A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

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I declare this is my own work.

A-level

FURTHER MATHEMATICS

Paper 3 Mechanics

7367/3M

Wednesday 14 June 2023 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

For this paper you must have:

- **the AQA Formulae and statistical tables booklet for A-level Mathematics and A-level Further Mathematics**
- **a graphical or scientific calculator that meets the requirements of the specification**
- **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. Do NOT write outside the box around each page or on blank pages.**
- **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).**
- **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 **State the dimensions of power.**

Circle your answer. [1 mark]

ML^2T^{-3} ML^3T^{-3} ML^3T^{-2} ML^2T^{-2}

2 **The force $(3\mathbf{i} + 4\mathbf{j})$N acts at the point with coordinates (0, 2)**

The unit vectors i and j are directed along the x-axis and the y-axis respectively.

Calculate the magnitude of the moment of this force about the origin.

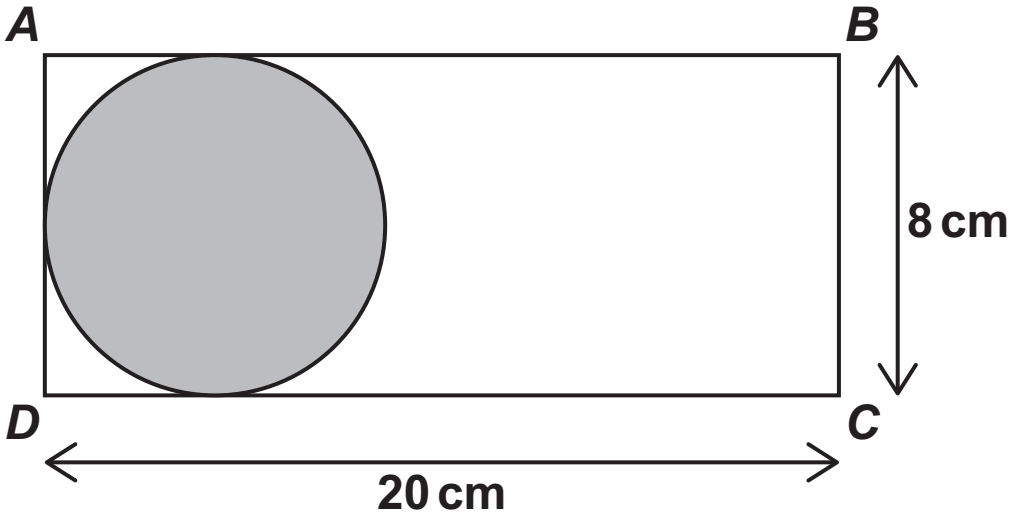
Circle your answer. [1 mark]

6Nm **8Nm** **10Nm** **14Nm**

3 A uniform disc has mass 6 kg and diameter 8 cm

A uniform rectangular lamina, *ABCD*, has mass 4 kg, width 8 cm and length 20 cm

The disc is fixed to the lamina to form a composite body as shown in the diagram below.



The sides *AB*, *AD* and *CD* are tangents to the disc.

Calculate the distance of the centre of mass of the composite body from *AD*

Circle your answer. [1 mark]

4 cm 5.6 cm 6.4 cm 8.8 cm

[Turn over]

4 A car of mass 1400 kg drives around a horizontal circular bend of radius 60 metres.

The car has a constant speed of 12 $m s^{-1}$ on the bend.

Calculate the magnitude of the resultant force acting on the car. [2 marks]

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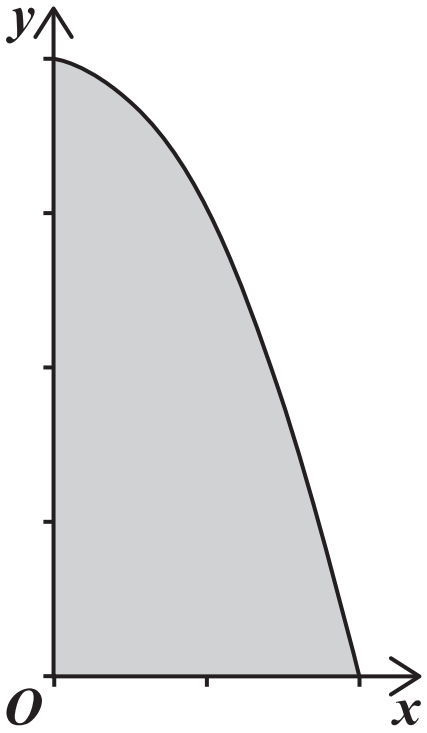
5 A region bounded by the curve with equation $y = 4 - x^2$, the x-axis and the y-axis is shown below.



The region is rotated through 360° around the x-axis to create a uniform solid.

5 (a) Show that the distance of the centre of mass of the solid from the circular face is $\frac{5}{8}$

[5 marks]

5(b) **The solid is suspended in equilibrium from a point on the edge of the circular face.**

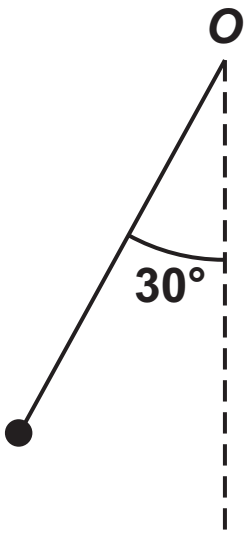
Find the angle between the circular face and the horizontal, giving your answer to the nearest degree. [2 marks]

6 **IN THIS QUESTION USE $g = 10\,\text{m s}^{-2}$**

A sphere of mass 0.8 kg is attached to one end of a string of length 2 metres.

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

The sphere is released from rest with the string taut and at an angle of 30° to the vertical, as shown in the diagram below.



6 (a) **Find the speed of the sphere when it is directly below *O* [3 marks]**

6(b) **State one assumption that you made about the string. [1 mark]**

6 (c) **As the sphere moves, the string makes an angle θ with the downward vertical.**

By finding an expression for the tension in the string in terms of θ, show that the tension is a maximum when the sphere is directly below *O*.
[6 marks]

6(d) A physics student conducts an experiment and uses a device to measure the tension in the string when the sphere is directly below *O*

They find that the tension is 9.5 newtons.

Explain why this result is reasonable, showing any calculations that you make. [2 marks]

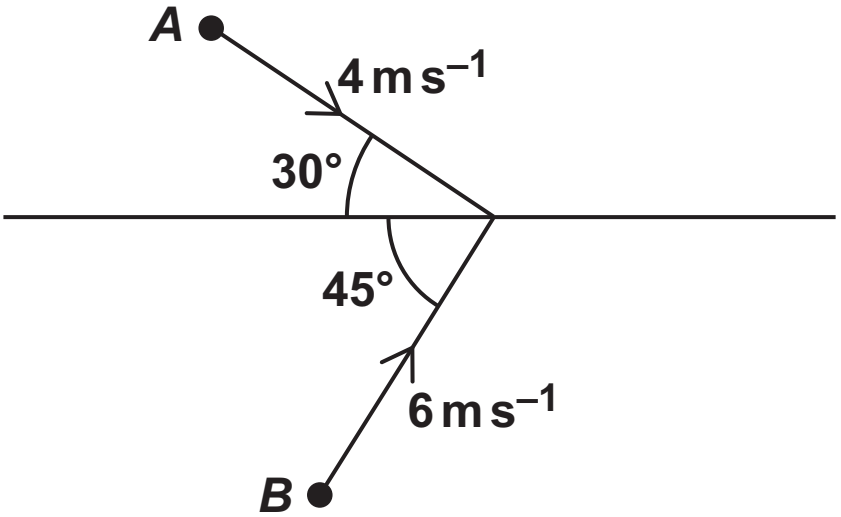
7 Two particles, *A* and *B*, are moving on a smooth horizontal surface.

A straight line has been marked on the surface and the particles are on opposite sides of the line.

Particle *A* has mass 2 kg and moves with velocity $4\,m\,s^{-1}$ at an angle of 30° to the line.

Particle *B* has mass 3 kg and moves with velocity $6\,m\,s^{-1}$ at an angle of 45° to the line.

The particles and their velocities are shown in the diagram below.



The particles collide when they reach the line and then move together as a single combined particle.

7 (a) **Show that the magnitude of the impulse on particle *A* during the collision is 7.55 N s correct to three significant figures. [8 marks]**

7 (b) **State the magnitude of the impulse on *B* during the collision, giving a reason for your answer. [2 marks]**

7 (c) **Find the size of the angle between the straight line and the IMPULSE acting on *B*, giving your answer to the nearest degree. [2 marks]**

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7 (d) **During the collision, one particle crosses the straight line.**

State which particle crosses the line, giving a reason for your answer. [1 mark]

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

A block has mass 10 kg and is at rest 1 metre from a fixed point *O* on a horizontal surface.

One end of an elastic string is attached to the block and the other end of the elastic string is attached to the point *O*

The elastic string has modulus of elasticity 40 newtons and natural length 2 metres.

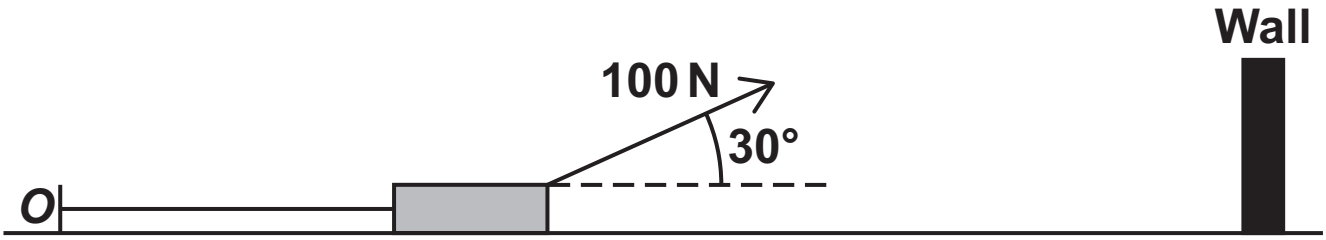
The coefficient of friction between the block and the surface is 0.6

A force is applied to the block so that it starts to move towards a vertical wall.

The block moves on a line that is perpendicular to the wall.

The force has magnitude 100 newtons and acts at an angle of 30° to the horizontal.

The situation is shown in the diagram below.



8 (a) **Show that the distance that the block has moved, when the forces acting on it are in equilibrium, is 3.9 metres correct to two significant figures. [4 marks]**

8 (b) State one limitation of the model that you have used. [1 mark]

8 (c) Find the maximum speed of the block. [4 marks]

8 (d) The vertical wall is 8.7 metres from O

Determine whether the block reaches the wall, showing any calculations that you make.
[4 marks]

END OF QUESTIONS

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.
Write the question numbers in the left-hand margin.

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Question	Mark
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