SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR AND FIVE
PRELIMINARY EXAMINATION

O

Name: _____ ( ) Class: _____

MATHEMATICS

4052/01

Paper 1

Monday 26 August 2024

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

Answer **all** the questions.
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 π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 90.

For Examiner's Use	
Section A	72
Section B	18
Total	90

This document consists of **22** printed pages and **2** blank pages.

Setter: Mr Ang Hanping
Vetter: Mdm Zoe Pow

[Turn over

Home of Thoughtful Leaders: Serve with Honour, Lead with Humility

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Mathematical Formulae

Compound Interest

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

Measurement

Curved surface area of a cone = πrl

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

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

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

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

Arc length $= r\theta$, where θ 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

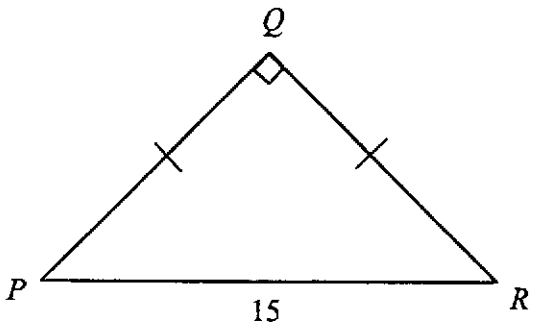
$$\text{Mean} = \frac{\sum fx}{\sum f}$$

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

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Section A (72 marks)
Answer **all** the questions.

1



In the triangle, $PQ = QR$, $PR = 15$ cm and angle $PQR = 90°$.

Calculate PQ.

Answer $PQ =$ ..... cm [2]

---

2 A bag contains 8 red balls, 5 green balls and 7 yellow balls.

(a) A ball is chosen at random and then replaced.
What is the probability that it is not a red ball?

Answer ..... [1]

(b) x yellow balls are removed from the bag.

The probability of choosing a green ball is now $\frac{1}{3}$.

Find the value of x.

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

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3 In 2023, the population in Singapore was 5 920 000, correct to the nearest ten thousand.

The population increased by 4% from 2020 to 2023.

Calculate the population in Singapore in 2020, giving your answer correct to the nearest ten thousand.

Answer ..... [2]

---

4 Write as a single fraction in its simplest form $\frac{2x}{3}-\frac{3(x-2)}{4}$.

Answer ..... [2]

---

5 Simplify $\left(\frac{x^3}{27y^6}\right)^{\frac{4}{3}}$.

Answer ..... [2]

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6 Peter has many cuboid blocks with dimensions 24 cm by 20 cm by 15 cm. He wishes to manufacture a box in the shape of a cube to pack the blocks such that there is no empty space in the box.

Find the smallest possible length of the box.

Answer ..... cm [2]

---

7 The students in a school participate in exactly one CCA each. The table shows information on the type of CCA which students in a class participate in.

	Clubs and Society	Sports	Uniformed Groups	TOTAL
Males	6			
Females	10	5	3	18
TOTAL	16	12		40

(a) How many males participate in uniformed groups?

Answer ..... [1]

(b) A pie chart is to be drawn showing the data for the **females**.

Calculate the angle representing females participating in uniformed groups.

Answer ..... [1]

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8 The mass of Jupiter is approximately 1.90×10^{27} kg.

The mass of Earth is approximately 5.97×10^{24} kg.

(a) Giving your answer in standard form, calculate how many times Jupiter's mass is, compared to that of Earth's.

Answer ..... [1]

(b) Density refers to the mass per unit volume.

Given that the volume of Jupiter is 1.43×10^{24} m^3 and that of Earth's is 1.08×10^{21} m^3, calculate and determine which planet has a higher density.

Answer ..... [2]

---

9 Elva invested a sum of money in an account paying compound interest at 4% per year. After 3 years, there was \$89 989.12 in her account.

How much did Elva invest in the account?

Answer \$ ..... [3]

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10 A metal sphere has a mass of 197 grams, correct to the nearest gram.

(a) Find the least possible mass of the metal sphere.

Answer ..... g [1]

(b) The volume of the metal sphere is 25 cm^3, correct to the nearest cubic centimetre.
Find the greatest possible mass of 1 cubic centimetre of the metal.

Answer ..... g [2]

---

11 A class of 10 boys and 10 girls took a test.
The girls' marks were 4, 5, 6, 7, 7, 7, 8, 8, 8 and 10.

(a) State the modal mark for the girls.

Answer ..... [1]

(b) Find the mean mark for the girls.

Answer ..... [1]

(c) The mean mark for the whole class was 7.5.
Aaron claims that the boys did better in the test.
Do you agree? Justify your answer.

Answer .....

.....

..... [1]

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12 **(a)** Factorise $a^4 - b^2$.

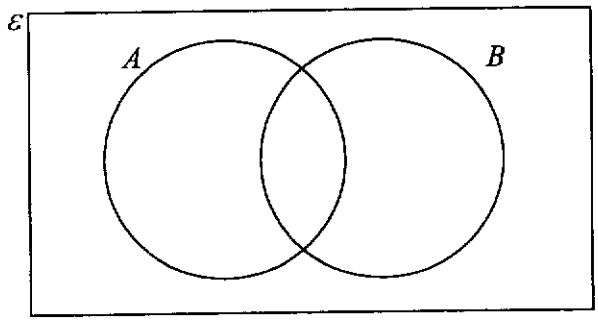
Answer ..... [1]

(b) Factorise completely $8xy - 1 - 4x + 2y$.

Answer ..... [2]

---

13 **(a)** On the Venn Diagram shown in the answer space, shade the set $A \cap B'$.



[1]

(b) $\varepsilon = \{x : x \text{ is an integer and } 1 \leq x \leq 100\}$

$P = \{x : x \text{ is a perfect square}\}$

$Q = \{x : x \text{ is a multiple of } 3\}$

$R = \{x : x \text{ is an integer ending in } 2\}$

(i) List the elements contained in the set $Q \cap R$.

Answer ..... [1]

(ii) Write down $\mathrm{n}(P \cap R)$.

Answer ..... [1]

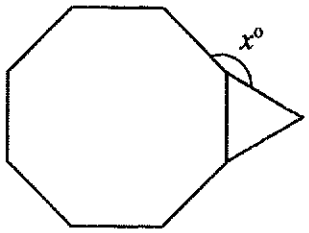
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14 **(a)** A regular polygon has interior angles of 140°.

Find the number of sides of the polygon

Answer ..... [2]

(b) The diagram shows a sketch of a regular octagon and an equilateral triangle.

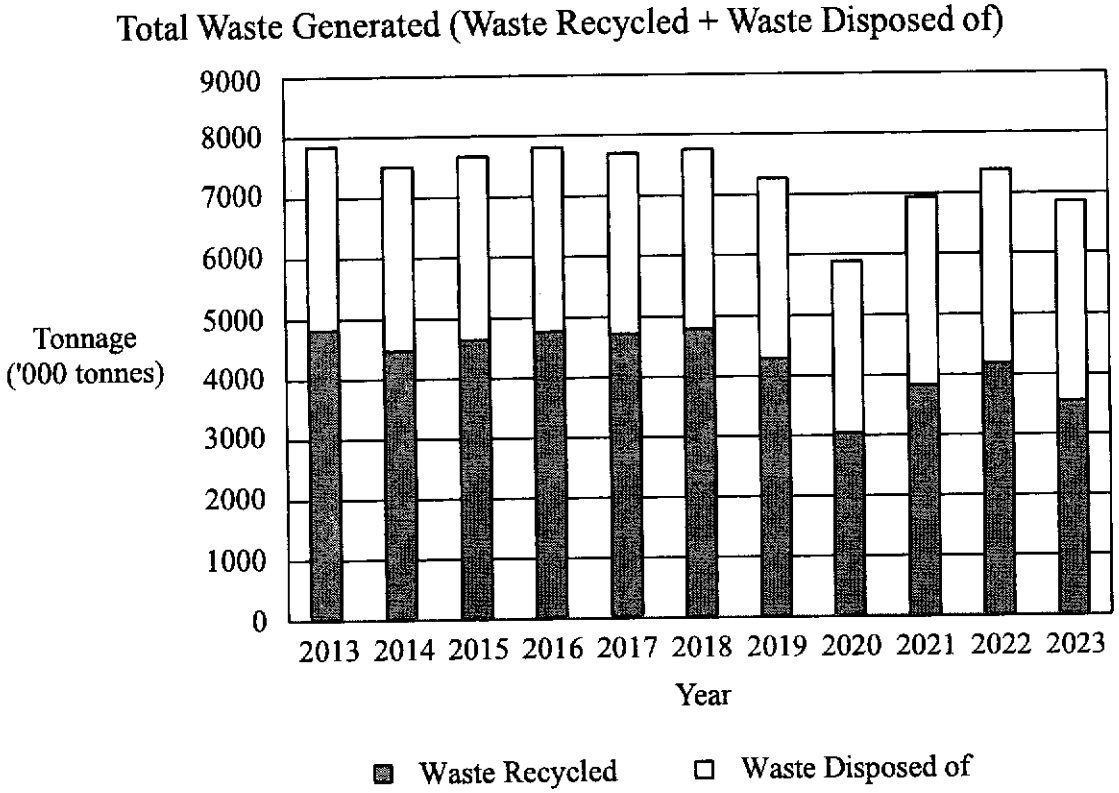


Calculate x.

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

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15 The graph shows information about the waste generated in Singapore from 2013 to 2023.



(a) Estimate the waste recycled in 2021.

Answer ..... tonnes [1]

(b) Make one comment about the total waste generated in the 2020s compared with the 2010s.

Answer .....

..... [1]

(c) There was a significant drop in the amount of construction and demolition waste, which is usually completely recycled, over the last decade. Brian claims that this contributed to a decline in the percentage of waste recycled in the 2020s compared with the 2010s.
Does the graph support his claim? Justify your answer with reference to the graph.

Answer .....

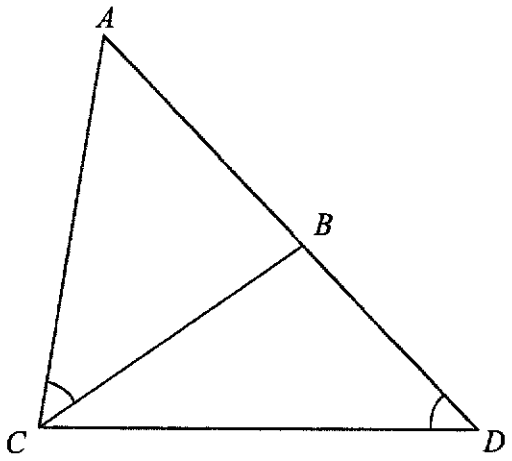
.....

.....

..... [2]

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16



In the diagram, ABC and ACD are triangles such that angle ACB = angle ADC.

(a) Show that the two triangles are similar.

Answer

[2]

(b) Given that $AB = 6.5$ cm and $BD = 5.5$ cm, find AC.

Answer $AC =$ ..... cm [2]

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17 **(a)** Simplify $(a+2b)(a-2b)-a^2$.

Answer ..... [2]

(b) Hence evaluate $12\,349\times12\,341-12\,345^2$.

Answer ..... [2]

---

18 **(a)** 8 men can build a structure in 15 days.
How long would it take 5 men to build the structure?

Answer ..... days [1]

(b) The period, T seconds, of a pendulum is proportional to the square root of the length, l metres, of the pendulum.
The length of a pendulum is increased by 50% of its original value.
Calculate the percentage increase in the period of the pendulum.

Answer ..... % [2]

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19 The scale of a map is 4 cm : 1 km.

(a) Write this scale in the form 1 : n.

Answer 1 : ..... [1]

(b) The distance between two cities on the map is 40 cm.
Find the actual distance, in kilometres, between the two cities.

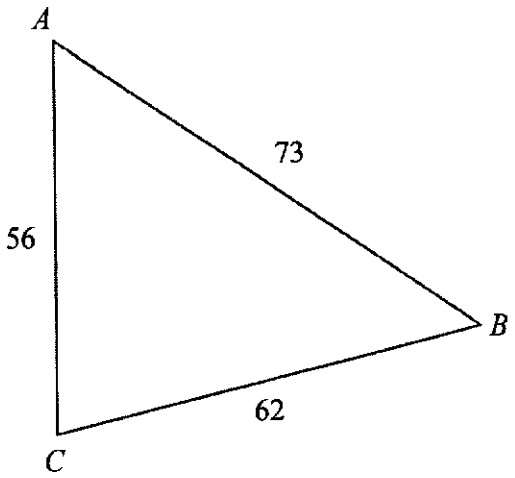
Answer ..... km [1]

(c) A park has an actual area of 4.5 km^2.
Find the area, in square centimetres, of the park on the map.

Answer ..... cm^2 [2]

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20



The diagram shows the positions of three towns, A, B and C.

AB is 73 km, BC is 62 km and AC is 56 km.

A is due North of C.

(a) Calculate the bearing of B from A.

Answer ..... [4]

(b) Calculate the area of triangle ABC.

Answer ..... km^2 [2]

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21 **(a)** Use prime factors to explain why 56×126 is a perfect square.

Answer .....

.....

.....

..... [3]

(b) Write down the greatest integer that will divide both 56 and 126 exactly.

Answer ..... [1]

(c) The number $126k$ is a perfect cube.
Find the smallest positive integer value of k.

Answer ..... [2]

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22 **(a)** Using factorisation, solve $9x^2+6x-8=0$.

Answer $x =$ ..... or ..... [3]

(b) Hence solve $9(y-1)^2+6y-14=0$.

Answer $y =$ ..... or ..... [2]

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Name : _____ ( ) Class : _____

Section B	18

Section B (18 marks)
Answer **all** the questions.

23 On every weekday morning, a theatre admits 20 adults and 40 children for a show.
On every weekday afternoon, the theatre admits 30 adults and 30 children.

This information can be represented by the matrix $\mathbf{A} = \begin{matrix} \text{Adults} & \text{Children} \\ \begin{pmatrix} 20 & 40 \\ 30 & 30 \end{pmatrix} & \begin{matrix} \text{Morning} \\ \text{Afternoon} \end{matrix} \end{matrix}$.

On every weekend morning, the theatre admits 30 adults and 60 children for the show.
On every weekend afternoon, the theatre admits 35 adults and 55 children.

(a) Represent the number of people admitted to the show on a day in the weekend by a matrix **B**.

Answer **B** = ... [1]

(b) Evaluate the matrix $\mathbf{C} = 5\mathbf{A} + 2\mathbf{B}$.

Answer **C** = ... [1]

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(c) State what the elements of **C** represent.

Answer .....

.....

..... [1]

(d) The admission fee for an adult is \$25 and for a child is \$12.

(i) Evaluate the matrix $\mathbf{D} = \mathbf{C}\begin{pmatrix}25\\12\end{pmatrix}$.

Answer **D** = ... [1]

(ii) Evaluate the matrix $\mathbf{E} = \frac{1}{7}\begin{pmatrix}1 & 1\end{pmatrix}\mathbf{D}$.

Answer **E** = ... [1]

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(iii) State what the elements of **E** represent.

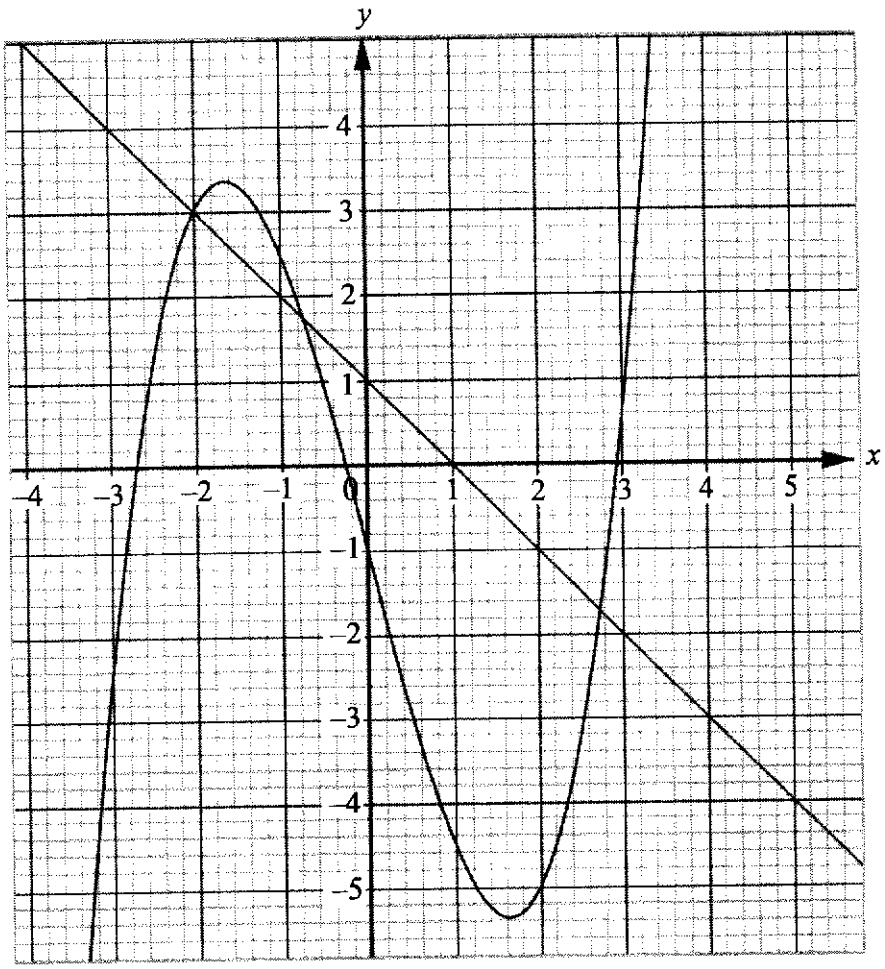
Answer .....

.....

..... [1]

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24 The graphs of $y = \frac{x^3}{2} - 4x - 1$ and $y = 1 - x$ are drawn on the grid.



(a) The points of intersection of the curve and the straight line give the solutions of a cubic equation. Find the cubic equation, giving your answer in the form $ax^3 + bx^2 + cx + d = 0$, where a, b, c and d are integers.

Answer ..... [1]

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(b) By drawing a tangent, find the gradient of the curve at $(-2, 3)$.

Answer ..... [2]

(c) The equation $x^3 - 4x = 0$ can be solved by drawing a suitable straight line on the grid.

(i) Find the equation of the straight line.

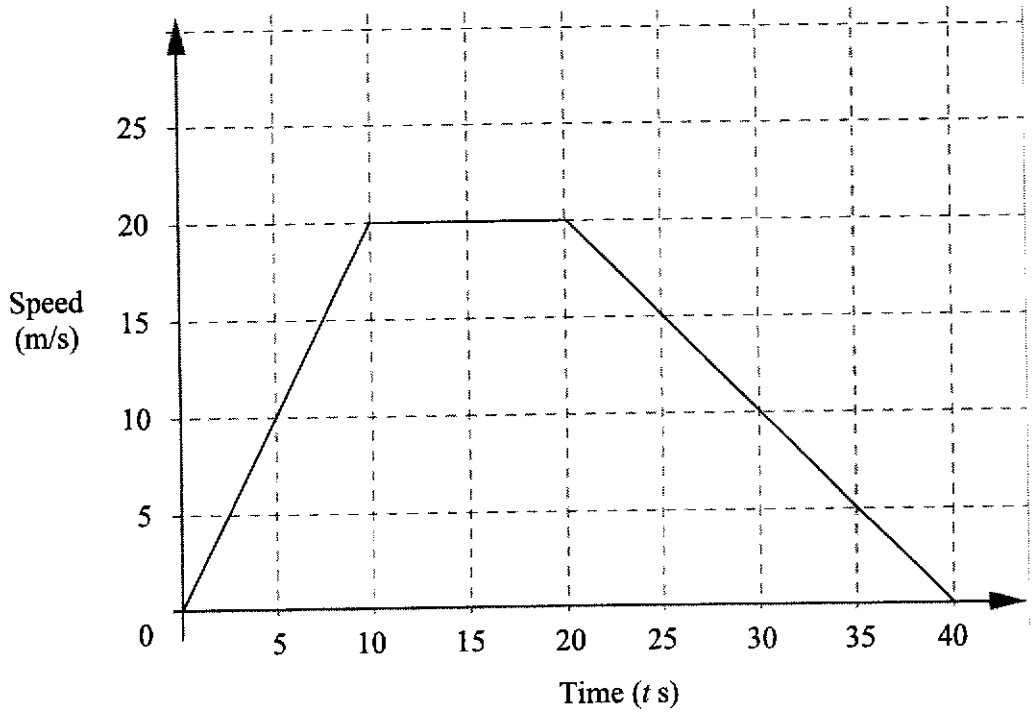
Answer ..... [1]

(ii) By drawing this straight line, solve the equation $x^3 - 4x = 0$.

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

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25 The diagram shows the speed-time graph for a car journey.



(a) Find the speed of the car when $t = 8$.

Answer ..... m/s [1]

(b) Find the acceleration of the car when $t = 8$.

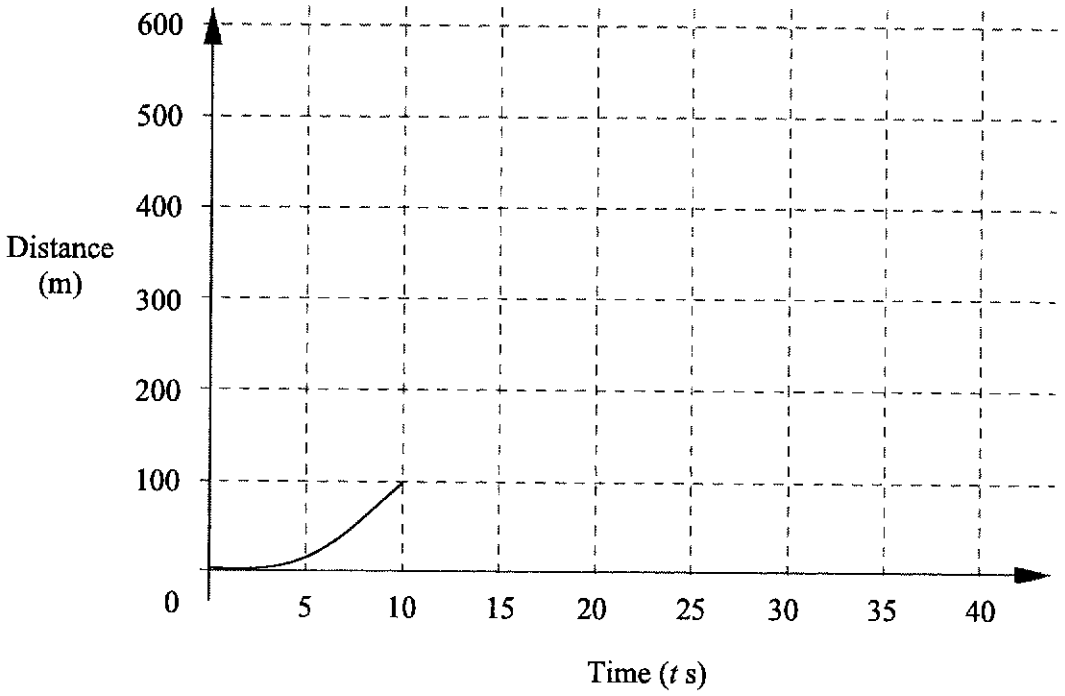
Answer ..... m/s^2 [1]

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(c) Find the total distance travelled on the journey.

Answer ..... m [2]

(d) Complete the distance-time graph for the journey on the grid below.



[2]

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SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR AND FIVE
PRELIMINARY EXAMINATION

O

Name: _____ ( ) Class: _____

MATHEMATICS

4052/02

Paper 2

Tuesday 27 August 2024

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
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Answer **all** the questions.
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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 π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 90.

For Examiner's Use	
Section A	31
Section B	59
Total	90

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Vetter: Mdm Zoe Pow

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Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

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TURN OVER FOR QUESTION 1

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Questions	1	2	3
Marks	/11	/10	/10

Section A (31 marks)

1 **(a)** Solve the inequality $\frac{3x+1}{3} < \frac{2-5x}{4}$.

Answer ..... [2]

(b) It is given that $a = \frac{2b-3c}{b+2c}$.

(i) Find a when $b = 0.2$ and $c = -1.5$.

Answer $a =$ ..... [1]

(ii) Express b in terms of a and c.

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

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(c) Solve the equation $\frac{5x}{x-3} - \frac{2}{2x-3} = 1$.

Give your solutions correct to 3 decimal places.

Answer $x =$ ..... or ..... [5]

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2 **(a)** Complete the table of values for $y = x^2 + 2x - 1$

x	–4	–3	–2	–1	0	1	2
y		2	–1	–2	–1	2	7

[1]

(b) On the grid opposite, draw the graph of $y = x^2 + 2x - 1$ for $-4 \le x \le 2$. [3]

(c) Use your graph

(i) to write down an inequality in x to describe the range of values where $y < 3$,

Answer ..... [1]

(ii) to solve the equation $x^2 + 2x + \frac{1}{2} = 0$.

Answer $x =$ ..... or ..... [3]

(d) Based on the graph, Eileen stated that 'the coordinates of the minimum point of the graph is $(-1, -2)$'.

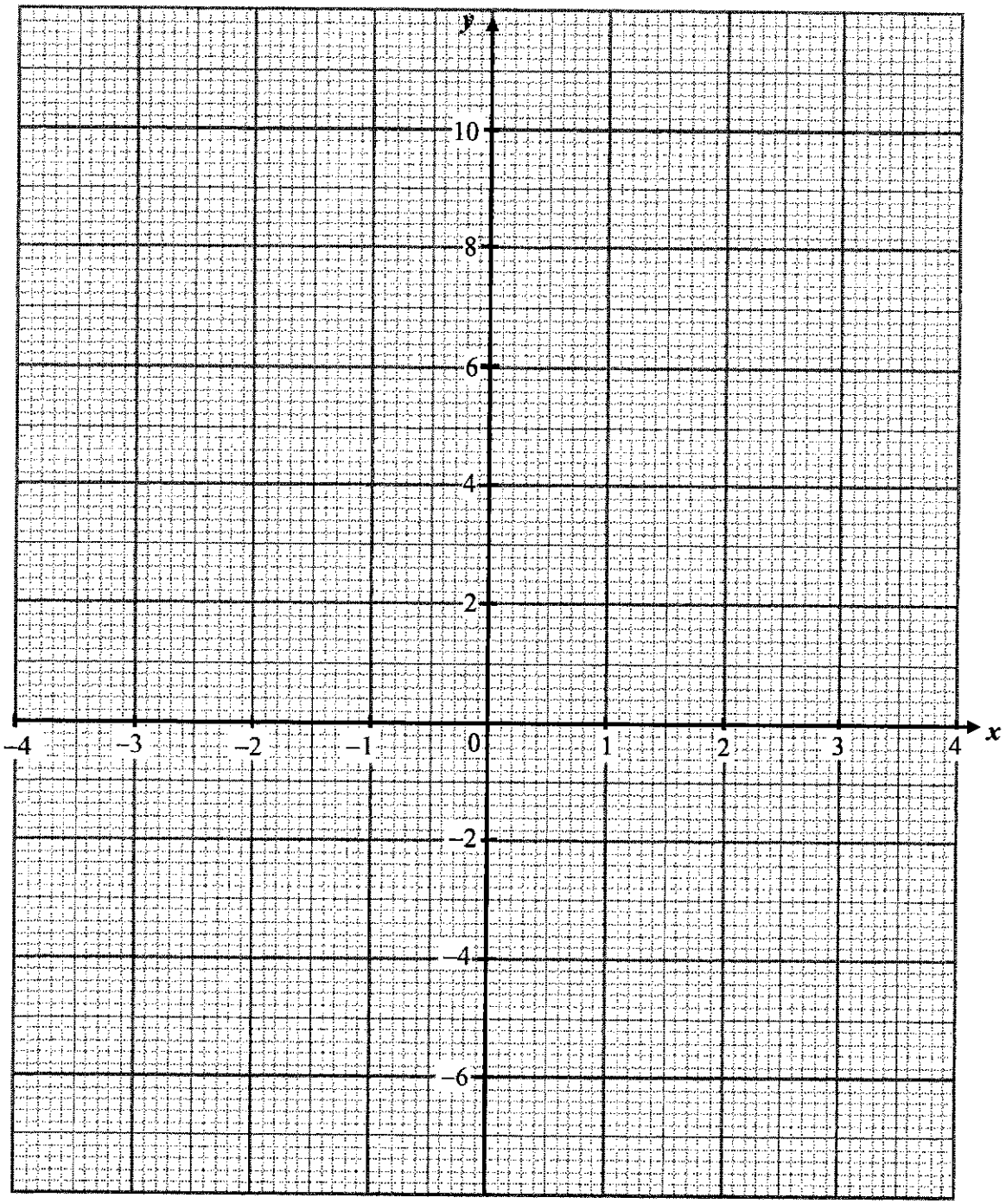
Show, with working, how you can verify this by expressing $x^2 + 2x - 1$ in the form $(x + p)^2 + q$.

Answer

[2]

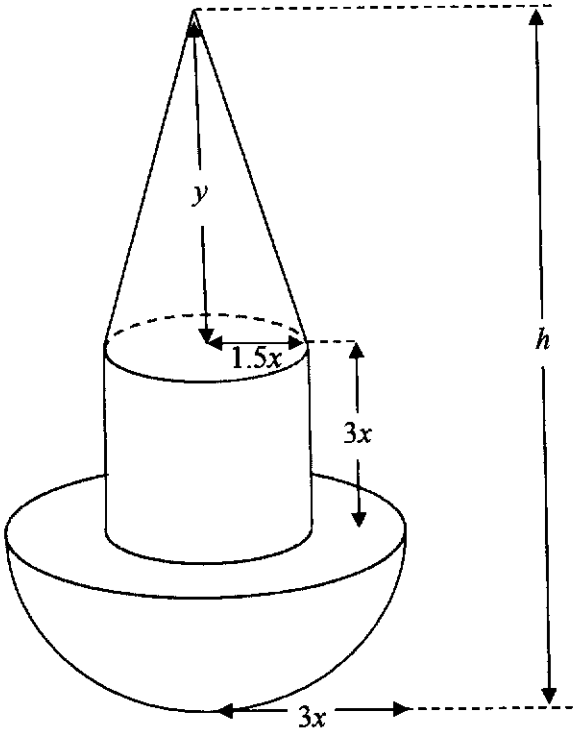
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7



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3



The diagram shows a solid formed from a cone, a cylinder and a hemisphere.
The cone has base radius $1.5x$ cm and height y cm.
The cylinder has radius $1.5x$ cm and height $3x$ cm.
The hemisphere has radius $3x$ cm.

(a) The volume of the hemisphere is thrice the volume of the cone.

Show that $y = 8x$.

Answer

[3]

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(b) The total surface area of the solid is 450 cm^2.

Calculate the total height, h cm, of the solid.

Answer $h =$ ..... cm [7]

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Name: _____( )

Class: _____

Questions	4	5	6	7	8	9
Marks	/8	/10	/9	/12	/10	/10

Section B (59 marks)

4 Here are the first four terms of a sequence.

$$\frac{13}{5} \quad \frac{10}{10} \quad \frac{7}{15} \quad \frac{4}{20}$$

(a) Find the fifth term of the sequence.

Answer ..... [1]

(b) T_n is the nth term of the sequence.

Find an expression, in terms of n, for T_n

Answer T_n = ... [3]

(c) The difference between the two consecutive terms of the sequence is $T_{n+1} - T_n$.

Show that $T_{n+1} - T_n = \dfrac{-16}{5n(n+1)}$.

Answer

[3]

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(d) Explain why the difference between the two consecutive terms of the sequence is always negative.

Answer.....

.....

..... [1]

---

5 Line l passes through the points $(-4, 4)$ and $(8, -2)$.

(a) Find the equation of line l.

Answer ..... [2]

(b) The equation of line m is $6y = 18 - 3x$.

Show how you can tell that the line m does **not** intersect the line l.

Answer

[2]

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(c) The equation of line n is $2y = 3x - 4$.

Line n and line l intersect at point A. Find the coordinates of A.

Answer A (....., ...) [3]

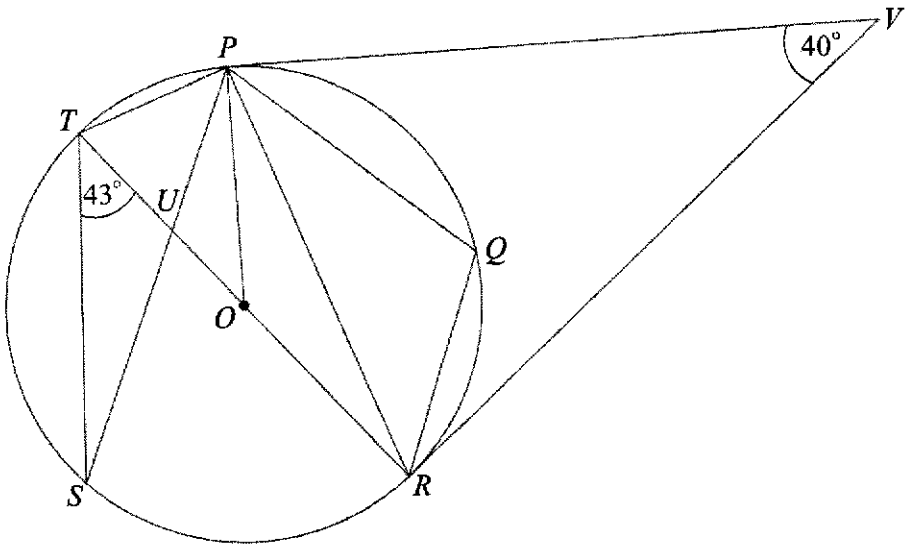
(d) Line l intersects the y-axis at point B and line n intersects the y-axis at point C.

Calculate the area of triangle ABC.

Answer ..... units^2 [3]

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6



The diagram shows a circle $PQRST$, with centre O.

PV and RV are tangents to the circle and U is the intersection of PS and TR.

Angle $PVR = 40^\circ$ and angle $STU = 43^\circ$.

(a) Find angle PQR.

Give a reason for each step of your working.

Answer Angle PQR = ... [3]

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(b) Find angle *TUP*.

Give a reason for each step of your working.

Answer Angle *TUP* = ... [3]

(c) Alice claims that the area of the minor sector *OSR* is more than one third of the area of the major sector *OSR*.

Do you support her claim?

Justify your decision with calculations.

Answer

..... because .....

..... [3]

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7 **(a)** The position vector of point X is $\begin{pmatrix} 8 \\ -4 \end{pmatrix}$.

The position vector of point Y is $\begin{pmatrix} 6 \\ 4 \end{pmatrix}$.

(i) Find the vector that represents the translation from X to Y.

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

(ii) Find the magnitude of $\overrightarrow{XY}$.

Answer ..... units [2]

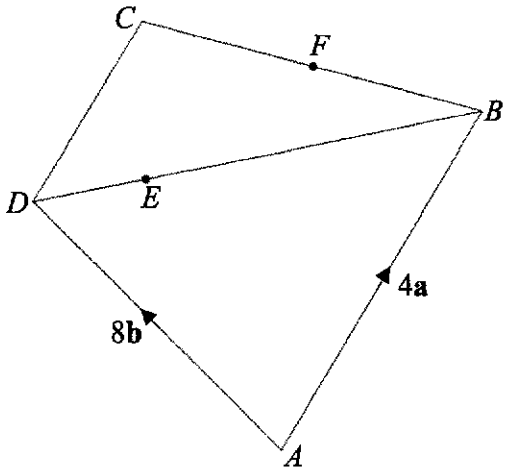
(iii) Z has coordinates $(-1, k)$ and lies on the line XY produced.

Find the position vector of point Z.

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

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(b)



In the diagram, $\overrightarrow{AB} = 4\mathbf{a}$, $\overrightarrow{AD} = 8\mathbf{b}$ and $\overrightarrow{EF} = 2(\mathbf{a} - \mathbf{b})$.
E is the point on BD such that $BE : BD = 3 : 4$.
F is the midpoint of BC.

(i) Express $\overrightarrow{BE}$ in terms of **a** and **b**, as simply as possible.

Answer ..... [2]

(ii) Express $\overrightarrow{BC}$ in terms of **a** and **b**, as simply as possible.

Answer ..... [2]

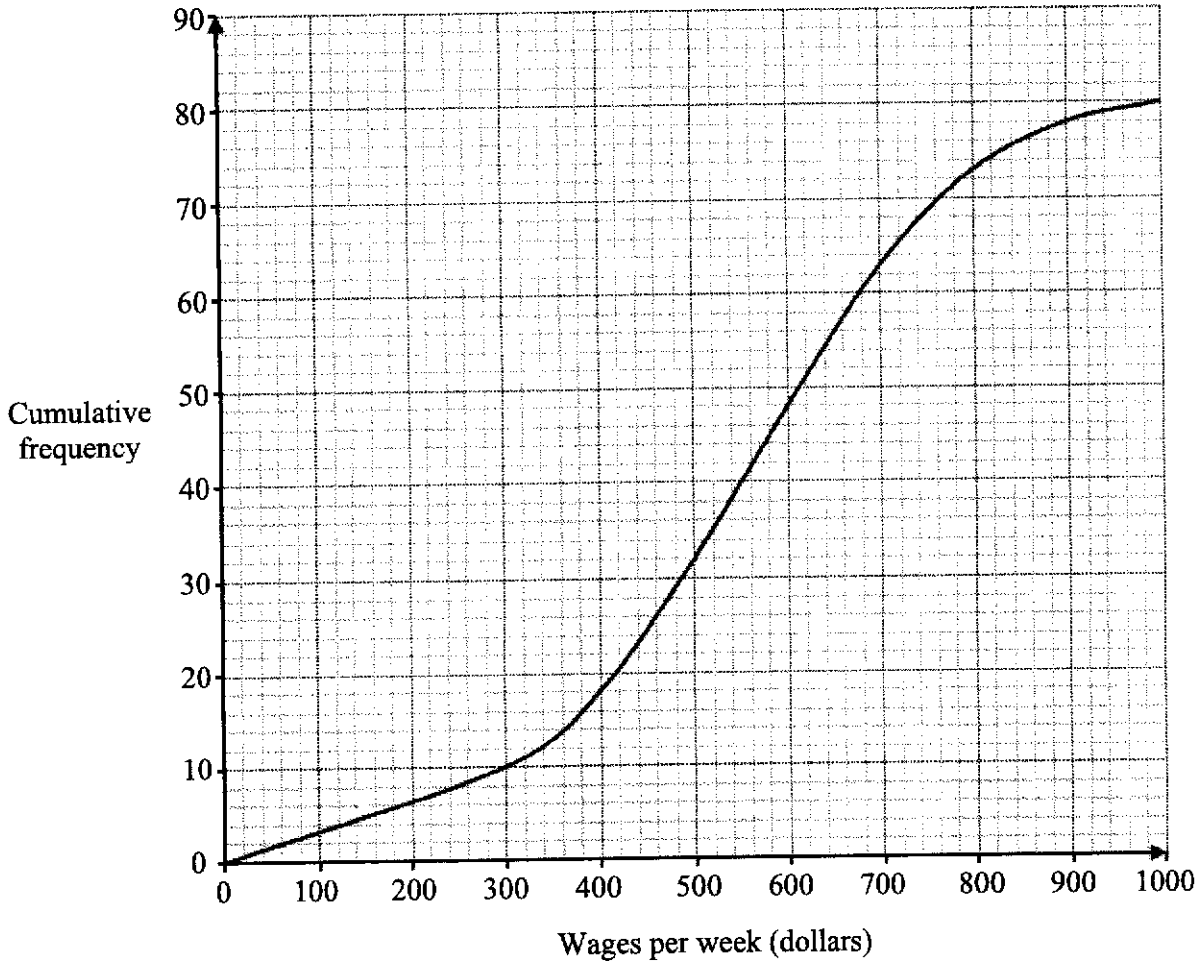
(iii) What type of quadrilateral is $ABCD$?
Justify your answer using vectors.

$ABCD$ is a ..... because .....

..... [3]

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8 The cumulative frequency curve shows the distribution of the wages per week of 80 workers in a factory.



(a) Use the curve to estimate

(i) the median wages per week,

Answer $ ..... [1]

(ii) the interquartile range of the wages per week.

Answer $ ..... [2]

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(b) In June 2024, the average wages per week of factory workers in Singapore was \$540.
Calculate the percentage of the workers in the factory who earned more than this average.

Answer ..... % [2]

(c) Find the number of workers who earned between \$460 and \$800.

Answer ..... [2]

(d) The factory employed more workers and paid them not more than \$650 per week.
Find the additional number of workers employed if the probability of choosing a worker who earned not more than \$650 is $\frac{11}{15}$.

Answer ..... [3]

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9 An event organiser is organising a 3-day Pet Festival for 300 exhibitors.
The event organiser charges each exhibitor a registration fee of \$90 and a daily booth rental of \$150.

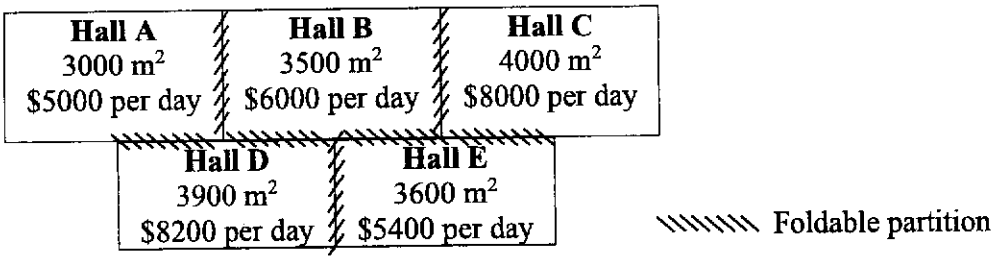
(a) Calculate the total amount of money the organiser collected from each exhibitor.

Answer \$ ..... [1]

The event organiser needs to rent an exhibition space for the Pet Festival.
The spaces required for the exhibition are as follows:

Each booth size	15 m^2
Aisle space for visitors and open spaces required	65% of the total area occupied by the booths

The layout, size and rental fees for the exhibition halls are as follows:



- *Adjacent halls have foldable partitions that can be opened up for rental of two halls.*
- *Rental is for one entire hall space.*

(b) Calculate the minimum amount payable by the event organiser for the daily rental of the exhibition hall(s) needed.

Answer \$ ..... [2]

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In order to set up the exhibition, the event organiser needs to rent the hall(s) and the items needed one day before the start of the 3-day Pet Festival.

Items needed for the exhibition and their rental fees are as follows:

Location	Items
Each booth	• 1 long table • 2 square tables • 4 chairs
Open space	• 75 round tables • 300 chairs

Items	Rental fees
Long table	\$2 each table per day
Square table	Every 100 tables at \$30 per day
Round table	Every 5 tables at \$20 per day
Chairs	Every 50 chairs at \$10 per day

For the 3 days of exhibition, the event organiser will employ 2 security guards and 4 part-timers for 12 hours for each day of the exhibition.
The costs are as follows:

- \$10 per hour for each security guard
- \$8 per hour for each part-timer

(c) It is estimated that there will be a total of 35 000 visitors for the 3-day exhibition.

The event organiser says:

> We will meet our minimum target profit of \$300 000 if we charge an entrance fee of \$6 per visitor.

Is the event organiser correct?
Using your answers in part **(a)** and **(b)**, justify your decision with calculations.

Answer

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Continuation of working space for question **9(c)**.

.....

..... [7]

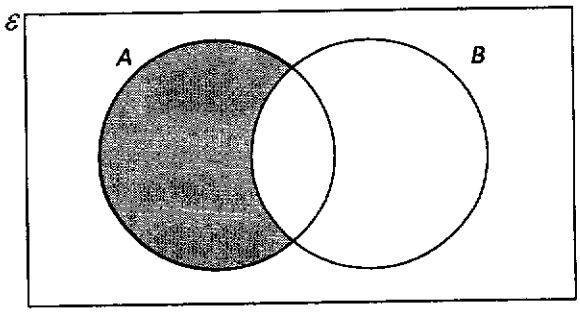
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2024 4E5N EM Prelim P1 Mark Scheme

1	$PQ^2+PQ^2=15^2$ $2PQ^2=225$ $PQ=10.6\,\text{cm}$	**M1** **A1**
2a	$\frac{3}{5}$	**B1**
2b	New total = $3\times5=15$ Yellow balls left $=15-8-5=2$ $x=7-2=5$	 **B1**
3	2020 population = $\frac{100}{104}\times5920000$ = 5690000 (nearest ten thousand)	**M1** **A1**
4	$\frac{2x}{3}-\frac{3(x-2)}{4}$ $=\frac{8x-9(x-2)}{12}$ $=\frac{8x-9x+18}{12}$ $=\frac{18-x}{12}$	 **M1** – Common denominator A1
5	$\left(\frac{x^3}{27y^6}\right)^{\frac{4}{3}}=\frac{x^4}{81y^8}$	**B1** - numerator **B1** - denominator
6	$24=2^3\times3$ $20=2^2\times5$ $15=3\times5$ LCM $=2^3\times3\times5$ Smallest length = 120 cm	 **M1** **A1**
7a	9	**B1**
7b	Angle = $\frac{3}{18}\times360=60$	**B1**
8a	$1.90\times10^{27}\div5.97\times10^{24}=3.18\times10^2$	**B1**
8b	Jupiter density = $1.90\times10^{27}\div1.43\times10^{24}$=1328.6713 kg/m^3 Earth density = $5.97\times10^{24}\div1.08\times10^{21}$ = 5527.7778 kg/m^3 Earth has a higher density	 **M1** **A1**

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9	$P\left(1+\frac{4}{100}\right)^3 = 89989.12$ $P = 89989.12 \div \left(1+\frac{4}{100}\right)^3$ $= \$80000$	**M1** **M1** **A1**
10a	196.5 g	**B1**
10b	$197.5 \div 24.5$ $= 8.06$ g	**M1** **A1**
11a	7 and 8	**B1**
11b	Mean $= \frac{4+5+6+3(7)+3(8)+10}{10} = 7$	**B1**
11c	Yes. The mean mark for the whole class, 7.5, was higher than the mean mark for the girls. Thus the **mean mark for the boys would have to be higher than 7.5**, which is better than the girls marks. Accept use of actual calculation of mean mark for boys to justify.	**B1**
12a	$a^4 - b^2 = (a^2+b)(a^2-b)$	**B1**
12b	$8xy - 1 - 4x + 2y$ $= 8xy - 4x + 2y - 1$ $= 4x(2y-1) + 2y - 1$ $= (2y-1)(4x+1)$	**M1** **A1**
13a		**B1**
13bi	{12, 42, 72}	**B1**
13bii	0	**B1**
14a	Exterior angle = 180 – 140 = 40 Number of sides $= 360 \div 40$ $= 9$ Or $(n-2) \times 180 = 140n$ $180n - 360 = 140n$ $40n = 360$ $n = 9$	**M1** **A1** **M1** **A1**

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14b	Exterior angle of octagon $= 360 \div 8 = 45$ Exterior angle of equilateral triangle $= 180 - 60 = 120$ $x = 120 + 45 = 165$	**M1** **A1**
15a	Accept 3 700 000 to 3 900 000	**B1**
15b	The total waste generated in the 2020s have decreased compared to the 2010s as the waste generated are lower on average.	**B1**
15c	Yes. The amount of **waste disposed of remains generally constant** over the last decade but the **waste recycled was generally lesser in the 2020s**, thus there is a decline in percentage of waste recycled in the 2020s.	**B1** **B1**
16a	angle ACB = angle ADC (given) angle BAC = angle CAD (common angle) Since all corresponding angles of the triangle are equal, triangles ABC and ACD *are similar*	**M1** **A1**
16b	$\frac{AB}{AC} = \frac{AC}{AD}$ $\frac{6.5}{AC} = \frac{AC}{6.5+5.5}$ $AC^2 = 78$ $AC = 8.83$ cm	**M1** **A1**
17a	$(a+2b)(a-2b)-a^2$ $= a^2 - 4b^2 - a^2$ $= -4b^2$	**M1** – correct expansion A1
17b	$12\,349 \times 12\,341 - 12\,345^2$ $(12\,345+2(2)) \times (12\,345-2(2)) - 12\,345^2$ $= -4(2)^2$ $= -16$	**M1** **A1**
18a	No. of days $= \frac{15}{5} \times 8 = 24$	**B1**
18b	$T = k\sqrt{l}$ % increase $= \frac{k\sqrt{1.5l} - k\sqrt{l}}{k\sqrt{l}} \times 100$ $= \frac{k\sqrt{l}\left(\sqrt{1.5}-1\right)}{k\sqrt{l}} \times 100$ $=22.5\%$	**M1** **A1**
19a	4 cm : 1 km 4 cm : 100 000 cm 1 : 25 000	**B1**

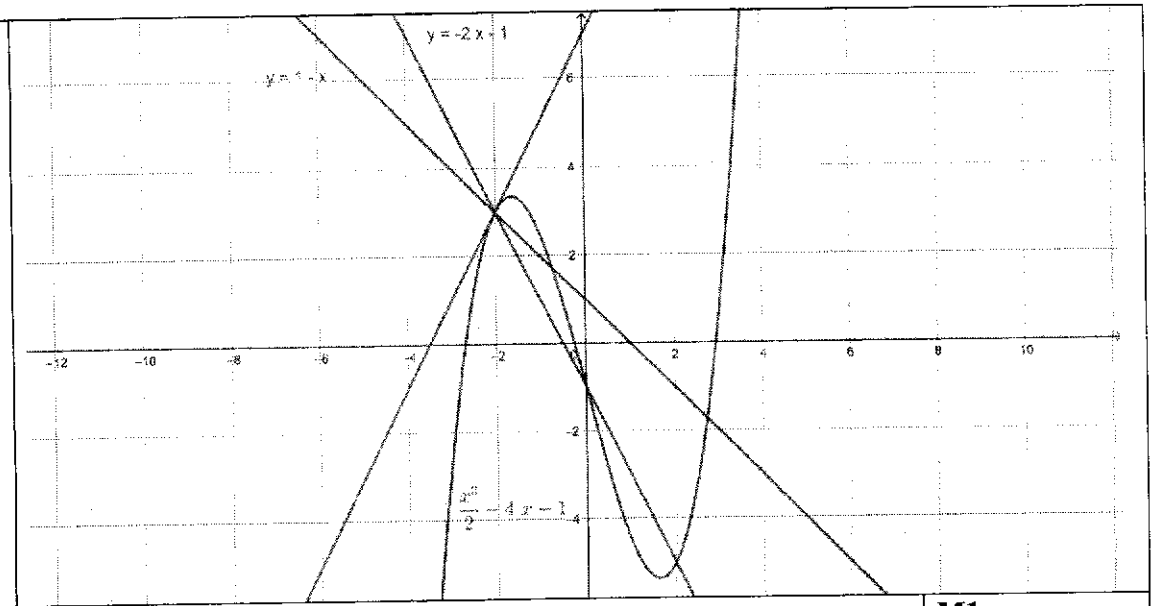
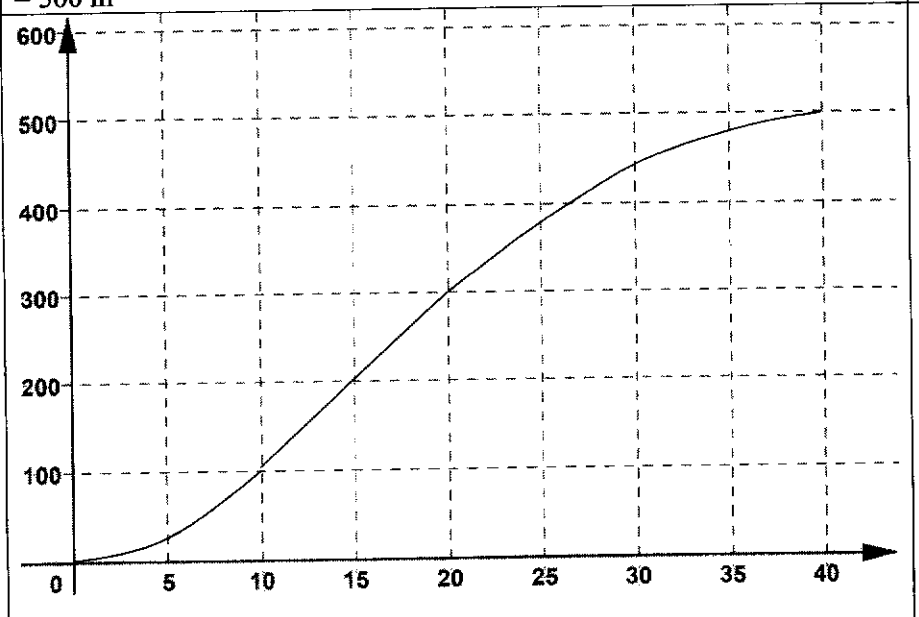
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19b	$40 \div 4 = 10$ km	**B1**
19c	4 cm : 1 km 16 cm^2 : 1 km^2 $4.5 \times 16 = 72$ cm^2	**M1** **A1**
20a	$62^2 = 56^2 + 73^2 - 2(56)(73)\cos \angle BAC$ $\angle BAC = 55.5845$ Bearing $= 180 - 55.5845$ $= 124.4$	**M2** **A1** **A1**
20b	Area of triangle ABC $= \frac{1}{2}(56)(73)\sin 55.5845$ $= 1686.2195$ $= 1690$ km^2	**M1** **A1**
21a	$56 = 2^3 \times 7$ $126 = 2 \times 3^2 \times 7$ $56 \times 126 = 2^4 \times 3^2 \times 7^2$ Since the powers of all prime factors are even, 56×126 is a perfect square.	**M1** **M1** **A1**
21b	$2 \times 7 = 14$	**B1**
21c	$k = 2^2 \times 3 \times 7^2$ $= 588$	**M1** **A1**
22a	$9x^2 + 6x - 8 = 0$ $(3x - 2)(3x + 4) = 0$ $x = \frac{2}{3}$ or $x = -\frac{4}{3}$	**M1** **A2**
22b	$9(y-1)^2 + 6y - 14 = 0$ $9(y-1)^2 + 6(y-1) + 6 - 14 = 0$ $9(y-1)^2 + 6(y-1) - 8 = 0$ From (a), $y - 1 = \frac{2}{3}$ or $y - 1 = -\frac{4}{3}$ $y = 1\frac{2}{3}$ or $y = -\frac{1}{3}$	**M1** **A1**
23a	$\mathbf{B} = \begin{bmatrix} 30 & 60 \\ 35 & 55 \end{bmatrix}$	**B1**
23b	$\mathbf{C} = 5\begin{bmatrix} 20 & 40 \\ 30 & 30 \end{bmatrix} + 2\begin{bmatrix} 30 & 60 \\ 35 & 55 \end{bmatrix}$	

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	$= \begin{bmatrix} 160 & 320 \\ 220 & 260 \end{bmatrix}$	**B1**
23c	Elements of **C** represent the total number people from each of the categories of adults and children, admitted to the theatre in the morning and afternoon respectively over one week.	**B1**
23di	$\mathbf{D} = \begin{bmatrix} 160 & 320 \\ 220 & 260 \end{bmatrix}\begin{bmatrix} 25 \\ 12 \end{bmatrix} = \begin{bmatrix} 7840 \\ 8620 \end{bmatrix}$	**B1**
23dii	$\mathbf{E} = \frac{1}{7}\begin{bmatrix} 1 & 1 \end{bmatrix}\begin{bmatrix} 7840 \\ 8620 \end{bmatrix} = \begin{bmatrix} 2351\frac{3}{7} \end{bmatrix}$	**B1**
23diii	**E** represents the average amount of money collected per day from admissions over one week.	**B1**
24a	$\frac{x^3}{2} - 4x - 1 = 1 - x$ $\frac{x^3}{2} - 3x - 2 = 0$ $x^3 - 6x - 4 = 0$	**B1**
24b	Draw tangent Gradient = 2	**M1** **A1**
24ci	$x^3 - 4x = 0$ $\frac{x^3}{2} - 2x = 0$ $\frac{x^3}{2} - 4x - 1 = -2x - 1$ Equation of line: $y = -2x - 1$	**B1**

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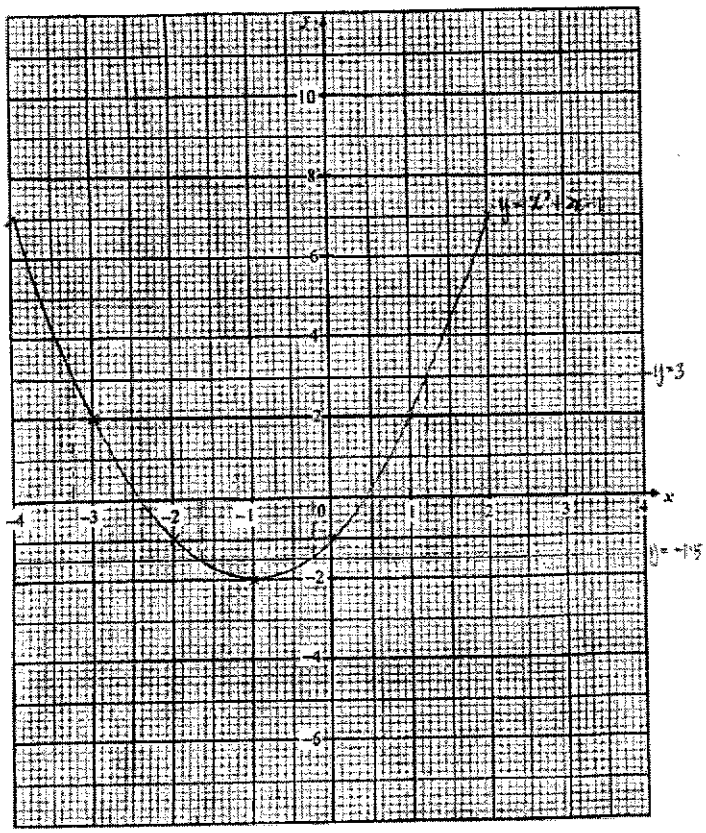
24cii		
24cii	Draw $y = -2x - 1$ $x = -2, 0, 2$	**M1** **A1**
25a	16 m/s	**B1**
25b	2 m/s^2	**B1**
25c	Distance = area under graph = 100 + 200 + 200 = 500 m	**M1** **A1**
25d		**B1 for straight section correct** **B1 for curved section correct**

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2024 4E/5N EM Prelim Paper 2 Marking Scheme (90 marks)

1a	$\frac{3x+1}{3} < \frac{2-5x}{4}$ $4(3x+1) < 3(2-5x)$ $12x+4 < 6-15x$ $27x < 2$ $x < \frac{2}{27}$	M1 A1
1bi	$a = \frac{2(0.2)-3(-1.5)}{0.2+2(-1.5)}$ $a = -\frac{7}{4} / -1.75$	 B1
1bii	$a = \frac{2b-3c}{b+2c}$ $a(b+2c) = 2b-3c$ $ab+2ac = 2b-3c$ $ab-2b = -3c-2ac$ $b(a-2) = -3c-2ac$ $b = \frac{-3c-2ac}{a-2}$ $b = \frac{3c+2ac}{2-a}$	 M1 M1 Either A1
1c	$\frac{5x}{x-3} - \frac{2}{2x-3} = 1$ $\frac{5x(2x-3)-2(x-3)}{(x-3)(2x-3)} = 1$ $10x^2-15x-2x+6 = 2x^2-3x-6x+9$ $10x^2-17x+6 = 2x^2-9x+9$ $8x^2-8x-3 = 0$ $x = \frac{-(-8) \pm \sqrt{(-8)^2-4(8)(-3)}}{2(8)}$ $x = 1.2906, -0.29057$ $x = 1.291, -0.291\ (3dp)$	 M1 – common denominator M1 – either expansion M1 A1A1

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2a	$y=7$	B1
2b		7 points – B2 4 points – B1 Curve – B1
2ci	$-3.25<x<1.2$	B1
2cii	$x^2+2x+\frac{1}{2}=0$ $x^2+2x+\frac{1}{2}-1.5=0-1.5$ $x^2+2x-1=-1.5$ $y=-1.5$ $x=-1.65 \quad or \quad x=-0.25$	M1 A1A1
2ciii	x^2+2x-1 $=\left(x+\frac{2}{2}\right)^2-\left(\frac{2}{2}\right)^2-1$ $=(x+1)^2-2$ Therefore, the minimum point is $(-1,-2)$	M1 - either x or y value seen A1 – in the form $(x+p)^2+q$

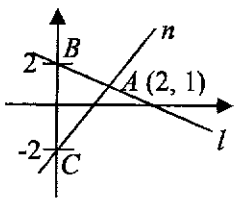
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3a	Vol of hemisphere $=\frac{2}{3}\times\pi\times(3x)^3$ $=18\pi x^3$ Vol of cone $=\frac{1}{3}\times\pi\times\left(\frac{3}{2}x\right)^2\times y$ $=\frac{1}{3}\times\pi\times\frac{9}{4}x^2\times y$ $=\frac{3\pi}{4}x^2y$ $18\pi x^3=3\times\frac{3\pi}{4}x^2y$ $18x^3=\frac{9}{4}x^2y$ $y=\frac{18x^3\times4}{9x^2}$ $y=8x$ *(shown)*	M1 M1 A1
3b	$l=\sqrt{y^2+\left(\frac{3}{2}x\right)^2}$ $=\sqrt{(8x)^2+\left(\frac{3}{2}x\right)^2}$ $=\sqrt{64x^2+\frac{9}{4}x^2}$ $=\sqrt{\frac{265x^2}{4}}$ $=8.1394x\ /\ \frac{\sqrt{265}}{2}x$ CSA of cone $=\pi\left(\frac{3}{2}x\right)\times l$ $=\pi\left(\frac{3}{2}x\right)\times8.1394x$ $=38.356x^2$ CSA of cylinder $=2\pi\times\left(\frac{3}{2}x\right)\times3x$ $=28.274x^2$ CSA of hemisphere $=2\pi\times(3x)^2$ $=56.549x^2$ rim area$=\pi(3x)^2-\pi\left(\frac{3}{2}x\right)^2$ $=21.206x^2$	M1 4 correct – M3 3 correct – M2 2 correct – M1

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3b	Total SA = 450 $38.356x^2 + 28.274x^2 + 56.549x^2 + 21.206x^2 = 450$ $144.385x^2 = 450$ $x^2 = 3.1167$ $x = 1.7654$ Total ht, $h = y + 3x + 3x$ $h = 8x + 3x + 3x$ $h = 14x$ $h = 14(1.7654)$ $h = 24.7156$ $h = 24.7\ (3sf)$	M1 M1 A1
4a	$\frac{1}{25}$	B1
4b	$T_n = \frac{16-3n}{5n}$	M1 - $-3n$ M1 – $5n$ A1 - T_n
4c	$T_{n+1} - T_n = \frac{16-3(n+1)}{5(n+1)} - \frac{16-3n}{5n}$ $= \frac{16-3n-3}{5(n+1)} - \frac{16-3n}{5n}$ $= \frac{n(13-3n)-(16-3n)(n+1)}{5n(n+1)}$ $= \frac{13n-3n^2-(16n+16-3n^2-3n)}{5n(n+1)}$ $= \frac{13n-3n^2-16n-16+3n^2+3n}{5n(n+1)}$ $= \frac{-16}{5n(n+1)}$ *(shown)*	M1 M1 A1
4d	For $n > 0$ $5n(n+1) > 0$ $\frac{-16}{5n(n+1)} < 0$ $T_{n+1} - T_n < 0$	B1

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5a	grad of line l $= \frac{-2-4}{8-(-4)}$ $= -\frac{1}{2}$ $y = -\frac{1}{2}x + c$ *subst* $(-4, 4)$ into $y = -\frac{1}{2}x + c$ $4 = -\frac{1}{2}(-4) + c$ $c = 2$ $y = -\frac{1}{2}x + 2$	M1 A1
5b	Line m $6y = 18 - 3x$ $y = -\frac{1}{2}x + 3$ The gradient of line l and line m are equal (gradient = $-\frac{1}{2}$) and the y-intercept not equal. Line l and line m are parallel. Therefore, line m does not intersect the line l.	 M1 – gradient value A1 – parallel
5c	$y = -\frac{1}{2}x + 2$ -------(1) $\quad 2y = 3x - 4$ --------(2) *Subst* (1) *into* (2) $2\left(-\frac{1}{2}x + 2\right) = 3x - 4$ $-x + 4 = 3x - 4$ $4x = 8$ $x = 2$ *Subst* $x = 2$ *into* (1) $y = -\frac{1}{2}x + 2$ $y = -\frac{1}{2}(2) + 2$ $y = 1$ $A(2,1)$	 M1 M1 – either x or y coordinate A1
5d	*Area of* $\Delta ABC = \frac{1}{2} \times 4 \times 2$ $= 4$ *units*^{2} 	M1 – BC = 4 units M1 – height of 2 units A1

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6a	$\angle OPV = \angle ORV = 90^\circ$ (tan ⊥ rad) $\angle POR = 360 - 90 - 90 - 40$ (sum of quad) $= 140$ *reflex* $\angle POR = 360 - 140$ ($\angle$ at a pt.) $= 220$ $\angle PQR = \frac{220}{2}$ ($\angle$ at ctr = 2× $\angle$ at circum) $= 110$	M1 M1 A1
6b	$\angle OPR = \frac{180 - 140}{2}$ (sum of isos Δ) $= 20$ $\angle SPR = \angle STR$ ($\angle$ in same seg) $= 43$ $\angle OPU = 43 - 20$ $= 23$ $\angle POU = 180 - 140$ ($\angle$ on str. line) $= 40$ $\angle TUP = \angle OPU + \angle POU$ (ext. $\angle$ of Δ) $= 23 + 40$ $= 63^\circ$	M1 M1 A1
6c	$\angle SOR = 2 \times \angle STR$ ($\angle$ at ctr = 2× $\angle$ at circum) $= 2 \times 43$ $= 86$ reflex $\angle SOR = 360 - 86$ $= 274$ area of minor sector $= \frac{86}{274} \times$ area of major sector $= 0.31387 \times$ area of major sector No because the area of the minor sector is 0.314 of the area of major sector, which is less than $\frac{1}{3}$ (0.333)	M1 M1 A1

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7ai	$\begin{pmatrix}8\\-4\end{pmatrix}+\begin{pmatrix}u\\v\end{pmatrix}=\begin{pmatrix}6\\4\end{pmatrix}$ $\begin{pmatrix}u\\v\end{pmatrix}=\begin{pmatrix}6\\4\end{pmatrix}-\begin{pmatrix}8\\-4\end{pmatrix}$ $=\begin{pmatrix}-2\\8\end{pmatrix}$	B1
7aii	$\overrightarrow{XY}=\begin{pmatrix}-2\\8\end{pmatrix}$ $\left\|\overrightarrow{XY}\right\| = \sqrt{(-2)^2+(8)^2}$ $=8.2462$ $=8.25 \text{ units}^2$	M1 A1
7aiii	Grad of ZY = Grad of XY $\frac{k-4}{-1-6}=\frac{8}{-2}$ $\frac{k-4}{-7}=-4$ $k=32$ $\overrightarrow{OZ}=\begin{pmatrix}-1\\32\end{pmatrix}$	M1 A1
7bi	ΔABD, $\overrightarrow{AB}+\overrightarrow{BD}=\overrightarrow{AD}$ $\overrightarrow{BD}=8\mathbf{b}-4\mathbf{a}$ 4 *units*, $\overrightarrow{BD}-8\mathbf{b}-4\mathbf{a}$ 3 *units*, $\overrightarrow{BE}-\frac{3}{4}(8\mathbf{b}-4\mathbf{a})$ $=6\mathbf{b}-3\mathbf{a}$	M1 A1
7bii	ΔBEF, $\overrightarrow{BE}+\overrightarrow{EF}=\overrightarrow{BF}$ $\overrightarrow{BF}=6\mathbf{b}-3\mathbf{a}+2\mathbf{a}-2\mathbf{b}$ $=4\mathbf{b}-\mathbf{a}$ $\overrightarrow{BC}=2\times\overrightarrow{BF}$ $=8\mathbf{b}-2\mathbf{a}$	M1 A1
7biii	ΔBCD, $\overrightarrow{BD}+\overrightarrow{DC}=\overrightarrow{BC}$ $\overrightarrow{DC}=\overrightarrow{BC}-\overrightarrow{BD}$ $=8\mathbf{b}-2\mathbf{a}-(8\mathbf{b}-4\mathbf{a})$ $=2\mathbf{a}$ $\overrightarrow{AB}=2(2\mathbf{a})$ $\overrightarrow{AB}=2\overrightarrow{DC}$ *ABCD* is a trapezium because $\overrightarrow{AB}=2\overrightarrow{DC}$, *AB* is parallel to *DC* 1 pair of opposite side parallel.	M1 M1 - $\overrightarrow{AB}=2\overrightarrow{DC}$, *AB* is parallel to *DC* A1 – awarded for 'trapezium' only if M1 awarded

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8ai	$\frac{50}{100}\times 80 = 40$ Median = \$550	 B1
8aii	$\frac{25}{100}\times 80 = 20 \Longrightarrow LQ = \$420$ $\frac{75}{100}\times 80 = 60 \Longrightarrow UQ = \$680$ $IQR = 680 - 420$ $= \$260$	 M1 A1
8b	No of workers ($\leq \$540$) = 38 No of workers ($> \$540$) = $80 - 38$ $= 42$ % of workers ($> \$540$) $= \frac{42}{80}\times 100\%$ $= 52.5\%$	 M1 A1
8c	No of workers ($\leq \$460$) = 26 No of workers ($\leq \$800$) = 73 No of workers btw \$460 and \$800 = $73 - 26$ $= 47$	M1 - either A1
8d	Let the additional no of workers be x. No of workers now ($\leq \$650$) = 56 $\frac{56+x}{80+x} = \frac{11}{15}$ $840 + 15x = 880 + 11x$ $4x = 40$ $x = 10$	 M1 M1 A1
9a	Total amt = $90 + 3\times 150$ = \$540	 B1
9b	Size of hall required = $(300\times 15)\times 1.65$ $= 7425\ m^2$ Hall C and Hall E (total area = 7600 m^2) daily rental = \$8000 + \$5400 = \$13400	M1 A1

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9c	Cost for 1. hall rental $= \$13400 \times 4$ $= \$53600$ 2. long tables $= 300 \times \$2 \times 4$ $= \$2400$ 3. square tables $= \frac{600}{100} \times \$30 \times 4$ $= \$720$ 4. round tables $= \frac{75}{5} \times \$20 \times 4$ $= \$1200$ 5. chairs $= \frac{1500}{50} \times \$10 \times 4$ no of chairs needed $= 300 \times 4 + 300$ $= \$1200$ $= 1500$ 6. security guard $= 2 \times \$10 \times 12 \times 3$ $= \$720$ 7. part-timers $= 4 \times \$8 \times 12 \times 3$ $= \$1152$ Total cost $= 53600 + 2400 + 720 + 1200 + 1200 + 720 + 1152$ $= \$60992$ Total amt collected for 3 days $= 300 \times \$540$ $= \$162000$ Total entrance fee collected $= 35000 \times 6$ $= 210000$ Profit $= 162000 + 210000 - 60992$ $= \$311008$ The profit of \$311008 is more than the minimum target of \$300000. ∴ The event organiser is correct.	5 items – M3 4 items – M2 2 items – M1 M1 – either item 6 or 7 M1 M1 A1- comparison made

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