

- 1 Circle the irrational number/s from the list below.

1.5π

$2.\dot{3}$

$\sqrt{12.1}$

25.82

[1]

- 2 Simplify $\sqrt[3]{\left(\frac{a^{15}}{b^6}\right)^{-2}}$, leaving your answer in positive indices.

Answer _____ [2]

- 3 Given that one solution for the equation $\frac{1}{2x^2 + kx} = \frac{1}{2}$ is $x = -2$, find
- (i) the value of k ,

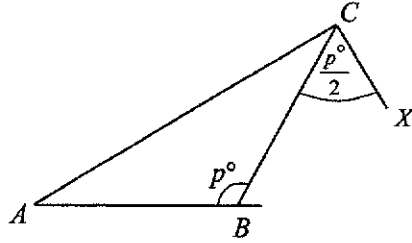
Answer $k =$ _____ [1]

- (ii) a second possible value of x .

Answer $x =$ _____ [1]

5

- 4 The diagram shows an isosceles triangle ABC where angle $ABC = p^\circ$ and $BA = BC$.
Point X is such that angle $BCX = \frac{p^\circ}{2}$.



D is the intersection of AB extended and CX extended.
John claims that AD will form a diameter of a circle with centre B .
Determine whether John's claim is correct or not.

Answer

[2]

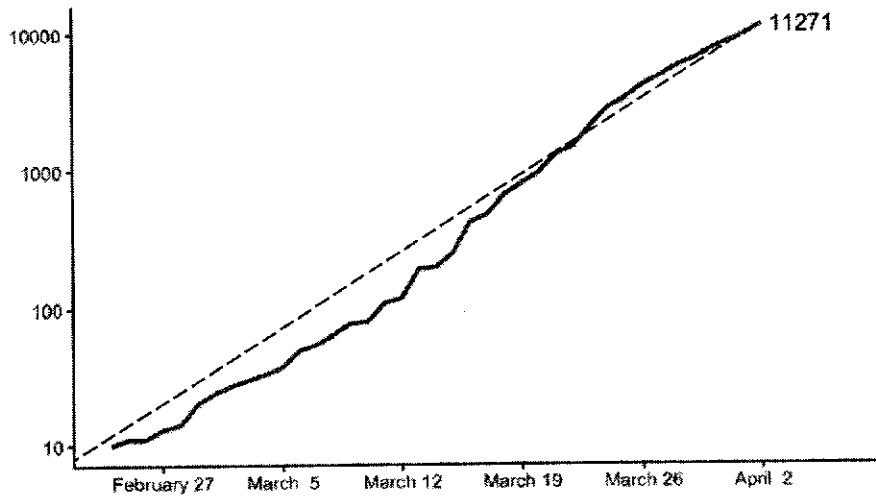
- 5 Given that $2m - 1 = (2n + 3)^2$, where n is a positive integer.
Show that m is an integer.

Answer

[2]

[Turn over

- 6 The graph below shows the trend in the number of cases of people infected with the coronavirus in a particular country.



Source: Johns Hopkins University (CSSE)

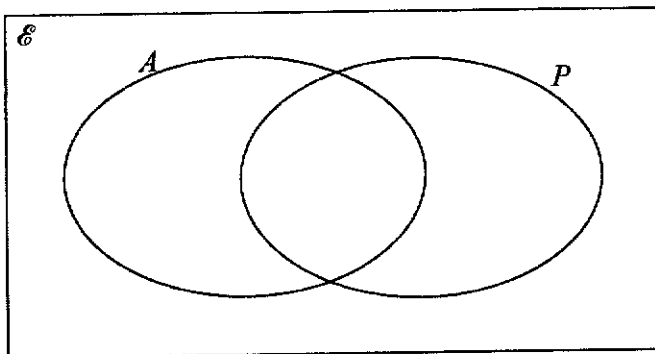
Jamie claims that the trend shown is approximated by a linear equation of the form $y = 320x$, where x is the number of days and y is the number of infections.

Explain why she is wrong.

Answer _____

[1]

- 7 There are 30 members in a community club.
 All the members take up at least one activity, either aqua aerobics or pickleball.
 There are 15 members who take up aqua aerobics and 24 who take up pickleball.
 Given that $A = \{\text{members who take up aqua aerobics}\}$ and
 $P = \{\text{members who take up pickleball}\}$
 Indicate in the Venn Diagram below, showing clearly, the number of members in each subset.



[2]

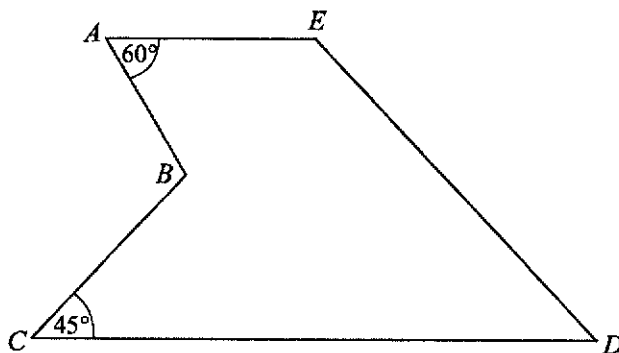
- 8 The table shows part of a payment plan for Mr Lee who borrowed \$50 000 from a bank when he bought a car.
The bank charges an interest of 2.5% per annum, calculated on a monthly basis.
Mr Lee pays \$1 000 at the end of each month.

	Amount owed at beginning of month	Interest for the month	Amount paid at end of month	Amount outstanding at end of month
Month 1	\$ 50,000.00	\$ 104.17	\$ 1,000.00	\$ 49,104.17
Month 2	\$ 49,104.17	\$ 102.30	\$ 1,000.00	\$ 48,206.47
Month 3	\$ 48,206.47	a		
Month 4	b			

Find a and b .

Answer $a = \$$ $b = \$$ [2]

- 9 In the pentagon $ABCDE$ shown, angle $BAE = 60^\circ$ and angle $BCD = 45^\circ$.
 AE is parallel to CD , E lies on CB extended and $CE = DE$.



Find

- (i) angle CED ,

Answer^o [1]

- (ii) angle ABC .

Answer^o [1]

Given further that $CD = 12$ cm,

- (iii) find the area of triangle CDE .

Answer cm^2 [1]

[Turn over

- 10 A package will leave Australia on 19 August at 21:15, local time in Australia. The time taken for the package to arrive at Singapore is 6 hours 30 minutes. Australia time is 2 hours ahead that of Singapore time. What is the date and time at which the package arrives in Singapore?

Answer [3]

- 11 The picture shows a model terracotta warrior.



The model has height of 15 cm and weighs 20 grammes.
A similar terracotta warrior has a height of 1.8 metres. Find the weight of the larger terracotta warrior.
Give your answer in kilogramme, correct to 1 decimal place.

Answer kg [3]

- 12 (a) The price, P , of an object varies directly as the square of its height, h .
The price is \$3 when the height is 20 cm.
Find the price when the height is 30 cm.

Answer \$ _____ [2]

- (b) Given that R varies inversely as the square of T , find the percentage change in R when T is doubled.

Answer _____ % [3]

- 13 Factorise completely the expressions.

(a) $4(x - y)^2 - 9(x + y)^2$

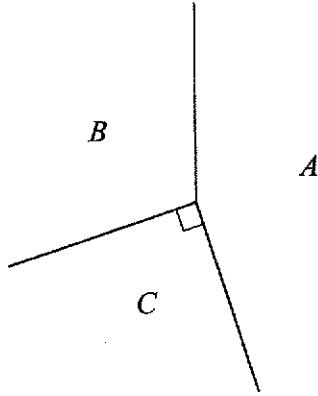
(b) $10ax + 15ay - 8bx - 12by$

Answer _____ [2]

_____ [2]

[Turn over

- 14 The diagram shows part of three regular polygons A , B and C fit together at a common vertex. Polygon A is an icosagon, a 20-sided polygon.



What is the special name for polygon B ?

Answer _____ [4]

- 15 Given that $x_1, x_2, x_3, \dots, x_{10}$ are 10 unique numbers whose mean, \bar{x} , is 11.8 and standard deviation is 4.729.

Find the value of

(i) $x_1 + x_2 + x_3 + \dots + x_{10}$

Answer [1]

(ii) $x_1^2 + x_2^2 + x_3^2 + \dots + x_{10}^2$, giving your answer to the nearest whole number.

Answer [2]

Each of the value of x_n is changed as follows:

If $x_n < \bar{x}$, then x_n is decreased by 2.

If $x_n > \bar{x}$, then x_n is increased by 2.

- (iii) Explain clearly, how this would affect the value of the standard deviation.

Answer

.....

.....

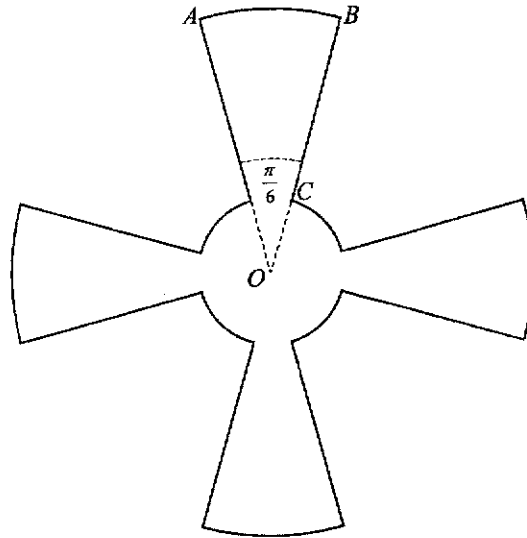
.....

.....

[2]

[Turn over

- 16 The diagram shows four identical blades of a fan, whose centre is O . Arc AB on the fan blade forms an angle of $\frac{\pi}{6}$ at the centre O . OC is 5 cm and BC is 25 cm.



- (i) Find arc length AB .

Answer cm [1]

- (ii) Find the perimeter of the shape.

Answer cm [3]

17 (i) Express $x^2 + 6x + 10$ in the form $(x + p)^2 + q$, where p and q are constants to be found.

Answer [1]

(ii) Given that $y = x^2 + 6x + c$, make x the subject of the formula.

Answer [3]

18 The stem-and-leaf diagram shows the daily number of customers over a period of one month at Branch A of a Food Outlet.

	Branch A								
1	0	7	8	9	9				
2	0	1	2	5	5	7	7		
3	3	3	3	4	8	9	9	9	
4	1	1	2	5	6	7			
5	2	3	4	4					

Key: 4 | 1 means 41 customers

(i) Write down the median of number of customers for Branch A.

Answer [1]

(ii) Find the interquartile range for Branch A.

Answer [2]

(iii) Another branch, Branch B, had a median of 27 customers and an interquartile range of 23 customers. The Food Outlet intends to expand only one of the two branches.

Which one of the two branches should be expanded?

Explain your choice clearly.

Answer

.....

.....

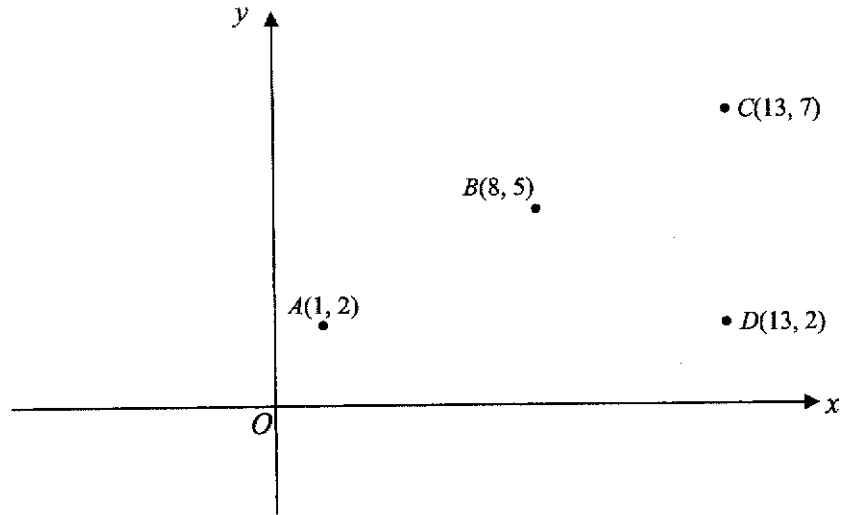
.....

.....

[1]

[Turn over

- 19 In the diagram, $A(1, 2)$, $B(8, 5)$, $C(13, 7)$ and $D(13, 2)$ are four points.



- (i) Show that $AB + BC = 13.0$, correct to 3 significant figures.
Answer

[2]

- (ii) By finding AC , determine the sum of interior angles in figure $ABCD$, justifying your answer.

Answer [3]

- 20 (i) Express 9801 as a product of its prime factors.

Answer [1]

- (ii) Hence, explain why 9801 is a square number.

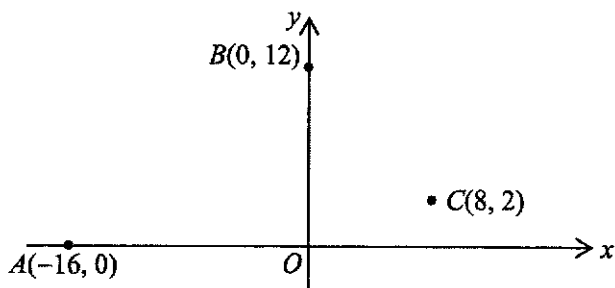
Answer [1]

- (iii) a and b are both prime numbers.

Find the smallest value of a and b such that $9801 \times \frac{a}{b}$ is a perfect cube.

Answer $a =$ $b =$ [2]

- 21 The diagram shows three points $A(-16, 0)$, $B(0, 12)$ and $C(8, 2)$.



- (i) Find the equation of line AB , expressing your answer in the form $ax + by + c = 0$, where a , b and c are constants to be found.

Answer [2]

A circle is drawn with centre C such that AB is a tangent to the circle.

The perpendicular distance of a point (p, q) from a line $ax + by + c = 0$ is given by the formula

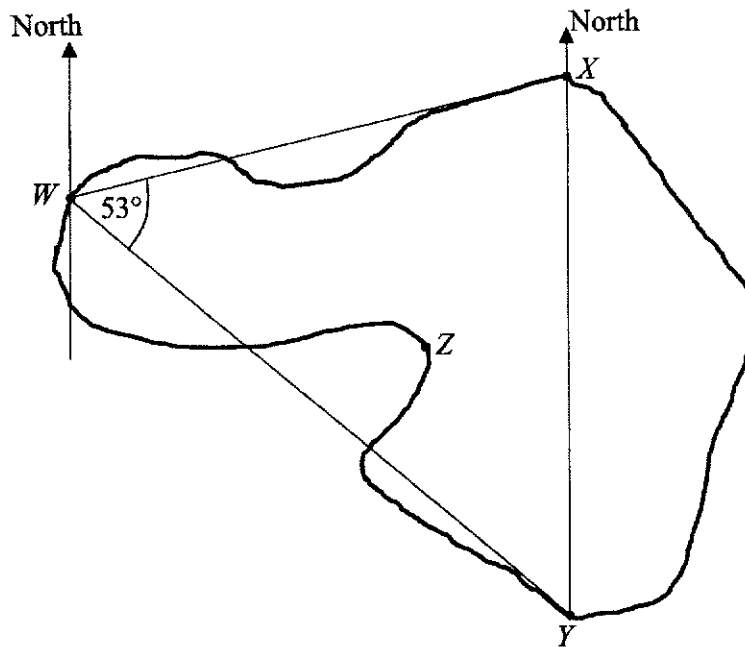
$$\text{Distance} = \frac{ap + bq + c}{\sqrt{a^2 + b^2}}$$

- (ii) Using the formula above, determine the radius of the circle.

Answer [2]

[Turn over

- 22 The diagram shows the positions of four checkpoints W , X , Y and Z in a jungle reserve area. The checkpoints are connected by the irregular tracks shown.



X is due north of Y and is on a bearing of 077° from W .
 Angle $XWY = 53^\circ$ and WY is 60 metres.

- (i) Calculate the distance XY .

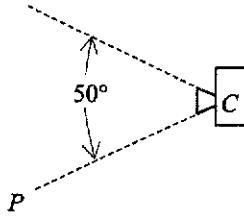
Answer m [2]

- (ii) Given that the bearing of Y from Z is 152° , write down the bearing of Z from Y .

Answer [1]

(iii) A hidden camera, C , is to be fixed at checkpoint Y to capture animals that move from W to Y via Z , along the irregular track.

The camera has a view angle of 50° and can capture anything within this angle as shown in the diagram below.



By measurement, determine the minimum bearing where the line CP must be pointed when the camera is fixed at point Y .

Answer [1]

[Turn over

- 23 Points P , Q and R have coordinates $(1, 1)$, $(5, 11)$ and $(9, 1)$ respectively.
 M is the midpoint of QR .

(i) Find the coordinates of point M .

Answer [1]

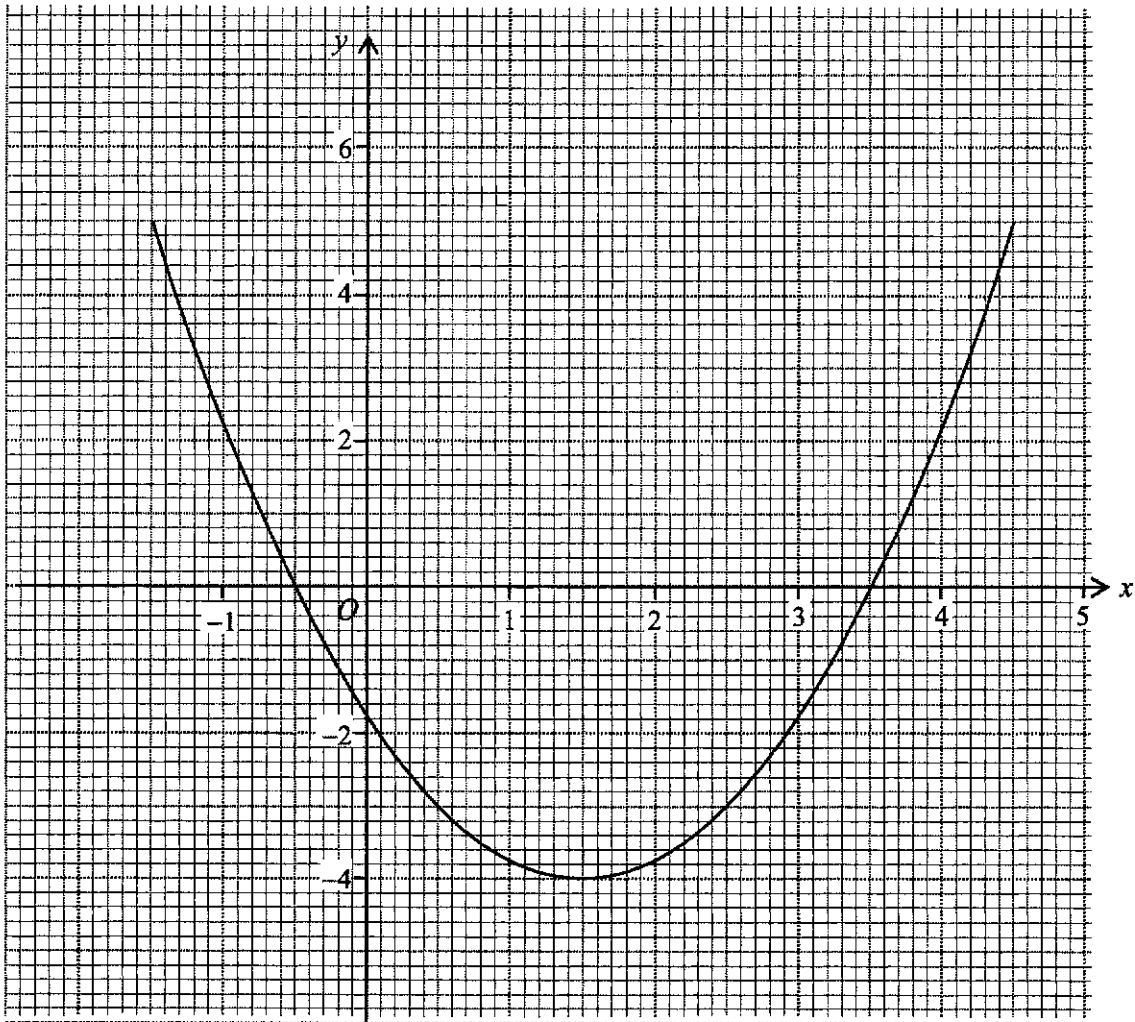
(ii) State the gradient of line segment PM .

Answer [1]

(iii) "The line segment PM bisects angle QPR ."
Determine whether the statement above is correct or not.
Answer

[2]

- 24 The graph of $y = x^2 - 3x - 1.75$ is shown on the grids below.



- (a) Write down the equation of the line of symmetry.

Answer _____ [1]

- (b) Draw the line representing $4y = 7x - 16$ for $-1 \leq x \leq 5$ on the grids.

[2]

- (c) Using the graphs and showing your working clearly, find the solutions of the equation $4x^2 - 19x + 9 = 0$.

Answer

[3]

Answer all questions.

- 1 (a) Write as a single fraction in its simplest form.

(i) $\frac{3t^2}{w} \div \frac{9t^2}{w^3}$

Answer [1]

(ii) $\frac{3}{y-1} - \frac{5}{y+6}$

Answer [2]

(b) Simplify $\frac{2v^2 - 5v - 12}{16 - v^2}$

Answer [3]

[Turn over

- 2 In stall A, one Chicken pie costs \$1.50, one Mushroom pie costs \$1.30 and one Tuna pie costs \$1.80. In stall B, one Chicken pie costs \$0.20 more, one Mushroom pie costs \$0.30 less and one Tuna pie costs \$0.10 less.

The information can be represented by the matrix $\mathbf{P} = \begin{pmatrix} \text{C} & \text{M} & \text{T} \\ 1.5 & 1.3 & 1.8 \\ 0.2 & -0.3 & -0.1 \end{pmatrix}$ Stall A
Stall B

- (a) Simon buys 50 Chicken pies and 20 Tuna pies.
Ivy buys 40 Chicken pies, 20 Mushroom pies and 30 Tuna pies.
Represent their purchases in a 3×2 Matrix \mathbf{Q} .

Answer $\mathbf{Q} =$ [1]

- (b) Evaluate the matrix $\mathbf{R} = \mathbf{PQ}$.

Answer $\mathbf{R} =$ [2]

- (c) Use your answer in (b) to explain whether it is better for Simon to buy from stall A or stall B.

Answer

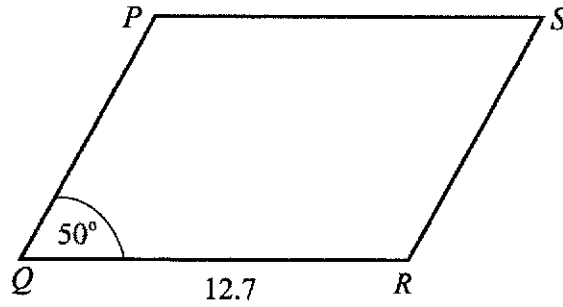
Stall because

..... [1]

- (d) Stall B has a promotion of 30% off on all pies while prices of pies in stall A has increased by 10%.
Using your answer in (b) or otherwise, calculate the **lowest** total amount both Simon and Ivy will pay for the pies.

Answer \$ [3]

- 3 (a) In the parallelogram $PQRS$, $QR = 12.7$ cm and angle $PQR = 50^\circ$.



The area of the parallelogram is 52.6 cm^2 .

- (i) Show that the length of $RS = 5.407$ cm.

Answer

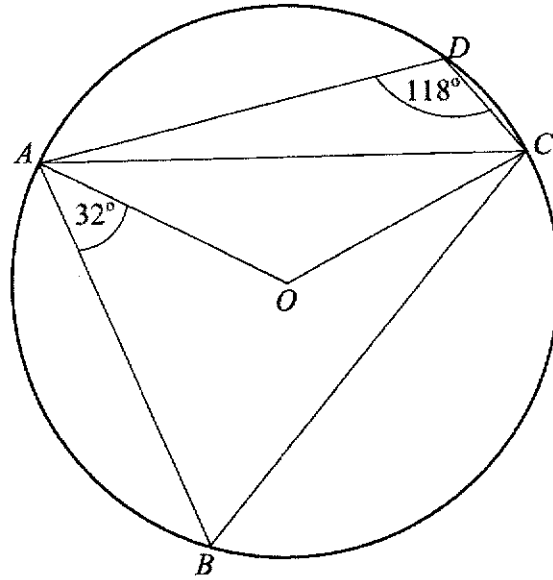
[2]

- (ii) Hence or otherwise, calculate the length of the longer diagonal of the parallelogram $PQRS$.

Answer cm [2]

[Turn over

- (b) In the diagram, the points A , B , C and D lie on a circle, centre O .
 $\angle ADC = 118^\circ$ and $\angle BAO = 32^\circ$.



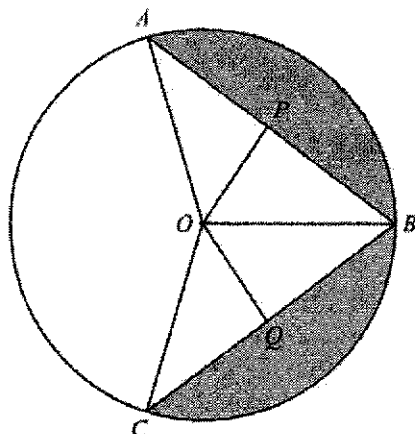
Find, giving reasons for each answer,
 (i) angle ABC ,

Answer [1]

(ii) angle BCO .

Answer [2]

4



A, B and C are points on the circle centre O and $AB = BC$.
 P is the midpoint of chord AB and Q is the midpoint of chord BC .

- (a) Prove that triangle OAP is congruent to triangle OCQ .
 Give a reason for each statement you make.

Answer

.....

[3]

- (b) Given that the radius of the circle is 6 cm and the obtuse angle $AOC = \frac{7\pi}{9}$,
 calculate the shaded area.

Answer cm^2 [4]

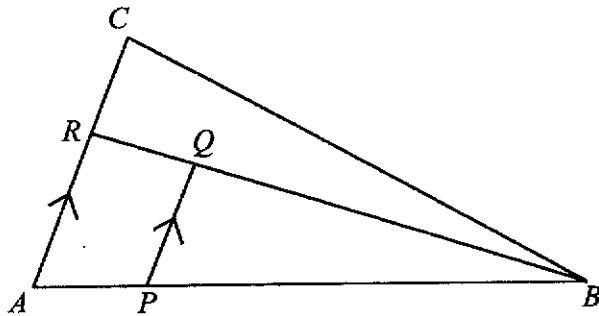
[Turn over

- 5 (a) A cuboid has a volume of 250 cm^3 , correct to the nearest cubic centimetre. The height of the cuboid is 8.4 cm , correct to 1 decimal place.

Calculate the greatest possible base area of the cuboid.

Answer cm^2 [2]

- (b) In the figure, AC and PQ are parallel lines. P lies on AB such that $AP : PB = 1 : 5$ and R lies on AC such that $AR : RC = 3 : 2$.



- (i) Explain why triangles ABR and PBQ are similar.

Answer

.....

[2]

- (ii) Show that the ratio of area of triangle PBQ to the area of trapezium $APQR$ is 25 : 11.

Answer

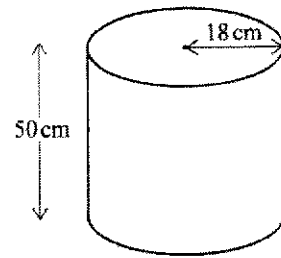
[1]

- (iii) If the area of the trapezium $APQR$ is 22 cm^2 , calculate the area of triangle ABC .

Answer cm^2 [3]

[Turn over

- 6 (a) The diagram shows a cylindrical container used to dispense coffee in a hotel.

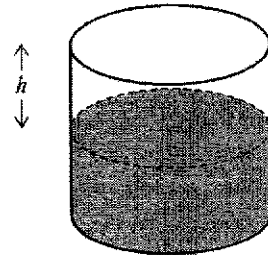


The container has a height of 50 cm and a radius of 18 cm.

- (i) Calculate the volume of the cylinder.

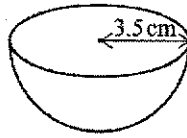
Answer cm³ [1]

- (ii) 25 litres of coffee are poured into the empty container.
Work out the height, h , of the empty space in the container.



Answer $h =$ cm [2]

(iii) Cups in the shape of a hemisphere of radius 3.5 cm are filled with coffee from the container.



Work out the maximum number of these cups that can be completely filled from the 25 litres of coffee in the container.

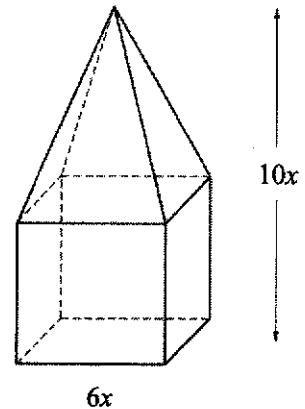
Answer [2]

(b) A solid shape consists of a cube with a pyramid on top has a total height of $10x$ cm. The pyramid sits perfectly on one surface of the cube.

Each side of the cube is $6x$ cm.

Find an expression, in terms of x , for the surface area of the solid.

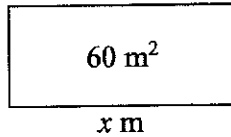
Give your answer in its simplest form.



Answer cm^2 [4]

[Turn over

- 7 Mabel wants to fence off some land as an enclosure for her chickens. The enclosure will be a rectangle with an area of 60 m^2 .



- (a) The enclosure is $x \text{ m}$ long. Show that the perimeter of fencing, $P \text{ m}$, required for the enclosure is given by

$$P = 2x + \frac{120}{x} \quad [1]$$

The table below shows some values of x and the corresponding values of P for the fencing.

x	2	4	6	8	10	12	14
P	k	38	32	31	32	34	36.6

- (b) Find the value of k .

Answer $k = \dots\dots\dots [1]$

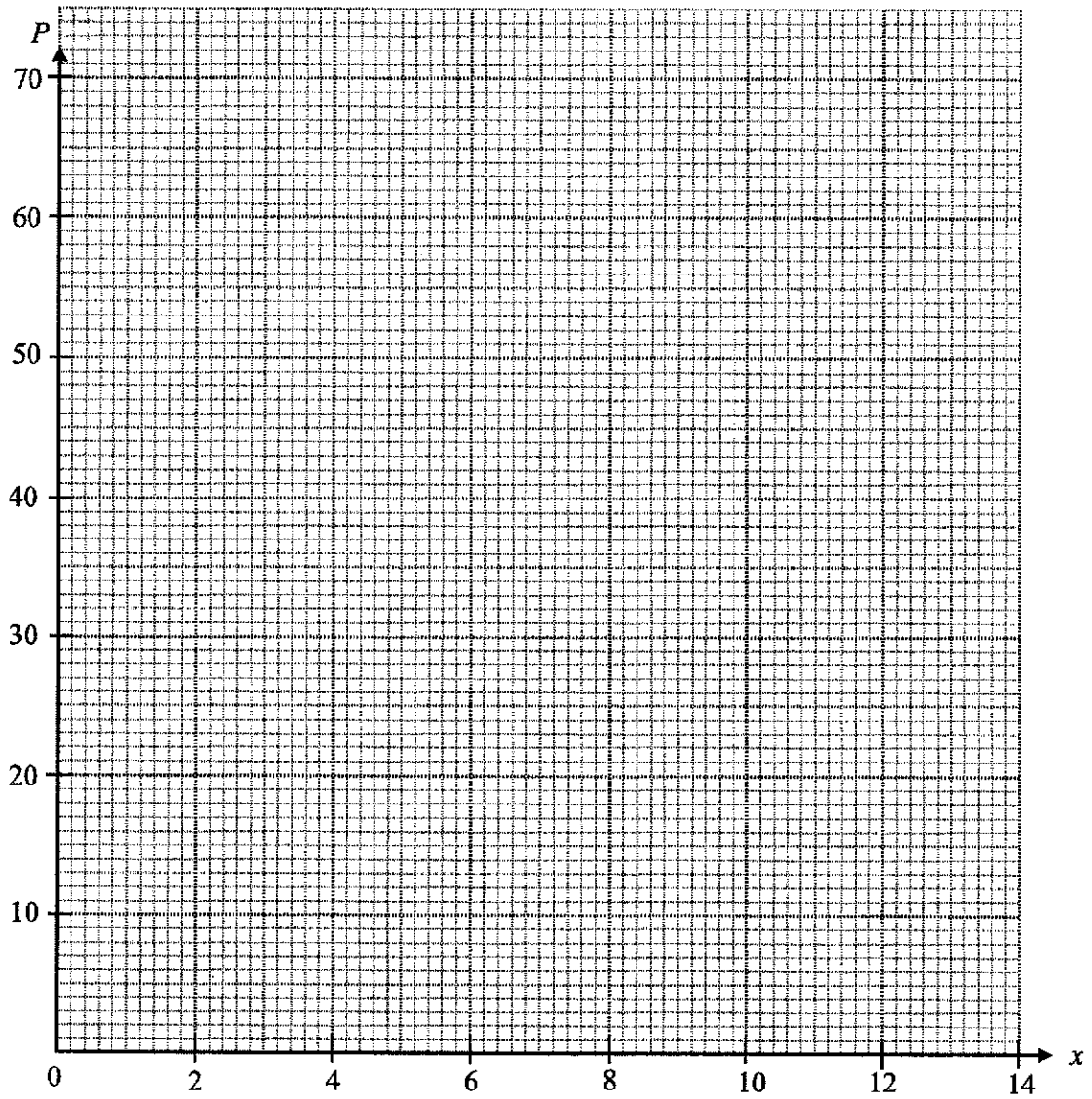
- (c) On the grid, plot the points given and draw the graph of $P = 2x + \frac{120}{x}$ for $2 \leq x \leq 14$.

- (d) Mabel only has 35 m of fencing. Use your graph to find the **range** of values of x that she can choose.

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

- (e) Mabel would like to use the graph to estimate the length and width of the enclosure when it is a square. Suggest an equation of the straight line that Mabel should draw.

Answer $\dots\dots\dots [1]$



[3]

[Turn over

- 8 The table below shows part of Ahmad's personal income tax bill.

	S'PORE (\$)	OTHER COUNTRIES (\$)	TOTAL (\$)
EMPLOYMENT	123, 419.00		123, 419.00
TOTAL INCOME	123, 419.00		123, 419.00
LESS: Approved Donations			1, 543.00
ASSESSABLE INCOME			<i>p</i>
LESS: PERSONAL RELIEFS			
Earned Income		1, 000.00	
NS-man/wife/parent		1, 500.00	
Life Insurance		19, 318.00	
TOTAL PERSONAL RELIEFS			<i>q</i>
CHARGEABLE INCOME			100, 058.00

- (a) Calculate the values of *p* and *q*.

Answer *p* =

q = [2]

- (b) The tax rate for the year is given in the table below.

	Chargeable Income (\$)	Rate (%)	Gross Tax Payable (\$)
On the first	20,000	0	0
On the next	10,000	2.0	200
On the first	30,000		200
On the next	10,000	3.5	350
On the first	40,000		550
On the next	40,000	7.0	2,800
On the first	80,000		3,350
On the next	40,000	11.5	4,600
On the first	120,000		7,950
On the next	40,000	15	6,000

<https://www.iras.gov.sg/irashome/Individuals/Locals/Working-Out-Your-Taxes/Income-Tax-Rates/>

- (i) Show that Ahmad's income tax payable is \$5656.67.

Answer

[2]

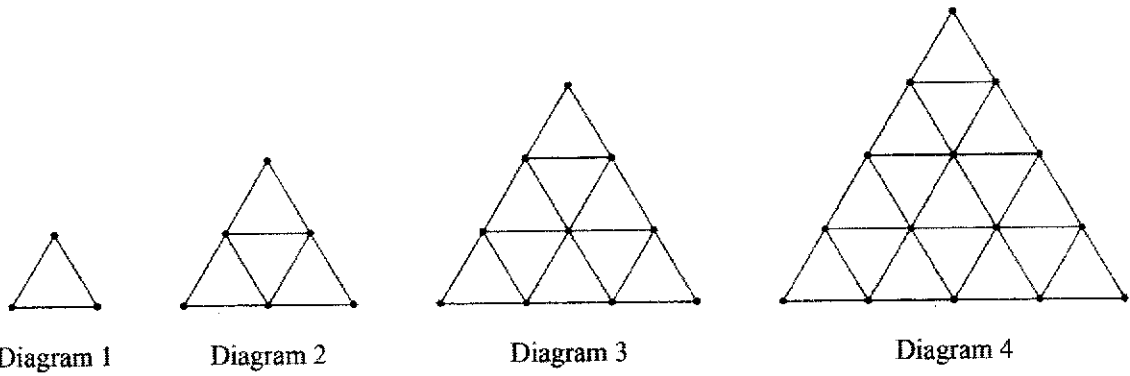
- (ii) In the same year of tax assessment, Angie's income tax payable is 0.55 of Ahmad's. Angie claims that her chargeable income is also 0.55 of Ahmad's chargeable income. Do you agree? Support your stand with calculations.

.....
.....

[5]

[Turn over

9 Small triangles are formed by placing rods between dots as shown in the diagrams.



(a) Complete the table below.

Diagram n	1	2	3	4	5
Number of small triangles (T)	1	4	9	16	
Number of dots (D)	3	6	10	15	
Number of rods (R)	3	9	18	30	45

[2]

(b) Explain why it is not possible to have 1025 small triangles.

.....

..... [1]

(c) Given that $R = D + T - 1$, find the value of n when $D = 561$ and $R = 1584$.

Answer $n = \dots\dots\dots$ [2]

(d) A sequence is 1, 3, 6, 10, 15 ...

(i) The n th term of the above sequence is $\frac{1}{2}n(n+1)$.

Write an expression for R in terms of n .

(ii) How many rods are there in Diagram 16? *Answer* [1]

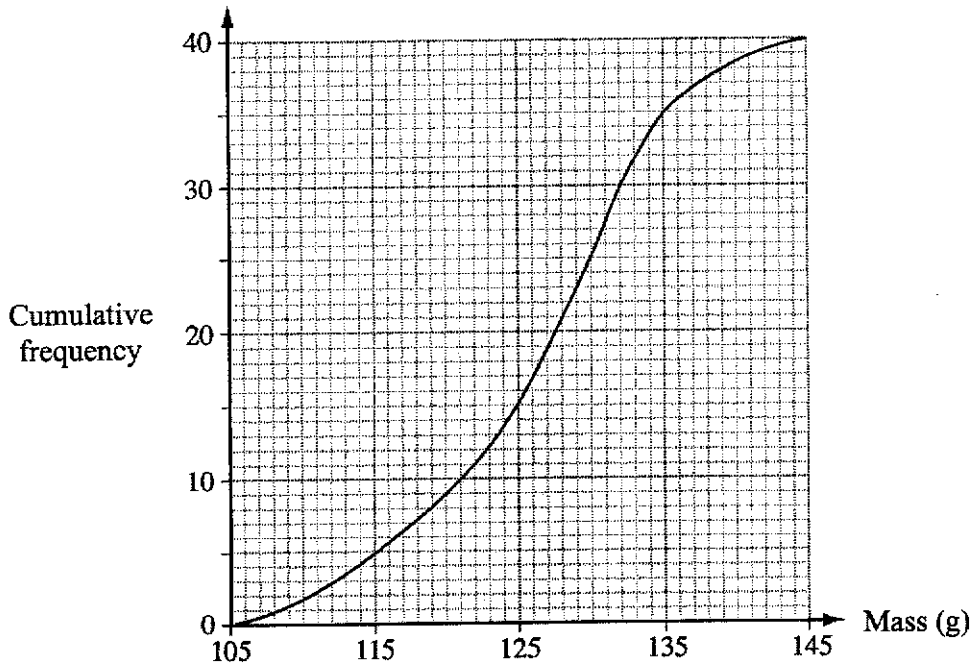
Answer [1]

(e) Find an expression for D in terms of n .

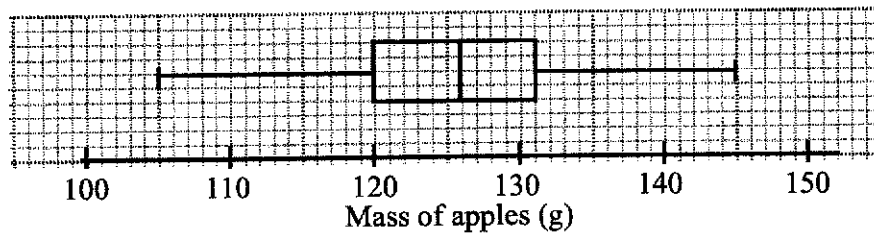
Answer [1]

[Turn over

- 10 The masses of 40 oranges were measured.
The cumulative frequency curve below shows the distribution of the masses.



The box-and-whisker below shows the distribution of the masses of 40 apples.



- (a) Use the two diagrams to complete this table for the two types of fruits.

Type	Lower quartile	Median	Upper quartile	Inter-quartile range
Orange	g	g	g	11 g
Apple	g	126 g	g	11 g

[3]

- (b) Describe how the cumulative frequency curve for the apples may differ from the curve for the oranges.

.....
..... [1]

- (c) Below are two statements comparing the distributions of the masses of oranges and apples.

For each statement, write **True** or **False**. Give a reason for each answer, stating clearly which statistics you use to make your decision.

- (i) The apples are heavier than the oranges.

..... because

..... [1]

- (ii) A greater percentage of oranges weigh more than 131g than apples.

..... because

..... [1]

- (d) The grouped frequency table for the masses of the oranges is given below.

Mass (m g)	$105 \leq m < 115$	$115 \leq m < 125$	$125 \leq m < 135$	$135 \leq m < 145$
Frequency	5	10	20	5

- (i) Calculate an estimate of the mean mass.

Answer g [1]

- (ii) Calculate an estimate of the standard deviation.

Answer g [1]

- (iii) 2 oranges are chosen at random without replacement.
Calculate the probability that at least one of the oranges weigh at least 125 g.

Answer [2]

[Turn over

11 (a) On Monday, Dev goes on a 3.6 km run.

(i) His average speed for the first 1.2 km is x km/h.

Simplify and write down an expression, in terms of x , for the time taken for the first 1.2 km.

Answer minutes [1]

(ii) His average speed for the last 2.4 km of the run is 2 km/h slower than the first 1.2 km.

Simplify and write down an expression, in terms of x , for the time taken for the final 2.4 km.

Answer minutes [1]

(iii) Dev takes 25 minutes to complete the full 3.6 km run.

Form an equation in x and show that it simplifies to $25x^2 - 266x + 144 = 0$.

[2]

- (iv) Solve the equation $25x^2 - 266x + 144 = 0$, leaving your answers correct to 3 decimal places.

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

- (b) On Friday, Dev completed a 4 km run on the same average speed that he ran for the last 2.4 km of the 3.6 km run on Monday.

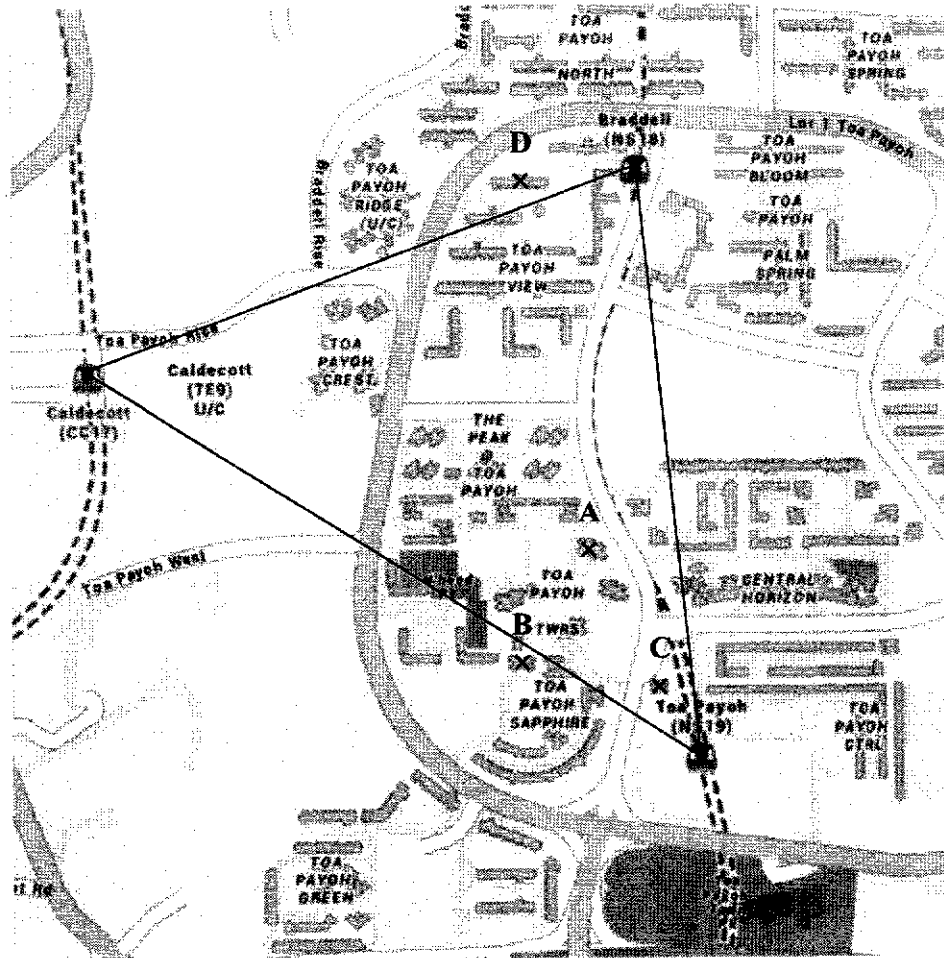
Calculate the time Dev took to run 4 km on Friday.

Give your answer in minutes and seconds, correct to the nearest seconds.

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

[Turn over

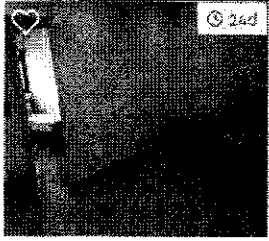



- 12 (a) On the map, 3 MRT stations, Braddell (NS18), Caldecott (CC17) and Toa Payoh (NS19) are joined to form a triangle.



On the map,

- (i) construct the perpendicular bisector of the line connecting NS18 and NS19. [1]
- (ii) construct the angle bisector at NS18. [1]
- (iii) shade the region inside the triangle that is closer to the line joining NS18 and CC17 and is closer to NS18 than NS19. [1]

John and Chieh, both Singaporeans, are looking at buying a re-sale unit in Toa Payoh. They found the following units below and marked them A, B, C and D on the map on page 22.

A	B
 <p>Blk 153 Toa Payoh Sapphire 4 Room • Model A 101 sqm / \$770 psf(Built) \$838,000 3 2</p>	 <p>Blk 163 Lorong 1 Toa Payoh 3 Room • Improved 67 sqm / \$483 psf(Built) \$348,338 2 1</p>
C	D
 <p>Blk 175 Lorong 2 Toa Payoh 4 Room • Improved 84 sqm / \$514 psf(Built) \$465,000 3 2</p>	 <p>Blk 116 Lorong 2 Toa Payoh 3 Room • Improved 63 sqm / \$457 psf(Built) \$310,000 2 2</p>

Adapted from: <https://www.srx.com.sg/singapore-property-listings/hdb-for-sale>

Note: sqm = square metre (m²)
psf = per square foot (psf)

(b) Which unit is the most value for money? Explain.

.....
.....

[1]

[Turn over

- (c) Both John and Chieh are first-time HDB applicants as a married couple, they want to purchase a unit that is closest to the MRT station. Their combined monthly income is \$7 500 and they wish to complete financing their home in 15 years' time using the HDB loan.

John's friend, Janet, also Singaporean, is looking at purchasing unit **B**, which is 2 km away from her mum's place, under the Single's scheme. Janet is 38 this year and her monthly salary is \$6 500.

Assuming that they receive **all** the relevant grants and take up the maximum loan amount, suggest the number of years Janet should take to service the bank loan such that her interest paid is lower than John's and Chieh's.

Justify any decisions you make and show your calculations clearly.

.....

.....





















.....

[8]

Table 1: Comparison between HDB and Bank Loan

	HDB Loan	Bank Loan
Maximum loan	90% of purchase price	75% of purchase price
Interest Rate (p.a)	2.6%	1.8%

Table 2: Grants that can be used to offset the purchase price of the flat

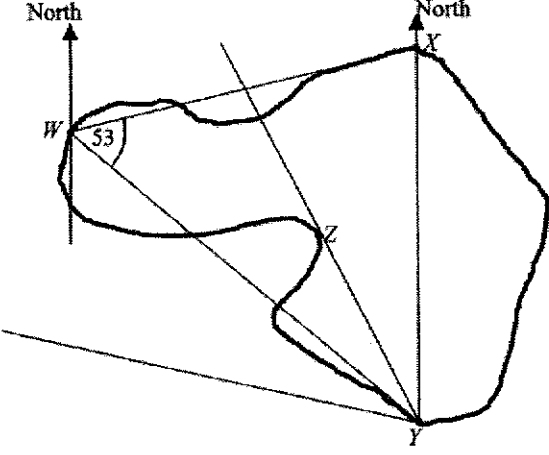
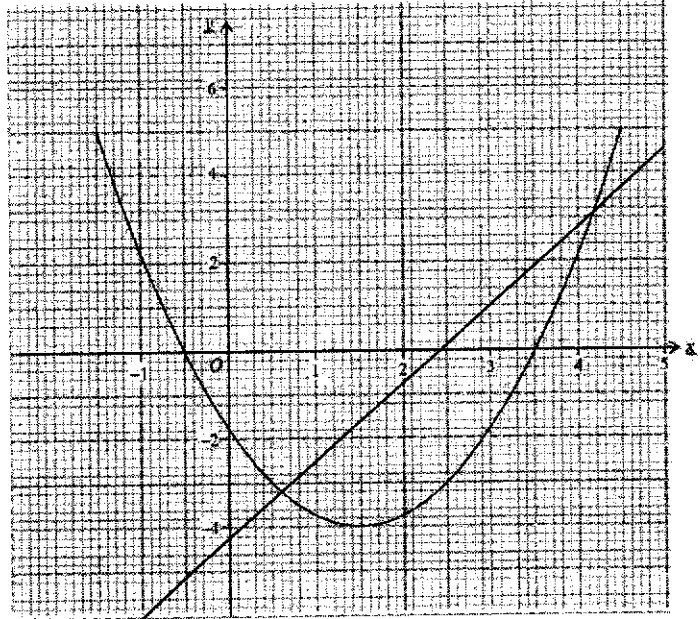
Enhanced CPF Housing Grant (EHG) [Only for Singaporeans]		
Who is eligible?	Income Ceiling	Grant Amount
 Singles	 \$4,500	 \$40,000
 Couples/ families	 \$9,000	 \$80,000
Proximity Housing Grant (PHG) [stay within 4km from parents*]		
Who is eligible?	Income Ceiling	Grant Amount
 Singles	No income ceiling!	 \$10,000— \$20,000*
 Couples/ families		 \$15,000— \$30,000*
Singles Grant		
Who is eligible?	Income Ceiling	Grant Amount
 Singles (35 years old and above)	 \$7,000 (purchase under Single Singapore Citizen Scheme)	 2 to 4-room \$50,000
	 \$14,000 (purchase under Non-Citizen Family Scheme)	 Min 5-room \$40,000
Family Grant		
Who is eligible?	Income Ceiling	Grant Amount
 Couples/ families	 \$14,000	 2 to 4-room \$50,000
	 \$21,000 (if buy with extended family)	 Min 5-room \$40,000

Adapted from: <https://www.homenoguru.sg/articles/tips-advice/hdb-resale-grant/>**End of Paper**

Answers:

		Key Steps	
1	$1.5\pi \sqrt{12.1}$	2. $\frac{b^4}{a^{10}}$	3(i) $k=3$ (ii) $x = \frac{1}{2}$
4	$\angle ACB = \frac{180-p}{2} = 90^\circ - \frac{p}{2}$ $\therefore \angle ACD = 90^\circ - \frac{p}{2} + \frac{p}{2} = 90^\circ$ John is correct (angle in semicircle)	5. $(2n+3)^2 = (\text{even} + \text{odd})^2$ $= (\text{odd})^2$ $= \text{odd}$ $\therefore 2m = \text{odd} + 1$ $= \text{even}$ $m = \text{even} \div 2 = \text{integer}$	
6	The scale on vertical axis is not uniform, hence the graph cannot be linear.		
7	<p>A Venn diagram with two overlapping ovals labeled A and P inside a rectangular universal set U. The number 6 is in the part of oval A that does not overlap with P. The number 9 is in the overlapping region of A and P. The number 15 is in the part of oval P that does not overlap with A.</p>		
8	$a = \$100.43, b = \$47\,306.90$		
9	(i) $\angle CED = 90^\circ$	(ii) $\angle ABC = 105^\circ$	(iii) Area of $\triangle CDE = 36 \text{ cm}^2$
10	20 Aug at 01 45	11. 34.6 kg	12(a) \$6.75 (b) Percentage change = -75%
13	(a) $-(5x+y)(x+5y)$	(b) $(5a-4b)(2x+3y)$	14. Pentagon
15	(i) 118 (ii) 1616	(iii) Each value would differ more from the mean. Hence, the standard deviation will increase.	
16	(i) arc $AB = 5\pi$ or 15.71	(ii) Perimeter = 283.76 cm	
17	(i) $(x+3)^2 + 1$	(ii) $y = x^2 + 6x + c$ $x^2 + 6x = y - c$ $x^2 + 6x + 3^2 = y - c + 3^2$ $(x+3)^2 = y - c + 9$ $x+3 = \pm\sqrt{y-c+9}$ $x = \pm\sqrt{y-c+9} - 3$	
18	(i) 33.5 (ii) 20	(iii) Expand Branch A because Branch A has consistently more customers.	
19	(ii) 360°		
20	(i) $3^4 \times 11^2$		
	(ii) All powers are even.		
	(iii) $a = 11, b = 3$		
21	(i) $3x - 4y + 48 = 0$		
	(ii) $\text{radius} = \frac{3 \times 8 + (-4) \times 2 + 48}{\sqrt{3^2 + (-4)^2}} = 12.8$		

Key Steps

22	(i) $XY = 49.18 \text{ m}$	(ii) 332°
	<p>(iii)</p>  <p>Minimum bearing = 281° to 283°</p>	
23	(i) (7, 6)	(ii) Gradient $PM = \frac{5}{6}$
	<p>(iii) $\tan QPR = \frac{10}{4} = \frac{5}{2}$, $\angle QPR = 68.2^\circ$ $\tan MPR = \frac{5}{6}$, $\angle MPR = 39.8^\circ$ $\angle QPR \neq 2 \times \angle MPR$ Hence statement is wrong.</p>	
	<p>Other possible approaches: Showing that $PQ \neq PR$ and stating that ΔPQR is not isosceles. Hence statement is wrong.</p> <p>Showing that PM and QM are not perpendicular and stating that ΔPQR is not isosceles. Hence statement is wrong.</p>	
24	(a) $x = 1.5$	
	<p>(b) Correct line seen within the domain $-1 \leq x \leq 5$</p> 	
	(c) $x = 0.5$ to 0.55 , 4.2 to 4.25	

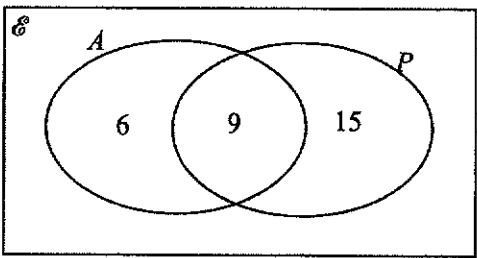
2021 Secondary 4 Mathematics Prelim Paper 2 Marking Scheme

No.	Solution
1ai	$\frac{w^2}{3}$
1aii	$\frac{-2y+23}{(y-1)(y+6)}$
1aiii	$\frac{2v+3}{v+4}$
2a	$\begin{pmatrix} 50 & 40 \\ 0 & 20 \\ 20 & 30 \end{pmatrix}$
2b	$\begin{pmatrix} 111 & 140 \\ 8 & -1 \end{pmatrix}$
2c	<u>Stall A because he would pay \$8 more in stall B</u>
2d	\$180.60
3ai	$\text{Height} = \frac{52.6}{12.7}$ $= 4.1417$ $\sin 50 = \frac{4.1417}{RS}$ $RS = 5.4066$ $= 5.407 \text{ (shown)}$
3aii	16.7
3bi	62
3bii	30
4a	$OP = OQ$ (equal chords; $AB = BC$) $\angle OPA = \angle OQC = 90$ (perpendicular bisector of chord) $AO = OC$ (radii of circle) Triangle $OAP \cong$ triangle OCQ (RHS)
4b	35.3

5a	30
5bi	$\angle RAB = \angle QPB$ (corresponding \angle) $\angle ARB = \angle PQB$ (corresponding \angle) $\angle RCA$ is shared/common Triangles ABR and PBQ are similar (AA)
5bii	Area PBQ : Area of Trapezium $= 25 : 36 - 25$ $= 25 : 11$
5biii	120
6ai	50900
6aai	25.4
6aaii	278
6b	$240x^2$
7a	$P = 2x + \left(\frac{60}{x}\right) \times 2$ $= 2x + \frac{120}{x}$
7b	64
7c	

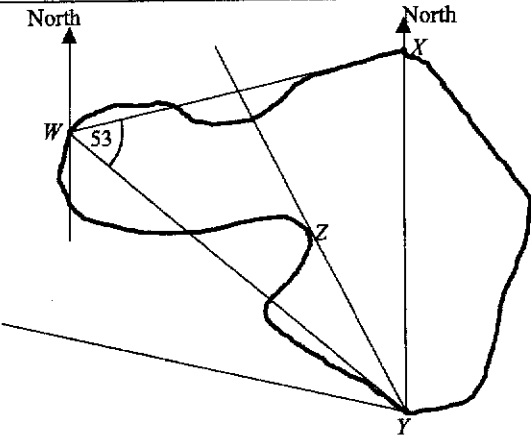
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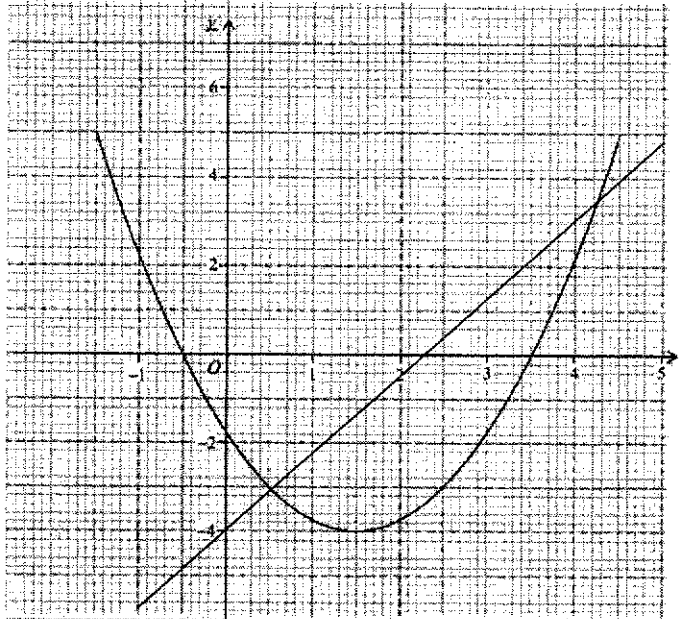
7d	$4.7 \leq x \leq 12.9$
7e	$p = 4x$
8a	$p = 121876.00$ $q = 21818.00$
8bi	$3350 + 0.115(100058 - 80000)$ $= \$5656.67$ (shown)
8bii	$\frac{76588.12}{100058} \times 100\% = 76.5\%$ Disagree as Angie's is 0.44 times Ahmad's chargeable income. or $100058 \times 55\% = \$55\,031.90$ Disagree as Angie's income is less than \$55 031.90.
9a	25 21
9b	1025 isn't a perfect square
9c	32
9di	$R = \frac{3}{2}n(n+1)$
9dii	408
9e	$D = \frac{1}{2}(n+1)(n+2)$
10a	121, 128.5, 132 120 and 131
10b	The median of the cumulative curve will be on the left.
10ci	<u>False because the median mass for apples is lower.</u>
10cii	<u>True because upper quartile for mass of oranges is higher</u>
10di	126.25 or $126\frac{1}{4}$
10dii	8.57
10diii	$\frac{45}{52}$
11ai	$\frac{72}{x}$

		Key Steps	Mark allocation / Remarks	
1		$1.5\pi \sqrt{12.1}$	B1 Both correct,	1
2		$\sqrt[3]{\left(\frac{a^{15}}{b^6}\right)^{-2}} = \left(\frac{a^{15}}{b^6}\right)^{-2 \times \frac{1}{3}}$ $= \left(\frac{b^6}{a^{15}}\right)^{2 \times \frac{1}{3}}$ $= \frac{b^4}{a^{10}}$	B1 Either root/reciprocal rule seen B1 cao	2
3	(i)	$\frac{1}{2(-2)^2 + k(-2)} = \frac{1}{2}$ $k = 3$	B1	
	(ii)	$2x^2 + 3x = 2$ $2x^2 + 3x - 2 = 0$ $(2x - 1)(x + 2) = 0$ <p>Another solution is $x = \frac{1}{2}$</p>	B1	2
4		$\angle ACB = \frac{180 - p}{2} = 90^\circ - \frac{p}{2}$ $\therefore \angle ACD = 90^\circ - \frac{p}{2} + \frac{p}{2} = 90^\circ$ <p>John is correct (angle in semicircle)</p>	B1 90° seen B1 with reason	2
5		$(2n + 3)^2 = (\text{even} + \text{odd})^2$ $= (\text{odd})^2$ $= \text{odd}$ $\therefore 2m = \text{odd} + 1$ $= \text{even}$ $m = \text{even} \div 2 = \text{integer}$	B1 Showing $(2n + 3)^2$ is odd, any method B1 Conclusion with clear reasons Zero mark for qn. if use specific nos.	2
6		The scale on vertical axis is not uniform, hence the graph cannot be linear.	B1 o.e.	1
7			B2, B1, B0 -1 m for each error	2
8		$a = \frac{2.5}{100} \times \frac{1}{12} \times 48206.47 = \$ 100.43$ $b = 48206.47 + 100.43 - 1$	B1 Must be 2 d.p. st be 2 d.p.	2

		Key Steps	Mark allocation / Remarks	
9	(i)	$\angle CED = 90^\circ$	B1	
	(ii)	$\angle ABC = 60^\circ + 45^\circ = 105^\circ$	B1	
	(iii)	Area of $\triangle CDE = (12 \times 12) \div 4 = 36 \text{ cm}^2$	B1	3
10		19:15 + 6:30 = 25:45 20 Aug 01 45 Accept 01:45 Reject 1:45	B1 25:45 soi B1 Correct Date B1 Correct Time	3
11		$\left(\frac{180}{15}\right)^3 \times 20 \text{ g}$ $= 34.6 \text{ kg}$	B1 (ratio) ³ seen accept $\left(\frac{1.8}{15}\right)^3$ B1 $\times 20$ seen B1 Ans (one d.p.)	3
12	(a)	$P = k h^2$ $3 = k (20)^2$ $k = \frac{3}{400}$ $\therefore P = \frac{3}{400} \times 30^2 = \6.75	M1 A1	
	(b)	$R = k \left(\frac{1}{T}\right)^2$ or $k \frac{1}{T^2}$ $T \rightarrow 2T; \quad R \rightarrow k \left(\frac{1}{2T}\right)^2$ $\rightarrow \frac{1}{4} \times k \left(\frac{1}{T}\right)^2$ Hence, percentage change = -75%	B1 reciprocal square seen or implied B1 $\frac{1}{4}$ seen B1 accept "decrease by 25%"	5
13	(a)	$4(x-y)^2 - 9(x+y)^2$ $= [2(x-y)]^2 - [3(x+y)]^2$ $= [2x-2y]^2 - [3x+3y]^2$ $= [2x-2y+3x+3y][2x-2y-3x-3y]$ $= [5x+y][-x-5y]$ $= -[5x+y][x+5y]$	B1 Use of diff of 2 sq seen B1 -ve also factorised	
	(b)	$10ax + 15ay - 8bx - 12by$ $= 5a(2x+3y) - 4b(2x+3y)$ $= (5a-4b)(2x+3y)$	B1 Use of grouping seen B1	4
14		One angle in icosagon $= \frac{18 \times 180^\circ}{20} = 162^\circ$ One angle in polygon B $= 360^\circ - 162^\circ - 90^\circ = 108^\circ$ Let $(n-2)180^\circ = 108n$ $n = 5$ B is a pentagon	M1 Finding angle in icosagon M1 Finding angle in polygon B A1 Sides in polygon B, soi A1	4

		Key Steps	Mark allocation / Remarks		
15	(i)	$x_1 + x_2 + x_3 + \dots + x_{10} = 11.8 \times 10$ $= 118$	B1		
	(ii)	$\sqrt{\frac{x_1^2 + \dots + x_{10}^2}{10}} - 11.8^2 = 4.729$ $\rightarrow x_1^2 + \dots + x_{10}^2 = 1616$	B1 B1	Correct subs into formula	
	(iii)	Each value would differ more from the mean. Hence, the standard deviation will increase.	B1 B1	Correct reasoning only if reason is correct	5
16	(i)	$\text{arc } AB = 30 \times \frac{\pi}{6}$ $= 5\pi \text{ or } 15.71$	B1	accept either (min 3 s.f.)	
	(ii)	Perimeter $= (4 \times 5\pi) + \left(4 \times 5 \times \frac{\pi}{3}\right) + 8 \times 25$ $= 283.76 \text{ cm}$	B1 B1 B1	$\frac{\pi}{3}$ seen Expression for perimeter min 3 s.f. (rej if in terms of π)	4
17	(i)	$(x+3)^2 + 1$	B1		
	(ii)	$y = x^2 + 6x + c$ $x^2 + 6x = y - c$ $x^2 + 6x + 3^2 = y - c + 3^2$ $(x+3)^2 = y - c + 9$ $x+3 = \pm\sqrt{y-c+9}$ $x = \pm\sqrt{y-c+9} - 3$	B1 B1 B1	Use of completing square method seen \pm seen	4
18	(i)	median = 33.5	B1		
	(ii)	LQ = 22, UQ = 42 Interquartile range = 20	B1 B1	At least LQ or UQ seen or implied	
	(iii)	Expand Branch A because Branch A has a more consistent flow of customers. or Expand Branch A because Branch A has more customers. or Expand Branch A because Branch A has consistently more customers.	B1	Branch A, with any logical supporting reason based on the central measure or dispersion measure.	4
19	(i)	$AB + BC = \sqrt{7^2 + 3^2} + \sqrt{5^2 + 2^2}$ $= 13.0009$ $= 13.0$	B1 B1 AG	Use of PT or distance formula Min of 4 sf must be seen	
	(ii)	$AC = \sqrt{12^2 + 5^2} = 13$ Sum angle of ABCD = 360° because ABCD is a 4-sided figure. OR Sum angle of ABCD = 360° because ABC is not a straight line.	B1 B1 B1	Use of PT or distance formula correct angle correct reason Accept $AC \neq AB + BC$ Accept A, B and C are not collinear.	
20	(i)	$3^4 \times 11^2$	B1		
	(ii)	All powers are even.	B1	o.e.	
	(iii)	$a = 11, b = 3$	B2		4

		Key Steps	Mark allocation / Remarks	
21	(i)	$y = \frac{3}{4}x + 12$ $3x - 4y + 48 = 0$	B1 equation s.o.i. B1 General form	
	(ii)	$= \frac{3 \times 8 + (-4)2 + 48}{\sqrt{3^2 + (-4)^2}}$ radius = 12.8	B1 Subs into given formula seen B1	4
22	(i)	$\frac{XY}{\sin 53^\circ} = \frac{60}{\sin 77^\circ}$ $XY = 49.18 \text{ m}$	B1 Sine Rule with subs B1	
	(ii)	332°	B1 Any method	
	(iii)	 <p>Minimum bearing = 281° to 283°</p>	B1 Bearing stated.	4
23	(i)	(7, 6)	B1	
	(ii)	Gradient $PM = \frac{5}{6}$	B1 reject 0.833 or 0.83	
	(iii)	$\tan QPR = \frac{10}{4} = \frac{5}{2}, \angle QPR = 68.2^\circ$ $\tan MPR = \frac{5}{6}, \angle MPR = 39.8^\circ$ $\angle QPR \neq 2 \times \angle MPR$ Hence statement is wrong.	B1 Finding $\angle QPR$ or $\angle MPR$ B1 Conclusion	4
		Other possible approaches: Showing that $PQ \neq PR$ and stating that ΔPQR is not isosceles. Hence statement is wrong. Showing that PM and QM are not perpendicular and stating that ΔPQR is not isosceles. Hence statement is wrong.	B1 B1 B1 B1	

		Key Steps	Mark allocation / Remarks	
24	(a)	$x = 1.5$	B1	
	(b)	Correct line seen within the domain $-1 \leq x \leq 5$ 	B1 B1	
	(c)	$x^2 - 3x - \frac{7}{4} = \frac{7}{4}x - 4$ $4x^2 - 12x - 7 = 7x - 16$ $4x^2 - 19x + 9 = 0$ $x = 0.5 \text{ to } 0.55, 4.2 \text{ to } 4.25$	B1 Form equation B2	6
		or $4x^2 - 19x + 9 = 0$ $4x^2 - 12x - 7 = 7x - 16$ $x^2 - 3x - \frac{7}{4} = \frac{7}{4}x - 4$ $x = 0.5 \text{ to } 0.55, 4.2 \text{ to } 4.25$	B1 Rearrange to the equations of the two graphs B2	

2021 Secondary 4 Mathematics Prelim Paper 2 Marking Scheme

No.	Solution	Mark	Remarks
1ai	$\frac{w^2}{3}$	B1	
1aii	$\frac{3}{y-1} - \frac{5}{y+6}$ $= \frac{3y+18-5y+5}{(y-1)(y+6)}$ $= \frac{-2y+23}{(y-1)(y+6)}$	M1 A1	Combine fraction
1aiii	$\frac{2v^2-5v-12}{16-v^2}$ $= \frac{(2v+3)(v-4)}{(4+v)(4-v)}$ $= -\frac{2v+3}{v+4}$	M1 B1 A1	Factorise numerator (4+v)(4-v) seen o.e
			Total: 6 marks
2a	$\begin{pmatrix} 50 & 40 \\ 0 & 20 \\ 20 & 30 \end{pmatrix}$	B1	cao
2b	$\begin{pmatrix} 111 & 140 \\ 8 & -1 \end{pmatrix}$	B1 B1	-1 for each error
2c	<u>Stall A because he would pay \$8 more in stall B</u>	B1	
2d	$[(111+8) + (140 - 1)] \times 0.7$ $= 83.3 + 97.3$ $= \$180.60$	B1 M1 A1	119 or 139 seen $\times 0.7$ 2 d.p
			Total: 7 marks
3ai	$\text{Height} = \frac{52.6}{12.7}$ $= 4.1417$ $\sin 50 = \frac{4.1417}{RS}$ $RS = 5.4066$ $= 5.407 \text{ (shown)}$	B1 B1	Height = $QR \sin 130$ 5.4066
3aii	$QS^2 = 12.7^2 + 5.407^2 - 2(12.7)(5.407) \cos 130$ $QS = 16.7$	M1 A1	Apply Cosine rule, $\cos 130$
3bi	$\angle ABC = 180 - 118 \text{ (}\angle\text{s in opposite segment)}$ $= 62$	B1	with reason
3bii	$\text{reflex } \angle AOC = 236 \text{ (}\angle \text{ at centre} = 2\angle \text{ at circumference)}$ $\angle BCO = 360 - 32 - 236 - 62$ $= 30$	B1 B1	
			Total: 7 marks

No.	Solution	Mark	Remark
4a	$OP = OQ$ (equal chords; $AB = BC$) $\angle OPA = \angle OQC = 90$ (perpendicular bisector of chord) $AO = OC$ (radii of circle) Triangle $OAP \equiv$ triangle OCQ (RHS) Alternatively, $AP = CQ$ ($AB = BC$, $AP = \frac{1}{2} AB$, $CQ = \frac{1}{2} BC$) $OP = OQ$ (equal chords; $AB = BC$) $AO = OC$ (radii of circle) Triangle $OAP \equiv$ triangle OCQ (SSS)	B1 B1 B1 B1 B1 B1	-1 for test not stated
4b	Shaded area = $2 \times$ $\left[\frac{1}{2}(6)^2 \left(\frac{11\pi}{18} \right) - \frac{1}{2}(6)^2 \sin \frac{11\pi}{18} \right]$ $= 35.3$ Alternatively, Shaded area = $\pi(6)^2 - \left(2 \times \frac{1}{2}(6)^2 \sin \frac{11\pi}{18} \right) - \frac{1}{2}(6)^2 \frac{7\pi}{9}$	B1 M1 M1 A1	$\frac{11\pi}{18}$ seen Area of sector Area of triangle
			Total: 7 marks
5a	greatest possible area = $\frac{250.5}{8.35}$ $= 30$	B1 B1	250.5 seen cao
5bi	$\angle RAB = \angle QPB$ (corresponding \angle) $\angle ARB = \angle PQB$ (corresponding \angle) $\angle RCA$ is shared/common Triangles ABR and PBQ are similar (AA)	B1 B1	
5bii	Area PBQ : Area of Trapezium $= 25 : 36 - 25$ $= 25 : 11$	B1 AG	36 - 25 seen
5biii	Area of $ABR = \frac{22}{11} \times 36 = 72$ Area of $ABC = \frac{72}{3} \times 5$ $= 120$	B1 M1 A1	72 soi $\frac{\text{Their area } ABR}{3} \times 5$
			Total: 8 marks

6ai	50 900	B1	50 893.8 50 900.4
6aii	$h = \frac{25893.8}{\pi(18)^2}$ $= 25.4$	M1 A1	$\frac{\text{their ans} - 25\ 000}{\pi(18)^2}$
6aiii	Number of cups = $\frac{25000}{\frac{2}{3}\pi(3.5)^3}$ = 278	M1 A1	Volume of hemp cao
6b	Surface area = $6x(6x) \times 5 + \frac{1}{2}(5x)(6x) \times 4$ = $240x^2$	M1 B1 M1 A1	6x6x (area of sq) Slant $h = 5x$ $\frac{1}{2}(\text{Their slant height})(6x) \times 4$ cao
			Total: 9 marks
7a	$P = 2x + \left(\frac{60}{x}\right) \times 2$ $= 2x + \frac{120}{x}$	B1	$\left(\frac{60}{x}\right) \times 2$ seen
7b	64	B1	
7c		P2 C1	-1 mark for every wrong point plotted
7d	$4.7 \leq x \leq 12.9$	B1 B1	4.6 to 4.8 and 12.8 to 13.0 $4.68 \leq x \leq 12.82$
7e	$p = 4x$	B1	
			Total: 8 marks

8a	$p = 121876.00$ $q = 21818.00$	B1 B1	Accept $p = 121876$ $q = 21818$
8bi	$3350 + 0.115 (100058 - 80000)$ $= \$5656.67$ (shown)	B1 B1	3350 seen 20058 soi
8bii	<p>Angie's income tax = 0.55×5656.67 $= \\$3111.1685$</p> <p>Let x be the remaining income. $550 + x (7\%) = 3111.1685$ $x = \\$36588.1214$ Angie's chargeable income $= 40\ 000 + 36588.1214$ $= \\$76588.12$</p> <p>$\frac{76588.12}{100058} \times 100\% = 76.5\%$</p> <p>Disagree as Angie's is 0.44 times Ahmad's chargeable income.</p> <p>or $100058 \times 55\% = \\$55\ 031.90$ Disagree as Angie's income is less than \$55 031.90.</p>	M1 M1 B1 A1 A1 A1	<p>Finding Angie's income tax</p> <p>Formulate 550 or 40000 seen \$76588.12</p> <p>Express Angie's income as percentage</p> <p>Finding what 55% of Ahmad's income is</p>
			Total: 9 marks

9a	25 21	B1 B1	
9b	1025 isn't a perfect square	B1	oe
9c	$1584 = 561 + n^2 - 1$ $n^2 = 1024$ $n = 32$	M1 A1	
9di	$R = \frac{3}{2}n(n+1)$	B1	oe
9dii	408	B1	
9e	$D = \frac{1}{2}(n+1)(n+2)$	B1	oe
			Total: 8 marks
10a	121, 127.5, 132 120 and 131	B1 B1 B1	<i>LQ UQ</i> Median <i>LQ UQ</i>
10b	The median of the cumulative curve will be on the left.	B1	
10ci	<u>False because the median mass for apples is lower.</u>	B1	
10cii	<u>True because upper quartile for mass of oranges is higher</u>	B1	
10di	126.25 or $126\frac{1}{4}$	B1	Accept 3s.f and above (126, ...)
10dii	8.57	B1	cao
10diii	$1 - \frac{15}{40} \times \frac{14}{39}$ $= \frac{45}{52}$ Or $\frac{25}{40} \times \frac{24}{39} + \frac{25}{40} \times \frac{15}{39} \times 2$ $= \frac{45}{52}$	M1 A1 M1 A1	When all weight less than 125g
			Total: 10 marks
11ai	$\frac{72}{x}$	B1	
11aii	$\frac{144}{x-2}$	B1	
11aiii	$\frac{72}{x} + \frac{144}{x-2} = 25$ $72(x-2) + 144x = 25(x-2)$ $216x - 144 = 25x^2 - 50x$	B1 B1	Their ai + aii = 25

	$25x^2 - 266x + 144 = 0$ (shown)		
11aiv	$x = \frac{22 \pm \sqrt{266^2 - 4(25)(144)}}{2(25)}$ $x = 10.068 \text{ or } 0.572$	M1	
11b	$\text{Time} = \frac{4}{10.068 - 2}$ $= 29 \text{ mins } 45 \text{ secs}$	M1 A1	Ignore rejection Replace 11aiv by $x = 10.068$
			Total: 9 marks
12ai 12aia 12aiii		B1 B1 B1	
12b	<p>D because the psf is the lowest</p> <p>Or D because price per metre square is the lowest.</p>	B1	
12c	<p>John and Chieh</p> $\begin{aligned} \text{Purchase price} &= 46\,500 - 80\,000 - 50\,000 \\ &= 46\,500 - 130\,000 \\ &= \$335\,000 \end{aligned}$ <p>Interest = (their purchase price) ██████████</p> $= \$117\,585$ <p>Janet</p> $\begin{aligned} \text{Purchase price} &= 348\,338 - 50\,000 - 15\,000^* \\ &= 283\,338 \end{aligned}$ <p>(their purchase price) ██████████ < 117585</p> <p style="text-align: right;">$n < 30.7$</p> <p>Janet should finish servicing her loan in 20 years to incur less interest. I took the average of the grant for PHG as I am unsure if she would receive the full grant or not.</p>	B1 M1 B1 M1 M1 M1 B1 B1	<p>[choosing C] 46 500 seen Find purchase price – grant 130 000 seen</p> <p>Find Int. (HDB)</p> <p>*10000 – 20000</p> <p>Find Int. (Bank)</p> <p>State the no of years. State assumption</p>
			Total: 12 marks