

NAME	FORM CLASS	ACAD CLASS	INDEX NO.
Answers			



ST. PATRICK'S SCHOOL

END-OF-YEAR EXAMINATION 2025

SUBJECT : Mathematics **DATE : 6 October 2025**
(4052/02)

LEVEL : Secondary 3 Express **DURATION : 2 hours 15 minutes**

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your Name, Form Class, Acad Class and Index No. in the spaces at the top of the 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** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value of 3.142, unless the equation requires the answer in terms of π .

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 Examiner's Use			
Type of Penalties		Question Number	
Presentation	−1		
	−2		
			90

This paper consists of 19 printed pages including this cover page.

Mathematical Formulae*Compound Interest*

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

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

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

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

Answer **all** questions.

- 1 (a) Solve the equation $(x-3)^2 = 16$.

$$\begin{array}{ccc} x-3=4 & \text{or} & x-3=-4 \\ x=7 & & x=-1 \end{array}$$

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [2]

- (b) Simplify $\frac{4x-6}{2x^2-9x+9}$.

$$\begin{aligned} & \frac{2(2x-3)}{(2x-3)(x-3)} \\ &= \frac{2}{x-3} \end{aligned}$$

Answer $\dots\dots\dots$ [2]

- (c) Rearrange the formula $x = \frac{p+1}{x-p}$ to make p the subject of the formula.

$$\begin{aligned} x^2 - xp &= p+1 \\ x^2 - 1 &= p + xp \\ (x-1)(x+1) &= p(1+x) \\ p &= \frac{(x-1)(x+1)}{(x+1)} \\ p &= x-1 \end{aligned}$$

Answer $p = \dots\dots\dots$ [3]

- 2 (a) Simplify $\frac{(4a^2b^3)^2}{2a^{-1}b^5}$, express your answer in positive index notation.

$$\frac{16a^4b^6 \cdot a}{2b^5}$$

$$= 8a^5b$$

Answer [2]

- (b) The mass of a dust particle is 7.5×10^{-6} kg.

Find the total mass of 2×10^8 such particles, giving your answer in standard form.

$$2 \times 10^8 \times 7.5 \times 10^{-6}$$

$$= 1.5 \times 10^3$$

Answer kg [1]

- (c) Solve the equation $5^{x+1} = 25^2$.

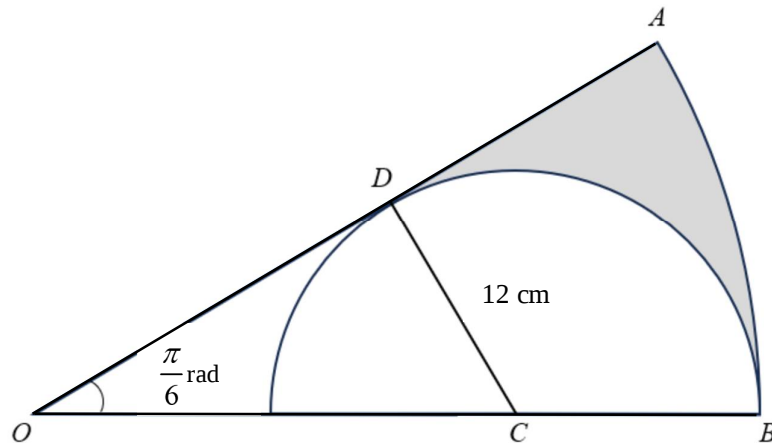
$$5^{x+1} = 5^4$$

$$x+1 = 4$$

$$x = 3$$

Answer [2]

- 3 The diagram shows a sector OAB of a circle with centre O and radius OA . A semi-circle with centre C and radius 12 cm is drawn inside the sector such that OA is the tangent to the semicircle at D , where angle $ODC = \frac{\pi}{2}$ radians. Angle $AOB = \frac{\pi}{6}$ radians and $CD = 12$ cm.



- (a) Show that the length of $OC = 24$ cm.

Answer

$$\sin \frac{\pi}{6} = \frac{12}{OC}$$

$$OC = 24 \text{ cm}$$

[1]

- (b) Find the perimeter of the shaded region

$$AB = r\theta$$

$$= 36 \left(\frac{\pi}{6} \right)$$

$$= 6\pi \text{ cm}$$

$$BD = 12 \left(\frac{\pi}{6} + \frac{\pi}{2} \right)$$

$$= 8\pi \text{ cm}$$

$$AD = 36 - \left(\sqrt{24^2 - 12^2} \right)$$

$$= 12\sqrt{3} \text{ cm}$$

$$\text{Perimeter} = 6\pi + 12\sqrt{3} + 8\pi$$

$$= 64.76690684$$

$$= 64.8 \text{ cm}$$

Answer cm [4]

(c) Find the area of the shaded region.

$$\begin{aligned}\text{Area of sector } AOB &= \frac{1}{2}(36)^2 \left(\frac{\pi}{6} \right) \\ &= 108\pi \text{ cm}^2\end{aligned}$$

$$\begin{aligned}\text{Area } \triangle OCD &= \frac{1}{2} \times \left(\sqrt{24^2 - 12^2} \right) \times 12 \\ &= 72\sqrt{3} \text{ cm}^2\end{aligned}$$

$$\begin{aligned}\text{Area of sector } BCD &= \frac{1}{2}(12)^2 \left(\frac{\pi}{6} + \frac{\pi}{2} \right) \\ &= 48\pi \text{ cm}^2\end{aligned}$$

$$\begin{aligned}\text{Area} &= 108\pi - 72\sqrt{3} - 48\pi \\ &= 63.7879 \\ &= 63.8 \text{ cm}^2\end{aligned}$$

Answer cm² [4]

- 4 (a) A laptop is sold in a shop for \$1600. During a promotion, the shop offers a 25% discount on the laptop. If the shop originally bought the laptop from the supplier at \$1000, calculate the percentage profit made by the shop.

$$\begin{aligned}\text{Discounted price} &= \frac{75}{100} \times 1600 \\ &= \$1200 \\ \text{Percentage profit} &= \frac{1200 - 1000}{1000} \times 100\% \\ &= 20\%\end{aligned}$$

Answer % [3]

- (b) Sam is travelling to Japan. He goes to a money changer to convert his Singapore dollars (SGD) into Japanese yen (JPY). The exchange rate is 1 SGD = 112 JPY.

The money changer also charges a 2% commission fee on the amount of SGD exchanged.

- (i) Sam prepares to exchange 1500 SGD inclusive of commission fee. Calculate the commission fee he needs to pay.

$$\begin{array}{rcl} 102\% & \text{-----} & \$1500 \\ 2\% & \text{-----} & 29.41 \end{array}$$

Answer SGD [2]

- (ii) Find the amount of money (in JPY) Sam receives after deducting the commission fee.

$$\begin{aligned}\text{Amount} &= (1500 - 29.41) \times 112 \\ &= 164706.08 \text{ JPY}\end{aligned}$$

Answer JPY [2]

- (iii) During his trip, Sam spends 90 000 JPY. When he returns, he converts the remaining yen back to SGD at the new rate 1 SGD = 110 JPY. How much money (in SGD) will he get back?

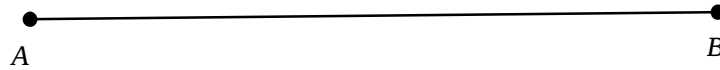
$$\begin{aligned}\text{Amount} &= \frac{164706.08 - 90000}{110} \\ &= 679.14618 \\ &= 679.15 \text{ SGD}\end{aligned}$$

Answer SGD [2]

- 5 (a) Construct triangle ABC on the given line AB , where angle $BAC = 45^\circ$ and angle $ABC = 75^\circ$.

Answer

[2]



- (b) Measure and state the length of AC .

Answer $AC = \dots\dots\dots$ cm [1]

- (c) Construct the perpendicular bisector of AB . [1]

- (d) Construct the angle bisector of angle ABC . [1]

- (e) Label the point of intersection as P . Measure and state the length of AP .

Answer $AP = \dots\dots\dots$ cm [1]

- 6** A tank has a capacity of 600 litres.

Tap A can fill the tank completely in a minutes.

Tap B can fill the tank completely in $(a - 5)$ minutes.

A drain pipe can empty the full tank in 30 minutes.

- (a)** Write down the rate of Tap A to fill the tank.

$$\text{Answer} \dots\dots \frac{600}{a} \dots\dots\dots \text{ l/min [1]}$$

- (b)** Write down the rate of Tap B to fill the tank.

$$\text{Answer} \dots\dots\dots \frac{600}{a-5} \dots\dots\dots \text{ l/min [1]}$$

- (c)** Both taps are turned on together with the drain pipe. The tank is filled in 20 minutes.

Form an equation in terms of a . Show that it reduces to $a^2 - 29a + 60 = 0$.

Answer

[3]

$$\frac{600}{a} + \frac{600}{a-5} - \frac{600}{30} = \frac{600}{20}$$

$$\frac{1}{a} + \frac{1}{a-5} = \frac{1}{20} + \frac{1}{30}$$

$$\frac{a-5+a}{a(a-5)} = \frac{1}{12}$$

$$12(2a-5) = a(a-5)$$

$$24a - 60 = a^2 - 5a$$

$$0 = a^2 - 29a + 60 \text{ (shown)}$$

(d) Solve the equation $a^2 - 29a + 60 = 0$.

Formula

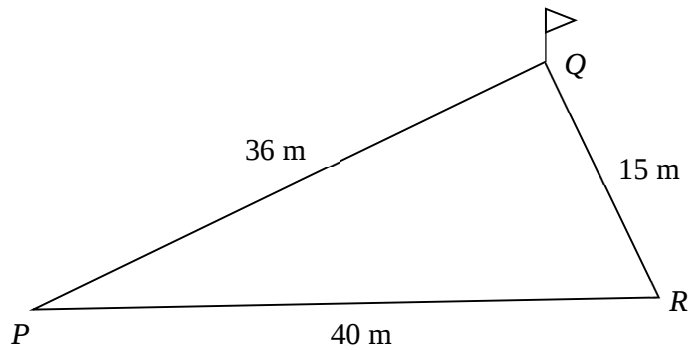
$$a = 2.2423 \text{ or } 26.7576$$

Answer $a = \dots\dots\dots$ or $\dots\dots\dots$ [3]

(e) Explain why one of the values of a has to be rejected.

Answer $(a - 5)$ gives a negative value when $a = 2.24$ s. Time cannot be negative. [1]

- 7 The diagram shows a triangular plot of field PQR . $PQ = 36$ m, $QR = 15$ m and $PR = 40$ m.



- (a) Prove that angle PQR is not a right angle.

Answer

[2]

$$\begin{aligned}
 40^2 &= 36^2 + 15^2 - 2(36)(15)\cos \theta \\
 \cos \theta &= \frac{36^2 + 15^2 - 40^2}{2(36)(15)} \\
 \theta &= 94.1948
 \end{aligned}
 \qquad
 \begin{aligned}
 &PQ^2 + QR^2 = 36^2 + 15^2 = 1521 \\
 &PR^2 = 40^2 = 1600 \\
 &PQ^2 + QR^2 \neq PR^2 \\
 &\text{Using Pythagoras Theorem, } \triangle PQR \text{ is} \\
 &\text{not a right-angled triangle.} \\
 &\angle PQR \neq 90^\circ
 \end{aligned}$$

- (b) Hence calculate angle PRQ .

$$\begin{aligned}
 36^2 &= 40^2 + 15^2 - 2(40)(15)\cos \theta \\
 \cos \angle PRQ &= \frac{40^2 + 15^2 - 36^2}{2(40)(15)} \\
 \angle PRQ &= 68.8429 \\
 &\approx 63.8^\circ
 \end{aligned}$$

Answer° [3]

- (c) Calculate the area of the triangular plot of field PQR .

$$\begin{aligned}
 &\frac{1}{2}(40)(15)\sin 63.8429 \\
 &= 269.27660 \\
 &\approx 269 \text{ m}^2
 \end{aligned}$$

Answer m² [2]

- (d) Find the shortest distance from Q to the line PR .

$$\frac{1}{2} \times h \times 40 = 269.27660$$

$$h = 13.46383$$

$$\approx 13.5 \text{ m}$$

Answer m [2]

- (e) A bird is perched on top of a 4.5 m vertical flag post located at Q . A man walks in a straight line from P to R . Calculate the greatest angle of depression of the man from the bird.

$$\tan \theta = \frac{4.5}{13.46383}$$

$$\theta = 18.4811$$

$$\approx 18.5^\circ$$

Answer° [2]

- 8 The variables x and y are connected by the equation $y = \frac{2}{x} - \frac{x^2}{4} + 3$.

Some corresponding values of x and y are given in the table below.

x	-6	-5	-4	-3	-2	-1	-0.5	-0.3
y	-6.3	-3.7	p	0.1	1	0.8	-1.1	-3.7

- (a) Find the value of p .

Answer $p = -1.5$ [1]

- (b) Draw the graph of $y = \frac{2}{x} - \frac{x^2}{4} + 3$ for $-6 \leq x < 0$. [3]

- (c) Use your graph to find the values of x when $y = -2$.

Answer $x = \dots -4.25 \dots$ and $\dots -0.4 \dots$ [1]

- (d) By drawing a tangent, find the gradient of the curve at $x = -1$.

Answer -1.5 [2]

- (e) By drawing a suitable straight line on the same axes, solve $-\frac{x^2}{4} + \frac{2}{x} + 2 - x = 0$

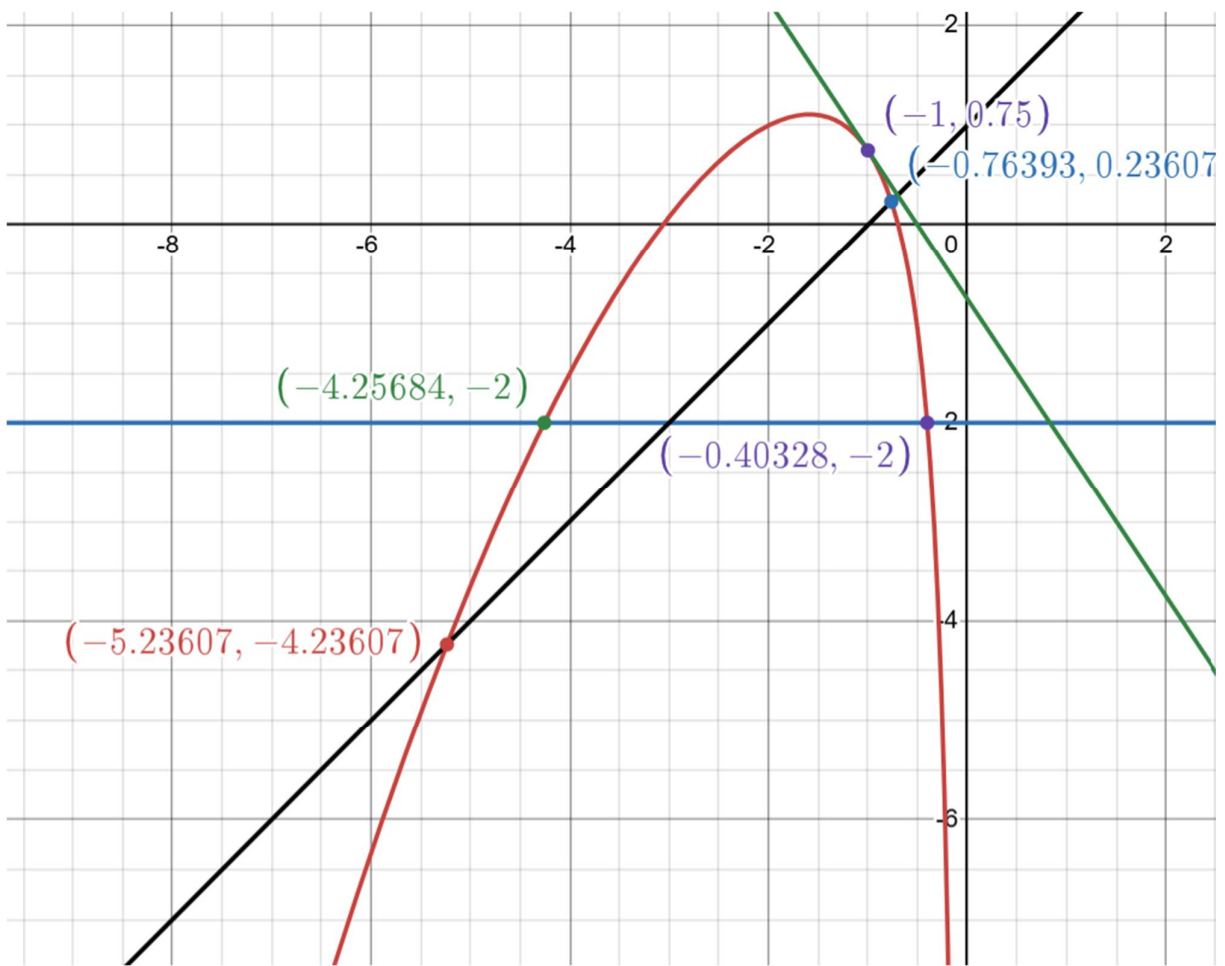
$$-\frac{x^2}{4} + \frac{2}{x} + 2 - x = 0$$

$$\frac{2}{x} - \frac{x^2}{4} = x - 2$$

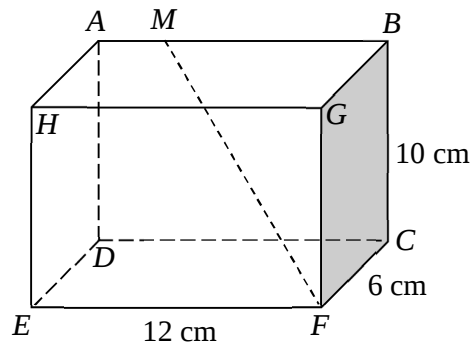
$$\frac{2}{x} - \frac{x^2}{4} + 3 = x - 2 + 3$$

$$\frac{2}{x} - \frac{x^2}{4} + 3 = x + 1$$

Answer $x = \dots -0.75 \dots$ and $\dots -5.2 \dots$ [3]



- 9 The solid shown is a cuboid.
 $EF = 12$ cm, $BC = 10$ cm, $CF = 6$ cm and $2AM = BM$.



- (a) Show that the length of $MF = 14.14$ cm, correct to 2 decimal places.

Answer

[2]

$$3AM = 12 \text{ cm}$$

$$AM = 4 \text{ cm}$$

$$BM = 8 \text{ cm}$$

$$\therefore MG = 10 \text{ cm}$$

$$MF = \sqrt{10^2 + 10^2}$$

$$= 14.142135$$

$$\approx 14.14 \text{ cm (shown)}$$

- (b) Find angle EFM .

$$\cos \angle EFM = \frac{8}{14.142135}$$

$$\angle EFM = 55.550$$

$$\approx 55.6^\circ$$

Answer ° [2]

(c) Calculate the length of EM .

$$EM^2 = 12^2 + 14.142135^2 - 2(12)(14.142135)\cos(55.550)$$

$$EM = 12.32880$$

$$EM \approx 12.3 \text{ cm (3sf)}$$

Answer cm [2]

(d) Find angle EMF .

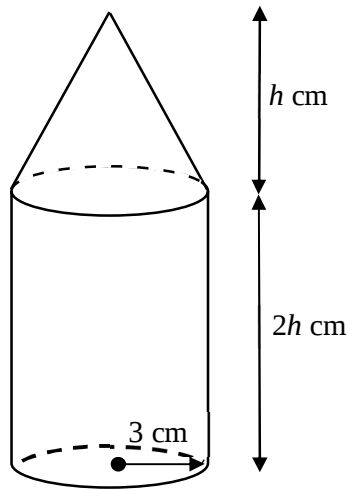
$$\frac{\sin \angle EMF}{12} = \frac{\sin(55.550)}{12.32880}$$

$$\angle EMF = 53.38175$$

$$\approx 53.4^\circ$$

Answer ° [2]

- 10** The diagram shows a metal solid consists of a cylinder and a cone. The radius of the cylinder is 3 cm and the height of the cylinder is twice the height of the cone. The cone and the cylinder have the same radius. The total volume of the solid is $105\pi \text{ cm}^3$.



- (a)** Show that the height of the cone is 5 cm.

Answer

[2]

$$\begin{aligned}\pi(3)^2(2h) + \frac{1}{3}\pi(3)^2h &= 105\pi \\ 18\pi h + 3\pi h &= 105\pi \\ 21\pi h &= 105\pi \\ h &= 5 \text{ (shown)}\end{aligned}$$

- (b)** Find the total surface area of the solid.

$$\begin{aligned}\pi rl + 2\pi rh + \pi r^2 \\ &= \pi(3)(\sqrt{5^2 + 3^2}) + 2\pi(3)(10) + \pi(3)^2 \\ &= 271.72532 \\ &\approx 272 \text{ cm}^2\end{aligned}$$

Answer cm^2 [3]

- (c) The solid is melted down and recast into a solid sphere. Find the radius of the sphere, correct to 2 decimal places.

$$\frac{4}{3}\pi r^3 = 105\pi$$

$$r^3 = 105 \times \frac{3}{4}$$

$$r = 4.28630$$

$$\approx 4.29 \text{ cm}$$

Answer cm [2]

- 11** Mr Tan, his wife, three sons and his 72 year old mother live together in a HDB flat. His mother goes to the day care centre for the elderly.

To be eligible for government subsidies for day care services, the subsidy amount is determined based on the combined annual income of all working family members residing in the household, including bonuses. The monthly household income per person is then calculated and used to determine the subsidy amount according to the formula below.

$$\text{monthly household income per person} = \frac{\text{total annual income of all household members}}{\text{number of household members} \times 12}$$

Eligibility for day care subsidies

Source: www.ntuchealth.sg

Criteria for monthly household income per person	Level of subsidy
\$800 and below	80%
\$801 - \$1,200	75%
\$1,201 - \$1,900	60%
\$1,901 - \$2,000	50%
\$2,001 - \$2,800	30%
\$2,801 and above	0%

In January 2023, Mr Tan applied for subsidies for his mother. Only Mr Tan and his wife were working in 2022.

Mr Tan earned a monthly income of \$9000 and his company paid him a bonus of 1.2 months' pay in 2022.

Mrs Tan earned a weekly income of \$800. For every full 10 weeks of work, she will receive an additional 5% of the 10 weeks' income. She worked for 46 weeks in 2022.

- (a) Calculate the total annual household income of Mr Tan and his wife in 2022.

$$\begin{aligned}\text{Mr Tan's income} &= 9000 \times 12 + 9000 \times 1.2 \\ &= \$118800\end{aligned}$$

$$\begin{aligned}\text{Mrs Tan's income} &= 800 \times 10 \times 4 \times 1.05 + 800 \times 6 \\ &= \$38400\end{aligned}$$

$$\text{Total} = \$157200$$

Answer \$ [3]

- (b) Calculate the monthly household income per person of Mr Tan's family.

$$\begin{aligned}\text{monthly household income} &= \frac{157200}{6 \times 12} \\ &= \$2183.33 \text{ (2dp)}\end{aligned}$$

Answer \$ [2]

- (c) Hence, determine the level of subsidy that the Tan family will qualify for.

Answer30..... % [1]

- (d) Mr Tan's eldest son started working on 1 March 2023. If the Tan family did not qualify for any subsidies when they re-applied again in January 2024, calculate the minimum possible monthly income of Mr Tan's son, given that he did not receive any annual bonus in 2023.

Assume that Mr and Mrs Tan's annual income remained unchanged.

Give your answer correct to the nearest \$.

$$\begin{aligned}\text{Total household income} &= 2801 \times 6 \times 12 \\ &= \$201672\end{aligned}$$

$$\begin{aligned}\text{Son's income} &= 201672 - 157200 \\ &= \$44472\end{aligned}$$

$$\begin{aligned}\text{min possible monthly income} &= \frac{44472}{10} \\ &= \$4447.20 \\ &\approx \$4448 \text{ (nearest dollar)}\end{aligned}$$

Answer \$ [3]

End of Paper