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Candidate number

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INTERNATIONAL AS MATHEMATICS

(9660/MA02) Unit PSM1 Pure Mathematics, Statistics and Mechanics

Tuesday 9 January 2024 07:00 GMT 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.

Information

- The marks for questions are shown in brackets.
- There are three sections to this paper.
- The maximum mark for this paper is 80. There are 40 marks for **Section A**, 20 marks for **Section B** and 20 marks for **Section C**.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
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6	
7	
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9	
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11	
12	
TOTAL	

Advice

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



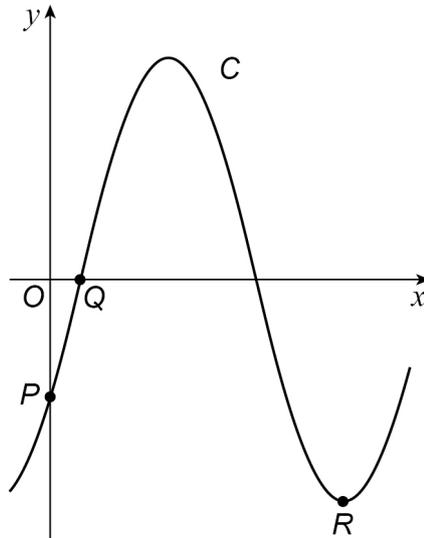
Section A

Pure Mathematics

Answer **all** questions in the spaces provided.

- 1 The diagram below shows part of the curve C with equation $y = 4 \sin(x - 30^\circ)$

Points P , Q and R lie on C



- 1 (a) The curve C has the following properties:

it intersects the y -axis at P

it intersects the x -axis at Q

it has a minimum at R

State the coordinates of P , the coordinates of Q and the coordinates of R

[3 marks]

P _____

Q _____

R _____



1 (b) The curve D has equation

$$y = 4\cos(x - 15^\circ)$$

Describe the transformation which maps C onto D

[2 marks]

5

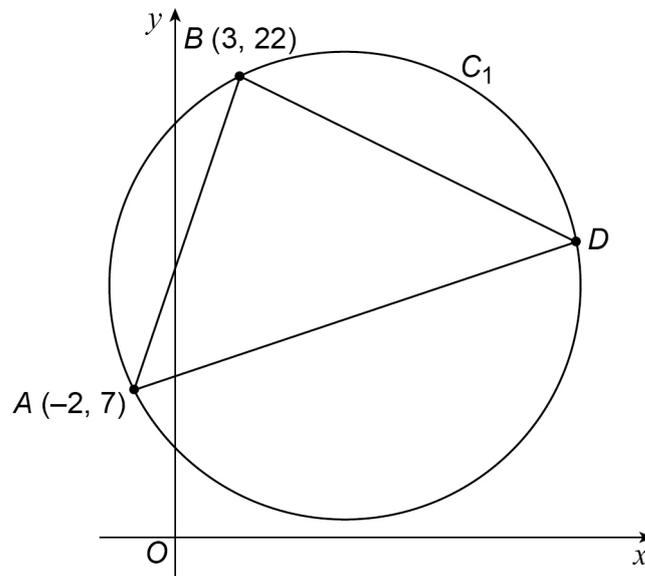
Turn over for the next question

Turn over ►



2 The circle C_1 and the triangle ABD are shown below.

The points $A(-2, 7)$, $B(3, 22)$ and D lie on the circle C_1



2 (a) The chord BD has gradient $-\frac{1}{2}$

Use the property of angles in a semicircle and the gradients of the chords AB and BD to show that the chord AD is **not** a diameter of C_1

[2 marks]

2 (b) (i) The point $E(18, 17)$ lies on C_1

The tangent to C_1 at A is parallel to the tangent to C_1 at E

Show that the coordinates of the centre of C_1 are $(8, 12)$

[1 mark]



2 (b) (ii) Find the equation of C_1

Give your answer in the form $(x-p)^2 + (y-q)^2 = k$ where p , q and k are integers.

[3 marks]

Answer _____

2 (c) Find the coordinates of the point where the normal to C_1 at B intersects the x -axis.

[3 marks]

Answer _____

2 (d) The circle C_2 has the same radius as C_1

The translation $\begin{bmatrix} -3 \\ 5 \end{bmatrix}$ maps C_2 onto C_1

Find the equation of C_2

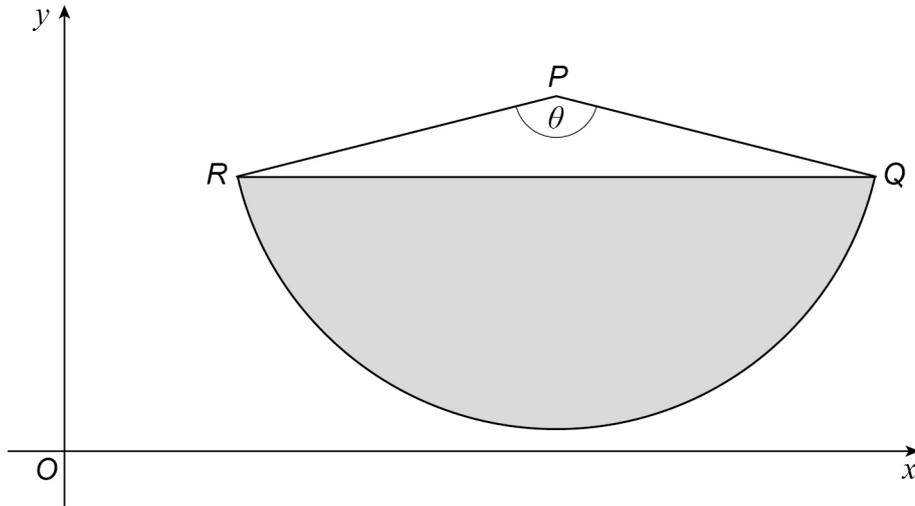
Give your answer in the form $(x-c)^2 + (y-d)^2 = n$ where c , d and n are integers.

[2 marks]

Answer _____



- 3 The diagram shows the sector PQR of a circle C with centre P and arc QR . The line segment QR is also shown, and the segment bounded by this line and the arc is shaded.



The **obtuse** angle $QPR = \theta$ radians.

- 3 (a) The equation of C is

$$x^2 - 24x + y^2 - 20y + 163 = 0$$

The triangle PQR has area 20.25 square units.

Show that $\theta = \frac{5\pi}{6}$

[5 marks]



4 (a) Solve the equation

$$8 \times 6^t = 27 \times 6^{1-2t}$$

Give your answer in the form $p + \log_6 q$ where p and q are rational numbers.

[3 marks]

$$t = \underline{\hspace{10em}}$$

4 (b) A curve C has equation

$$y = 2\log_{10} x + \log_{10}(x+5)$$

where $x > 0$

4 (b) (i) Show that the equation of C can be written as

$$y = \log_{10}(x^3 + 5x^2)$$

[2 marks]



Section B**Statistics**

Answer **all** questions in the spaces provided.

- 6** The discrete random variables X_1 , X_2 , X_3 and X_4 are independent.
The mean and variance of each of the variables is given in the table.

Variable	Mean	Variance
X_1	2	1
X_2	13	6
X_3	6	4
X_4	9	3

- 6 (a)** Find $E(X_1 + X_3)$

[1 mark]

Answer _____

- 6 (b)** Find $E\left(\sum_{i=1}^4 X_i\right)$

[1 mark]

Answer _____



6 (c) Find $\text{Var}(X_2 - X_4)$

[1 mark]

Answer _____

6 (d) The discrete random variable X_5 is independent of X_1 , X_2 , X_3 and X_4

It is given that $\text{Var}\left(\sum_{i=1}^5 X_i\right) = 39$

Find the standard deviation of X_5

[2 marks]

Answer _____

5

Turn over for the next question

Turn over ►



7 A game of darts has two possible outcomes: win or lose.

The probability of winning the game is 0.286

The random variable X is defined as equal to 0 if the game is lost and 1 if the game is won.

7 (a) (i) State the name of the distribution of X

[1 mark]

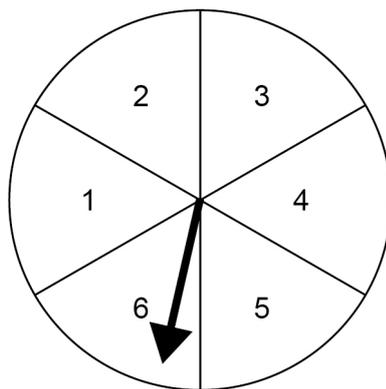
Answer _____

7 (a) (ii) State the value of $E(X)$

[1 mark]

Answer _____

7 (b) An unbiased spinner is numbered 1, 2, 3, 4, 5 and 6



The arrow on the spinner is spun 5 times.

The random variable Y represents the number of times the arrow lands on a 6



7 (b) (i) Find $\text{Var}(Y)$

[2 marks]

Answer _____

7 (b) (ii) Find $P(Y = 2)$

[2 marks]

Answer _____

7 (c) The game of darts is played and then the arrow is spun 5 times.

The random variable X is independent of Y

Find the probability that the game of darts is won and exactly 2 spins of the arrow land on a 6

[2 marks]

Answer _____

Turn over ►



- 8** A company has 200 employees.
- The company makes products P , Q and R
- 78 employees work on product P
- 101 employees work on product Q
- 91 employees work on product R
- 26 employees work on products P and Q
- 44 employees work on products Q and R
- An employee is chosen at random.

- 8 (a)** Find the probability that the employee works on product R given that they work on product Q

[2 marks]

Answer _____



Section C**Mechanics**

Answer **all** questions in the spaces provided.

- 9** A particle of mass 0.6 kg is moving with speed $3u \text{ m s}^{-1}$ on a smooth horizontal surface towards a fixed vertical wall.
- The particle collides directly with the wall and rebounds with speed $u \text{ m s}^{-1}$
- The impulse exerted on the particle by the wall during the collision has magnitude 3 N s
- Find the value of u
- [2 marks]**

Answer _____

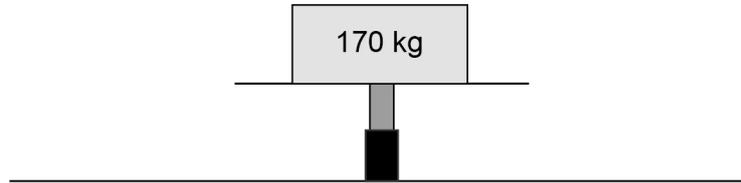
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10 The acceleration due to gravity, g , should be taken as 9.8 m s^{-2}

A horizontal platform can move vertically upwards and vertically downwards.

A box of mass 170 kg is placed on the platform as shown in the diagram.



The reaction force between the box and the platform has magnitude R newtons.

10 (a) Find the magnitude of the acceleration of the box when $R = 1800$

[2 marks]

Answer _____

10 (b) A student claims that if $R < 1600$ then the platform must be moving downwards.

Explain why the student's claim is incorrect.

[2 marks]



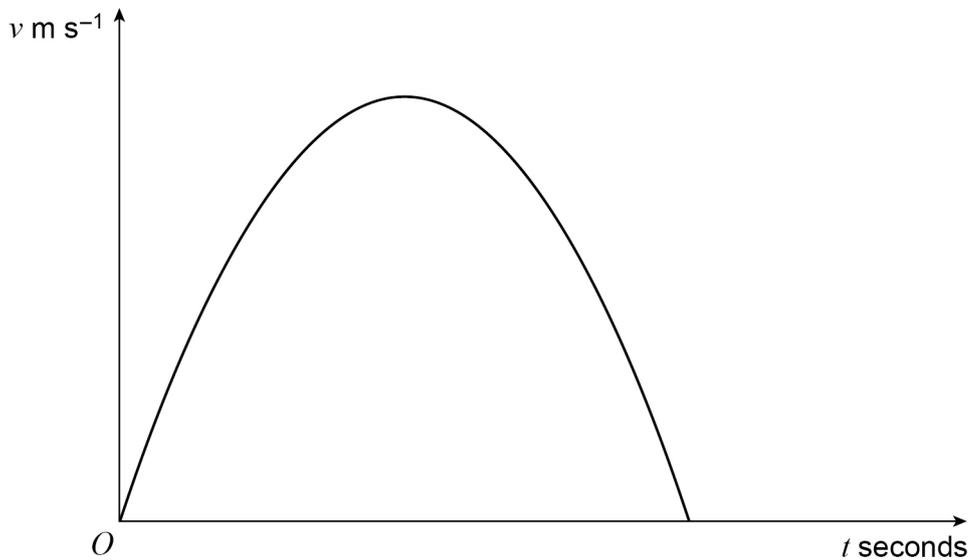
11 A car starts from rest and travels in a straight line along a horizontal road.

The car comes to rest k seconds later.

The velocity $v \text{ m s}^{-1}$ of the car at time t seconds is given by

$$v = 3t - 0.1t^2 \text{ for } 0 \leq t \leq k$$

The velocity-time graph for the motion of the car is shown below.



11 (a) (i) Show that $k = 30$

[2 marks]

11 (a) (ii) Find the maximum speed of the car and the time at which it occurs.

[2 marks]

Maximum speed _____

Time _____



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