Cambridge
O Level

**Cambridge International Examinations**
Cambridge Ordinary Level

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|---|---|
| CANDIDATE NAME | |
| CENTRE NUMBER | CANDIDATE NUMBER |

*9653730277*

**MATHEMATICS (SYLLABUS D)** **4024/21**

Paper 2 **May/June 2016**

**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, 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.



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**Section A** [52 marks]

Answer **all** questions in this section.

**1** A shopkeeper buys some plates from a manufacturer for $12 each.

**(a)** The manufacturer makes a profit of 60%.

Calculate the cost of manufacturing each plate.

*Answer* $ ..... [2]

**(b)** The shopkeeper sells each plate for $17.40.

Calculate the percentage profit made by the shopkeeper.

*Answer* .....% [2]

**(c)** In a sale, each plate is reduced from $17.40 to $11.31.

Calculate the percentage discount given.

*Answer* .....% [2]

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**(d)** The shopkeeper buys 100 plates at \$12 each.
He sells 60 plates at \$17.40 each and $x$ plates at \$11.31 each.
The shopkeeper makes a profit of at least 10%.

Find the least possible value of $x$.

*Answer* ..... [3]

**2** **(a)** Solve the equation $\frac{p-1}{7-p} = 5$.

*Answer* ..... [2]

**(b)** Simplify $\left(\frac{9ab^6}{a^3b^2}\right)^{\frac{1}{2}}$.

*Answer* ..... [2]

**(c)** Simplify $\dfrac{q^2 - q^3}{3 - 3q}$.

*Answer* ..... [2]

**(d)** **(i)** Factorise $4t^2 + 35t - 9$.

*Answer* ..... [2]

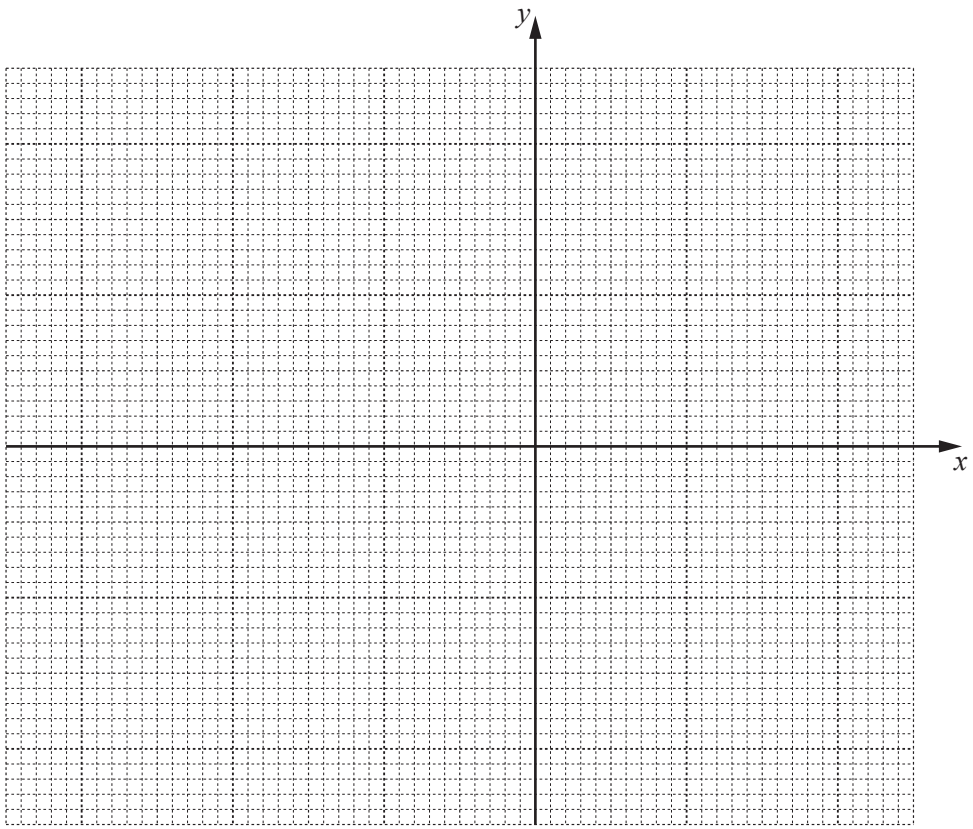
**(ii)** Hence solve the equation $4t^2 + 35t - 9 = 0$.

*Answer* ..... [1]

**3** The table below is for $y = x^2 + x - 3$.

| $x$ | –3 | –2 | –1 | 0 | 1 | 2 |
|---|---|---|---|---|---|---|
| $y$ | 3 | –1 | –3 | –3 | –1 | 3 |

**(a)** Using a scale of 2 cm to 1 unit on the $x$-axis for $-3 \leqslant x \leqslant 2$ and a scale of 1 cm to 1 unit on the $y$-axis for $-4 \leqslant y \leqslant 4$, plot the points from the table and join them with a smooth curve.




[2]

**(b) (i)** Use your graph to estimate the solutions of the equation $x^2 + x - 3 = 0$.

*Answer* $x =$ ..... or ..... [1]

**(ii)** Use your graph to estimate the solutions of the equation $x^2 + x - 5 = 0$.

*Answer* $x =$ ..... or ..... [2]

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**(c)** By drawing a tangent, estimate the gradient of the curve at $(1, -1)$.

*Answer* ..... [2]

**(d)** The equation $x^2 - x - 1 = 0$ can be solved by drawing a straight line on the graph of $y = x^2 + x - 3$.

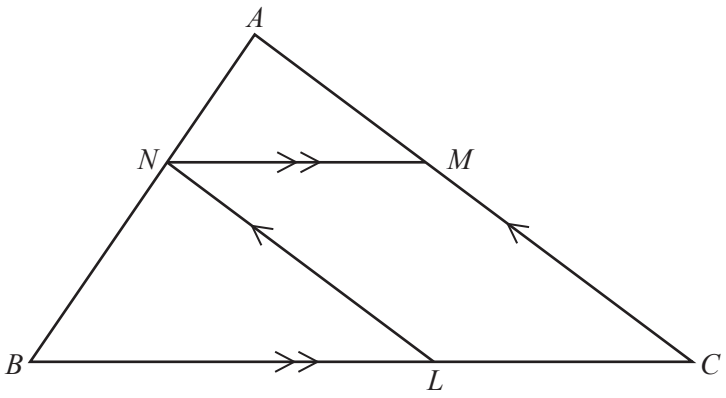
**(i)** Find the equation of this straight line.

*Answer* ..... [2]

**(ii)** Draw this straight line and hence solve $x^2 - x - 1 = 0$.

*Answer* $x =$ ..... or ..... [2]

**4**




*ANB*, *BLC* and *CMA* are straight lines. *NM* is parallel to *BC* and *LN* is parallel to *CA*.

**(a)** Prove that triangle *ANM* is similar to triangle *NBL*.
Give a reason for each statement you make.

.....

.....

.....

..... [3]

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**(b)** $AN : NB = 2 : 3$

**(i)** Find $NM : BC$.

*Answer* ..... : ..... [2]

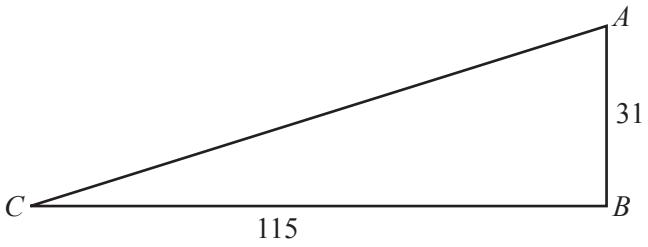
**(ii)** Find area $ANM$ : area $NBL$.

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

**(iii)** Find area $ANM$ : area $NMCL$.

*Answer* ..... : ..... [2]

**5 (a)**



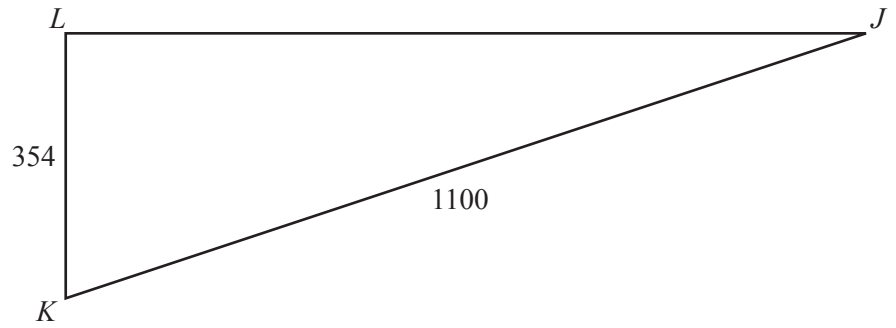

*AB* is vertical and *CB* is horizontal.
*AB* = 31 m and *CB* = 115 m.

Calculate the angle of depression of *C* from *A*.

*Answer* ..... [3]

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**(b)**




$J$ and $K$ are two positions at sea.
The base of a lighthouse is at $L$.
$J$ is due East of $L$ and $K$ is due South of $L$.
$KL = 354$ m and $KJ = 1100$ m.

**(i)** Calculate $L\hat{J}K$.

*Answer* ..... [2]

**(ii)** Hence find the bearing of $K$ from $J$.

*Answer* ..... [1]

**6** $\mathbf{A} = \begin{pmatrix} 4 & -1 \\ 1 & 3 \end{pmatrix}$ $\mathbf{B} = \begin{pmatrix} 2 & 0 \\ 7 & -5 \end{pmatrix}$

**(a)** Evaluate $2\mathbf{A} - \mathbf{B}$.

*Answer* $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

**(b)** Find $\mathbf{A}^2$.

*Answer* $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

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**(c)** Find $\mathbf{B}^{-1}$.

*Answer* $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

**(d)** $\mathbf{A} + \mathbf{Z} = \mathbf{A}$

Find $\mathbf{Z}$.

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

**(e)** $\mathbf{M} + 2\mathbf{I} = \mathbf{B}$, where $\mathbf{I}$ is the $2 \times 2$ identity matrix.

Find $\mathbf{M}$.

*Answer* $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

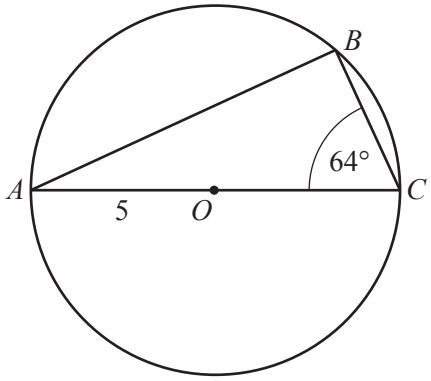
**Section B** [48 marks]

Answer **four** questions in this section.

Each question in this section carries 12 marks.

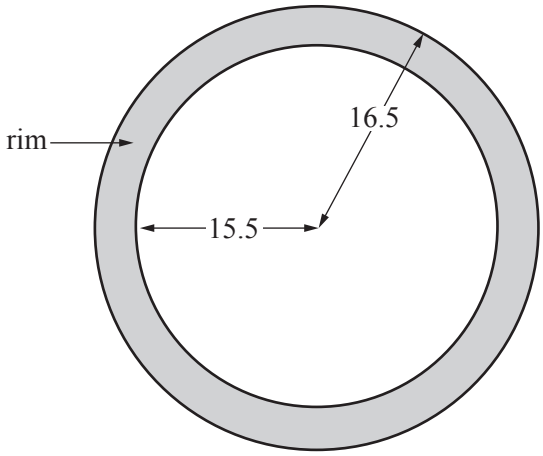
**7** **(a)** $AC$ is a diameter of the circle, centre $O$, radius 5 cm.
$A\hat{C}B = 64°$.

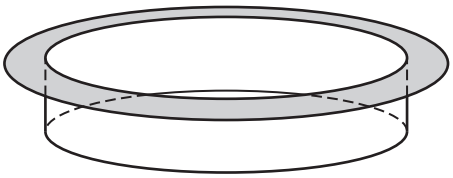
Calculate the length of the minor arc $BC$.




*Answer* ..... cm [4]

**(b)**



A baking tray is an open cylinder of radius 15.5 cm with a rim.
The outer edge of the rim is a circle of radius 16.5 cm.

**(i)** Calculate the area of the top surface of the rim.

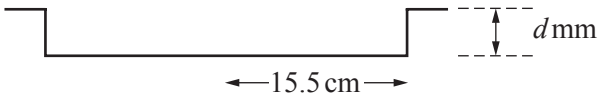
*Answer* ..... $cm^2$ [2]

**(ii)** 44 identical circular holes are cut out of the bottom of the baking tray.
The area of the bottom that remains is 650 $cm^2$.

Calculate the radius of each circular hole.

*Answer* ..... cm [3]

**(iii)**




To make a pizza, the baking tray is completely filled with dough to a depth of $d$ mm.
The open cylinder holds 500 $cm^3$ of dough.

Calculate the depth of the dough, $d$ mm, giving your answer correct to the nearest millimetre.

*Answer* ..... mm [3]

**8** **(a)** $p = \dfrac{8 - 5q}{q}$

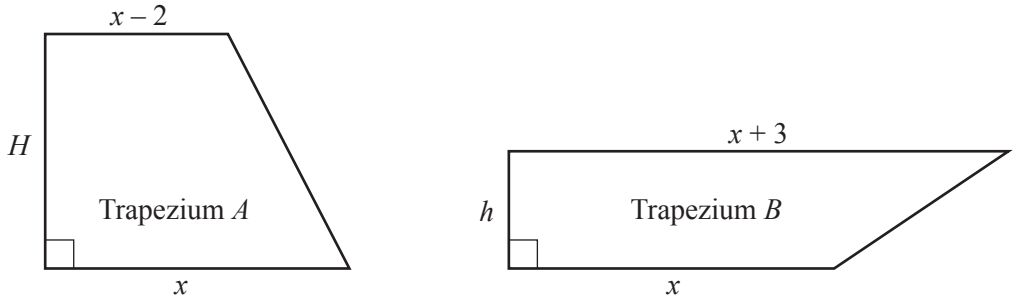
**(i)** Find $p$ when $q = 2.6$ .

*Answer* ..... [1]

**(ii)** Express $q$ in terms of $p$.

*Answer* ..... [2]

**(b)**




The lengths of the parallel sides of trapezium $A$ are $x$ cm and $(x - 2)$ cm.
The lengths of the parallel sides of trapezium $B$ are $x$ cm and $(x + 3)$ cm.
The height of trapezium $A$ is $H$ cm and the height of trapezium $B$ is $h$ cm.
The area of each trapezium is 15 $\text{cm}^2$.

**(i)** Show that $H = \dfrac{15}{x - 1}$ and $h = \dfrac{30}{2x + 3}$.

[2]

**(ii)** Find an expression in terms of $x$ for the difference in height, $H - h$, between trapezium $A$ and trapezium $B$, and show that it simplifies to $\frac{75}{(x-1)(2x+3)}$.

[3]

**(iii)** The difference in height is 1.5 cm.

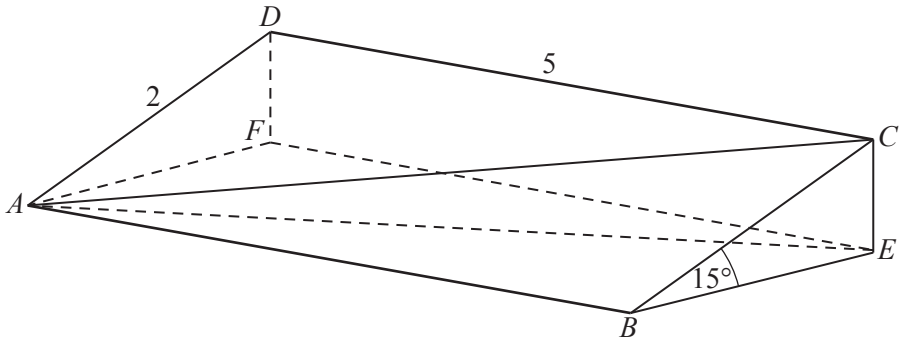
**(a)** Show that $2x^2 + x - 53 = 0$.

[2]

**(b)** Find $x$, giving your answer correct to 2 decimal places.

*Answer* $x =$ ..... [2]

**9 (a)**




*ABCD* represents the rectangular sloping surface of a triangular prism.
*ABEF* is a horizontal rectangle. *CE* and *DF* are vertical.
$C\hat{B}E = 15°$, $DC = 5$ m and $AD = 2$ m.

**(i)** Calculate *AC*.

*Answer* ..... m [2]

**(ii)** Calculate *CE*.

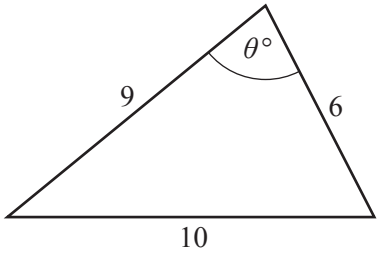
*Answer* ..... m [2]

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**(iii)** Calculate $F\hat{A}E$.

*Answer* ..... [4]

**(b) (i)**

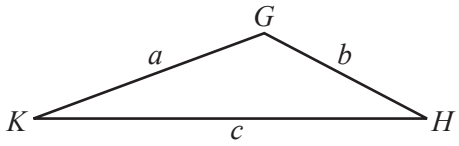



A triangle has sides of 10 cm, 9 cm and 6 cm, and an angle of $\theta°$, as shown in the diagram.

Calculate $\theta$.

*Answer* ..... [3]

**(ii)** The triangle $KGH$ has sides of $a$ cm, $b$ cm and $c$ cm as shown in the diagram.




It is given that $K\hat{G}H$ is an obtuse angle.

Complete the statement below using **one** of the symbols $< \leqslant = \geqslant >$.

$c^2$ ..... $(a^2 + b^2)$ [1]

**10** 100 electric light bulbs of Brand A were tested to find how long each bulb lasted. The results are summarised in the table below.

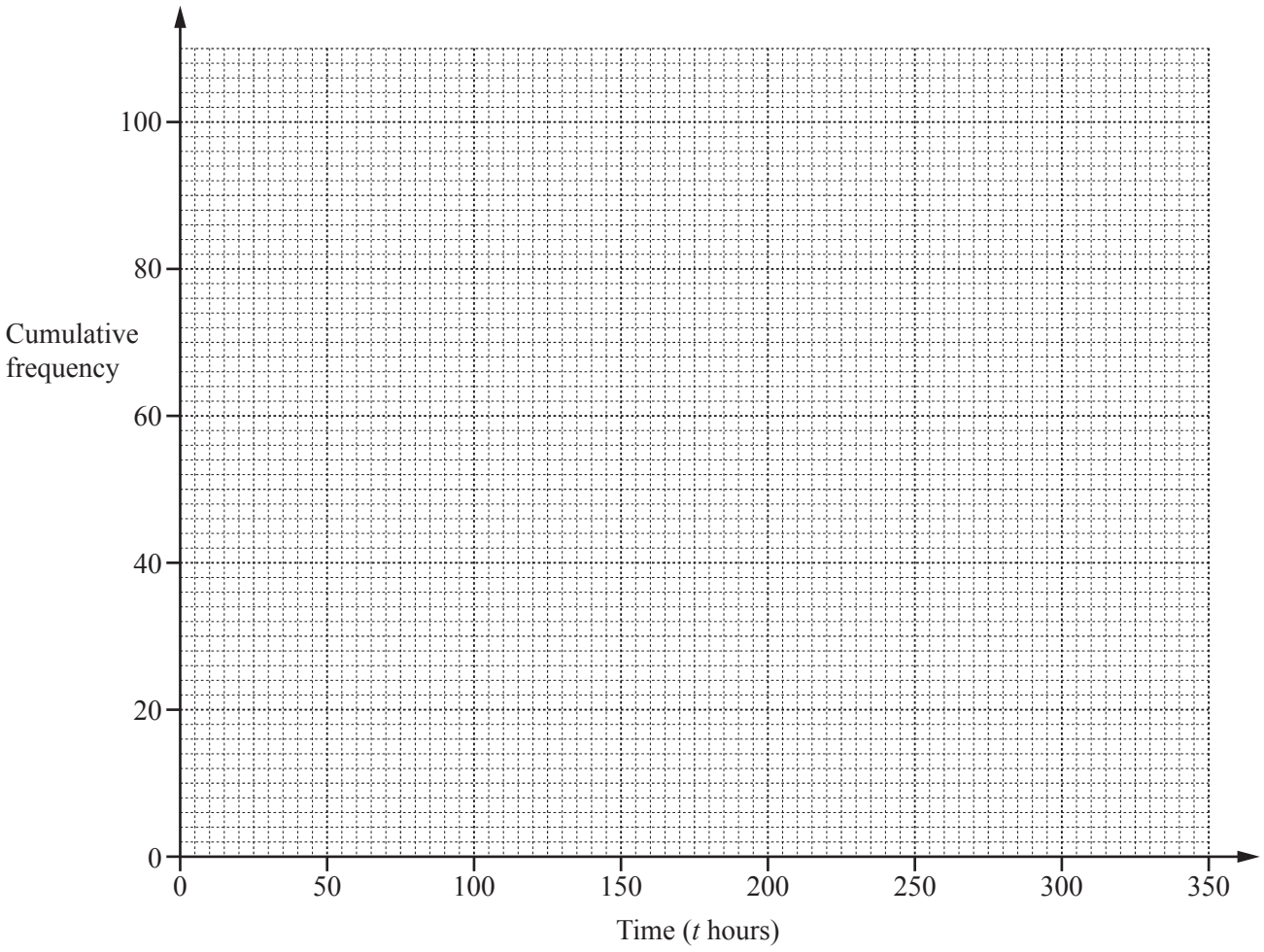
| Time ($t$ hours) | $t \leqslant 50$ | $50 < t \leqslant 100$ | $100 < t \leqslant 150$ | $150 < t \leqslant 200$ | $200 < t \leqslant 250$ | $250 < t \leqslant 300$ | $300 < t \leqslant 350$ |
|---|---|---|---|---|---|---|---|
| Number of bulbs | 2 | 2 | 10 | 40 | 30 | 14 | 2 |

**(a)** Complete the cumulative frequency table.

| Time ($t$ hours) | $t \leqslant 50$ | $t \leqslant 100$ | $t \leqslant 150$ | $t \leqslant 200$ | $t \leqslant 250$ | $t \leqslant 300$ | $t \leqslant 350$ |
|---|---|---|---|---|---|---|---|
| Cumulative frequency | 2 | 4 | | | | | 100 |

[1]

**(b)** On the grid, draw a smooth cumulative frequency curve to represent this information. Label this curve Brand A.




[2]

**(c)** **(i)** Use your graph to estimate the median.

*Answer* ..... hours [1]

**(ii)** Use your graph to estimate the interquartile range.

*Answer* ..... hours [2]

**(d)** 100 Brand B bulbs gave the following results.
4 bulbs lasted 50 hours or less.
The longest time any bulb lasted was 300 hours.
The median is 250 hours.
The upper quartile is 275 hours.
The interquartile range is 75 hours.

On the grid, draw and label the cumulative frequency curve for the Brand B bulbs. [4]

**(e)** Using your graph, estimate the number of Brand A bulbs that lasted 275 hours or less.

*Answer* ..... [1]

**(f)** Complete the statement below.

Brand ..... had ..... more bulbs that lasted longer than 275 hours than Brand ..... . [1]

**11** **(a)** Triangle $ABC$ has vertices $A(2, 2)$, $B(3, 5)$ and $C(4, 1)$.
Triangle $A'B'C'$ has vertices $A'(-4, 4)$, $B'(-3, 7)$ and $C'(-2, 3)$.

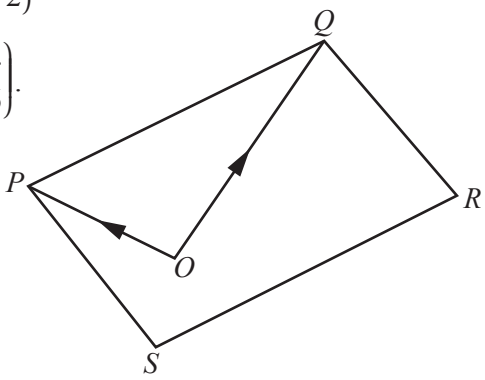
Write down the column vector of the translation that maps triangle $ABC$ onto triangle $A'B'C'$.

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

**(b)** $PQRS$ is a parallelogram.

The position vector of $P$ relative to $O$ is given by $\overrightarrow{OP} = \begin{pmatrix} -4 \\ 2 \end{pmatrix}$.

The position vector of $Q$ relative to $O$ is given by $\overrightarrow{OQ} = \begin{pmatrix} 4 \\ 6 \end{pmatrix}$.




**(i)** Express $\overrightarrow{PQ}$ as a column vector.

*Answer* $\begin{pmatrix} \\ \end{pmatrix}$ [2]

**(ii)** Find $\overrightarrow{RS}$.

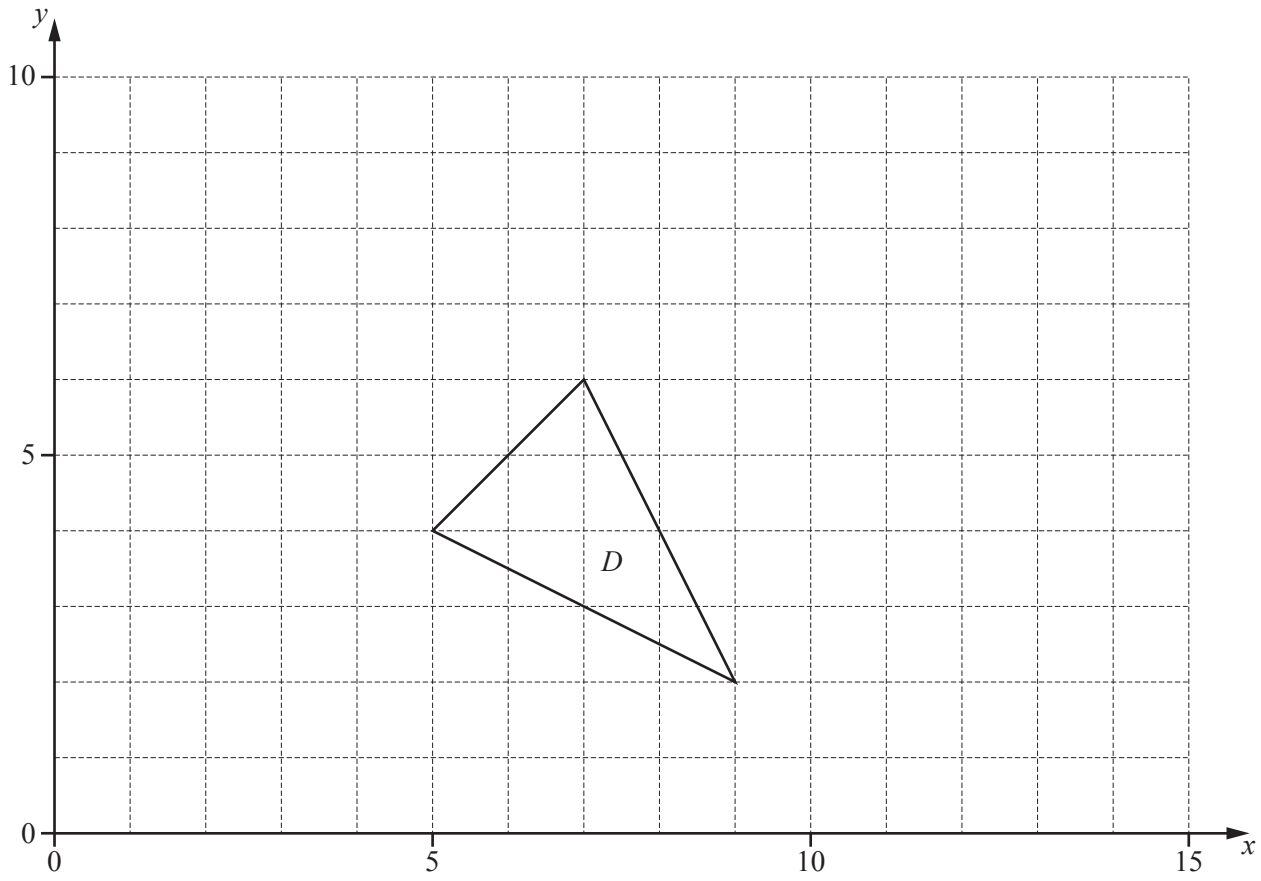
*Answer* $\begin{pmatrix} \\ \end{pmatrix}$ [1]

**(iii)** Find $|\overrightarrow{RS}|$.

*Answer* .....units [2]

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**(c)**




The diagram shows triangle $D$.

**(i)** An enlargement with centre (5, 4), scale factor 2, maps triangle $D$ onto triangle $E$.

Draw and label triangle $E$. [2]

**(ii)** An enlargement with centre (5, 4), scale factor 0.5, maps triangle $D$ onto triangle $F$.

Draw and label triangle $F$. [1]

**(iii)** Triangle $G$ has vertices (5, 4), (4, 3) and (3, 5).
Triangle $F$ can be mapped onto triangle $G$ using a single enlargement.
Triangle $F$ can also be mapped onto triangle $G$ using a **different single** transformation T.

Describe fully the **single** transformation T.

*Answer* .....

.....

..... [3]

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