A

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

AS

FURTHER MATHEMATICS

Paper 2 Mechanics

7366/2M

Friday 19 May 2023 Afternoon

Time allowed: 1 hour 30 minutes

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

[Turn over]

JUN237366 2M01

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 1 hour 30 minutes 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 on blank pages.**

- If you require 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 that you do not want to be marked.

INFORMATION

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 40.

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 along the x-axis under the action of a force, F newtons, where**

$$F = 3x^2 + 5$$

Find the work done by the force as the particle moves from $x = 0$ metres to $x = 2$ metres.

Circle your answer. [1 mark]

12 J **17 J**

18 J **34 J**

2 **Two particles are moving directly towards each other when they collide.**

Given that the collision is perfectly elastic, state the value of the coefficient of restitution.

Circle your answer. [1 mark]

$e = -1$ $e = 0$

$e = \frac{1}{2}$ $e = 1$

3 A stone of mass 0.2 kg is thrown vertically upwards with a speed of 10 m s^{-1}

Find the initial kinetic energy of the stone.

Circle your answer. [1 mark]

1 J

5 J

10 J

20 J

4 Reena is skating on an ice rink, which has a horizontal surface.

She follows a circular path of radius 5 metres and centre O

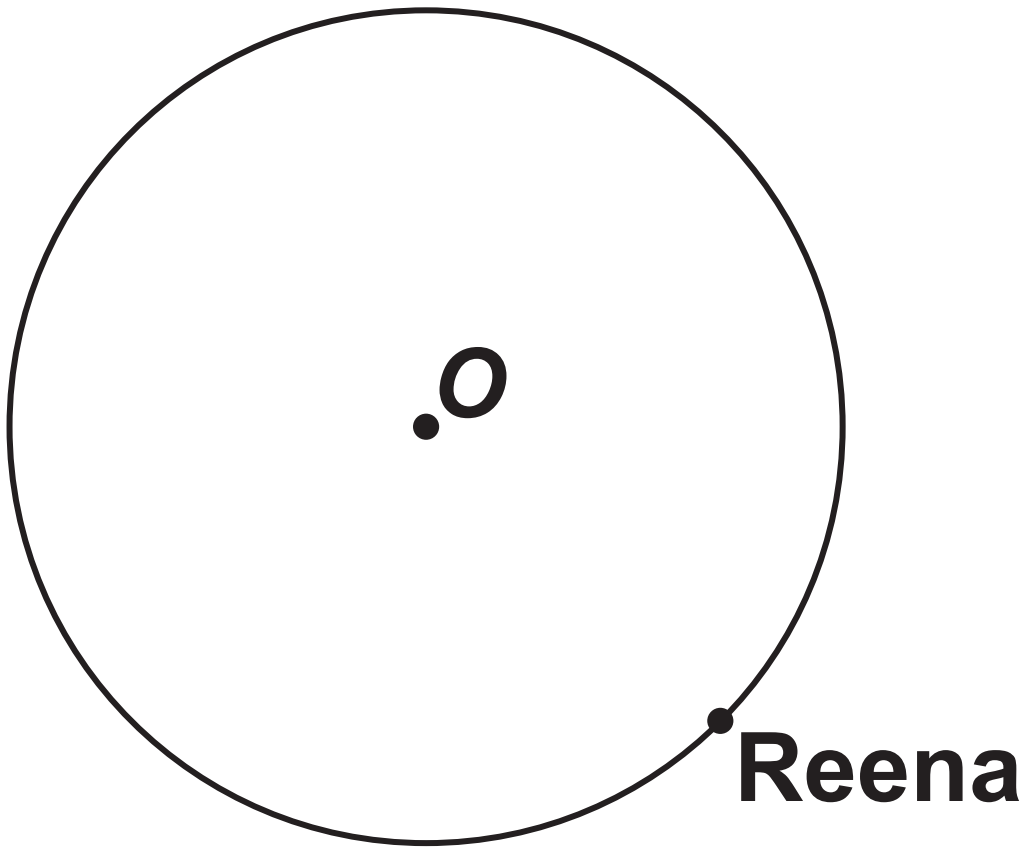
She completes 10 full revolutions in 1 minute, moving with a constant angular speed of ω radians per second.

The mass of Reena is 40 kg

4 (a) Find the value of ω [1 mark]

4 (b) (i) Find the magnitude of the horizontal resultant force acting on Reena. [2 marks]

4 (b) (ii) Show the direction of this horizontal resultant force on the diagram below. [1 mark]



5 An impulse of $\begin{bmatrix} -5 \\ 12 \end{bmatrix}$ N s is applied to a particle of mass 5 kg which is moving with velocity $\begin{bmatrix} 6 \\ 2 \end{bmatrix}$ m s^{-1}

5 (a) Calculate the magnitude of the impulse. [1 mark]

5 (b) **Find the SPEED of the particle immediately after the impulse is applied. [3 marks]**

6 A ball is thrown with speed u at an angle of 45° to the horizontal from a point O

When the horizontal displacement of the ball is x, the vertical displacement of the ball above O is y where

$$y = x - \frac{kx^2}{u^2}$$

6 (a) Use dimensional analysis to find the dimensions of k
[3 marks]

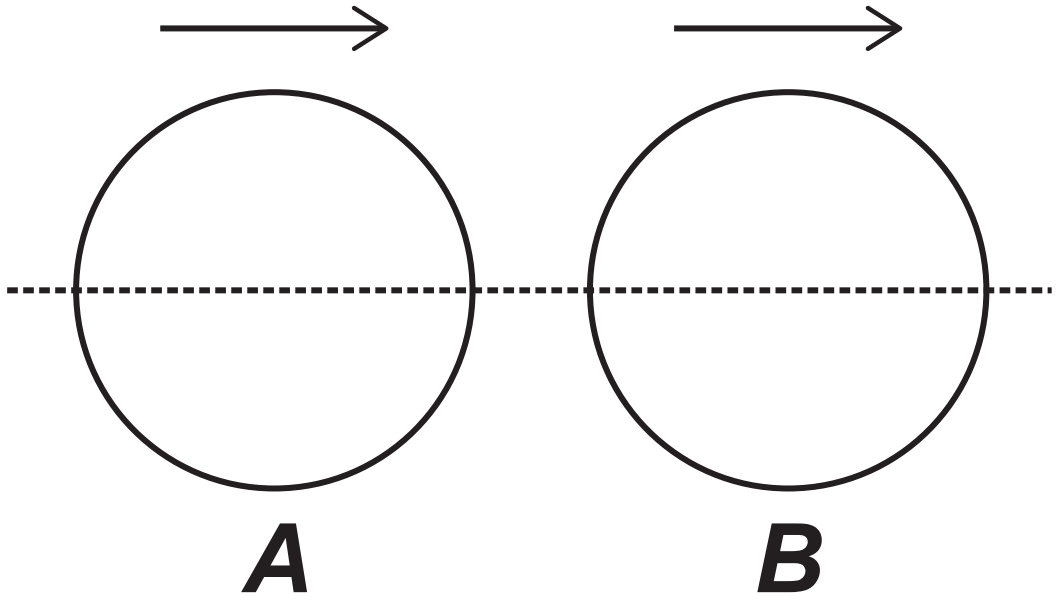
[Turn over]

6 (b) State what can be deduced about k from the dimensions that you found in part (a). [1 mark]

BLANK PAGE

[Turn over]

7 **Two smooth, equally sized spheres, *A* and *B*, are moving in the same direction along a straight line on a smooth horizontal surface, as shown in the diagram below.**



The spheres subsequently collide.

Immediately after the collision, *A* has speed 2.5 m s^{-1} and *B* has speed 3.5 m s^{-1}

The coefficient of restitution between the spheres is e

7 (a) (i) **Show that *A* does not change its direction of motion as a result of the collision.**
[2 marks]

7 (a) (ii) Find the value of e [1 mark]

7 (b) Given that the mass of B is 0.6 kg, find the mass of A [3 marks]

[Turn over]

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

Omar, a bungee jumper of mass 70 kg, has his ankles attached to one end of an elastic cord.

The other end of the cord is attached to a bridge which is 80 metres above the surface of a river.

Omar steps off the bridge at the point where the cord is attached and falls vertically downwards.

The cord can be modelled as a light elastic string of natural length L metres and modulus of elasticity 2800 N

Model Omar as a particle.

8 (a) Given that Omar just reaches the surface of the river before being pulled back up, find the value of L

Fully justify your answer.
[5 marks]

8 (b) If Omar is not modelled as a particle, explain the effect of revising this assumption on your answer to part (a).
[2 marks]

9 Christina is investigating two possible models for the resistance force, R newtons, acting on a car when it is moving in a straight line on a horizontal road.

She uses the following information in both models:

- Mass of the car is 1000 kg
- Maximum power of the engine is 51 kW
- With maximum power, the car accelerates at 4.9 m s^{-2} when travelling at 10 m s^{-1}

9 (a) For Model 1, Christina assumes that R is constant.

9 (a) (i) Show that $R = 200$ [3 marks]

9 (a) (ii) Hence, calculate the maximum possible speed of the car using Model 1. [2 marks]

9 (b) For Model 2, Christina assumes that $R = kv$, where k is a constant and v m s^{-1} is the speed of the car.

9 (b) (i) Find the value of k **[2 marks]**

9 (b) (ii) Hence, calculate the maximum possible speed of the car using Model 2. [2 marks]

9 (c) Evaluate each model, giving reasons for your answers.
[2 marks]

Model 1 _____

_____

_____

Model 2 _____

_____

_____

9 (d) **Suggest a further model for R that Christina could consider. [1 mark]**

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.

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.

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

BLANK PAGE

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	