

External Assessment 2021

# MATHEMATICS METHODS FOUNDATION

MTM315117

## Part **1**

Pages	24
Questions	20
Information Sheet	1

**Reading time:** 15 minutes – you may begin writing during this time

**Suggested working time:** 80 minutes

### Instructions

**Calculators are not allowed to be used.**

**Part 1 will be collected after 80 minutes.**

- There are **five (5)** sections to this exam paper.
- Attempt **all questions** and **all parts** within each question.
  - Questions worth **more than one** mark – you must show your workings.
  - Questions worth **one mark** – markers will look at presentation of the answer and at the argument leading to the answer.
- Write your answers in the spaces provided in this question booklet.
  - Spare diagrams have been provided at the end of each section. Indicate in the box provided if you have used the spare diagram.
- All written responses must be in **English**.
- During the first 80 minutes you may move onto Part 2, but you **cannot** use your calculator until told by your Supervisor(s).
- 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.

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

# Guide to Exam Structure

		Sections	Questions available	How many questions to answer	Suggested working time	Marks available
<b>Part 1</b>		Section A	4	4	16 minutes	16
		Section B	4	4	16 minutes	16
		Section C	5	5	16 minutes	16
		Section D	4	4	16 minutes	16
		Section E	3	3	16 minutes	16
<b>Total</b>			<b>20</b>	<b>20</b>	<b>80 minutes</b>	<b>80</b>
<b>Part 2</b>		Section A	5	5	20 minutes	20
		Section B	3	3	20 minutes	20
		Section C	5	5	20 minutes	20
		Section D	4	4	20 minutes	20
		Section E	3	3	20 minutes	20
<b>Total</b>			<b>20</b>	<b>20</b>	<b>100 minutes</b>	<b>100</b>
<b>Total</b>			<b>40</b>	<b>40</b>	<b>180 minutes (3 hours)</b>	<b>180</b>

# Section A

- Attempt **all questions** in this section.
- This section assesses **Criterion 4**.

## Question 1

Expand the following expressions:

a)  $(x - 3)(2x + 1)$ .

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1

b)  $(x + 3)(x^2 - 3x + 9)$ .

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## Question 2

Factorise the following expressions (simplify as required):

a)  $x^2 - 7x + 12$ .

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b)  $\frac{3x^2 + 6x - 9}{3(x - 1)}$ .

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2

Section A continues

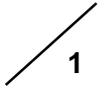
**Section A continued**

**Marker use**

**Question 3**

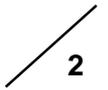
Solve the following for  $x$ :

a)  $3(x + 4) = 18.$

 **1**

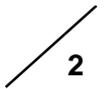
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b)  $-4(x - 3) = 3x - 2.$

 **2**

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c)  $\frac{2(1-x)}{5} = x + 2.$

 **2**

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# Section B

- Attempt **all questions** in this section.
- This section assesses **Criterion 5**.

## Question 5

a) Rearrange the equation  $2y + x - 4 = 0$  to show that its gradient is  $-\frac{1}{2}$ .

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Marker use

2

b) Determine the equation of the line that is **perpendicular** to the equation above and passes through the point (1,4).

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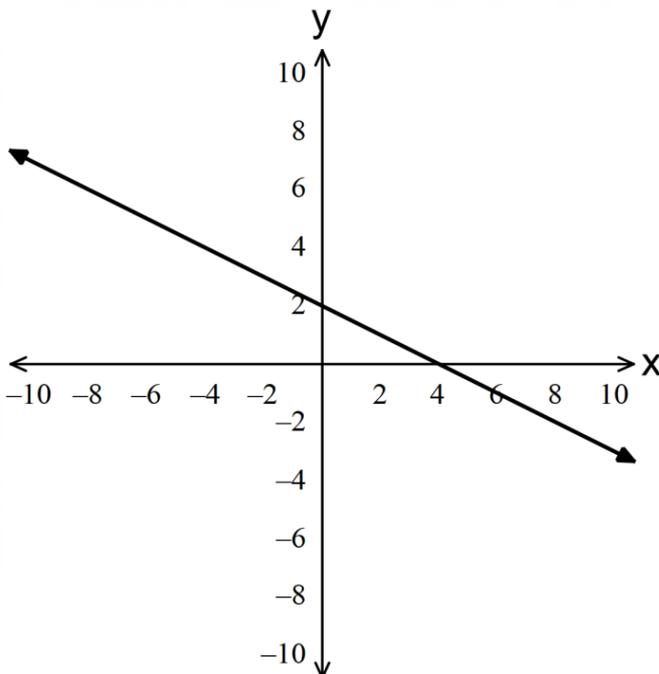
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2

c) Add the line of the equation from part b to the graph of the original equation and clearly label the point of intersection.



2

Spare diagram used  
(✓)

Section B continues

Section B continued

Marker use

Question 6

For the function:  $f(x) = 2(x - 2)^2 + 1$ .

a) Determine the **y intercept and turning point**.

2

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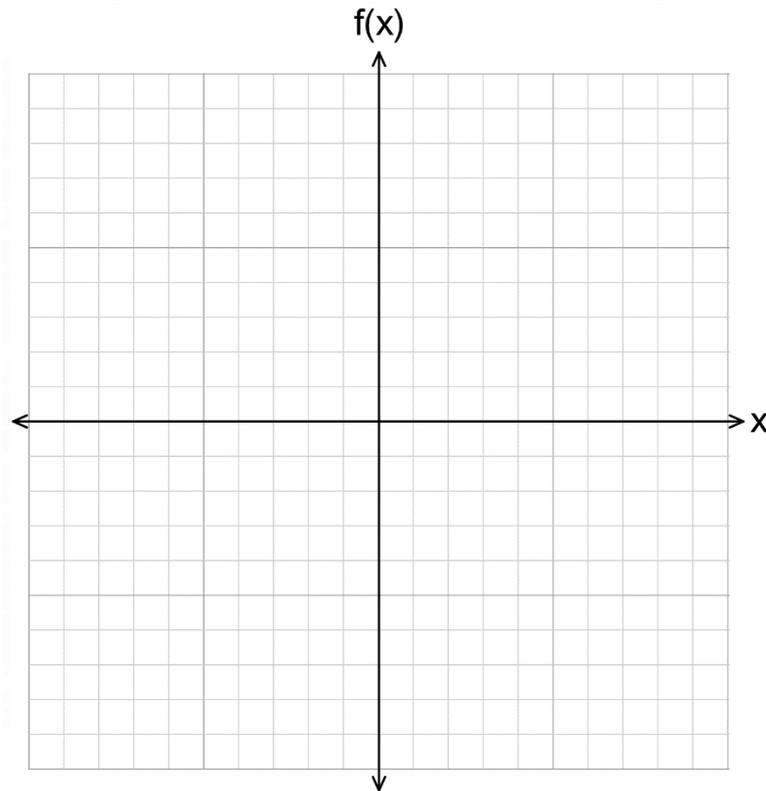
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b) Sketch the graph on the axes below, labelling any intercepts and turning point.

2



Spare diagram used (✓)

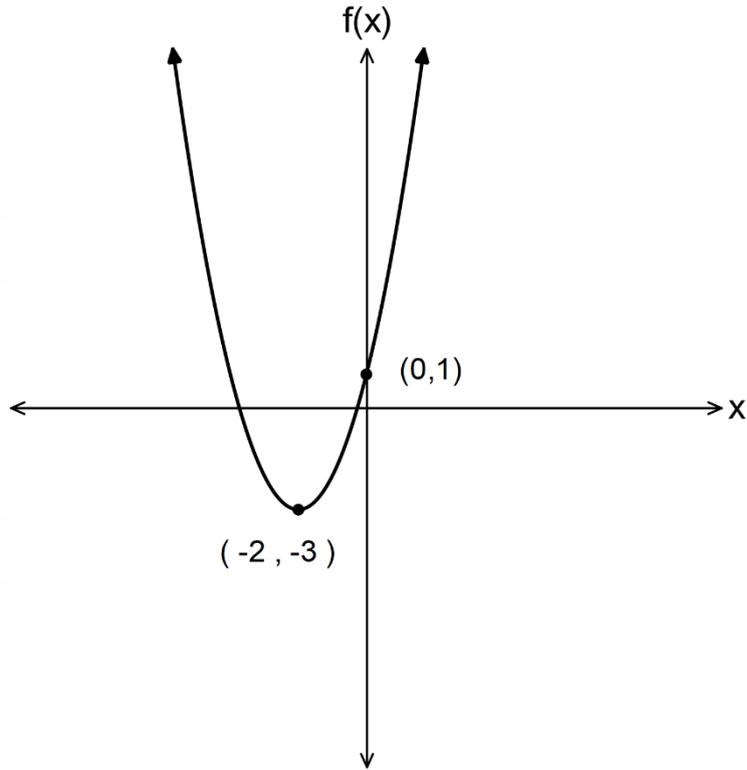
Section B continued

Marker use

Question 7

From the graph, determine the equation of the function.

2



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Section B continues

Section B continued

Question 8

For the function:  $f: [-3, 2) \rightarrow R$ , where  $f(x) = (x - 1)^2(x + 2)$ .

a) Determine all the  $x$  intercepts.

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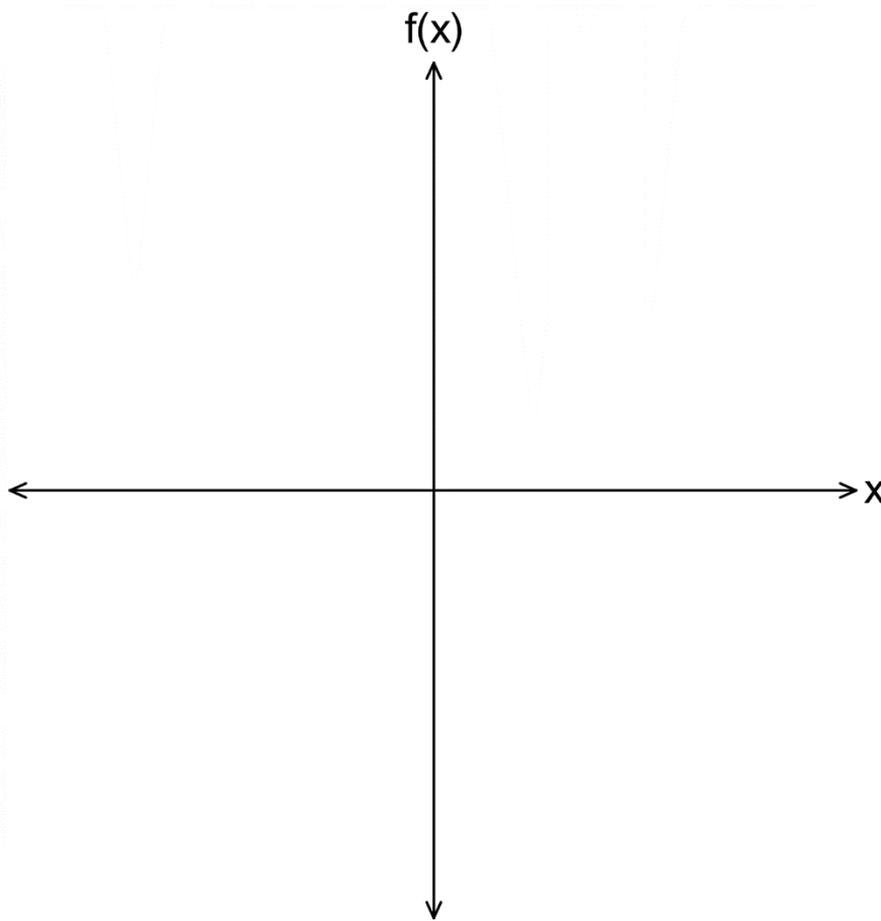
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Marker use

/ 1

b) Sketch the graph on the axes below, clearly labelling intercepts and end points.

/ 3



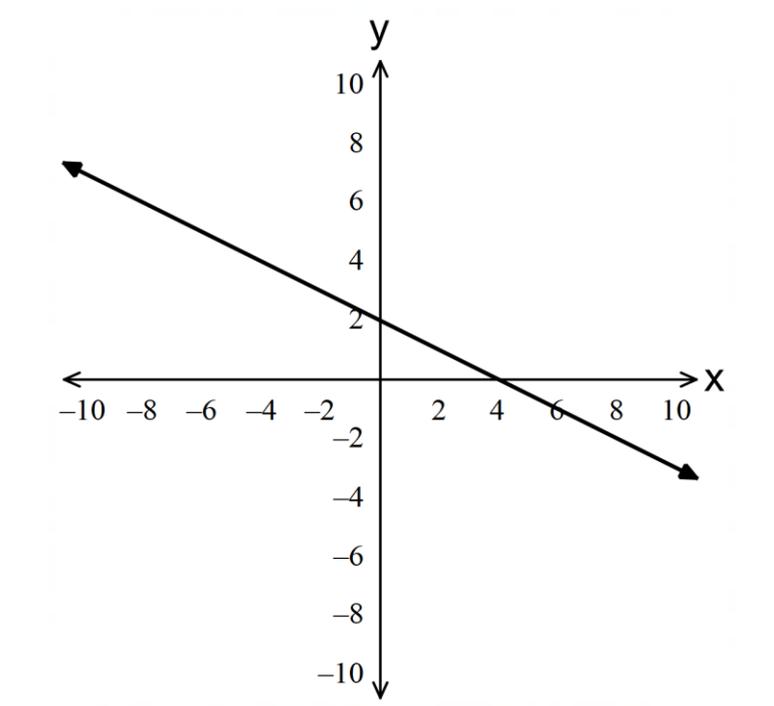
Spare  
diagram  
used  
(✓)

Total C5

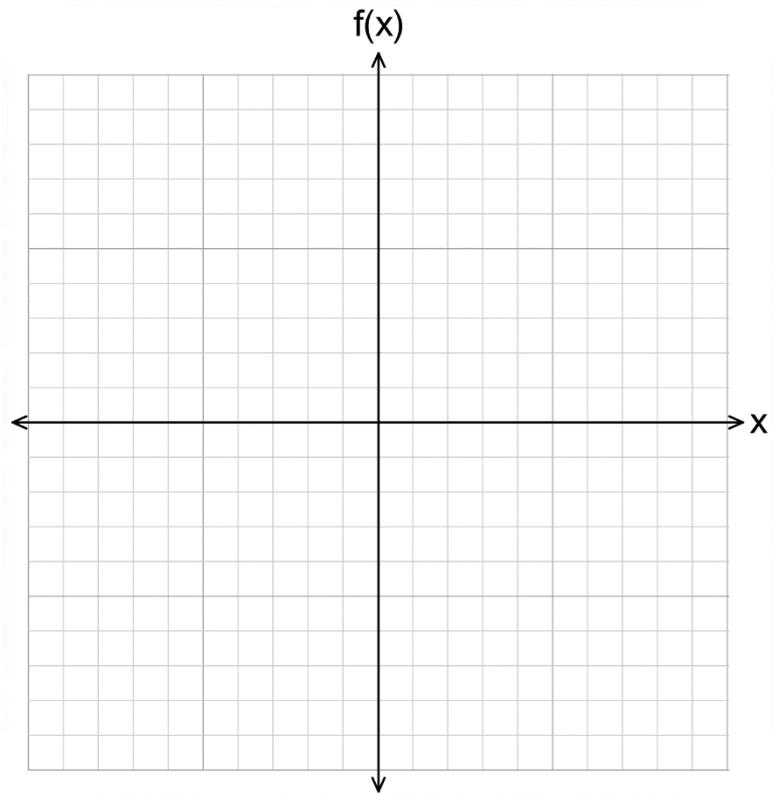
/ 16

# Spare Diagrams

Question 5c)

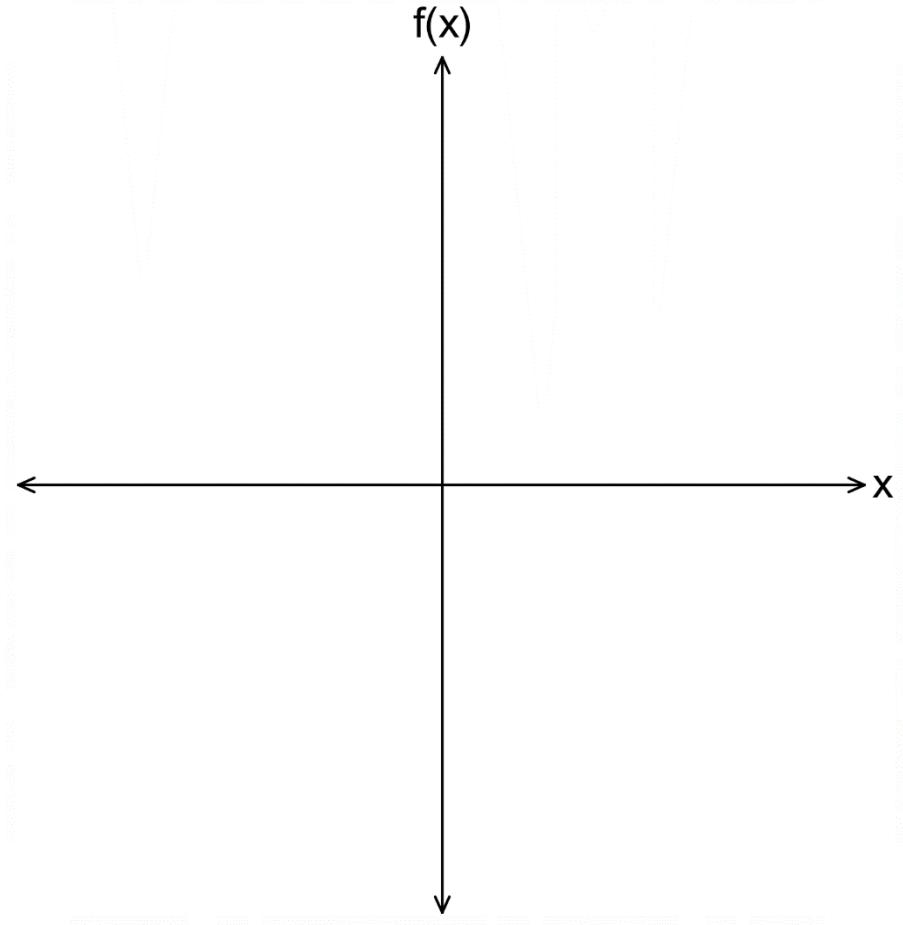


Question 6b)



# Spare Diagrams

Question 8b)



Exam continues

# Section C

- Attempt **all questions** in this section.
- This section assesses **Criterion 6**.

## Question 9

Simplify the following expressions, state indices in positive form:

a)  $ab^2c \times ba^3c^{-1}$ .

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b)  $\frac{(4m)^2 \times m^3 n^2}{n^4 \times 16nm^5}$ .

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## Question 10

Evaluate the following expressions:

a)  $\log_2 8 + \log_2 \left(\frac{1}{2}\right)$ .

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b)  $2 \log_4 2 - \log_4 \sqrt{16}$ .

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/ 2

Section C continues

Section C continued

Marker use

Question 11

Solve the following equations for  $x$ :

a)  $2^{2x+1} = 8.$

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

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Question 12

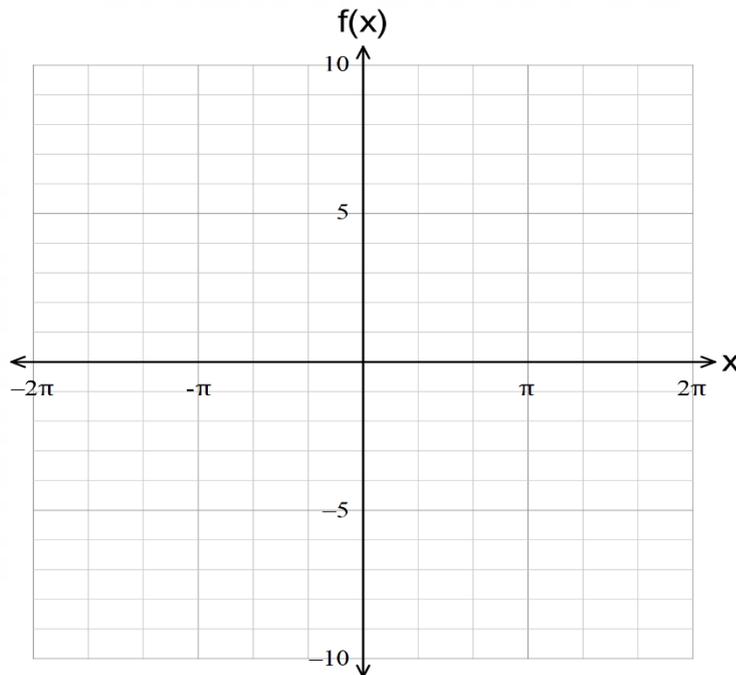
For the function:  $f(x) = \tan \frac{x}{2}$  for  $x \in [-2\pi, 2\pi]$ .

a) Determine the period.

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1

b) Sketch this function, clearly indicating  $x$  intercept(s).



2

Spare diagram used (✓)

Section C continues

Section C continued

Marker use

Question 13

For the equation:  $y = 2\log_3(x + 3) + 1$ .

- a) Determine the y intercept and the vertical asymptote.

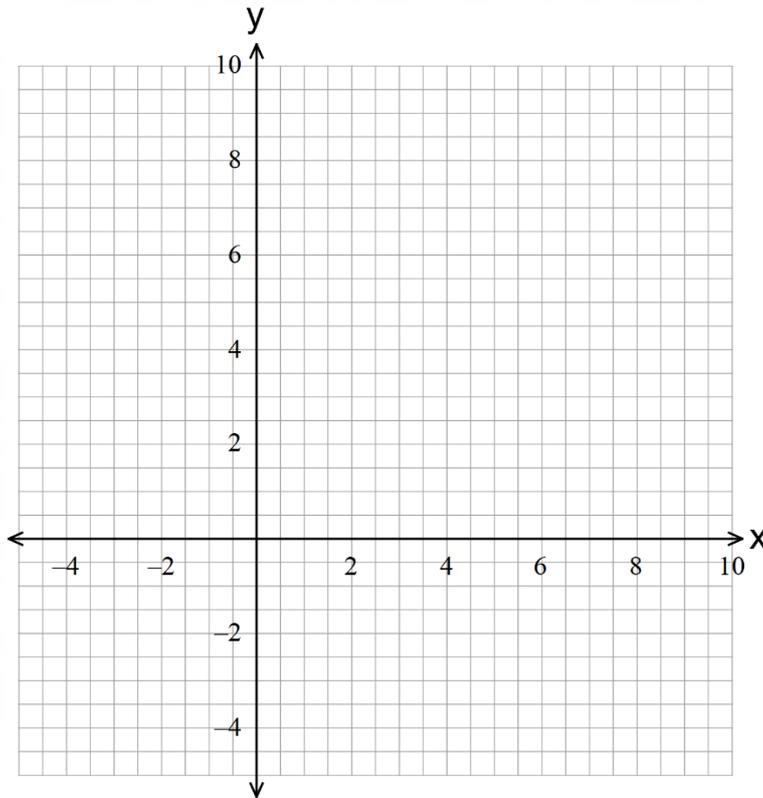
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2

- b) Sketch the graph, labelling y intercept and vertical asymptote on the axes below:



2

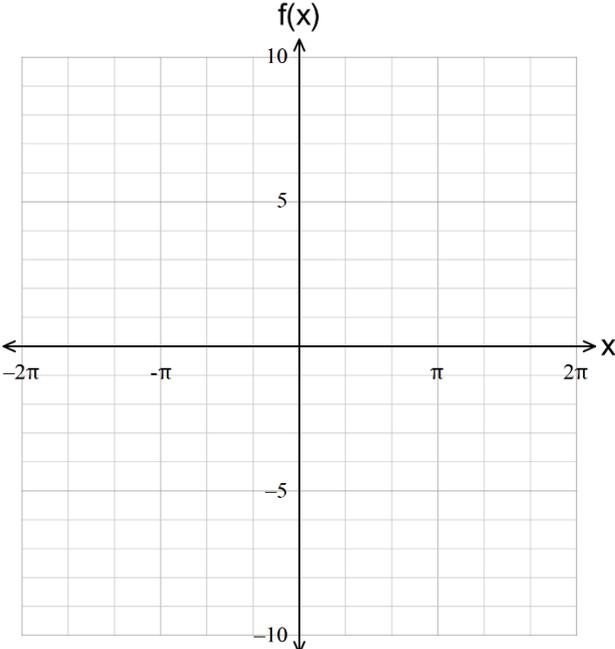
Spare diagram used (✓)

Total C6

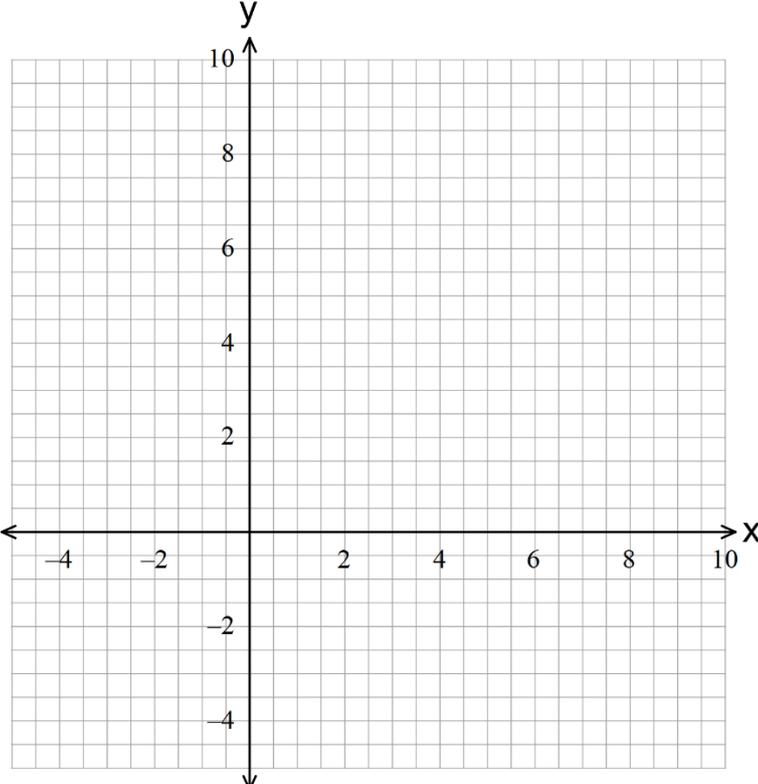
16

# Spare Diagrams

Question 12b)



Question 13b)



# Section D

- Attempt **all questions** in this section.
- This section assesses **Criterion 7**.

## Question 14

Determine the derivative of each of the following functions:

a)  $y = 3x^2 + 6x$ .

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/ 1

b)  $f(x) = -4x^3 + 2x^2 - 7$ .

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/ 1

c)  $y = 6x^{-2} + 3x^{-3} + x$ .

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## Question 15

Using first principles, determine the derivative of  $f(x) = x^2 + 2x - 3$ .

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**Section D continued**

**Marker use**

**Question 16**

Use calculus to determine the turning point of the function  $y = -x^2 + 8x - 7$ .

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**Section D continues**

Section D continued

Marker use

Question 17

A toy rocket is fired directly off the ground, up into the air (vertically). The vertical height of the rocket can be modelled using the following equation:

$$H = -2t^3 + 9t^2, \text{ where } t \text{ is time in seconds and } H \text{ is height in metres.}$$

- a) Determine the height the rocket will have reached 2 seconds after launch.

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- b) Using calculus techniques, determine when the rocket reaches its maximum height. Justification not required.

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- c) What is the maximum height?

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- d) Calculate the velocity of the rocket 4 seconds after launch.

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Total C7

16

# Section E

- Attempt **all questions** in this section.
- This section assesses **Criterion 8**.

## Question 18

A 6-sided die is rolled randomly. Determine the probability of rolling the following:

- a) The number 4.

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- b) An even number.

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- c) An odd number, given that the number is also less than 4.

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Marker use

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## Question 19

A group of students were surveyed on whether they travelled to and from college by bus or by car. The survey found that:

- 30% travel by car
- 50% travel by bus
- 40% do NOT travel by bus or car.

- a) Complete the probability table below:

	Bus (B)	No Bus (B')	
Car (C)	0.20		
No car (C')		0.40	
	0.50		1.00

Spare diagram used  
(✓)

/ 2

- b) What is the probability that a student surveyed does not travel by bus?

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- c) If **200** students were surveyed, how many said they travel by bus and car?

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/ 1

/ 2

Section E continues

Section E continued

Marker use

Question 20

The individual letters of the word STRAWBERRY were printed on individual cards (as shown in the diagram below) and placed in a bag. A card is drawn out of the bag, the letter **and** colour is recorded, **then the card is put back in the bag**.



a) What is the probability that a white card is drawn the first time a card is removed?

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b) Given that a dark card is drawn, what is the probability that it will **also be** a vowel (A, E, I, O or U)?

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c) What is the probability that the word **B-E-A-R** is drawn with the letters in the **same order** as the word? Remember that the cards are returned to the bag after the letter is recorded.

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/ 2

Cards are drawn randomly and **not** replaced back in the bag.

d) What is the probability that the word **B-A-R-B** is drawn with the letters in the **same order** as the word?

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Total C8

/ 16

# Spare Diagram

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Question 19a)

	<b>Bus (B)</b>	<b>No Bus (B')</b>	
<b>Car (C)</b>	0.20		
<b>No car (C')</b>		0.40	
	0.50		1.00

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End of Part 1

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ASSESSMENT, STANDARDS  
& CERTIFICATION

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External Assessment 2021

# MATHEMATICS METHODS FOUNDATION

MTM315117

Part **2**

Pages	24
Questions	20
Information Sheet	1

**Suggested working time:** 100 minutes

## Instructions

## Calculators are allowed to be used.

- There are **five (5)** sections to this exam paper.
- Attempt **all questions** and **all parts** within each question.
  - Questions worth **more than one** mark – you must show your workings.
  - Questions worth **one mark** – markers will look at presentation of the answer and at the argument leading to the answer.
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  - 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.

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

# Guide to Exam Structure

		Sections	Questions available	How many questions to answer	Suggested working time	Marks available
Part 1	1	Section A	4	4	16 minutes	16
		Section B	4	4	16 minutes	16
		Section C	5	5	16 minutes	16
		Section D	4	4	16 minutes	16
		Section E	3	3	16 minutes	16
<b>Total</b>			<b>20</b>	<b>20</b>	<b>80 minutes</b>	<b>80</b>
Part 2	2	Section A	5	5	20 minutes	20
		Section B	3	3	20 minutes	20
		Section C	5	5	20 minutes	20
		Section D	4	4	20 minutes	20
		Section E	3	3	20 minutes	20
<b>Total</b>			<b>20</b>	<b>20</b>	<b>100 minutes</b>	<b>100</b>
<b>Total</b>			<b>40</b>	<b>40</b>	<b>180 minutes (3 hours)</b>	<b>180</b>

# Section A

- Attempt **all questions** in this section.
- This section assesses **Criterion 4**.

## Question 21

The following equation can be used to convert degrees Fahrenheit ( $F$ ) to degrees Celsius ( $C$ ).

$$C = \frac{5(F - 32)}{9}$$

- a) If  $F = 30$ , find  $C$ .

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Marker use

1

- b) Transpose the equation to make  $F$  the subject of the equation.

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## Question 22

Factorise the following expression:  $8x^3 - 27y^3$ .

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Section A continues

Section A continued

Marker use

Question 23

- a) Use the **discriminant** to predict the number and type (rational or irrational) of solution(s) for the equation:

$$2x^2 - 7x + 9 = 0$$

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- b) Determine the value(s) for  $k$  for which the equation  $2x^2 - 4x + k$  has **one real solution**.

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- c) Use the **quadratic formula** to solve the equation  $3x^2 - 7x + 4 = 0$ . Give your answer as exact values.

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Section A continues

Section A continued

Marker use

Question 24

a) Factorise  $y = 2x^2 - 10x - 6$  by **completing the square**.

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b) Given that  $2x^2 - 10x - 6 = 0$ , state the solution(s).

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Question 25

a) Solve the following simultaneous equations. Show **all** required algebraic working.

/ 3

$$4 = y - 2x$$

$$x = 2y + 12$$

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b) Solve  $(x + 1)^3 - 8(x + 1)^2 = 0$ .

/ 3

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Total C4

/ 20

# Section B

- Attempt **all questions** in this section.
- This section assesses **Criterion 5**.

## Question 26

Marker use

Given that a linear function passes through the points (1.5, 1.4) and (3.2, 8.2).

- a) **Algebraically** determine the equation, showing that the equation of this function is:

$$y - 4x + 4.6 = 0$$

2

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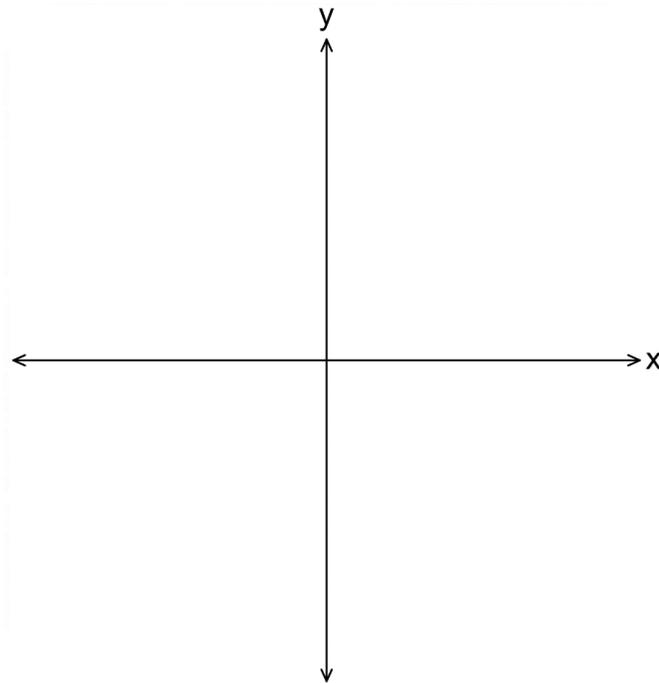
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- b) Draw the graph of the equation on the axes below, labelling  $x$  and  $y$  intercepts.

2



Spare  
diagram  
used  
(✓)

- c) Determine the equation of the line **parallel** to the function which goes through the point (3.4, 15.8). Add this function to the graph in b), labelling intercepts.

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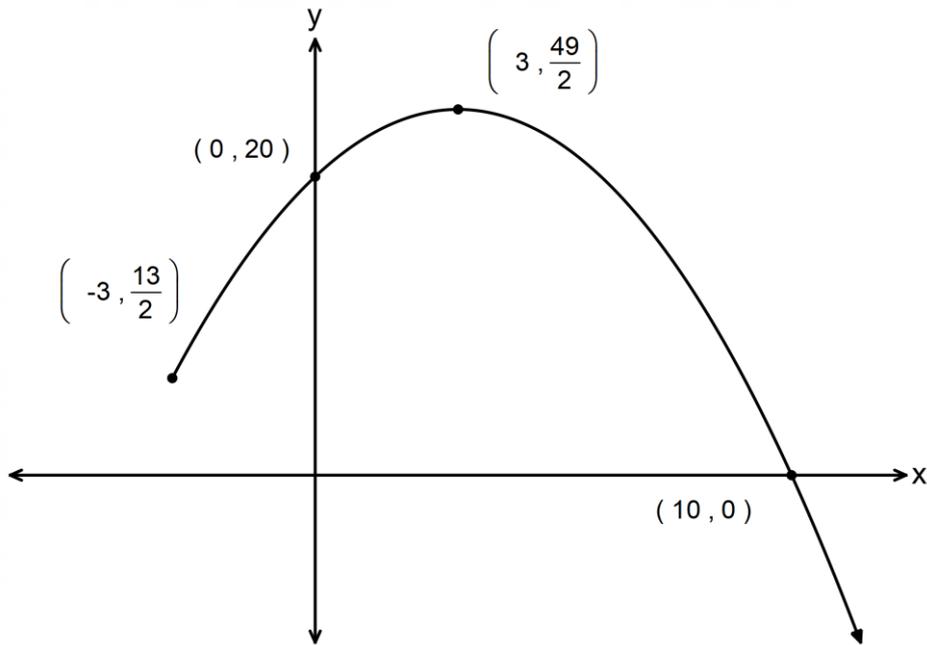
Section B continues

Section B continued

Marker use

Question 27

A quadratic function is represented below.



- a) Determine the equation of this function and state **in expanded form**.

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- b) State the domain and range of the function.

Domain: .....

Range: .....

2

- c) Give a reason why this is a function not just a relation.

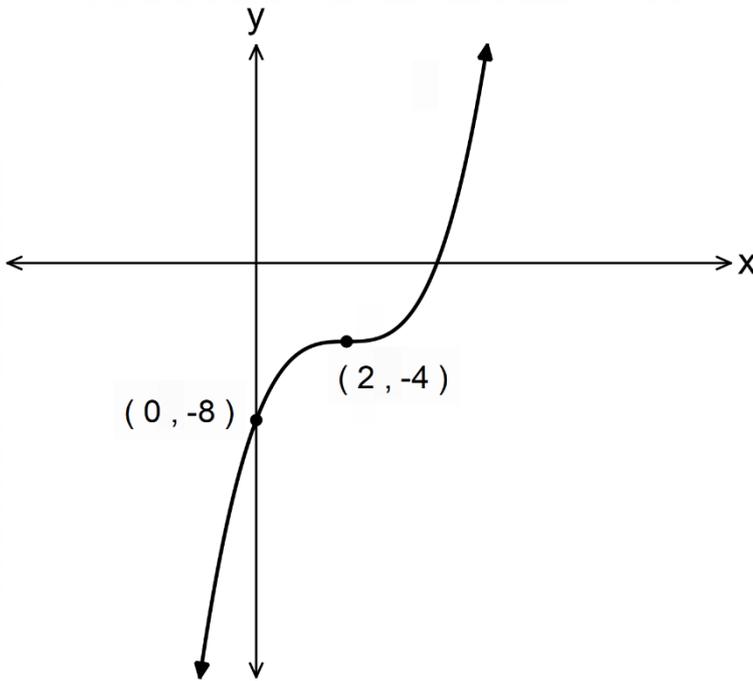
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Section B continues

Question 28



a) Determine the equation of the function graphed above.

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b) State all transformations of the graph of the function above from  $y = x^3$ .

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c) Determine the  $x$  intercept.

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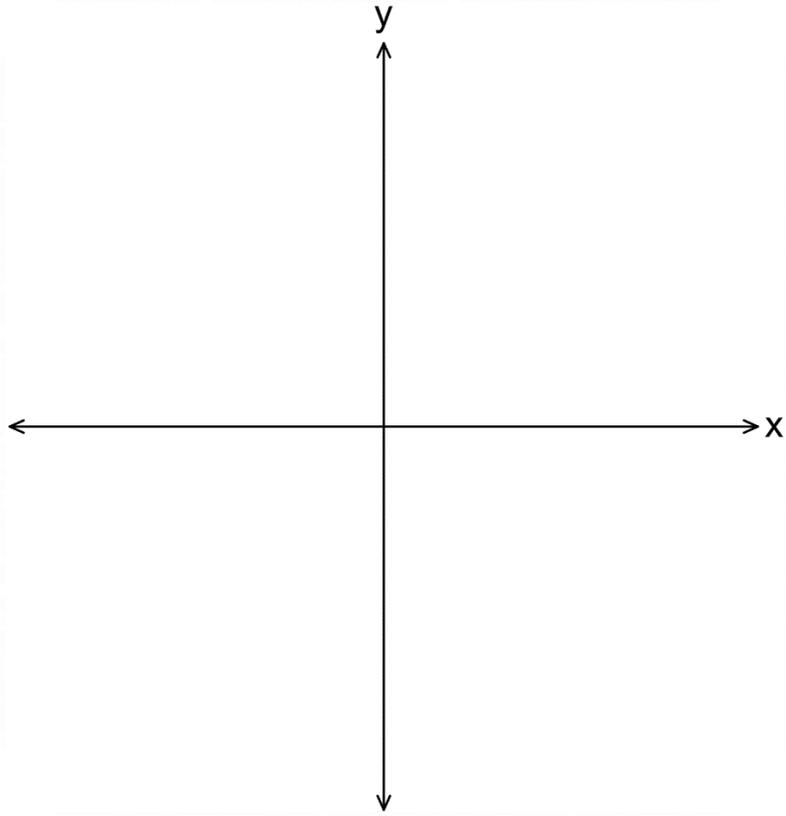
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Total C5  
/ 20

# Spare Diagram

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Question 26b)



# Section C

- Attempt **all questions** in this section.
- This section assesses **Criterion 6**.

## Question 29

Convert the following:

- a)  $154^\circ$  into radians. Give answer in exact form.

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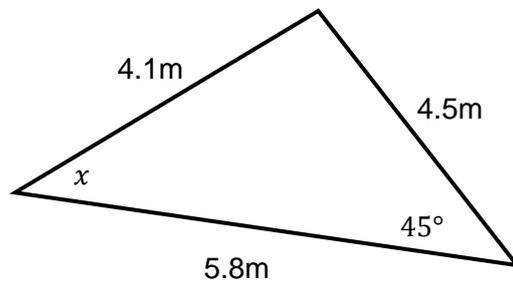
- b)  $\frac{4\pi}{7}$  radians into degrees. Give answer to 2 decimal places.

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1

## Question 30

Determine the value of  $x$  in the diagram below.



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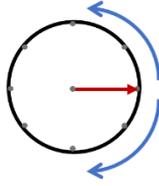
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Section C continues

Section C continued

Question 31

The function below shows the height of the needle on a dial relative to the horizontal through one rotation.



$$y = -1.4\sin(2x), \quad \text{where } 0 \leq x \leq 2\pi$$

- a) State the amplitude of the function.

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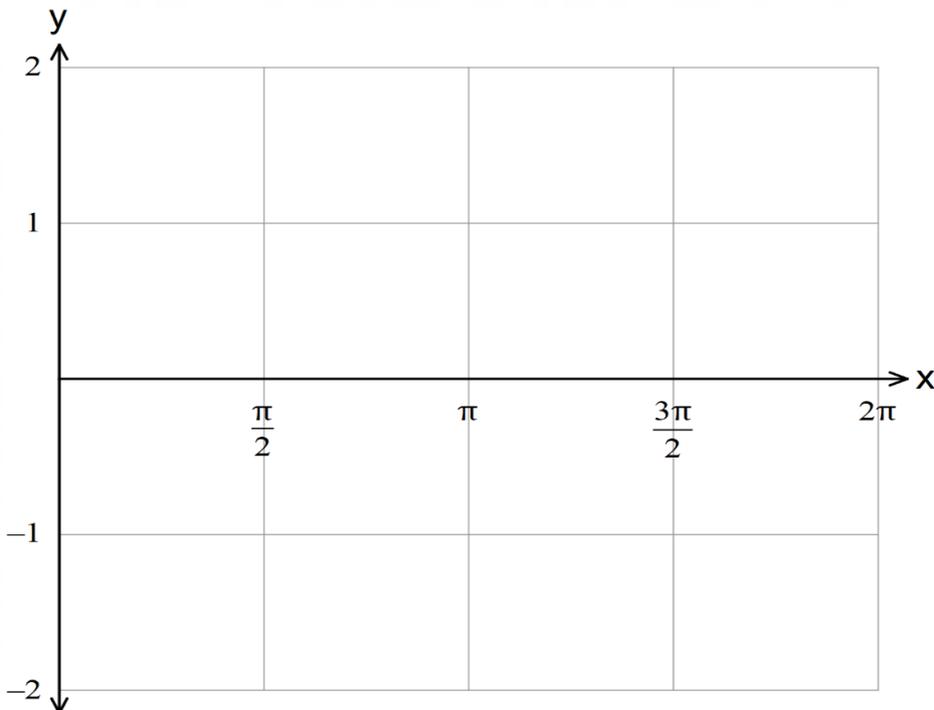
- b) Calculate the period of the function. State the answer in **radians**.

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1

- c) Sketch the graph of  $y = -1.4\sin(2x)$  on the grid below.



Spare diagram used  
(✓)

2

- d) In which direction is the hand moving (clockwise or anticlockwise)?

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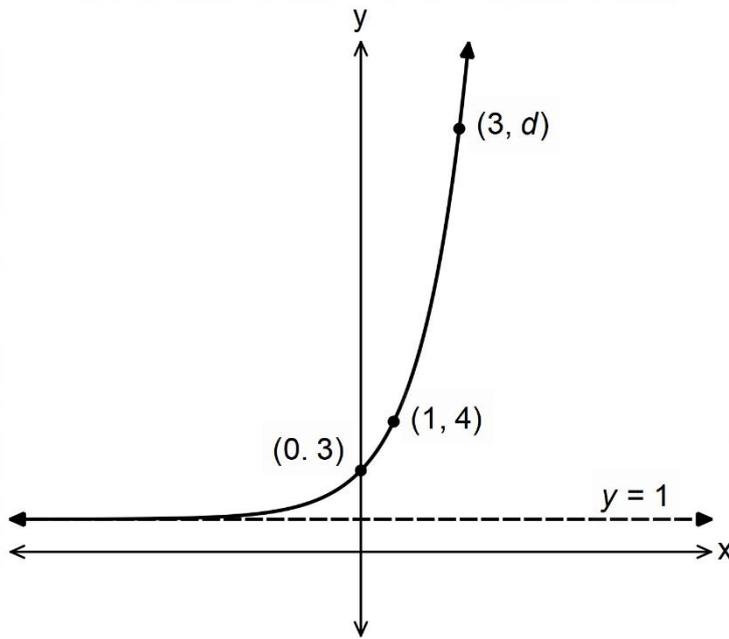
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Section C continued

Marker use

Question 32

Consider the graph below of the exponential equation  $y = a \times 1.5^x + k$  where  $a$  and  $k$  are constants.



a) Determine the equation of the above exponential function.

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2

b) Determine the value of  $d$  on the graph at point  $(3, d)$ .

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2

c) State the domain and range of the function.

Domain: .....

Range: .....

1

Section C continues

Section C continued

Marker use

Question 33

A wildlife research group uses the mathematical model:  $n = 120 \log_4 A$ , to estimate the number of Spotted Quoll ( $n$ ) that live in a state reserve on the West Coast of Tasmania, with an area ( $A$ ) in  $\text{km}^2$ .

- a) Determine the number of Spotted Quoll that live in an area of  $800\text{km}^2$ . (Give answer in whole numbers).

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- b) If the area of the reserve was **halved** due to logging, how many Spotted Quoll would researchers expect to find in the reduced reserve? (Give answer in whole numbers).

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- c) Determine the size of the reserve required to maintain 400 Spotted Quoll.

/ 2

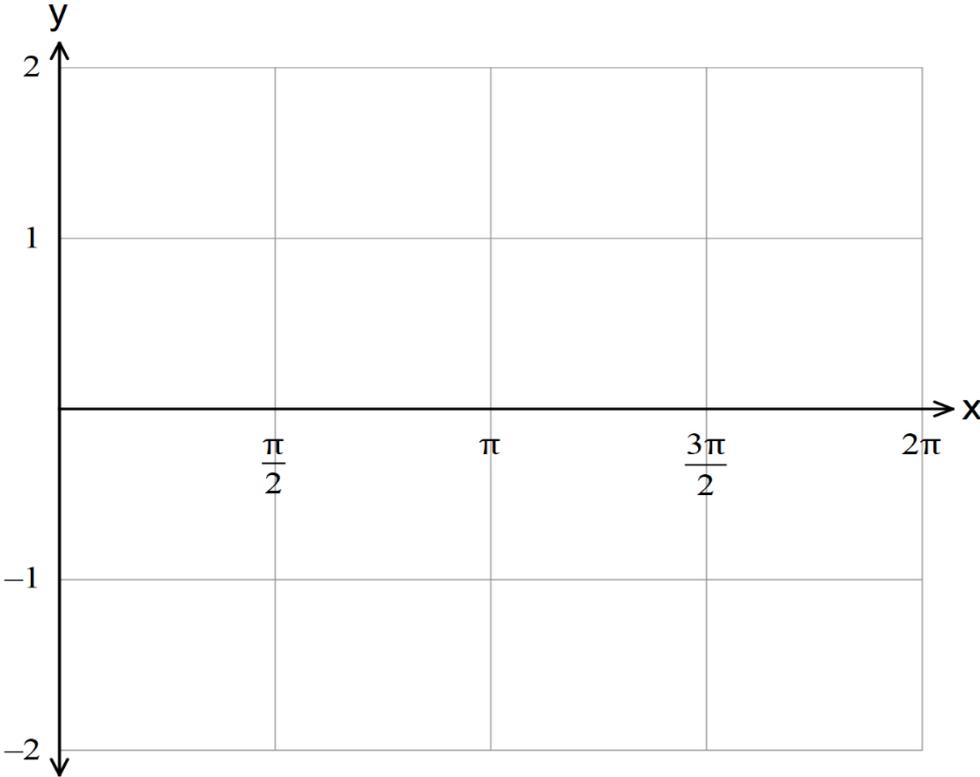
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Total C6

/ 20

# Spare Diagram

Question 31c)

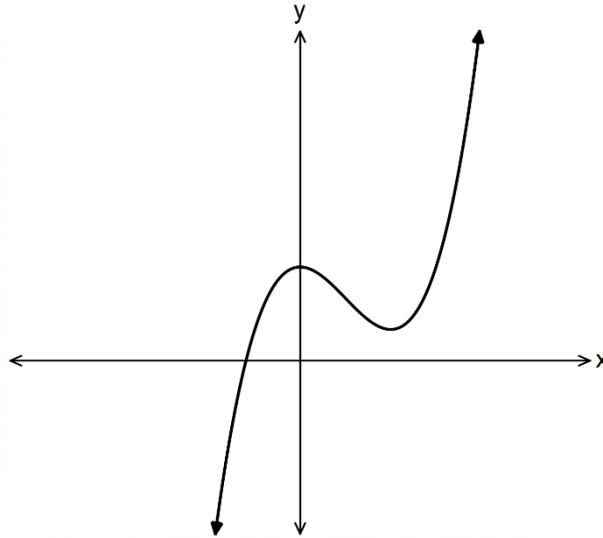


# Section D

- Attempt **all questions** in this section.
- This section assesses **Criterion 7**.

## Question 34

Marker use



Spare  
diagram  
used  
(✓)

There are two types of rate of change: average and instantaneous. The derivative of the function graphed above is  $\frac{dy}{dx} = 1.5x^2 - 3.0x$ .

- a) Calculate the rate of change between (0, 3) and (4, 11), also stating the type of rate of change.

2

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- b) Calculate the rate of change at the point (3, 3) also stating the type of rate of change.

2

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- c) Sketch the graph of the gradient function on the axes above.

2

Section D continues

**Section D continued**

**Question 35**

The function  $f(x) = 0.5x^2 + 4x - 7$  has a gradient of 1 at a particular point  $(x, y)$ .

Use calculus techniques to determine the point.

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**Marker use**

3

**Question 36**

Use calculus techniques to determine the equation of the tangent to the function below at the point  $(-3, -7)$

$$y = \frac{2}{3}x^3 + 2x^2 - 7$$

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3

Section D continued

Marker use

Question 37

An antifungal spray is being tested to determine its effectiveness. Researchers found that the number of living fungal spores ( $F$ ) can be modelled by the function below, after a certain time ( $t$ ) in hours.

$$F = 2t^3 - 38t^2 + 164t + 160, \text{ where } 0 \leq t \leq 10 \text{ and } F \text{ is measured in 1000s of spores.}$$

- a) What was the initial number of living fungal spores? (Before the researchers applied the antifungal spray).

/ 1

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- b) Use calculus techniques to determine at what time the number of living fungal spores reached its maximum number. Justification is required.

/ 3

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- c) What was the **maximum** number of living fungal spores?

/ 2

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- d) What was the rate of change in the number of living fungal spores 6 hours ( $t = 6$ ) after the antifungal was used?

/ 2

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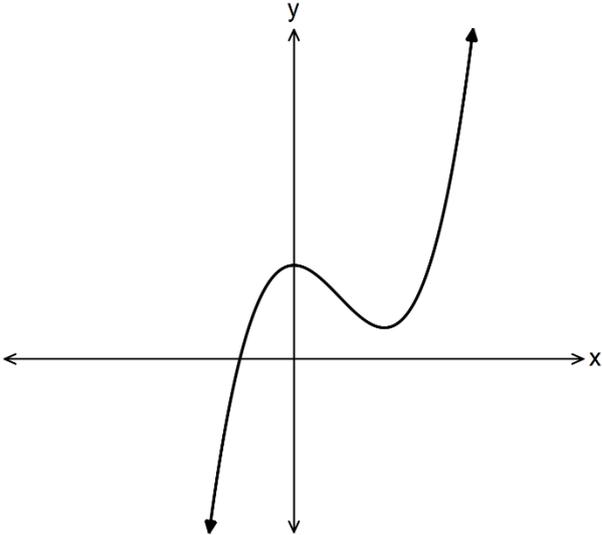
Total C7

/ 20

# Spare Diagram

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Question 34



# Section E

- Attempt **all questions** in this section.
- This section assesses **Criterion 8**.

## Question 38

Two four-sided dice (1, 2, 3, 4) are rolled at the same time. The lattice below shows all possible outcomes.

4	1, 4	2, 4	3, 4	4, 4
3	1, 3	2, 3	3, 3	4, 3
2	1, 2	2, 2	3, 2	4, 2
1	1, 1	2, 1	3, 1	4, 1
	1	2	3	4

- a) Determine the probability of rolling a 3 **and** a 4 in any order.

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- b) Determine the probability of rolling “doubles” (**same numbers**).

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- c) Determine the probability of rolling the dice and **not** getting an even number on either die.

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- d) Determine the probability of rolling a total **greater than or equal** to 6.

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Marker use

/ 1

/ 1

/ 2

/ 2

Section E continues

**Section E continued**

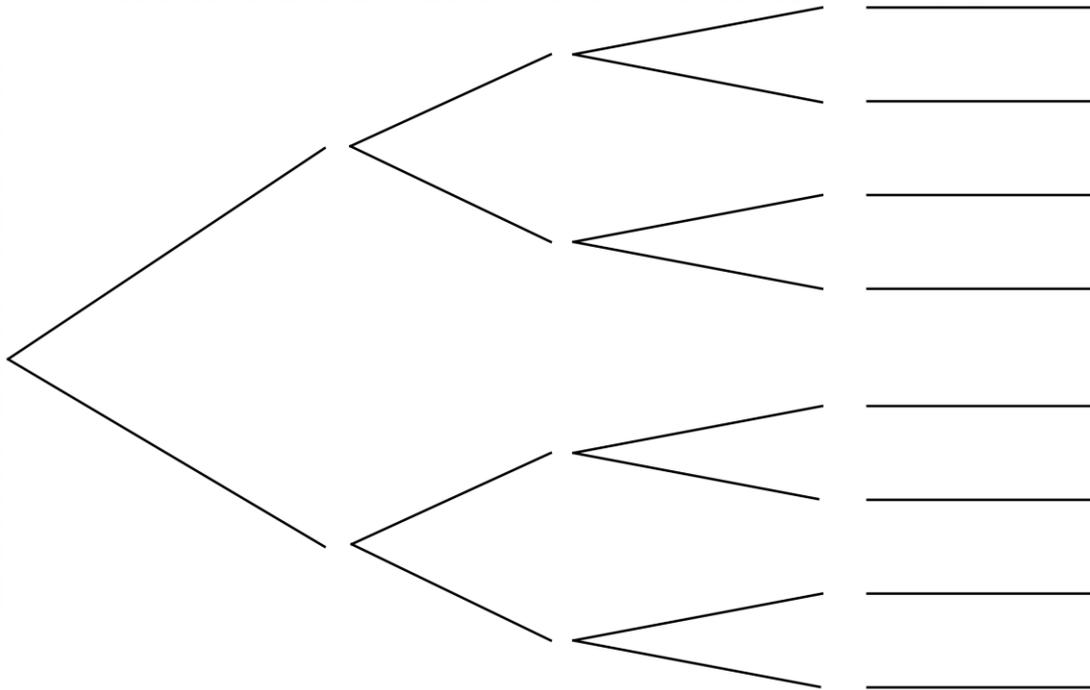
Marker use

**Question 39**

A travel agency runs tours in the north, west and south of the state. The probability of a person booking a tour to each region is:

- North 0.55
- West 0.35
- South 0.70

a) Complete the diagram below using N, N', W, W' and S, S'. List the possible outcomes.



Spare diagram used (✓)

3

b) Determine the probability that a person will go on tours in all three regions.

2

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c) Determine the probability that they will go on a tour in at least two regions.

3

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**Section E continues**

Section E continued

Marker use

Question 40

A museum has a collection of paintings by the following famous artists:

- 6 paintings by Picasso
- 4 paintings by Rembrandt
- 5 paintings by Monet

a) The museum wants to display the artwork in a **group of 5**. How many different arrangements are there if the paintings are chosen at random?

1

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b) Determine the probability of **3 Picasso** paintings and **2 Monet** paintings being selected at random.

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c) Determine the probability of **at least 1** painting by Monet being chosen.

3

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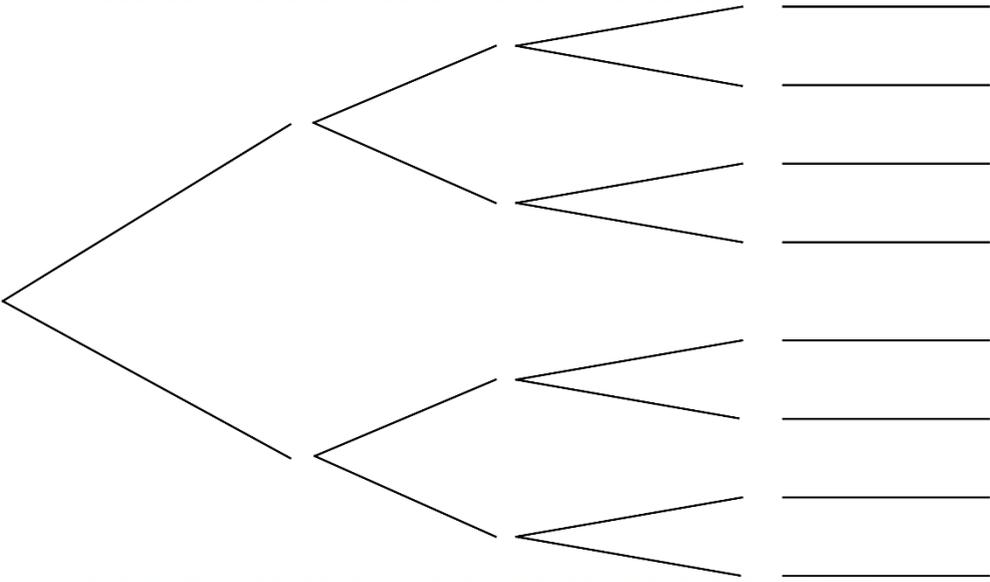
Total C8

20

# Spare Diagram

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Question 39



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End of Part 2



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