| Name: | | Index Number: | | Class: | |
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# CATHOLIC HIGH SCHOOL
## Preliminary Examination
## Secondary 4 (O-Level Programme)

## Mathematics

**4052/01**

Paper 1

**25 August 2025**

**2 hours 15 minutes**

Additional Materials: Booklets A and B

Candidates answer in the space provided on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the space provided.
If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
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 **90**.

| For Examiner's Use |
|---|
| 90 |

This paper consists of 26 printed pages.

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## MATHEMATICAL FORMULAE

*Compound interest*

$$\text{Total amount} = P\left(1 + \frac{r}{100}\right)^n$$

*Mensuration*

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of a triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

*Trigonometry*

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

*Statistics*

$$\text{Mean} = \frac{\Sigma fx}{\Sigma f}$$

$$\text{Standard deviation} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$



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**1** Simplify $\frac{5}{2-x}+\frac{4x-8}{(x-2)^2}$.

*Answer* ..... [3]

**2** Rearrange the formula to make $p$ the subject.

$$pr=\frac{6p^2-1}{p}$$

*Answer* ..... [2]



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3 Factorise the following expressions completely.

**(a)** $5m+2n-mn-10$

*Answer* ..... [2]

**(b)** $x^2+4xy-9+4y^2$

*Answer* ..... [2]



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**4** The product of two numbers, $x$ and $y$, is 6300 and their highest common factor is 6. Given $6 < x < y$, find the value of $x$ and the value of $y$.

*Answer* $x =$ .....

$y =$ ..... [2]

**5** Simplify $\left(\frac{49x^4}{y^{16}}\right)^{-\frac{3}{2}}$, leaving your answer in positive indices.

*Answer* ..... [2]



[TURN OVER

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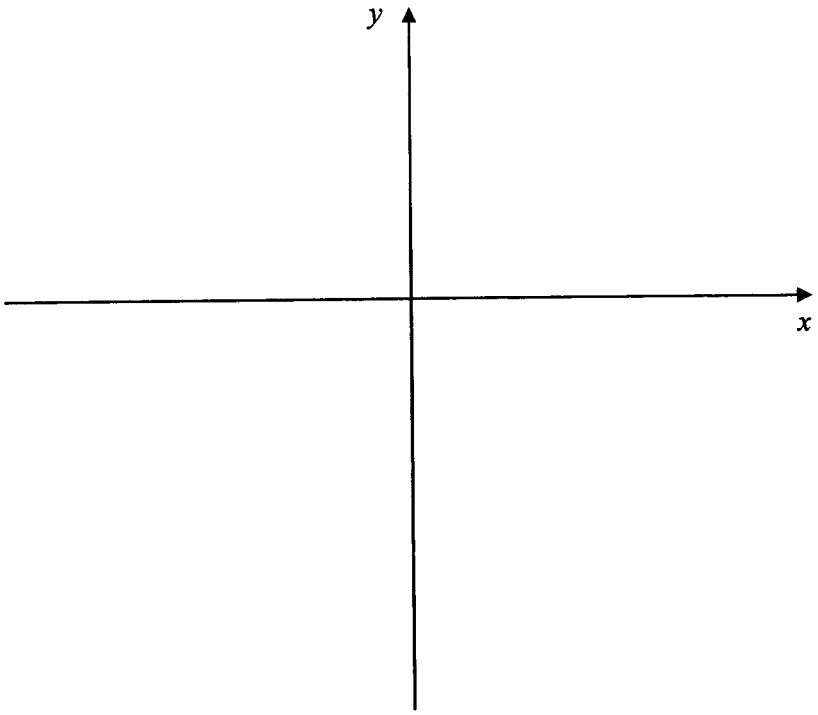
6 **(a)** Express $-x^2-8x-19$ in the form of $-(x+p)^2+q$.

*Answer* ..... [2]

**(b)** Hence, sketch the graph of $y=-x^2-8x-19$ on the axes below.

Indicate clearly the turning point and axes intercept(s).

*Answer* [2]






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7 Andy places an order for some polo shirts that come in three sizes $S$, $M$ and $L$.

The ratio of the number of polo shirts $S : M = 3 : 8$.

The ratio of the number of polo shirts $S : L = 5 : 2$.

There are 306 more polo shirts in size $M$ than $L$.

Find the total number of polo shirts ordered.

*Answer* ..... [2]

8 Solve $2^p \times 6 = 96$.

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



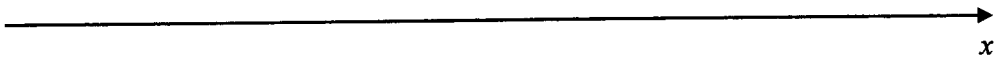
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**9** Solve the inequality $x-6 \leq 3x-17 < 32-4x$.

Show your solution on the number line below.

*Answer* ..... [2]

*Answer* [1]






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**10** The cash price of a refrigerator is \$2499.

The hire-purchase price of the refrigerator is \$2999.

The hire-purchase price is a deposit of 25% of the cash price plus 24 equal monthly payments.

Calculate one monthly payment.

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



[TURN OVER

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11 Michael deposited some money into bank A which pays a simple interest rate of 3% per annum for 18 months.

If he had deposited the same amount of money with bank B, which pays a simple interest rate of 2.5% per annum for 24 months, he would receive $500 more in interest.

**(a)** Find the amount of money he deposited.

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

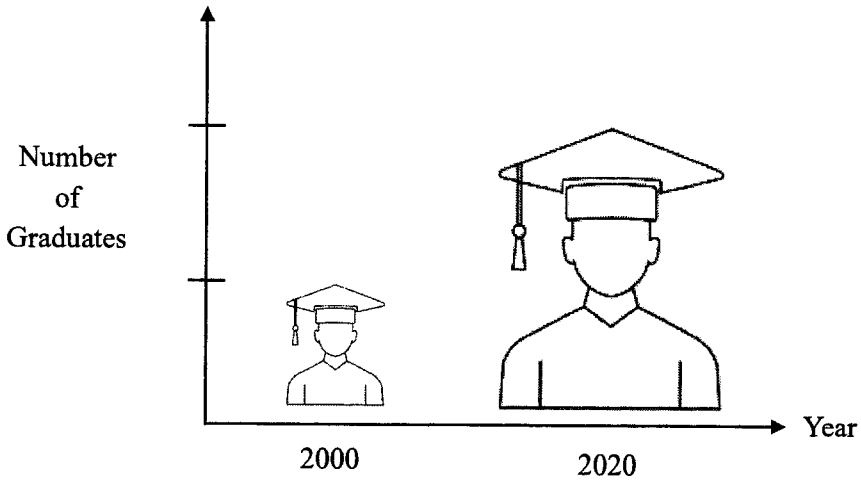
**(b)** Find the amount of interest Michael would receive if he were to deposit his money into bank C, which pays a compound interest of 1.9% per annum compounded every 6 months for 24 months.

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



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12 The number of university graduates for the year 2000 and year 2020 are represented by the chart below. Statistics have shown that the number of university graduates in year 2020 is doubled the number of university graduates in year 2000.




Explain how the above chart may be misleading and suggest a possible way to improve the chart.

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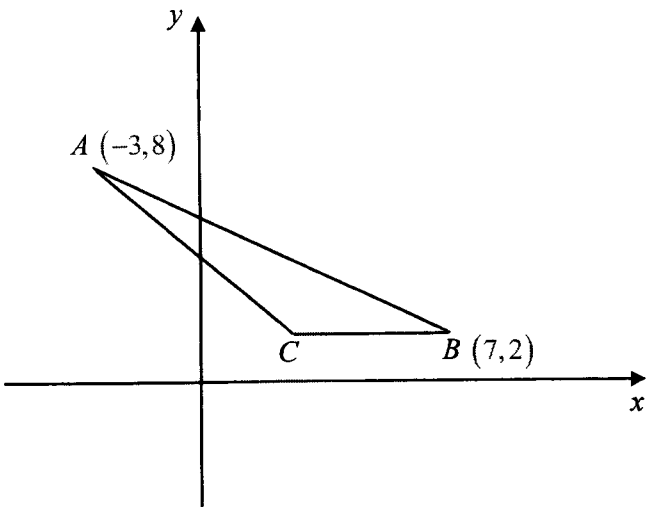
[TURN OVER

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13 The vertices of $A$ and $B$ are $(-3,8)$ and $(7,2)$.

The line $BC$ is parallel to the $x$ – axis.

The area of triangle $ABC$ is 12 square units.




**(a)** Find the coordinates of $C$.

*Answer* ..... [2]

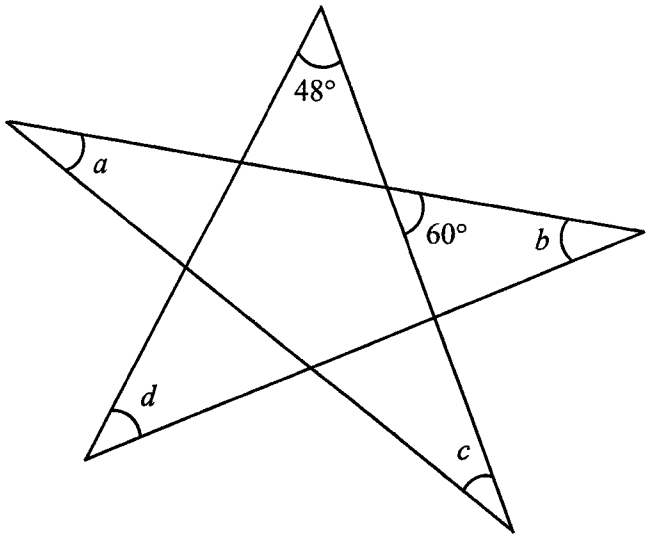
**(b)** Find the exact value of $\cos A\hat{C}B$.

*Answer* ..... [2]



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**14** Find $\angle a + \angle b + \angle c + \angle d$.




*Answer* .....° [2]



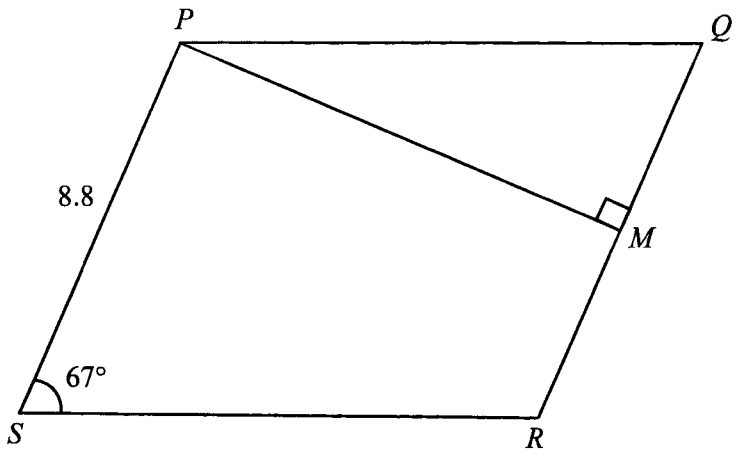


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**15** $PQRS$ is a parallelogram. $PM$ is perpendicular to $QR$ and $M$ is the midpoint of $QR$.

$PS = 8.8$cm and angle $PSR = 67°$.

Find the area of $PQRS$.




*Answer* .....cm$^2$ [3]



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**16** The first four terms of a sequence are 1, 5, 9 and 13.

**(a)** Find an expression, in terms of $n$, for the $n$th term of the sequence.

*Answer* ..... [1]

**(b)** Find an expression, in terms of $n$, for the $(n + 1)$th term of the sequence.

*Answer* ..... [1]

**(c)** Explain why the difference between the squares of two consecutive terms is always a multiple of 8.

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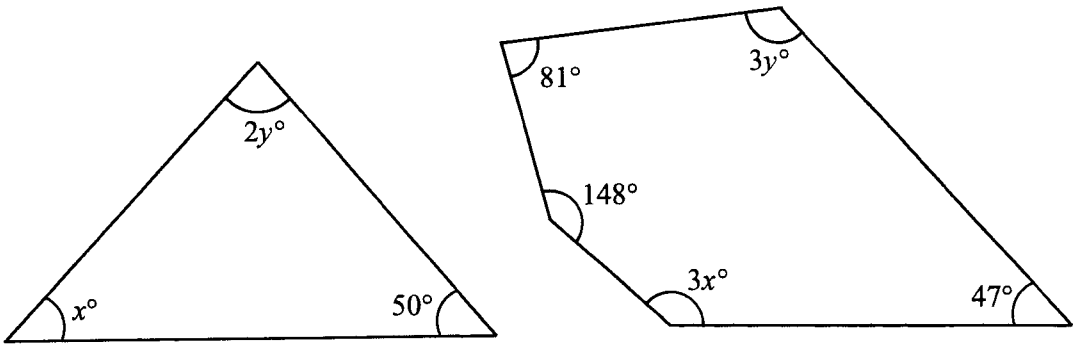
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.....[2]



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17




**(a)** Using the information shown in the diagrams, write down and simplify two equations in $x$ and $y$.

*Answer* [3]

**(b)** Solve these equations to find the value of $x$ and of $y$.

*Answer* $x =$.....

$y =$ ..... [2]



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**18** **(a)** In a company of 120 workers, the ratio of female worker to male workers is 2 : 3.

| | Female | Male |
|---|---|---|
| Full time | $p$ | $q$ |
| Part time | 9 | $r$ |

20% of the workers work part time.

Find the value of $p$, of $q$ and of $r$.

*Answer* $p$ =.....

$q$ = .....

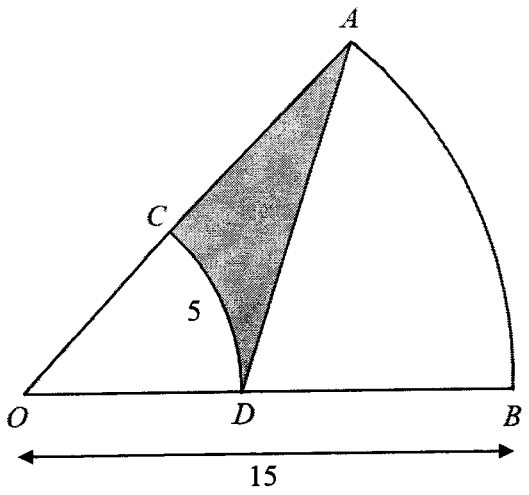
$r$ = ..... [2]

**(b)** The annual salary of a particular male worker is \$85000 in 2023. His salary in 2023 was 12% higher than in 2021. Find his annual salary in 2021.

*Answer* \$..... [1]

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**19** The diagram shows two sectors $OAB$ and $OCD$ with centre at $O$. $OB$ is 15 cm and $CD$ has an arc length of 5 cm. The ratio of area of sector $OCD$ : area of $ABDC$ is 16 : 65.




**(a)** Find angle $COD$ in radian.

*Answer* .....rad [3]



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**(b)** Find the area of the shaded region.

*Answer* .....cm$^2$ [3]

**20** In this table, $p$ is inversely proportional to $q^2$.

| | | | |
|---|---|---|---|
| $p$ | 0.08 | 0.5 | $b$ |
| $q$ | $a$ | 4 | 2 |

Calculate the value of $a$ and of $b$.

*Answer* $a$ =.....

$b$ = ..... [3]



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21 **(a)** A river with an actual length of 1 km is represented on a map with a length of 8 cm.

Find the map scale in the form 1 : $n$.

*Answer* ..... [1]

**(b)** A forest is represented by an area of 200 $cm^2$ on the map. Calculate the actual area of forest in square metres, giving your answer in standard form.

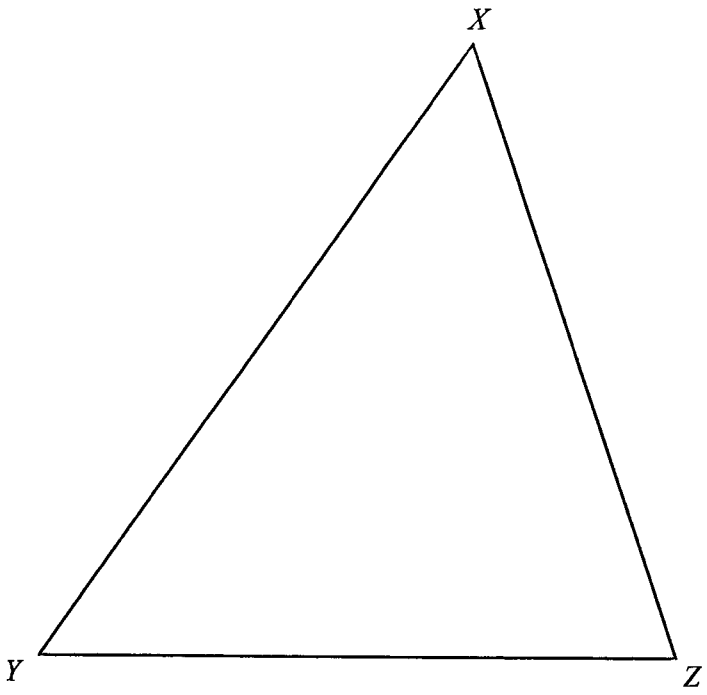
*Answer* .....$m^2$ [2]



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**22** A triangle $XYZ$ is shown below.

*Answer*




**(a)** Construct

**(i)** the perpendicular bisector of $XY$, [1]

**(ii)** the bisector of angle $XYZ$. [1]

**(b)** Mark clearly a possible point which is inside the triangle, equidistant from $X$ and $Y$, and nearer to $YZ$ than $XY$. Label this point $P$. [1]

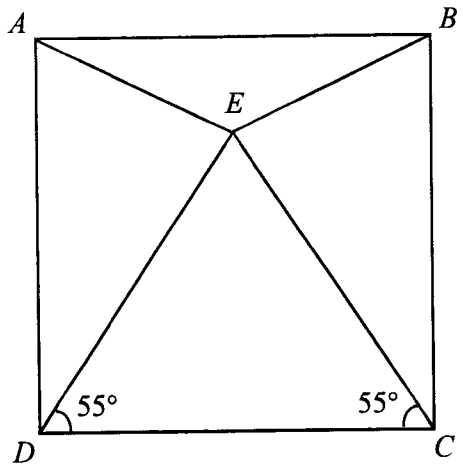
**(c)** The point $M$ is such that angle $YZM = 100°$ and $XM = 5$ cm. Mark and label the point $M$ at the position that is closer to point $Z$. Measure and write down the length $ZM$.

*Answer* ..... [2]



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**23** $ABCD$ is a square and angle $EDC$ = angle $ECD$ = 55°.




Prove that triangle $AEB$ is an isosceles triangle.

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.....[4]



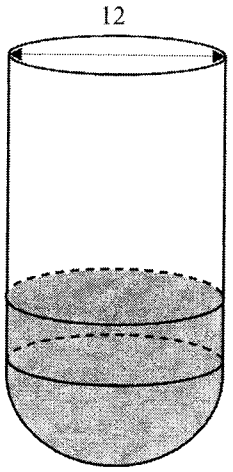
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**24** **(a)** A container is made from a hemisphere and cylinder.

The container has a diameter of 12 cm.

The container is filled with water such that the total surface area of water in contact with the container is $120\pi$.

Find the volume of water in the container, leaving your answer in terms of $\pi$.

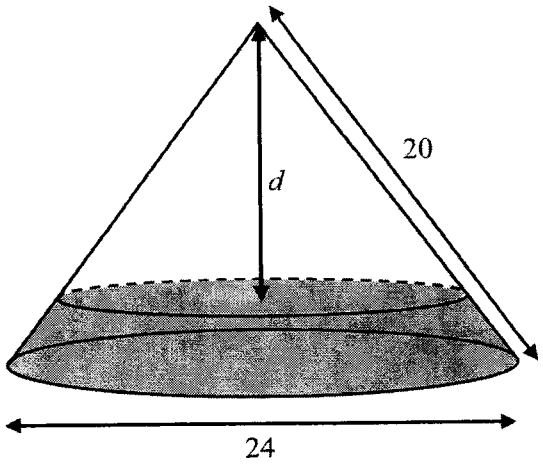



*Answer* .....cm$^3$ [4]



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**(b)** All the water in the container was poured into a cone with diameter 24 cm and a slant height of 20 cm. The cone was covered and inverted as shown in the diagram below. Calculate the depth, $d$, of the empty space.




*Answer* $d$ =.....cm [4]

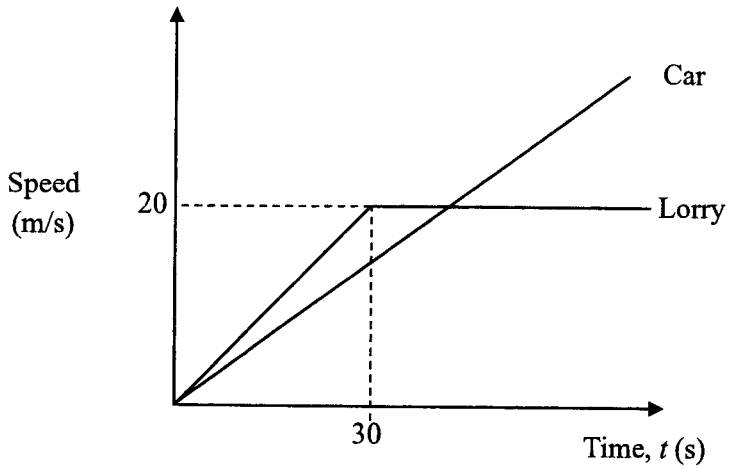
24

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**25** The diagram shows the speed-time graphs of a car and lorry traveling along the same road in the same direction. Both vehicles begin their journey from the same starting point.

The lorry accelerates for 30 seconds and then travels at a constant speed of 20 m/s.

The car accelerates at a uniform rate of 0.5 $m/s^2$ from rest.

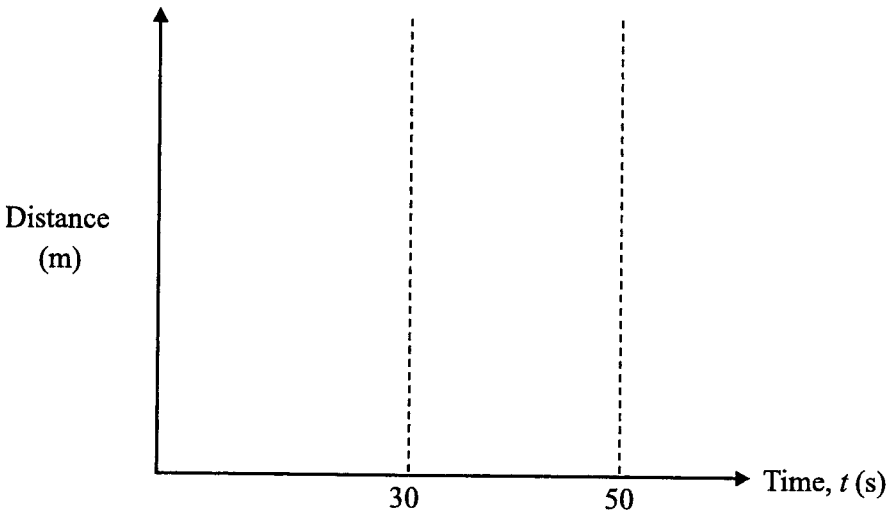



**(a)** Find the speed of lorry at 12 seconds.

*Answer* .....m/s [2]

**(b)** Draw the distance-time graph of the lorry for $0 \leq t \leq 50$ s.

*Answer* [2]






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**(c)** Find the time taken for the car to meet the lorry.

*Answer* .....s [4]



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# CATHOLIC HIGH SCHOOL
## 2025 Preliminary Examination
## Secondary 4 (O-Level Programme)

**A**

# Mathematics

**4052/02**

Paper 2

**27 Aug 2025**

**2 hours 15 minutes**

Booklet A

Additional material: Question Booklet B

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The total mark for this paper is **90.**

*For examiners' use*

| |
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| 40 |

This booklet consists of **12** printed pages



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## *Mathematical Formulae*

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$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$



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**1** Every evening Juline and Evangeline play a game of tic-tac-toe. When they play against each other, Juline has a $\frac{2}{5}$ chance of winning and Evangeline has a $\frac{1}{6}$ chance of winning. Find, as a fraction in its simplest form, the probability that

**(i)** Juline will win on both Monday and Tuesday next week.

Answer ..... [1]

**(ii)** Juline will win on either Wednesday or Thursday next week but not on both days.

Answer .....[2]

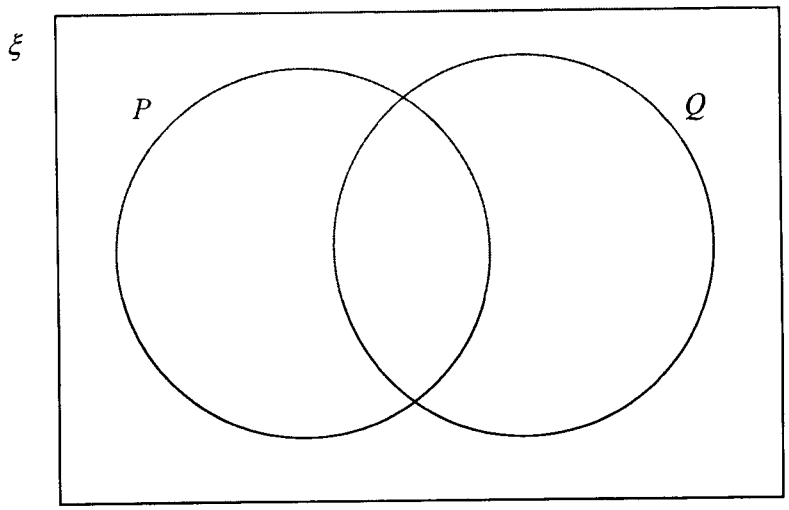
**(iii)** it will be a draw on Friday next week.

Answer .....[2]



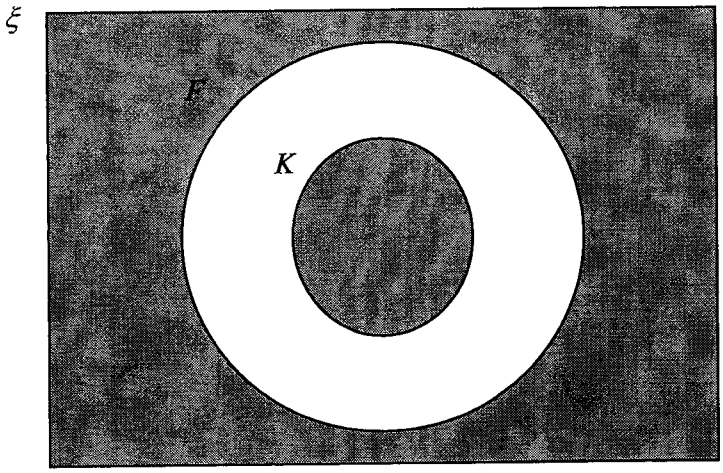
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**2(a)(i)** On the Venn diagram, shade the region which represents $(P' \cap Q)'$.




[1]

**(ii)** Use set notation to describe the shaded region.




Answer .....[1]



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**2(b)** $\xi = \{\text{integers } x : 20 \leq x \leq 50\}$

$A$ = { perfect square }

$B$ = { prime numbers }

$C$ = { multiples of 7}

**(i)** List the elements in $A \cap C'$.

Answer .....[1]

**(ii)** Find the value of $\text{n}(B \cap C)$.

Answer .....[1]

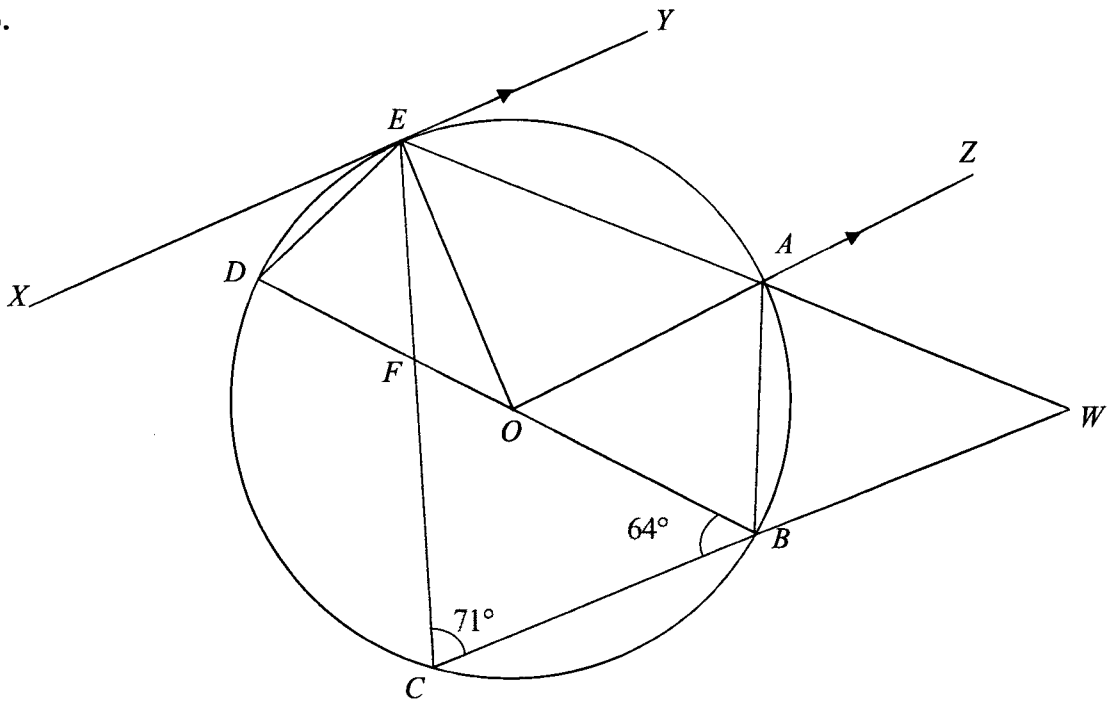
**(iii)** A number, $p$, is chosen at random from the set ($B$ U $C$).
Find the probability that $p \in A$.

Answer .....[2]



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**3.**




$O$ is the centre of the circle $ABCDE$. $XY$ is a tangent to the circle at $E$ and $EC$ intersects $BD$ at $F$. $OZ$ is a straight line that passes through $A$ and is parallel to $XY$. The lines $CB$ produced and $EA$ produced meet at $W$. $\angle BCE = 71°$ and $\angle OBC = 64°$.

**(a)** Complete the following statements.

(i) $\angle BDE$ = .....°

because .....[2]

(ii) $\angle AOE$ = .....°

because .....[2]



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Find

**(b)** $\angle BOE$ ,

Answer $\angle BOE =$.....° [1]

**(c)** $\angle OCE$,

Answer $\angle OCE =$.....° [1]

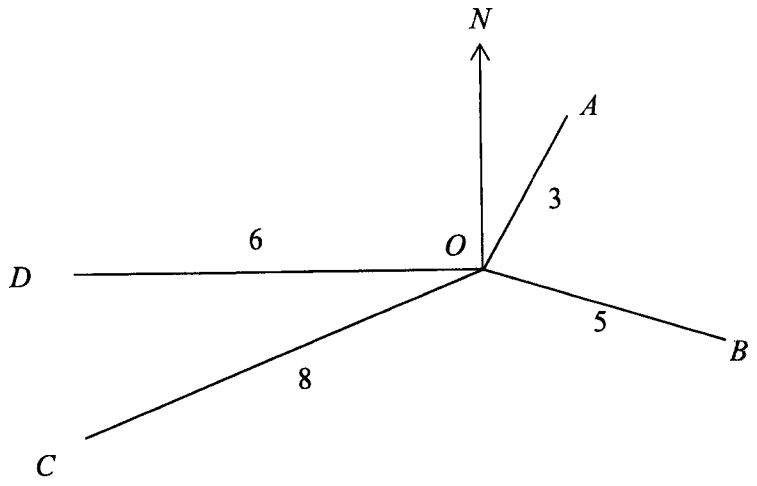
**(d)** $\angle ABW$ .

Answer $\angle ABW =$.....° [2]



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**4.** In the diagram, a lighthouse is at $O$.
Four ships, $A$, $B$, $C$ and $D$ are positioned around it with $OA = 3$ km , $OB = 5$ km, $OC = 8$ km and $OD = 6$ km. The bearing of $A$ from $O$ is 027° and the bearing of $B$ from $O$ is 103°. Ship $D$ lies due west of $O$ and Ship $C$ lies due south of $D$.




**(a)** Calculate the distance between Ship $A$ and Ship $B$.

Answer .....km [3]



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**(b)** The keeper of the lighthouse is standing on top of the lighthouse, which is 20 m tall. Calculate the angle of depression, from where he is standing to Ship *A*.

Answer ..... ° [2]

**(c)** Calculate the bearing of Ship *C* from *O*.

Answer .....° [2]



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**(d)** A speedboat travels directly from Ship $A$ to Ship $B$. Calculate the shortest distance between the speedboat and the lighthouse during its journey.

Answer ..... km [2]

**(e)** It is suggested that Ships $A$, $B$ and the lighthouse at $O$ form a right-angled triangle. Showing your working clearly, determine whether this is true.

Answer

[2]



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**5. (a)** As part of a school fundraising event, Jamie buys $x$ boxes of snacks for a total of \$180. She plans to sell each box at a profit of 80 cents.

**(i)** Write, in terms of $x$, an expression for the price, in dollars, Jamie paid for one box.

Answer \$..... [1]

**(ii)** Hence, write an expression for her selling price, in dollars, of one box.

Answer \$.....[1]

**(b)** Jamie managed to sell all except 15 of the boxes and collected \$171 from his sales. Form an equation in $x$, and show that it simplifies to $4x^2-15x-13500=0$.

Answer Shown above [3]



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**(c)** Showing your working clearly, solve the equation in (b) and calculate the selling price of 1 box of snacks.

Answer $x$ = .....

Selling price = $.....[3]

**(d)** Jamie considers increasing her selling price by $0.25 per box for the remaining 15 boxes. Would this allow her to make a profit overall?
Justify your conclusion with mathematical calculations.

Answer

_____

_____

_____

_____

[2]

**END OF BOOKLET A**



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# CATHOLIC HIGH SCHOOL
## 2025 Preliminary Examination
## Secondary 4 (O-Level Programme)

**B**

## Mathematics

**4052/02**

Paper 2

**27 August 2025**

Booklet B

**READ THESE INSTRUCTIONS FIRST**

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

*For examiners' use*

**50**

This booklet consists of **17** printed pages and **1** blank pages.



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**6.(a)** Complete the table of values for $y = \frac{1}{10}\left(x^2 + \frac{7}{x}\right)$.

Values are given to one decimal place where appropriate.

| $x$ | 0.6 | 1 | 1.5 | 2.2 | 3.1 | 4 | 5.1 | 5.8 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 1.2 | 0.8 | 0.7 | 0.8 | | 1.8 | 2.7 | 3.5 |

[1]

**(b)** On the grid opposite, draw the graph of $y = \frac{1}{10}\left(x^2 + \frac{7}{x}\right)$ for $0.6 \le x \le 5.8$. [3]

**(c)** Using your graph, estimate the value(s) of $x$ for which $x^2 + \frac{7}{x} = 20$, where $0.6 \le x \le 5.8$.

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

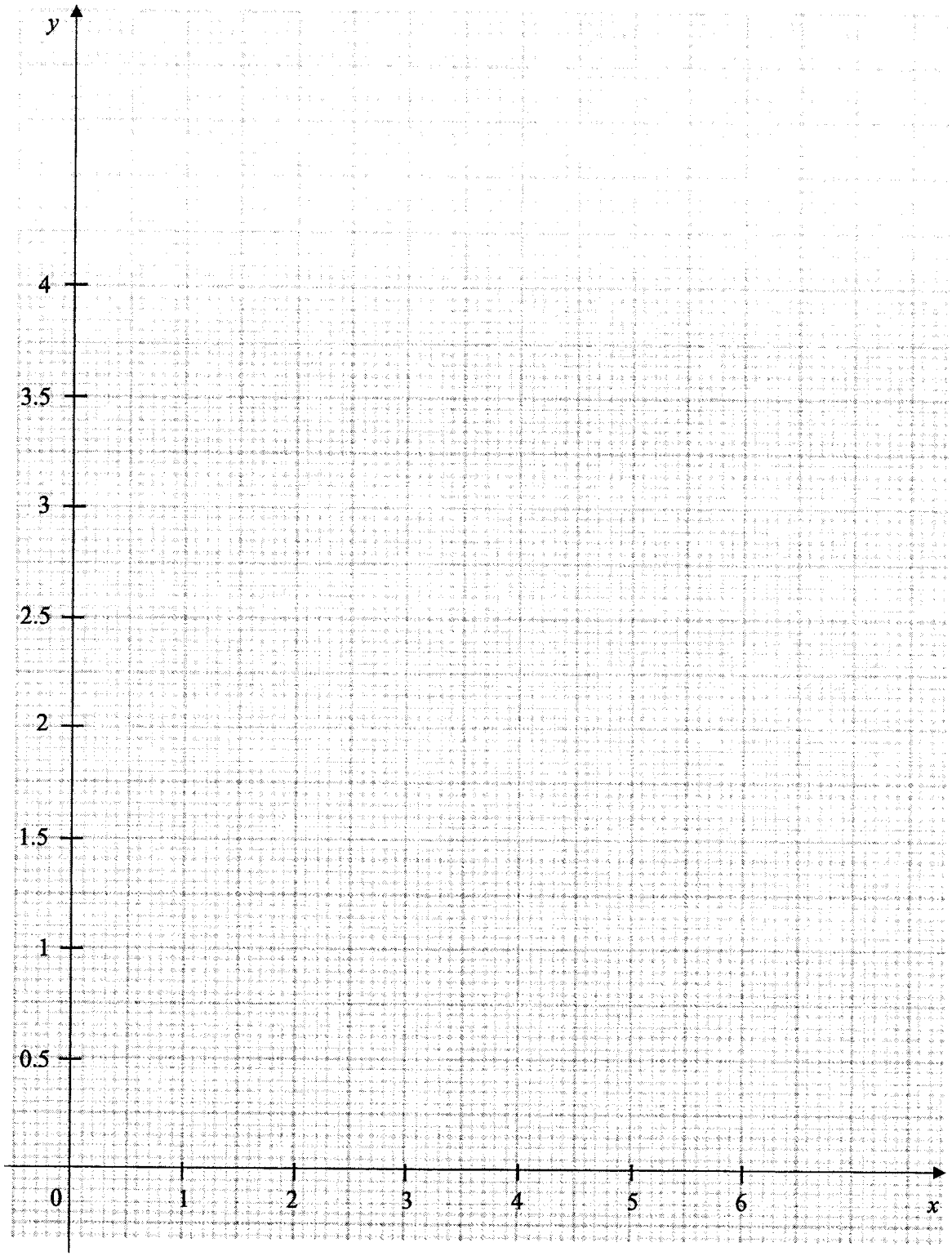
**(d) (i)** On the same grid, draw the graph of $3y - x = 3$ for $0.6 \le x \le 5.8$. [1]

**(ii)** Write down the $x$-coordinates of the points where the line intersects the curve.

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



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**(iii)** These values of $x$ are solutions of the equation $3x^3 + Ax^2 + Bx + 21 = 0$.
Find the value of $A$ and of $B$.

Answer $A$ =.....

$B$ = .....[3]

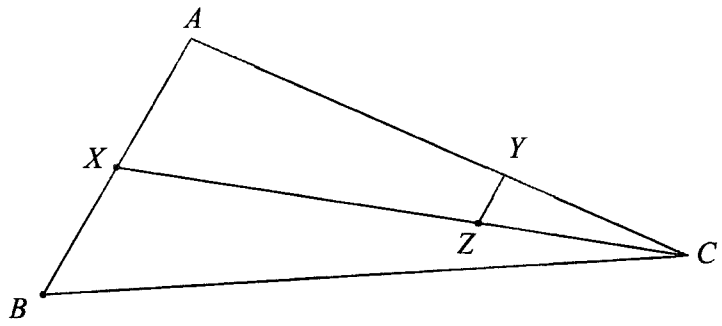
**(e)** By drawing a tangent, find the gradient of the curve where $x = 2.2$.

Answer .....[2]



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**7.** $ABC$ is a triangle. $\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{AC} = \mathbf{q}$. $X$ is the midpoint of $AB$. $Z$ and $Y$ are points on $XC$ and $AC$ respectively such that $\overrightarrow{XZ} = \frac{2}{3}\overrightarrow{XC}$ and $\overrightarrow{YC} = k\overrightarrow{AC}$.




**(a)** Express the following vectors in terms of **p** and/or **q**, giving your answers in the simplest terms.

**(i)** $\overrightarrow{AX}$,

Answer $\overrightarrow{AX}$ =.....[1]

**(ii)** $\overrightarrow{CX}$.

Answer $\overrightarrow{CX}$ =..... [2]

**(b)** Express $\overrightarrow{YZ}$ in terms of $k$, **p** and **q**.

Answer $\overrightarrow{YZ}$ =..... [2]



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(c) Given that $YZ$ is parallel to $AX$, find the numerical value of

**(i)** $k$,

Answer $k =$ ..... [1]

**(ii)** $\frac{YZ}{AB}$,

Answer $\frac{YZ}{AB} =$ ..... [1]

**(iii)** $\frac{\text{Area of } \Delta XYC}{\text{Area of } \Delta ABC}$.

Answer $\frac{\text{Area of } \Delta XYC}{\text{Area of } \Delta ABC} =$ ..... [1]



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**8.** A manufacturer sells lightbulbs under two different brands, **BrightLite** and **EcoGlow**. The lifespan, in days, of **500 BrightLite lightbulbs** is summarised in the table below.

Lifespan of **BrightLite Lightbulbs**

| Length of life ($x$ days) | Number of bulbs |
|---|---|
| $100 < x \leq 120$ | 15 |
| $120 < x \leq 140$ | 35 |
| $140 < x \leq 160$ | 70 |
| $160 < x \leq 180$ | 130 |
| $180 < x \leq 200$ | 150 |
| $200 < x \leq 220$ | 80 |
| $220 < x \leq 240$ | 20 |

**(a) (i)** Calculate an estimate of the mean lifespan of the **BrighLite bulbs** in days.

Answer.....days [1]

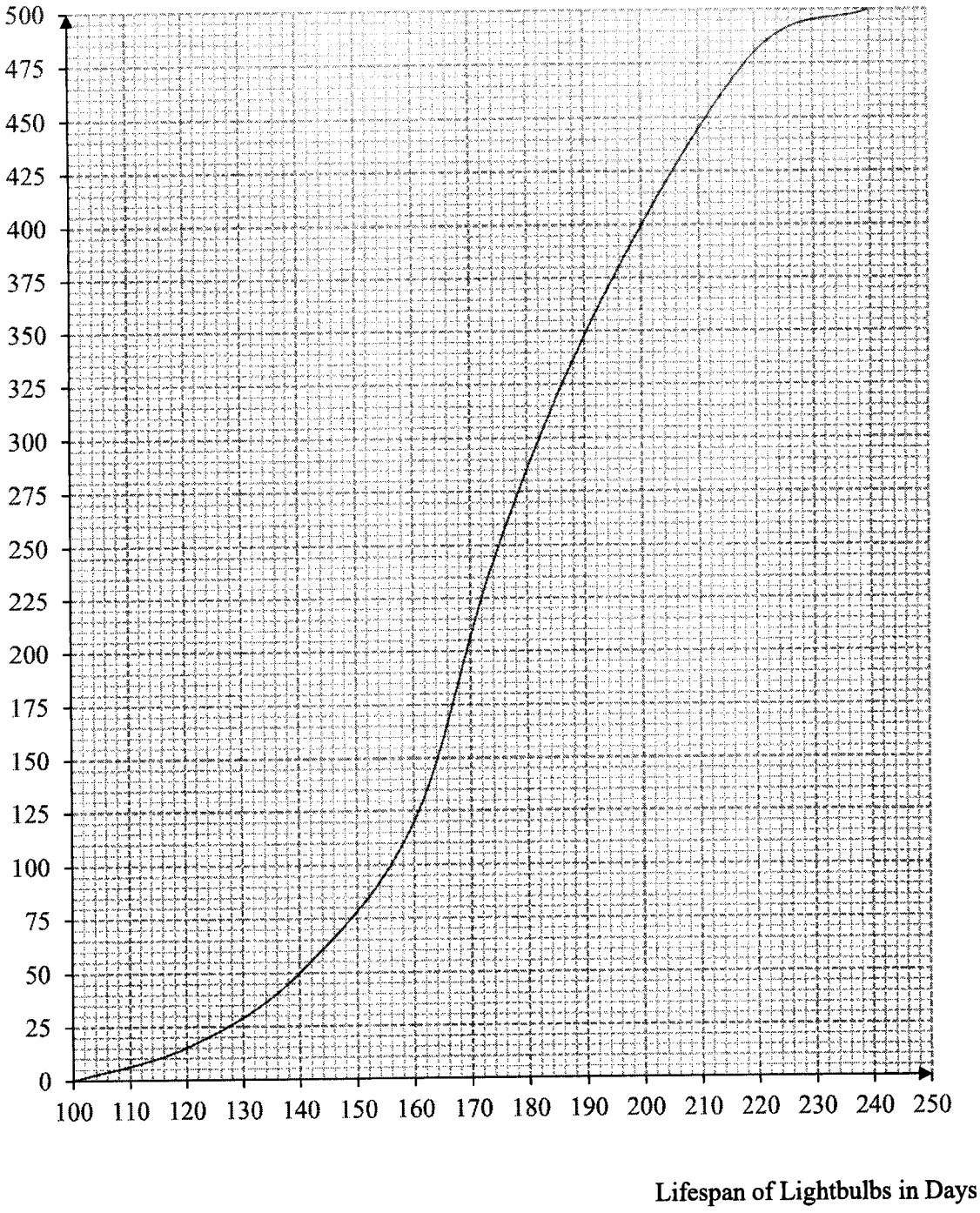
**(ii)** Calculate an estimate of the standard deviation.

Answer .....days [1]



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**(b)** The cumulative frequency curve shows the same information for the 500 **BrightLite Bulbs.**






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Use the curve to estimate

**(i)** the median lifespan of the bulbs,

Answer .....days[1]

**(ii)** the interquartile range of the lifespans.

Answer .....days [2]

**(iv)** If a bulb is selected, find the probability that its lifespan is more than 160 days.

Answer .....[2]

**(iv)** 90% of the bulbs have lifespan more than $n$ days. Find $n$.

Answer $n$ = .....[1]



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**(v)** If two bulbs are randomly chosen, find the probability that one bulb has a lifespan of more than 160 days while the other has a lifespan of less than 140 days.

Answer .....[2]

**(c)** The manufacturer also tested 500 **EcoGlow bulbs**. These bulbs had a smaller interquartile range as the **BrightLite bulbs**, but the same median lifespan. Describe how the cumulative frequency curve for the **EcoGlow bulbs** may differ from that of the **BrightLite bulbs**.

Answer

[1]



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**9.** A company produces four types of healthy snacks — granola bars, fruit juices, protein shakes, and yoghurt cups. The quantities delivered daily to three health stores are shown in the table below.

| Snack Type | Granola Bars | Fruit Juices | Protein Shakes | Yoghurt Cups |
|---|---|---|---|---|
| Store A | 45 | 30 | 25 | 20 |
| Store B | 50 | 25 | 30 | 35 |
| Store C | 60 | 40 | 20 | 25 |

**(a)** Write down a $3 \times 4$ matrix $P$ to show the number of each type of snack delivered to each store.

Answer $P =$ .....[1]

**(b)** The cost of each granola bar, fruit juice, protein shake, and yoghurt cup is \$1.50, \$2.00, \$3.20 and \$1.80 respectively. Represent these prices in a 4 x 1 column matrix $Q$.



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Answer $Q =$ .....[1]

**(c)** Evaluate the matrix $T = PQ$.

Answer $T =$ .....[2]

**(d)** State what each of the elements in matrix $T$ represents.

Answer

_____

_____

_____

[1]

**(e) (i)** Find the matrix $\begin{pmatrix}1 & 1 & 1\end{pmatrix}P$.

Answer .....[1]



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**(ii)** Explain what each element in $\begin{pmatrix}1 & 1 & 1\end{pmatrix}P$ represents.

Answer

[1]



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**10.** Alex is starting a vertical farming business in Singapore, using hydroponics to grow leafy vegetables in an indoor warehouse space of floor area 50 $m^2$ with a ceiling height of 2.5 metres. The current setup consists of 8 vertical hydroponic shelves arranged within the space.

***Fixed Overheads and Costs:***

- Electricity: $0.25 per kWh
- Water: $2.50 per $m^3$
- Nutrients: $0.30 per kg of vegetables grown

The business rents a government-subsidised commercial unit at a special rate of **$500/month**, under a national initiative to support sustainable urban agriculture and small business growth.

The table below gives information on the Monthly Production, Unit price, and Resource Usage for January to June 2025.

| | | | Resource Usage | |
|---|---|---|---|---|
| Month | Monthly production (kg) | Price ($/kg) | Electricity (kWh) | Water ($m^3$) |
| Jan | 240 | 6.00 | 800 | 15 |
| Feb | 260 | 6.10 | 820 | 16 |
| Mar | 280 | 6.20 | 840 | 17 |
| Apr | 300 | 6.30 | 860 | 18 |
| May | 320 | 6.40 | 880 | 19 |
| Jun | 340 | 6.50 | 900 | 20 |



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**(a)** Calculate the profit for the month of June.

Answer $ .....[3]

**(b)** Suggest a possible reason for the increase in crop prices from January to June.

Answer

_____

_____

[1]



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(c) The vertical farming system uses hydroponic shelves, each measuring 2.0 m (length) × 0.5 m (width) × 1.8 m (height), with 5 levels of planting trays per shelf. Each level grows 10 kg of vegetables per month. There are currently 8 such shelves arranged in the warehouse . Safety guidelines require a minimum clearance of 0.2 m from the ground and 0.5 m from the ceiling.

The maximum number of shelves that can be installed is limited by both walking and maintenance space requirements. Each shelf occupies **2.0 m × 0.5 m** of floor space, and minimum clear walking space of **0.5 m** must be provided around each shelf. This clearance applies to the warehouse walls and between shelves.

The warehouse has a total floor area of **50 m²** (10 m × 5 m).

Due to airflow and light distribution limits, the maximum number of shelves that can physically fit in the warehouse is limited.

- For **10 shelves or fewer**, each shelf operates at **100 %** of its production capacity.
- When **11 or more shelves** are installed, airflow saturation occurs, reducing the production of **all** shelves to **85 %** of their monthly production.
- In addition, **each shelf beyond the 10th** operates at only **70 %** of its monthly production due to poor light and air mixing at the edges.

Alex's goal is to **maximise revenue** for the month of July. Assume that the unit price and resource usage for July is the same as June.

**Task:**
Determine the number of shelves Alex should install. Justify your answer clearly with mathematical calculations that consider both **space constraints** and the **productivity limitations.** You may wish to draw diagrams to aid in your understanding. [6]



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**Continue with solutions for 10(c)**



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**END OF BOOKLET B**



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