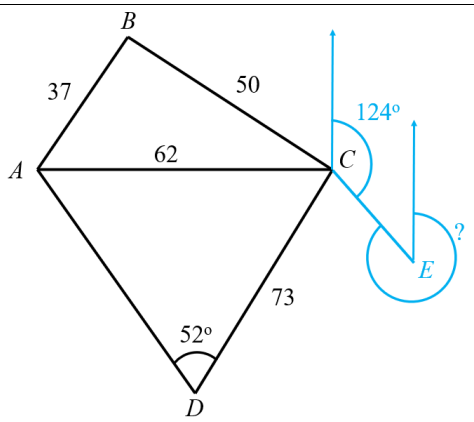
2025 Sec 4E Math Prelim Paper 2 Marking Scheme

Qn		Working	Mark Awarded	Sub-total	Remarks
1	(a)	$-5 \le 2x-1 < x+3$ $-5 \le 2x-1$ and $2x-1 < x+3$ $-4 \le 2x$ $x < 4$ $-2 \le x$ $-2 \le x < 4$ Primes that satisfy the inequality: 2, 3	M2 A1	 3	M1 for $-2 \le x$ M1 for $x < 4$
	(b)	$\frac{30x^2y^2}{11z} \div \frac{25xz^3}{22y}$ $= \frac{30x^2y^2}{11z} \times \frac{22y}{25xz^3}$ $= \frac{12xy^3}{5z^4}$	B3	2	4 terms to simplify: $\frac{12}{5}$, x, y^3, z^4. **B1** for one correct term in the correct position (numerator or denominator). **B2** for two or three correct terms. **B3** for all four correct terms.
	(c)	$\left(\frac{p^{12}}{81q^{16}}\right)^{-\frac{3}{4}}$ $= \left(\frac{81q^{16}}{p^{12}}\right)^{\frac{3}{4}}$ $= \frac{27q^{12}}{p^9}$	B2	2	B1 for numerator, B1 for denominator.
	(d)	$\frac{x}{x-1} + 2 = \frac{4}{2-x}$ $\frac{x+2(x-1)}{x-1} = \frac{4}{2-x}$ $\frac{3x-2}{x-1} = \frac{4}{2-x}$ $(3x-2)(2-x) = 4(x-1)$ $6x - 3x^2 - 4 + 2x = 4x - 4$ $-3x^2 + 4x = 0$ $x(-3x + 4) = 0$ $x = 0$ or $-3x + 4 = 0$ $x = \frac{4}{3}$	 M1 M1 A1	 3	M1 for correct quadratic equation. M1 for correct factorisation or correct substitution into quadratic formula A1 for both correct answers.

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Qn		Working	Mark Awarded	Sub-total	Remarks
2	**(a)(i)**	$(-4, 9)$	B1	1	
	(a)(ii)	Gradient $= \dfrac{\text{rise}}{\text{run}}$ $= \dfrac{5}{-3}$ $= -\dfrac{5}{3}$ $y = mx + c$ $y = -\dfrac{5}{3}x + c$ When $x = -1$ and $y = 4$, $4 = -\dfrac{5}{3}(-1) + c$ $c = \dfrac{7}{3}$ $y = -\dfrac{5}{3}x + \dfrac{7}{3}$	M1 A1	 2	M1 for correct gradient.
	(b)	$D(3, y)$ Length of $CD = 3$ $\sqrt{(3-(-2))^2 + (y-5)^2} = 13$ $(3-(-2))^2 + (y-5)^2 = 13^2$ $5 + (y-5)^2 = 13^2$ $(y-5)^2 = 13^2 - 5^2$ $(y-5)^2 = 144$ $y - 5 = \pm 12$ $y = 5 \pm 12$ $y = -7$ or $y = 17$ $D(3, -7)$ $D(3, 17)$	M1 M1 A1	 3	M1 for identifying that the x-coordinate of D is 3. M1 for correct formula for length of line segment. A1 for both correct answers.

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Qn		Working	Mark Awarded	Sub-total	Remarks
3	(a)	Cosine Rule $62^2 = 37^2 + 50^2 - 2(37)(50)\cos\angle ABC$ $62^2 - 37^2 - 50^2 = -2(37)(50)\cos\angle ABC$ $\dfrac{62^2 - 37^2 - 50^2}{-2(37)(50)} = \cos\angle ABC$ $\angle ABC = \cos^{-1}\left(\dfrac{62^2 - 37^2 - 50^2}{-2(37)(50)}\right)$ $\angle ABC = 89.61286341°$ $\angle ABC = 89.6°$ (to 1 d.p.)	M1 M1 A1	 3	M1 for correct substitution of values into Cosine Rule. M1 for rearranging and making $\angle ABC$ the subject of the equation.
	(b)	 Method 1: Interior angles 180° – 124° = 56° (interior angles, parallel lines) 360° – 56° = 304° (angles at a point) Method 2: Alternate angles 180° + 124° = 304°	 B1 [B1]	 1	B1 for 304° Angle properties not required.
	(c)	Sine Rule $\dfrac{\sin\angle CAD}{73} = \dfrac{\sin 52°}{62}$ $\sin\angle CAD = \dfrac{73\sin 52°}{62}$ $\angle CAD = \sin^{-1}\left(\dfrac{73\sin 52°}{62}\right)$ Let the North of A be N. Since A is due west of C, $\angle NAC = 90°$	M1 M1		M1 for substituting the values correctly into Sine Rule. M1 for rearranging the equation and finding the value of $\angle CAD$.

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Qn		Working	Mark Awarded	Sub-total	Remarks
		Bearing of D from A $= \angle NAC + \angle CAD$ $= 90° + \sin^{-1}\left(\frac{73\sin 52°}{62}\right)$ $= 158.0973671°$ $= 158.1°$ (to 1 d.p.)	 A1	 3	
	(d)	Using TOA CAH SOH, $\tan 8° = \frac{CF}{50}$ $CF = 50\tan 8°$ $\tan \angle FDC = \frac{CF}{73}$ $\tan \angle FDC = \frac{50\tan 8°}{73}$ $\angle FDC = \tan^{-1}\left(\frac{50\tan 8°}{73}\right)$ $\angle FDC = 5.498398955°$ $\angle FDC = 5.5°$ (to 1 d.p.)	 M1 M1 A1	 3	 M1 to find correct height of flagpole. M1 for correct equation involving $\angle FDC$ and CF.
4	**(a)**	<table><tr><th>Town A to Town B</th><th>Town B</th><th>Town B to Town C</th></tr><tr><td>Speed x km/h</td><td></td><td>Speed $(x-20)$ km/h</td></tr><tr><td>Time 1 h</td><td>30 min</td><td>x min</td></tr></table> Total distance $= (x)(1) + (x-20)\left(\frac{x}{60}\right)$ $= x + \frac{x(x-20)}{60}$ $x + \frac{x(x-20)}{60} = 120$ $60x + x(x-20) = 7200$ $60x + x^2 - 20x = 7200$ $x^2 + 40x - 7200 = 0$ (shown)	 M1 M1 A1	 3	 M1 for correct distance from Town B to Town C $\frac{x(x-20)}{60}$. M1 for equating total distance to 120. Correct expansion and simplication of equation

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Qn		Working	Mark Awarded	Sub-total	Remarks
	(b)	$x^2 + 40x - 7200 = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $x = \frac{-40 \pm \sqrt{40^2 - 4(1)(-7200)}}{2(1)}$ $x = \frac{-40 \pm \sqrt{30400}}{2}$ $x = 67.17797887$ or $x = -107.1779789$ $x = 67.18$ (to 2 d.p.) or $x = -107.18$ (to 2 d.p.)	M1 A2	3	M1 for substitution of values into quadratic formula correctly. A1 for each correct x. Deduct one mark if not 2 d.p.
	(c)	$x = -107.18$ is rejected as **time/speed cannot be negative.**	B1	1	
	(d)	Difference in time = 67.17797887 – 60 minutes = 7.17797887 minutes = 7 minutes (0.17797887×60) seconds = 7 minutes 10.67873225 seconds = 7 minutes 11 seconds	B1	1	
	(e)	Total distance = 120 km Total time = 1 h + 0.5 h + $\frac{67.17797887}{60}$ h = 2.619632981 h Average speed = $\frac{\text{total distance}}{\text{total time}}$ = $\frac{120}{2.619632981}$ = 45.8 km/h	M1 M1 A1	3	M1 for correct calculation of total time. M1 for substitution of total distance / total time.
5	**(a)(i)**	$150 < x \leq 160$	B1	1	
	(a)(ii)	Estimate of Mean Height = $\frac{3(145) + 10(155) + 7(165) + 4(175) + 1(185)}{25}$ = 161 cm	B1	1	

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Qn		Working	Mark Awarded	Sub-total	Remarks
	(a)(iii)	10.19803903 = 10.2 (to 3 s.f.)	B1	1	
	(a)(iv)	We do not know the actual heights of the students.	B1	1	
	(a)(v)	The **<u>mean height</u>** of the five students is **<u>less that 161 cm</u>**.	B1	1	
5	**(b)(i)**	$\frac{3}{15} = \frac{1}{5}$	B1	1	
	(b)(ii)	P(both different colours) = 1 – P(both same colours) = 1 – [P(red, red) + P(blue, blue) + P(Y, Y)] $= 1 - \left[\left(\frac{5}{15}\times\frac{4}{14}\right)+\left(\frac{7}{15}\times\frac{6}{14}\right)+\left(\frac{3}{15}\times\frac{2}{14}\right)\right]$ $= 1-\frac{34}{105}$ $= \frac{71}{105}$ <u>Alternative Method</u> P(red, blue) + P(red, yellow) + P(blue, red) + P(blue, yellow) + P(yellow, red) + P(yellow blue) $= \left(\frac{5}{15}\times\frac{7}{14}\right)+\left(\frac{5}{15}\times\frac{3}{14}\right)+\left(\frac{7}{15}\times\frac{5}{14}\right)$ $+\left(\frac{7}{15}\times\frac{3}{14}\right)+\left(\frac{3}{15}\times\frac{5}{14}\right)+\left(\frac{3}{15}\times\frac{7}{14}\right)$ $= \frac{71}{105}$	M1 A1 [M1] [A1]	2 [2]	M1 for correct calculation. M1 for correct calculation.
	(b)(iii)	P(two red, one blue) = P(R, R, B) + P(R, B, R) + P(B, R, R) $= \frac{5}{15}\times\frac{5}{15}\times\frac{7}{15}\times 3$ $= \frac{7}{45}$	M2 A1	3	M1 for $\frac{5}{15}\times\frac{5}{15}\times\frac{7}{15}$ M1 for ×3
6	**(a)**	$\frac{30}{10} = 3\,\text{m/s}^2$	B1	1	

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<table>
<tr><th colspan="2">Qn</th><th>Working</th><th>Mark Awarded</th><th>Sub-total</th><th>Remarks</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td>Duration of deceleration
$= \frac{30}{2} = 15$ s

Total time = 45 s

OR

<u>Method 2: Use gradient</u>
$\frac{30-0}{t-30} = 2$
$30 = 2(t-30)$
$30 = 2t - 60$
$t = 45$

Total distance
= area of trapezium
$= \frac{1}{2} \times (20+45) \times 30$
= 975 km</td><td>M1

[M1]

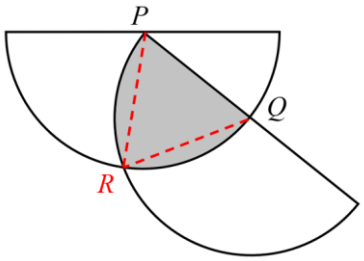
M1
A1</td><td>3</td><td>M1 for finding the correct total time of the journey, 45 s.

M1 for area of trapezium.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>(a)(i)</td><td>$\frac{d}{10} = \frac{15}{25}$
$d = \frac{15}{25} \times 10$
$d = 6$ cm</td><td>M1

A1</td><td>2</td><td>M1 for correct equation showing the relationship between the diameter and height of the two similar bottles.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>(a)(ii)</td><td><table><tr><th>smaller bottle</th><th>(new) larger bottle</th></tr><tr><td>400 ml</td><td>1.2 litres
= 1200 ml</td></tr><tr><td>400 cm^3</td><td>1200 cm^3</td></tr><tr><td>1 cm^3</td><td>3 cm^3</td></tr><tr><td>1 cm</td><td>$\sqrt[3]{3}$ cm</td></tr><tr><td>15 cm</td><td>$15 \times \sqrt[3]{3}$ cm
= 21.63374355 cm
= 21.6 cm (to 3.s.f.)</td></tr></table>Answer: 21.6 cm</td><td>M1

A1</td><td>2</td><td>M1 for 1 : $\sqrt[3]{3}$ ratio</td></tr>
</table>

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Qn		Working	Mark Awarded	Sub-total	Remarks
		Alternative Method $\left(\frac{h}{15}\right)^3 = \frac{1200}{400}$ $\frac{h}{15} = \sqrt[3]{3}$ $h = \sqrt[3]{3} \times 15$ $h = 21.6$ cm	[M1] [A1]	 [2]	[M1 for $\left(\frac{h}{15}\right)^3 = \frac{1200}{400}$]
	(b)	 $PR = PQ = QR$ (radii) ΔRQR is an equilateral triangle. Area of sector $= \frac{60}{360} \times \pi \times 4^2$ $= \frac{8}{3}\pi$ cm^2 Area of triangle $= \frac{1}{2}(4)(4)\sin 60°$ $= 8\sin 60°$ cm^2 Area of shaded region $= \frac{8}{3}\pi + \frac{8}{3}\pi - 8\sin 60°$ $= 9.826951589$ $= 9.83$ cm^2 (to 3 s.f.)	 M1 M1 M1 M1 A1	 5	M1 for recognizing that ΔRQR is an equilateral triangle, or that $\angle PQR = \angle PRQ = \angle RPQ = 60°$. M1 for area of sector M1 for area of triangle M1 for relating area of sector and area of triangle with area of shaded region
8	**(a)**	$\begin{pmatrix} 48 & 30 & 12 \\ 36 & 24 & 18 \end{pmatrix}$	B1	1	

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Qn		Working	Mark Awarded	Sub-total	Remarks
	(b)	$\begin{pmatrix}10\\15\\20\end{pmatrix}$	B1	1	
	(c)	$\begin{pmatrix}48 & 30 & 12\\36 & 24 & 18\end{pmatrix}\begin{pmatrix}10\\15\\20\end{pmatrix}$ $=\begin{pmatrix}48(10)+30(15)+12(20)\\36(10)+24(15)+18(20)\end{pmatrix}$ $=\begin{pmatrix}1170\\1080\end{pmatrix}$	B2	2	B1 for 1170 B1 for 1080
	(d)	**<u>$1170</u>** represents the **<u>total cost</u>** of making the **<u>chocolate cakes</u>** in **<u>a week</u>**, while **<u>$1080</u>** represents the **<u>total cost</u>** of making the **<u>blackforest cakes</u>** in **<u>a week</u>**.	B1	1	Key points required: - Numbers (1170 and 1080) - Units ($ or "in dollars") - "Cost" - Duration: "in a week" or "six days".
	(e)	<u>Cakes sold in that week:</u> Small Medium Large $\begin{pmatrix}32 & 20 & 8\\30 & 20 & 15\end{pmatrix}$ Chocolate Blackforest <u>Sale price:</u> $\begin{pmatrix}17\\25.50\\34\end{pmatrix}$	M1 M1 M1		M1 for calculating the number of cakes of each type and size sold that week. M1 for calculating the sale price of each size of cake. M1 for calculating the sale of each cake flavour.

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Qn		Working	Mark Awarded	Sub-total	Remarks
		Sales of each type of cake flavour $= \begin{pmatrix} 32 & 20 & 8 \\ 30 & 20 & 15 \end{pmatrix} \begin{pmatrix} 17 \\ 25.50 \\ 34 \end{pmatrix}$ $= \begin{pmatrix} 32(17)+20(25.50)+8(34) \\ 30(17)+20(25.50)+15(34) \end{pmatrix}$ $= \begin{pmatrix} 1326 \\ 1530 \end{pmatrix}$ Total sales: $(1 \quad 1)\begin{pmatrix} 1326 \\ 1530 \end{pmatrix} = (2856)$ Total profit = 2856 – 2250 = \$606	A1	4	
		<u>Alternative Method</u> $\frac{2}{3}(1170)(1.7)+\frac{5}{6}(1080)(1.7)$ $=1326+1530$ $=2856$ Total profit = 2856 – 2250 = \$606	[M2] [M1] [A1]	[3]	[M1 for $\frac{2}{3}(1170)$ and $\frac{5}{6}(1080)$] [M1 for multiplying both by 1.7] [M1 for adding both together to find total sales]
9	**(a)**	–1, –1	B1	1	
	(b)	B1 for 4 correctly plotted points. B2 for 7 correctly plotted points. B1 for smooth curve. Deduct one mark if graph goes beyond –1 or 3.	B2 B1	3	
	(c)	Draw a tangent – M1 Gradient = 3 ± 0.5	M1 A1	2	M1 for drawing a tangent on the graph where $x = 1$.

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Qn		Working	Mark Awarded	Sub-total	Remarks
	(d)	$3-x=\frac{1}{x^2}-\frac{1}{x}$ $3x^2-x^3=1-x$ $3x^2-x^3-1=-x$ Draw the line $y=-x$. Acceptable range: $x=-0.55$ to -0.8 and $x=0.35$ to 0.55	 M1 M1 A1	 3	M1 for obtaining $3x^2-x^3-1=-x$ M1 for drawing the line $y=-x$. A1 for both correct answers.
10	**(a)**	1 m = 3.28 feet 1 m^2 = 3.28^2 $feet^2$ 60×3.28^2 $feet^2$ = 645.504 $feet^2$ = 646 $feet^2$ (to 3 s.f.)	M1 A1	 2	M1 for correct ratio of m^2 to $feet^2$. A1 for 60×3.28^2 and 645.504 (more 3 s.f.).
	(b)	$\$990\times645.504$ $=\$639\ 048.96$ OR $\$990\times646$ $=\$639\ 540$	B1 [B1]	 1	Exact floor area is used. Rounded-off floor area from **part (a)** is used.
	(c)	Let $\$x$ be the cost of the unit. Amount to be covered using housing loan $=\$0.55x$ Simple interest $=\frac{PRT}{100}$ $=\frac{0.55x\times3.0\times25}{100}$ $=0.4125x$ Total amount to be repaid for housing loan $=0.55x+0.4125x$ $=0.9625x$ Each monthly instalment	 M1 M1	 	 M1 for calculating simple interest M1 for calculating the total loan amount to be repaid.

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Qn		Working	Mark Awarded	Sub-total	Remarks
		$= \frac{0.9625x}{12 \times 25}$ $= \frac{77x}{24000}$ 30% of gross monthly salary $= 30\% \times 7500$ $= \$2250$ $\frac{77x}{24000} \leq 2250$ $x \leq 701\ 298.70$ (to 2 d.p.) Amount for additional levels $= 701\ 298.70 - 639\ 048.96$ $= \$62\ 249.74$ Maximum number of additional levels $= \frac{62\ 249.74}{16\ 000}$ $= 3.89060875$ $= 3$ (round down to nearest integer) Maximum level that Lisa can afford to purchase $= 1 + 3$ $= 4^{th}$ level	M1 M1 M1 M1 A1	7	M1 for calculating one monthly instalment. M1 for inequality between monthly instalment and 30% of gross monthly income. M1 for calculating amount for additional levels M1 for rounding down to find number of additional levels.
		<u>Alternative Method 2:</u> (Calculate price of unit on the first level then increase of each level). <u>Unit on the First Level:</u> Total amount to be repaid for housing loan $= \frac{0.55 \times 639048.96 \times 3 \times 25}{100} + 0.55 \times 639048.96$ $=615\ 084.63$ Each monthly instalment $= \frac{615084.62}{25 \times 12}$ $= 2050.28$ <u>Increase per level</u>	[M1] [M1]		M1 for calculating simple interest. ECF from (b). M1 for calculating one monthly instalment.

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Qn		Working	Mark Awarded	Sub-total	Remarks
		Increase in amount to be covered using housing loan per level $= 16000 \times 0.55$ $= \$8800$ Increase in amount to be repaid for housing loan per level $= \frac{8800 \times 3 \times 25}{100} + 8800$ $= \$15\ 400$	[M1]		M1 for calculating simple interest.
		Increase in each monthly instalment per level $= \frac{15400}{12 \times 25}$ $= \$51.33$	[M1]		M1 for calculating increase in each monthly instalment per level.
		30% of gross monthly salary $= 30\% \times 7500$ $= \$2250$			
		Let x be the maximum number of additional levels possible. $2050.28 + 51.33x \leq 2250$ $2050.28 + 51.33x \leq 2250$ $51.33x \leq 199.72$ $x \leq 3.8909$ $x = 3$ The maximum level that Lisa can afford to purchase is the 4th level.	[M1] [M1] [A1]	[7]	M1 for inequality between monthly instalment and 30% of gross monthly income. M1 for finding the maximum number of additional levels.
		<u>Method 3: Guess and Check</u> <u>If the unit is on the 4th level, then</u> the price of the flat $= \$639\ 048.96 + 3(16000)$ $= \$687\ 048.96$ Amount to be covered using housing loan $= 0.55 \times 687048.96$ Simple interest Total amount to be repaid for housing loan	[M1]		M1 for calculating price of unit on 4th level.

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Qn	Working	Mark Awarded	Sub-total	Remarks
	$= \frac{0.55 \times 687048.96 \times 3 \times 25}{100} + 0.55 \times 687048.96$ $= \$661\ 284.62$	[M1]		M1 for simple interest.
	Each monthly instalment $= \frac{661284.62}{12 \times 25}$ $= \$2204.28$	[M1]		M1 for monthly instalment
	30% of gross monthly salary $= 30\% \times 7500$ $= \$2250$			
	$2204.28 < 2250$	[M1]		M1 for inequality.
	4^{th} floor is within Lisa's budget.			
	<u>If the unit is on the 5^{th} level, then</u>			
	the price of the flat $= \$639\ 048.96 + 4(16000)$ $= \$703\ 048.96$	[M1]		M1 for considering 5^{th} unit (as a form of comparison).
	Amount to be covered using housing loan $= 0.55 \times 703048.96$			
	Simple interest Total amount to be repaid for housing loan $= \frac{0.55 \times 703048.96 \times 3 \times 25}{100} + 0.55 \times 703048.96$ $= \$676\ 684.62$			
	Each monthly instalment $= \frac{676684.62}{12 \times 25}$ $= \$2255.62$			
	30% of gross monthly salary $= 30\% \times 7500$ $= \$2250$			
	$2255.62 > 2250$	[M1]		M1 for inequality showing how level 5 is not suitable.
	5^{th} floor is out of Lisa's budget.			
	Therefore, the maximum level that Lisa can afford to purchase is the 4^{th} level.	[A1]		

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Qn		Working	Mark Awarded	Sub-total	Remarks
					A1 for correct conclusion.
		Method 4: Calculate maximum cost of 3-room unit from maximum cost to be paid by monthly instalments. Assuming gross monthly salary remains constant across 25 years. Maximum cost of each monthly instalment $= 30\% \times 7500$ $= \$2250$ Maximum total cost of all monthly instalments $= \$2250 \times 25 \times 12$ $= \$675\ 000$ Let P be the remaining amount to be paid by monthly instalments (55% of the price of the unit). $P + \frac{P \times 3 \times 25}{100} = 675\ 000$ $\frac{7}{4}P = 675\ 000$ $P = \$385714.2857$ (to 4 d.p.) Total cost of planned 3-room unit $= \frac{385714.2857}{55} \times 100$ $= \$701297.7013$ (to 4 d.p.) Maximum number of additional levels $= \frac{701298.7013 - 639048.96}{16000}$ $= 3.8906$ (5.s.f) $= 3$ (round down to nearest whole number) Maximum level that Lisa can afford to purchase $= 1 + 3$ $= 4^{th}$ level	[M1] [M1] [M1] [M1] [M1] [M1]	[7]	[M1 for total cost of all monthly instalments, aka \$675 000] [M1 for calculating simple interest correctly] [M1 for finding 55% of cost of unit] [M1 for calculating 100% of cost of unit] [M1 for calculating additional levels] [M1 for rounding down and finding exact number of additional levels].

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