STUDENT NAME: ____________________

TEACHER: ____________________________

HURLSTONE

AGRICULTURAL

HIGH

SCHOOL

2025

Year 11

Assessment Task 1

Mathematics Extension 1

General Instructions

- **Senior Examiner:** Mrs P Biczo
- Reading time – 3 minutes
- Working time – 40 minutes
- Write using black or blue pen
- Calculators approved by NESA may be used
- A Reference sheet is provided
- In Questions 5 – 7, show relevant mathematical reasoning and/or calculations

Total marks: 26

Section I – 4 marks

- Attempt Questions 1 – 4
- Allow about 6 minutes for this section

Section II – 22 marks

- Attempt Questions 5 – 7
- Allow about 34 minutes for this section

This examination paper must not be removed from the examination centre.

SECTION 1

4 marks

Attempt Questions 1 – 4

Allow about 6 minutes for this section.

Use the multiple-choice answer sheet for Questions 1 – 4.

Question 1

For what values of x is $3x^2 \geq x$?

A. $x \leq 0$ and $x \geq \frac{1}{3}$

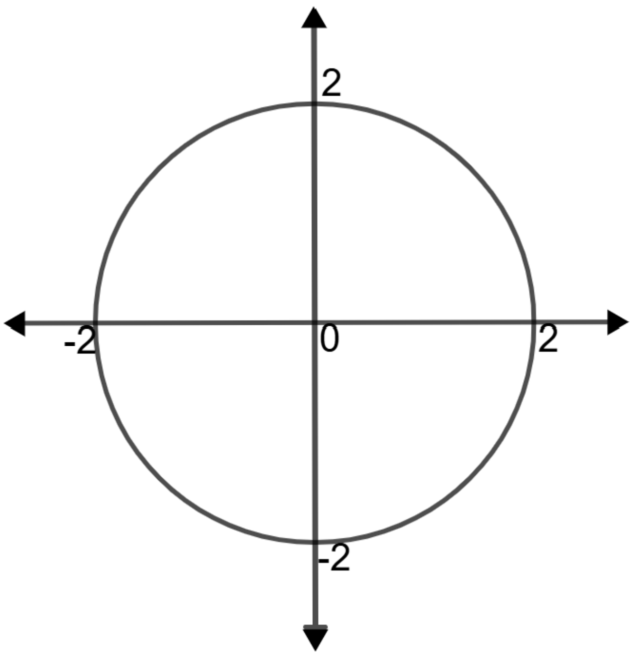
B. $0 \leq x \leq \frac{1}{3}$

C. $x \leq -\frac{1}{3}$ and $x \geq 0$

D. $-\frac{1}{3} \leq x \leq 0$

Question 2

Which of the following are the parametric equations for the graph shown?



A. $x = \cos t,\ y = \sin t$

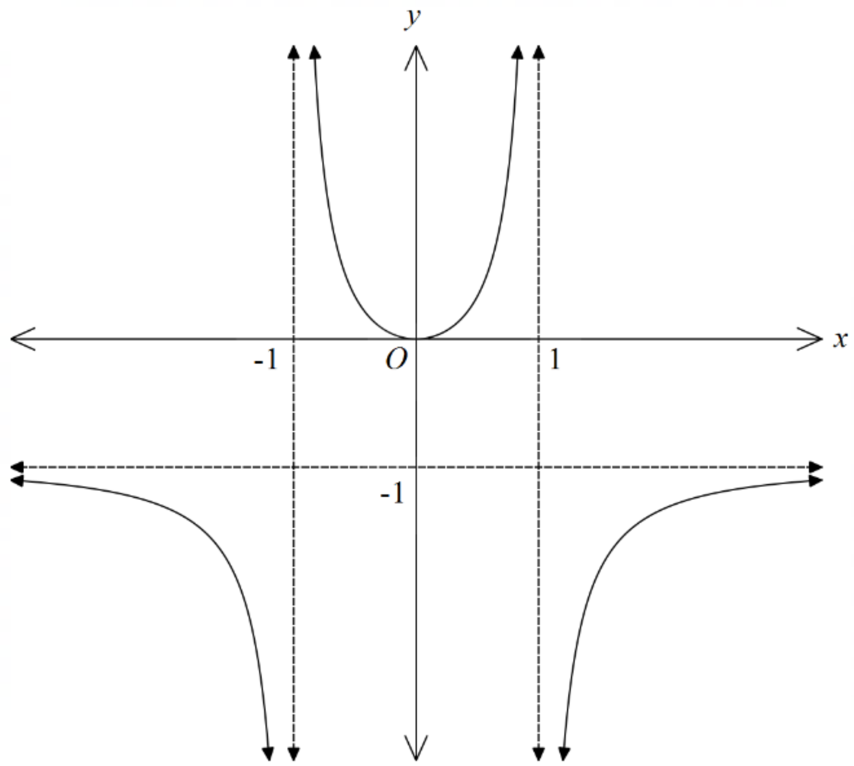
B. $x = \dfrac{\cos t}{2},\ y = \dfrac{\sin t}{2}$

C. $x = 2\cos t,\ y = 2\sin t$

D. $x = 4\cos t,\ y = 4\sin t$

Question 3

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



Which equation best represents the graph?

A. $y=\dfrac{x}{x^2-1}$

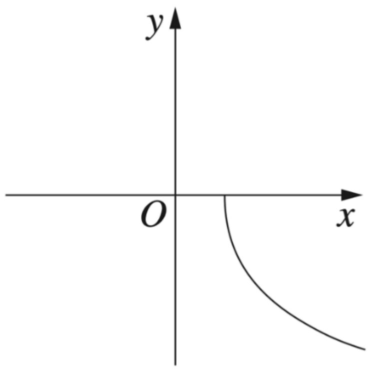
B. $y=\dfrac{x^2}{x^2-1}$

C. $y=\dfrac{x}{1-x^2}$

D. $y=\dfrac{x^2}{1-x^2}$

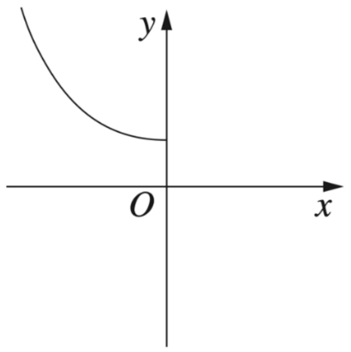
Question 4

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

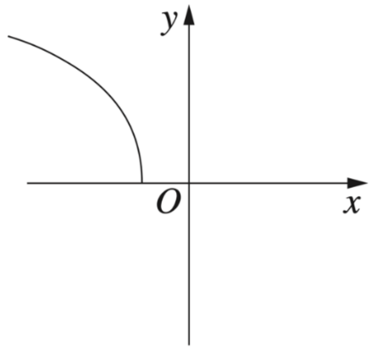


Which diagram shows the graph of $y = f^{-1}(x)$?

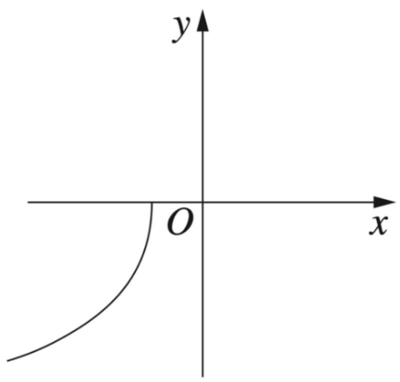
A.



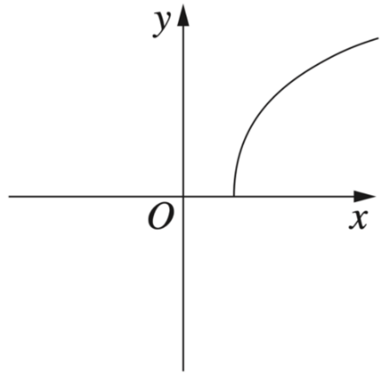
B.



C.



D.



End of Section 1

SECTION II

22 marks

Attempt Questions 5 – 7.

Allow about 34 minutes for this section.

In Questions 5 – 7, your responses should include relevant mathematical reasoning and / or calculations.

Answer each question in a separate writing booklet.

Clearly label each writing booklet with your name and indicate if extra booklets are used.

Question 5 (8 marks) Answer in a separate booklet **Marks**

(a) For what values of x is the inequality $|3x+4| < 2$ true? **2**

(b) Solve the inequality $\dfrac{4}{x-3} \leq 2$. **3**

(c) Consider the parametric equations:

$$x = 3 - t^2$$
$$y = 2 + t^2$$

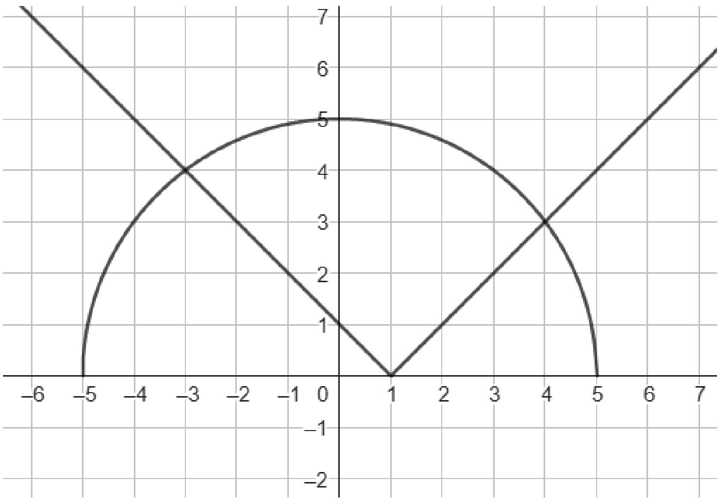
(i) State the cartesian equation. **1**

(ii) Sketch the graph of the parametric equations defined. **1**

Question 5 continued over the page

Marks

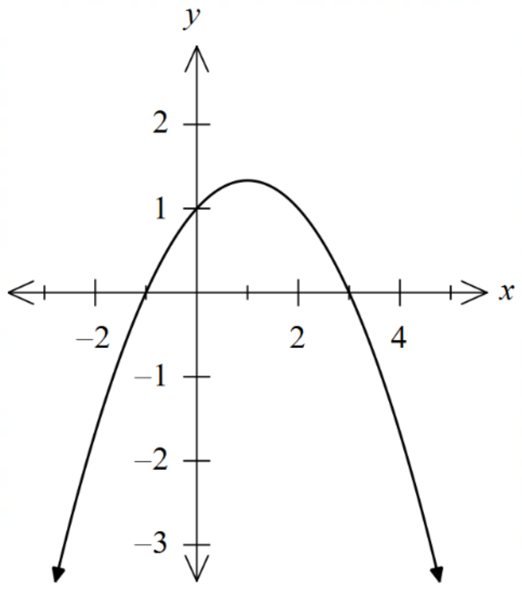
(d) The graphs of $y = \sqrt{25 - x^2}$ and $y = |x - 1|$ are shown on the number plane below. **1**



Hence, determine the x values for which: $|x - 1| > \sqrt{25 - x^2}$

Question 6 (7 marks) Answer in a separate booklet

(a) The diagram shows the graph of $y = f(x)$.



In your answer booklet, on the graphs provided, sketch the following functions, showing all intercepts and asymptotes.

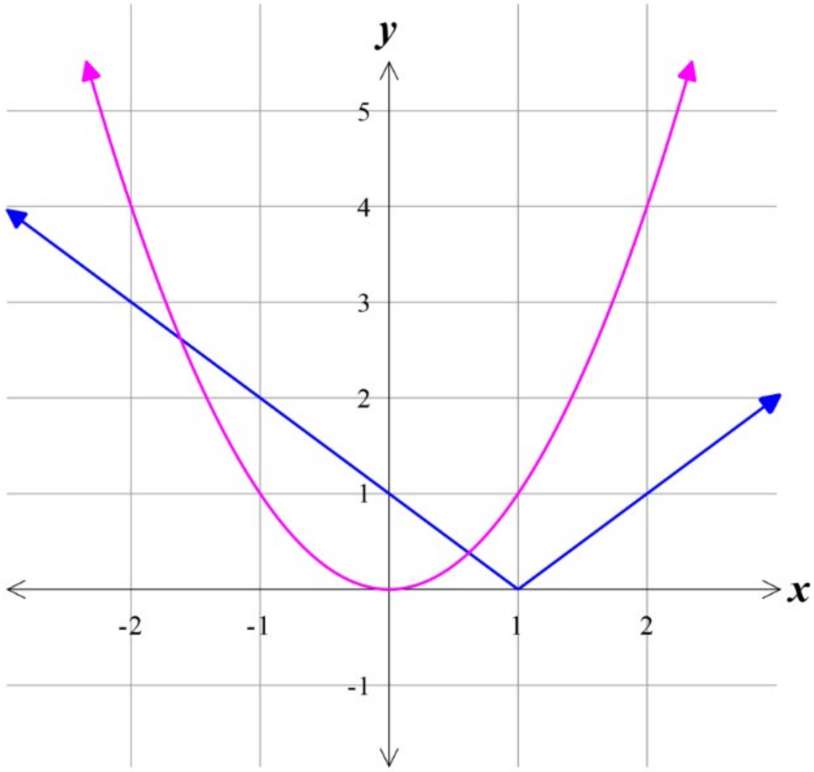
(i) $y = \left| f(x) \right|$ **1**

(ii) $y = \dfrac{1}{f(x)}$ **3**

Question 6 continued over page.

Question 6 continued **Marks**

(b) An absolute value function $y = f(x)$, and a parabolic function $y = g(x)$ are shown below.



In your answer booklet, on the same set of axes, sketch the graph of $y = f(x) \times g(x)$. **3**

Question 7 (7 marks) Answer in a separate booklet **Marks**

(a) Consider the function $f(x)=2x^3-1$.

The curve intersects the line $y=x$ at the point $(1,1)$.

(i) Find the domain for which $f^{-1}(x)$ exists. **1**

(ii) Hence, sketch the graphs of $y=f(x)$ and $y=f^{-1}(x)$ on the same cartesian number plane, showing all important features. **2**

(b) Explain why the inverse of $y=\dfrac{2}{x}$ is itself, where x is any real number. **1**

(c) Let $g(x)=2x^2-x^4$ for $x\geq 1$. This function has an inverse, $g^{-1}(x)$.

Find an expression for $\left[g^{-1}(x)\right]^2$. **3**

End of paper

NSW Education Standards Authority

2020 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Advanced
Mathematics Extension 1
Mathematics Extension 2

REFERENCE SHEET

Measurement

Length

$$l = \frac{\theta}{360} \times 2\pi r$$

Area

$$A = \frac{\theta}{360} \times \pi r^2$$

$$A = \frac{h}{2}(a + b)$$

Surface area

$$A = 2\pi r^2 + 2\pi rh$$

$$A = 4\pi r^2$$

Volume

$$V = \frac{1}{3}Ah$$

$$V = \frac{4}{3}\pi r^3$$

Functions

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $ax^3 + bx^2 + cx + d = 0$:

$$\alpha + \beta + \gamma = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \beta\gamma = \frac{c}{a}$$

and $\alpha\beta\gamma = -\frac{d}{a}$

Relations

$$(x - h)^2 + (y - k)^2 = r^2$$

Financial Mathematics

$$A = P(1 + r)^n$$

Sequences and series

$$T_n = a + (n - 1)d$$

$$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}(a + l)$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r} = \frac{a(r^n - 1)}{r - 1}, \; r \neq 1$$

$$S = \frac{a}{1 - r}, \; |r| < 1$$

Logarithmic and Exponential Functions

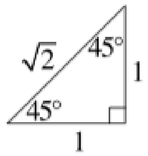
$$\log_a a^x = x = a^{\log_a x}$$

$$\log_a x = \frac{\log_b x}{\log_b a}$$

$$a^x = e^{x \ln a}$$

Trigonometric Functions

$$\sin A = \frac{\text{opp}}{\text{hyp}}, \quad \cos A = \frac{\text{adj}}{\text{hyp}}, \quad \tan A = \frac{\text{opp}}{\text{adj}}$$



$$A = \frac{1}{2}ab\sin C$$

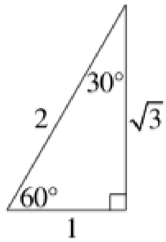
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$l = r\theta$$

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



Trigonometric identities

$$\sec A = \frac{1}{\cos A}, \ \cos A \neq 0$$

$$\operatorname{cosec} A = \frac{1}{\sin A}, \ \sin A \neq 0$$

$$\cot A = \frac{\cos A}{\sin A}, \ \sin A \neq 0$$

$$\cos^2 x + \sin^2 x = 1$$

Compound angles

$$\sin(A + B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A + B) = \cos A\cos B - \sin A\sin B$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}$$

If $t = \tan\dfrac{A}{2}$ then $\sin A = \dfrac{2t}{1 + t^2}$

$$\cos A = \frac{1 - t^2}{1 + t^2}$$

$$\tan A = \frac{2t}{1 - t^2}$$

$$\cos A\cos B = \frac{1}{2}\left[\cos(A - B) + \cos(A + B)\right]$$

$$\sin A\sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$$

$$\sin A\cos B = \frac{1}{2}\left[\sin(A + B) + \sin(A - B)\right]$$

$$\cos A\sin B = \frac{1}{2}\left[\sin(A + B) - \sin(A - B)\right]$$

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

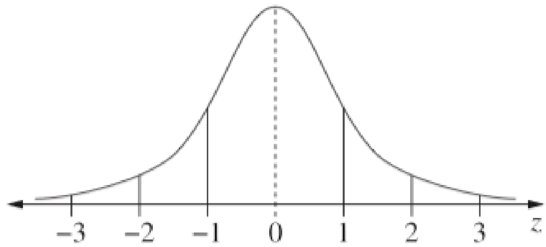
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

Statistical Analysis

$$z = \frac{x - \mu}{\sigma}$$

An outlier is a score
less than $Q_1 - 1.5 \times IQR$
or
more than $Q_3 + 1.5 \times IQR$

Normal distribution



- approximately 68% of scores have z-scores between −1 and 1
- approximately 95% of scores have z-scores between −2 and 2
- approximately 99.7% of scores have z-scores between −3 and 3

$$E(X) = \mu$$

$$\operatorname{Var}(X) = E\left[(X - \mu)^2\right] = E\left(X^2\right) - \mu^2$$

Probability

$$P(A \cap B) = P(A)P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}, \ P(B) \neq 0$$

Continuous random variables

$$P(X \leq x) = \int_a^x f(x)\,dx$$

$$P(a < X < b) = \int_a^b f(x)\,dx$$

Binomial distribution

$$P(X = r) = {}^nC_r p^r (1 - p)^{n - r}$$

$$X \sim \operatorname{Bin}(n, p)$$

$$\Rightarrow \quad P(X = x)$$

$$= \binom{n}{x} p^x (1 - p)^{n - x}, \ x = 0, 1, \ldots, n$$

$$E(X) = np$$

$$\operatorname{Var}(X) = np(1 - p)$$

Differential Calculus

Function	Derivative
$y = f(x)^n$	$\dfrac{dy}{dx} = nf'(x)[f(x)]^{n-1}$
$y = uv$	$\dfrac{dy}{dx} = u\dfrac{dv}{dx} + v\dfrac{du}{dx}$
$y = g(u)$ where $u = f(x)$	$\dfrac{dy}{dx} = \dfrac{dy}{du} \times \dfrac{du}{dx}$
$y = \dfrac{u}{v}$	$\dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$
$y = \sin f(x)$	$\dfrac{dy}{dx} = f'(x)\cos f(x)$
$y = \cos f(x)$	$\dfrac{dy}{dx} = -f'(x)\sin f(x)$
$y = \tan f(x)$	$\dfrac{dy}{dx} = f'(x)\sec^2 f(x)$
$y = e^{f(x)}$	$\dfrac{dy}{dx} = f'(x)e^{f(x)}$
$y = \ln f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{f(x)}$
$y = a^{f(x)}$	$\dfrac{dy}{dx} = (\ln a)f'(x)a^{f(x)}$
$y = \log_a f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{(\ln a)f(x)}$
$y = \sin^{-1} f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{\sqrt{1-[f(x)]^2}}$
$y = \cos^{-1} f(x)$	$\dfrac{dy}{dx} = -\dfrac{f'(x)}{\sqrt{1-[f(x)]^2}}$
$y = \tan^{-1} f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{1+[f(x)]^2}$

Integral Calculus

$$\int f'(x)[f(x)]^n dx = \frac{1}{n+1}[f(x)]^{n+1} + c$$

where $n \neq -1$

$$\int f'(x)\sin f(x)dx = -\cos f(x) + c$$

$$\int f'(x)\cos f(x)dx = \sin f(x) + c$$

$$\int f'(x)\sec^2 f(x)dx = \tan f(x) + c$$

$$\int f'(x)e^{f(x)}dx = e^{f(x)} + c$$

$$\int \frac{f'(x)}{f(x)}dx = \ln|f(x)| + c$$

$$\int f'(x)a^{f(x)}dx = \frac{a^{f(x)}}{\ln a} + c$$

$$\int \frac{f'(x)}{\sqrt{a^2-[f(x)]^2}}dx = \sin^{-1}\frac{f(x)}{a} + c$$

$$\int \frac{f'(x)}{a^2+[f(x)]^2}dx = \frac{1}{a}\tan^{-1}\frac{f(x)}{a} + c$$

$$\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$$

$$\int_a^b f(x)dx$$

$$\approx \frac{b-a}{2n}\left\{f(a) + f(b) + 2\left[f(x_1) + \cdots + f(x_{n-1})\right]\right\}$$

where $a = x_0$ and $b = x_n$

Combinatorics

$${}^{n}P_{r} = \frac{n!}{(n-r)!}$$

$$\binom{n}{r} = {}^{n}C_{r} = \frac{n!}{r!\,(n-r)!}$$

$$(x+a)^n = x^n + \binom{n}{1}x^{n-1}a + \cdots + \binom{n}{r}x^{n-r}a^r + \cdots + a^n$$

Vectors

$$\left|\underset{\sim}{u}\right| = \left|x\underset{\sim}{i} + y\underset{\sim}{j}\right| = \sqrt{x^2 + y^2}$$

$$\underset{\sim}{u} \cdot \underset{\sim}{v} = \left|\underset{\sim}{u}\right|\left|\underset{\sim}{v}\right|\cos\theta = x_1x_2 + y_1y_2,$$

where $\underset{\sim}{u} = x_1\underset{\sim}{i} + y_1\underset{\sim}{j}$

and $\underset{\sim}{v} = x_2\underset{\sim}{i} + y_2\underset{\sim}{j}$

$$\underset{\sim}{r} = \underset{\sim}{a} + \lambda\underset{\sim}{b}$$

Complex Numbers

$$\begin{aligned} z = a + ib &= r(\cos\theta + i\sin\theta) \\ &= re^{i\theta} \end{aligned}$$

$$\begin{aligned} \left[r(\cos\theta + i\sin\theta)\right]^n &= r^n(\cos n\theta + i\sin n\theta) \\ &= r^n e^{in\theta} \end{aligned}$$

Mechanics

$$\frac{d^2x}{dt^2} = \frac{dv}{dt} = v\frac{dv}{dx} = \frac{d}{dx}\left(\frac{1}{2}v^2\right)$$

$$x = a\cos(nt + \alpha) + c$$

$$x = a\sin(nt + \alpha) + c$$

$$\ddot{x} = -n^2(x - c)$$

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Student Name ________________________

Teacher ____________________________

Mathematics Extension 1

2025 Year 11 Assessment Task 1

Multiple Choice Answer Sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ● C ○ D ○

If you have changed your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A ● B ● C ○ D ○

correct

Question

1. **A** ○ **B** ○ **C** ○ **D** ○

2. **A** ○ **B** ○ **C** ○ **D** ○

3. **A** ○ **B** ○ **C** ○ **D** ○

4. **A** ○ **B** ○ **C** ○ **D** ○

Teacher Record	Question	Marks
	MC Q1 – Q2	/2
	MC Q3	/1
	MC Q4	/1
	ER Q 5	/8
	ER Q 6	/7
	ER Q 7	/7
	Total	/26

Year 11 2025	**Mathematics Extension 1 Task 1**
Questions 1 - 4	**1 mark each**

Outcome	**Multiple Choice Solutions**

Question 1

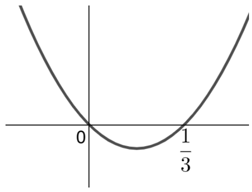
ME11-2

$3x^2 \geq x$

$\therefore x(3x-1) \geq 0$

$\therefore x \leq 0$ and $x \geq \frac{1}{3}$

$\therefore$ **answer** $\boldsymbol{A}$



ME11-2

Question 2

As $x = 2\cos t,\ y = 2\sin t$ gives $\cos t = \frac{x}{2},\ \sin t = \frac{y}{2}$ and substituting into $\cos^2 t + \sin^2 t = 1$ gives $\left(\frac{x}{2}\right)^2 + \left(\frac{y}{2}\right)^2 = 1$ and hence $x^2 + y^2 = 4$.

$\therefore$ **answer** $\boldsymbol{C}$

Question 3

ME11-7

$$y = \frac{x^2}{1 - x^2}$$

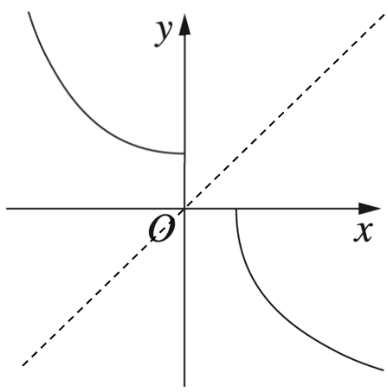
As $x \to \pm\infty$, the graph levels off at $y = -1$ which suggests that since it approaches a non-zero asymptote, the degree of the numerator is the same as the denominator.

Checking the values between [-1,1], the graph is positive between that interval and negative outside which only fits with the **answer D.**

Question 4

Reflecting the graph about $y = x$ we get

ME11-1

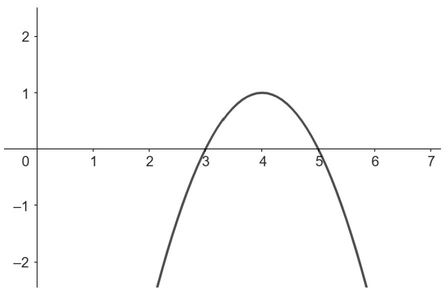


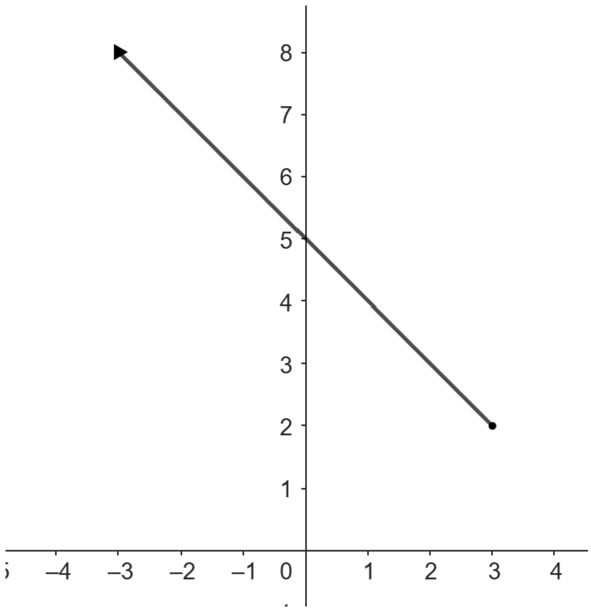
Answer: A

Year 11 Mathematics Extension 1 Task 1 Examination 2025
Question No.5 Solutions and Marking Guidelines

Outcomes Addressed in this Question

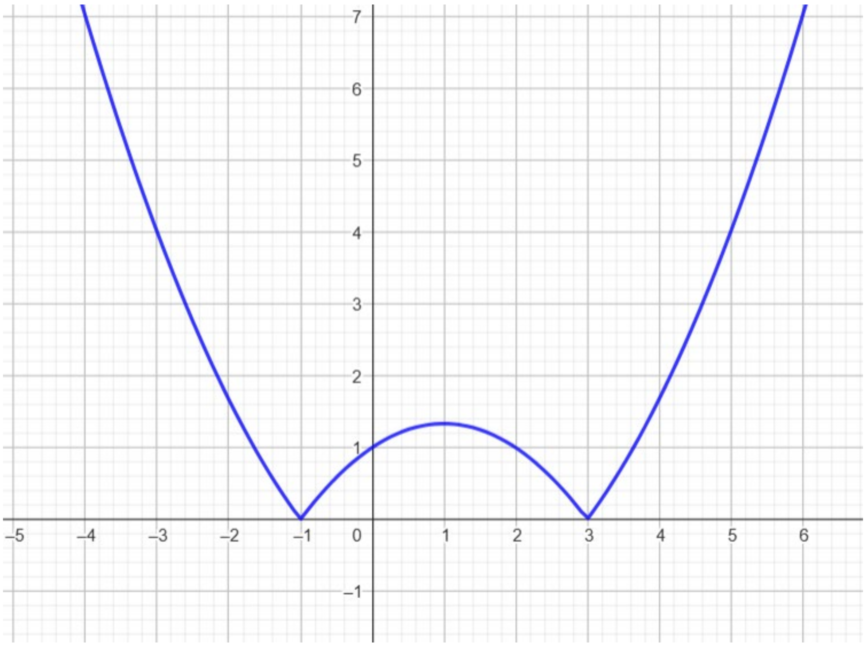
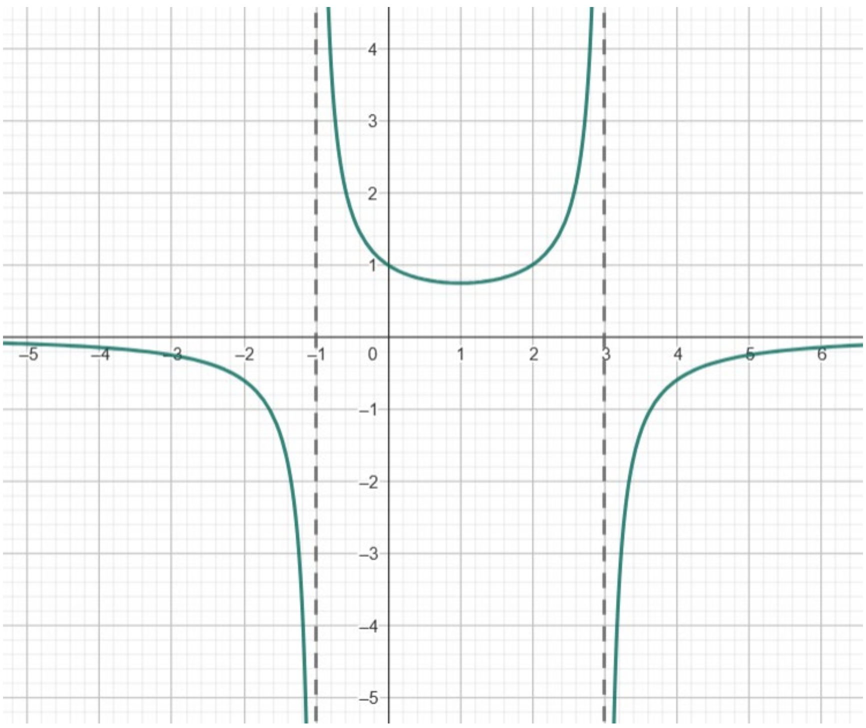
ME11-2 manipulates algebraic expressions and graphical functions to solve problems

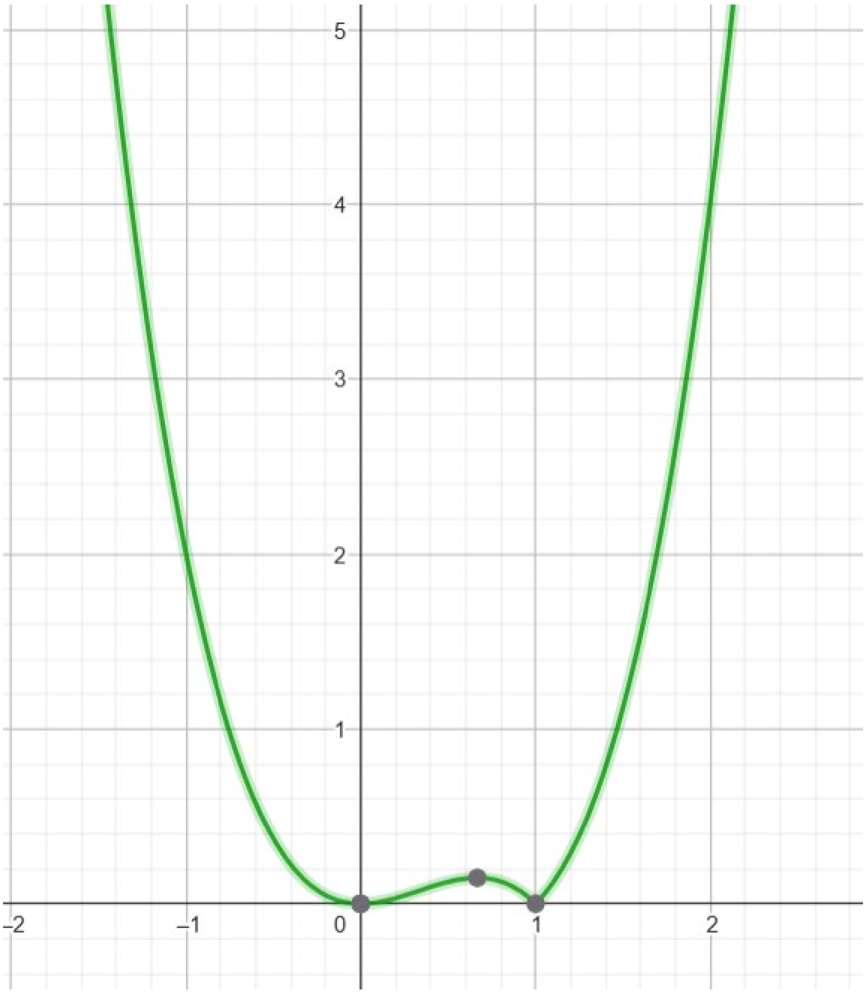
Outcome	**Solutions**	**Marking Guidelines**
ME11-2	**(a)** $\lvert 3x+4\rvert < 2$ $\therefore -2 < 3x+4 < 2$ $\therefore -6 < 3x < -2$ $\therefore -2 < x < -\frac{2}{3}$ Students solving two separate inequalities, $3x+4<2$ and $-(3x+4)<2$ needed to ensure they swapped the inequality sign when dividing by a negative and that they combined the two solutions by finding the intersection	2 marks : correct solution 1 mark: correctly removes absolute value signs and correctly solves equivalent inequality or equivalent merit
ME11-2	**(b)** $\frac{4}{x-3} \leq 2, \quad x \neq 3$ $\frac{4(x-3)^2}{x-3} \leq 2(x-3)^2$ $4(x-3) - 2(x-3)^2 \leq 0$ $2(x-3)\big(2-(x-3)\big) \leq 0$ $(x-3)(5-x) \leq 0$  From the graph $x \leq 3$ and $x \geq 5$ But, $x \neq 3$, $\therefore x < 3$ and $x \geq 5$ Needed to demonstate Extension 1 method to gain marks. Students who did not use a graph to solve the inequality mostly got the answer wrong. Must remember if the inequality has an equals sign, to exclude the value that makes the denominator zero.	3 marks: correct solution 2 marks: identifies the correct critical values or equivalent merit 1 mark: excludes $x = 3$ or deals with unknown in denominator or equivalent merit
ME11-2	**(c) (i)** Given $x = 3 - t^2$, $y = 2 + t^2$,	1 mark: correct answer

	from equation 2, $t^2 = y - 2$. Substituting in equation 1, $x = 3 - (y - 2)$ $\therefore y = -x + 5$ **(ii)** As $t^2 \geq 0$ for all values of t and $t^2 = 3 - x$, then $3 - x \geq 0$ and $x \leq 3$. $\therefore$ the parametric equations give the line $y = -x + 5$, where $x \leq 3$. When parametric equations are used, the domain may have restrictions. If so, this must be reflected in the graph.  	1 mark: correct solution
ME11-2	**(d)** $y = \sqrt{25 - x^2}$ and $y = \lvert x - 1 \rvert$ meet at $x = -3$ and $x = 4$. The graph of $y = \lvert x - 1 \rvert$ is above the graph of $y = \sqrt{25 - x^2}$ when $x < -3$ and $x > 4$. But, $y = \sqrt{25 - x^2}$ is undefined when $x < -5$ and $x > 5$. Thus, $\lvert x - 1 \rvert > \sqrt{25 - x^2}$ when $-5 \leq x < -3$ and $4 < x \leq 5$. **Must check if each expression has any restrictions on its domain. If so, answer must reflect this.**	1 mark: correct answer

Outcomes Addressed in this Question

ME11-7 communicates making comprehensive use of mathematical language, notation, diagrams and graphs

Question 6	Solutions	Marking Guidelines
(a) (i)	 Students must make an effort to shade in the graph above the x-axis. At the roots, the graph must be reflected as best as possible as opposed to being a "straight-line"	**1 mark** Correct and neatly drawn sketch.
(ii)		**3 marks** Neatly drawn sketch with correct shape and clearly outlines the vertical asymptotes and limiting behaviour. **2 marks** Substantial progress towards the correct solution. **1 mark** Some progress towards the correct solution.

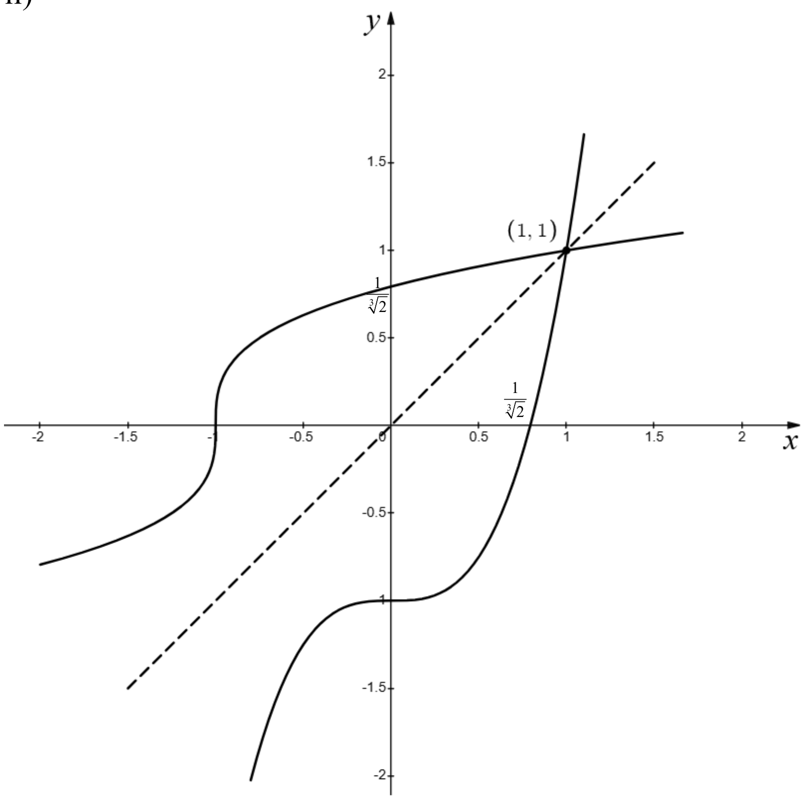
	To achieve full marks for this question, the following characteristics must be present: • Vertical asymptotes must be clearly shown. • At $y = -1$ and $y = 1$, your reciprocal function should be intersecting the parabola. • The turning point where $x = 1$ should not be too high or too low. • Limiting behaviour of the curve should be approaching an asymptote and not appear to be "moving away".	
(b)	 To achieve full marks for this question, the following characteristics must be present: • Intercepts at $x = 0$ and $x = 1$ must be clearly shown and only 1 turning point between the two values must be at an appropriate value. • Two critical points at $x = 2$ and $x = -1$ were used in determining the accuracy of your sketch. If your graph was way off these values, full marks were not awarded. • The limiting behaviour when $x \to \pm\infty$ must also demonstrate the curve getting steeper.	**3 marks** Neatly drawn graph with correct shape. **2 marks** Substantial progress towards the correct solution. **1 mark** Some progress towards the correct solution.

2025 Yr11 Assessment Task 1

Question 7 Solutions and Marking Guidelines

Outcomes Addressed in this Question

ME11-1 uses algebraic and graphical concepts in the modelling and solving of problems involving functions and their inverses

Solutions	**Marking Guidelines**
a i) Domain: For all real *x*. Note: there was inappropriate use of equal sign. This was ignored when marking. Also, it is important to mention that domain refers to *x*.	**1 mark** Correct Answer
ii) 	**2 marks** Correct graphs including labelled intersection point and *y*- and *x*-intercepts. **1 mark** Demonstrates knowledge that the graph of $f^{-1}(x)$ is a reflection of $f(x)$ about $y = x$
b) Swapping both *y* and *x* and rearranging to find the inverse functions gives the same function. OR When the graph of function is reflected about the *y*-axis, it will be the same graph. Note: for a more complete solution the mention both functions being one-to-one is necessary. This addresses the “any real number” part. Also, the questions should have said “any real number in the function’s natural domain” to be more correct.	**1 mark** Correct explanation (purely algebraic solutions were accepted this time)

c) Swapping x and y and rearraigning to make y^2 the subject gives: $x = 2y^2 - y^4$ $-x = -2y^2 + y^4$ $-x = -1 + 1 - 2y^2 + y^4$ $1 - x = (y^2 - 1)^2$ $\pm\sqrt{1-x} = y^2 - 1$ $y^2 = 1 \pm \sqrt{1-x}$ We take the positive of the square root as the domain of $f(x)$ is restricted to $x \geq 1$. This means the range of the square of the inverse function is restricted to $y \geq 1$. So $y^2 = 1 + \sqrt{1-x}$.	**3 marks** Correct solution with $y \geq 1$ considered. **2 marks** Correctly finds y^2 but does not address $\pm$ within the equation. **1 mark** Swaps the x and y variables and attempts to make y the subject