



2020 YEAR 11 ASSESSMENT TASK 3

Mathematics Advanced

Thursday 10th September

General**Instructions**

- Reading time – 10 minutes
- Working time – 3 hours
- Write using black pen
- Calculators approved by NESA may be used
- A reference sheet is provided
- For questions in Section II, show relevant mathematical reasoning and/or calculations

Total marks:
100**Section I – 10 marks**

- Attempt Questions 1 – 10
- Allow about 15 minutes for this section

Section II – 90 marks

- Attempt Questions 11– 40
- Allow about 2 hours and 45 minutes for this section

Name: _____

Student Number: _____

Outcomes

A student:

- | | |
|--------|---|
| MA11-1 | uses algebraic and graphical techniques to solve, and where appropriate, compare alternative solutions to problems |
| MA11-2 | uses the concepts of functions and relations to model, analyse and solve practical problems |
| MA11-3 | uses the concepts and techniques of trigonometry in the solution of equations and problems involving geometric shapes |
| MA11-4 | uses the concepts and techniques of periodic functions in the solutions of trigonometric equations or proof of trigonometric identities |
| MA11-5 | interprets the meaning of the derivative, determines the derivative of functions and applies these to solve simple practical problems |
| MA11-6 | manipulates and solves expressions using the logarithmic and index laws, and uses logarithms and exponential functions to solve practical problems |
| MA11-7 | uses concepts and techniques from probability to present and interpret data and solve problems in a variety of contexts, including the use of probability distributions |
| MA11-9 | provides reasoning to support conclusions which are appropriate to the context |

Section I

10 marks

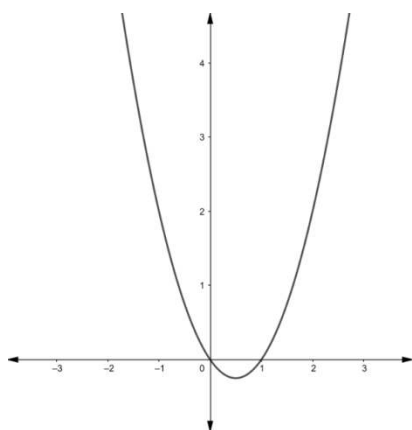
Attempt Questions 1–10

Allow about 15 minutes for this section

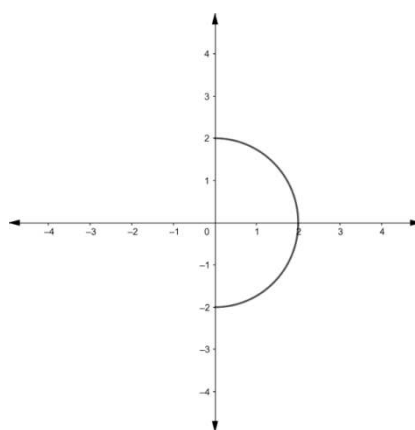
Use the multiple-choice answer sheet for Questions 1–10

1 Which graph represents a one-to-one function?

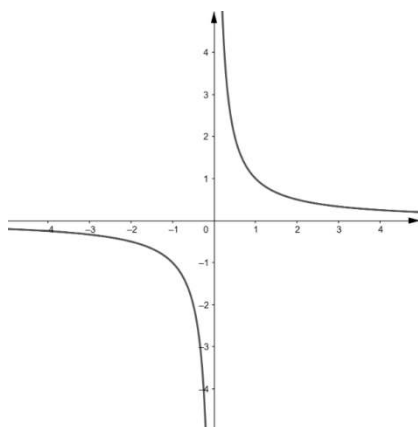
A.



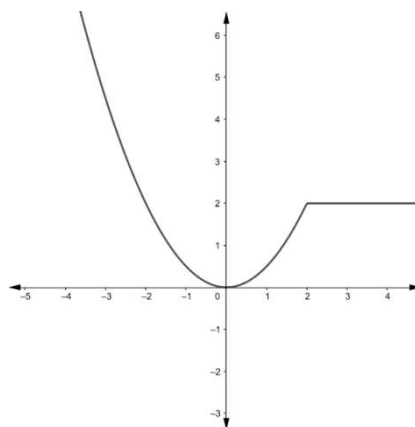
B.



C.



D.



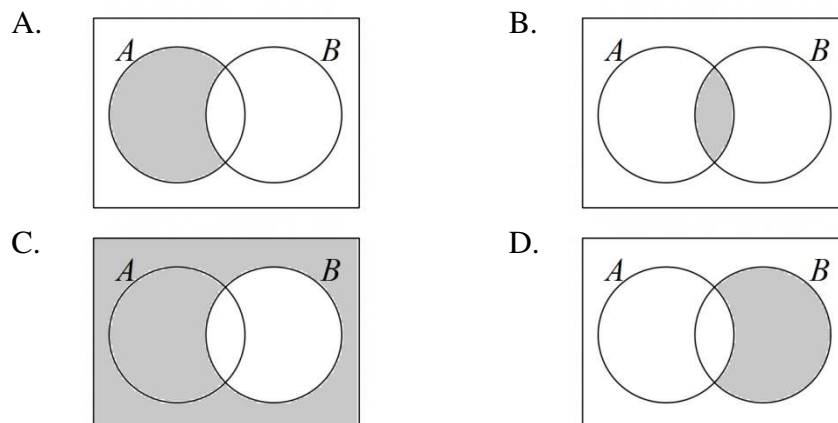
2 If $f(x) = x^2 - 2x$, what is the value of $f(-3)$?

- A. -15
- B. -3
- C. 0
- D. 15

3 How many x -intercepts does the graph of $f(x) = (x-2)(x^2 + 4x + 3)$ have?

- A. 0
- B. 1
- C. 2
- D. 3

4 In which of the Venn diagrams is $A \cap B'$ shaded?



5 Which of the following lines is parallel to the line $6x - 2y - 3 = 0$?

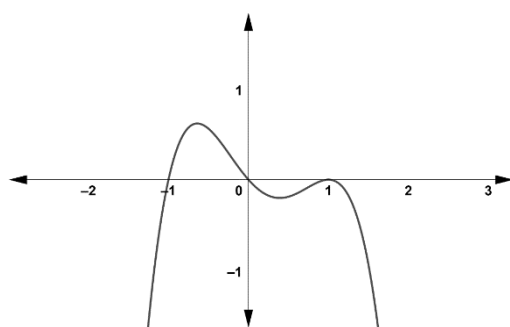
- A. $6x - y - 5 = 0$
- B. $y = 3x - 5$
- C. $y = \frac{1}{3}x - 8$
- D. $y = -3x + 5$

6 What are the solutions to $|2x + 3| = 1$?

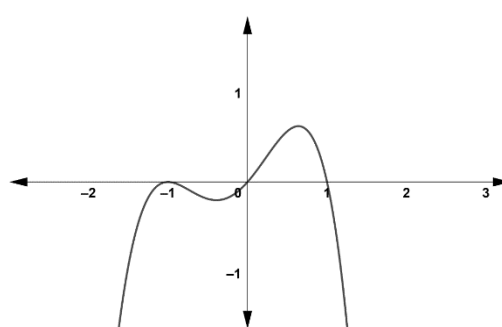
- A. $x = -2$ or $x = -1$
- B. $x = -2$ or $x = 1$
- C. $x = 1$ or $x = 2$
- D. $x = 2$ or $x = -1$

7 Which of the following graphs shows the function $y = -x(x-1)^2(x+1)$?

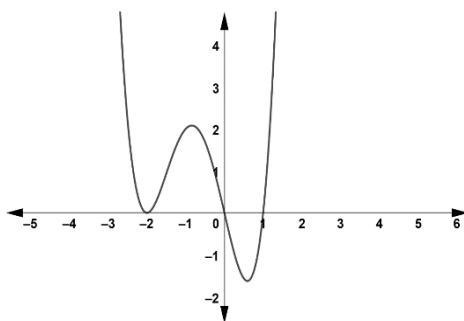
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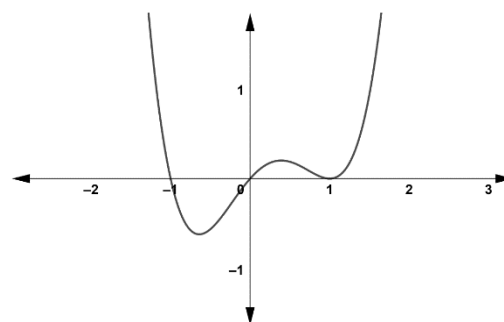
B.



C.



D.



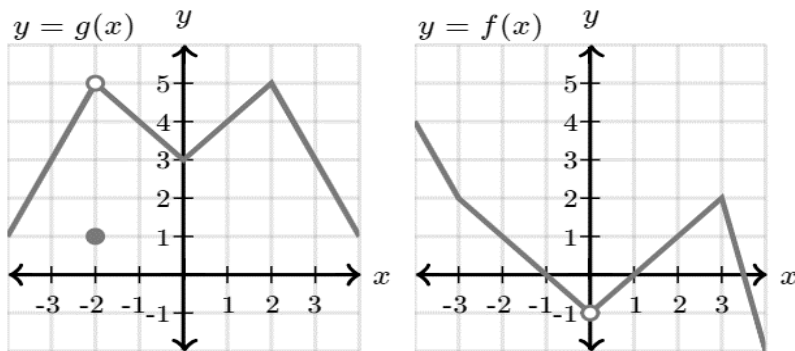
8 Which of the following is always true for $0^\circ < \theta < 90^\circ$?

- A. $\sin(90 - \theta) = \sin \theta$
- B. $\sin(180 - \theta) = \sin \theta$
- C. $\sin(180 + \theta) = \sin \theta$
- D. $\sin(360 - \theta) = \sin \theta$

9 What are the solutions to $\sin x = -\frac{1}{2}$ for $0 \leq x \leq 360^\circ$?

- A. $x = 30^\circ$
- B. $x = 30^\circ$ and $x = 150^\circ$
- C. $x = 150^\circ$ and $x = 210^\circ$
- D. $x = 210^\circ$ and $x = 330^\circ$

10 The functions $f(x)$ and $g(x)$ are graphed below.
What is the value of $g(f(x))$ when $x = -2$?



- A. 0
- B. 1
- C. 4
- D. The value does not exist.

Student Number: _____

2020 YEAR 11 ASSESSMENT TASK 3

Mathematics Advanced

Section II Answer Booklet

90 marks

Attempt Questions 11 - 40

Allow about 2 hours and 45 minutes for this section

Instructions

- Answer the questions in the spaces provided. Sufficient spaces are provided for typical responses.
 - Your responses should include relevant mathematical reasoning and/or calculations.
 - Extra writing paper is provided at the back of each booklet. If you use this space, clearly indicate which question you are answering.
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Question 11 (2 marks)

Simplify $\frac{2x^2 - 5x - 12}{x - 4}$.

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Question 12 (3 marks)

Write $\frac{20}{x^2 + 5x} - \frac{4}{x}$ as a single fraction in simplest form.

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Question 13 (1 mark)

Evaluate $\log_a a^2$.

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Question 14 (2 marks)

Solve $\log_2(x+2) = 3$.

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Question 15 (1 mark)

Convert 225° to radians in exact form.

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Question 16 (2 marks)

State the natural domain of $f(x) = \frac{5}{\sqrt{5-x}}$ using interval notation.

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Question 17 (2 marks)

Determine whether the function $f(x) = x^3 + 2x$ is odd, even or neither and justify your answer. **2**

[illegible]

Question 18 (2 marks)

A bag contains 4 yellow and 3 red balls. Two balls are chosen at random and the first ball is not replaced before the second ball is chosen. Find the probability that one ball of each colour is chosen.

This image shows a full page of primary-ruled paper. It features ten sets of horizontal lines across the page. Each set consists of three lines: a solid top line, a dashed midline, and a solid bottom line. The lines are evenly spaced and extend from the left margin to the right edge of the page. There is no handwriting or other markings on the paper.

Question 19 (2 marks)

Given $\sin \theta = \frac{5}{6}$ and $90^\circ \leq \theta \leq 180^\circ$, find the exact value of $\cos \theta$.

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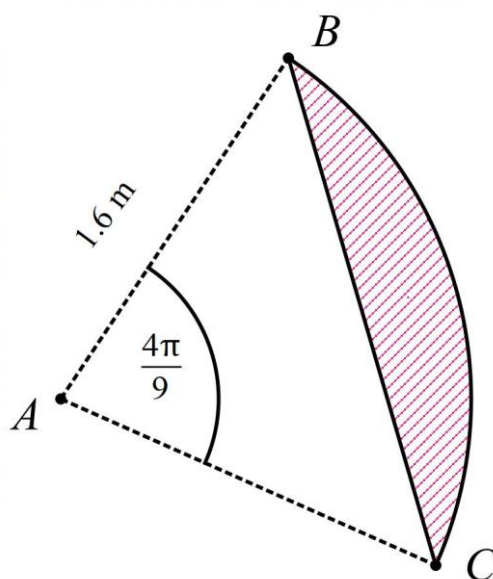
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Question 20 (2 marks)

The shaded segment shown is formed by an arc BC of a circle with radius 1.6 metres and the chord BC which subtends an angle of $\frac{4\pi}{9}$ radians at its centre A . Find the area of the shaded segment, correct to 3 significant figures.

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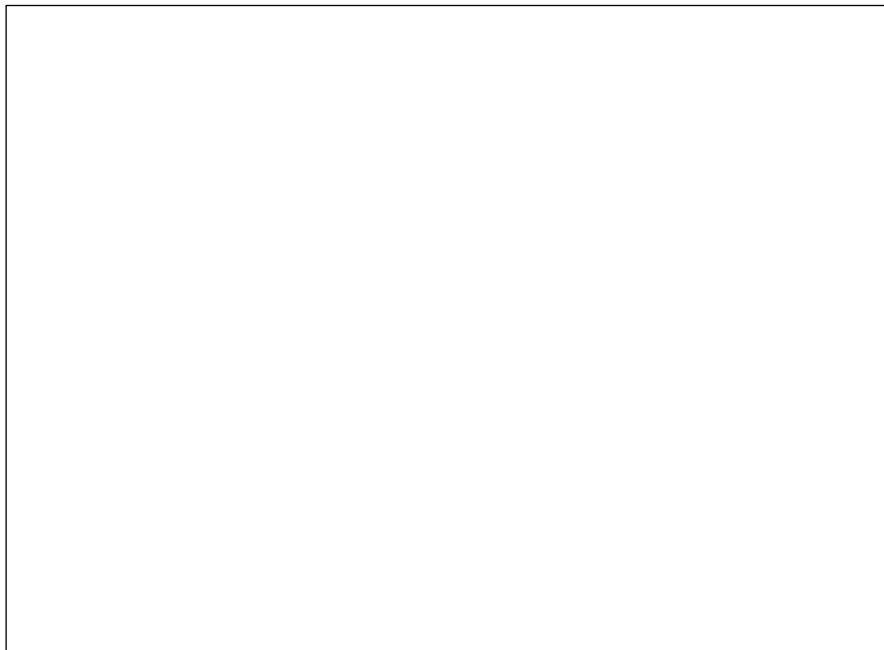
Student Number: _____

Question 21 (4 marks)

- (a) Sketch the graph of the function $f(x) = x^2 - 5x + 6$ showing all intercepts and important features. **2**



- (b) Sketch the graph of the function $f(x) = 1 + 3^x$ showing all important features. **2**



Question 22 (4 marks)

The table shows the value of tips Isabella receives when she works in a restaurant on a Friday night. The probabilities of each value being received are based on experience.

Tips (to the nearest Dollar)	\$5	\$12	\$23	\$35	\$38	\$40
Probability	0.15	0.26	0.3	0.16	0.1	0.03

- (a) Explain why the above table is a probability distribution. **2**

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- (b) Calculate the expected value of Isabella's tips for the next Friday she works. **1**

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- (c) What is the percentage probability that Isabella will receive at least \$35 worth of tips? **1**

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Question 23 (2 marks)

Sketch the graph of $y = (x - 4)^2(x + 1)$.

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Question 24 (4 marks)

- a) Find the centre and the radius of the circle represented by the equation $x^2 - 6x + y^2 + 2y + 1 = 0$. **2**

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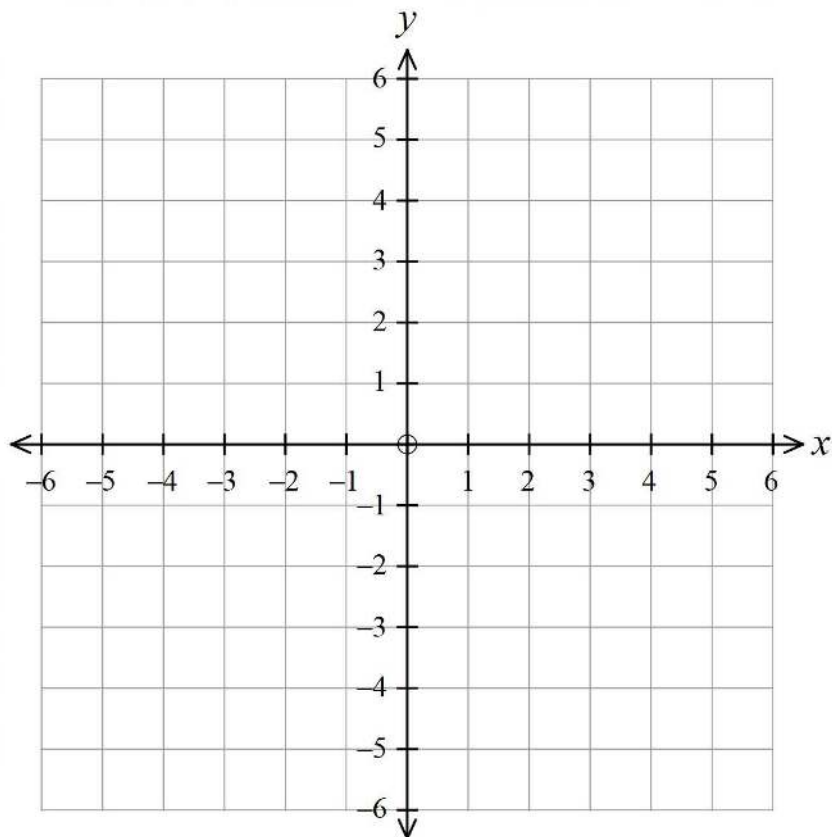
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- (b) Draw the circle on the number plane below. You do **not** need to find any x -intercepts. **2**



Question 25 (5 marks)

- (a) Find the equation of the tangent to the curve $y = 3x^3 - 10x^2 + 1$ at the point where $x = 2$. **3**

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- (b) Find the angle of inclination between the tangent and the positive x -axis to the nearest degree. **2**

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Student Number: _____

Question 26 (2 marks)

At a Performing Arts College 70% of students study Drama, 55% of students study Music and 35% of students study both Drama and Music.

- (a) What is the probability that a randomly selected student studies Music or Drama or both? **1**

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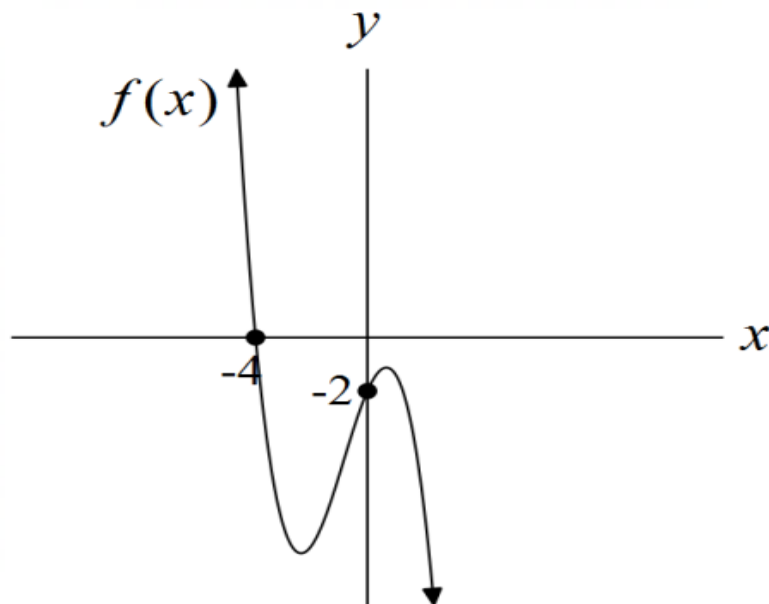
- (b) Given that a student studies Drama what is the probability that this student also studies Music? **1**

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Question 27 (2 marks)

The diagram shows the curve $y = f(x)$.

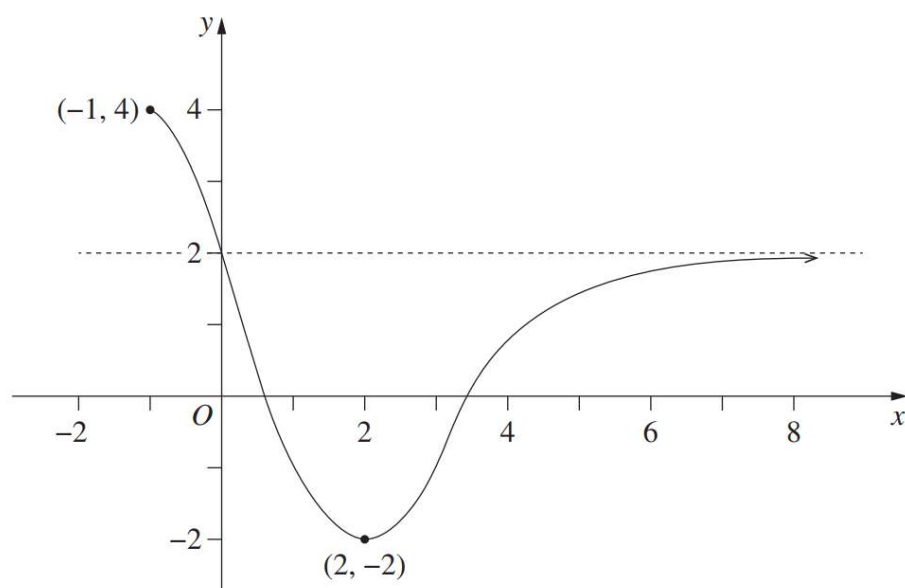
Sketch $y = f(-x)$ on the same set of axes, showing any x - and y -intercepts. **2**



Question 28 (2 marks)

The graph of a function $y = f(x)$ is shown. It has an asymptote at $y = 2$.

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Using interval notation, state the domain and range of $y = f(x)$.

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Question 29 (8 marks)

Differentiate the following with respect to x .

(a) $y = 2x(x + 7)$ **1**

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(b) $y = 3(x^2 - 1)^3$ **2**

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(c) $y = 2x\sqrt{x}$ **2**

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(d) $y = \frac{2x^3}{x^2 - 5}$ **3**

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Question 30 (2 marks)

A piecewise function $f(x)$ is defined as follows.

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$$f(x) = \begin{cases} -x + a, & x < 1 \\ x^2 - ax + 2, & x \geq 1 \end{cases}$$

What value of a makes this function continuous?

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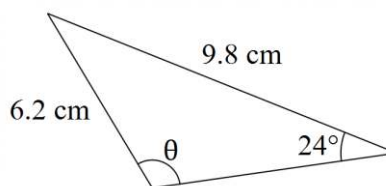
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Question 31 (3 marks)

The diagram shows an obtuse triangle with side lengths 6.2 cm and 9.8 cm, and angles 24° and θ , where θ is the largest angle.

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Find the value of θ to the nearest degree.

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Student Number: _____

Question 32 (3 marks)

The function $f(x) = 2x(x-4)^3$ has two horizontal tangents. Given that one horizontal tangent touches the curve at $(4, 0)$, find the coordinates of the other point on the curve at which the tangent is horizontal.

3

This image shows a full page of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for handwriting practice or general writing. There are no margins, text, or other markings on the page.

Question 33 (3 marks)

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Solve $2\cos^2 x - \cos x = 0$ for $0 \leq x \leq 2\pi$.

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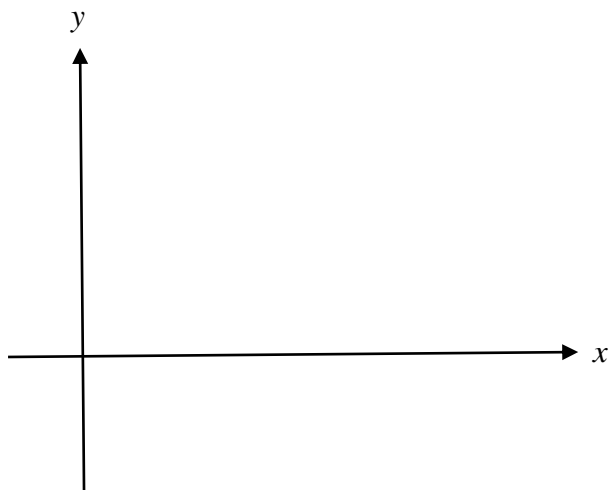
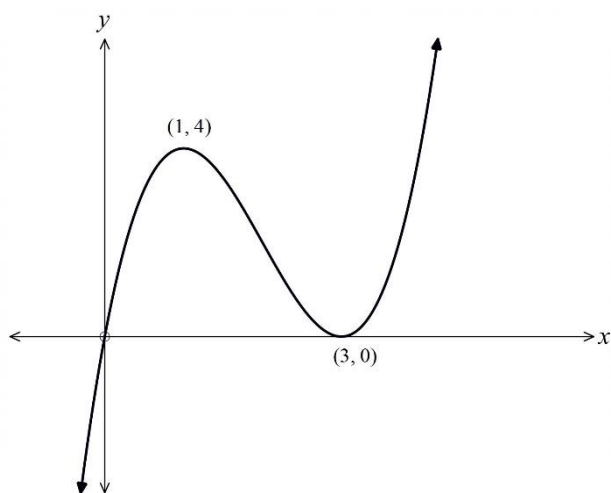
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Question 34 (2 marks)

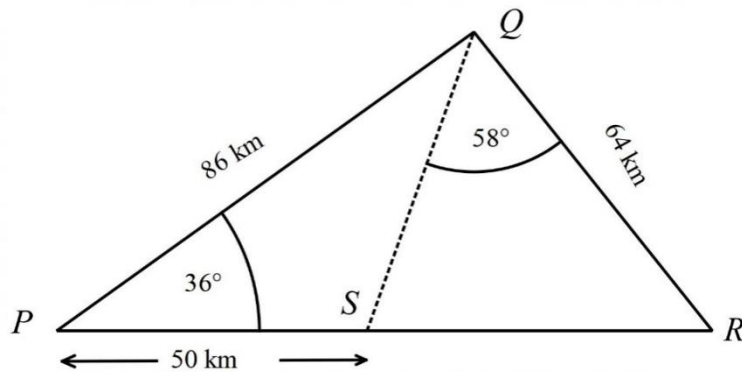
2

The diagram shows the graph of the curve $y = f(x)$. Sketch the graph of the gradient function on the number plane below.



Question 35 (4 marks)

Triangles PQS and QRS have a common side QS , as shown.



- (a) Show that the length $QS = 54.2$ km correct to 3 significant figures.

2

[illegible]

- (b) Hence or otherwise find the area of $\triangle PQR$ correct to the nearest square kilometre.

2

[illegible]

Question 36 (2 marks)

Use the formula $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ to find $f'(x)$ given $f(x) = x^2 - 2x$.

2

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Question 37 (4 marks)

The decibel, dB, is a logarithmic unit used to measure sound level. The formula to find the decibel level of a sound is $\text{dB} = 10 \log_{10} \left(\frac{I}{I_o} \right)$ where I is the intensity of the sound, and I_o is the intensity of the threshold of sound (sound which can barely be perceived).

- (a) According to Safe Work Australia, workers should wear ear protection if they are exposed to sound levels of 85 dB or more for an extended period of time. A machine produces sound at an intensity of $(1.8 \times 10^{10})I_o$. **2**

Should workers who spend time near this machine wear ear protection?
Justify your answer with calculations.

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- (b) If a cat's purr is about 25 dB, approximately how many times as intense is a cat's purr relative to the threshold of sound? **2**

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Questions 11 – 37 are worth 75 marks in total
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Student Number: _____

Question 38 (7 marks)

A particle is moving along the x -axis. Its displacement x centimetres at time t seconds is given by $x = 2t^3 - 5t^2 - 2t + 1$ for $t \geq 0$.

- (a) What is the initial displacement of the particle? 1

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- (b) What is the particle’s initial velocity? 2

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- (c) How many times after $t = 0$ is the particle stationary? Justify your answer with calculations. 2

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- (d) Calculate the average velocity of the particle during the first two seconds. 2

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4

Diagram illustrating a triangular plot ABC with a point D on side AC . A line segment BD is drawn. The length of BD is 48 m , the length of BC is 50 m , and the angle BDC is 28° . The length of AC is 120 m .

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Question 40 (4 marks)

Solve the trigonometric equation $2 \sin^2 2x - \sin 2x = 1$ for $0 \leq x \leq 2\pi$.

4

[illegible]

End of paper

STUDENT NUMBER: _____



YEAR 11 MATHEMATICS ADVANCED
2020 YEAR 11 ASSESSMENT TASK 3

Answer Sheet for Section I

- | | | | | |
|----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1 | A ☐ | B ☐ | C ☐ | D ☐ |
| 2 | A ☐ | B ☐ | C ☐ | D ☐ |
| 3 | A ☐ | B ☐ | C ☐ | D ☐ |
| 4 | A ☐ | B ☐ | C ☐ | D ☐ |
| 5 | A ☐ | B ☐ | C ☐ | D ☐ |
| 6 | A ☐ | B ☐ | C ☐ | D ☐ |
| 7 | A ☐ | B ☐ | C ☐ | D ☐ |
| 8 | A ☐ | B ☐ | C ☐ | D ☐ |
| 9 | A ☐ | B ☐ | C ☐ | D ☐ |
| 10 | A ☐ | B ☐ | C ☐ | D ☐ |

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

[illegible]

Section II extra writing space

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Mathematics Advanced

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Name: Solutions

Student Number: _____

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- MA11-9 provides reasoning to support conclusions which are appropriate to the context

Section I

10 marks

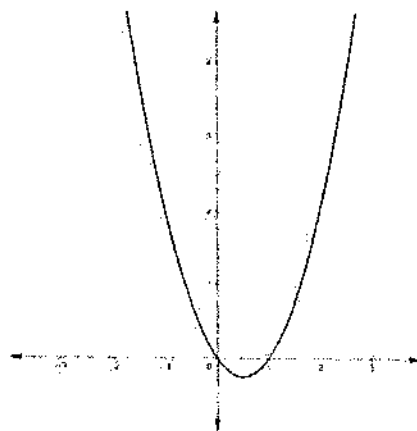
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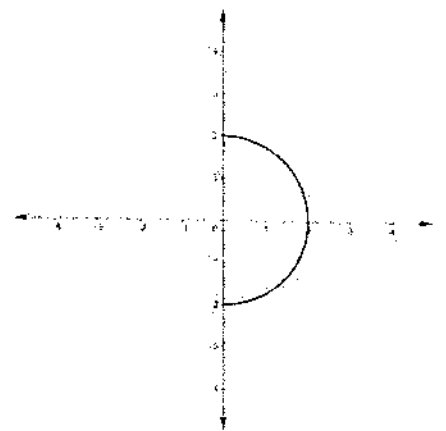
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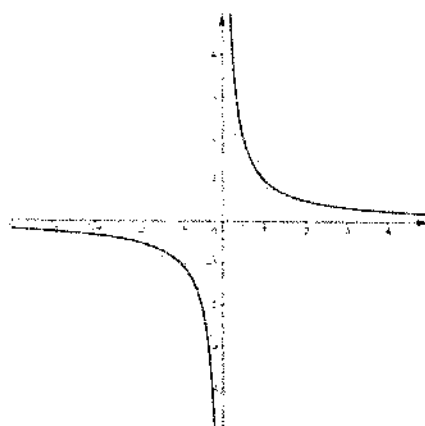
A.



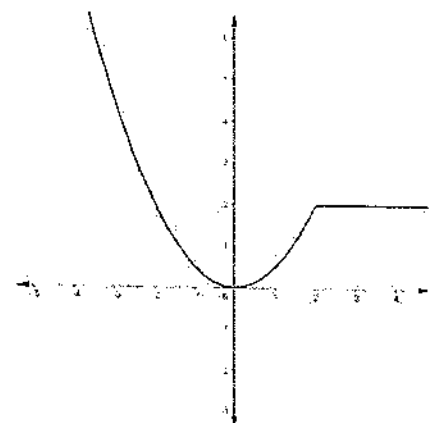
B.



C.



D.



- 2 If $f(x) = x^2 - 2x$, what is the value of $f(-3)$?

- A. -15
B. -3
C. 0
☒ D. 15

$$\begin{aligned} f(-3) &= (-3)^2 - 2(-3) \\ &= 9 + 6 \\ &= 15 \end{aligned}$$

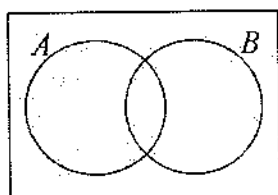
- 3 How many x -intercepts does the graph of $f(x) = (x-2)(x^2 + 4x + 3)$ have?

- A. 0
B. 1
C. 2
☒ D. 3

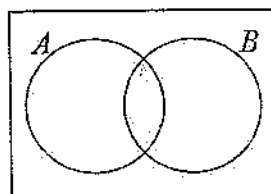
$$= (x-2)(x-3)(x+1)$$

- 4 In which of the Venn diagrams is $A \cap B'$ shaded?

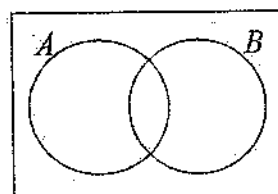
☒ A.



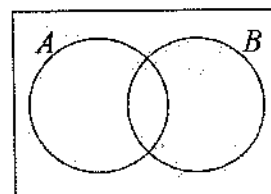
B.



C.



D.



- 5 Which of the following lines is parallel to the line $6x - 2y - 3 = 0$?

A. $6x - y - 5 = 0$

☒ B. $y = 3x - 5$

C. $y = \frac{1}{3}x - 8$

D. $y = -3x + 5$

$$6x - 3 = 2y$$

$$3x - \frac{3}{2} = y$$

$$\therefore m = 3$$

6 What are the solutions to $|2x+3|=1$?

☒ A. $x=-2$ or $x=-1$

B. $x=-2$ or $x=1$

C. $x=1$ or $x=2$

D. $x=2$ or $x=-1$

$$2x+3=1 \quad \text{or} \quad -(2x+3)=1$$

$$2x=-2$$

$$x=-1$$

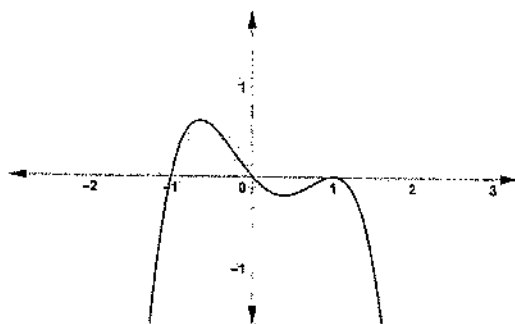
$$2x+3=-1$$

$$2x=-4$$

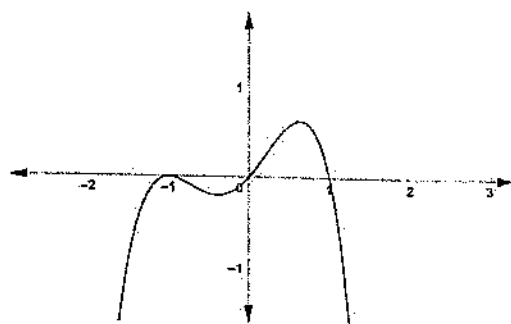
$$x=-2$$

7 Which of the following graphs shows the function $y=-x(x-1)^2(x+1)$?

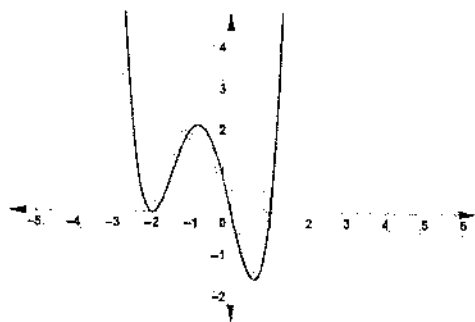
☒ A.



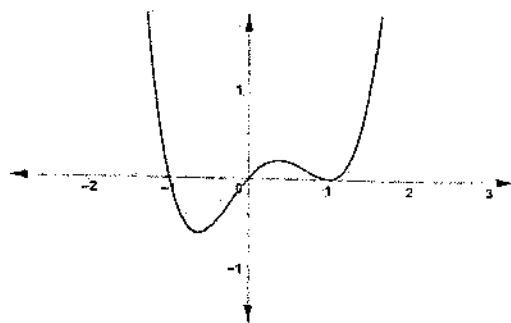
B.



C.



D.



8 Which of the following is always true for $0^\circ < \theta < 90^\circ$?

A. $\sin(90-\theta) = \sin \theta$

☒ B. $\sin(180-\theta) = \sin \theta$

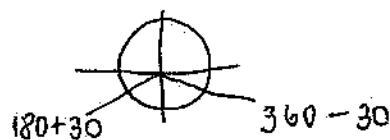
C. $\sin(180+\theta) = \sin \theta$

D. $\sin(360-\theta) = \sin \theta$

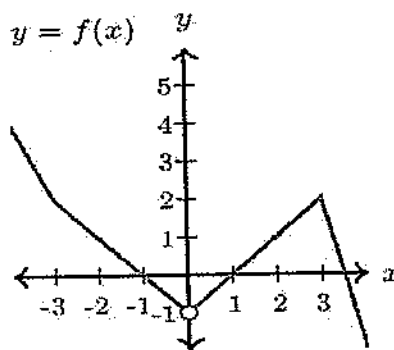
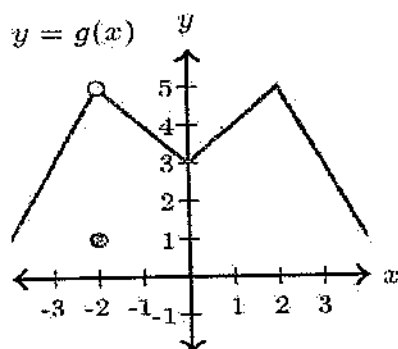
- 9 What are the solutions to $\sin x = -\frac{1}{2}$ for $0 \leq x \leq 360^\circ$?

- A. $x = 30^\circ$
 B. $x = 30^\circ$ and $x = 150^\circ$
 C. $x = 150^\circ$ and $x = 210^\circ$
 D. $x = 210^\circ$ and $x = 330^\circ$

$$\sin^{-1}\left(\frac{1}{2}\right) = 30^\circ$$



- 10 The functions $f(x)$ and $g(x)$ are graphed below.
 What is the value of $g(f(x))$ when $x = -2$?



- A. 0
 B. 1
 C. 4
 D. The value does not exist.

$$f(-2) = 1$$

$$g(1) = 4$$

STUDENT NUMBER:

Solutions



YEAR 11 MATHEMATICS ADVANCED
2020 YEAR 11 ASSESSMENT TASK 3

Answer Sheet for Section I

- | | | | | |
|----|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 1 | A ☐ | B ☐ | C ☒ | D ☐ |
| 2 | A ☐ | B ☐ | C ☐ | D ☒ |
| 3 | A ☐ | B ☐ | C ☐ | D ☒ |
| 4 | A ☒ | B ☐ | C ☐ | D ☐ |
| 5 | A ☐ | B ☒ | C ☐ | D ☐ |
| 6 | A ☒ | B ☐ | C ☐ | D ☐ |
| 7 | A ☒ | B ☐ | C ☐ | D ☐ |
| 8 | A ☐ | B ☒ | C ☐ | D ☐ |
| 9 | A ☐ | B ☐ | C ☐ | D ☒ |
| 10 | A ☐ | B ☐ | C ☒ | D ☐ |

Student Number: Solutions

2020 YEAR 11 ASSESSMENT TASK 3

Mathematics Advanced

Section II Answer Booklet

90 marks

Attempt Questions 11 - 40

Allow about 2 hours and 45 minutes for this section

Instructions

- Answer the questions in the spaces provided. Sufficient spaces are provided for typical responses.
 - Your responses should include relevant mathematical reasoning and/or calculations.
 - Extra writing paper is provided at the back of each booklet. If you use this space, clearly indicate which question you are answering.
-

Question 11 (2 marks)

Simplify $\frac{2x^2 - 5x - 12}{x - 4}$.

2

$$= \frac{(2x + 3)(x - 4)}{x - 4} \quad | \quad \textcircled{2} \text{ correct solution}$$

$$= 2x + 3 \quad | \quad \textcircled{1} \text{ substantially correct solution}$$

Question 12 (3 marks)

Write $\frac{20}{x^2 + 5x} - \frac{4}{x}$ as a single fraction in simplest form.

3

$$= \frac{20}{x(x+5)} - \frac{4}{x} \quad \textcircled{3} \text{ correct solution fully simplified}$$

$$= \frac{20 - 4(x+5)}{x(x+5)} \quad | \quad \textcircled{2} \text{ substantially correct solution - correct expansion and collection of like terms}$$

$$= \frac{20 - 4x - 20}{x(x+5)} \quad \textcircled{1} \text{ correctly expressing fraction with a common denominator}$$

$$= \frac{-4x}{x(x+5)} \quad |$$

$$= \frac{-4}{x+5} \quad |$$

Question 13 (1 mark)

Evaluate $\log_a a^2$.

1

$$= 2$$

Question 14 (2 marks)

Solve $\log_2(x+2) = 3$.

2

$$\begin{aligned} \log_2(x+2) &= 3 \\ 2^3 &= x+2 & 1 \\ 8 &= x+2 \\ \therefore x &= 6 & 1 \end{aligned}$$

(2) correct solution

(1) Rewriting equation without log.

Question 15 (1 mark)

Convert 225° to radians in exact form.

1

$$\begin{aligned} 225 \times \frac{\pi}{180} \\ = \frac{5\pi}{4} \end{aligned}$$

(1) correct answer

Question 16 (2 marks)

State the natural domain of $f(x) = \frac{5}{\sqrt{5-x}}$ using interval notation.

2

$$\begin{aligned} 5-x &> 0 \\ 5 &> x & \therefore x < 5 \end{aligned}$$

(2) correct domain

(1) Realising $x \neq 5$
or $x < 5$

$$D: x \in (-\infty, 5)$$

Question 17 (2 marks)

Determine whether the function $f(x) = x^3 + 2x$ is odd, even or neither and justify your answer.

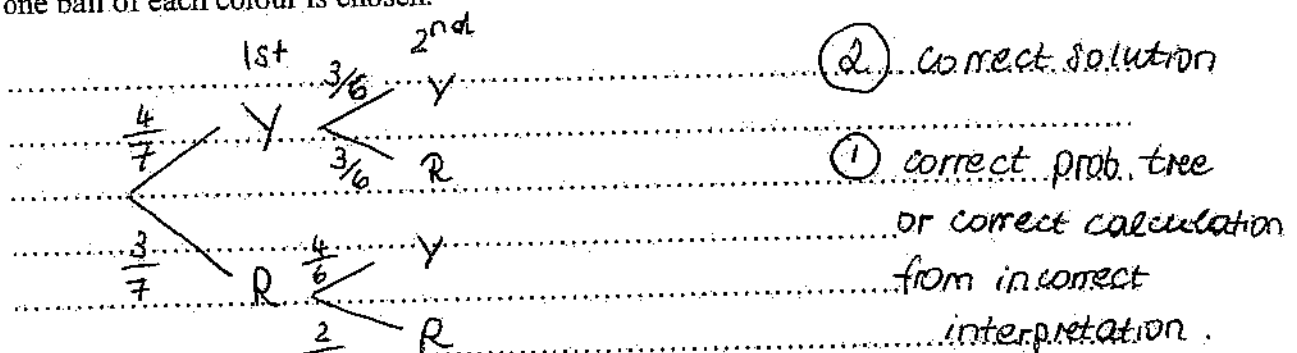
2

$$\begin{aligned}
 f(-x) &= (-x)^3 + 2(-x) & \textcircled{2} \text{ correct solution} \\
 &= -x^3 - 2x & \text{with conclusion} \\
 &= -(x^3 + 2x) & \textcircled{1} \text{ substantially} \\
 &= -f(x) & \text{correct solution} \\
 & & \text{or} \\
 \therefore f(x) \text{ is an odd function} & & \text{correctly finding} \\
 & & f(-x) \text{ simplified}
 \end{aligned}$$

Question 18 (2 marks)

A bag contains 4 yellow and 3 red balls. Two balls are chosen at random and the first ball is not replaced before the second ball is chosen. Find the probability that one ball of each colour is chosen.

2



$$\begin{aligned}
 P(RY) + P(YR) &= \frac{3}{7} \times \frac{4}{6} + \frac{4}{7} \times \frac{3}{6} \\
 &= \frac{24}{42} \\
 &= \frac{4}{7}
 \end{aligned}$$

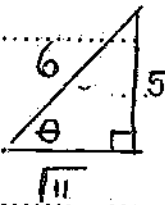
② correct solution

① correct ratio for acute angle θ .

Question 19 (2 marks)

Given $\sin \theta = \frac{5}{6}$ and $90^\circ \leq \theta \leq 180^\circ$, find the exact value of $\cos \theta$.

2



$$6^2 = 5^2 + x^2$$

$$x^2 = 11$$

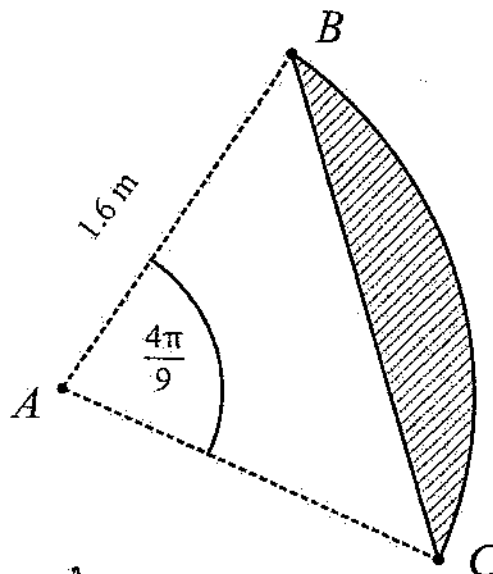
$$x = \sqrt{11}, x > 0$$

Since θ is obtuse $\cos \theta = -\frac{\sqrt{11}}{6}$

Question 20 (2 marks)

The shaded segment shown is formed by an arc BC of a circle with radius 1.6 metres and the chord BC which subtends an angle of $\frac{4\pi}{9}$ radians at its centre A . Find the area of the shaded segment, correct to 3 significant figures.

2



$$A = \frac{1}{2} r^2 \theta - \frac{1}{2} r^2 \sin \theta$$

$$= \frac{1}{2} r^2 (\theta - \sin \theta)$$

$$= \frac{1}{2} (1.6)^2 \left(\frac{4\pi}{9} - \sin \frac{4\pi}{9} \right)$$

$$= 0.52666 \dots$$

$$= 0.527 \text{ m}^2 \text{ (3 sig. fig.)}$$

② correct solution
correctly rounded

① substantially
correct solution

Questions 11 – 20 are worth 19 marks in total

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

(This area contains faint horizontal lines for writing.)

F 10
C 5
P 4
J 4

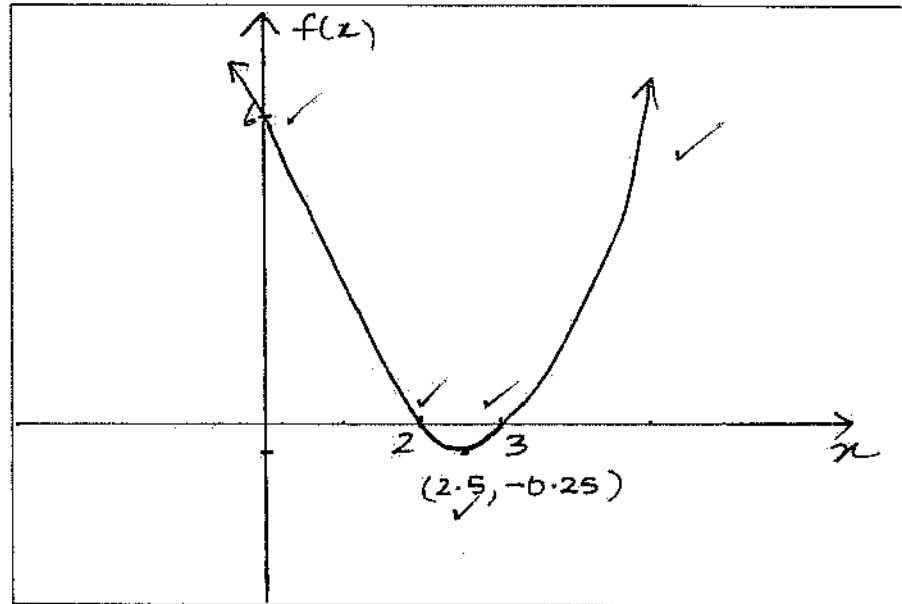
Student Number: _____

Question 21 (4 marks)

- (a) Sketch the graph of the function $f(x) = x^2 - 5x + 6$ showing all intercepts and important features.

2 F

$f(x) = x^2 - 5x + 6$
 $= (x-2)(x-3)$
 $\therefore x$ -intercepts $x=3, 2$
 y -intercept $y=6$
 $\text{vertex } x = -\frac{(-5)}{2}$
 $= 2.5$
 $y = -0.25$
 $\therefore (2.5, -0.25)$



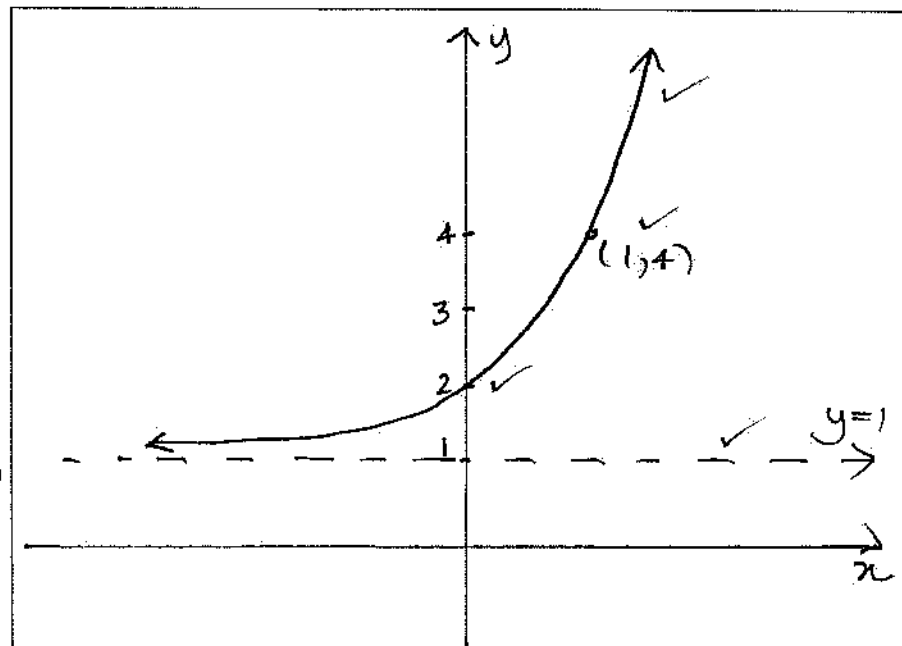
correct graph including x, y intercepts, vertex and shape.

① substantially correct graph

- (b) Sketch the graph of the function $f(x) = 1 + 3^x$ showing all important features.

2 F

$f(x) = 1 + 3^x$
 $\therefore$ graph of $y = 3^x$
 translated up 1.



② correct graph with asymptote, y intercept, point on curve, shape.

① attempt to translate $y = 3^x$ up 1.

Question 22 (4 marks)

The table shows the value of tips Isabella receives when she works in a restaurant on a Friday night. The probabilities of each value being received are based on experience.

Tips (to the nearest Dollar)	\$5	\$12	\$23	\$35	\$38	\$40
Probability	0.15	0.26	0.3	0.16	0.1	0.03

- (a) Explain why the above table is a probability distribution.

② J.

② correct statement

① correct statement

$$\begin{aligned} & \bullet 0 \leq P(X=x) \leq 1 \\ & \bullet \sum p x_i = 0.15 + 0.26 + 0.3 + 0.16 + 0.1 + 0.03 \\ & \quad = 1 \end{aligned}$$

The probabilities are all from 0 to 1, and the sum of the probabilities is one.

- (b) Calculate the expected value of Isabella's tips for the next Friday she works.

1

$$\begin{aligned} E(X) &= 5 \times 0.15 + 12 \times 0.26 + 23 \times 0.3 + 35 \times 0.16 \\ &\quad + 38 \times 0.1 + 40 \times 0.03 \\ &= \$21.37 \end{aligned}$$

- (c) What is the percentage probability that Isabella will receive at least \$35 worth of tips?

1

$$\begin{aligned} P(\text{at least } 35) &= P(X=35) + P(X=38) + P(X=40) \\ &= 0.16 + 0.1 + 0.03 \\ &= 0.29 \\ &= 29\% \end{aligned}$$

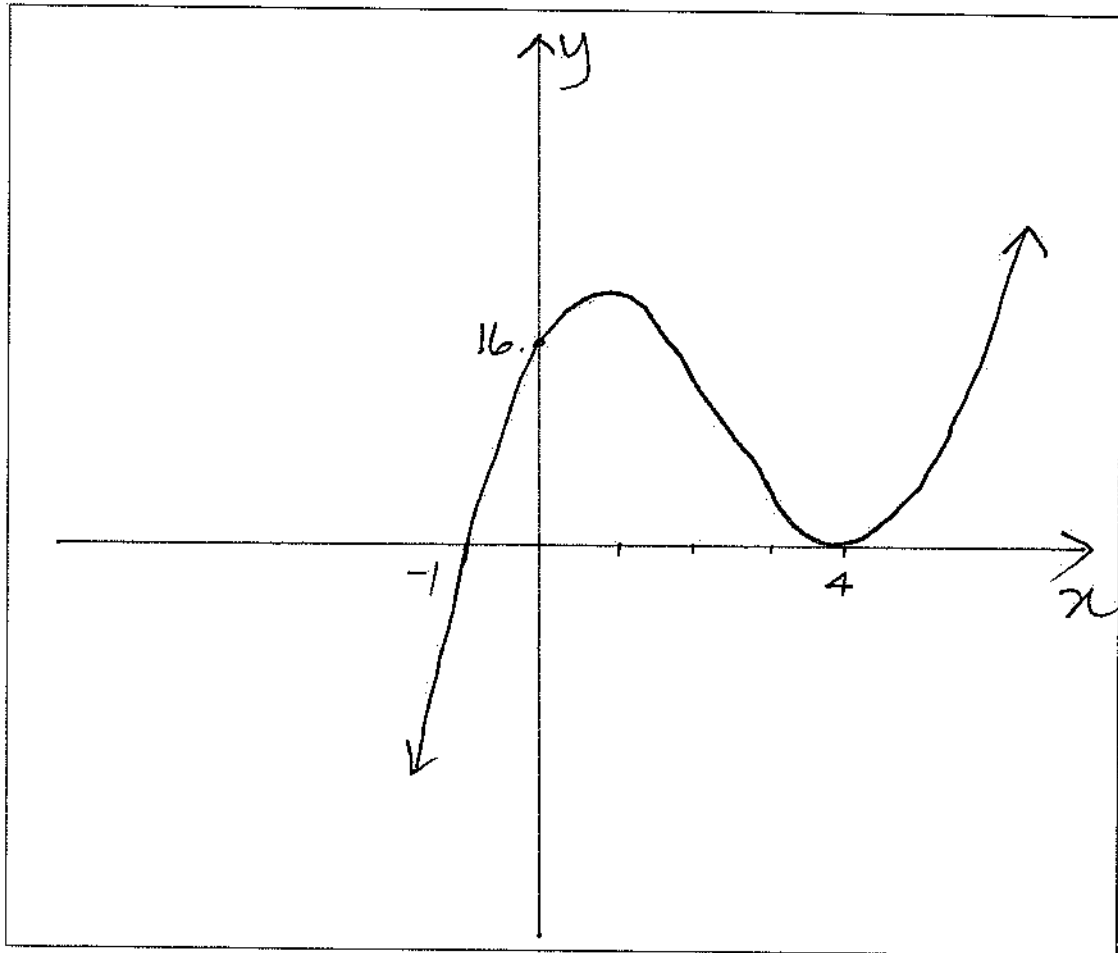
Question 23 (2 marks)

Sketch the graph of $y = (x-4)^2(x+1)$.

double root at $x=4$

single root at $x=-1$

2



$$\text{when } x=0, \quad y = (-4)^2(1) \\ = 16.$$

Question 24 (4 marks)

- a) Find the centre and the radius of the circle represented by the equation.

2

$$x^2 - 6x + y^2 + 2y + 1 = 0$$

$$(x^2 - 6x) + (y^2 + 2y) = -1$$

$$(x^2 - 6x + 9) + (y^2 + 2y + 1) = -1 + 9 + 1$$

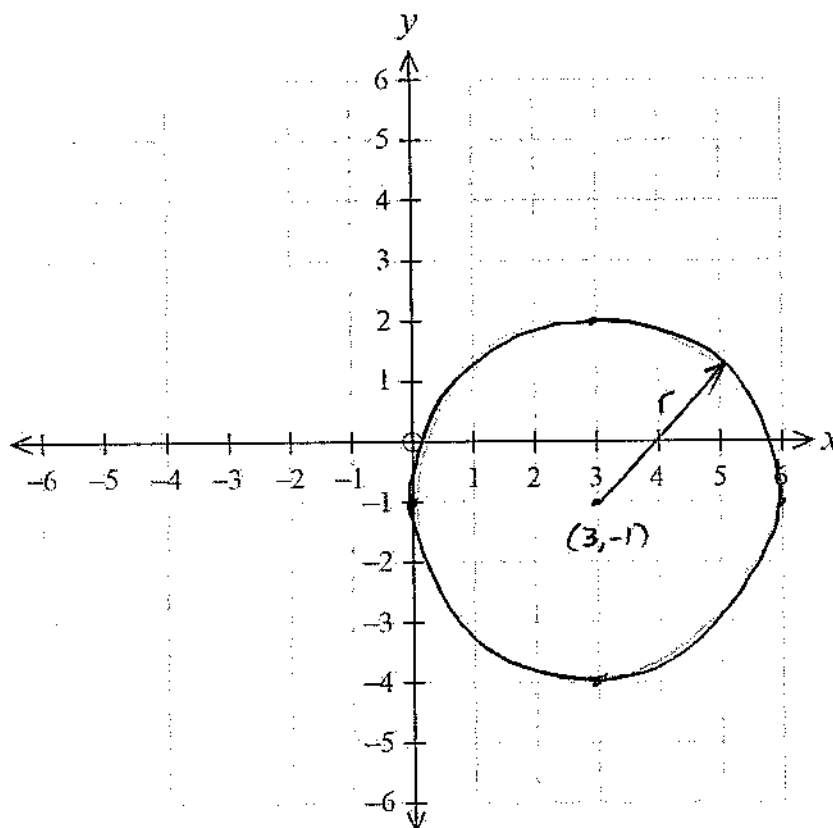
$$(x - 3)^2 + (y + 1)^2 = 9$$

Centre (3, -1)

Radius 3

- (b) Draw the circle on the number plane below. You do **not** need to find any x-intercepts.

2



Question 25 (5 marks).

- (a) Find the equation of the tangent to the curve $y = 3x^3 - 10x^2 + 1$ at the point where $x = 2$.

3

③ correct solution

$$y = 3x^3 - 10x^2 + 1$$

$$\frac{dy}{dx} = 9x^2 - 20x$$

② correct derivative and y. value or equivalent.

When $x = 2$, $y = 3(2)^3 - 10(2)^2 + 1$
 $= -15$

$$m_t = 9(2)^2 - 20(2)$$

$$= -4$$

∴ Gradient tangent at (2, -15) is -4.

Equation of tangent.

① correct derivative or y. value.

$$y - y_1 = m(x - x_1)$$

$$y + 15 = -4(x - 2)$$

$$y + 15 = -4x + 8$$

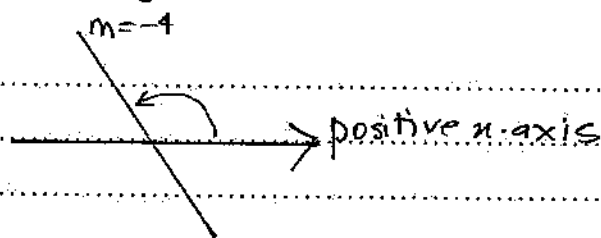
④ Use of words to aid in setting/ understanding

$$y = -4x - 7 \quad \text{or} \quad 4x + y + 7 = 0.$$

- (b) Find the angle of inclination between the tangent and the positive x-axis to the nearest degree.

2

② correct angle.



$$\tan \theta = m$$

$$\tan \theta = -4$$

$$\theta = 180 - \tan^{-1}(4)$$

$$= 104.0362$$

$$\theta = 104^\circ (\text{nearest } ^\circ)$$

① finding acute angle or equivalent

∴ The angle of inclination is 104° .

Justification 1 obtuse angle.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

1. *Introduction*
 2. *Background*
 3. *Methodology*
 4. *Results*
 5. *Discussion*
 6. *Conclusion*
 7. *References*
 8. *Appendix*
 9. *Figure 1*
 10. *Figure 2*
 11. *Figure 3*
 12. *Figure 4*
 13. *Figure 5*
 14. *Figure 6*
 15. *Figure 7*
 16. *Figure 8*
 17. *Figure 9*
 18. *Figure 10*
 19. *Figure 11*
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 215. *Figure 207*
 216. *Figure 208*
 217. *Figure 209*

Student Number: Solutions

Question 26 (2 marks)

At a Performing Arts College 70% of students study Drama, 55% of students study Music and 35% of students study both Drama and Music.

- (a) What is the probability that a randomly selected student studies Music or Drama or both?

1

$$\begin{aligned} P(M \cup D) &= P(M) + P(D) - P(M \cap D) \\ &= 70\% + 55\% - 35\% \\ &= 90\% \end{aligned}$$

① correct solution

- (b) Given that a student studies Drama what is the probability that this student also studies Music?

1

$$\begin{aligned} P(M|D) &= \frac{P(M \cap D)}{P(D)} \\ &= \frac{0.35}{0.7} \\ &= 0.5 \end{aligned}$$

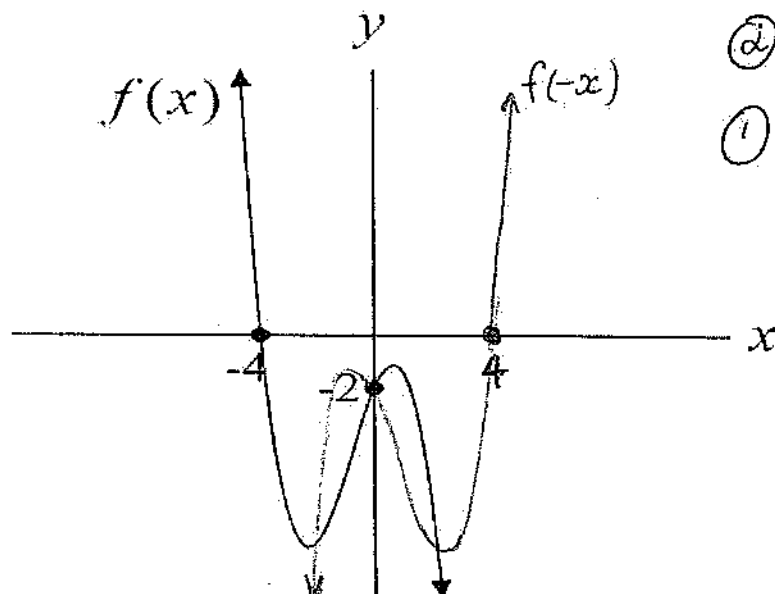
① correct sol.

Question 27 (2 marks)

The diagram shows the curve $y = f(x)$.

Sketch $y = f(-x)$ on the same set of axes, showing any x - and y -intercepts.

2



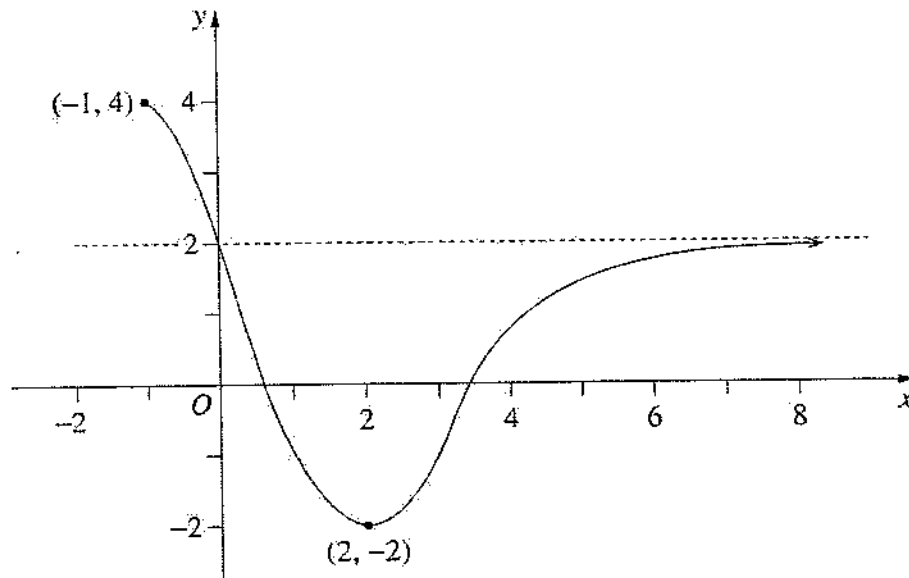
② correct graph

① subst. correct graph

Question 28 (2 marks)

The graph of a function $y = f(x)$ is shown. It has an asymptote at $y = 2$.

2



Using interval notation, state the domain and range of $y = f(x)$.

Domain $x \in [-1, \infty)$

Range $y \in [-2, 4]$

② correct domain and range

① either domain or range correct

Question 29 (8 marks)

Differentiate the following with respect to x

(a) $y = 2x(x+7)$

1

$= 2x^2 + 14x$ ① correct derivative

$y' = 4x + 14$

(b) $y = 3(x^2-1)^3$

2

$y' = 9(x^2-1)^2 \times 2x$ ② correct derivative (simplified)

$= 18x(x^2-1)^2$

① substantially correct derivative)

(c) $y = 2x\sqrt{x}$

2

$= 2x^{3/2}$

② correct derivative
① correctly using index

$y' = 2 \times \frac{3}{2} x^{1/2}$

$= 3\sqrt{x}$ or $3x^{1/2}$

(d) $y = \frac{2x^3}{x^2-5}$

3

$u = 2x^3$ ~~$v = x^2-5$~~

$u' = 6x^2$ ~~$v' = 2x$~~

$y' = \frac{vu' - uv'}{v^2}$

$= \frac{6x^2(x^2-5) - 4x^4}{(x^2-5)^2}$ ③ correct derivative

$= \frac{6x^4 - 30x^2 - 4x^4}{(x^2-5)^2}$ ② correct subst. into form

$= \frac{2x^4 - 30x^2}{(x^2-5)^2}$ ① correct differentiation of num. and denom.

Question 30 (2 marks)

A piecewise function $f(x)$ is defined as follows.

2

$$f(x) = \begin{cases} -x + a, & x < 1 \\ x^2 - ax + 2, & x \geq 1 \end{cases}$$

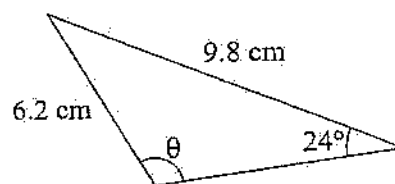
What value of a makes this function continuous?

$$\begin{aligned} -x + a &= x^2 - ax + 2 \text{ when } x = 1 \\ -1 + a &= 1^2 - a + 2 \\ -1 + a &= 3 - a & \textcircled{2} \\ 2a &= 4 \\ a &= 2 & \textcircled{1} \end{aligned}$$

Question 31 (3 marks)

The diagram shows an obtuse triangle with side lengths 6.2 cm and 9.8 cm, and angles 24° and θ , where θ is the largest angle.

3



Find the value of θ to the nearest degree.

$$\begin{aligned} \frac{\sin \theta}{9.8} &= \frac{\sin 24^\circ}{6.2} & \text{But } \theta \text{ needs to be obtuse, so} \\ \sin \theta &= \frac{9.8 \sin 24^\circ}{6.2} & \theta = 180 - 40.0088 \dots \\ & & = 140^\circ \text{ (nearest deg.)} \\ \theta &= \sin^{-1} \left(\frac{9.8 \sin 24^\circ}{6.2} \right) & \textcircled{3} \text{ correct solution} \\ & & \textcircled{2} \text{ correct acute angle} \\ &= 40.0088 \dots^\circ & \textcircled{1} \text{ correct substitution into sine rule} \end{aligned}$$

Questions 11 – 31 are worth 57 marks in total

Question 32 (3 marks)

The function $f(x) = 2x(x-4)^3$ has two horizontal tangents. Given that one horizontal tangent touches the curve at $(4, 0)$, find the coordinates of the other point on the curve at which the tangent is horizontal.

3

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

$$u = 2x \quad v = (x-4)^3$$

$$u' = 2 \quad v' = 3(x-4)^2$$

$$f'(x) = vu' + uv'$$

$$= 2(x-4)^3 + 6x(x-4)^2$$

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

$$= 2(x-4)^2(4x-4)$$

$$= 8(x-4)^2(x-1)$$

$$f'(x) = 0 \text{ at } x=4, x=1$$

$$\text{When } x=1 \quad f(x) = 2(1)(1-4)^3$$

$$= -54$$

∴ Horizontal tangents at $(4, 0)$ and $(1, -54)$

③ correct solution

② correct solving of $f'(x) = 0$

① correct derivative

Question 33 (3 marks)

3

Solve $2\cos^2 x - \cos x = 0$ for $0 \leq x \leq 2\pi$.

$$\cos x (2\cos x - 1) = 0$$

$$\cos x = 0 \quad \text{or} \quad 2\cos x - 1 = 0$$

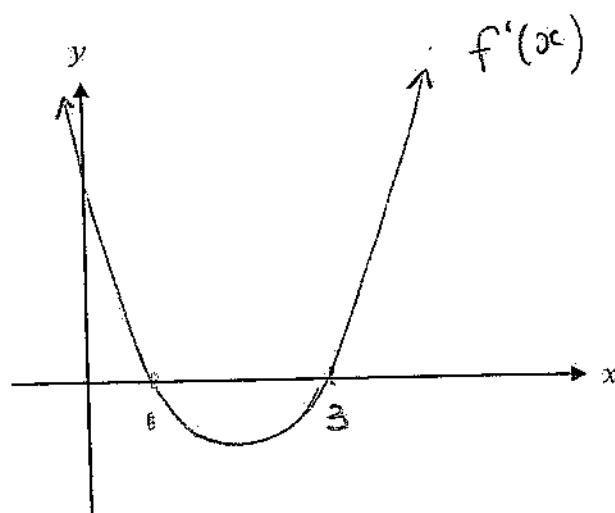
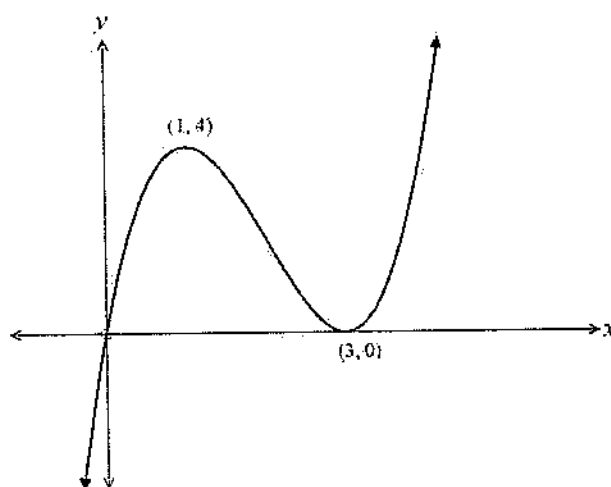
$$x = \frac{\pi}{2}, \frac{3\pi}{2} \quad \cos x = \frac{1}{2} \quad x = \frac{\pi}{3}, \frac{5\pi}{3}$$

$$\therefore x = \frac{\pi}{3}, \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{3}$$

③ correct solution
② correctly finding acute solutions
① correct factorisation

Question 34 (2 marks)

The diagram shows the graph of the curve $y = f(x)$. Sketch the graph of the gradient function on the number plane below. 2

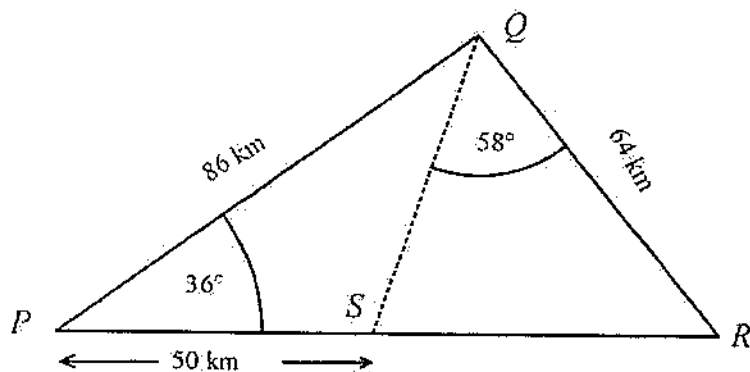


② correct shape and intercepts

① correct shape

Question 35 (4 marks)

Triangles PQS and QRS have a common side QS , as shown.



- (a) Show that the length $QS = 54.2$ km correct to 3 significant figures.

2

$$\begin{aligned} (QS)^2 &= 50^2 + 86^2 - 2(50)(86) \cos 36^\circ \\ &= 2938.4538 \\ QS &= 54.20750 \dots \quad QS > 0 \\ &= 54.2 \quad (3 \text{ s.f.}) \end{aligned}$$

② correct length (unrounded)

① correct substitution in formula

- (b) Hence or otherwise find the area of $\triangle PQR$ correct to the nearest square kilometre.

2

$$\begin{aligned} \text{Area } PQR &= \frac{1}{2} \times 86 \times 50 \sin 36^\circ + \frac{1}{2} \times 64 \times 54.2 \sin 58^\circ \\ &= 2734.592 \\ &= 2735 \text{ m}^2 \quad (\text{nearest m}^2) \end{aligned}$$

Also accept:

$$A = 2728 \text{ km}^2$$

or

$$A = 2752 \text{ km}^2$$

with correct working.

② correct area

① finding one area correctly

Question 36 (2 marks)

Use the formula $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ to find $f'(x)$ given $f(x) = x^2 - 2x$.

2

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$= \lim_{h \rightarrow 0} \frac{[(x+h)^2 - 2(x+h)] - (x^2 - 2x)}{h}$$

$$= \lim_{h \rightarrow 0} \frac{x^2 + 2xh + h^2 - 2x - 2h - x^2 + 2x}{h}$$

$$= \lim_{h \rightarrow 0} \frac{2xh + h^2 - 2h}{h}$$

$$= \lim_{h \rightarrow 0} \frac{h(2x + h - 2)}{h}$$

$$= \lim_{h \rightarrow 0} 2x + h - 2$$

$$= 2x - 2$$

(2) correct differentiation by first principles

(1) substantially correct solution

Question 37 (4 marks)

The decibel, dB, is a logarithmic unit used to measure sound level. The formula to find the decibel level of a sound is $\text{dB} = 10 \log_{10} \left(\frac{I}{I_0} \right)$ where I is the intensity of the sound, and I_0 is the intensity of the threshold of sound (sound which can barely be perceived).

- (a) According to Safe Work Australia, workers should wear ear protection if they are exposed to sound levels of 85 dB or more for an extended period of time. A machine produces sound at an intensity of $(1.8 \times 10^{10}) I_0$. Should workers who spend time near this machine wear ear protection? Justify your answer with calculations. 2

$$\begin{aligned} \text{dB} &= 10 \log_{10} \left(\frac{I}{I_0} \right) \\ &= 10 \log_{10} \left(\frac{1.8 \times 10^{10} I_0}{I_0} \right) \quad (2) \\ &= 10 \log_{10} (1.8 \times 10^{10}) \quad (1) \\ &= 102.5527 \dots \\ &\approx 103 \text{ dB} \end{aligned}$$

$\therefore$ Yes, they should wear protection.

- (b) If a cat's purr is about 25 dB, approximately how many times as intense is a cat's purr relative to the threshold of sound? 2

$$\begin{aligned} 25 &= 10 \log_{10} \left(\frac{I}{I_0} \right) \\ 2.5 &= \log_{10} \left(\frac{I}{I_0} \right) \\ 10^{2.5} &= \frac{I}{I_0} \\ \frac{I}{I_0} &= 316.2277 \dots \end{aligned}$$

$\therefore$ It is approximately 316 times the threshold of sound.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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Student Number: Solution

Question 38 (7 marks)

A particle is moving along the x -axis. Its displacement x centimetres at time t seconds is given by $x = 2t^3 - 5t^2 - 2t + 1$ for $t \geq 0$.

- (a) What is the initial displacement of the particle?

1

$t = 0$ $x = 1$ ✓
 $\therefore 1$ cm to the right of the origin

- (b) What is the particle's initial velocity?

2

$\dot{v} = 6t^2 - 10t - 2$ ✓ (2) correct solution
 when $t = 0$ (1) correct derivative
 $v = -2$ cm/s ✓
 $\therefore$ The particle is moving to the left at 2 cm/sec.
 or -2 cm/s

- (c) How many times after $t = 0$ is the particle stationary? Justify your answer with calculations.

2

Stationary when $v = 0$ (2) correct sol.
 $6t^2 - 10t - 2 = 0$ $t_1 = 1.847$ (1) only once
 $3t^2 - 5t - 1 = 0$ $t_2 = -0.180$
 $t = \frac{5 \pm \sqrt{(-5)^2 - 4(3)(-1)}}{2 \times 3}$
 $= \frac{5 \pm \sqrt{37}}{6}$ Since $t \geq 0$, the particle is stationary only once after $t = 0$

- (d) Calculate the average velocity of the particle during the first two seconds.

2

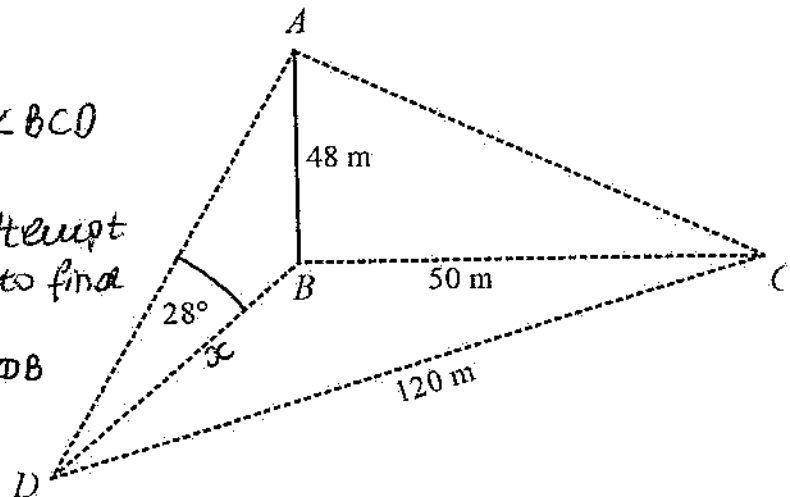
Average velocity = $\frac{x_2 - x_1}{t_2 - t_1}$ (2) correct sol.
 $x(2) = -7$
 $x(0) = 1$
 $= \frac{-7 - 1}{2 - 0}$ (1) correctly finding $x(2) = -7$
 $= -4$ cm/sec
 $= -8$ cm/sec
 $\therefore$ Average velocity 8 cm/sec to the left.

Question 39 (4 marks)

4

A 48-metre high, vertical pole AB stands in the middle of a flat sporting ground. Diana starts from the base of the pole and walks 50 m due east to a point C where she places a peg. She attaches a 120 m long string to the peg and walks in a roughly south-westerly direction until the string is taut, at point D . She then measures the angle of elevation of the pole to be 28° .

④ correct solution

③ correct angle $\angle BCD$ ② substantial attempt using cosine rule to find $\angle BCD$ ① finding length of DB 

Use the information provided to find the *actual* bearing on which she was walking from C to D , correct to the nearest degree.

$$\tan 28^\circ = \frac{48}{x}$$

$$x = \frac{48}{\tan 28^\circ}$$

$$= 90.2748 \dots$$

$$= 90.27 \text{ m (2 d.p.)}$$

$$\angle BCD : \cos(BCD) = \frac{50^2 + 120^2 - (90.27)^2}{2 \times 50 \times 120}$$

$$\angle BCD = 43.1741 \dots^\circ$$

$$\text{Bearing from } C \text{ to } D = 270^\circ - 43.1741 \dots^\circ$$

$$= 227^\circ \text{ T. (nearest degree)}$$

Question 40 (4 marks)

Solve the trigonometric equation $2 \sin^2 2x - \sin 2x = 1$ for $0 \leq x \leq 2\pi$.

4

$$2 \sin^2 2x - \sin 2x - 1 = 0$$

$$(2 \sin 2x + 1)(\sin 2x - 1) = 0$$

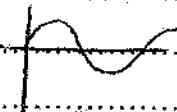
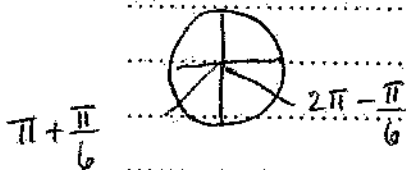
$$\sin 2x = -\frac{1}{2} \quad \text{or} \quad \sin 2x = 1$$

$$0 \leq x \leq 2\pi$$

$$0 \leq 2x \leq 4\pi$$

$$\sin^{-1}\left(-\frac{1}{2}\right) = \frac{7\pi}{6}$$

$$\sin^{-1}(1) = \frac{\pi}{2}$$



$$2x = \frac{7\pi}{6}, \frac{11\pi}{6}, \frac{19\pi}{6}, \frac{23\pi}{6} \quad \text{or} \quad 2x = \frac{\pi}{2}, \frac{5\pi}{2}$$

$$\therefore x = \frac{7\pi}{12}, \frac{11\pi}{12}, \frac{19\pi}{12}, \frac{23\pi}{12} \quad \text{or} \quad x = \frac{\pi}{4}, \frac{5\pi}{4}$$

(4) correct sol.

(3) substantial solution, not all sol. found.

(2) correct domain/factorised

(1) correct change of domain

End of paper

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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