

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

Friday 16 January 2026

07:00 UK Time

Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the OxfordAQA 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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11	
TOTAL	



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1 A disc is moving on a smooth horizontal surface when it collides with a smooth fixed vertical wall.

When the disc leaves the wall, it has velocity $v \text{ m s}^{-1}$ at an angle of θ° to the wall.

Find the value of θ

[4 marks]

[illegible]

$$\theta = \underline{\hspace{10cm}}$$

4

2 A particle of mass 3 kg is moving in a straight line on a smooth horizontal surface.

The displacement of the particle from the point O is x metres.

A force F newtons acts on the particle, where

$$F = \frac{x(5-x)}{4}$$

The force F acts along the line on which the particle is moving.

At O the particle has a speed of 4 m s^{-1}

The particle passes through the point A which has displacement 5 metres from O

2 (a) Find the work done by the force as the particle moves from O to A

Give your answer in an exact form.

[3 marks]

Answer _____



2 (b) Find the speed of the particle at A

Give your answer in the form $\frac{\sqrt{a}}{b}$ where a and b are integers.

[2 marks]

Answer _____

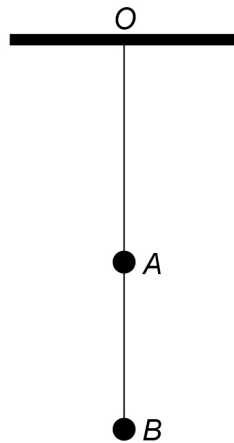
5

Turn over for the next question

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- 3** Two identical light elastic strings have natural length a metres and modulus of elasticity λ newtons.
- One end of the first string is attached to a fixed point O and the other end is attached to a particle A of mass 2 kg
- One end of the second string is also attached to A and the other end of this string is attached to a particle B of mass 3 kg
- The system is initially in equilibrium, with A and B vertically below O , as shown in **Figure 1**

Figure 1

- 3 (a)** Find the length OB

Give your answer in terms of a , g and λ

[4 marks]

Answer _____



3 (b) The upper string connecting A and O is now cut.

3 (b) (i) Find the magnitude of the acceleration of A at the instant that this string is cut.

Give your answer in terms of g

[2 marks]

Answer _____

3 (b) (ii) State the acceleration of B at the instant that this string is cut.

[1 mark]

Answer _____

<hr/> 7

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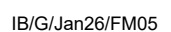


As the particle falls a resistance force of magnitude $\frac{v}{4}$ newtons acts on the particle.

[5 marks]

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Answer



- 4 (b) On the axes in **Figure 2** sketch a graph to show how v varies with t

[2 marks]

Figure 2



- 4 (c) Find the time that it takes for the particle to reach a speed of $2mg \text{ m s}^{-1}$

Give your answer in the form $m \ln a$ where a is an integer.

[2 marks]

Answer _____

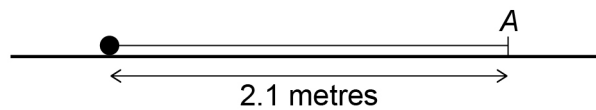
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- 5** A light elastic string has natural length 1.5 metres and modulus of elasticity 125 newtons. One end of the string is attached to a fixed point A on a horizontal surface. The other end of the string is attached to a particle of mass 4.2 kg. The coefficient of friction between the particle and the horizontal surface is μ . The particle is released from rest at a distance of 2.1 metres from A . The particle comes to rest with the string slack but before the particle reaches A . **Figure 3** shows the initial position of the particle.

Figure 3

- 5 (a)** Calculate the elastic potential energy of the string when its length is 2.1 metres.

[2 marks]

Answer _____



[5 marks]

[illegible]

Answer _____

[3 marks]

Answer _____

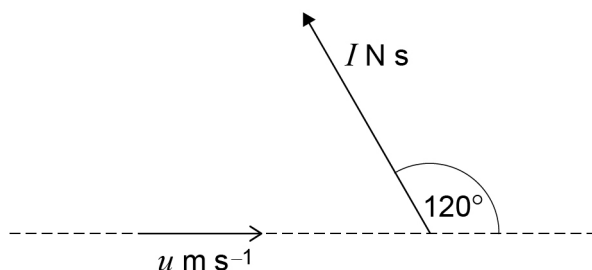
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6 A particle of mass m kg is moving with a speed u m s⁻¹ in a straight line on a smooth horizontal surface.

An impulse is exerted on the particle and causes it to change speed and direction.

The impulse of magnitude $I \text{ N s}$ acts at 120° to the original direction of motion of the particle as shown in **Figure 4**

Figure 4



After the impulse has been exerted the particle has speed $v \text{ m s}^{-1}$ and moves in a direction at an angle of 45° to the original motion of the particle.

6 (a) Express v in terms of u

Give your answer in an exact form.

[5 marks]

[illegible]

Answer



Give your answer in the form $mu(\sqrt{a}-b)$ where a and b are integers.

[illegible]

7

Turn over ►



- 7** A simple pendulum consists of a light inextensible string of length L metres attached to a small sphere.

The motion of a simple pendulum satisfies the differential equation

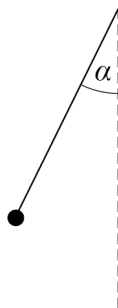
$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\theta$$

where θ radians is the angle between the string and the vertical at time t seconds.

It has been assumed that the angle θ is small.

The sphere is released from rest with the string taut and at an angle α to the downward vertical, as shown in **Figure 5**

Figure 5



For a particular simple pendulum $L = 0.7$ and the average speed of the sphere during each cycle is $\frac{7\sqrt{14}}{75} \text{ m s}^{-1}$

- 7 (a)** Find the value of α

Give your answer in terms of π

[3 marks]

Answer _____



- 7 (b)** Find the time that it takes for the angle between the string and the vertical to decrease from α to $\frac{\alpha}{3}$

Give your answer to three decimal places.

[3 marks]

Answer _____

6

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A particle is set into motion on the hemisphere so that it has a speed $U \text{ m s}^{-1}$ at the top of the hemisphere.

The radius OP makes an angle of 30° to the vertical as shown in **Figure 6**

Give your answer in terms of r and g

[5 marks]

[illegible]

Answer

E

- 9** A light spring has natural length 0.4 metres and stiffness 28 N m^{-1}
- One end of the spring is attached to a fixed point.
- The other end of the spring is attached to a particle of mass 0.2 kg
- The particle initially hangs in equilibrium below the fixed point.
- The particle is then pulled down and released from rest 0.03 metres below the equilibrium position.

- 9 (a)** Find the extension of the spring when the particle is in equilibrium.

[2 marks]

Answer _____

- 9 (b)** Show that the particle moves with simple harmonic motion.

[4 marks]



[1 mark]

Answer

[6 marks]

Answer

13

Turn over ►



Two spheres A and B of equal radius are moving on a smooth horizontal surface when they collide.

Before the collision A has velocity $\begin{bmatrix} 4 \\ -2 \end{bmatrix}$ m s⁻¹ and B has velocity $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$ m s⁻¹

After the collision A has velocity $\begin{bmatrix} 3 \\ 0 \end{bmatrix} \text{ m s}^{-1}$

Find the acute angle between the velocity of B after the collision and the line of centres at the time of the collision.

Give your answer to the nearest degree.

[7 marks]

[illegible]

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Answer _____

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11

A plane is inclined at an angle θ to the horizontal.

The points A and B are on the plane a distance of d metres apart.

A ball is projected from A up the plane with velocity $2V$ at an angle α to the plane, where $\alpha \leq 30^\circ$

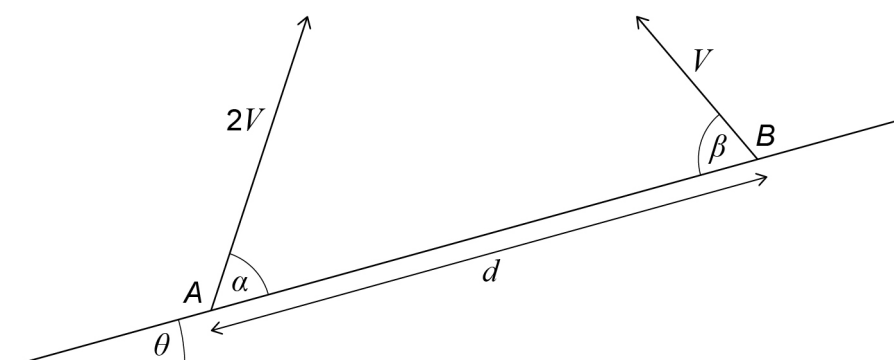
At the same instant in time a ball is projected from B down the plane with velocity V at an angle β to the plane.

The balls collide when they are each at their maximum distance from the plane.

The motion of the balls is in a plane that contains the line of greatest slope of the inclined plane.

Figure 7 shows the initial velocities of the balls.

Figure 7



Show that

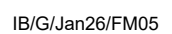
$$d = \frac{V^2}{2g\cos\theta} \left(4\sin(2\alpha) + \sin(2\beta) \right)$$

[7 marks]



[illegible]

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