

External Assessment 2023

MATHEMATICS METHODS – FOUNDATION

MTM315117

Section **A**

Pages: 24

Questions: 24

Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 80 minutes

Instructions:

Calculators are not allowed to be used in this section.

Section A will be collected after 80 minutes.

- There are **five (5) parts** to this section.
- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
 - Spare diagrams have been provided at the end of each part.
Indicate in the box provided if you have used the spare diagram.
- The exam is **three (3) hours** in length. It is suggested that you spend **approximately 80 minutes** in total answering the questions in this exam booklet.
- During the first 80 minutes you may move onto Section B, but you **cannot** use your calculator until told by your supervisor(s).
- The Mathematics Methods-Foundation Information Sheet can be used throughout the exam.
- All answers must be written in **English**.

Marker use	
C4	/ 16
C5	/ 16
C6	/ 16
C7	/ 16
C8	/ 16

Additional Exam Instructions

- You **must** make sure your answers address the listed criteria.
- For questions worth **one (1)** mark, you are not required to show workings. Markers will look at the presentation of the answer(s) and at the argument(s) leading to the final answer(s).
- For questions worth **two (2)** or more marks **you are required** to show relevant workings.
- Marks will be allocated:
 - according to the degree to which workings convey a logical line of reasoning, and
 - for suitable justifications and explanations of methods and processes when requested.

Criteria

You **must** make sure your answers address:

- Criterion 4 manipulate algebraic expressions and solve equations
- Criterion 5 understand linear, quadratic and cubic functions
- Criterion 6 understand logarithmic, exponential and trigonometric functions
- Criterion 7 use differential calculus in the study of functions
- Criterion 8 understand experimental and theoretical probabilities and of statistics.

Guide to Exam Structure

		Parts	Questions available	Questions to answer	Suggested working time	Marks available
Section A	Part 1		5	5	16 minutes	16 marks
	Part 2		6	6	16 minutes	16 marks
	Part 3		4	4	16 minutes	16 marks
	Part 4		4	4	16 minutes	16 marks
	Part 5		5	5	16 minutes	16 marks
Totals			24	24	80 minutes	80 marks
Section B	Part 1		6	6	20 minutes	20 marks
	Part 2		6	6	20 minutes	20 marks
	Part 3		5	5	20 minutes	20 marks
	Part 4		6	6	20 minutes	20 marks
	Part 5		4	4	20 minutes	20 marks
Totals			27	27	100 minutes	100 marks
Totals			51	51	180 minutes (3 hours)	180 marks

Part 1

- Answer **all** questions in this part.
- This part assesses **Criterion 4**.

Question 1

Rearrange the following formula to make u the subject: $s = ut + \frac{1}{2}at^2$

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Question 2

Factorise:

a) $32 - 8b^2$

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b) $x^2 - 7x + 12$

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Question 3

Solve each of the following for x :

a) $\frac{4x-3}{3} - 2 = 5$

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Question 3 continues

Question 3 continued

Marker use

b) $(x - 1)(x + 2)(3 - 2x) = 0$

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Question 4

Simplify the following, giving your answers in positive index form:

a) $3\sqrt{x} \times 2\sqrt{x^3}$

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b) $\frac{6a^2 b^{-3} \times (2ab^{-2})^3}{4a^3 b^{-1}}$

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Question 5

a) Without dividing, show that $(x - 1)$ is a factor of $P(x) = x^3 + 5x^2 + 2x - 8$

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b) Fully factorise $x^3 + 5x^2 + 2x - 8$

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Total
C4

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Part 2

- Answer **all** questions in this part.
- This part assesses **Criterion 5**.

Question 6

a) Find the equation of the line with a gradient 3 and y intercept -5

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b) Find the equation of the line parallel to the line in a) which passes through the point $(1, -4)$

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Question 7

Sketch the curve $y = 3(x + 1)(x - 2)^2$ below, clearly indicating all intercepts.

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Question 8

Marker use

Determine the equations of the following functions:

a)

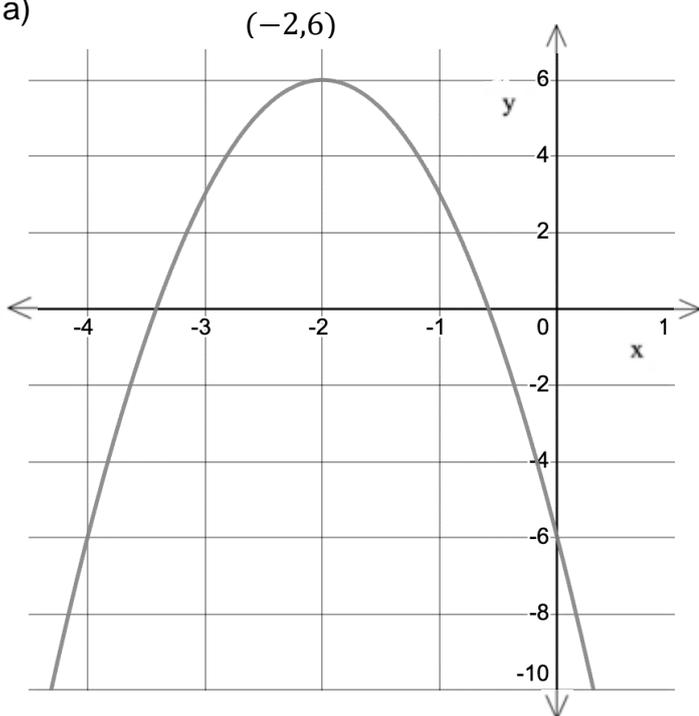


Figure 1: Graph of a function.

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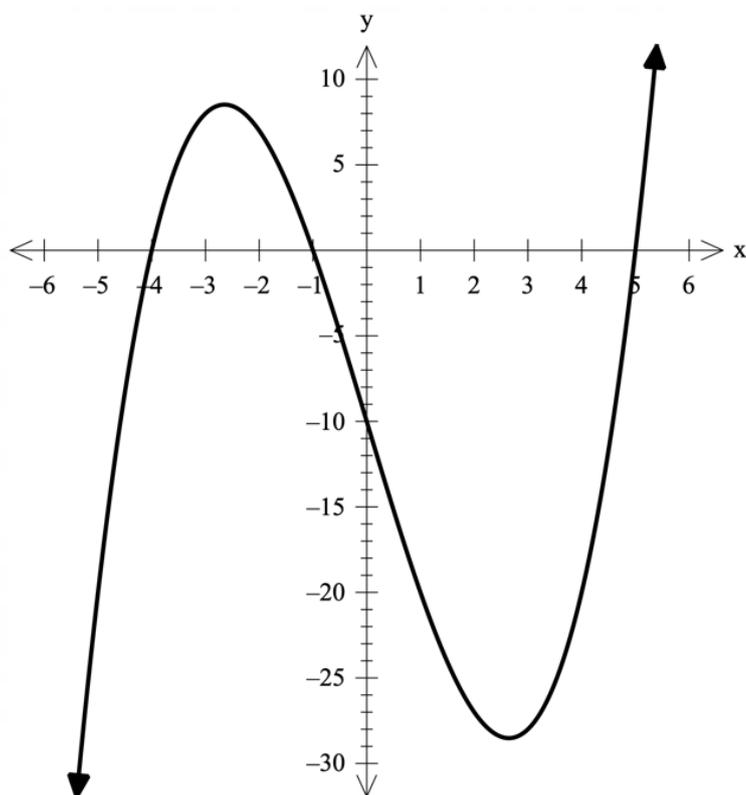


Figure 2: Graph of a function.

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Question 9

Marker use

State whether the following are functions. Give a **reason** for your answer.

a) $\{(-1, 2), (0, 3), (2, -3), (5, 0)\}$

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b)

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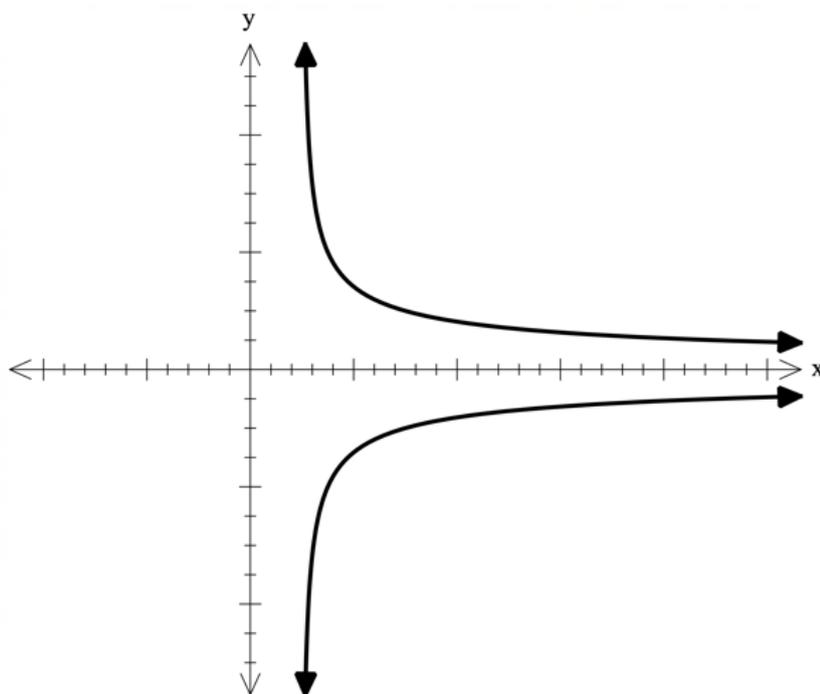


Figure 3: Graph 3.

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Question 10

Marker use

For the function below, which has the form $y = ax^2 + bx + c$, circle the appropriate statements for each of the values a , b , c and Δ :

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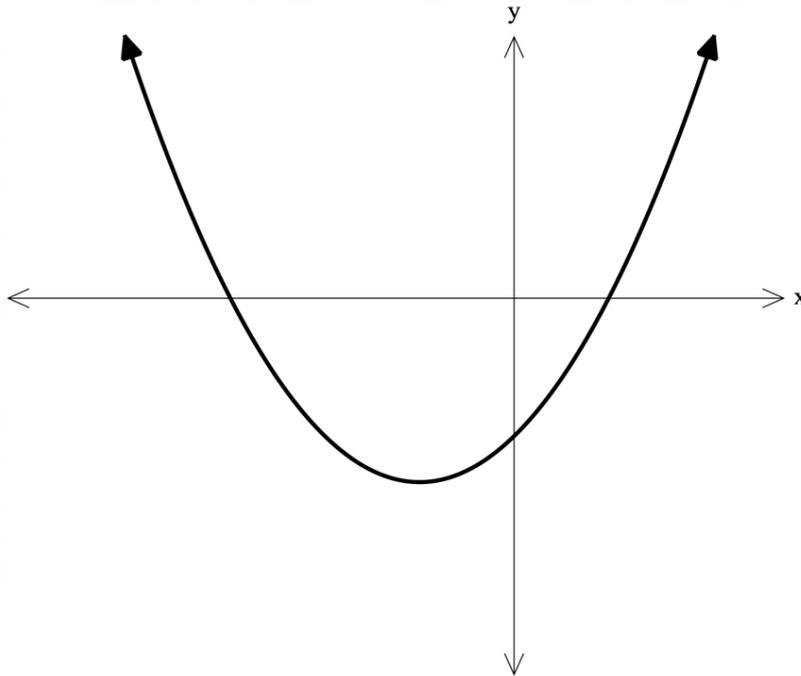


Figure 4: Graph of a function.

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|---------|---------|---------|--------------|
| $a > 0$ | $b > 0$ | $c > 0$ | $\Delta > 0$ |
| $a < 0$ | $b < 0$ | $c < 0$ | $\Delta < 0$ |

Question 11

The function $f(x) = x^3$ undergoes the following transformations:

- dilated by a factor of 3 in the direction of the y axis
- reflected in the x axis
- translated left 2 units
- translated up 1 unit.

State the equation of the new function.

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Total
C5
/16

Part 3

- Answer **all** questions in this part.
- This part assesses **Criterion 6**.

Question 12

Solve algebraically for x :

a) $2^{2x} = 16$

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b) $\log_3(3x + 1) - \log_3 2 = 1$

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c) $\log_3 x = 2$

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Question 13

Marker use

Sketch the graph of $y = 3^{x-1} + 2$. Clearly label the asymptote, any axis intercepts and **one (1)** other point.

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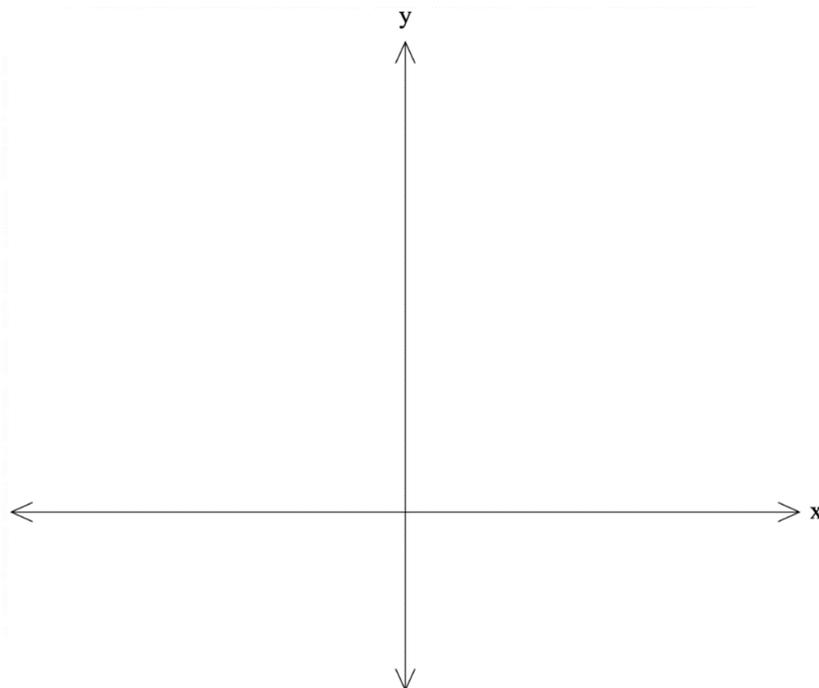


Figure 5: Axes for sketching answer to Question 13.

Spare diagram used (X)

Question 14

If $\sin x = \frac{4}{5}$ and $\frac{\pi}{2} \leq x \leq \pi$, find the value of:

a) $\cos x$

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b) $\tan x$, leaving your answer in simplified form.

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Question 15

Marker use

a) State the period for the function $y = \tan\left(\frac{x}{2}\right)$

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b) Sketch a graph of this function over the domain $x \in [-2\pi, 4\pi]$

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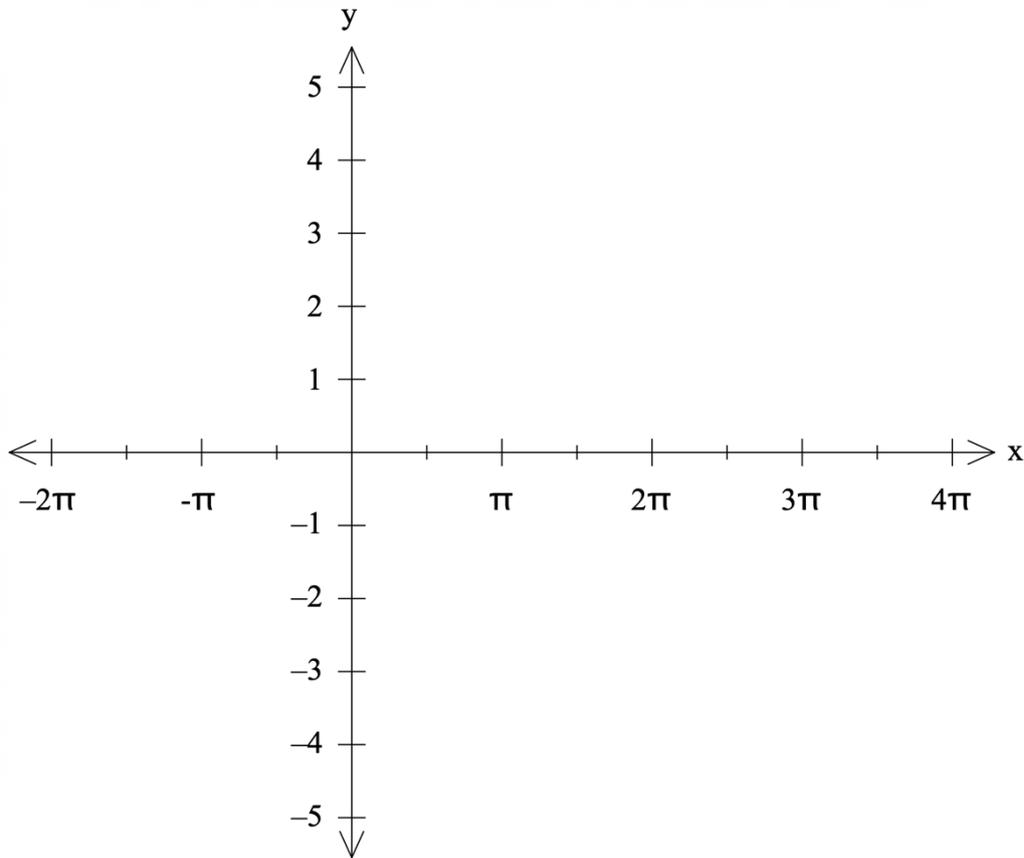


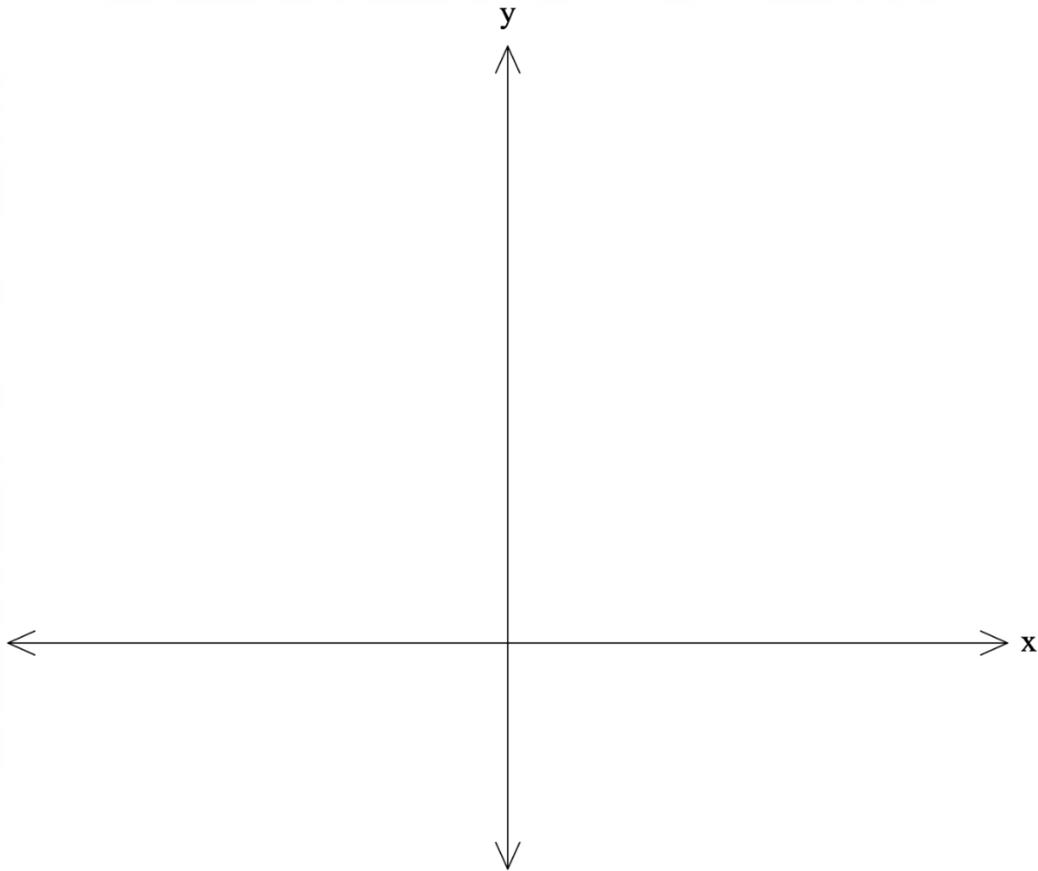
Figure 6: Axes for sketching answer to Question 15 b).

Spare diagram used (X)

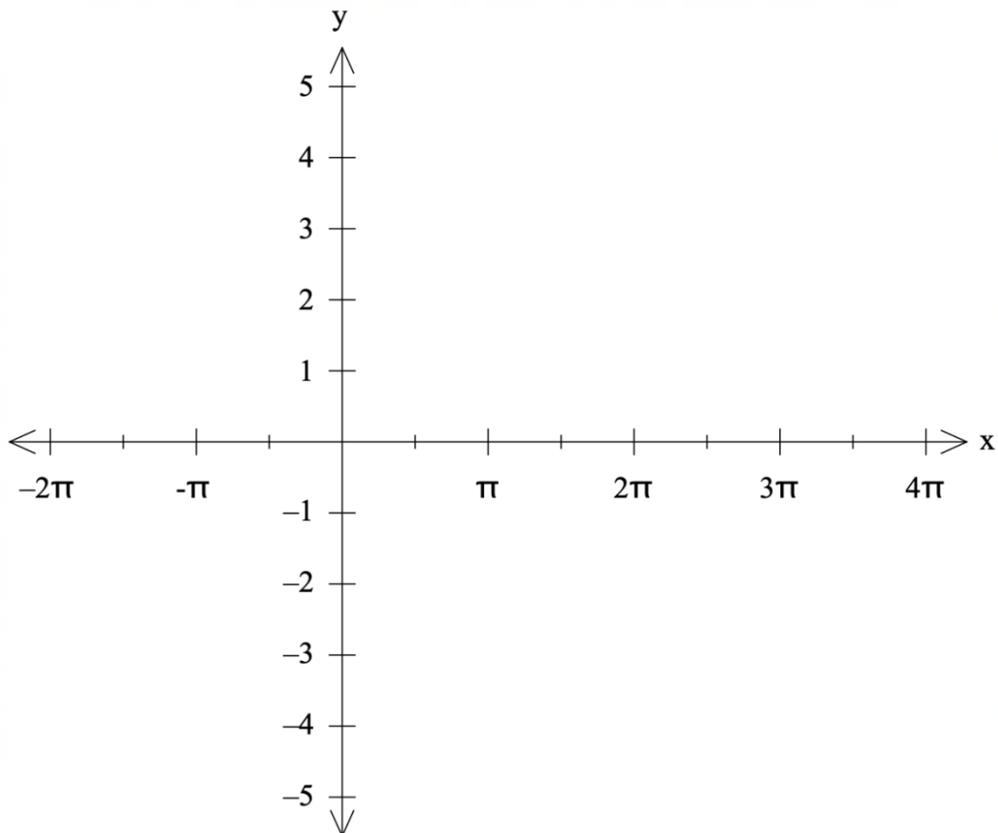
Total
C6
/ 16

Spare Diagrams

Question 13



Question 15 b)



Part 4

- Answer **all** questions in this part.
- This part assesses **Criterion 7**.

Question 16

Differentiate the following with respect to x :

a) $f(x) = 2x^4 + 3x^2 - 4x$

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b) $y = 2x^2(3 - 4x)$

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c) $y = 3x^{-2} + \frac{2}{x^3}$

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d) $y = \sqrt[3]{x^5} + 6\sqrt{x}$

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Question 17

Marker use

For the function $y = x^2 + 3x - 5$, find the equation of the tangent when $x = 2$

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Question 18

Differentiate $f(x) = x^2 + 2x - 1$ using first principles.

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Question 19

Marker use

Sketch a possible graph of the function $y = f(x)$ which has the following properties:

$$f(-2) = 0, \quad f'(-2) = 0 \quad f'(x) < 0 \text{ for } x < -2 \text{ and } x > 3$$

$$f(3) = 10 \quad f'(3) = 0 \quad f'(x) > 0 \text{ for } -2 < x < 3$$

/3

Total
C7
/16

Part 5

- Answer **all** questions in this part.
- This part assesses **Criterion 8**.

Question 20

From a survey of a group of 50 students it was found that over the past year, 35 had made a donation to a local charity, 20 had donated to an international charity and 15 students had donated to both local and international charities.

a) Show this information clearly on the Venn Diagram in Figure 7 below:

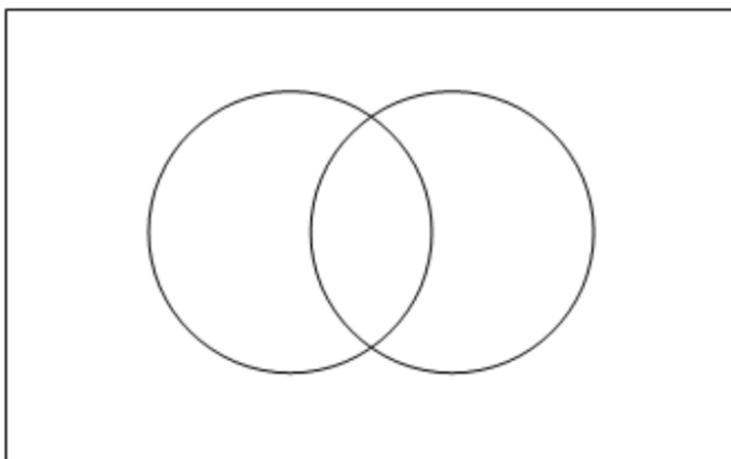


Figure 7: Venn diagram for annotation to answer Question 20 a).

Spare diagram used (X)

b) If **one (1)** person is chosen at random, calculate the probability that this person donates to an international charity but not a local one.

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Question 21

Marker use

Events A and B are independent. If $\Pr(B) = \frac{2}{3}$ and $\Pr(A|B) = \frac{4}{5}$, find:

a) $\Pr(A)$

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b) $\Pr(A \cap B)$

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Question 22

The probability that Harper uses a car (C) during their commute to university is 0.4, the probability they use public transport (P) is 0.7 and the probability they use both is 0.2.

a) Complete this probability table (Table 1) using this information:

	C	C'	
P			
P'			
			1

Table 1

Spare diagram used (X)

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b) Find the probability that on a given day, Harper:

i. uses public transport but not a car.

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ii. does not use a car at all.

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/1

Question 23

Marker use

Baby Fleur has 12 different bibs and 10 different bodysuits. She wears one (1) bodysuit and one (1) bib at a time.

a) How many different combinations of bib and bodysuit does Fleur have?

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b) If **five (5)** of her bodysuits are red and **three (3)** of her bibs are striped, what is the probability that Fleur is dressed in a red bodysuit and a striped bib?

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Question 24

A committee of four (4) is chosen from five (5) staff members and five (5) students.

a) How many different committees can be formed?

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b) What is the probability of having a committee with **two (2)** staff members and **two (2)** students?

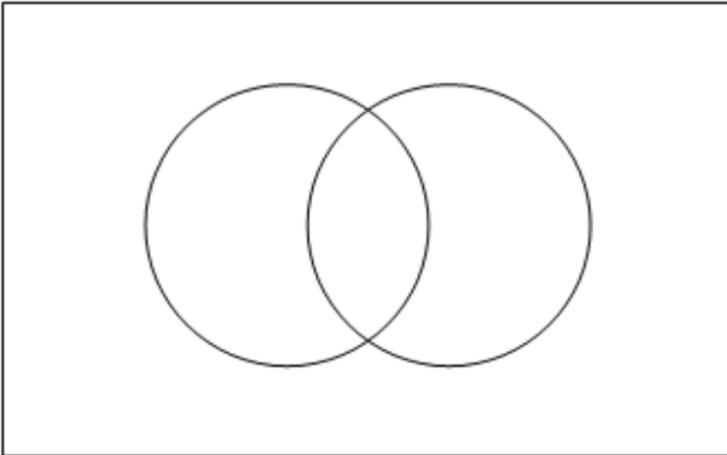
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Total
C8
/16

Spare Diagrams

Question 20



Question 22

	C	C'	
P			
P'			
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& CERTIFICATION

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External Assessment 2023

MATHEMATICS METHODS – FOUNDATION

MTM315117

Section **B**

Pages: 28

Questions: 27

Information Sheet: 1

Suggested working time: 100 minutes

Instructions:

Calculators are allowed to be used in this section.

- There are **five (5) parts** to this section.
- Answer **all** questions and **all** items within each question.
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- All answers must be written in **English**.
- You **must** make sure your answers address the listed criteria.

Marker use	
C4	/ 20
C5	/ 20
C6	/ 20
C7	/ 20
C8	/ 20

Additional Exam Instructions

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- Criterion 6 understand logarithmic, exponential and trigonometric functions
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	Part 4		4	4	16 minutes	16 marks
	Part 5		5	5	16 minutes	16 marks
Totals			24	24	80 minutes	80 marks
Section B	Part 1		6	6	20 minutes	20 marks
	Part 2		6	6	20 minutes	20 marks
	Part 3		5	5	20 minutes	20 marks
	Part 4		6	6	20 minutes	20 marks
	Part 5		4	4	20 minutes	20 marks
Totals			27	27	100 minutes	100 marks
Totals			51	51	180 minutes (3 hours)	180 marks

Part 1

- Answer **all** questions in this part.
- This part assesses **Criterion 4**.

Question 25

a) Transform $2x^2 + 4x - 1$ into the form $a(x - h)^2 + k$ by completing the square.

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b) Using this information or the quadratic formula, find the exact solutions to:

$$2x^2 + 4x - 1 = 0$$

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Question 26

Expand $(1 - 2x)^4$ using Pascal's triangle or the Binomial Theorem to assist.

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Question 27

Marker use

The cost of hiring an e-scooter through Venus e-scooters in Burnie is a \$1 unlocking fee and then \$0.45 per minute. Another company, Saturn e-scooters, is looking to open up their e-scooter business in Burnie and has a pricing model of a \$5 unlocking fee and then \$0.25 per minute.

- a) Write **two (2)** equations for the price (**P**) of using an e-scooter through Venus and Saturn for a trip of **m** minutes.

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- b) Solve these equations simultaneously, showing full algebraic working, to find the number of minutes riding and the price paid when both e-scooter companies charge the same amount.

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Question 28

Marker use

The hypotenuse of a right-angled triangle is $(2x + 3)$ cm and the other two (2) sides are $2x$ cm and $(x - 2)$ cm.

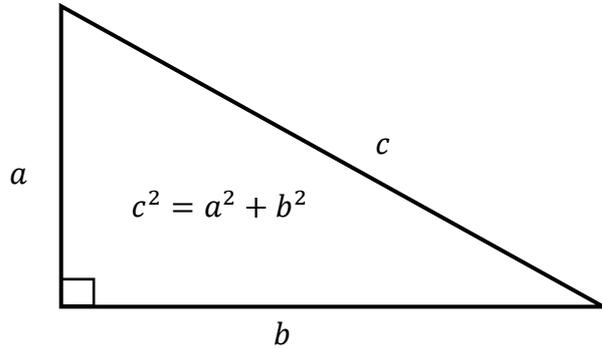


Figure 8: Diagram of a right-angled triangle.

- a) Show that Pythagoras' rule as shown in Figure 8 can be simplified to give $x^2 - 16x - 5 = 0$ for this triangle.

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- b) Hence, determine the value(s) of x . Give your answer(s) to **one (1)** decimal place.

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Question 29

Marker use

a) Show the discriminant of the equation $2x^2 - 2x + 1 = m$ is $\Delta = 8m - 4$.

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b) Hence, find the value of m for which the equation has **one (1)** solution.

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Question 30

The number of bacteria in a slow growing culture is given by $N = 50 + 20t + t^3$ where t is the number of hours after 8:00am.

a) What is the initial number of bacteria at 8:00am?

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b) The experiment is stopped when the number of bacteria reaches 500. At what time of day is the experiment stopped?

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**Total
C4**

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Part 2

- Answer **all** questions in this part.
- This part assesses **Criterion 5**.

Question 31

Determine the equation of the line shown:

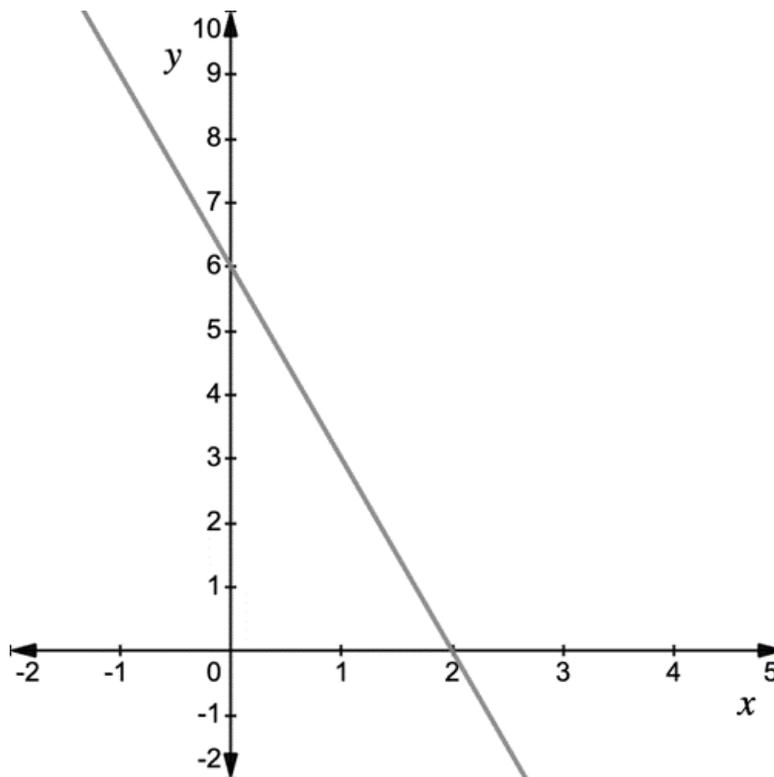


Figure 9: Graph of a straight line.

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Question 32

Marker use

The function $y = f(x)$ is graphed below (Figure 10). The function $y = g(x)$ is the function $y = f(x)$ after it has been translated left two (2) units and three (3) units up. On the same set of axes, graph the function $y = g(x)$.

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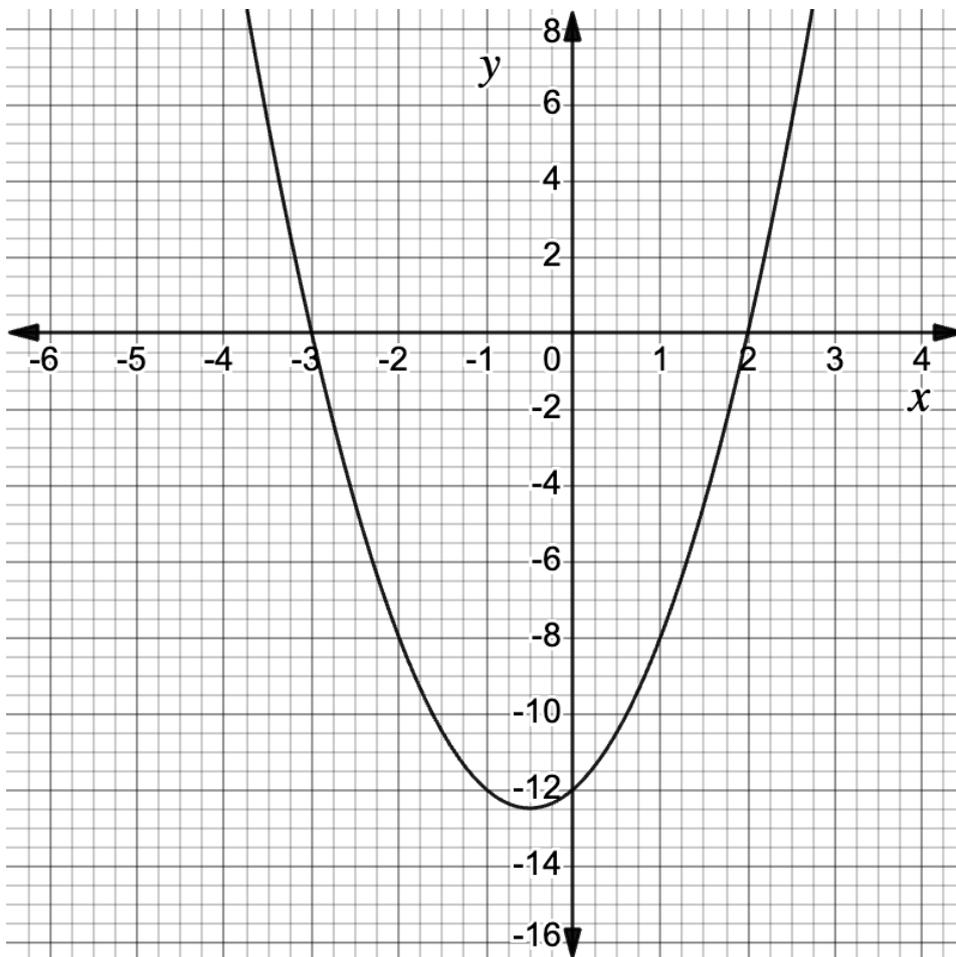


Figure 10: Graph of the function $y = f(x)$.

Spare diagram used (X)

Question 33

A bridge is built over a small creek. The bridge is parabolic in shape and has its feet evenly spaced from the ends of the bridge. The points A, B and C all lie on the parabola. AC is 8m.

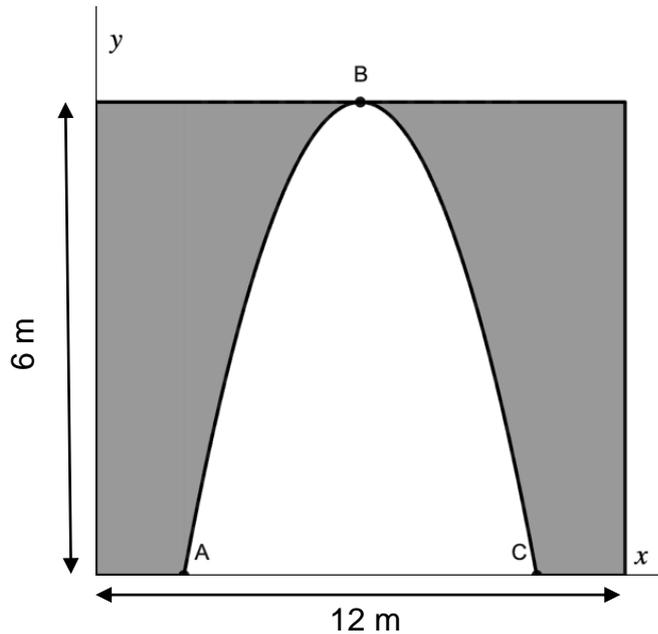


Figure 11: Diagram of a bridge built over a creek, highlighting points A – C.

a) Show the equation of the parabola which goes through A, B and C is:

$$y = \frac{-3}{8} x^2 + \frac{9}{2} x - \frac{15}{2}$$

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b) After heavy rain, the creek reaches 1.5m above AC. Find the width of water within the bridge to 1 decimal place.

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Question 34

Marker use

a) Graph the function $y = x(x + 3)(x - 4)$ for the domain $x \in [-5, 6)$

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b) State the range.

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Question 35

Determine the equation of the line which is perpendicular to $4y - 2x + 3 = 5$ passing through the point $(-3, -1)$

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Question 36

Marker use

A rectangular storage container is designed with an open top and a square base. The base has a side length of x m and the height of the container is h m. The 12 edges are strengthened with 6m of metal.

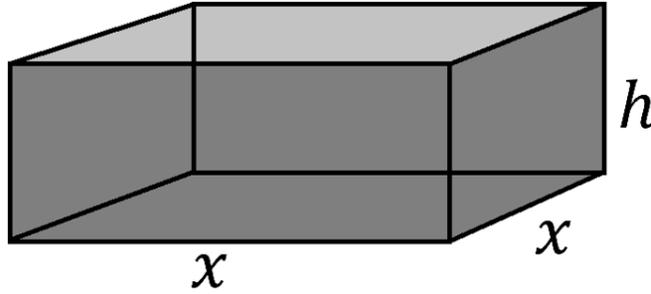


Figure 12: Diagram of a rectangular container, highlighting side length and height.

a) Show that $h = 1.5 - 2x$

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b) Hence, show the expression for the volume (V) of the container is $V = 1.5x^2 - 2x^3$

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c) State any restrictions on the values x can take.

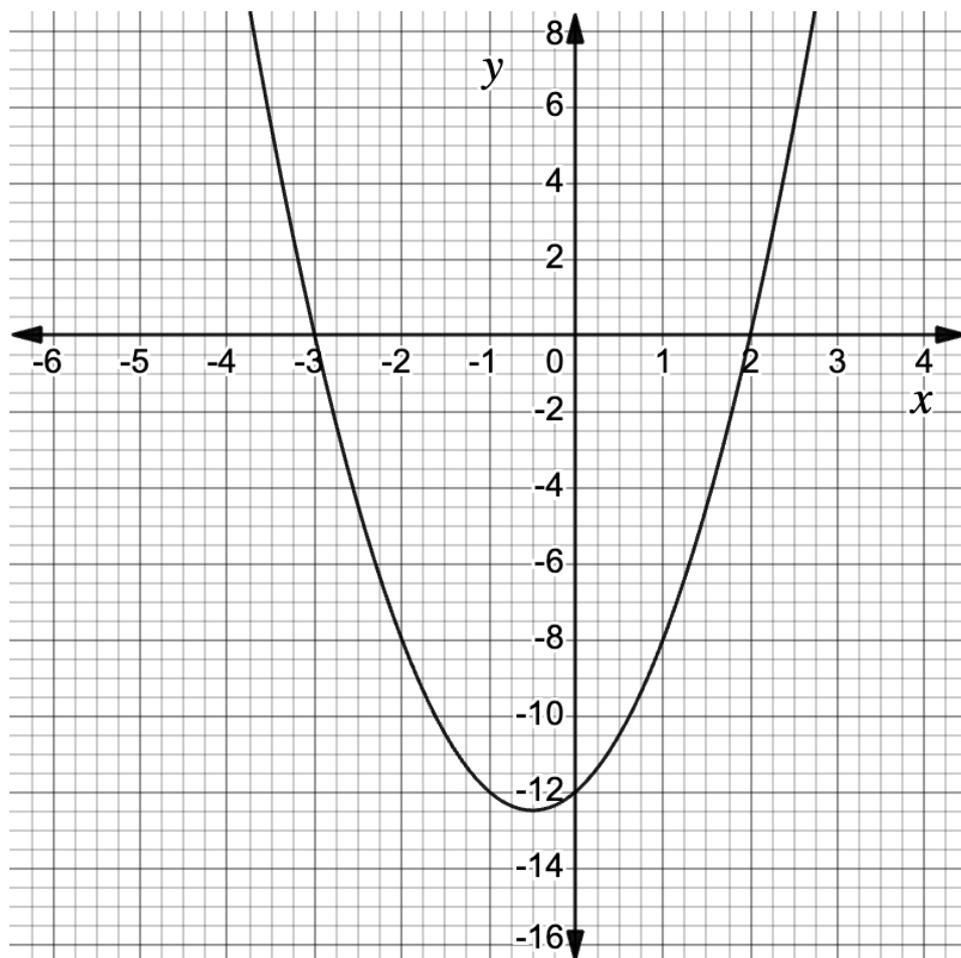
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Total
C5
/20

Spare Diagram

Question 32



Part 3

- Answer **all** questions in this part.
- This part assesses **Criterion 6**.

Question 37

Convert 75° into radians, giving your answer to **three (3)** decimal places.

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Question 38

A teacher is concerned about the amount of time he spends dealing with the number of emails he receives daily. The teacher starts keeping records and finds the average number of emails he receives each day can be modelled by:

$$E = 30 \times 2^{\frac{t}{12}}$$

Where E is the average number of emails received per day and t is the number of weeks from the time he started taking records.

- a) What was the average number of daily emails the teacher was receiving when he first started taking records?

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- b) How many weeks will it take before the predicted average number of emails received will double?

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Question 39

This crane has been seen in the Hobart skyline for a number of months. At the time of this photo, the largest angle inside the triangle was 100° and the smallest angle was 25° . The length of wire connecting these two (2) angles was 25m.

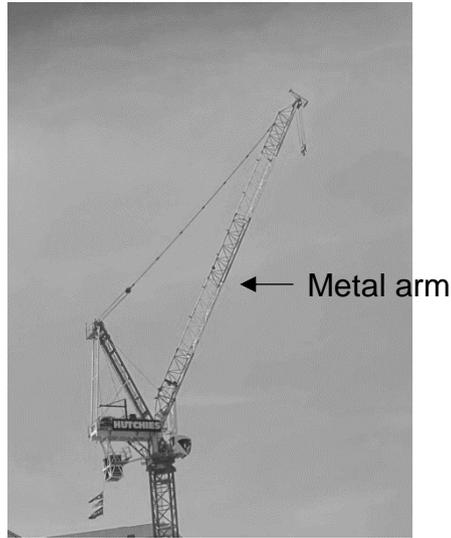


Figure 13: Photo of a mechanical crane, highlighting its metal arm.

a) Place this information on the triangle below.

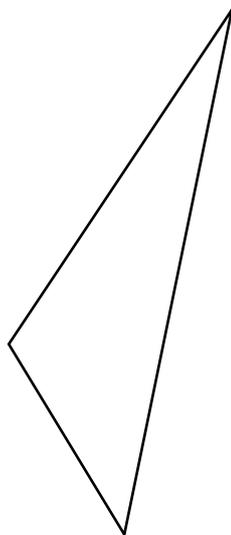


Figure 14: Diagram for annotation to answer Question 39 a).

Spare diagram used (X)

b) Hence, find the length of the metal arm of the crane.

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Question 40

Marker use

For the function $y = 3\log_2(x + 2) + 1$

a) State the transformations, in order, to transform $y = \log_2 x$ to this function.

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b) Sketch the graph of the function.

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/3

c) State the function's domain:

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d) State the function's range:

/1

Question 41

Sam plays with a yo-yo attached to a string. The yo-yo goes up and down from its rest position so that the distance above the rest position, D cm, at time t seconds is given by:

$$D = -40 \cos\left(\frac{\pi}{3}t\right)$$

- a) Determine the period of the yo-yo.

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/1

- b) Draw a graph of the yo-yo's movement over 12 seconds. Clearly label all intercepts.

/3

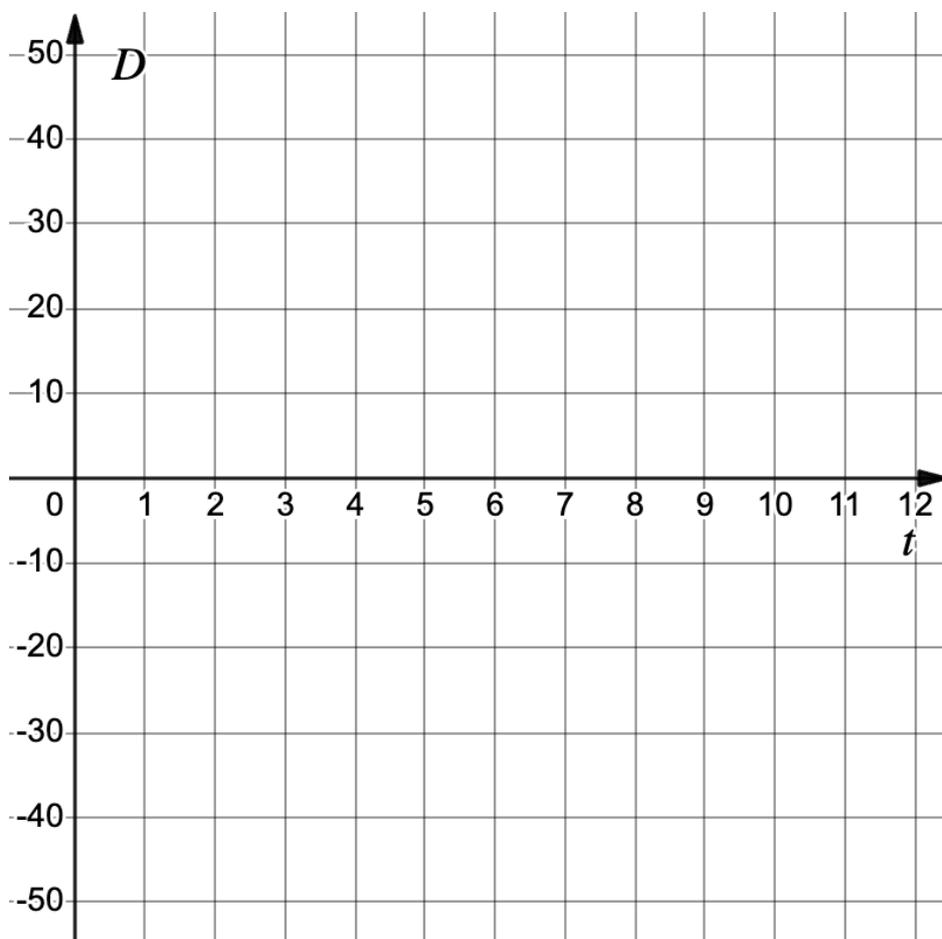


Figure 15: Axes for drawing answer to Question 41 b).

Spare diagram used (X)

- c) After how many seconds does the yo-yo first reach a height above 15cm? Give your answer to **two (2)** decimal places.

/2

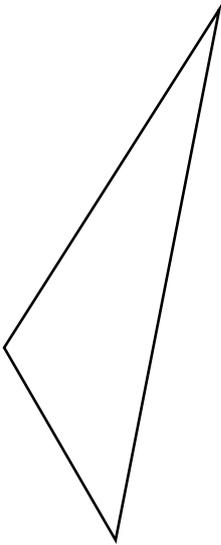
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Total
C6

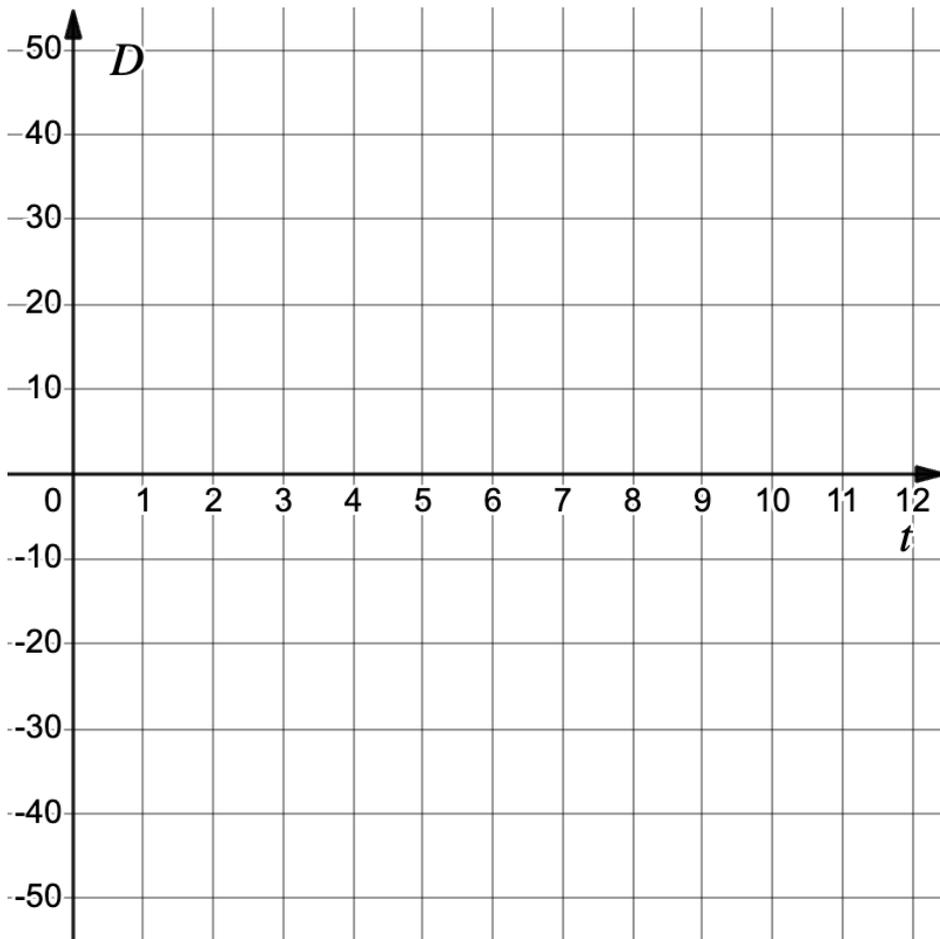
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Spare Diagrams

Question 39 a)



Question 41 b)



Part 4

- Answer **all** questions in this part.
- This part assesses **Criterion 7**.

Question 42

Figure 16 shows the motion of a stone over time. The vertical height (H) is measured in metres and the time (t) is measured in seconds.

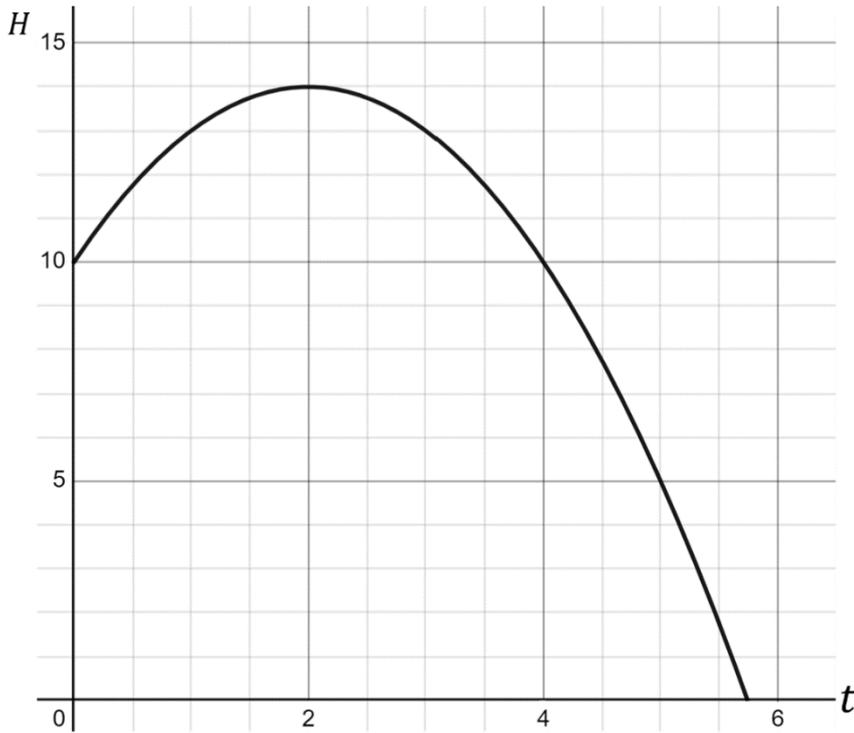


Figure 16: Graph of the motion of a stone over time.

- a) Use **Figure 16** to determine the vertical height at two (2) seconds and four (4) seconds.

/1

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- b) Determine the average rate of change of the stone's height from two (2) seconds to four (4) seconds.

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Question 43

Marker use

A bank of dirt has the cross section shown below. The curve of the bank is given by the equation:

$$H = \frac{x^2}{100}(15 - x) \quad x \in [0,15]$$

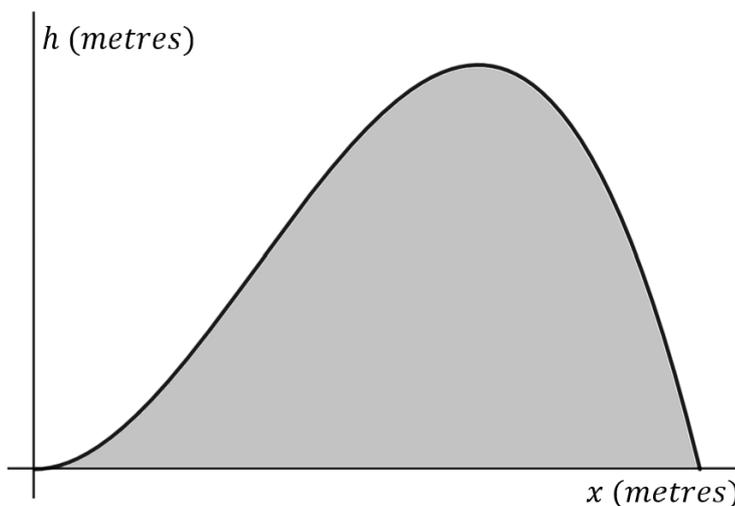


Figure 17: Diagram of a bank of dirt, highlighting h and x .

- a) **Using calculus**, find the value of x for which the height is a maximum (no justification is required).

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- b) Find the maximum height of the bank.

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Question 44

Marker use

Use calculus to determine the equation of the **normal** to the curve

$$y = \frac{1}{8}x^4 + 2x^2 - 2x + 5 \text{ at the point } (2, 11).$$

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Question 45

If the curve $y = 2x^2 + px - 3$ has a gradient of -2 when $x = -1$, find the value of p .

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Question 46

Marker use

a) Using calculus, find the stationary point(s) of $f(x) = 1 - 4x + 4x^2 - x^3$

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b) Justify the nature of the stationary point(s) found in a).

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Question 47

The position p metres, at time t seconds ($t \geq 0$) of a particle is given by $p = t^2 - 5t + 6$

a) When does $\frac{dp}{dt}$ equal zero?

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b) What is the particle's position at this time?

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c) What is the significance of this point in terms of the particle's motion?

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**Total
C7**

/20

Part 5

- Answer **all** questions in this part.
- This part assesses **Criterion 8**.

Question 48

Four (4) identical balls are numbered 2, 4, 6 and 8 and put into a box. A ball is randomly drawn from the box and not returned. A second ball is then randomly drawn from the box.

a) Complete Table 2 to display the **sum** of the **two (2)** balls.

Ball 1 \ Ball 2	2	4	6	8
2		6	8	10
4	6			
6	8			
8	10			

Table 2

Spare diagram used (X)

b) What is the probability the sum of the **two (2)** numbers is more than 7?

/2

/1

/2

c) Given that the sum of the **two (2)** balls is 10, what is the probability the number on the second ball was a 2?

Question 49

Marker use

Two (2) events A and B are such that $\Pr(A) = 0.6$, $\Pr(B) = 0.55$ and $\Pr(A \cup B) = 0.86$

a) Find $\Pr(A \cap B)$

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b) Determine, showing mathematical working, if the events A and B are independent.

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Question 50

Incy Wincy Spider likes to climb up the water spout. His chance of falling is affected by the weather. If it is raining, the probability he will fall is 0.75. If it is not raining, the probability he will fall is 0.05. On average, it rains **three (3)** days out of 10 where Incy Wincy lives.

a) Complete the tree diagram for Incy Wincy's water spout climbing using this information. A sample space is not required.

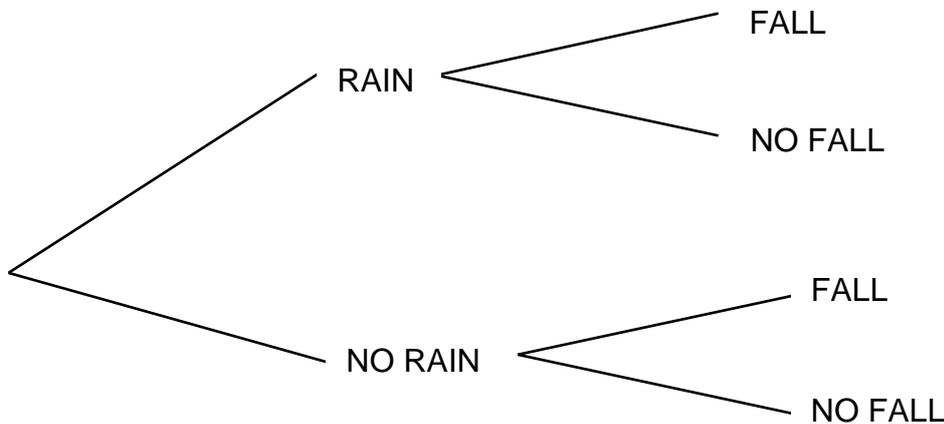


Figure 18: Tree diagram for completion to answer Question 50 a).

Spare diagram used (X)

/2

b) Find the probability that Incy Wincy will make it to the top of the spout without falling.

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Question 51

Marker use

A seven-member committee is to be made up of representatives from a number of sports:

- 12 cricket players
- 10 netball players and
- 3 badminton players.

a) How many seven-member committees are possible?

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b) What is the probability the committee is made up of only cricket players **or** only netball players?

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c) What is the probability the committee contains at least **one (1)** badminton player?

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d) What is the probability the committee contains exactly **three (3)** badminton players, given that it contains at least **one (1)** badminton player?

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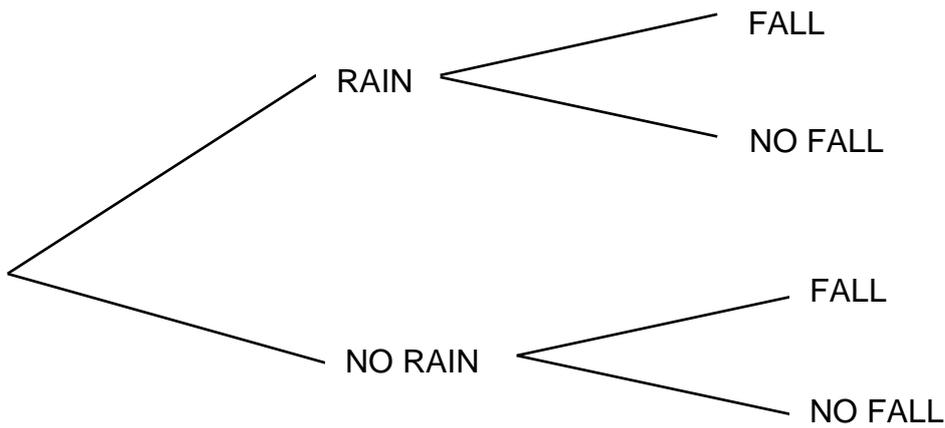
Total
C8
/20

Spare Diagrams

Question 48 a)

Ball 2 \ Ball 1	2	4	6	8
2		6	8	10
4	6			
6	8			
8	10			

Question 50 a)



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