



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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**MATHEMATICS (SYLLABUS D)**

**4024/21**

Paper 2

**October/November 2011**

**2 hours 30 minutes**

Candidates answer on the Question Paper.

Additional Materials:      Geometrical instruments  
                                         Electronic calculator

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen.  
You may use a pencil for any diagrams or graphs.  
Do not use staples, paper clips, highlighters, glue or correction fluid.  
DO **NOT** WRITE IN ANY BARCODES.

**Section A**

Answer **all** questions.

**Section B**

Answer any **four** questions.

If working is needed for any question it must be shown in the space below that question.  
Omission of essential working will result in loss of marks.  
You are expected to use an electronic calculator to evaluate explicit numerical expressions.  
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.  
For  $\pi$ , use either your calculator value or 3.142, unless the question requires the answer in terms of  $\pi$ .

The number of marks is given in brackets [ ] at the end of each question or part question.  
The total of the marks for this paper is 100.

**For Examiner's Use**

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This document consists of **20** printed pages.



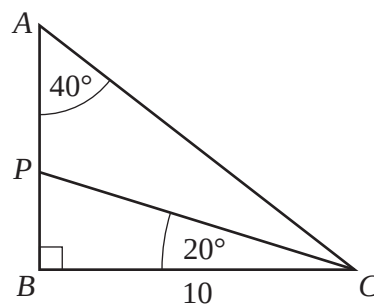
## Section A [52 marks]

Answer **all** the questions in this section.

1

$ABC$  is a triangle in which  $\hat{ABC} = 90^\circ$ ,  $\hat{BAC} = 40^\circ$  and  $BC = 10$  cm.

$P$  is the point on  $AB$  such that  $\hat{PCB} = 20^\circ$ .



Calculate

(a)  $PB$ ,

Answer ..... cm [2]

(b)  $AP$ ,

Answer ..... cm [2]

(c) the perimeter of triangle  $PBC$ .

Answer ..... cm [3]

- 2 (a) Solve  $5t(3t + 7) = 0$  .

Answer  $t = \dots\dots\dots$  or  $\dots\dots\dots$  [2]

- (b) Solve the simultaneous equations.

$$\begin{aligned} 3x + 4y &= 1 \\ 5x - 8y &= 9 \end{aligned}$$

Answer  $x = \dots\dots\dots$

$y = \dots\dots\dots$  [3]

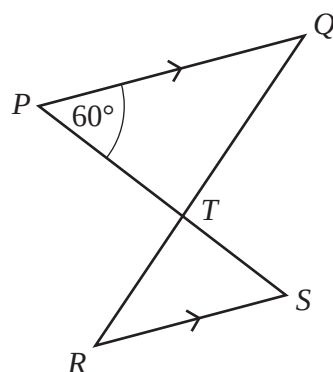
- (c) Express as a single fraction  $\frac{5}{p-2} - \frac{4}{2p+3}$  .

Answer  $\dots\dots\dots$  [3]

- (d) Simplify  $\frac{q^2 - 1}{2q^2 - 3q + 1}$  .

Answer  $\dots\dots\dots$  [3]

- 3  $P, Q, R$  and  $S$  are four points on level ground.  
 $PQ$  is parallel to  $RS$  and  $\angle QPS = 60^\circ$ .  
 $PS$  and  $RQ$  intersect at  $T$ .



- (a) Write down the value of  $\angle PSR$ . Give a reason for your answer.

Answer  $\angle PSR = \dots\dots\dots$  because  $\dots\dots\dots$   
 $\dots\dots\dots$  [1]

- (b) The bearing of  $Q$  from  $P$  is  $070^\circ$ .  
 Find the bearing of

- (i)  $S$  from  $P$ ,

Answer  $\dots\dots\dots$  [1]

- (ii)  $P$  from  $S$ ,

Answer  $\dots\dots\dots$  [1]

- (iii)  $R$  from  $S$ .

Answer  $\dots\dots\dots$  [1]

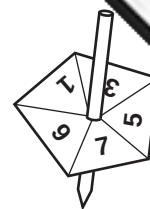
- (c) (i) Explain why triangles  $PQT$  and  $SRT$  are similar.

Answer  $\dots\dots\dots$   
 $\dots\dots\dots$  [1]

- (ii) Given that  $PT = 54\text{ m}$ ,  $TS = 36\text{ m}$  and  $RQ = 85\text{ m}$ , find  $TQ$ .

Answer  $\dots\dots\dots$  m [3]

- 4 A fair five-sided spinner is numbered 1, 3, 5, 7 and 9.



- (a) Maria spins it once. Find the probability that the number obtained is

(i) 7,

Answer ..... [1]

(ii) an odd number.

Answer ..... [1]

- (b) Pedro spins it twice and adds the two numbers obtained.  
Some of the results are shown in the possibility diagram below.

| + | 1 | 3 | 5 | 7  | 9  |
|---|---|---|---|----|----|
| 1 | 2 | 4 |   |    |    |
| 3 |   |   |   |    | 12 |
| 5 |   |   |   |    |    |
| 7 |   |   |   | 14 |    |
| 9 |   |   |   |    |    |

(i) Complete the possibility diagram.

[2]

(ii) Find the probability that the sum of the two numbers is

(a) odd,

Answer ..... [1]

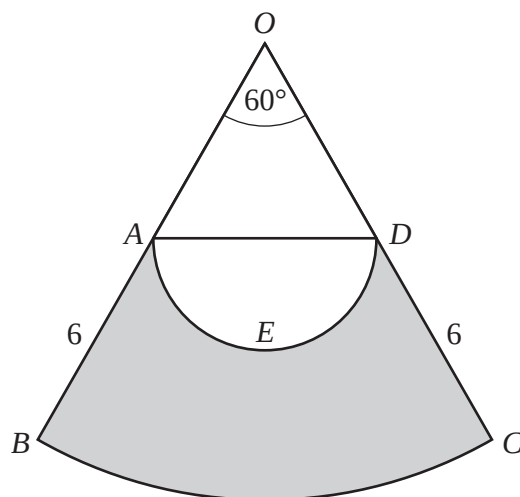
(b) 14 or more.

Answer ..... [1]

(c) Katrina spins it three times.

Calculate the probability that the three numbers obtained are the same.  
Express your answer as a fraction in its lowest terms.

Answer ..... [2]



In the diagram,  $OBC$  is the sector of a circle, centre  $O$ , and  $\angle BOC = 60^\circ$ .  
 $A$  and  $D$  are the midpoints of  $OB$  and  $OC$  respectively, and  $AB = DC = 6$  cm.  
 $AED$  is a semicircle with  $AD$  as diameter.

(a) Show that  $AD = 6$  cm.

[1]

(b) The length of the arc  $BC$  is  $n\pi$  centimetres.

(i) Find  $n$ .

Answer ..... [1]

(ii) Find  $\frac{\text{the length of the arc } AED}{\text{the length of the arc } BC}$ .

Answer ..... [2]

- (c) (i) Find the area of the sector  $BOC$ .

*Answer* .....  $\text{cm}^2$  [2]

- (ii) Hence find the area of the shaded region.

*Answer* .....  $\text{cm}^2$  [3]

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- 6 (a) Ada and Bill own a company.  
In 2008 Ada invests \$22 500 in the company and Bill invests \$37 500.
- (i) Express  $22\,500 : 37\,500$  in the form  $m : n$ , where  $m$  and  $n$  are the smallest possible integers.

Answer ..... : ..... [1]

- (ii) The profit made by the company in 2008 is shared in the ratio of the amounts invested.

Given that Ada's share of the profit is \$3 600, calculate the total profit made by the company.

Answer \$..... [1]

- (iii) Ada's investment in 2008 is  $12\frac{1}{2}\%$  more than the amount she invested in 2007.

Calculate the amount that Ada invested in 2007.

Answer \$..... [2]

(b)

|                                                                                   |                                                              |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>LAWNMOWER</b>                                                                  | Plan A: Deposit \$595 and<br>12 monthly payments of \$171.04 |
| <b>\$2395</b>                                                                     | Plan B: Deposit \$395 and<br>24 monthly payments of \$       |
|  |                                                              |

- (i) Rashid buys one of these lawnmowers for \$2395.  
Sayeed buys one of these lawnmowers using Plan A.

In total, how much **more** than Rashid will Sayeed pay?

Answer \$..... [1]

- (ii) When one of these lawnmowers is bought using Plan B, the total cost is \$3054.20.  
Calculate the monthly payment.

Answer \$..... [2]

- (iii) In a sale, the price of the lawnmower is reduced from \$2395 to \$1595.  
Calculate the percentage discount.

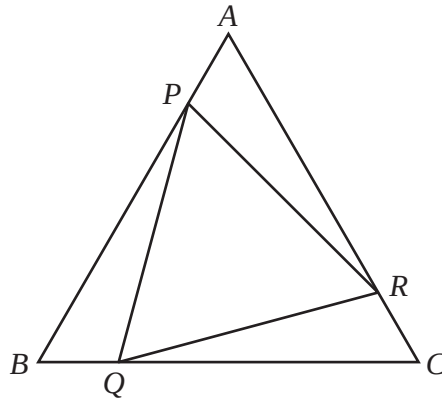
Answer ..... % [2]

**Section B** [48 marks]

Answer **four** questions in this section.

Each question in this section carries 12 marks.

7 (a)



In the diagram,  $ABC$  is an equilateral triangle.

The points  $P$ ,  $Q$  and  $R$  lie on  $AB$ ,  $BC$  and  $CA$  respectively, such that  $AP = BQ = CR$ .

(i) Show that triangles  $APR$ ,  $BQP$  and  $CRQ$  are congruent.

[3]

(ii) It is given that  $AB = 5$  cm and  $PQ = 4$  cm .

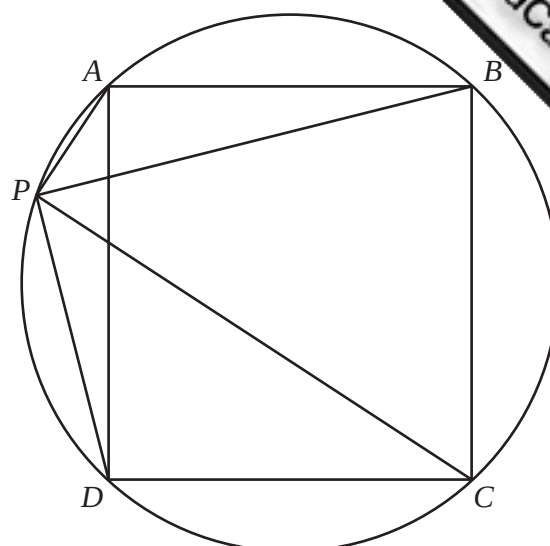
(a) Find  $\frac{\text{Area of triangle } PQR}{\text{Area of triangle } ABC}$  .

Answer .....[1]

(b) Find  $\frac{\text{Area of triangle } APR}{\text{Area of triangle } ABC}$  .

Answer .....[1]

- (b) In the diagram,  $ABCD$  is a square.  
The point  $P$  lies on the circle through  $A$ ,  $B$ ,  $C$  and  $D$ .



- (i) Explain why  $\hat{APC} = 90^\circ$ .

Answer ..... [1]

- (ii) Explain why  $\hat{APB} = \hat{BPC}$ .

Answer ..... [2]

- (iii) Hence find

- (a)  $\hat{APB}$ ,

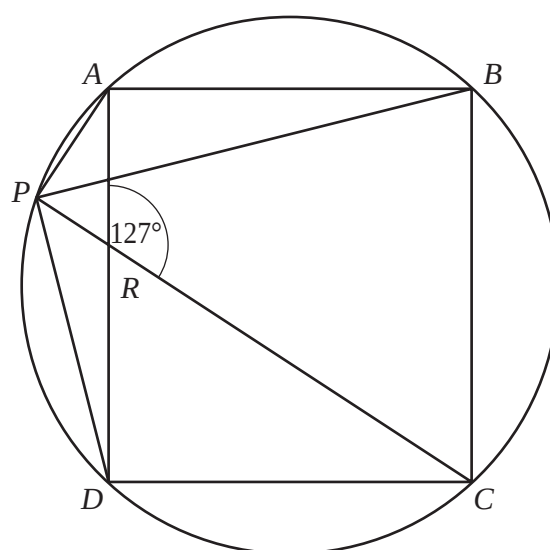
Answer ..... [1]

- (b)  $\hat{APD}$ .

Answer ..... [1]

- (iv)  $PC$  and  $AD$  intersect at  $R$ .

Given that  $\hat{ARC} = 127^\circ$ , find  $\hat{PDC}$ .



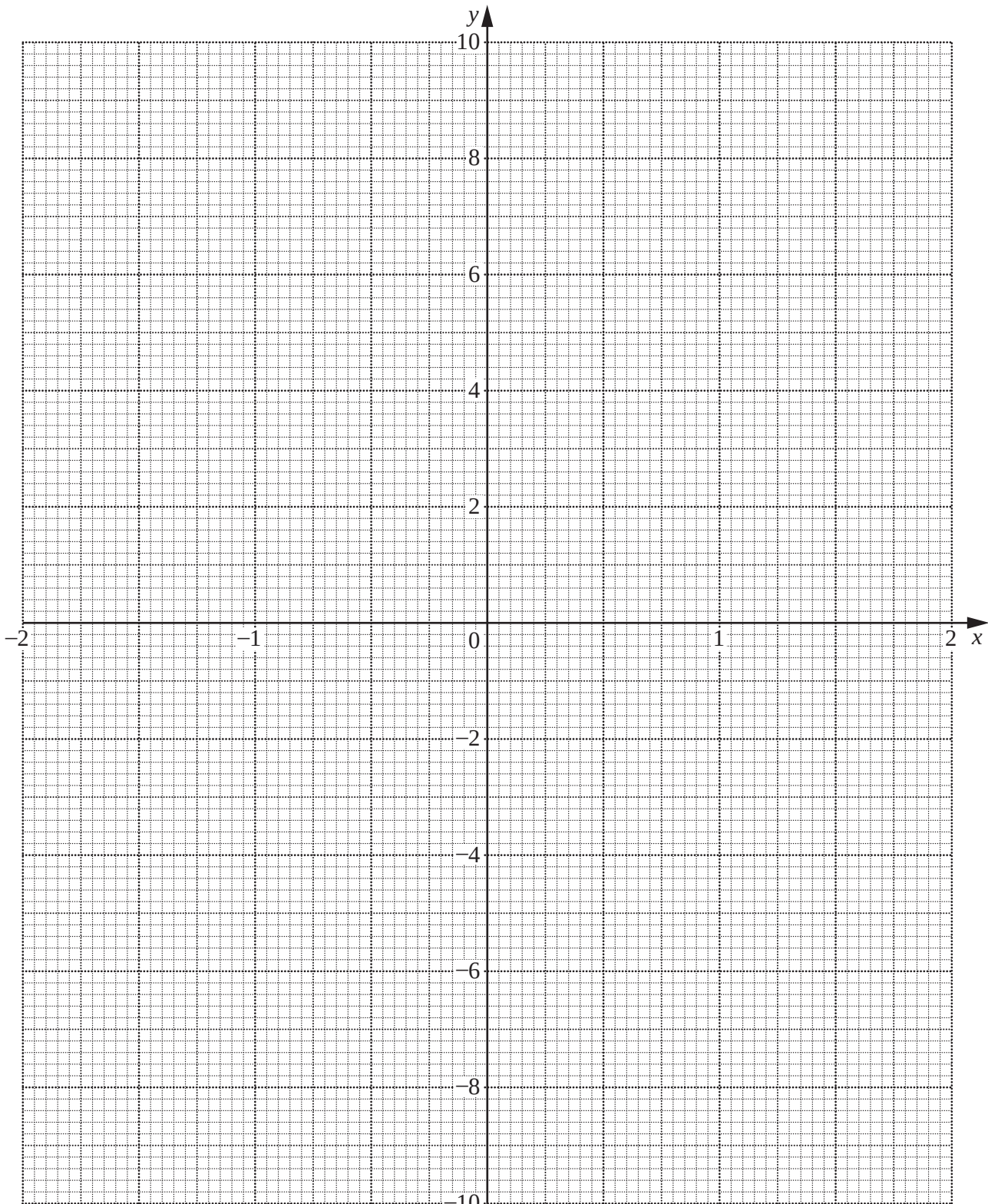
Answer ..... [2]

- 8 The variables  $x$  and  $y$  are connected by the equation  $y = 2x - \frac{5}{2x}$ .

The table below shows some values of  $x$  and the corresponding values of  $y$ .  
The values of  $y$  are correct to 1 decimal place where appropriate.

|     |      |     |      |      |      |     |      |     |
|-----|------|-----|------|------|------|-----|------|-----|
| $x$ | 0.25 | 0.5 | 0.75 | 1    | 1.25 | 1.5 | 1.75 | 2   |
| $y$ | -9.5 | -4  | -1.8 | -0.5 | 0.5  | 1.3 | 2.1  | 2.8 |

- (a) On the grid, plot the points given in the table and join them with a smooth curve.



- (b) By drawing a tangent, find the gradient of the curve at the point  $(0.75, -1.8)$ .

Answer ..... [2]

- (c) The line  $y = 2 - x$  intersects the curve  $y = 2x - \frac{5}{2x}$  at the point  $P$ .

- (i) On the grid, draw the graph of the straight line  $y = 2 - x$ .

[2]

- (ii) Write down the  $x$  coordinate of  $P$ .

Answer ..... [1]

- (iii) This value of  $x$  is a solution of the equation  $6x^2 - Bx - C = 0$ .

Find  $B$  and  $C$ .

Answer  $B =$  .....

$C =$  ..... [3]

- (d) Let  $f(x) = 2x - \frac{5}{2x}$ .

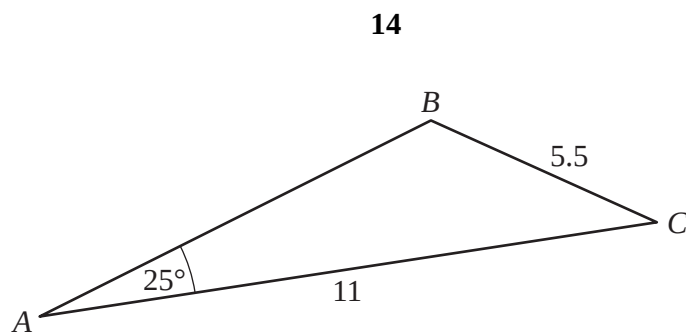
- (i) Given that  $f(a) = b$ , show that  $f(-a) = -b$ .

[1]

- (ii) **Hence**, using the table on the previous page, draw the graph of  $y = 2x - \frac{5}{2x}$  for  $-2 \leq x \leq -0.25$ .

[1]

9 (a)

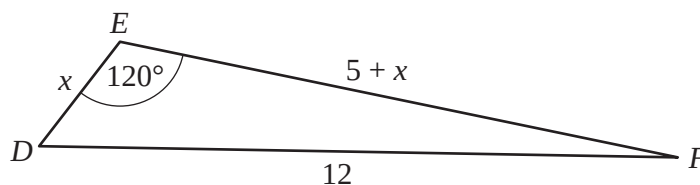


In the diagram,  $AC = 11$  cm,  $BC = 5.5$  cm and  $\angle BAC = 25^\circ$ .  
It is given that  $\angle ABC$  is an **obtuse** angle.

Calculate  $\angle ACB$ .

Answer ..... [4]

(b)



In the diagram,  $DF = 12$  cm,  $DE = x$  centimetres and  $EF = (5 + x)$  centimetres.

(i) Form an equation in  $x$  and show that it reduces to  $3x^2 + 15x - 119 = 0$ .

[3]

(ii) Solve the equation  $3x^2 + 15x - 119 = 0$ , giving each answer correct to 3 decimal places.

Answer  $x = \dots\dots\dots$  or  $\dots\dots\dots$  [4]

(iii) Find the length of  $EF$  in millimetres, correct to the nearest millimetre.

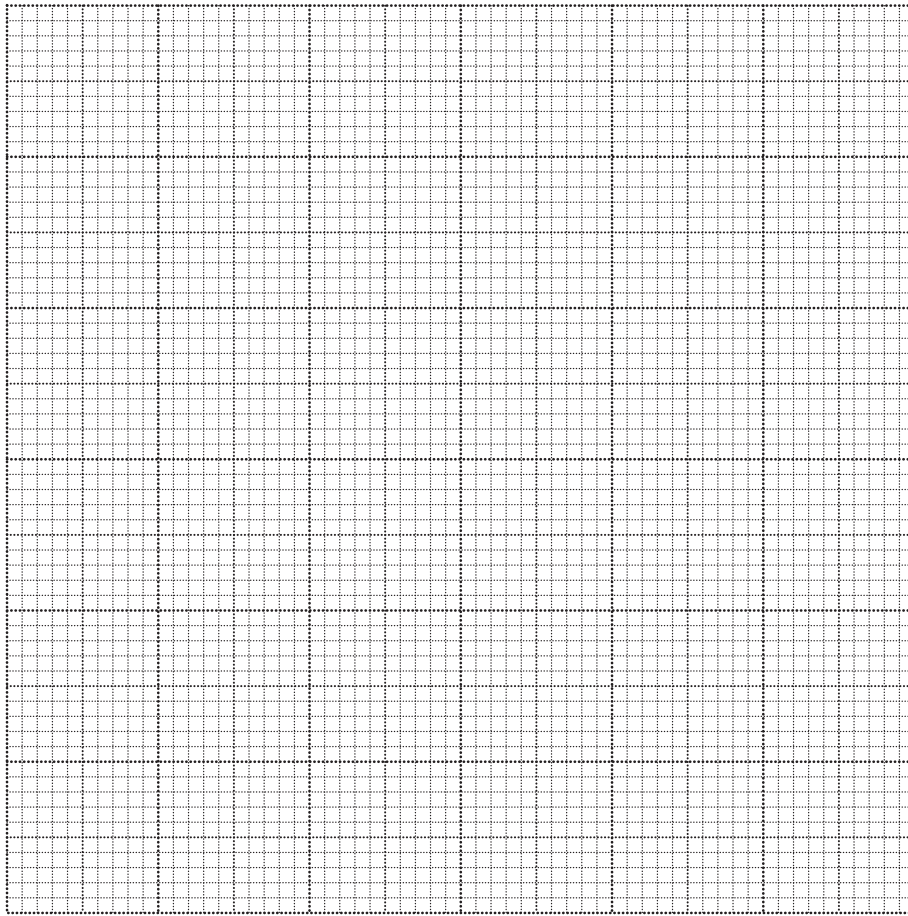
Answer  $\dots\dots\dots$  mm [1]

**10** The distribution of the masses of 140 eggs is given in the table below.

| Mass<br>( $m$ grams) | $35 < m \leq 40$ | $40 < m \leq 45$ | $45 < m \leq 50$ | $50 < m \leq 55$ | $55 < m \leq 60$ | $60 < m \leq 70$ |
|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Number of<br>eggs    | 15               | 20               | 30               | 35               | 28               | 12               |

- (a)** Using a scale of 1 cm to represent 5 grams, draw a horizontal axis for  $30 \leq m \leq 70$ .  
Using a scale of 1 cm to 1 unit, draw a vertical axis to represent frequency density.

Draw a histogram to represent the information in the table.



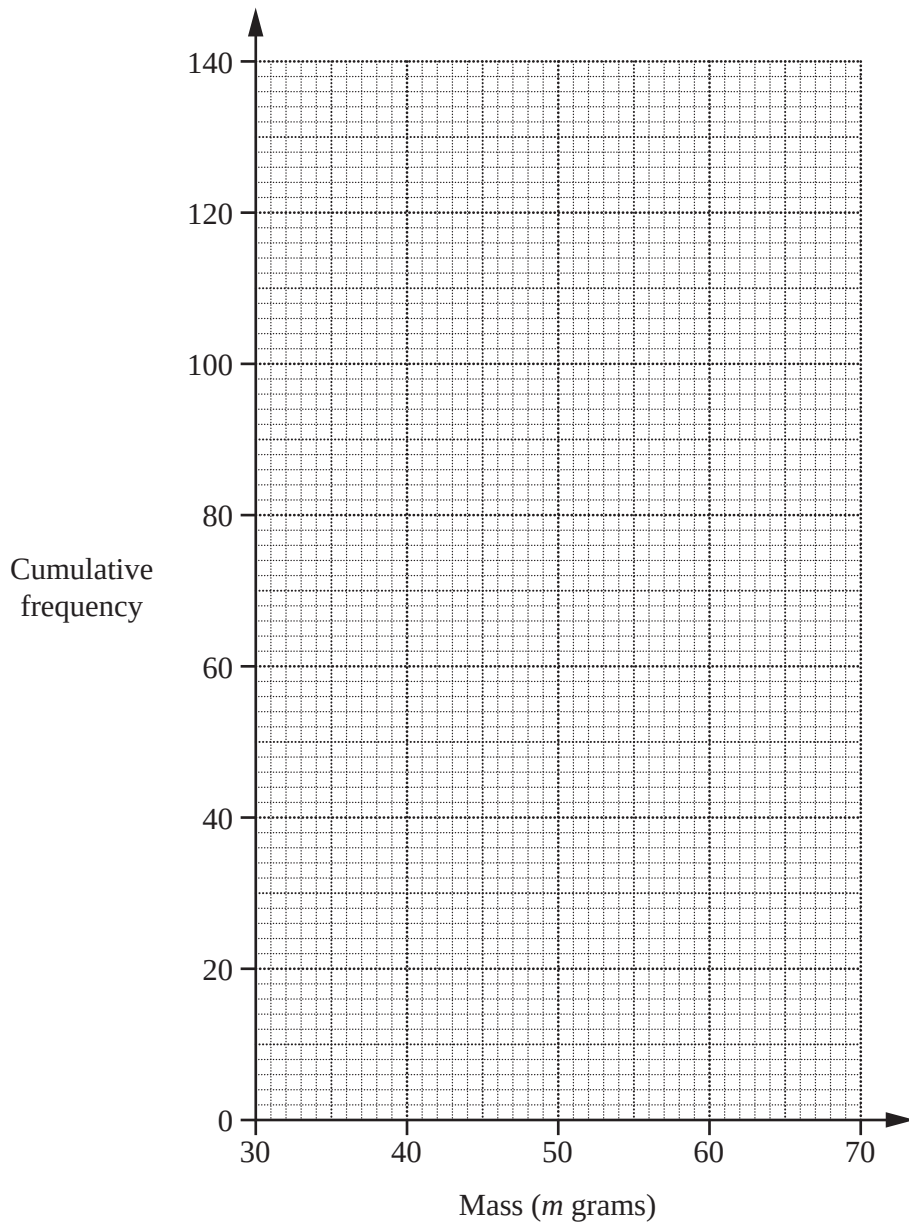
[3]

- (b) (i)** Complete the cumulative frequency table below.

| Mass<br>( $m$ grams)    | $m \leq 35$ | $m \leq 40$ | $m \leq 45$ | $m \leq 50$ | $m \leq 55$ | $m \leq 60$ | $m \leq 70$ |
|-------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Cumulative<br>frequency | 0           | 15          |             |             |             |             | 140         |

[1]

- (ii)** On the grid on the next page, draw a smooth cumulative frequency curve to represent this information.



[3]

(c) Use your graph to find

(i) the median mass of the eggs,

Answer ..... g [1]

(ii) the interquartile range.

Answer ..... g [2]

(d) The 12 eggs with the greatest mass are classed as extra large.  
The 30 eggs with the least mass are classed as small.

Use your graph to find an estimate of the smallest difference in mass between an extra large egg and a small egg.

Answer ..... g [2]

- 11 (a) Some transformations of the plane are given in the following table.

|           |                                                              |
|-----------|--------------------------------------------------------------|
| $M_x$     | Reflection in the $x$ -axis                                  |
| $M_y$     | Reflection in the $y$ -axis                                  |
| $M_d$     | Reflection in the line $y = -x$                              |
| $R_{90}$  | Rotation of $90^\circ$ , anti-clockwise, centre the origin   |
| $R_{180}$ | Rotation of $180^\circ$ , centre the origin                  |
| $R_{270}$ | Rotation of $270^\circ$ , anti-clockwise, centre the origin. |

You may use the grid on the next page to help answer the following questions.

- (i) The point  $A$  has coordinates  $(2, 3)$ .

- (a) Find the coordinates of  $M_y(A)$ .

Answer (..... , ..... ) [1]

- (b) Find the coordinates of  $M_d M_y(A)$ .

Answer (..... , ..... ) [1]

- (c) The inverse of  $R_{90}$  maps  $B$  onto  $A$ .

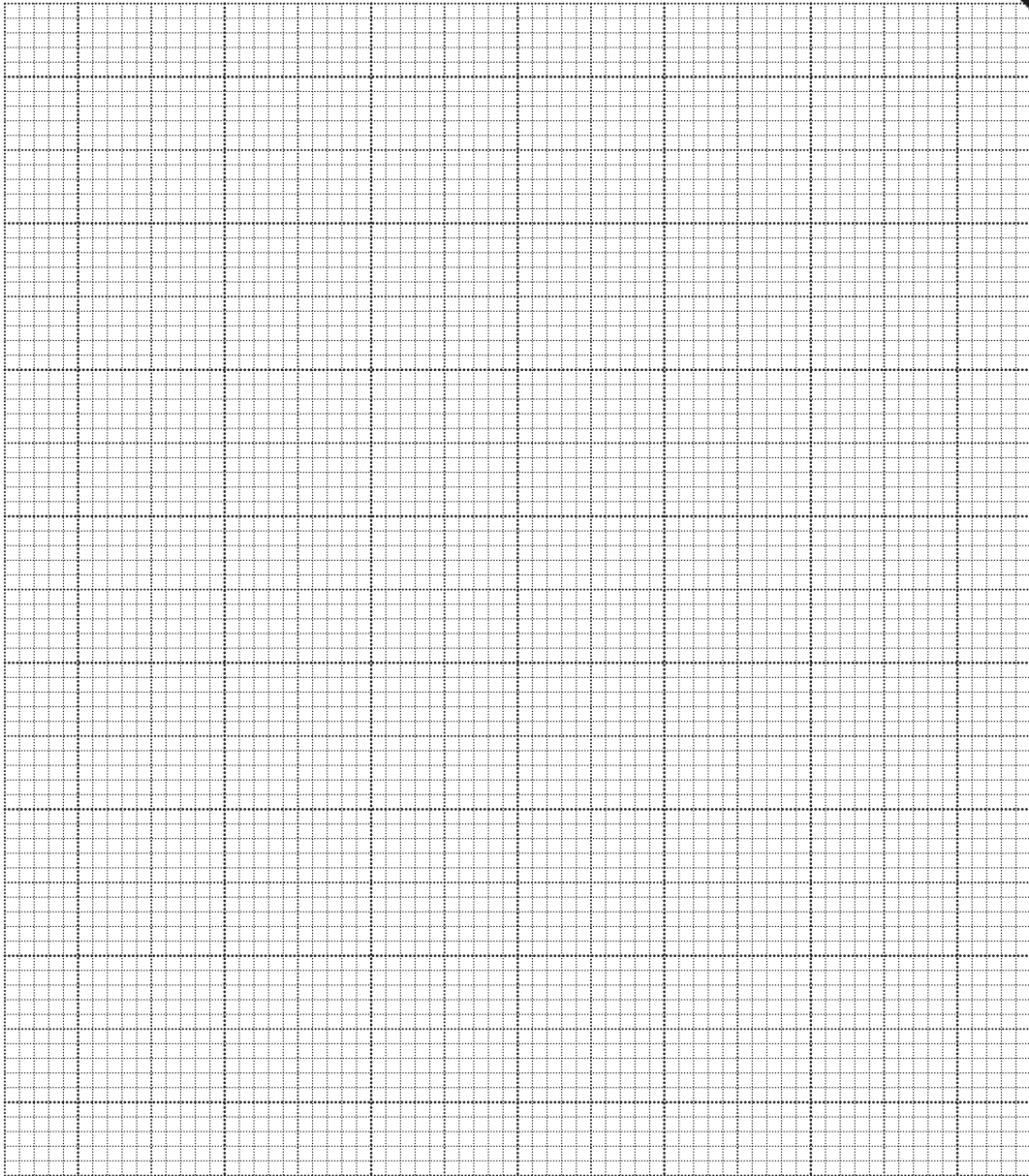
Find the coordinates of  $B$ .

Answer (..... , ..... ) [2]

- (ii) (a) Write down the matrix which represents  $M_x$ .

Answer  $\begin{pmatrix} & \\ & \end{pmatrix}$  [1]

- (b) Which single transformation given in the table is equivalent to  $R_{180} M_x$ ?



**Turn over for the rest of this question.**

- (b) The points  $P$  and  $Q$  have coordinates  $(4, 0)$  and  $(9, 0)$  respectively.  
The points  $P'$  and  $Q'$  have coordinates  $(4, 4)$  and  $(7, 8)$  respectively.

- (i) Write down the length of  $PQ$ .

Answer  $PQ = \dots\dots\dots$  units [1]

- (ii) Calculate the length of  $P'Q'$ .

Answer  $P'Q' = \dots\dots\dots$  units [2]

- (iii)  $PQ$  is mapped onto  $P'Q'$  by a single rotation.  
By using the grid below,

- (a) find, by drawing, the coordinates of the centre of this rotation,

Answer  $(\dots\dots\dots, \dots\dots\dots)$  [2]

- (b) measure the clockwise angle of rotation.

Answer  $\dots\dots\dots$  [1]

