Class/ Index Number	Centre Number/ 'O' Level Index Number	Name
/	/	

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR

ADDITIONAL MATHEMATICS **4049/1**

Paper 1

21 August 2025

Candidates answer on the Question Paper. **2 hours 15 minutes**

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
The use of an approved scientific calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

The total of the marks for this paper is 90.

For Examiners' Use

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
/ 5	/ 6	/ 5	/ 6	/ 5	/ 6	/ 7	/ 7	/ 7

Q10	Q11	Q12	Q13	SUBTOTAL		
/ 8	/ 8	/ 10	/ 10	Statement		90
				Presentation		
				Units		
				Rounding Off		

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

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

Binomial expansion

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\ldots(n-r+1)}{r!}$

2. TRIGONOMETRY

Identities

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

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

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

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$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$$

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Formulae for ΔABC

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

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

$$\Delta = \frac{1}{2} bc \sin A$$

1 The curve $(x-1)^2+(y-3)^2=5$ intersects the line $y-3x=5$ at two points. Find the coordinates of these two points. [5]

2 A stone is thrown vertically upwards such that its height, h metres from the ground at time t seconds after being thrown is given by the formula $h = -9t^2 + 12t + 1$.

(a) Explain the meaning of the constant term in the formula. [1]

(b) Express h in the form $a(t+b)^2 + c$, where a, b and c are constants to be determined. [3]

(c) Hence state the maximum height attained by the stone and the time at which this occurs. [2]

3 Find the range of values of the constant p such that $y = px^2 - 4x + p - 3$ is always positive for all real values of x. [5]

4 Express $\dfrac{15x^2 - 13x + 18}{(x-2)(3x^2+1)}$ in partial fractions. [6]

5 (a) Find the first 4 terms in the expansion of $\left(\frac{a}{x}+3x^2\right)^6$ in ascending power of x, simplifying each term. [3]

(b) Given that there is no term in x^3 in the expansion of $(2x^3-1)\left(\frac{a}{x}+3x^2\right)^6$, find the value of the positive constant a. [2]

6 A particle moves along the curve $y = \dfrac{5}{(3x-1)^2}$, where $x \neq \dfrac{1}{3}$, in such a way that the x-coordinate is decreasing at a rate of 0.1 units per second.

(a) Find the rate of change of the y-coordinate when $x = 1$. [4]

(b) Find the value of x when y increases at the rate of $\dfrac{3}{125}$ units per second. [2]

7 **A calculator must not be used in this question.**

(a) Show that $\tan 15° = 2 - \sqrt{3}$. [4]

(b) Use the result from **part (a)** to find an expression for $\text{cosec}^2 15°$, in the form $a + b\sqrt{3}$ where a and b are integers. [3]

8 **(a)** Prove the identity $\frac{\sin x}{1-\cos x}+\frac{1-\cos x}{\sin x}=2\operatorname{cosec} x$. [4]

(b) Hence solve the equation $\frac{\sin x}{1-\cos x}+\frac{1-\cos x}{\sin x}=5$ for $0 \le x \le 2\pi$. [3]

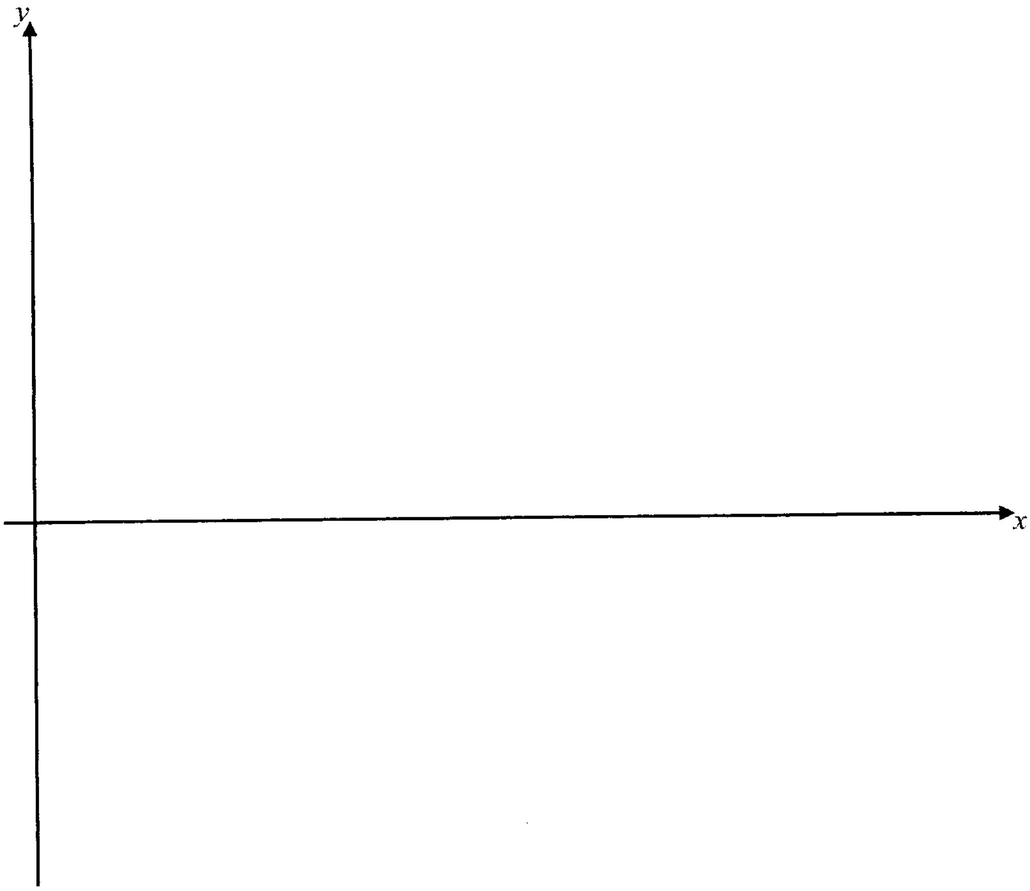
9 A curve is such that $\frac{d^2y}{dx^2} = 3e^{2x} - e^{-x}$. The curve cuts the y-axis at P (0, 1) and has a gradient of 4 at P.

(a) Show that the curve has no stationary points. [3]

(b) Find the equation of the curve. [4]

10 **(a)** State the amplitude and period of $2\sin 3x + 1$. [2]

(b) Sketch the graph of $y = 2\sin 3x + 1$ for $0 \le x \le \pi$. [3]



(c) By drawing a suitable straight line on your sketch, determine the number of solutions of the equation $\pi \sin 3x - x = 0$. [3]

11 **Solutions to this equation by accurate drawing will not be accepted.**

ABC is a triangle with vertices $A\ (0, h)$, $B\ (2h, -2)$ and $C\ (7, 5)$, where h is a positive integer. The area of the triangle is 20 units^2.

(a) Show that $h = 2$. [3]

(b) Find the equation of the perpendicular bisector of *AB*. [3]

(c) Explain why triangle *ABC* is isosceles. [2]

12 **(a)** The table shows experimental values of two variables x and y. It is known that x and y are related by the equation $y = Ak^x$, where A and k are constants.

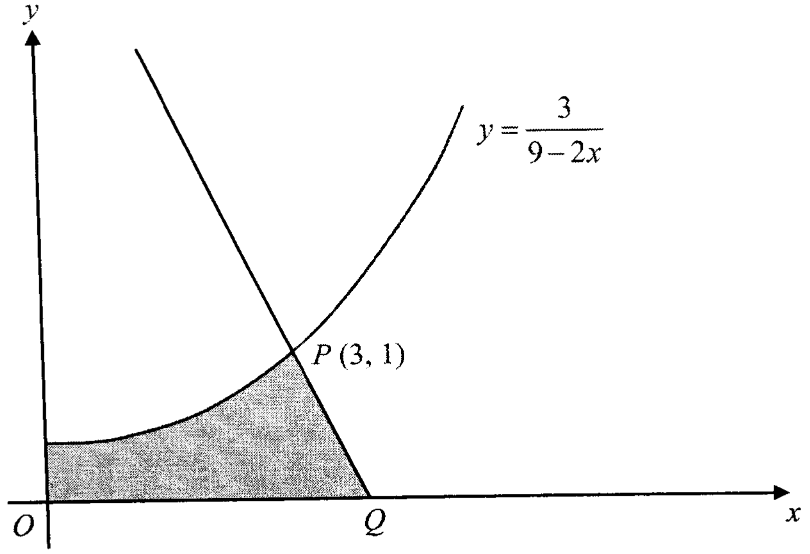
x	1	2	3	4	5
y	2.63	3.89	5.62	8.32	12.02

(i) On the grid below plot lg y against x and draw a straight line graph to illustrate the information. [2]

(ii) Use your graph to estimate the value of A and of k. [4]

(b) Variables x and y are related by the formula $y = ax^3 + bx^2$, where a and b are constants. Explain clearly how a straight line graph can be drawn to represent this formula. You should state which variables should be plotted on each axis and explain how the values of a and b can be calculated. [4]

13



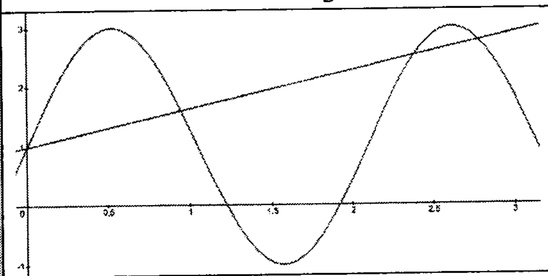
The diagram shows part of the curve $y = \dfrac{3}{9-2x}$. The point P (3, 1) lies on the curve and the normal to the curve at P meets the x-axis at Q.

(a) Find the coordinates of Q. [5]

(b) Find the area of the shaded region bounded by the curve, the normal PQ and the coordinate axes. [5]

End of Paper

Maris Stella High School
2025 Secondary 4 Additional Mathematics
Prelim Examination Paper 1 Answer Keys

Qn	Answer Key
1	(0, 5) and (−1, 2)
2(a)	**Initial height** of the stone is **1m above the ground.**
2(b)	$h=-9\left(t-\frac{2}{3}\right)^2+5$
2(c)	Maximum height = 5m when time $=\frac{2}{3}$ s
3	$p>4$
4	$\frac{15x^2-13x+18}{(x-2)(3x^2+1)}=\frac{4}{x-2}+\frac{3x-7}{3x^2+1}$
5(a)	$\frac{a^6}{x^6}+\frac{18a^5}{x^3}+135a^4+540a^3x^3+\ldots$
5b)	$a=2$
6(a)	$\frac{3}{8}$ units/s
(b)	$x=2$
7(b)	$8+4\sqrt{3}$
8(b)	$x=0.412, 2.73$
9(b)	$y=\frac{3}{4}e^{2x}-e^{-x}+\frac{3}{2}x+\frac{5}{4}$
10(a)	Amplitude =2, Period $=\frac{2\pi}{3}$ (accept 120°)
(b)	
10(c)	4
11(a)	$h=2$
11(b)	$y=x-2$
12(aii)	$A=1.82$ (accept 1.78 to 1.86), $k=1.46$ (accept 1.43 to 1.50)
13(a)	$\left(\frac{11}{3},0\right)$
(b)	1.98 units^2

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/	/	

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR

ADDITIONAL MATHEMATICS **4049/2**
Paper 2
26 August 2025
Candidates answer on the Question Paper. **2 hours 15 minutes**

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/ 7	/ 7	/ 9	/ 7	/ 12	/ 9	/ 8	/ 11

Q9	Q10
/ 9	/ 11

SUBTOTAL		
Statement		
Presentation		
Units		
Rounding Off		90

[Turn over

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1 **(a)** A polynomial $f(x)$ has a remainder of -1 when divided by $2x + 3$.

(i) Find the remainder when $f(x) - 1$ is divided by $2x + 3$. [1]

(ii) Find in terms of $f(x)$, a polynomial which is divisible by $2x + 3$. [1]

(b) The cubic polynomial $g(x)$ is such that the coefficient of x^3 is 2 and the roots of $g(x) = 0$ are -1, m and $2m$, where m is an integer. It is given that $g(x)$ has a remainder of 12 when divided by $x - 1$.

Find an expression for $g(x)$ in descending powers of x. [5]

2 The equation of a curve is $y = \frac{\ln x}{x}$.

(a) Find the coordinates of the stationary point of this curve.
Leave your answer in terms of e. [4]

(b) Determine the nature of the stationary point. [3]

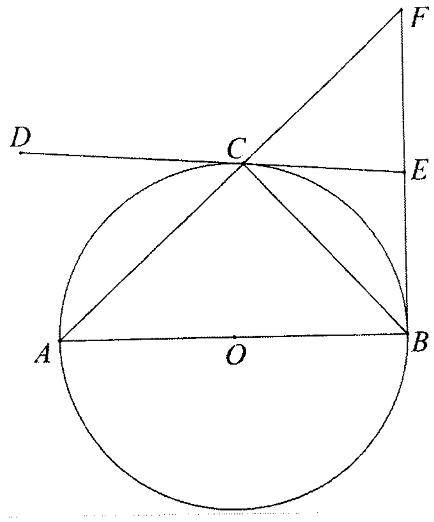
3 The decay of a certain radioactive isotope can be modelled by the exponential equation $N = N_0 e^{-at}$ after t weeks, where N represents the amount of radioactive isotope, N_0 and a are constants.
A sample of this radioactive isotope has a mass of 100.9 g initially.
After 2 weeks, it is found that the amount of this sample left is 84.6 g.

(a) Calculate the value of a. [3]

(b) What percentage of this sample has decayed after 5 weeks? [3]

(c) Find the number of weeks when the amount of radioactive isotope decayed first exceeds 60 g. Give your answer correct to the nearest week. [3]

4 In the diagram, AB is the diameter of the circle with centre O. DE and BF are tangents to the circle at C and B respectively. DCE and BEF are straight lines.



(a) Prove that triangle ABC and triangle AFB are similar. [3]

(b) Show that $EC = EF$. [4]

5 **(a)** Find the integer a and b which satisfy the equation

$$\left(\frac{1}{8}y^3\right)^{-1} \div \left(4y^2\right)^{\frac{1}{2}} = 2^a y^b.$$ [3]

(b) Solve the equation $\log_3(x-8) = 2 - \frac{1}{\log_x 3}$. [5]

(c) Solve the equation $4^{x+1} + 7\left(2^{x}\right) = 2$. [4]

6 **(a)** Given that $y = 2\cos x \sin 2x - \sin x \cos 2x$, show that $\frac{\mathrm{d}y}{\mathrm{d}x} = k \cos x \cos 2x$, stating the value of k. [4]

(b) Hence, show that $\int_0^{\frac{\pi}{4}} \left(7\cos x \cos 2x + \sec^2 x\right) dx = \frac{7\sqrt{2}}{3} + 1$. [5]

7 Two points $A(-3, -6)$ and $B(7, -6)$ lie on a circle with centre G. The equation of the tangent to the circle at the point $Q(1, -12)$ is $x + 5y + 59 = 0$.

(a) Show that the coordinates of G is $(2, -7)$. [5]

(b) Find the equation of the circle in the form of $x^2 + y^2 + 2gx + 2fy + c = 0$, stating the value of *f*, *g* and *c*. [3]

8 A particle P moves in a straight line and passes through a fixed point O so that its velocity, v m/s is given by $v = t^2 - 5t + 4$, where t is the time in seconds after passing O.

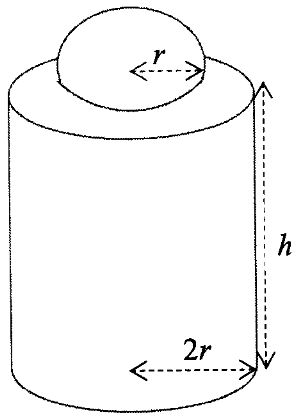
(a) Find the values of t when the particle is instantaneously at rest. [2]

(b) Find the values of t when the particle returns to O. [4]

(c) Find the acceleration of the particle when it first returns to *O*. [2]

(d) Find the average speed during the first 5 seconds. [3]

9 The diagram shows a paper weight which is made up of a solid hemisphere of radius r cm, resting on top of a solid cylinder of radius $2r$ cm and height h cm.

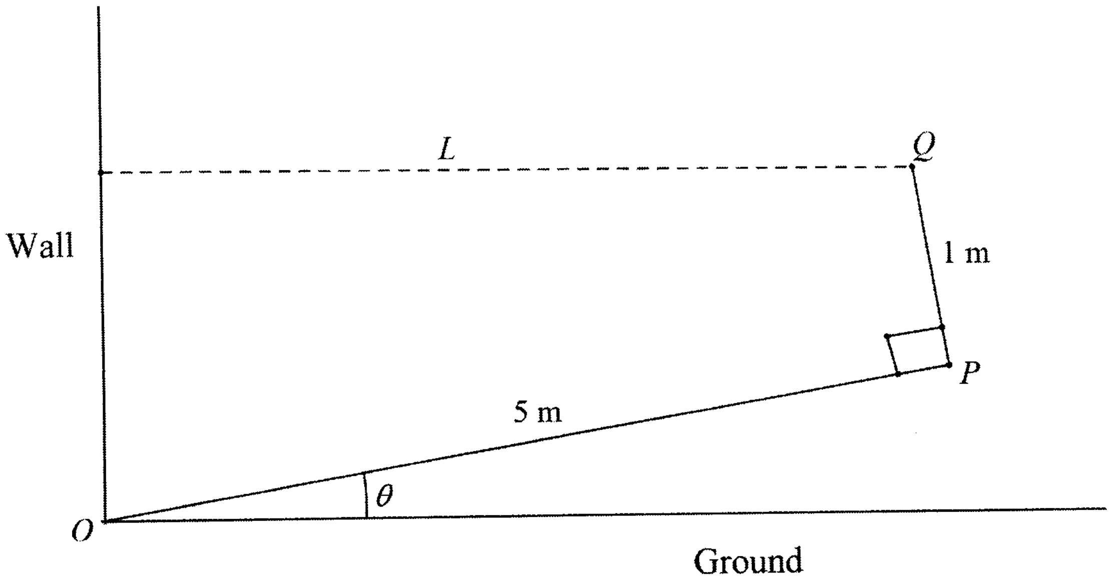


(a) Given that the total volume of the solid is 216π cm^3, express h in terms of r. [2]

(b) Show that the total surface area, A cm^2, of the solid is given by, $A = \frac{25\pi r^2}{3} + \frac{216\pi}{r}$. [2]

(c) Given that r can vary, find the value of r for which A has a stationary value. Find this value of A and determine whether it is a maximum or a minimum. [5]

10 A L-shaped structure, OPQ can be rotated about O. OP and PQ measures 5 m and 1 m respectively. OP makes an acute angle, θ, with the ground. The shortest distance from Q to the wall is is L m.



(a) Show that $L = 5\cos\theta - \sin\theta$. [2]

(b) Express L in the form $R\cos(\theta+\alpha)$, where $R > 0$ and $0° < \alpha < 90°$. [3]

(c) State the minimum value of L and the corresponding value of θ. [3]

(d) Find the value of θ when $L = 3$. [2]

(e) Explain why the maximum value of L is not R. [1]

End of Paper