Mathematical Formulae

Compound interest

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

Geometry and Measurement

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Answer **all** the questions.

1. Calculate $\frac{0.85^2 - 5.34}{\sqrt{81.2} + 3.134}$, giving your answer correct to 3 significant figures.

Answer _____ [1]

---

2. A set of numbers is given below.

$$-0.4,\ \frac{1}{3},\ \sqrt[3]{3},\ \frac{\pi}{7},\ 0.\dot{6}\dot{6},\ -\sqrt{4}$$

(a) Write the set of numbers in descending order.

Answer _____ [1]

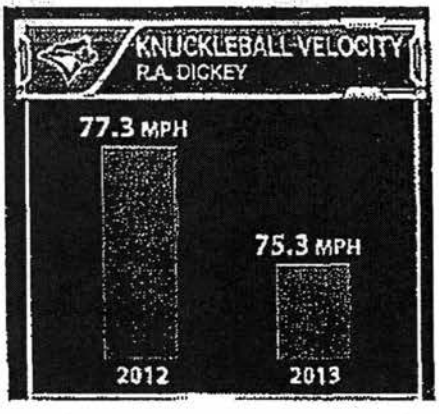
(b) Write down the irrational number(s) from the given set.

Answer _____ [1]

3. Factorise completely $6a^2(a^2-1)-(a^2-1)^2$.

Answer ..... [2]

4. The figure below is extracted from a baseball game broadcast.
It shows the knuckleball velocity statistics of a baseball player.
State one aspect of the data that may be misleading and explain how it might lead to a mis-interpretation of the data by the audience.



Answer .....

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..... [2]

5. Given that $a^2 + 6a = 6$, find the value of $a^3 + 7a^2$.

Answer _____ [2]

---

6. On Monday, the temperature of a certain location at 12 00 was 34°C.
The temperature dropped to −5°C at 14 00 on Tuesday.
Given that the temperature decreases at a constant rate,
find the temperature at 07 00 on Tuesday.

Answer _____ °C [2]

7. An integer k undergoes a series of operations as shown in the steps below.

Step 1: $\frac{1}{6}$ is added to k.

Step 2: The value from step 1 is multiplied by 24.

Step 3: The value from step 2 is increased by 2.

Step 4: The value from step 3 is divided by 2 to give the resultant value n.

(a) Express n in terms of k.
Give your answer in its simplest form.

Answer _____ [1]

(b) Hence explain why n is an integer and a multiple of 3.

Answer _____

_____

_____

_____ [1]

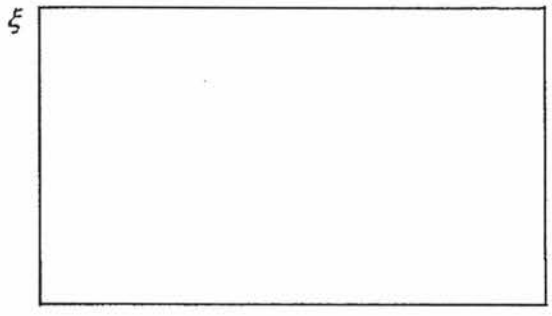
8. V is inversely proportional to the cube of T.
Calculate the percentage change in V, given that T is increased by 300%.

Answer _____ [2]

9. $\xi = \{x : x \text{ is an integer, } 10 < x \leq 23\}$
$A = \{x : x \text{ is an prime number}\}$
$B = \{x : x \text{ is a multiple of } 3\}$

(a) Complete the Venn diagram below to illustrate this information.

Answer [1]



(b) List the elements of $(A \cup B)'$.

Answer _____ [1]

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10. It is given that $\cos(180° - A) = -\frac{24}{25}$ and $0° < A < 90°$.

Find, without the use of a calculator, the value of $\sin(180° - A)$.

Answer $\sin(180° - A) =$ _____ [2]

---

11. Express $-8x-11+x^2$ in the form $(x+p)^2+q$.

Answer _____ [2]

12. The table below shows the number of books that a group of students has.

Number of books	1	2	3	4
Number of students	5	14	x	7

(a) Write down the largest possible value of x if the mode is 2.

Answer _____ [1]

(b) Find the value of x if the mean is 2.8.

Answer _____ [2]

13. (a) Express 60 as the product of its prime factors.

Answer 60 = _____ [1]

(b) Find the smallest positive integer value of x for which $60x$ is a multiple of 378.

Answer x = _____ [2]

14. Each term in this sequence is found by adding the same number to the previous term.

a, 13, b, c, 37, ...

(a) Find the values of a, b and c.

Answer $a =$ _____ $b =$ _____ $c =$ _____ [1]

(b) Write down an expression, in terms of n, for the n^{th} term.

Answer _____ [1]

(c) Explain why 121 is not a term in this sequence.

Answer _____

_____

_____

_____

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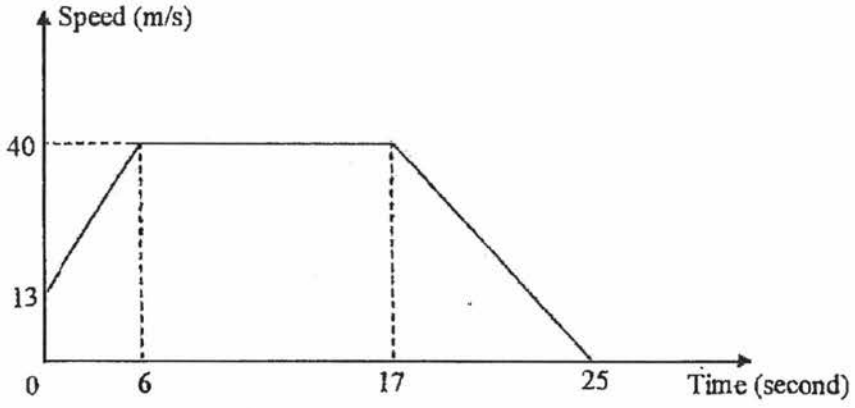
_____

_____ [1]

15. The diagram shows the speed-time graph for the first 25 seconds of a car's journey.



(a) Find the instantaneous speed of the car after travelling for 20 seconds.

Answer _____ m/s [2]

(b) Find the total distance travelled by the car.

Answer _____ m [2]

16. Solve the equation $\frac{8}{3-x} = 5x - 2$.

Answer _____ [3]

---

17. **(a)** Simplify $18p^2c^3 \div 4p^5c^{-4}$.

Answer _____ [1]

(b) Given that $9 \times 27^{2n} = 1$, find the value of n.

Answer $n =$ _____ [2]

---

18. (a) Solve the inequalities $-7 \leq 15-5k < 9$.

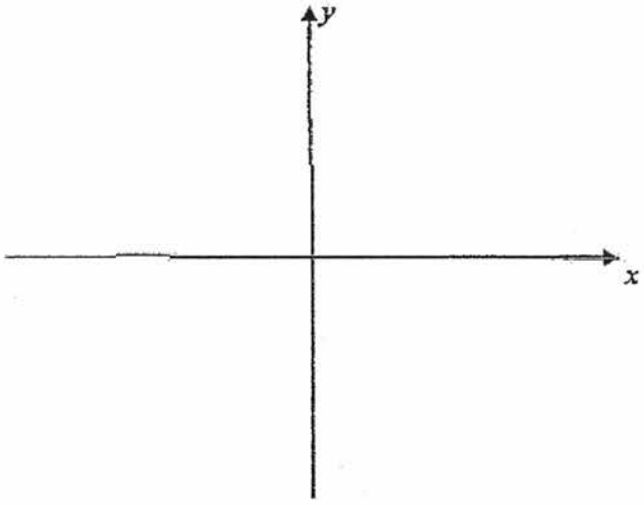
Answer _____ [2]

(b) Write down the integer(s) that satisfy $-7 \leq 15-5k < 9$.

Answer _____ [1]

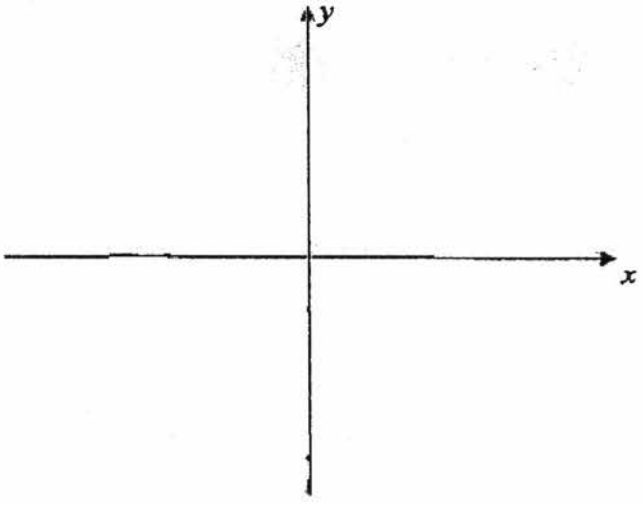
19. (a) (i) Sketch the graph of $y=-\frac{1}{2}x^2$.

Answer [1]



(ii) Sketch the graph of $y=\frac{5}{x^2}$.

Answer [1]



(b) A student claimed that there are roots to the equation $\frac{x^2}{2}+\frac{5}{x^2}=0$.

Do you agree? Justify your answer.

Answer .....

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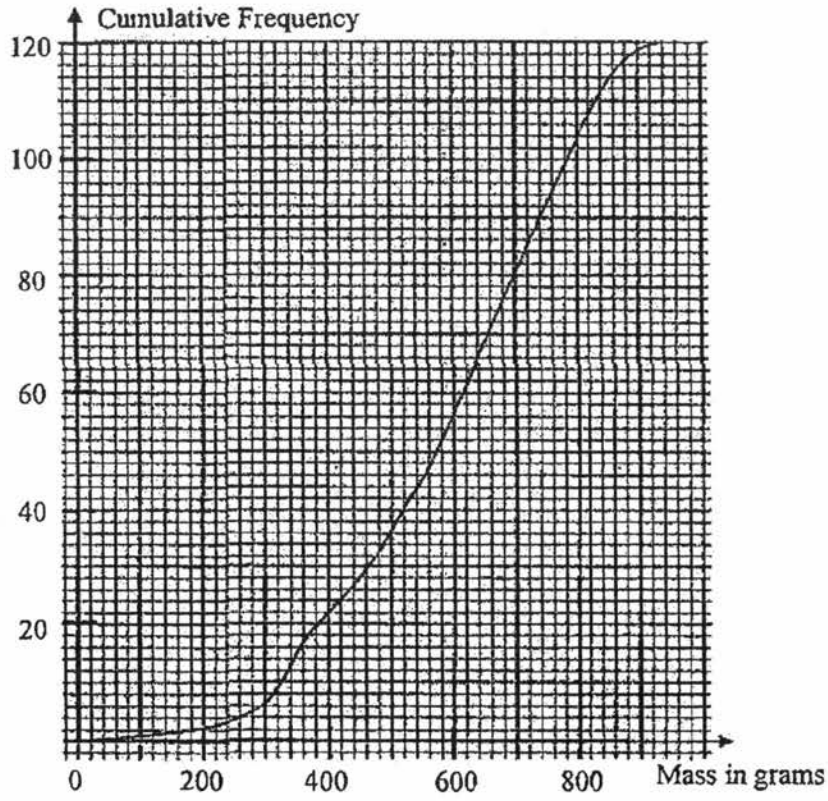
.....

..... [1]

20. The cumulative frequency distribution shows the results of a group of students estimating the mass, in grams, of metal balls in a container.



The actual mass of the metal balls is 500 grams.

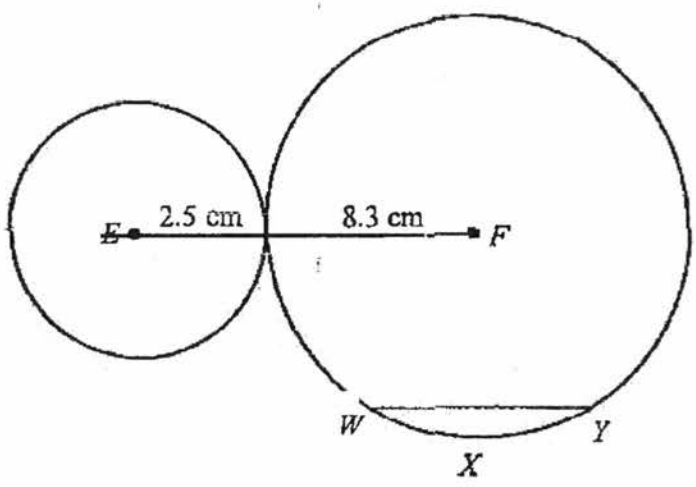
(a) Find the probability that a student, chosen at random, overestimated the mass.

Answer _____ [2]

(b) Find the number of students who gave estimates within 20% of the actual mass.

Answer _____ [2]

21. Two connected discs of radii 2.5 cm and 8.3 cm are shown below.
A clockwise motion in the smaller disc will result in an anti-clockwise motion of the bigger disc.
W, X, Y are points on the circumference of the bigger disc and EF is parallel to WY.
E and F are the center of the smaller and bigger discs respectively.



(a) The smaller disc makes one full complete clockwise rotation.
Find, in terms of π, the angle of rotation made by the larger disc.
Assume that friction is negligible in this question.

Answer _____ radians [2]

(b) Given that $\angle EFW = 1.03$ radians, find the area of the minor segment WXY.

Answer _____ cm^2 [2]

22. A lake has an area of 6.25 km^2.
It is represented by an area of 0.16 cm^2 on map A.

(a) (i) Find the scale of map A in the form $1 : n$.

Answer _____ [2]

(ii) The length of a road on map A is 8.5 cm.
Find the actual length, in kilometres, of the road.

Answer _____ km [1]

(b) The area of the lake is represented on another map B.
The scale of map B is 1 : 450 000.
Find the area, in square centimetres, of the lake represented on map B.

Answer _____ cm^2 [2]

23. The planet Earth can be modelled by a sphere.
The Earth's circumference is estimated to be 40 075 km.

[Take $\pi = 3.142$]

(a) Find the radius, in kilometres, of the Earth.
Give your answer in standard form, correct to 3 significant figures.

Answer _____ km [2]

(b) The speed of light is 3×10^8 m/s.
Express this speed in kilometres per hour.

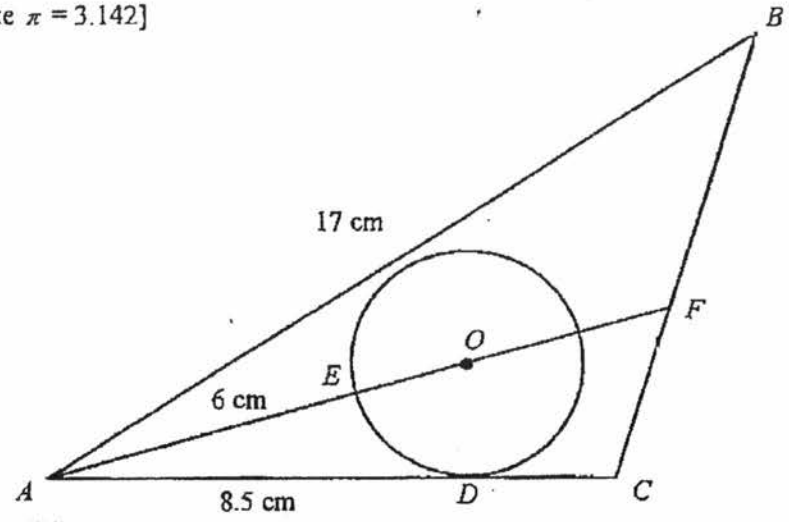
Answer _____ km/h [1]

(c) Find the time taken, in minutes, for a beam of light to travel a distance half the circumference of the Earth.
Give your answer in standard form, correct to 3 significant figures.

Answer _____ minutes [2]

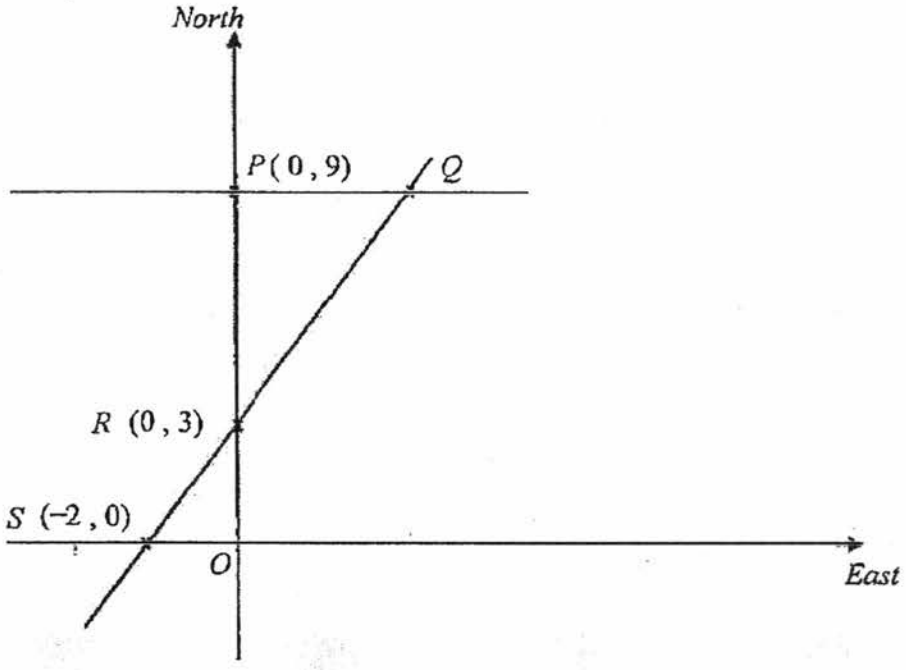
24. In the following figure, a circle with center O is located in triangle ABC.
AC meets the circle at point D and $AD = 8.5$ cm.
E is a point on the circumference of the circle, $AB = 17$ cm and $AE = 6$ cm.
The ratio of the area of triangle ABC to the area of the circle is 5 : 2.
Find the shortest distance from C to AB.

[Take $\pi = 3.142$]



Answer _____ cm [4]

25. In a battleship board game, the position of four ships labelled P, Q, R and S are represented on a Cartesian Plane with the North and East directions given.
Point O is the origin.



(a) Given that line PQ is perpendicular to line OR,
Find the coordinates of the ship at Q.

Answer Q (_____, _____) [3]

(b) Find the distance between Ship P and Ship S.

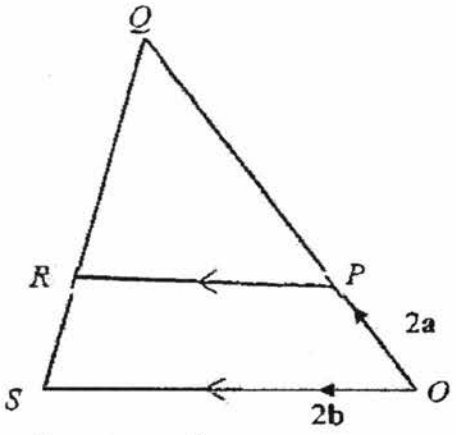
Answer _____ units [1]

(c) Find the bearing of Ship R from Ship Q.

Answer _____ ° [2]

26. In the diagram, $OPRS$ is a trapezium where PR is parallel to OS.

The line OP is produced to the point Q such that $\frac{OP}{OQ} = \frac{1}{3}$.



(a) Given that $\overrightarrow{OP} = 2\mathbf{a}$ and $\overrightarrow{OS} = 2\mathbf{b}$, express in terms of **a** and **b**, as simply as possible,

(i) $\overrightarrow{SQ}$,

Answer _____ [1]

(ii) $\overrightarrow{OR}$

Answer _____ [1]

(b) It is given that $\overrightarrow{OT} = 6\mathbf{a} + 4\mathbf{b}$.

(i) Explain why O, R and T lie on a straight line.

Answer .....

.....

.....

..... [1]

(ii) State the name of quadrilateral $OQTS$.

Answer ..... [1]

(c) (i) Find, giving your answer as a fraction in its simplest form, $\frac{\text{area of triangle } PQR}{\text{area of triangle } OQS}$

Answer ..... [1]

(ii) Hence write down the ratio of $\frac{\text{area of triangle } PQR}{\text{area of quadrilateral } OPRS}$.

Answer ..... [1]

End of Paper 1

Mathematical Formulae

Compound interest

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

Mensuration

Curved surface area of a cone $= \pi rl$

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

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

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

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

Arc length $= r\theta$, where θ is in radians

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

Trigonometry

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

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

Statistics

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

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

1. (a) (i) Simplify the expression $\frac{2x^2+7x-4}{x^2-16}$. [2]

(ii) Hence make x the subject of the formula $y=\frac{2x^2+7x-4}{x^2-16}$. [2]

(b) Solve these simultaneous equations. [3]

$$2x = 1-y,$$
$$4x+5y=8.$$

(c) Given that $\frac{1}{x+y}+\frac{2}{x-y}=\frac{2x+5y}{x^2-y^2}$,

(i) show that $\frac{x}{y}=4$. [2]

(ii) Hence find the value of $\left(\frac{3x}{2y}\right)^2$. [2]

---

2. Alan bought m water bottles for \$128.

(a) Write down an expression, in terms of m, for the cost, in dollars, of one water bottle. [1]

(b) Alan sold 12 of the water bottles at a profit of \$2 each and the rest at \$7 per water bottle.

Write an expression, in terms of m, for the total amount of money he received from the sale of the water bottles. [1]

(c) Alan found that he made a profit of \$20 from the sale.

Write an equation in m to represent this information and show that it reduces to

$$7m^2-208m+1536=0.$$ [3]

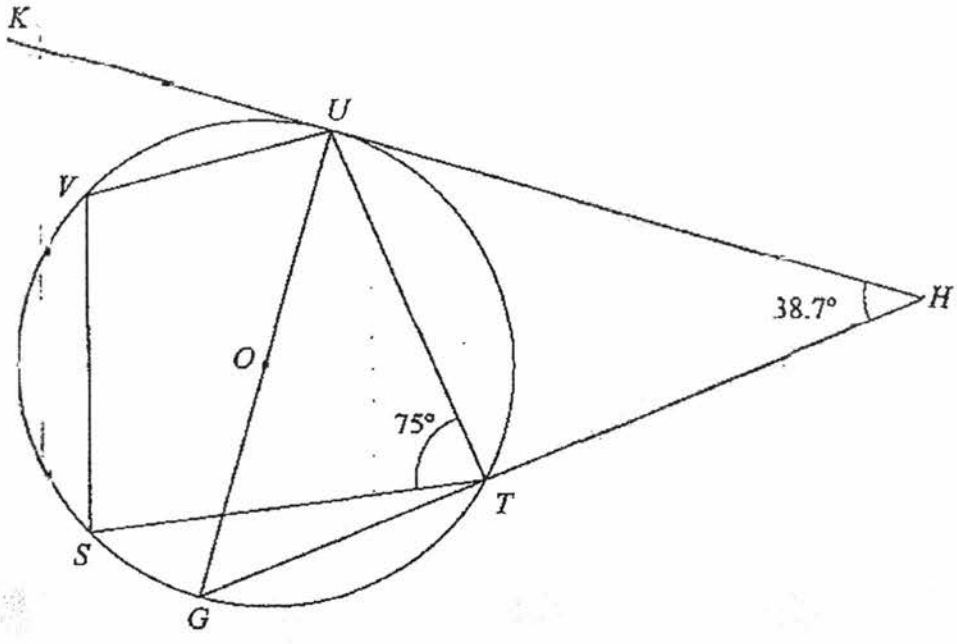
(d) Solve the equation $7m^2-208m+1536=0$. [3]

(e) Find the selling price of each water bottle so that Alan makes a profit of 20%. [1]

---

3. In the diagram, the points S, T, U and V lie on a circle with centre O.

G is a point on the circle such that GU is the diameter of the circle.
The tangent KU and the chord GT are extended to meet at point H.
$\angle STU = 75°$ and $\angle GHU = 38.7°$.



(a) Prove that triangle GTU and triangle GUH are similar. [2]

(b) Given that $HU = 8$ cm and $UT : GT = 5 : 4$, find the area of triangle GUH. [3]

(c) Stating your reasons clearly, calculate

(i) $\angle SVU$, [1]

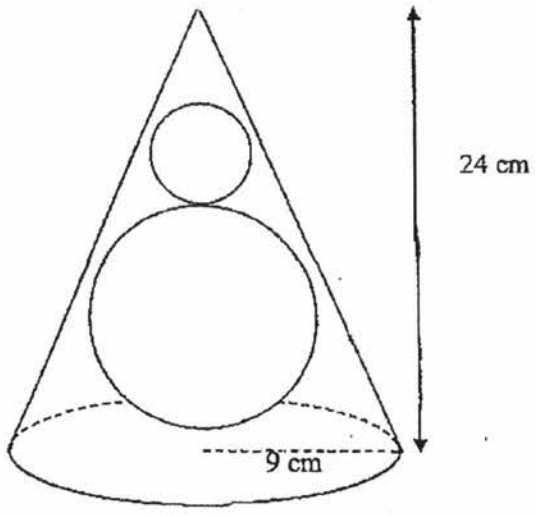
(ii) $\angle GTS$, [1]

(iii) $\angle TGU$, and [1]

(iv) $\angle TOU$. [1]

4. The diagram shows a conical container with radius 9 cm and height 24 cm.

Two balls are placed in the container as shown and 49.5π cm^3 of sand are needed to fill the container completely.



(a) Calculate the total surface area of the container. [2]

(b) If the balls are removed and the container is inverted, find the height of the sand in the container. [4]

(c) The radii of the two balls are in the ratio of 2 : 5.

Calculate the radius of the smaller ball. [4]

5. **Answer the whole of this question on a single sheet of graph paper.**

The variables x and y are connected by the equation

$$y = x - 2 + \frac{8}{x}.$$

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

x	1	1.5	2	3	4	5	6	7	8
y	7.0	4.8	4.0	3.7	4.0	4.6	5.3	h	7.0

(a) Find the value of h. [1]

(b) Using a scale of 2 cm to represent 1 unit on each axis, draw a horizontal x-axis for $0 \le x \le 8$ and a vertical y-axis for $0 \le y \le 8$.

On your axes, plot the points in the given table and join them with a smooth curve. [3]

(c) By drawing a tangent, find the gradient of the curve at (4, 4.0). [2]

(d) Use your graph to solve the equation $x + \frac{8}{x} = 8.5$ for $0 \le x \le 8$. [2]

(e) (i) On the same axes, draw the line $y = 7 - x$ for $0 \le y \le 8$. [2]

(ii) Write down the x-coordinates of the points at which the two graphs intersect. [1]

(iii) Hence state the value of c such that the equation $2x^2 + cx + 8 = 0$ is satisfied by the values of x found in part **(e)(ii)**. [1]

6. Diagram I shows a table with a horizontal plane $ABCD$ such that $AB = 120$ cm and $AD = 70$ cm.
Three vertical planes are erected along three sides of the table such that E and F are vertically above C and D respectively and $CE = DF = 30$ cm.
Q and P are the midpoints of BC and BE respectively.

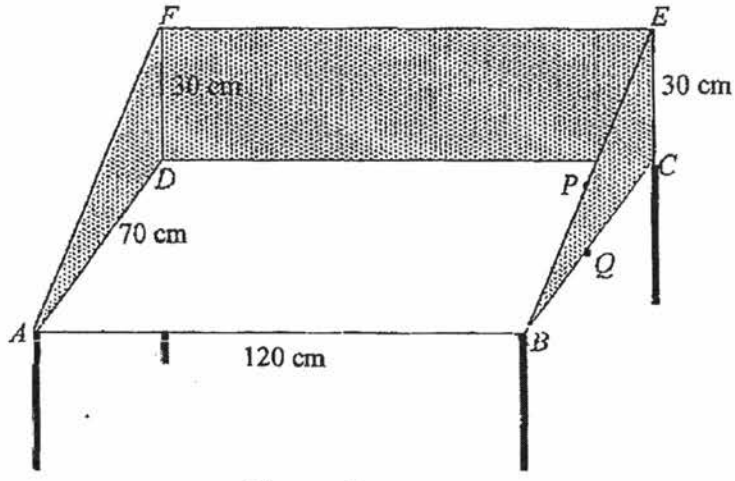


Diagram I

(a) Calculate

(i) AQ, [2]

(ii) angle PAQ. [2]

A wooden board is attached along EF with hinges such that it covers $ABEF$ in Diagram I.
$ABEF$ then becomes a tabletop that can be used by an architect when he draws his designs.
This tabletop can be lifted up and Diagram II shows the side view when this is done.
The new position for B is now B', 60 cm directly above B.

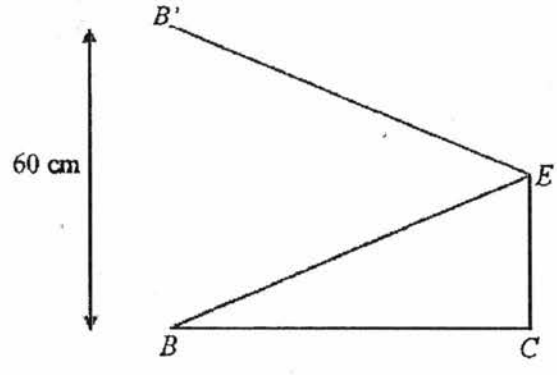


Diagram II

(b) **(i)** Show that angle BEB' is 46.397°, correct to 3 decimal places. [3]

(ii) Hence find the distance moved by point B, when the tabletop is lifted up to B'. [2]

7. A shop sells two types of cookies, Cranberry and Blueberry.

Each type is sold in packets of three different sizes, small (S), medium (M) and large (L). They are each sold at a different price.

The sales for two consecutive weeks, Week 1 and 2, are given in the following table.

	Week 1			Week 2		
Size	S	M	L	S	M	L
No. of packet of Cranberry cookies sold	15	10	12	7	11	9
No. of packet of Blueberry cookies sold	13	11	14	12	8	17
Cost per packet	$4	$5.50	$6.50	$4	$5.50	$6.50

The matrix **G** shows the sales of the cookies in Week 1.

$$\mathbf{G} = \begin{matrix} \\ \text{Cranberry} \\ \text{Blueberry} \end{matrix} \begin{matrix} \begin{matrix} \text{S} & \text{M} & \text{L} \end{matrix} \\ \begin{pmatrix} 15 & 10 & 12 \\ 13 & 11 & 14 \end{pmatrix} \end{matrix}$$

(a) Write down a matrix **D** to represent the sales of the cookies in Week 2. [1]

(b) Evaluate $\mathbf{M} = (\mathbf{G} + \mathbf{D})$ and state what its elements represent. [2]

(c) The cost of each packet of cookies for each size can be represented by the matrix **C**.

$$\mathbf{C} = \begin{matrix} \text{Cost} \\ \begin{pmatrix} 4 \\ 5.5 \\ 6.5 \end{pmatrix} \\ \begin{matrix} \text{S} \\ \text{M} \\ \text{L} \end{matrix} \end{matrix}$$

Evaluate $\mathbf{L} = \frac{1}{2}(\mathbf{MC})$ and state what its elements represent. [3]

(d) (i) Write down a matrix **T** such that **TMC** gives the total sales for the two weeks. [1]

(ii) Hence evaluate **TMC**. [1]

(e) The target sales of the cookies in Week 3, as compared to Week 1 are as follow:

Cranberry: increase by 35%
Blueberry: decrease to 85%

Write down the value of a and of b such that the matrix product

$$\begin{pmatrix} a & b \end{pmatrix} \begin{pmatrix} 15 & 10 & 12 \\ 13 & 11 & 14 \end{pmatrix}$$

gives the target sales of the cookies in Week 3. [1]

8. Diagram I shows a regular hexagon $ABCDEF$ and squares $AFPQ$ and $CBRS$.

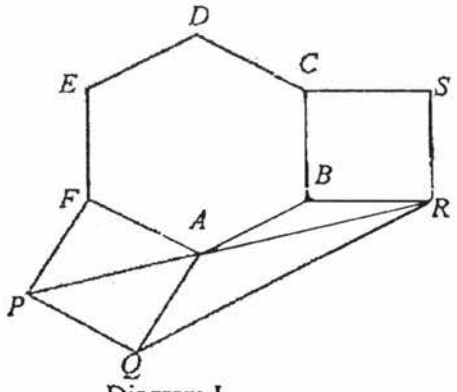


Diagram I

(a) Find

(i) reflex $\angle BAQ$, [2]

(ii) $\angle AQR$. [2]

(b) Show that PAR is a straight line. [2]

(c) Additional squares and hexagons are added to Diagram I to form a regular polygon, $ABR.....Q$, as shown in Diagram II.

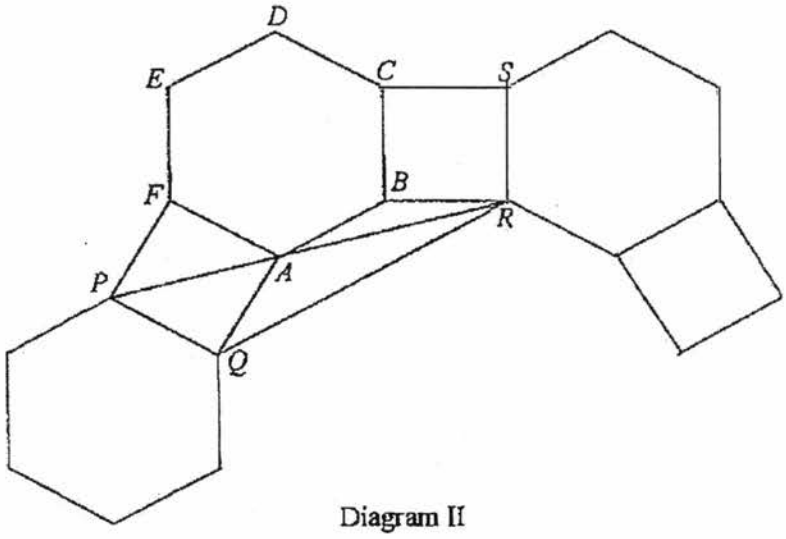


Diagram II

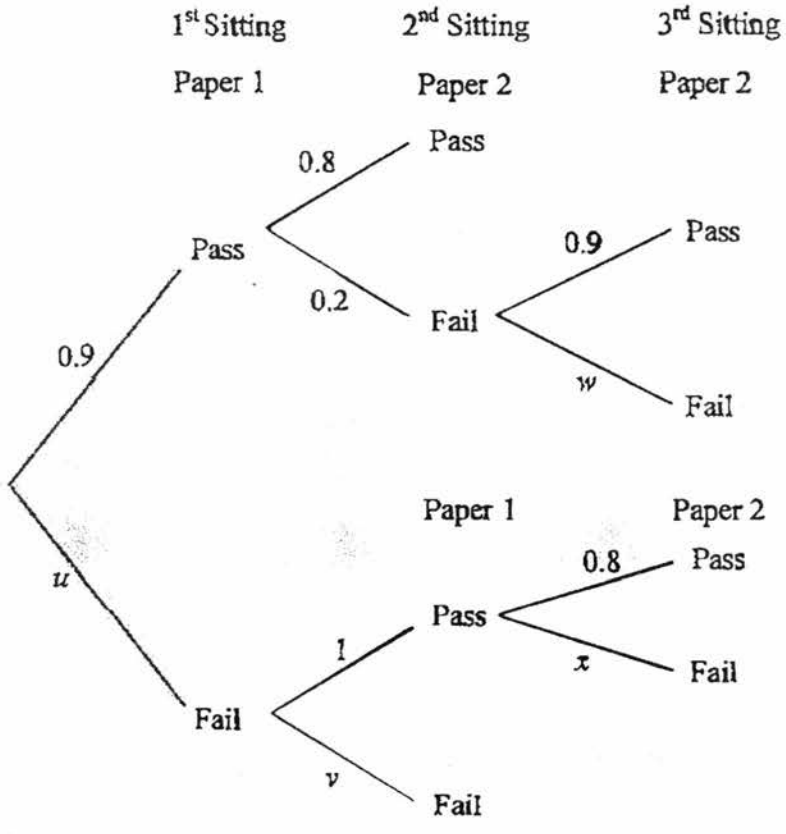
Calculate the number of squares added to form the polygon $ABR....Q$. [3]

9. (a) An entrance examination consists of 2 different papers, Paper 1 and Paper 2.

A candidate must pass Paper 1 before he can proceed to sit for Paper 2.
He must pass both papers in order to pass the examination.
He has a maximum of 3 sittings to pass the examination.

The probability of passing Paper 1 and 2 are 0.9 and 0.8 respectively, and increases by 0.1 for each subsequent attempt of the same paper.

(i) The tree diagram shows the probabilities of the possible outcomes.



Find the respective values of u, v, w, and x. [2]

(ii) Calculate the probability that a candidate

(a) passes the examination at the end of the second sitting, [1]

(b) does not pass the examination. [2]

(iii) If 1000 candidates enrolled for the examination, estimate the number of candidates expected to pass eventually. [1]

9. (b) The stem-and-leaf diagram shows the amount of time, in seconds, a group of boys can hold their breath when under water.

Stem	Leaf
1	5
2	
3	
4	0 0 1 2 3 5 7 7
5	2 4 4 4 5 6 6 6 6 6 7 8
6	1 2 3 3 5 7 8
7	0 0

Key : 4 | 2 means 42

(i) Find the

(a) median time taken, and [1]

(b) mean time taken. [1]

(ii) Is the median or the mean time a better representation, for the time taken by this group of boys?
Explain your answer. [1]

(iii) Calculate the standard deviation. [2]

(iv) Another group of 30 boys measured the time they took to hold their breath underwater.
Their mean time taken was 53.5 seconds and the standard deviation was 7.86.

Compare and comment on the results between these two groups of boys. [1]

10. ERGO is a company that sells ergonomic furniture for homes.
The types of furniture include study table-chair sets, chairs, baby cots and bunk beds.
The table below shows the average time taken by the delivery men to assemble each type of furniture.

Furniture	Average time taken to assemble each piece (minutes)
Study table-chair set	45
Chair	3
Baby cot	12
Bunk bed	105

(a) Find the total average time taken, in hours and minutes, to assemble one set of study table-chair set, one baby cot and one bunk bed. [1]

(b) The Operation Manager in the company is responsible for planning the daily delivery route.
On a particular day, the delivery route is as shown below.

No.	Location	Order	Estimated time of delivery
1	Happy Valley	• 1 study table-chair set • 2 chairs	09 00 to 10 30
2	Joyful Pasture	• 1 baby cot	10 30 to 12 00
3	Dream Cove	• 1 baby cot • 1 bunk bed	10 30 to 12 00
4	Blissful Ave	• 1 study table-chair set • 1 baby cot • 1 bunk bed	13 00 to 15 00
5	Peace Link	• 1 study table-chair set • 1 baby cot	15 00 to 17 00

Additional information needed for the delivery is shown on the opposite page.

The delivery men left the office at 09 15 for the first location at Happy Valley.
After assembling the orders, they proceeded to the second location at Joyful Pasture and arrived at 10 30.

(i) Calculate the average speed, in km/h, of the delivery van, leaving your answer to the nearest whole number.
Do you think the answer is a reasonable estimate of the actual travelling speed of the van? Justify your answer. [3]

(ii) The daily working hours for the delivery men is 08 30 to 18 00, and they are

Determine if the delivery men can leave the office punctually at 18 00 for that day.
Support your answer with appropriate calculations.
State one reasonable assumption you have made in your calculations. [6]

DISTANCE CHART BETWEEN THE VARIOUS LOCATIONS

Distance (in km)	ERGO Office	Happy Valley	Joyful Pasture	Dream Cove	Blissful Ave	Peace Link
ERGO Office	–	13.8	18.1	9.7	7.2	1.9
Happy Valley	13.8	–	4.7	3.8	8	16.3
Joyful Pasture	18.1	4.7	–	6.1	10.6	20
Dream Cove	9.7	3.8	6.1	–	5.4	9.3
Blissful Ave	7.2	8	10.6	5.4	–	8.8
Peace Link	1.9	16.3	20	9.3	8.8	–

SPEED LIMITS FOR VEHICLES

The following speed limits are enforced by LTA to ensure everyone's safety:

Type of Vehicle	Roads	Expressways	Tunnels
Cars & motorcycles	50km/h	70-90km/h	50-80km/h
Buses & coaches	50km/h	60km/h	50-60km/h
Light commercial vehicles (includes Light Goods Vehicles and small buses not exceeding 3.5 tonnes and seating capacity of up to 15 passengers)	50km/h	60-70km/h	50-70km/h
Exceptions: Fire engines, Ambulances, and Government vehicles used by Singapore Police Force or the Singapore Civil Defence Force			

https://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/road-safety-and-regulations/road-regulations.html

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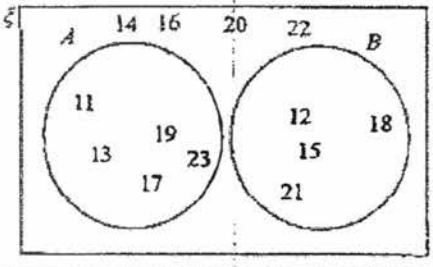
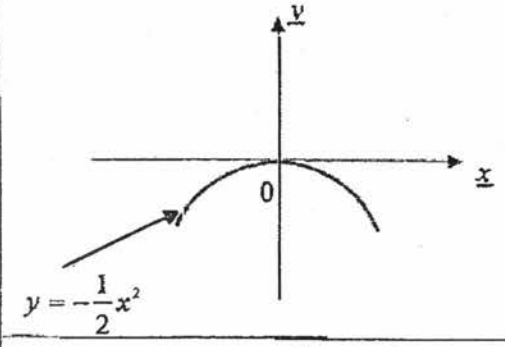
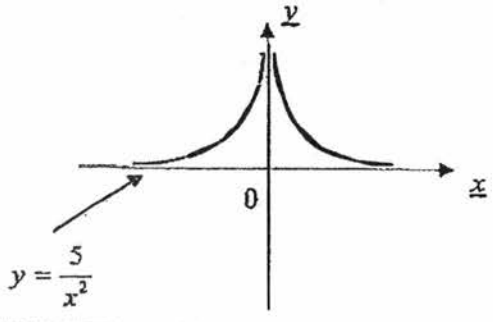
End of Paper 2

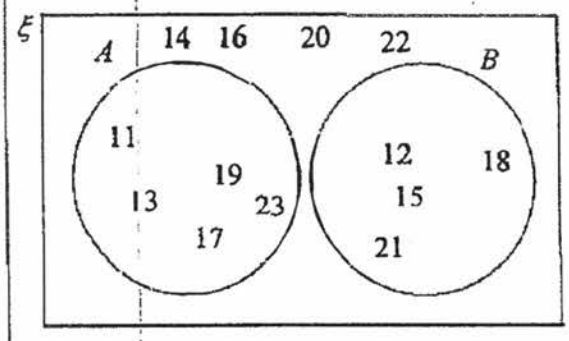
Qn			
1	-0.380	12a	13
2a	$\sqrt[3]{3},\ 0.\dot{6}\dot{6},\ \frac{\pi}{7},\ \frac{1}{3},\ -0.4,\ -\sqrt{4}$	12b	$x = 59$
2b	$\sqrt[3]{3},\ \frac{\pi}{7}$	13a	$60 = 2^2 \times 3 \times 5$
3	$(a+1)(a-1)(5a^2+1)$	13b	$x = 63$
4	Stating aspect or equivalent – 1 mark Explaining how audience might be mislead or equivalent – 1 mark	14	a = 5 b = 21 and c = 29
5	6	14b	$T_n = 8n - 3$
6	5.5 °C	14c	When 121 is a term in the sequence, n will have a value of 15.5. A pattern number n must be an integer. The value of 121 is resulted from a value of $n = 15.5$. This imply that the pattern number of 15.5 doesn't exist and hence 121 is not a term in this sequence.
7a	$n = 12k + 3$	15a	Speed = 25 m/s
7b	$n = 3(4k+1)$ Since k is an integer, $4k+1$ will always be an integer. Therefore, n will be an integer. Based on $n = 3(4k+1)$, n can be factorized to give $3(4k+1)$. Hence 3 and $4k+1$ are factors of $n = 3(4k+1)$ and n will be a multiple of 3.	15b	759 m
8	-98.4375%	16	$x = 1\frac{2}{5}$ or $x = 2$
9a		17a	$\frac{9c^7}{2p^3}$
9b	14 , 16 , 20 and 22	17b	$n = -\frac{1}{3}$
10	$\frac{7}{25}$	18a	$1\frac{1}{5} < k \leq 4\frac{2}{5}$
11	$(x-4)^2 - 27$	18b	2, 3 and 4

Qn			
19ai		23a	6.38×10^3km
		23b	1.08×10^9 km/h
		23c	1.11×10^{-3} minutes
		24	$x=8.43$cm
19aii		25a	Coordinates of ship Q is (4, 9)
		25b	9.22 units
		25c	213.7°
19b	No, I do not agree. There are no roots to the equation as there are no common points of intersection between the two curves. These two curves will never meet each other.	26ai	$6a-2b$
20a	$\frac{7}{10}$	26aii	$2a+\frac{4}{3}b$
20b	34	26bi	$\overrightarrow{OT}=6a+4b$ $=3(2a+\frac{4}{3}b)$ $=3\overrightarrow{OR}$ $\overrightarrow{OT}$ is parallel to $\overrightarrow{QR}$ and O is a common point. O, R and T are collinear.
21a	$\frac{50}{83}\pi$	26bii	Trapezium
21b	6.85 cm^2	26ci	$\frac{4}{9}$
22ai	1 : 625000	26cii	4 : 5
22aii 22b	53.125 km 0.309 cm^2		

Sec 4 Express/5 Normal Prelim Paper 1 Marking Scheme

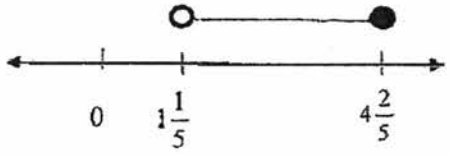
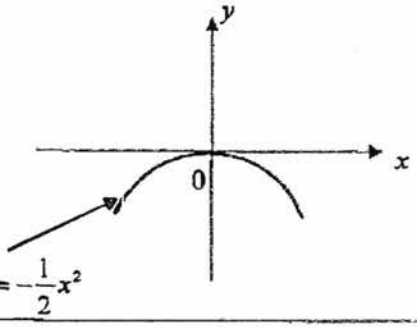
SN	Answer	Mark	Comments
1	$\frac{0.85^2 - 5.34}{\sqrt{81.2} + 3.134}$ $= -0.38019$ $= -0.380$	 B1	 Correct rounding off to 3sf must be shown to be awarded B1
2a	$\sqrt[3]{3} = 1.442249$ $\frac{\pi}{7} = 0.448857$ $0.\dot{6}\dot{6} = \frac{2}{3}$ $\sqrt[3]{3},\ 0.\dot{6}\dot{6},\ \frac{\pi}{7},\ \frac{1}{3},\ -0.4,\ -\sqrt{4}$	 B1	 Correct order
2b	Irrational numbers are $\sqrt[3]{3},\ \frac{\pi}{7}$	B1	
3	$6a^2(a^2-1) - (a^2-1)^2$ $= (a^2-1)[6a^2 - (a^2-1)]$ $= (a^2-1)[5a^2+1)]$ $= (a+1)(a-1)(5a^2+1)$	 M1 A1	Accept $5a^4 - 4a^2 - 1$ $= (5a^2+1)(a^2-1)$ $= (5a^2+1)(a+1)(a-1)$
4	The chart shown for year 2012 is approximately twice the size of the chart shown in 2013. However, the value of the knuckle velocity in 2012 is not twice the velocity as shown in 2013. Audience might be visually misled into thinking that the baseball player has reduced his knuckle velocity by a great amount.	B1 B1	Stating aspect or equivalent Explaining how audience might be mislead or equivalent

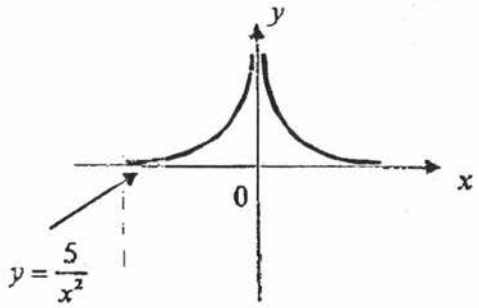
5	$a^2+6a=6$ $a(a^2+6a)=6a$ $a^3+6a^2=6a$ $a^3+6a^2+a^2=6a+a^2$ $a^3+7a^2=6a+a^2$ $=6$	M1 A1	a^3+7a^2 $=a^2(a+7)$ $=a^2[(a+6)+1]$ $=a^2(a+6)+a^2$ $=a(a^2+6a)+a^2$ $=6a+a^2$ $=6$ Or factoise to solve for 2 values of a and perform substitution to find answer.
6	Temperature difference $=34-(-5)$ $=39$ °C Required temperature $=34-\left(\frac{39}{26}\times 19\right)$ $=5.5$ °C	 M1 A1	 Accept workings like $-5+7(1.5)$ $=5.5$
7a	$n=12k+3$	B1	Accept $n=3(4k+1)$ o.e.
7b	$n=3(4k+1)$ **Since k is an integer, $4k+1$ will always be an integer. Therefore, n will be an integer.** Based on $n=3(4k+1)$, n can be factorized to give $3(4k+1)$. **Hence 3 and $4k+1$ are factors of $n=3(4k+1)$ and n will be a multiple of 3.**	 B1	 Only award B1 if student managed to explain both conditions of n.
8	$V=\frac{k}{T^3}$ When T is increased by 300%, New $T=4T$ $V=\frac{k}{(4T)^3}$ $V=\frac{k}{64T^3}$	 M1	

	Percentage decrease $= \dfrac{\dfrac{k}{64T^3} - \dfrac{k}{T^3}}{\dfrac{k}{T^3}} \times 100\%$ $= \dfrac{\dfrac{1}{64} - 1}{1} \times 100\%$ $= -98.4375\%$	A1	
9a		B1	Any missing term will result in zero marks
9b	14 , 16 , 20 and 22	B1	
10	$\cos A = \dfrac{24}{25}$ Let the unknown side of the triangle be x $x^2 = 25^2 - 24^2$ $x^2 = 625 - 576$ $x^2 = 49$ $x = 7$ $\sin(180° - A) = \sin A$ $= \dfrac{7}{25}$	M1 A1	Accept if students show triangles with values of Pythagoras' Theorem applied with writing out the steps.

11	$-8x-11+x^2$ $= x^2-8x+\left(\frac{-8}{2}\right)^2-\left(\frac{-8}{2}\right)^2-11$ $=(x-4)^2-27$	 M1 A1	
12a	13	B1	
12b	$\frac{5(1)+14(2)+3x+7(4)}{26+x}=2.8$ $61+3x=2.8(26+x)$ $61+3x=72.8+2.8x$ $0.2x=11.8$ $x=59$	M1 B1	
13a	$60=2^2\times3\times5$	B1	
13b	$378=2\times3^3\times7$ LCM of 60 and 378 $=2^2\times3^3\times5\times7$ $=3780$ $60x=3780$ $x=63$	 M1 B1	 Finding LCM Accept if students have written down workings and could make observations to find the value of x.
14a	a = 5 b = 21 and c = 29	B1	
14b	$T_n=8n-3$	B1	Accept $5+8(n-1)$
14c	$8n-3=121$ $8n=124$ $n=15.5$ **When 121 is a term in the sequence, n will have a value of 15.5. A pattern number n must be an integer.** The value of 121 is resulted from a value of n = 15.5. This imply that the pattern number of 15.5 doesn't exist **and hence 121 is not a term in this sequence.**	 B1	 Keywords must be seen in students' answer Accept words like **whole number** instead of integer, decimal and fraction accepted too Students must mention that n is not an integer

15a	Let the speed be x m/s $\frac{x-40}{20-17}=\frac{0-40}{25-17}$ $\frac{x-40}{3}=-5$ $x-40=-15$ $x=25$ Speed = 25 m/s	M1 A1	Deceleration $=\frac{40}{8}$ $=5$ m/s^2 M1 Speed = $40-3(5)$ $=25$ m/s A1
15b	Total distance travelled $=\frac{1}{2}(13+40)(6)+(17-6)(40)+\frac{1}{2}(25-17)(40)$ $=159+440+160$ $=759$ m	M1 A1	
16	$\frac{8}{3-x}=5x-2$ $(3-x)(5x-2)=8$ $15x-6-5x^2+2x=8$ $-5x^2+17x-14=0$ $5x^2-17x+14=0$ $(5x-7)(x-2)=0$ $(5x-7)=0$ or $(x-2)=0$ $x=1\frac{2}{5}$ or $x=2$	M1 M1 A1	Marks awarded if student did not write "x = ____" (i.e some students wrote down 1.4 or 2 as answers) Accept $x=1.4$
17a	$18p^2c^3\div 4p^5c^{-4}$ $=\frac{18p^2c^3}{4p^5c^{-4}}$ $=\frac{9p^{2-5}c^{3+4}}{2}$ $=\frac{9p^{-3}c^7}{2}$ $=\frac{9c^7}{2p^3}$	 B1	Accept $\frac{9}{2}p^{-3}c^7$ Do not accept $4.5p^{-3}c^7$

17b	$9\times27^{2n}=1$ $3^2\times(3^3)^{2n}=3^0$ $3^2\times3^{6n}=3^0$ $2+6n=0$ $n=-\frac{1}{3}$	M1 A1	
18a	$-7\leq 15-5k<9$ $-7\leq 15-5k$ $-5k\geq -22$ $k\leq \frac{22}{5}$ $k\leq 4\frac{2}{5}$ and $15-5k<9$ $-5k<9-15$ $-5k<-6$ $k>1\frac{1}{5}$  $1\frac{1}{5}<k\leq 4\frac{2}{5}$	 M1 A1	 For both correct inequalities Accept $1.2<k\leq 4.4$ [Number line is optional]
18b	2, 3 and 4	B1	
19ai	 	B1	

19aii		B1	
19b	No, I do not agree. There are no roots to the equation as there are no common points of intersection between the two curves. These two curves will never meet each other.	B1	Accept alternative method $x^4+10=0$ $x^4=-10$ $x^4=\sqrt[4]{-10}$ $=$ *no solution* Therefore, there are no roots. Students need to mention that x = no solution and conclude that there are no roots to be given marks.
20a	Number of students who overestimate $=120-36$ $=84$ P(student overestimate the mass) $=\frac{84}{120}$ $=\frac{7}{10}$	M1 A1	 Accept 0.7
20b	120% of actual mass $=\frac{120}{100}\times 500$ $=600$ 80% of actual mass $=\frac{80}{100}\times 500$ $=400$	M1	Working out the respective upper and lower limits of the given range

	Number of students $= 56-22$ $= 34$	A1	Readings/Markings must be shown on graph to score M1 if students didn't work out/write down the limits on their answer scripts.
21a	Arc length travelled by smaller disc $= 2.5\times 2\pi$ $= 5\pi$ cm Let θ be the angle of rotation made by the larger disc $8.3\,\theta = 5\pi$ $\theta = \frac{5\pi}{8.3}$ $= \frac{50\pi}{83}$ or $\frac{50}{83}\pi$ radian	M1 A1	Accept 0.602π
21b	$\angle FWY = 1.03$ radian (alternate angles) $\angle WFY = \pi - 2(1.03)$ $= 1.08159$ radian Area of segment = $(\frac{1}{2}\times 8.3^2 \times 1.08159) - (\frac{1}{2}\times 8.3^2 \times \sin 1.08159)$ $= 37.25536 - 30.40481$ $= 6.85055$ $= 6.85$ cm^2	M1 A1	Accept $\angle WFY = 1.081$ *or* 1.082 Area of segment will be 6.84 cm^2 or 6.86 cm^2 respectively. *premature rounding will only be awarded method mark
22ai	Map:Actual 0.16 cm^2 : 6.25 km^2 0.4 cm : 2.5 km 1 cm : 6.25 km Scale of map = 1 : 625000	M1 A1	
22aii	Map:Actual 1 cm : 6.25 km 8.5 cm : 53.125 km Actual length of road = 53.125 km	B1	

22b	Map : Actual 1 : 450000 1 cm : 450000 cm 1 cm : 4.5 km $1\ cm^2 : 20.25\ km^2$ Actual : Map $20.25\ km^2 : 1\ cm^2$ $1\ km^2 : \frac{1}{20.25}\ cm^2$ $\text{Area} = \frac{1}{20.25} \times 6.25$ $= 0.308641$ $= 0.309\ cm^2$	M1 A1	Accept $\frac{25}{81}\ cm^2$ Students should refrain from giving this answer
23a	$2\pi r = 40075$ Radius $= \frac{40075}{2(3.142)}$ $= 6377.3074$ $= 6.38 \times 10^3 km$	M1 A1	
23b	Speed $= \frac{3 \times 10^8 m}{1s}$ $= \frac{3 \times 10^8 \times 10^{-3}}{\frac{1}{3600}}$ $= 1080000000$ $= 1.08 \times 10^9\ km/h$	B1	Accept 1080 000 000 km/h
23c	Time taken $= \frac{\frac{1}{2} \times 40075}{1.08 \times 10^9} \times 60$ $= 1.11319 \times 10^{-3}$ $= 1.11 \times 10^{-3}$ minutes	M1 A1	No marks awarded if speed is wrong.

24	$\angle ODA = 90°$ (tangent perpendicular to radius) Let the radius of the circle be r $(6+r)^2 = r^2 + 8.5^2$ $36 + 12r + r^2 = r^2 + 8.5^2$ $12r = 36.25$ $r = 3.02083$ Area of triangle ABC $= 2.5 \times \pi(3.02083)^2$ $= 71.6802$ Let the shortest distance be x $\frac{1}{2} \times x \times 17 = 71.6802$ $x = 8.4329$ $x = 8.43$cm	 M1 M1 M1 A1	 Application of pythagoras' Theorem Finding radius Finding area of triangle Accept 3.020 or 3.021 Finding shortest distance
25a	Gradient $= \frac{3-0}{0-(-2)}$ $= \frac{3}{2}$ Equation of line QR is $y = \frac{3}{2}x + 3$ Sub $y = 9$ into $y = \frac{3}{2}x + 3$ $9 = \frac{3}{2}x + 3$ $18 = 3x + 6$ $3x = 12$ $x = 4$ Coordinates of ship Q is (4, 9).	 M1 M1 A1	
25b	Distance between ship P and ship S $= \sqrt{[0-(-2)]^2 + [9-0]^2}$ $= \sqrt{4+81}$ $= \sqrt{85}$ $= 9.2195$ $= 9.22$ units	 B1	Do not accept $\sqrt{85}$

25c	$\tan \angle PQR = \frac{6}{4}$ $\angle PQR = \tan^{-1}(\frac{6}{4})$ $= 56.30993$ Bearing of R from Q $= 360 - 90 - 56.30993$ $= 213.69°$ $= 213.7°$	M1 A1	
26ai	$\overrightarrow{SQ} = \overrightarrow{SO} + \overrightarrow{OQ}$ $= -2b + 6a$ $= 6a - 2b$	B1	Accept $2(3a - b)$
26aii	$\overrightarrow{OR} = \overrightarrow{OQ} + \overrightarrow{QR}$ $= 6a + \frac{2}{3}\overrightarrow{QS}$ $= 6a + \frac{2}{3}(-6a + 2b)$ $= 6a - 4a + \frac{4}{3}b$ $= 2a + \frac{4}{3}b$	B1	$2(a + \frac{2}{3}b)$
26bi	$\overrightarrow{OT} = 6a + 4b$ $= 3(2a + \frac{4}{3}b)$ $= 3\overrightarrow{OR}$ $\overrightarrow{OT}$ is parallel to $\overrightarrow{OR}$ and O is a common point. O, R and T are collinear.	B1	Students must prove that the value of k = 3 and state that there is a common point O to score B1
26bii	Trapezium	B1	
26ci	$\frac{\text{area of } \Delta PQR}{\text{area of } \Delta OQS}$ $= \left(\frac{2}{3}\right)^2$ $= \frac{4}{9}$	B1	

26cii	Ratio of $\frac{\text{area of } \Delta PQR}{\text{area of quadrilateral } OPRS}$ $= \frac{4}{5}$ $= 4 : 5$	B1	Accept $\frac{4}{5}$

Answers to 2017 Preliminary Exam Mathematics Paper 2

Qn	Answer
1ai	$\frac{2x-1}{x-4}$
aii	$x=\frac{4y-1}{y-2}$
b	$y=2,\ x=-0.5$
cii	36
2a	$\$\frac{128}{m}$
b	$\$\left[12\left(\frac{128}{m}+2\right)+(m-12)7\right]$
d	16 , 13.7 (or $13\frac{5}{7}$)
e	\$9.60
3a	$\angle GTU = 90°$ (right angle in semicircle) $\angle GUH = 90°$ (radius perpendicular to tangent) $\Rightarrow \angle GTU = GUH = 90°$ $\angle G$ is a common angle ∴ Triangle GTU and triangle GUH are similar. (All 3 corrsponding angles are equal)
b	$25.6cm^2$
ci	105°
cii	15°
ciii	51.3°
civ	102.6°
4a	979 cm^2
b	10.2 cm
c	3 cm
5a	6.1
c	0.510 (accept 0.4 to 0.6)
d	$x = 1.05, 7.4$ (accept ±0.05)
eii	$x = 1.2, 3.25$ (accept ±0.05)
6ai	125 cm
aii	6.8°
bii	61.7 cm
7a	$\begin{pmatrix} 7 & 11 & 9 \\ 12 & 8 & 17 \end{pmatrix}$
b	$\begin{pmatrix} 22 & 21 & 21 \\ 25 & 19 & 31 \end{pmatrix}$ It represents the **total sale or number of cookies** of each type and each size sold in the two weeks. (number of **cranberry and blueberry** cookies sold in **small, medium and large**

Qn	Answer
7c	$\begin{pmatrix} 170 \\ 203 \end{pmatrix}$ **Average amount of money collected per week** of each type of cooki es.
di	$\begin{pmatrix} 1 & 1 \end{pmatrix}$
dii	(746)
e	$a = 1.35,\ b = 0.85$
8ai	210°
aii	30°
b	$\angle BAR = (180° - 150°) \div 2 = 15°$ (base ∠ of isos. Δ) $\angle PAR = 45° + 120° + 15° = 180°$ ∴ By the property *Adjacent angles on a straight line is supplementary*, PAR is a straight line
c	4 squares
9ai	$u = 0.1,\ v = 0,\ w = 0.1,\ x = 0.2$
aiia	$0.9 \times 0.8 = 0.72$
aiib	$0.9 \times 0.2 \times 0.1 + 0.1 \times 1 \times 0.2 + 0.1 \times 0 = 0.038$
aiii	$1000 - 1000(0.038) = 962$
9bia	Median time taken = 56 sec
bib	Mean time taken = 53.8 sec
bii	Median, as the extreme value of 15 can lower the mean time taken
biii	Standard deviation = 11.3
biv	The 2 groups of boys have comparable lung power since they have almost the same mean, but the second group of boys are **more consistent** in the amount of time they take to hold their breath under water (or there is a **smaller variation** in the amount of time they take to hold their breath under water) due to the **smaller standard deviation**.

PRELIMINARY EXAM 2017

SECONDARY 4 EXPRESS 5 NORMAL (ACADEMIC)

Mathematics Paper 2

Qn	Solution and Answer	Marks allocation
1ai	$\frac{2x^2+7x-4}{x^2-16}=\frac{(2x-1)(x+4)}{(x-4)(x+4)}=\frac{2x-1}{x-4}$	**M1**: factorization **A1**
aii	$y=\frac{2x^2+7x-4}{x^2-16}$ $y=\frac{2x-1}{x-4}$ $xy-4y=2x-1$ $xy-2x=4y-1$ $x(y-2)=4y-1$ $\therefore x=\frac{4y-1}{y-2}$	**M1** **A1**
b	$2x=1-y$ ------ Eqn 1 $4x+5y=8$ ------ Eqn 2 Subst. Eqn 1 into Eqn 2 $2(1-y)+5y=8$ $3y=6$ $\therefore y=2,\ x=-0.5$	**M1**: method of solving **A1 each**
ci	$\frac{1}{x+y}+\frac{2}{x-y}=\frac{2x+5y}{x^2-y^2}$ $\frac{x-y+2x+2y}{x^2-y^2}=\frac{2x+5y}{x^2-y^2}$ $\Rightarrow 3x+y=2x+5y$ $\Rightarrow x=4y$ $\therefore \frac{x}{y}=4$ (shown)	**M1**: combine LHS as 1 fraction **A1**
cii	$\left(\frac{3x}{2y}\right)^2=\frac{9}{4}\left(\frac{x}{y}\right)^2=\frac{9}{4}(4)^2=36$	**M1**: using (i) **A1**

Qn	Solution and Answer	Marks allocation
2a	$\$\dfrac{128}{m}$	**B1**: must show unit \$
b	$\$\left[12\left(\dfrac{128}{m}+2\right)+(m-12)7\right]$	**B1**: o.e.
c	$12\left(\dfrac{128}{m}+2\right)+(m-12)7-128=20$ $\dfrac{1536}{m}+24+7m-84-128=20$ $1536+7m^2-208m=0$ $7m^2-208m+1536=0$ (shown)	**M1**: form equation **M1**: simplification **A1**: required equation
d	$7m^2-208m+1536=0$ $\therefore m=\dfrac{-(-208)\pm\sqrt{(-208)^2-4(7)(1536)}}{2(7)}$ $=\dfrac{208\pm\sqrt{256}}{14}$ $=16$, 13.7 (or $13\frac{5}{7}$)	**M1**: method of solving **M1**: simplification **A1**: both answers
e	As no. of water bottles must be a whole number, m = 13.7 is not accepted. Selling price of each bottle for 20% profit $=\$\left[1.2\left(\dfrac{128}{16}\right)\right]=\$9.60$	(students are STRONGLY ENCOURAGED to explain why one of the values is not accepted) **B1**
3a	$\angle GTU = 90°$ (right angle in semicircle) $\angle GUH = 90°$ (radius perpendicular to tangent) $\Rightarrow \angle GTU = GUH = 90°$ $\angle G$ is a common angle $\therefore$ Triangle GTU and triangle GUH are similar. (All 3 corrsponding angles are equal)	**B1**: 2 statements of evidence **B1**: concluding statement (accept 'By AA similarity')
b	From (a), ΔGTU and ΔGUH are similar $\Rightarrow \dfrac{TU}{UH}=\dfrac{GT}{GU}$ $\Rightarrow \dfrac{TU}{GT}=\dfrac{UH}{GU}=\dfrac{5}{4} \quad \Rightarrow \dfrac{8}{GU}=\dfrac{5}{4} \quad \Rightarrow GU=\dfrac{4}{5}\times 8=6.4$ cm $\therefore$ Area of triangle $GUH=\dfrac{1}{2}\times GU\times HU=\dfrac{1}{2}\times 6.4\times 8=25.6\text{ cm}^2$ **Alternative approach** $\tan 38.7°=\dfrac{GU}{8} \quad \Rightarrow GU=8\tan 38.7°=6.4092$ cm $\therefore$ Area of triangle $GUH=\dfrac{1}{2}\times GU\times HU=\dfrac{1}{2}\times 6.4092\times 8=25.6\text{cm}^2$	**M1** **M1, A1**

Qn	Solution and Answer	Marks allocation
3ci	$\angle SVU = 180° - 75° = 105°$ (angles in opposite segment)	**B1**: subtract 1 mark from whole question if no or wrong angle properties
cii	$\angle GTU = 90°$ (right angle in semicircle) $\therefore \angle GTS = 90° - 75° = 15°$	**B1**
ciii	$\angle GUH = 90°$ (radius perpendicular to tangent) $\therefore \angle TGU = 180° - 90° - 38.7° = 51.3°$ (angle sum in triangle)	**B1**
civ	$\angle TOU = 51.3° \times 2 = 102.6°$ (angles at centre is twice angle at circum)	**B1**
4a	Slant height of cone, $l = \sqrt{24^2 + 9^2} = \sqrt{657}$ cm $\therefore$ Total surface area of ~~container~~ $= \pi \times \sqrt{657} \times 9 + \pi \times 9^2 = 979.197... \approx 979\ \text{cm}^2$ (3 s.f.)	**M1** **A1**
b	Volume of container $= \frac{1}{3} \times \pi \times 9^2 \times 24 = 648\pi$ $\left(\frac{\text{Height of sand}}{24}\right)^3 = \frac{49.5\pi}{648\pi} = \frac{11}{144}$ $\therefore$ Height of sand $= \sqrt[3]{\frac{11}{144}} \times 24 = 10.183... \approx 10.2$ cm (3 s.f.)	**M1** (accept method using ratio of radius to find new volume) **M1**: ratios of similar solids **M1, A1**
c	Volume of the 2 balls $= 648\pi - 49.5\pi = 598.5\pi\ \text{cm}^3$ $\frac{\text{Volume of small ball}}{\text{Volume of big ball}} = \left(\frac{2}{5}\right)^3 = \frac{8}{125}$ $\Rightarrow$ Volume of small ball $= \frac{8}{133} \times 598.5\pi$ $\frac{4}{3} \times \pi \times r^3 = 36\pi$ $\Rightarrow r^3 = 27$ $\therefore r = 3$ cm	**M1** **M1**: ratios of similar solids (accept method using radius as 2 times and 5 times respectively) **M1**: volume of small ball **A1**
5a	$h = 6.1$	**B1**: c.a.o.
b	See attached graph paper Points Smooth curve	**P2**: all points plotted correctly [**P1**: at least 6 points plotted correctly] **C1**: smooth curve
c	Tangent drawn at (4 , 4.0) Gradient = 0.510 (accept 0.4 to 0.6) (Calculated value = 0.5)	**B1** **B1**
d	Draw $y = 6.5$ $\therefore x = 1.05, 7.4$	**B1** **B1**: $\pm$ 0.05
ei	Draw the line $y = 7 - x$ for $0 \le x \le 8$	**B2**: correct line that span across the required range [**B1**: correct line but not long enough]

Qn	Solution and Answer	Marks allocation
5eii	$x = 1.2, 3.25$	**B1**: both, ± 0.05
eiii	$x - 2 + \frac{8}{x} = 7 - x$ $2x - 9 + \frac{8}{x} = 0$ $2x^2 - 9x + 8 = 0 \qquad \therefore c = -9$	Method using substitution of x values from (eii) is not accepted **B1**
6ai	$BQ = 35$ cm $AQ = \sqrt{35^2 + 120^2} = \sqrt{15625} = 125$ cm	**M1, A1**
aii	$PQ = 15$ cm $\tan P\hat{A}Q = \frac{15}{125}$ $\therefore$ angle $PAQ = \tan^{-1}\left(\frac{15}{125}\right) = 6.84.. \approx 6.8°$ (1 d.p.)	**√M1**: s.o.i, using AQ from (ai) **A1**
bi	$BE = \sqrt{30^2 + 70^2} = \sqrt{5800}$ cm $\therefore \cos BEB' = \frac{5800 + 5800 - 60^2}{2(5800)} = \frac{20}{29}$ $\angle BEB' = \cos^{-1}\left(\frac{20}{29}\right) = 46.3971... \approx 46.397°$ (3 d.p.) [shown] **Alternative approach** $\tan EBC = \frac{30}{70} \Rightarrow \angle EBC = \tan^{-1}\left(\frac{30}{70}\right) = 23.1985...°$ $\angle B'BE = 90° - 23.1985° = 66.8015°$ $\therefore \angle BEB' = 180° - 66.8015° \times 2 = 46.397°$ ($\angle$sum in isos. Δ)	**M1**: find BE, s.o.i. **M1**: applying Cosine Rule **A1** **M1** **M1** **A1**
bii	Distance moved by B is the length of arc on a circle centre E and radius BE, over an angle of BEB'. Distance moved by B $= \frac{46.397}{360} \times 2\pi \times \sqrt{5800} = 61.671... \approx 61.7$cm (3 s.f.)	**M1, A1**
7a	$\mathbf{D} = \begin{pmatrix} 7 & 11 & 9 \\ 12 & 8 & 17 \end{pmatrix}$	**B1**
b	$\mathbf{M} = \begin{pmatrix} 22 & 21 & 21 \\ 25 & 19 & 31 \end{pmatrix}$ It represents the **total sale or number of cookies** of **each type** and **each size** sold in the two weeks. (**number** of **cranberry and blueberry** cookies sold in **small, medium and large size respectively** in 2 weeks.)	**B1** **B1**
c	$\mathbf{L} = \frac{1}{2}\begin{pmatrix} 22 & 21 & 21 \\ 25 & 19 & 31 \end{pmatrix}\begin{pmatrix} 4 \\ 5.5 \\ 6.5 \end{pmatrix} = \frac{1}{2}\begin{pmatrix} 88 + 115.5 + 136.5 \\ 100 + 104.5 + 201.5 \end{pmatrix} = \begin{pmatrix} 170 \\ 203 \end{pmatrix}$ **Average amount of money collected per week** of **each type** of cookies.	**√M1**: using **M** from (b), product step, s.o.i **A1** **B1**: interpretation with 'earnings' or earned' not accepted.

Qn	Solution and Answer	Marks allocation
7di	$\mathbf{T} = \begin{pmatrix} 1 & 1 \end{pmatrix}$	**B1**
dii	$\mathbf{TMC} = \begin{pmatrix} 1 & 1 \end{pmatrix}\begin{pmatrix} 340 \\ 406 \end{pmatrix} = \begin{pmatrix} 340 + 406 \end{pmatrix} = \begin{pmatrix} 746 \end{pmatrix}$	**B1**: not awarded if not in proper matrix representation
e	$a = 1.35, b = 0.85$	**B1**: both, o.e.
8ai	Int. $\angle$ of hexagon $= 720° \div 6 = 120°$ Reflex $\angle BAQ = 90° + 120° = 210°$	**M1** **A1**
aii	$\angle BAQ = 360° - 210° = 150°$ ($\angle$ sum at a pt.) $\therefore \angle AQR = 180° - 150° = 30°$ (int. $\angle$s, $AB \parallel QR$)	**M1** **A1**
b	$\angle BAR = (180° - 150°) \div 2 = 15°$ (base $\angle$ of isos. Δ) $\angle PAR = 45° + 120° + 15° = 180°$ $\therefore$ By the property *Adjacent angles on a straight line is supplementary*, PAR is a straight line **Alternative approach** $\angle BAR = (180° - 150°) \div 2 = 15°$ (base $\angle$ of isos. Δ) $\angle QAR = 150° - 15° = 135°$ $\angle PAQ + \angle QAR = 45° + 135° = 180°$	**M1** **A1**: showing $\angle PAR$ is $180°$, with $\angle$ property and concluding statement
c	Int. $\angle$ of polygon $= \angle BAQ = 150°$ $\Rightarrow$ ext. $\angle$ of polygon $= 30°$ $\Rightarrow$ no. of sides of polygon $= 360° \div 30° = 12$ No. of pairs of square and hexagon $= 6$ Total no. of squares $= 6$ $\therefore$ No. of squares added $= 4$	**M1** $\sqrt{}$**M1**: using no. of sides **A1**
9ai	$u = 0.1, v = 0, w = 0.1, x = 0.2$	**B2**: all [**B1**: 2 correct]
aiia	$0.9 \times 0.8 = 0.72$	**B1**: o.e.
aiib	$0.9 \times 0.2 \times 0.1 + 0.1 \times 1 \times 0.2 + 0.1 \times 0 = 0.038$	**M1, A1**: o.e.
aiii	$1000 - 1000(0.038) = 962$	**B1**
9bia	Median time taken = 56 sec	**B1**
bib	Mean time taken = 53.8 sec	**B1**
bii	Median, as the extreme value of 15 can lower the mean time taken	**B1**
biii	Standard deviation = 11.3	**B2** [**B1**: correct value but not 3 s.f.]
biv	The 2 groups of boys have comparable lung power since they have almost the same mean, but the second group of boys are more consistent in the amount of time they take to hold their breath under water (or there is a smaller variation in the amount of time they take to hold their breath under water) due to the smaller standard deviation.	**B1**: words in bold and underlined must be seen

Qn	Solution and Answer	Marks allocation
10a	Total time needed to assemble a study table-chair set, 1 baby cot and a bunk bed $= 45 + 12 + 105 = 162$ mins $= 2$ hrs 42 mins	**B1**: working expected
bi	Total distance from ERGO office to Joyful Pasture $= 13.8 + 4.7 = 18.5$ km Total time taken for travelling = Time duration from 09 15 to 10 30 – Total assemble time at Happy Valley $= 75 - (45 + 6) = 24$ mins $\therefore$ Average speed of delivery van $= 18.5 \div \frac{24}{60} = 46.25 \approx 46$ km/h (nearest whole number) This value **may not be a reasonable estimate** of the actual travelling speed of the van, as it **could be higher**, but **due to the road condition** and **time** spent for **stopping** at traffic lights, the **average speed is lower.** **Accept also:** Yes it is a reasonable value as it is within the speed limit by LTA.	**M1**: total distance ÷ total travelling time **A1** **B1**: comment that actual speed could be higher
bii	**Assumption:** • Traffic condition is about the same on the roads to the various locations, such that the average speed of the van is 46 km/h. • Owners are at home when the delivery men reach each location • There is no major traffic delay that day • Delivery van travels on normal road and not using expressway Total travelling time between the various locations from Joyful Pasture to ERGO Office $= \frac{(6.1 + 5.4 + 8.8 + 1.9)\text{ km}}{46\text{ km/h}} \approx 29$ mins (nearest min) Total assemble time at Joyful Pasture to Peace Link $= 12 \times 4 + 105 \times 2 + 45 \times 2 = 348$ mins $\Rightarrow$ Total time needed to complete all delivery and return to ERGO office $= 29 + 348 + 45 = 422$ mins $= 7$ hrs 2 mins Time to reach ERGO office after all delivery = 10 30 + 7 hrs 2 mins = 17 32 $\therefore$ The delivery men **will be able to leave work punctually** at 18 00 that day. * award marks if calculated from the start: ERGO office to all locations and back to ERGO office again	**B1**: any valid assumptions **√M1***: using speed in (bi) **M1*** **M1*** **M1** **B1**: must be supported with appropriate calculation

	Alternative approach: Total time to complete all delivery before lunch = Total travelling time from 10 30 to next location after lunch + total assemble time $= \frac{6.1+5.4}{46} + \left(\frac{12+12+105}{60}\right) = \frac{1}{4} + 2\frac{3}{20} = 2\text{h } 24 \text{ mins}$ $\Rightarrow$ Lunch time at (10 30 + 2 h 24 mins) = 12 54 $\Rightarrow$ Time reach Blissful Ave after lunch = 12 54 + 45 mins = 13 39 Time to reach office after last delivery = 13 39 + Total assemble time after luncgh + Total travelling time after lunch $= 13\,39 + \frac{12\times 2+105+45\times 2}{60} + \frac{8.8+1.9}{46}$ = 13 39 + 3 h 53 mins = 17 32 ∴ The delivery men **will be able to leave work punctually** at 18 00 that day. * award marks if calculated from the start: ERGO office to all locations and back to ERGO office again Accept method using total time to complete delivery and back to office is shorter than total time available from start of delivery at 09 15 to 18 00.	**B1:** valid assumptions as above **M1*** **M1** **M1** **M1*** **B1:** must be supported with appropriate calculation