P1 - Ans

Answer **all** the questions.

1 Expand and simplify $(2p+5q)(3p^2-q+5r)$.

$6p^3-2pq+10pr+15p^2q-5q^2+25qr$

B2 if all terms are correct B1 if at least 3 terms are right

Answer ..... [2]

---

2 Lee has two pieces of string.
Their lengths are in the ratio 5 : 3 and the total length of the two pieces of string is $8x$ cm.
Lee cuts 6 cm from each piece of string.
The ratio of their lengths is now 9 : 5.
Find the value of x. the first piece of string be $5x$ cm.

The first piece of string is $5x$ cm.
The second piece of string is $3x$ cm.

$\frac{5x-6}{3x-6}=\frac{9}{5}$ | M1 for setting up the right equation

$25x-30=27x-54$ | M1 for manipulation of algebraic terms

$24=2x$

$x=12$ | A1

Answer $x=$..... [3]

---

3 A salesperson earns a fixed weekly salary of \$1000 plus 8% commission on the total value of items he sells.

(a) In one week, he sold items worth \$1750.
Calculate the total amount the salesperson earned that week.

Total amount $= \$1000 + \frac{8}{100}\times 1750$

$= \$1140$ | B1

Answer \$..... [1]

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(b) The following week, the salesperson earned a total of \$1450.
Calculate the total value of items he sold that week.

Commission = \$1450 − \$1000
= \$450
8% represents \$450

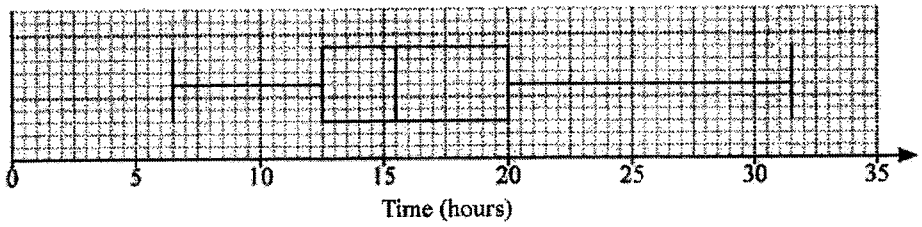
M1 for recognising that 8% rep \$450

100% represents $\$\frac{450}{8}\times 100$
= \$5625

A1

---

4 The box-and-whisker-plot gives information about the time, in hours, that 120 adults spent on social media in one week.



(a) State the median time.

15.5 hours

B1

Answer .....hours [1]

(b) State the range.

Range = 31.5 − 6.5
= 25

B1

Answer ..... hours [1]

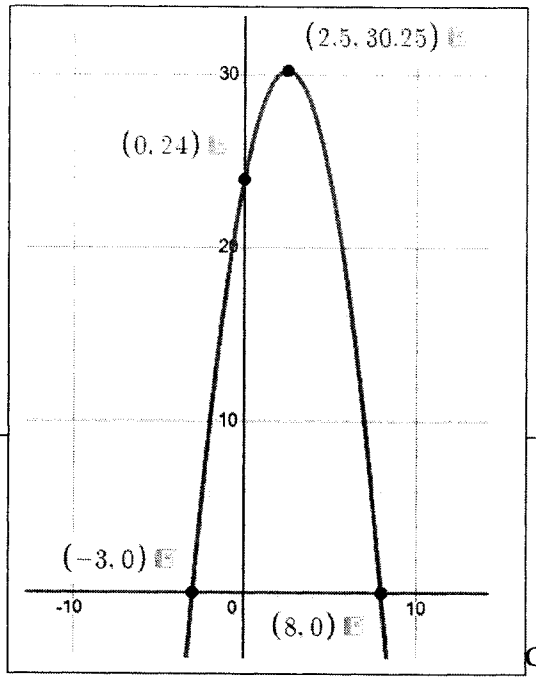
(c) There was an error in the collection of data.
Every adult spent 2 hours less on social media in one week.
Describe the effect this change would have on the box-and-whisker plot.

The whole box-and-whisker plot will move to the **left** by **4 square units**.

B1 all key words must be present

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5 Sketch the graph of $y=-(x+8)(x-3)$ on the axes below.
Indicate clearly the values where the graph crosses the x- and y- axes.



[3]

Coor of turning point (2.5, 30.25)

B1 correct shape and y-intercept
B1 correct turning point
B1 correct x-intercepts

---

6 Express as a single fraction in its simplest form $\frac{4}{3-2y}-\frac{5}{y+3}$.

$$\frac{4}{3-2y}-\frac{5}{y+3}$$
$$=\frac{4y+12-15+10y}{(3-2y)(y+3)}$$

M1 for combining to a single fraction

$$=\frac{14y-3}{(3-2y)(y+3)}$$

A1

Answer ..... [2]

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7 **(a)** A map has a scale of 1 : 2 500 000.

The distance between Singapore and Phuket is 1314 km.
Calculate the distance, in centimetres, between Singapore and Phuket on the map.

25 km represents 1 cm
1314km represents **52.56cm**

M1 for correctly converting from cm to km

A1, exact answer only

Answer .....cm [2]

(b) When a ball is dropped, the distance, d metres, it falls is directly proportional to square of the time, t seconds, from when the ball is released.
The distance from which the ball is dropped is increased by 44%.
Calculate the percentage change in the time taken for the ball to reach the ground.

d	t^2
$1.44\,d$	$(1.2t)^2=1.44\,t^2$

M1 for getting $1.2^2\,t^2$ or 1.2t as t

$$\text{Percentage change} = \frac{1.2t-t}{t}\times 100\%$$
$$= 20\%$$

A1

Answer .....% [2]

---

8 Simplify $\dfrac{x^2-9}{3x^2-9x}$

$$\frac{x^2-9}{3x^2-9x}$$
$$=\frac{(x-3)(x+3)}{3x(x-3)}$$
$$=\frac{x+3}{3x}$$

B2, factorising numerator and denominator correctly

A1

Answer ..... [3]

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9 Factorise $6x^2y^2+xy-3x^2y-2xy^2$.

$6x^2y^2+xy-3x^2y-2xy^2$
$=xy(6xy+1-3x-2y)$ — M1 for extracting common term
$=xy(6xy-3x+1-2y)$
$=xy[3x(2y-1)-(2y-1)]$ — M1 for factorising by grouping
$=xy(3x-1)(2y-1)$ — A1

Answer ..... [3]]

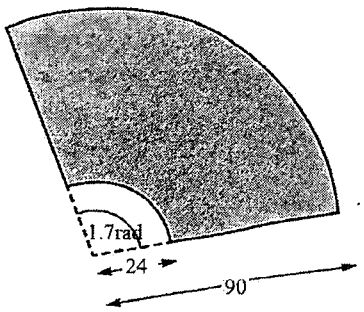
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10 Five positive integers have a mean of 6, a median of 7 and a mode of 10.
Find the five numbers.

1, 2, 7, 10,10 — B2 for getting all the numbers correct right
B1 if for getting 7, 10, 10

Answer ....., ..., ..., ..., ...[2]

11



Calculate the perimeter of the shaded area.
All lengths are in centimetres.

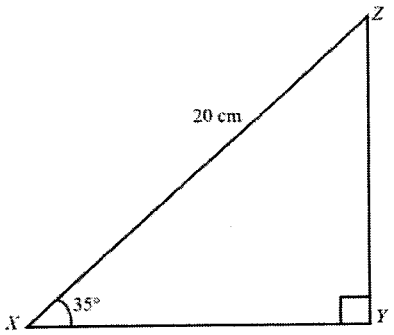
Perimeter of shaded area = $1.7\times24+1.7\times90+2(66)$ — M1 for setting up the equation correctly

= 325.8 cm — A1, exact so do not accept 3 s.f ans

..... cm [2]

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12



(a) Calculate the distance YZ.

$\sin 35° = \frac{YZ}{20}$ M1 for setting up the correct equation

$YZ = 20\sin 35°$

$= 11.472$ cm

$= 11.5$ cm (3 s.f.) A1

Answer $YZ =$ .....cm [2]

(b) Calculate the area of triangle XYZ.

$\cos 35° = \frac{XY}{20}$

$XY = 20\cos 35°$

$= 16.383$ cm M1 for finding XY

$= 16.4$ cm (3 s.f.)

Area of triangle $XYZ =$

$= 94.0$ cm^2 A1

Alternative solution

$\angle XZY = 55°$ M1 for finding angle XZY

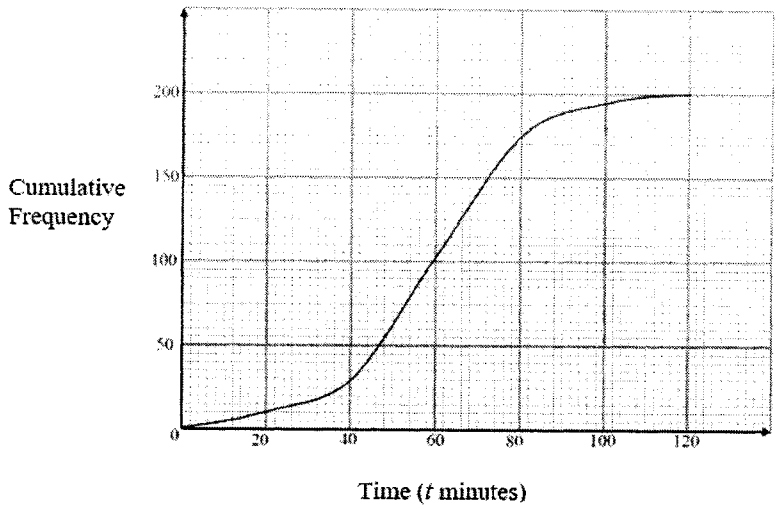
Area of triangle $= \frac{1}{2} \times (20)(11.472)\sin 55°$

$= 94.0$ cm^2 A1

Answer ..... cm^2 [2]

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13 A group of 200 people estimated the time, t minutes, they spent at an exhibition. The cumulative frequency diagram represents their estimates.



(a) Use the diagram to find the estimated interquartile range of the estimated times.

Interquartile range = 72 – 47 — M1 for finding the UQ and LQ

= 25 minutes — A1

Answer .....minutes [2]

(b) One of these people is chosen at random.

The probability that the person's estimate is greater than t minutes is $\frac{4}{5}$.

Find the value of t.

Probability of a person's estimate less than or equal to t minutes is $\frac{1}{5}$.

Number of people = 40 — M1 for 40

From graph, t = 44 — A1

Answer t = ... [2]

[Turn over

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14 $n = \dfrac{m\left(x - y^2\right)}{p}$, where $p \neq 0$.

(a) Find n when $m = 14$, $p = 9$, $x = 2$ and $y = -3$.

$$n = \frac{14(2-9)}{9}$$

$$n = \frac{14(2-9)}{9}$$

$$= -10\frac{8}{9} \text{ or } -\frac{98}{9}$$

A1, exact value, hence do not accept answers corrected to 3 s.f

Answer $n =$ ..... [1]

(b) Rearrange the formula to make y the subject.

$$n = \frac{m\left(x - y^2\right)}{p}$$

$$np = mx - my^2$$

M1 for multiplying n by p

$$my^2 = mx - np$$

$$y^2 = \frac{mx - np}{m}$$

M1 for finding y^2

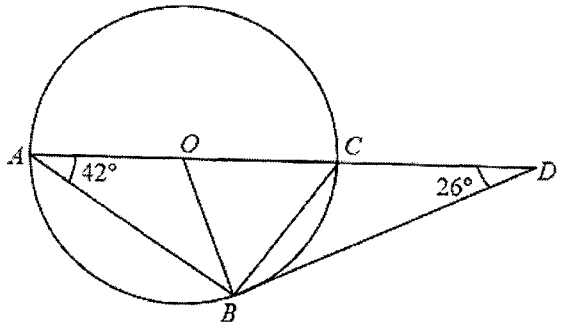
$$y = \pm\sqrt{\frac{mx - pn}{m}} \text{ or } \pm\sqrt{x - \frac{pn}{m}}$$

A1, no marks if $\pm$ is not seen

Answer $y =$ ..... [3]

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15



A, B and C are points on a circle, centre O.
ACD is a straight line, angle $BDC = 26°$ and angle $BAO = 42°$.

(a) Find angle OBC.
Give a reason for each step of your working.

Minus 1 mark if no mention of radii or radius of circle

$OA = OB$ (radii of a circle)
$\angle OBA = 42°$ (base angle of isosceles triangle OAB)
$\angle ABC = 90°$ (angle in a semicircle)
$\angle OBC = 90° - 42°$
$= 48°$ A1

M1 for finding either finding angle OBA or angle ABC

(b) Explain why BD is **not** a tangent to the circle.

$\angle BOC = 84°$ (ext angle of isosceles triangle OBC)
$\angle OBD = 180° - 84° - 26°$(sum of angles in a triangle)
$= 70°$

M1 for finding angle OBD

Since $\angle OBD \neq 90°$, therefore by the converse of the radius perpendicular to tangent, BD is not a tangent to the circle.

A1 stating it's not 90° with (by converse) tangent ⊥ radisus

Alternative solution

$\angle BOC = 84°$ (angle at centre = 2 angle at circumference)
$\angle OBD = 180° - 84° - 26°$(sum of angles in a triangle)
$= 70°$

M1 for finding angle OBD

Since ⟺ , therefore by the converse of the radius perpendicular to tangent, BD is not a tangent to the circle.

A1 stating it's not 90° with (by converse) tangent ⊥ radius

[Turn over

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16 Solve these simultaneous equations.

$$3x+5y+8=0$$
$$4x+13y-2=0$$

You must show your working.

$3x+5y+8=0 \quad -(1)$
$4x+13y-2=0 \quad -(2)$
$(1)\times 4 \quad 12x+20y+32=0 \quad -(3)$
$(2)\times 3 \quad 12x+39y-6=0 -(4)$
$(4)-(3) \quad 19y-38=0$
$y=2$
Sub y = 2 into (1)
$3x+10+8=0$
$3x=-18$
$x=-6$
Ans : $x=-6$ or $y=2$

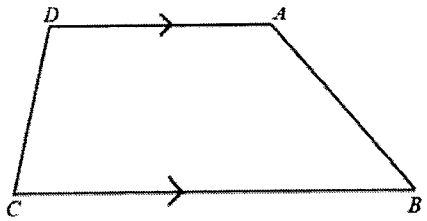
M1 for making coeff of x or y the same/ M1 for making x or y the subject of the equation

M1 for eliminating x or y/ M1for correct substitution

A1 for getting both x and y correct

Answer $x =$ .....
$y =$ ..... [3]

17



ABCD is a trapezium.
The ratio angle *CDA* : angle *DCB* : angle *CBA*= 18 : 6 : 2.
Find angle *DAB*.

24 units represent 180°

1 unit represents 7.5°
2 units represent 15°

$\angle DAB = 180° - 15°$ (int angles, *AB// BC*)
$= 165°$

M1 for recognising that angle *CDA* and *DCB* are int angles. It is good practice to write the angle reasoning so that markers understand your work.

M1 for either applying int angles or sum of angles in quad correctly

A1

Note: Answer mark is deducted if there is no clear indication of the unit of measure used throughout the entire working.

Answer Angle *DAB* = ... [3]

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18 Alice borrowed a sum of money from the bank which charges a compound interest of 3.5% per annum, compounded quarterly.
Given that Alice had to pay \$67.30 in interest at the end of the first year, find the original sum of money borrowed, giving your answer correct to the nearest dollar.

Let the original sum of money Alice borrowed be \$$P$.

$$P + 67.30 = P\left(1+\frac{0.875}{100}\right)^4$$

M1 for setting up the correct equation

$$67.30 = P\left(1+\frac{0.875}{100}\right)^4 - P$$

$$67.30 = P\left[\left(1+\frac{0.875}{100}\right)^4 - 1\right]$$

M1 for factorising, only awarded if original set up has total = principal + interest.

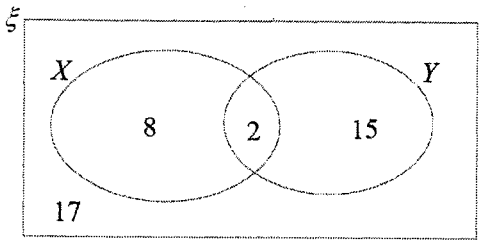
$$P = \frac{67.30}{\left[\left(1+\frac{0.875}{100}\right)^4 - 1\right]}$$

P = \$1898 (nearest dollar) A1

Answer \$ ..... [3]

---

19 The Venn diagram shows the universal set and the number of elements in each of its subsets.



Find the value of

(a) $n(X' \cap Y)'$,

$= 17 + 8 + 2 = 27$ B1

Answer ..... [1]

(b) $n((X' \cup Y) \cap (X \cup Y)')$.

$= 17$ B1

Answer ..... [1]

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20 **(a)** Write 0.0000000357 in standard form.

3.57×10^{-8} B1

Answer ..... [1]

(b) **(i)** Write 5.7×10^{97} in the form $A\times10^{98}$.

$= 0.57\times10^{98}$ B1

Answer ..... [1]

(ii) **Hence** work out $\left(\left(100.2\times10^{98}\right)-\left(5.7\times10^{97}\right)\right)$.
Give your answer in standard form.

$\left(100.2\times10^{98}\right)-\left(0.57\times10^{98}\right)$
$= 99.63\times10^{98}$
$= 9.963\times10^{99}$ B1

Answer ..... [1]

---

21 x is a number between 200 and 300.
The highest common factor of x and 126 is 21.
Find the smallest possible value of x.

$126 = 2\times3^2\times7$ M1 for writing 126 in terms of its prime factors

$HCF = 3\times7$

$x = 3\times7\times11$
$= 231$ A1

Answer $x =$ ..... [2]

22

$$\sin\left(\frac{1}{2}x^\circ\right)=0.961$$

Find two possible values of x in the range $0\le x\le360$.

$$\sin\left(\frac{1}{2}x^\circ\right)=0.961$$

$$\frac{1}{2}x^\circ = 73.946^\circ, 180^\circ - 73.946^\circ$$

$x^\circ = 147.9^\circ$ or 212.1° B1, B1

Note: 1 mark is deducted if both answers are left to 3 significant figures. Students are to follow instructions on cover page.

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23 12 24 8 21 28 17 $2p$ $4p^2$

The list shows information about the number of text messages Mei received each day for 8 days.
The total number of text messages is 140.

(a) Show that $p = 2.5$.

Answer

$12 + 24 + 8 + 21 + 28 + 17 + 2p + 4p^2 = 0$ — M1 for showing the correct set up of equation

$4p^2 + 2p + 110 = 140$

$2p^2 + p - 15 = 0$

$(p+3)(2p-5) = 0$ — M1 for correct factorisation or correct application of quadratic formula

$p + 3 = 0$ or $2p - 5 = 0$

$p = -3$ (rej bec $p > 0$) or $p = 2.5$ (shown) — M1 for applying zero product rule and sound rejection reason.

[3]

(b) The standard deviation for Mei's data is 7.89.

For the same 8 days, Mei's brother also received some text messages.
For his data, the mean is 19 and the standard deviation 8.51.

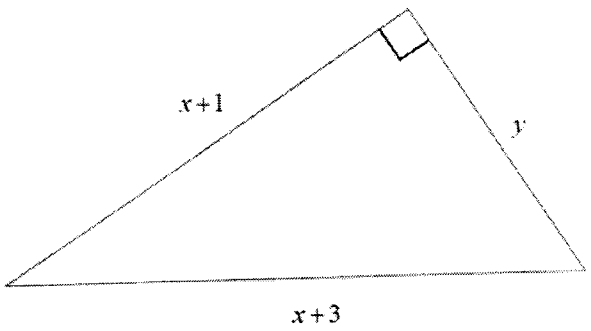
Make two comparisons between the distributions for the number of text messages received by Mei and her brother.

1. Mei's brother received **more text messages** on average because the **mean is higher** at 19 compared to Mei's mean which is 17.5. B1
2. The **number of text messages** Mei's brother received **is less consistent** since the **standard deviation is higher** at 8.51 compared to Mei's which is 7.89. B1

[2]

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24



The right-angled triangle has sides $(x+1)$, $(x+3)$ and y where x and y are integers.

(a) Show that y is an even number.
Answer

$$y^2 = (x+3)^2 - (x+1)^2$$
$$= x^2 + 6x + 9 - (x^2 + 2x + 1)$$
$$= 4x + 8$$
$$= 4(x+2)$$

M1 for setting up the correct equation

M1 for correct expansion/applying difference of squares to reach $4x+8$

Since 4 **is even**, multiplying it by $(x+2)$, an integer, will make y^2 even.
Taking square root of an even number gives an even number.
Therefore y even. (shown)

M1 for convincingly establishing y^2 is even.
A1 for stating that the square root of an even number must be even and concluding for y.

OR

$$y^2 = 4(x+2)$$
$$y = 2\sqrt{x+2}$$

Since y is an integer, $\sqrt{x+2}$ must be an integer.
As such, 2 is a factor of y, therefore y is even.

M1 correct y.
A1 for stating that $\sqrt{x+2}$ is an integer and therefore 2 is a factor. Proper conclusion for y.

[4]

(b) Find a possible value of y and the corresponding value of x.

Let $y^2 = 16^2$
$\therefore y = 4$
Hence $4x + 8 = 16$
$x = 2$

B1: accept any logical y, where y^2 is a multiple of 4

B1

Answer $x =$ ..... $y =$ ..... [2]

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25 Solve the equation $a^2+17a-30=0$ by completing the square.
Give your solutions correct to 2 decimal places.

$a^2+17a-30=0$

$\left(a+\frac{17}{2}\right)^2-\left(\frac{17}{2}\right)^2-30=0$ M1 for completing the square correctly

$\left(a+\frac{17}{2}\right)^2=\left(\frac{17}{2}\right)^2+30$

$\left(a+\frac{17}{2}\right)^2=102.25$

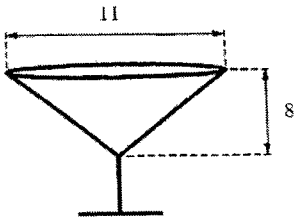
$a+\frac{17}{2}=\pm\sqrt{102.25}$ M1 for taking square root

$a=1.61$ or -18.61 (2 d.p) A1 for both correct answers

Answer $a=$ ..... or $a=$ ..... [3]

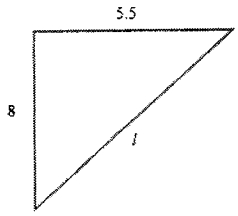
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26



A glass is in the shape of a cone on a stem is filled to the brim with water.
The diameter of the top of the glass is 11 cm.
The height of the cone is 8 cm.
The thickness of the glass is negligible.

(a) Calculate the curved surface area of the inside of the glass.



$l^2 = 5.5^2 + 8^2$
$= 94.25$
$l = \sqrt{94.25}$

M1 for finding the slant height of the cone

Curved surface area of the inside of the glass $= \pi(5.5)\left(\sqrt{94.25}\right)$
$= 168 \text{ cm}^2$ (3s.f.)

A1

Answer ..... cm^2 [2]

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(b) Ethan pours 40% of the water in this glass into a second glass.
The second glass is in the shape of a cylinder.
The depth of water in the cylindrical glass is 2.5 cm.
Calculate the diameter of the cylindrical glass.

Volume of water in the glass $= \frac{1}{3} \times \pi \times 5.5^2 \times 8$

$= 80\frac{2}{3}\pi \text{cm}^3$

M1 for finding the vol of water in the glass

$\pi r^2 (2.5) = 80\frac{2}{3}\pi \times 0.4$

M1 for correct formula of volume of cylinder and taking 40% of their volume of cone.

$r^2 = \frac{80\frac{2}{3} \times 0.4}{2.5}$

$r = \sqrt{\frac{80\frac{2}{3} \times 0.4}{2.5}}$

M1 for correct r

diameter $= 2r$

$= 2 \times \sqrt{\frac{80\frac{2}{3} \times 0.4}{2.5}}$

$= 7.19$ cm (3 s.f)

A1

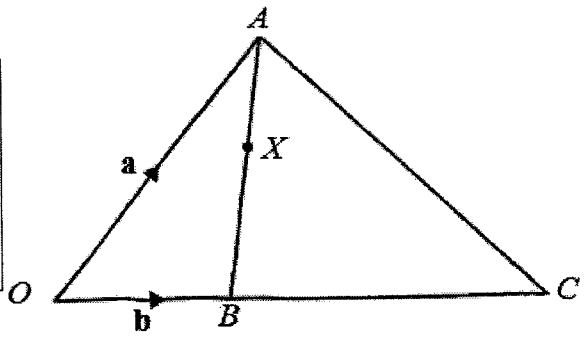
Answer ..... cm [4]

[Turn over

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27

Note: 1 mark is deducted from overall of this question if students did not use proper vector notations.



OAC is a triangle and B is a point on OC.
$\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = \mathbf{b}$ and $OB : BC = 2 : 3$.
X is the point on AB such that $AX : XB = 1 : 2$.

(a) Express $\overrightarrow{AC}$ in terms of **a** and **b**, as simply as possible.

$\overrightarrow{OC} = 2.5\mathbf{b}$
$\overrightarrow{AC} = 2.5\mathbf{b} - \mathbf{a}$

M1 for correct $\overrightarrow{OC}$ in terms of **b**

A1

Answer $\overrightarrow{AC}$ = ... [2]

(b) Express $\overrightarrow{XB}$ in terms of **a** and **b**, as simply as possible.

$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$
$\overrightarrow{XB} = \frac{2}{3}(\mathbf{b} - \mathbf{a})$

M1 for correct $\overrightarrow{AB}$ in terms of **a** and **b**

A1

Answer $\overrightarrow{XB}$ = ... [2]

(c) Y is the point on OC such that $AXYC$ is a trapezium.
Find, in terms of **a** and **b**, $\overrightarrow{XY}$.

For $AXYC$ to be a trapezium, triangle BXY is similar to triangle BAC.

$\frac{XY}{AC} = \frac{BX}{BA} = \frac{2}{3}$

M1 for identifying triangle BXY to be similar to triangle BAC

$\overrightarrow{XY} = \frac{2}{3}\overrightarrow{AC}$

$= \frac{2}{3}\left(\frac{5}{2}\mathbf{b} - \mathbf{a}\right)$

$= \frac{5}{3}\mathbf{b} - \frac{2}{3}\mathbf{a}$

A1

$\overrightarrow{XY}$ = ... [2]

END OF PAPER

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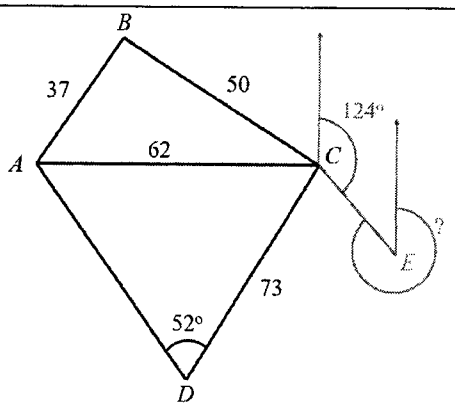
2025 Sec 4E Math Prelim Paper 2 Marking Scheme

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 $= \frac{\text{rise}}{\text{run}}$ $= \frac{5}{-3}$ $= -\frac{5}{3}$ $y = mx + c$ $y = -\frac{5}{3}x + c$ When $x = -1$ and $y = 4$, $4 = -\frac{5}{3}(-1) + c$ $c = \frac{7}{3}$ $y = -\frac{5}{3}x + \frac{7}{3}$	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 $62^2 = 37^2 + 50^2 - 2(37)(50)\cos\angle ABC$ $62^2 - 37^2 - 50^2 = -2(37)(50)\cos\angle ABC$ $\frac{62^2 - 37^2 - 50^2}{-2(37)(50)} = \cos\angle ABC$ $\angle ABC = \cos^{-1}\left(\frac{62^2 - 37^2 - 50^2}{-2(37)(50)}\right)$ $\angle ABC = 89.61286341°$ $\angle ABC = 89.6°$ (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 $\frac{\sin\angle CAD}{73} = \frac{\sin 52°}{62}$ $\sin\angle CAD = \frac{73\sin 52°}{62}$ $\angle CAD = \sin^{-1}\left(\frac{73\sin 52°}{62}\right)$ 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)	**Town A to Town B** | **Town B** | **Town B to Town C** Speed x km/h | | Speed $(x-20)$ km/h Time 1 h | 30 min | x min 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 $= 1\text{ h} + 0.5\text{ h} + \frac{67.17797887}{60}\text{ h}$ $= 2.619632981$ 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 **mean height** of the five students is **less that 161 cm**.	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)] $=1-\left[\left(\frac{5}{15}\times\frac{4}{14}\right)+\left(\frac{7}{15}\times\frac{6}{14}\right)+\left(\frac{3}{15}\times\frac{2}{14}\right)\right]$ $=1-\frac{34}{105}$ $=\frac{71}{105}$ Alternative Method 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]

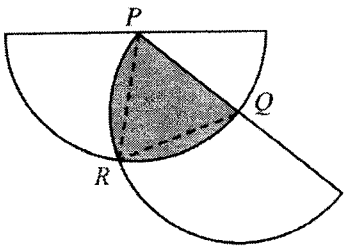
M1
A1</td><td>3</td><td>M1 for finding the correct total time of the journey, 45 s.

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)	**$1170** represents the **total cost** of making the **chocolate cakes** in **a week**, while **$1080** represents the **total cost** of making the **blackforest cakes** in **a week**.	B1	1	Key points required: - Numbers (1170 and 1080) - Units ($ or "in dollars") - "Cost" - Duration: "in a week" or "six days".
(e)	Cakes sold in that week: Small Medium Large $\begin{pmatrix}32 & 20 & 8\\30 & 20 & 15\end{pmatrix}$ Chocolate Blackforest Sale price: $\begin{pmatrix}17\\25.50\\34\end{pmatrix}$	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 × 645.504 = \$639 048.96 OR \$990 × 646 = \$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.
		Method 3: Guess and Check If the unit is on the 4th level, then 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>	[M1]		M1 for considering 5^{th} unit (as a form of comparison).
	the price of the flat $= \$639\ 048.96 + 4(16000)$ $= \$703\ 048.96$			
	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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