must have the AQA Formulae and statistical tables booklet for A-level Mathematics and A-level Further Mathematics.
- You should have a graphical or scientific calculator that meets the requirements of the specification.
- You must ensure you have the other optional Question Paper/Answer Book for which you are entered (EITHER Discrete OR Statistics). You will have 2 hours to complete BOTH papers.

## **INSTRUCTIONS**

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer ALL questions.
- You must answer each question in the space provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do NOT write on blank pages.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work you do not want to be marked.



## INFORMATION

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 50.

## ADVICE

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



Answer ALL questions in the spaces provided.

- 1 A particle moves in a circular path so that at time  $t$  seconds its position vector,  $r$  metres, is given by

$$r = 4 \sin(2t)\mathbf{i} + 4 \cos(2t)\mathbf{j}$$

Find the velocity of the particle, in  $\text{m s}^{-1}$ , when  $t = 0$

Circle your answer. [1 mark]

$8\mathbf{i}$

$-8\mathbf{j}$

$8\mathbf{j}$

$8\mathbf{i} - 8\mathbf{j}$



- 2 As a particle moves along a straight horizontal line, it is subjected to a force  $F$  newtons that acts in the direction of motion of the particle.

At time  $t$  seconds,  $F = \frac{t}{5}$

Calculate the magnitude of the impulse on the particle between  $t = 0$  and  $t = 3$

Circle your answer. [1 mark]

0.3 N s

0.6 N s

0.9 N s

1.8 N s

[Turn over]

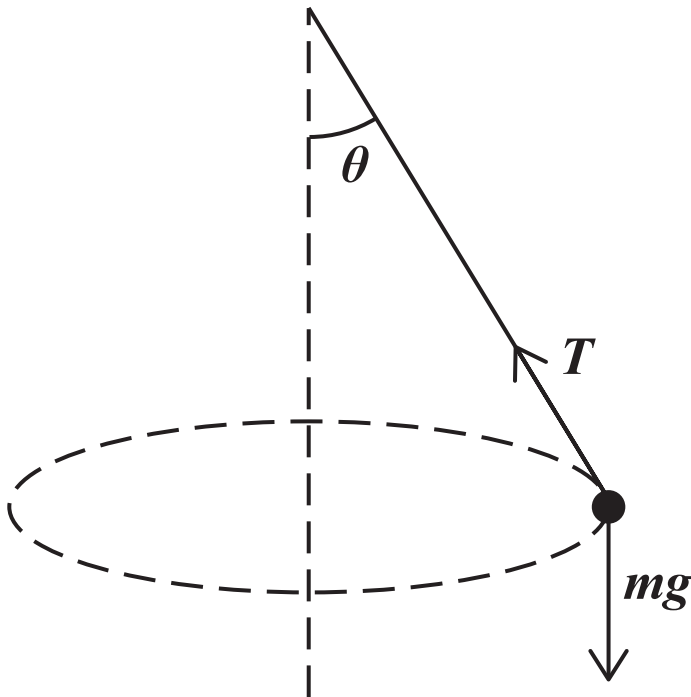


- 3 A conical pendulum consists of a light string and a particle of mass  $m$  kg

The conical pendulum completes horizontal circles with radius  $r$  metres and angular speed  $\omega$  radians per second. The string makes an angle  $\theta$  with the downward vertical.

The tension in the string is  $T$  newtons.

The conical pendulum and the forces acting on the particle are shown in the diagram.



Which one of the following statements is correct?

Tick (✓) ONE box. [1 mark]

$T \cos \theta = m r \omega^2$

$T \sin \theta = m r \omega^2$

$T \cos \theta = \frac{m \omega^2}{r}$

$T \sin \theta = \frac{m \omega^2}{r}$

[Turn over]





**4 (b) Find the tension in the string. [1 mark]**

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**4 (c) Show that the angular speed of the particle is 48 revolutions per minute correct to two significant figures. [2 marks]**

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**[Turn over]**



- 5 When a sphere of radius  $r$  metres is falling at  $v$  m s<sup>-1</sup> it experiences an air resistance force  $F$  newtons.

The force is to be modelled as

$$F = kr^\alpha v^\beta$$

where  $k$  is a constant WITH UNITS kg m<sup>-2</sup>

- 5 (a) State the dimensions of  $F$  [1 mark]

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**6** IN THIS QUESTION USE  $g = 9.8 \text{ m s}^{-2}$

**A light elastic string has natural length 3 metres and modulus of elasticity 18 newtons.**

**One end of the elastic string is attached to a particle of mass 0.25 kg**

**The other end of the elastic string is attached to a fixed point  $O$**

**The particle is released from rest at a point  $A$ , which is 4.5 metres vertically below  $O$**



**6 (a)** Calculate the elastic potential energy of the string when the particle is at A [2 marks]

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**[Turn over]**



6 (b) The point  $B$  is 3 metres vertically below  $O$

Calculate the gravitational potential energy gained by the particle as it moves from  $A$  to  $B$   
[2 marks]

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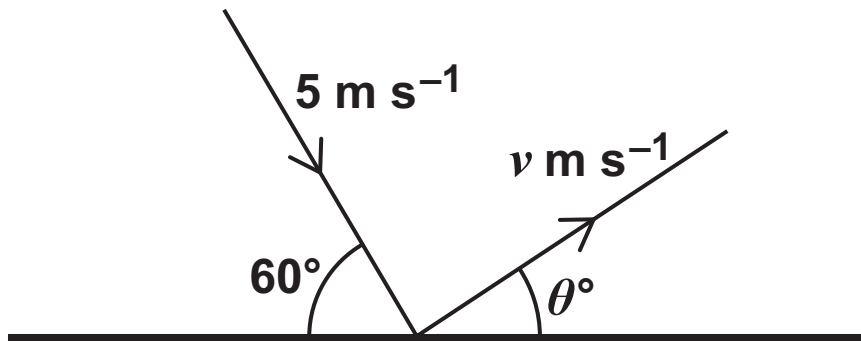


7 A sphere, of mass 0.2 kg, moving on a smooth horizontal surface, collides with a fixed wall.

Before the collision the sphere moves with speed  $5 \text{ m s}^{-1}$  at an angle of  $60^\circ$  to the wall.

After the collision the sphere moves with speed  $v \text{ m s}^{-1}$  at an angle of  $\theta^\circ$  to the wall.

The velocities are shown in the diagram below.



The coefficient of restitution between the wall and the sphere is 0.7





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**7 (a) (ii) Find the value of  $\theta$**

**Give your answer to the nearest whole number.  
[2 marks]**

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**7 (a) (iii) Find the magnitude of the impulse exerted on the sphere by the wall.**

**Give your answer to two significant figures.**

**[2 marks]**

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**7 (b) In reality the wall is not smooth.**

**Explain how this would cause a change in the magnitude of the impulse calculated in part (a)(iii). [2 marks]**

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**8(a) (ii) State the distance between the base of the cone and its centre of mass. [1 mark]**

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**8(b) State one assumption that you have made about the cone. [1 mark]**

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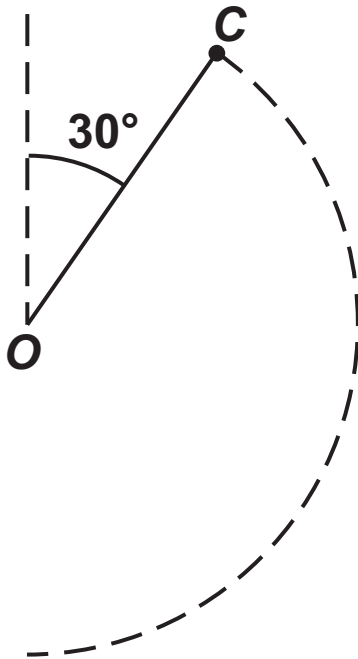
9 A small sphere, of mass  $m$ , is attached to one end of a light inextensible string of length  $a$

The other end of the string is attached to a fixed point  $O$

The sphere is at rest in equilibrium directly below  $O$  when it is struck, giving it a horizontal impulse of magnitude  $mU$

After the impulse, the sphere follows a circular path in a vertical plane containing the point  $O$  until the string becomes slack at the point  $C$

At  $C$  the string makes an angle of  $30^\circ$  with the upward vertical through  $O$ , as shown in the diagram below.







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**9 (b)** With reference to any modelling assumptions that you have made, explain why giving your answer as an inequality would be more appropriate, and state this inequality.  
[2 marks]

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**END OF QUESTIONS**







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For Examiner's Use	
Question	Mark
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<b>TOTAL</b>	

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**G/LM/Jun24/7367/3M/G4006/V3**