

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL A-LEVEL FURTHER MATHEMATICS

(9665/FM05) Unit FM2 Mechanics

Wednesday 18 January 2023 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the Oxford International AQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphical calculator.

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces 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).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to two significant figures, unless stated otherwise.
- Unless stated otherwise, the acceleration due to gravity, g , should be taken as 9.8 m s^{-2}

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

For Examiner's Use	
Question	Mark
1	
2	
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8	
9	
TOTAL	



J A N 2 3 F M 0 5 0 1

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FM05

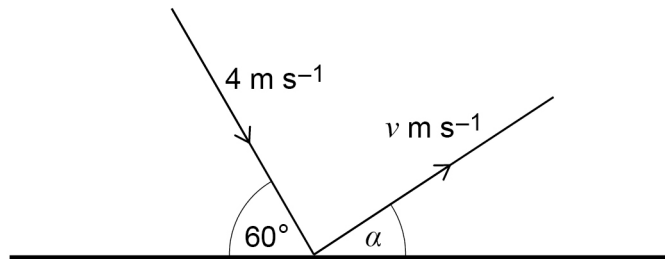
4



4

When the disc hits the wall, it has a speed of 4 m s^{-1} and is moving at an angle of 60° to the wall.

The motion of the disc is shown in the diagram below.



[4 marks]

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on the right side, suggesting it's resting on a surface.

3 (b) Determine the range of possible values of v

[2 marks]

Answer

6

Turn over for the next question

Turn over ►



A diagram showing a projectile launched from point A on an inclined plane. The incline makes an angle of 10° with the horizontal. The projectile is launched at an angle θ to the incline with an initial velocity of $V \text{ m s}^{-1}$. It follows a parabolic path and lands at point B on the incline.

[5 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Answer _____

4 (b) Calculate the value of V giving your answer to **two** significant figures.

[2 marks]

 $V =$ _____

7

Turn over ►



[6 marks]

[illegible]

[4 marks]

[illegible]

Answer _____

10

Turn over for the next question

Turn over ►



One end of the string is attached to a fixed point O and the other end is attached to a small sphere of mass 0.2 kg

The sphere is released from rest at O and falls vertically.

[4 marks]

[illegible]

Answer

[3 marks]



[5 marks]

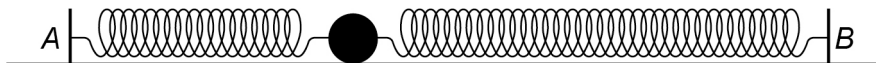
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Answer _____

12

- 7** A particle of mass m kg is on a smooth horizontal surface.

Two springs are attached to the particle, with the other ends of the springs attached to fixed points A and B , as shown in the diagram.



The spring attached to A has stiffness $4k \text{ N m}^{-1}$ and natural length $2d$ metres.

The spring attached to B has stiffness $3k \text{ N m}^{-1}$ and natural length $3d$ metres.

The distance between A and B is $7d$ metres.

- 7 (a)** Find in terms of d the distance of the particle from A when it is in equilibrium.

[3 marks]

Answer _____



- In the subsequent motion the displacement of the particle to the right of its equilibrium position is x metres at time t seconds.

- [2 marks]**

Answer

- [5 marks]**

[illegible]

Question 7 continues on the next page

Turn over ►



7 (b) (iii) Find in terms of k , m and π the period of the motion.

[2 marks]

Answer _____

7 (b) (iv) Determine the maximum speed of the particle in terms of d , k and m

[2 marks]

Answer _____



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

Turn over ►



8

A block of mass 1.5 kg is placed on a rough horizontal surface.

The coefficient of friction between the block and the surface is 0.3

A light inextensible string is attached to the block and passes over a smooth peg.

The smooth peg is positioned on the edge of the horizontal surface.

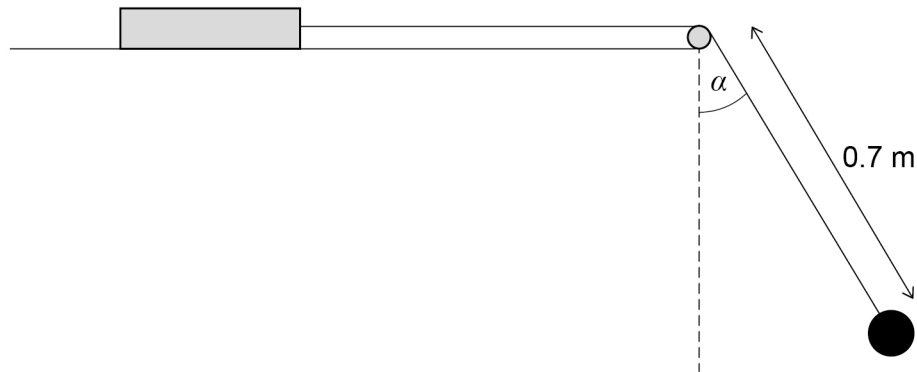
The string between the block and the peg is horizontal.

The other end of the string is attached to a particle of mass 0.4 kg

The particle is released from rest with the string at an angle α degrees to the downward vertical.

The initial path of the particle is part of a vertical circle of radius 0.7 metres.

The diagram below shows the initial situation.



8 (a) In a first case $\alpha = 30$

Find the angle between the string and the vertical when the block is on the point of sliding for the first time, giving your answer to the nearest degree.

[7 marks]



8 (b) In a second case the block does not move.

Find the maximum possible value of α giving your answer to the nearest degree.

12



9

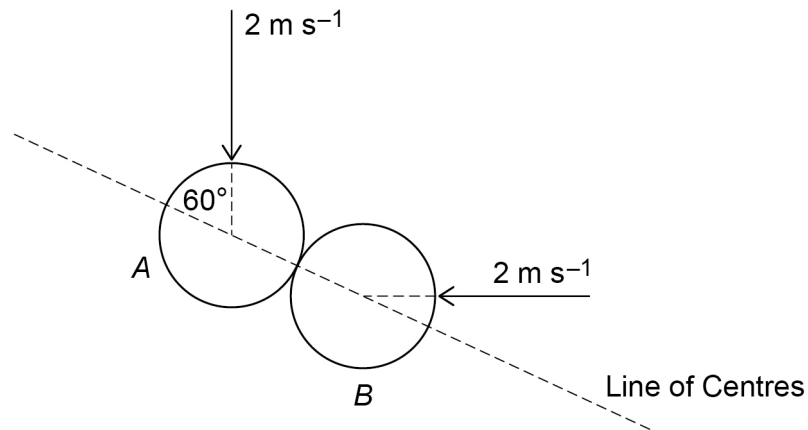
Two smooth spheres, A and B , have the same radius of 1 cm and are moving on a horizontal surface when they collide.

The velocities of the spheres are perpendicular when they collide.

Before the collision, the speeds of both A and B are 2 m s^{-1}

On impact, the velocity of A makes an angle of 60° to the line of centres.

The diagram shows the directions of the velocities of the spheres before the collision.



The mass of A is 4 kg and the mass of B is 5 kg.

The coefficient of restitution between the spheres is $\frac{3}{4}$

Find the distance between the centres of the spheres 2 seconds after the collision, giving your answer to three significant figures.

[11 marks]



11

END OF QUESTIONS



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