Full Name	Class Index No	Class

Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS / FIVE NORMAL (ACADEMIC)

MATHEMATICS
4052
PAPER 1

2 HOURS 15 MINUTES

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.

If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The total of the marks for this paper is 90.

The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142.

For Examiner's Use

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Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

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1 Write the following numbers in order of size, starting with the smallest.

$$\sqrt{0.81}, \quad 0.902, \quad \frac{399}{441}, \quad 0.86^{\frac{2}{3}}$$

Answer _____, _____, _____, _____ [1]

---

2 Write as a single fraction in its simplest form $\frac{7x}{(x-5)^2}+\frac{1}{5-x}$.

Answer _____ [2]

---

3 The capacity of a SD card is 250 gigabytes correct to 2 significant figures.
The size of a picture file is 2.5 megabytes correct to 1 decimal place.

Calculate the largest number of files that can be stored in this SD card.
Give your answer in standard form, correct to 3 significant figures.
(1 gigabyte = 10^9 bytes, 1 megabyte = 10^6 bytes)

Answer _____ [2]

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4 Simplify $\frac{5c}{2} \div \frac{20c^2}{d}$.

Answer _____ [2]

---

5 y is directly proportional to x^2.
If x is increased by 200%, find the percentage increase in y.

Answer _____ % [2]

---

6 A sum of money was divided between Amelia, Brandon and Claire in the ratio 2 : 3 : 4.
If instead, this money had been divided equally between them, Amelia would have received an extra $20.
What was the total sum of money?

Answer $ _____ [2]

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7 **(a)** Solve the inequalities $-8 \le 2-3x < 7-\frac{1}{2}x$.

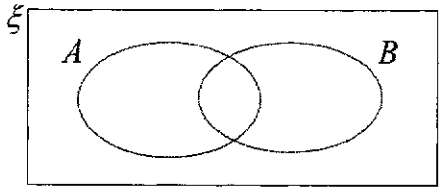
Answer _____ [2]

(b) Write down all the integers that satisfy $-8 \le 2-3x < 7-\frac{1}{2}x$.

Answer _____ [1]

---

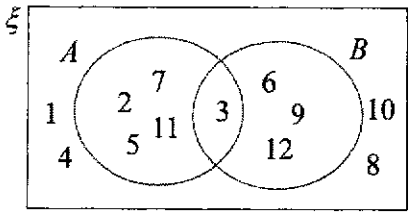
8 **(a)** On the Venn diagram, shade the region which represents $A \cup B'$.



[1]

(b) $\xi = \{\text{integers } x : 1 \le x \le 12\}$
$A = \{2, 3, 5, 7, 11\}$
$B = \{3, 6, 9, 12\}$

This information is shown on the Venn diagram.



Use one of the symbols below to complete each statement.

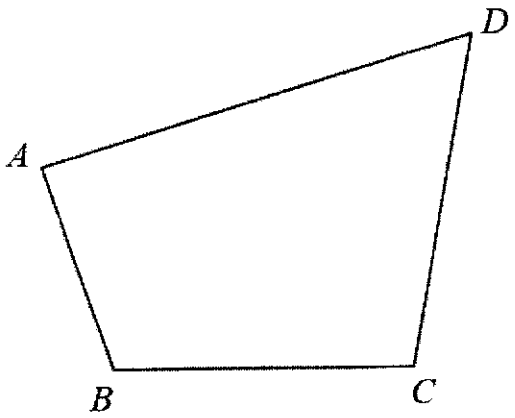
$\varnothing \quad \in \quad \subset \quad \notin \quad \not\subset$

(i) 7 _____ B [1]

(ii) $\{3,7\}$ _____ A [1]

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9 The diagram represents a plot of land, $ABCD$, which is to be used for a park.



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

(b) Construct the perpendicular bisector of AD. [1]

(c) A toilet is to be built in the park, nearer to A than to D and nearer to BC than to AB. Shade the region where the toilet is to be built. [1]

---

10 Using factorisation, solve $6p^2 - 9p - 6 = 0$.

Answer $p =$ _____ or _____ [3]

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11 A supplier sells watches at $210 each.
Jimmy buys the watches from the supplier at a discount of 20%.
Jimmy intends to then sell the watches at a profit of 20%.

As a marketing strategy, Jimmy plans to offer a 10% discount on the marked price without affecting his intended 20% profit.
Calculate the marked price that Jimmy should sell each watch at.

Answer $_____$ [3]

---

12 Jim sets off at 08 50 to walk 1000 metres at an average speed of 4 km/h.
He takes a 5 minutes break and then runs 1.3 km in 5 minutes.

(a) He aims to complete the entire exercise by 09 30. Will he achieve his target?
Show your working clearly.

Answer _____ [2]

(b) Calculate his average speed for the entire exercise.
Give your answer in metres per minute.

Answer _____ m/min [1]

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13 (a)

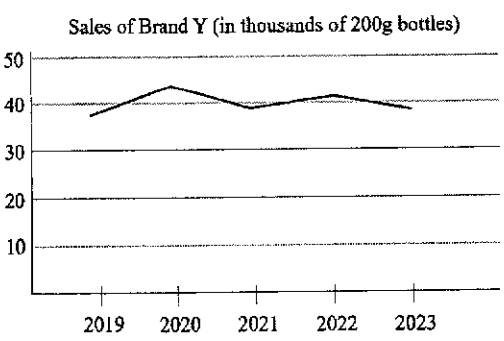


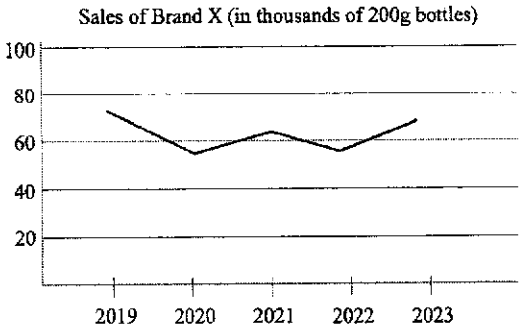
Two bottles of Brand A coffee are geometrically similar.
The larger bottle contains 200 g of coffee granules.

The larger bottle is approximately 49% taller than the smaller bottle.
Find, in grams, the amount of coffee granules in the smaller bottle.
Give your answer to the nearest gram.

Answer _____ g [2]

(b)





Brand Y claims that its sales of 200 g bottles of coffee are better than that of Brand X in the past 5 years.
State one aspect of the charts that makes this claim wrong.

Answer _____

_____ [1]

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14 **(a)** Express 1260 as a product of its prime factors.

Answer _____ [1]

(b) The highest common factor of two numbers is 12 while the lowest common multiple is 1260. Both numbers are less than 200.
Find the two numbers.

Answer _____ and _____ [2]

(c) $486 = 2 \times 3^5$.
m and n are both prime numbers.
Find the values of m and n so that $486 \times \frac{m}{n}$ is both a perfect square and a perfect cube.

Answer $m =$ _____ and $n =$ _____ [1]

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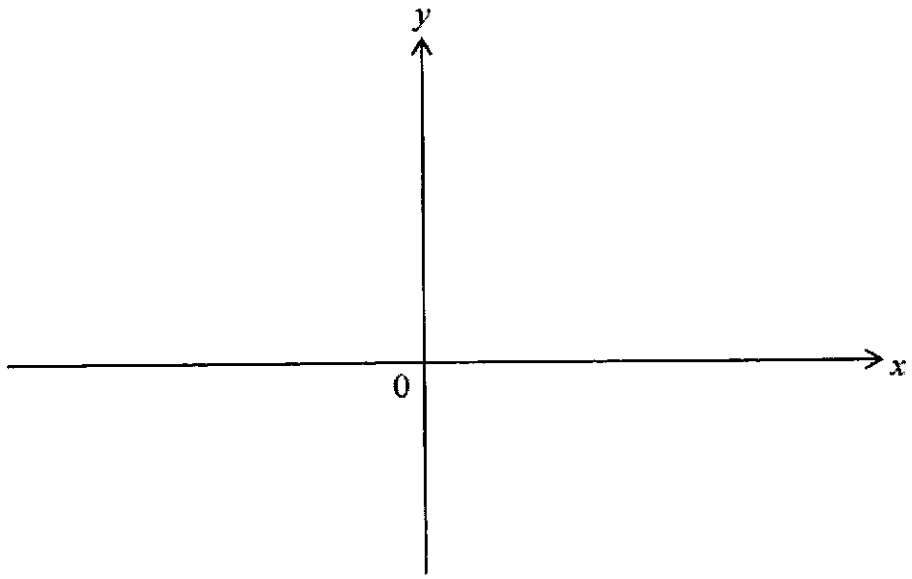
15 **(a)** Express $x^2+\frac{1}{2}x+1$ in the form $(x+a)^2+b$.

Answer _____ [2]

(b) Sketch the graph of $y=x^2+\frac{1}{2}x+1$ on the axes below.

Indicate clearly the coordinates of the point where the graph crosses the y-axis and the turning point on the curve.

Answer



[2]

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16 The table below shows the number of cars and motorcycles passing through an Electronic Road Pricing (ERP) gantry on certain days of the week from 7.30 am to 7.55 am.

	Cars	Motorcycles
Wednesday	320	120
Thursday	380	100
Friday	410	130
Charges per vehicle	\$2	\$0.50

(a) Represent the number of vehicles passing through the ERP gantry in a 3×2 matrix **V**.

Answer $\mathbf{V} =$ $\begin{pmatrix} & \\ & \\ & \end{pmatrix}$ [1]

(b) Write down a matrix **C** such that the product **P** = **VC** represents the total charges incurred by all vehicles on each of the days.

Answer $\mathbf{C} =$

[1]

(c) Evaluate the matrix **P** = **VC**.

Answer $\mathbf{P} =$

[1]

(d) **A** is a matrix such that $\mathbf{A} = \frac{1}{3}(1 \quad 1 \quad 1)\mathbf{P}$.

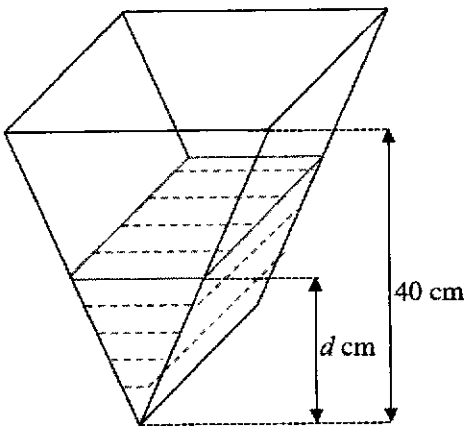
State what **A** represents.

Answer _____

_____ [1]

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17



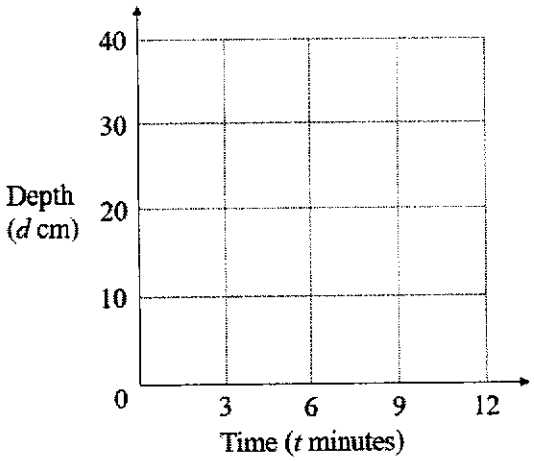
The diagram shows a container in the shape of a prism with a triangular cross-section.
The container has a height of 40 cm.
Water is poured into the empty container at a constant rate.
It takes 12 minutes to fill the container completely.
After t minutes, the depth of the water is d cm.

(a) Find the value of t when $d = 20$.

Answer $t =$ _____ [2]

(b) On the grid, sketch the graph showing how the depth varies during the 12 minutes.

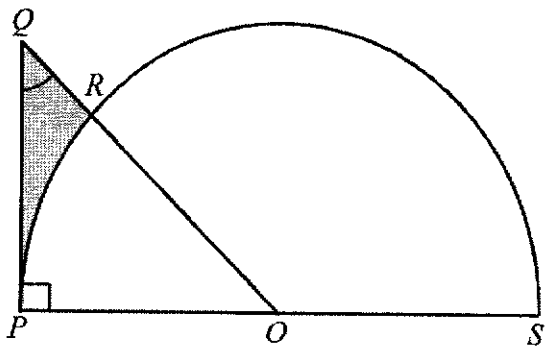
Answer



[2]

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18 The diagram shows a semicircle with centre O and radius 8 cm.
OP is perpendicular to PQ.
Angle $PQO = 0.7$ radians.

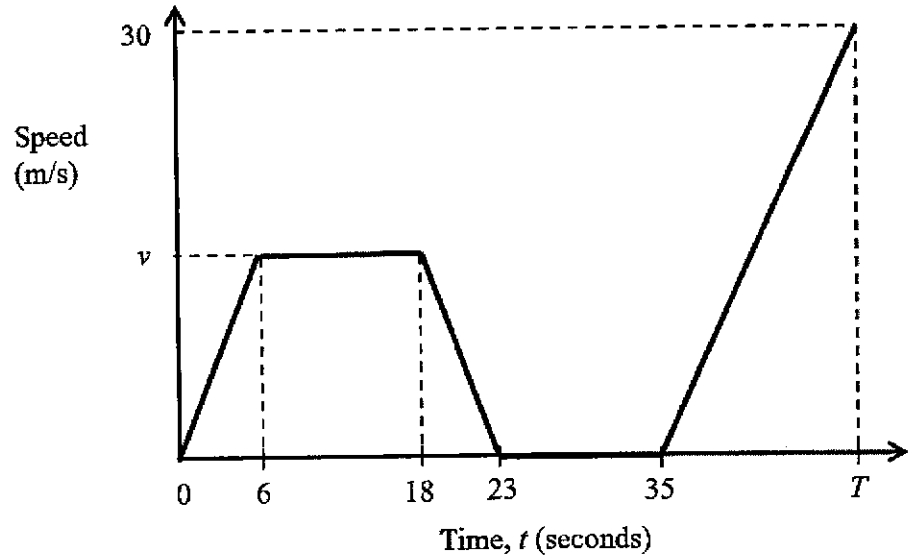


Find the area of the shaded region.

Answer _____ cm^2 [4]

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19 The diagram below shows the speed-time graph for a car travelling on the road.



(a) The total distance travelled by the car from 0 to 23 seconds is 385 metres.
Calculate the value of v.

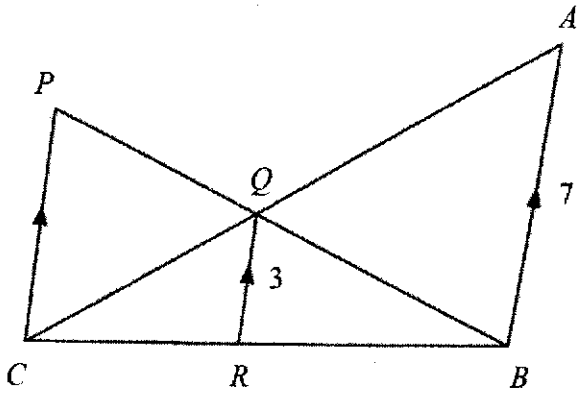
Answer $v =$ _____ [2]

(b) When $t = 45$, the car is travelling at a speed of 25 m/s.
When $t = T$, the car is travelling at a speed of 30 m/s.
Find the value of T.

Answer $T =$ _____ [2]

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20 In the diagram, AB, QR and PC are parallel.
PQB, CQA and CRB are straight lines.
$AB = 7$ cm and $QR = 3$ cm.



(a) Show that triangle PCB and triangle QRB are similar.
Give a reason for each statement.

Answer

_____

_____

_____

_____ [2]

(b) Write down another pair of similar triangles.

Answer Triangles _____ and _____ [1]

(c) Calculate PC.

Answer _____ cm [2]

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21 **(a)** Simplify $\left(\frac{4a^6}{b^4}\right)^{-\frac{1}{2}}$, giving your answer in positive index.

Answer _____ [2]

(b) $\frac{2^k}{\sqrt[4]{8}} = 4^{2k}$.

Use the laws of indices to find the value of k.
Show your working.

Answer $k =$ _____ [3]

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22 The first three terms in a sequence of numbers are given below.

$$T_1 = 1\times 2+10 = 12$$
$$T_2 = 2\times 3+6 = 12$$
$$T_3 = 3\times 4+2 = 14$$
$$T_4 = 4\times 5-2 = 18$$

(a) Show that the n^{th} term of the sequence, T_n, is given by $T_n = n^2 - 3n + 14$.

Answer

[2]

(b) Evaluate T_{50}.

Answer _____ [1]

(c) Explain why every term in the sequence is even.

Answer _____

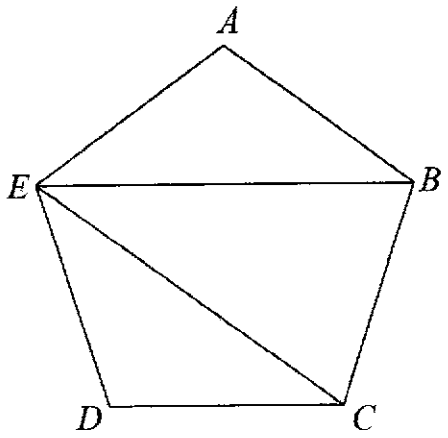
_____

_____

_____ [2]

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23 In the diagram, $ABCDE$ is a regular pentagon.



(a) Show that BE is parallel to CD.

Answer _____

_____

_____

_____

_____

_____

_____ [3]

(b) The sides AB and DC are produced to meet at X.
What type of quadrilateral is $BECX$?
Explain your answer.

Answer _____

_____

_____

_____

_____

_____

_____ [3]

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24 A is the point $(8, -2)$ and $\overrightarrow{AB} = \begin{pmatrix} 4 \\ -3 \end{pmatrix}$.

(a) Find

(i) $\left|\overrightarrow{AB}\right|$,

Answer _____ [1]

(ii) the equation of the line AB.

Answer _____ [2]

(b) The equation of the line CD is $2y - 4x = 19$.
Find the coordinates of the point of intersection of AB and CD.

Answer (_____, _____) [3]

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25 There are 12 boys and 13 girls in a class.
Two of the children are selected at random to participate in a forum.

(a) Draw a tree diagram below to show the probabilities of the possible outcomes.

[2]

(b) Find, as a fraction in its simplest form, the probability that

(i) two boys are selected,

Answer _____ [1]

(ii) one boy and one girl are selected.

Answer _____ [2]

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(c) As a standby, a third student is selected.
Find the probability that out of the three students, there will be at least one boy and one girl selected.

Answer _____ [2]

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

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1 On a particular day in 2023, the exchange rate between Singapore dollars (SGD) and United States dollars (USD) was USD 1 = SGD x.

(a) Write down an expression, in terms of x, for the USD received in exchange for SGD 10 000.

Answer USD = _____ [1]

In 2022, the rate was such that USD 1 would exchange for SGD 0.030 **less** than in 2023. The difference in exchanging SGD 10 000 in 2023 and SGD 10 000 in 2022, is USD 166.

(b) Write down an equation to represent this information and show that it reduces to $83x^2 - 2.49x - 150 = 0$.

Answer

[3]

(c) Solve the equation $83x^2 - 2.49x - 150 = 0$, giving your solutions correct to three decimal places.

Answer x = _____ or _____ [3]

(d) Find the amount of USD received in exchange for SGD 20 000 in 2022. Give your answer correct to the nearest dollar.

Answer USD = _____ [2]

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2 **(a)** It is given that $sq^2 = r - 3q^2$.

(i) Evaluate s when $q = -3$ and $r = 5$.

Answer $s =$ _____ [1]

(ii) Express q in terms of r and s.

Answer $q =$ _____ [2]

(b) **(i)** Show that $(7n-1)^2 - (n-1)^2$ is a multiple of 12 for all integer values of n.

Answer

[2]

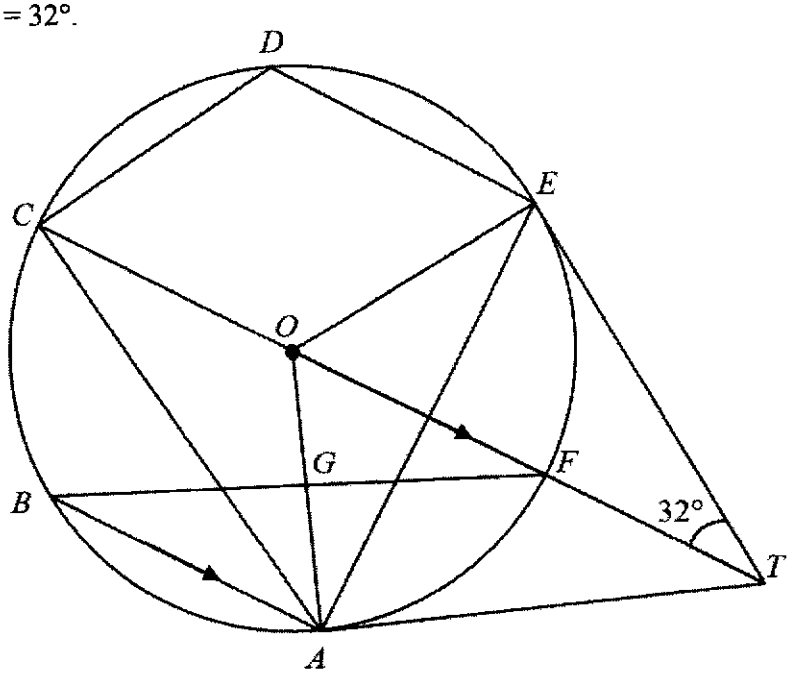
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(b) (ii) Simplify $\dfrac{p-3n+12n^2-4np}{(7n-1)^2-(n-1)^2}$.

Answer _____ [3]

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3 The diagram shows a circle $ABCDEF$, with centre O.
TA and TE are tangents to the circle.
BGF and COT are straight lines.
OA intersects BF at G. CT is parallel to BA.
Angle $OTE = 32°$.



(a) Identify the triangle that is congruent to triangle TOE and show that they are congruent.
Give a reason for each statement you make.

Answer

_____

_____

_____

_____

_____

_____ [3]

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(b) Find, giving reasons for each step of your working,

(i) angle OFG,

Answer angle OFG = _____ [3]

(ii) angle CDE.

Answer angle CDE = _____ [3]

(c) Explain why points O, E, T and A can also be points on the circumference of another circle.

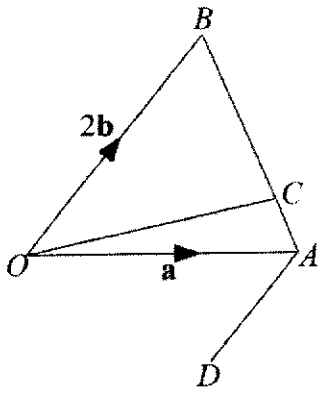
Answer _____

_____

_____ [1]

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4



The position vectors of A and B, relative to O, are **a** and 2**b** respectively.

$\overrightarrow{BC} = \frac{3}{4}\overrightarrow{BA}$ and $\overrightarrow{AD} = \frac{1}{2}\overrightarrow{BO}$.

(a) Find, in terms of **a** and **b**,

(i) $\overrightarrow{AB}$,

Answer $\overrightarrow{AB} =$ _____ [1]

(ii) $\overrightarrow{OC}$.

Answer $\overrightarrow{OC} =$ _____ [2]

(b) **(i)** P is a point outside of triangle ABO.
Find $\overrightarrow{OP}$, such that $\overrightarrow{BP} = 3\overrightarrow{OA}$.

Answer $\overrightarrow{OP} =$ _____ [1]

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(ii) Show that O, C and P lie on a straight line.

Answer _____

_____ [2]

(c) Find the ratio

(i) area of triangle OCB : area of triangle OCA,

Answer _____ : _____ [1]

(ii) area of triangle OAC : area of triangle OAD.

Answer _____ : _____ [1]

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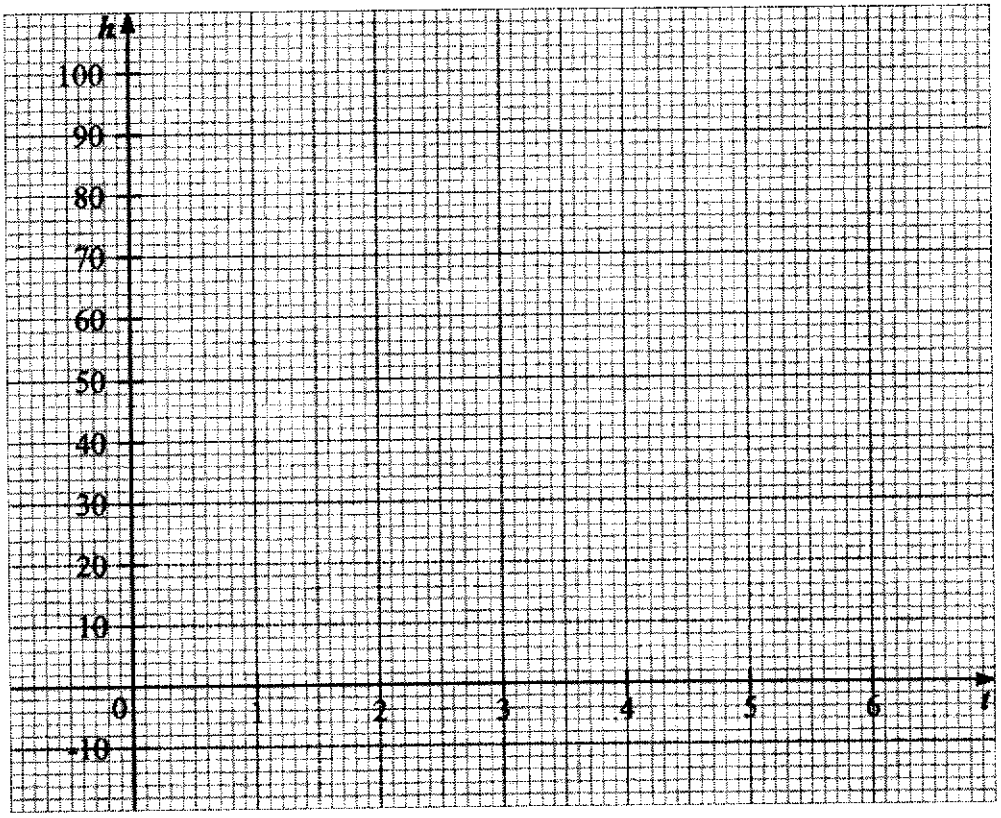
5 A stone is thrown from the top of a cliff next to the sea.
The height, h metres, of the stone above the sea level t seconds after it is released can be modelled by the equation $h = 16t - 5t^2 + 80$.
Some corresponding values of t and h are given in the table below.

t	0	1	2	3	4	5	6
h	80	91	92	83	64	35	p

(a) Calculate the value of p.

Answer $p =$ _____ [1]

(b) On the grid, draw the graph of $h = 16t - 5t^2 + 80$ for $0 \le t \le 6$.



[3]

(c) Explain how the graph shows that the stone will not reach a height of 100m.

Answer _____

_____ [1]

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(d) Use the graph to find the length of time that the stone was 84 metres or more above sea level.

Answer _____ s [1]

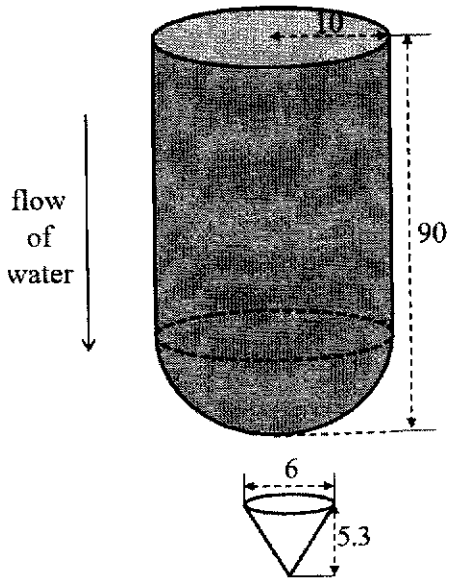
(e) By drawing a tangent on the grid in **part (b)**, find the gradient of the curve at (4, 64). State the units of your answer.

Answer _____ [3]

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6 A water dispenser is in the shape of a cylinder and a hemisphere both of radius 10 cm. The height of the dispenser is 90 cm.

Conical disposable cups of diameter 6 cm and height 5.3 cm are provided to drink the water from the dispenser.



(a) Water is filled to the brim of the dispenser.

Show that the amount of water in the dispenser is $8666\frac{2}{3}\pi$ cm^3.

Answer

[2]

(b) Find the capacity of one conical cup.
Give your answer to the nearest cm^3.

Answer _____ cm^3 [2]

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(c) Find the height of the water remaining in the dispenser after 250 cups of water have been dispensed.

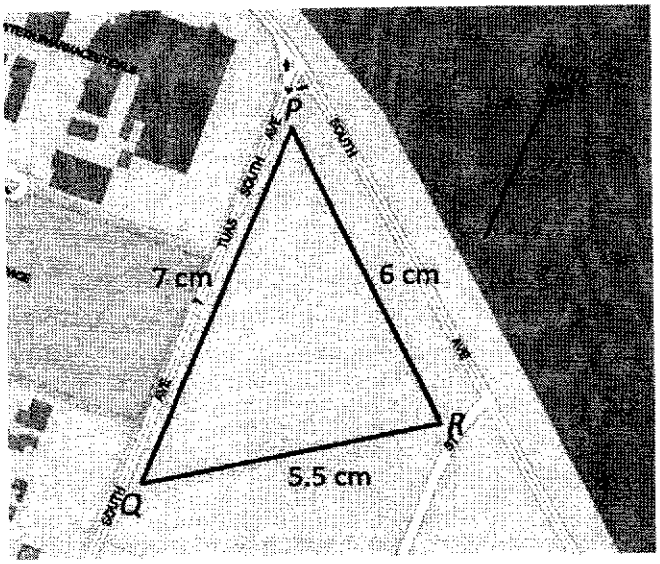
Answer _____ cm [4]

(d) The conical disposable cups are made of a thin material of negligible thickness. Calculate the cost of 250 conical cups given that the cost of material is 0.003 cents/cm^2.
Give your answer to the nearest cent.

Answer _____ cents [3]

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7 The map shown has a scale of 1 : 7500.
An area on the map is formed by a triangle PQR.
$PQ = 7$ cm, $QR = 5.5$ cm and $RP = 6$ cm.



(a) Find the actual perimeter, in kilometres, of triangle PQR.

Answer _____ km [2]

(b) P is due north of Q.
Calculate the bearing of Q from R.

Answer _____ [4]

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(c) Calculate, in square metres, the actual area of triangle PQR.

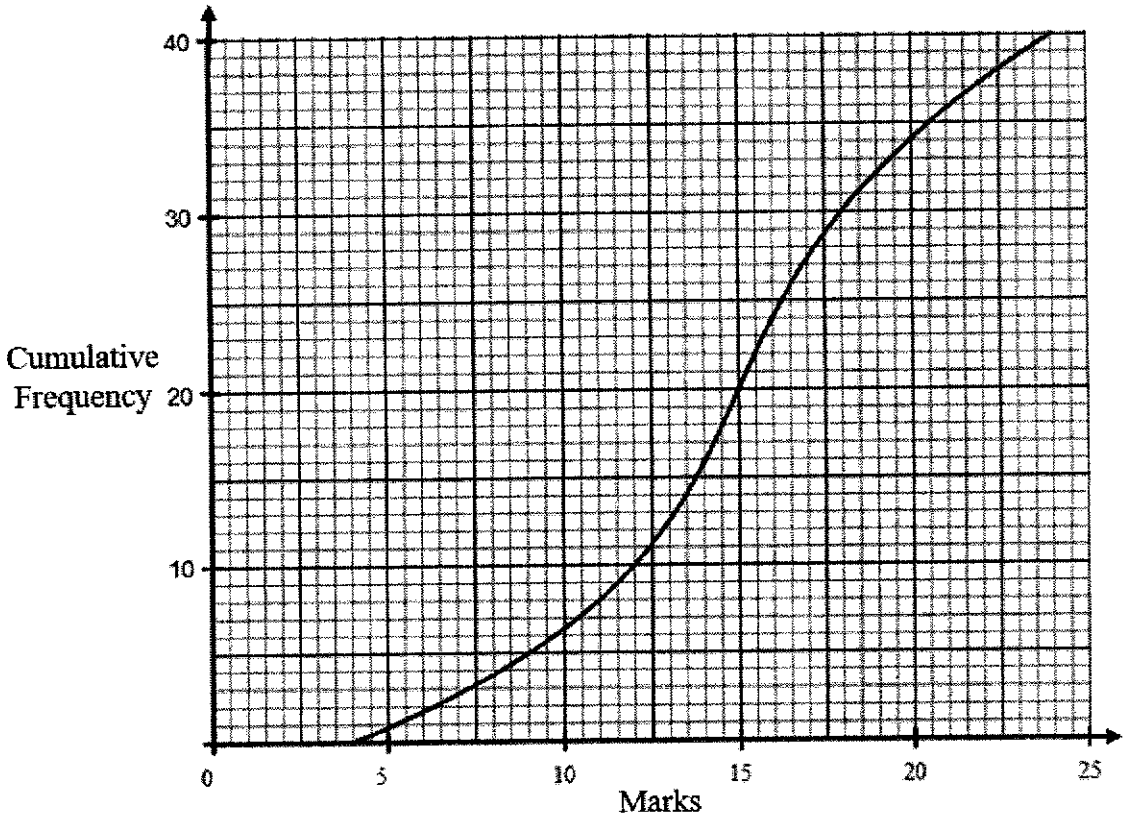
Answer _____ m^2 [3]

(d) A drone flies along the line QP at a vertical height of 75m.
Find the greatest angle of elevation of the drone from R.

Answer _____ [4]

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8 The marks attained by 40 students in a Mathematics test were recorded.
The cumulative frequency curve shows the distribution of the marks.



(a) Use the curve to estimate the
(i) the median mark,

Answer _____ [1]

(ii) the interquartile range.

Answer _____ [2]

(b) 12.5% of students achieved more than x marks in this test. Estimate the value of x.

Answer $x =$ _____ [1]

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(c) Complete the frequency distribution table of the marks attained by the students.

Marks (x)	$4 \le x < 10$	$10 \le x < 15$	$15 \le x < 20$	$20 \le x < 24$
Number of students				

[2]

Calculate an estimate for

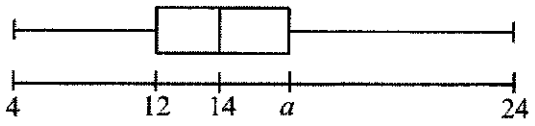
(i) the mean mark,

Answer _____ [1]

(ii) the standard deviation of their marks.

Answer _____ [1]

The same group of students sat for a Chemistry test.
The maximum mark for the test was also 25.
The box-and-whisker plot of the distribution of the marks is shown below.



(d) The scores of the top 25% of the students for the Chemistry test were less consistent than the scores of the bottom 25%.
Given that a is an integer, write down the value of a.

Answer $a =$ _____ [1]

(e) Make two comparisons between the performances of the students in the Mathematics test and the Chemistry test.
Use figures to support your answer.

1. _____

_____

2. _____

_____ [2]

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9 Lee started work on 1 January 2019.
He started with a monthly salary of $4100 and has seen his salary increase by 4% annually.

(a) Show that Lee's current monthly salary, in January 2024, is $5000, correct to the nearest thousand.

Answer

[1]

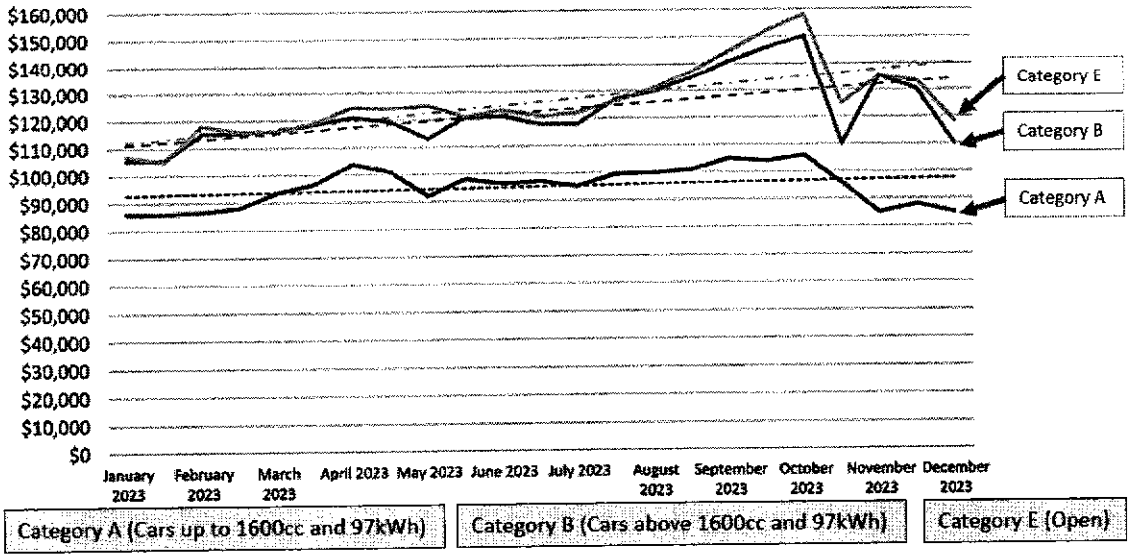
Lee has savings of $105 000.
With his savings and monthly income, he intends to buy a car, in January 2024.
He is deciding between buying an EV 60kWh electric car or a 1998cc petrol car.

The table below is used to calculate the cost price of the car:

	Car Type	EV 60kWh electric car	1998cc petrol car
a.	Base cost (without COE)	$100,000	$110,000
b.	COE	Refer to Table A (COE Prices)	
c.	Rebates (clean energy initiatives)	$30,000	Not applicable
Total cost price of car = a + b – c			

Every car owner in Singapore must purchase a Certificate of Entitlement (COE) for the car, which gives him the right to own and use a vehicle in Singapore. The COE prices since January 2023 can be seen below.

Table A: COE Prices



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Lee will take a loan from a financial institution. He intends to take the largest loan possible. The loan amount can be calculated using the information in Table B below:

Table B: Calculation of Loan

Car Type	EV 60kWh	1998cc petrol car
Maximum loan amount	60% of cost price of car	70% of cost price of car
Maximum loan period	7 years	7 years
Interest rate (based on simple interest)	2.78% yearly	2.78% yearly

Being prudent, he would like to maintain an amount equivalent to at least 6 months of his salary in his savings.

(b) Show that Lee can only make the downpayment for **one** of the two cars.
Show your calculations clearly and justify any decisions you make.

Answer

[3]

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The approximate expenses for each car are seen in Table C below.

Table C: Maintenance Cost

	Car Type	EV 60kWh	1998cc petrol car
a.	Road Tax	Refer to Table D below	
b.	Repayment of loan	to be calculated	
c.	Other costs (Annual)	$4700	$3000
d.	Other costs (Monthly)	$600	$800
Total expenses = a + b + c + d			

Table D: Road Tax (for 6 months)

The table calculates the road tax for 6 months		
For Petrol Car Engine Capacity (EC) in cc	$1000 < EC \leq 1600$	[$250 + $0.375(EC - 1000)] x 0.782
	$1600 < EC \leq 3000$	[$475 + $0.75(EC - 1600)] x 0.782
For Electric Car Power Rating (PR) in kWh	$30 < PR \leq 230$	[$250 + $3.75(PR – 30)] x 0.782
	$PR > 230$	[$1,525 + $10(PR – 230)] x 0.782

(c) Lee's monthly expenditure is around $2700 on average.
Based on the information given, determine if Lee can afford the car identified in **part (b)**.
Show your calculations clearly and justify any decisions you make.

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Answer Lee _____afford the car. [7]

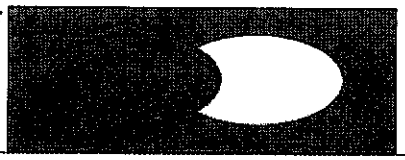
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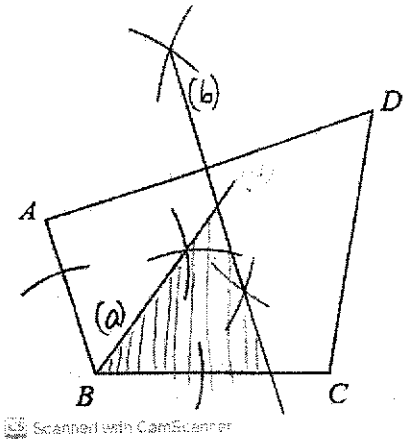
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Qn		Steps/Answer	Remarks
1		$\sqrt{0.81}$ 0.902 $0.86^{\frac{2}{3}}$ $\frac{399}{441}$	
2		$=\frac{7x}{(x-5)^2}-\frac{1}{x-5}$	Also accept $\frac{7x}{(5-x)^2}+\frac{1}{5-x}$
		$=\frac{7x-(x-5)}{(x-5)^2}$	$=\frac{7x+5-x}{(5-x)^2}$
		$=\frac{6x+5}{(x-5)^2}$	$=\frac{6x+5}{(5-x)^2}$
3		$(254.9\times10^9)\div(2.45\times10^6)$	Accept $(254\times10^9)\div(2.45\times10^6)$ or higher accuracy
		$=1.04\times10^5$	
4		$\frac{5c}{2}\div\frac{20c^2}{d}$	
		$=\frac{5c}{2}\times\frac{d}{20c^2}$	
		$=\frac{d}{8c}$	
5		$\frac{9kx^2-kx^2}{kx^2}\times100\%$	
		$=800\%$	
6		(3-2) units -> \$20	
		Total 9 units -> \$180	
7	(a)	$-8\le2-3x$ and $2-3x<7-\frac{1}{2}x$	
		$-10\le-3x$ and $-5<2\frac{1}{2}x$	
		$-2<x\le3\frac{1}{3}$	cannot accept 3.33
	(b)	-1, 0, 1, 2, 3	
8	(a)	ε 	
	(bi)	$7\notin B$	
	(bii)	$\{3,7\}\subset A$	

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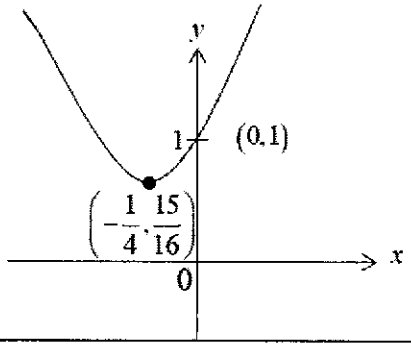
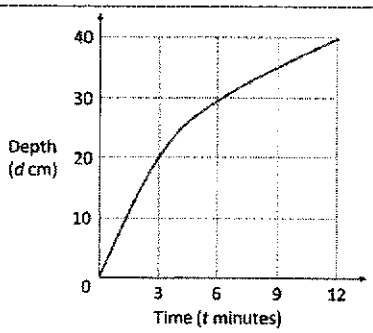
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9		Scanned with CamScanner	Construction arcs are to be clearly seen.
		Correct angle bisector	
		Correct perpendicular bisector	
		Correct region shaded	
10		$(2p+1)(p-2)=0$	Accept $(2p+1)(3p-6)=0$
		$p=-\frac{1}{2}, p=2$	
11		Cost price of watch for Jimmy $=\frac{80}{100}\times 210$ $=\$168$	
		Profit price $=\frac{120}{100}\times\$168$ $=\$201.60$	
		Marked price $=\frac{100}{90}\times\$201.60=\$224$	
12	(a)	Total time taken $=15+5+5=25$ min	
		Yes, he will achieve his target as he will complete by **09 15.**	
	(b)	$\frac{2.3\times 1000}{25}$	
		$=92$ m/min	
13	(a)	$\frac{200}{V}=(\frac{1.49}{1})^3$	
		$V=60$g	
	(b)	Different **vertical scales/intervals** are used.	
14	(a)	$1260=2^2\times 3^2\times 5\times 7$	
	(b)	84 and 180	
	(c)	$m=3, n=2$	

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15	(a)	$x^2+\frac{1}{2}x+1$ $=\left(x+\frac{1}{4}\right)^2+\frac{15}{16}$	
	(b)		
16	(a)	$\mathbf{V}=\begin{pmatrix}320 & 120\\ 380 & 100\\ 410 & 130\end{pmatrix}$	
	(b)	$\mathbf{C}=\begin{pmatrix}2\\ 0.5\end{pmatrix}$	
	(c)	$\mathbf{P}=\begin{pmatrix}700\\ 810\\ 885\end{pmatrix}$	
	(d)	**A** represents the average ERP charges collected across the three days.	
17	(a)	$\frac{\frac{1}{2}\times base\times 20\times width}{\frac{1}{2}\times(2\times base)\times 40\times width}\times 12$	or $\left(\frac{20}{40}\right)^2\times 12$
		$=3$ min	
	(b)		

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18		$QP = \dfrac{8}{\tan 0.7rad} = 9.4979$	
		Area of triangle $OPQ = \dfrac{1}{2}(8)(9.4979) = 37.992$	
		Area of sector $= \dfrac{1}{2}(8^2)\left(\dfrac{\pi}{2} - 0.7\right) = 27.865$	
		Area of shaded region = 10.1 cm^2	
19	(a)	$\dfrac{1}{2}(6)v + (18-6)v + \dfrac{1}{2}(23-18)v = 385$	
		$v = 22$ m/s	
	(b)	$\dfrac{30-0}{T-35} = \dfrac{25-0}{45-35}$	$\dfrac{10}{2} = 2$ or
		$30(10) = 25(T-35)$	
		$T = 47$s	or 45+2=47
20	(a)	angle PBC = angle QBR (common angle) angle BQR = angle BPC (corr. angles, $PC//QR$)	
		Triangle PCB and triangle QRB are similar (AA test)	
	(b)	Triangles ABC and QRC *or* Triangles ABQ and CPQ	
	(c)	$\dfrac{CR}{CB} = \dfrac{3}{7}$	
		$\dfrac{QR}{PC} = \dfrac{BR}{BC}$ $\dfrac{3}{PC} = \dfrac{4}{7}$	
		$PC = 5.25$	

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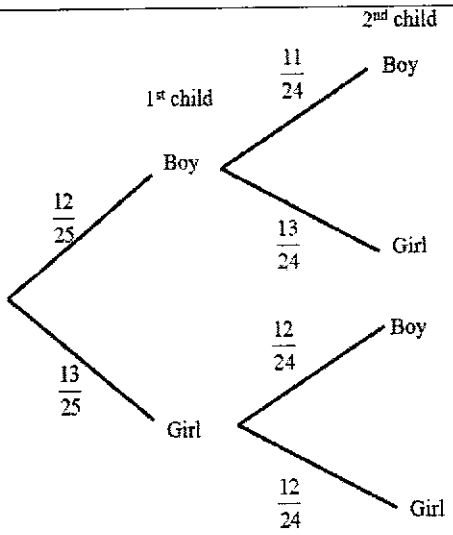
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21	(a)	$\left(\frac{4a^6}{b^4}\right)^{-\frac{1}{2}}$	
		$=\left(\frac{b^4}{4a^6}\right)^{\frac{1}{2}}$	
		$=\frac{b^2}{2a^3}$	
	(b)	$\frac{2^k}{\sqrt[4]{8}}=4^{2k}$	
		$\frac{2^k}{2^{\frac{3}{4}}}=2^{4k}$	
		$k=4k+\frac{3}{4}$	
		$k=-\frac{1}{4}$	
22	(a)	$T_n=n(n+1)+10-4(n-1)$ $=n^2+n+10-4n+4$ $=n^2-3n+14$	
	(b)	$T_{50}=2364$	
	(c)	$n^2-3n+14=n(n-3)+14$	
		When n is even n(n-3) is (even x odd) = even. When n is odd, n(n-3) is (odd x even) = even. Adding to 14 which is also even, $T_n=n^2-3n+14$ will always be even for all terms.	
23	(a)	$\angle EDC=\angle BAE=\frac{(5-2)\times 180}{5}=108°$	
		$\angle AEB=\frac{180-108}{2}=36°$	
		$\angle BED=108-36=72°$	
		$\angle BED+\angle EDC=72+108=180°$	
		By the converse of interior angles, *BE* is parallel to *CD*	
	(b)	$\angle EBX=180-36=144°$	Or equivalent methods, with correct reasoning. (eg ***BE//CX*** and a pair of opposite equal angles)
		$\angle BEC=108-36-36=36°$	
		As $\angle EBX+\angle BEC=180°$, by the converse/property of **interior angles**, *EC//BX*.	
		BECX is a rhombus as ***BE//CX (or DX)*** and ***EC//BX*** and adjacent sides *BE=EC*.	

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24	(ai)	5	
	(aii)	Gradient of PQ $= \frac{-3}{4}$	
		$-2 = \frac{-3}{4}(8) + c$	
		$c = 4$	
		Equation is $y = \frac{-3}{4}x + 4$	
	(b)	$2\left(\frac{-3}{4}x + 4\right) - 4x = 19$	Or elimination method correctly follow-thru from a(ii)
		$x = -2, y = 5.5$	
		$(-2, 5.5)$	
25	(a)		
	(b)	$\left(\frac{12}{25}\right)\left(\frac{11}{24}\right) = \left(\frac{11}{50}\right)$	
	(c)	$\left(\frac{13}{25}\right)\left(\frac{12}{24}\right) \times 2$	
		$= \left(\frac{13}{25}\right)$	
	(d)	$1 - \left(\frac{12}{25}\right)\left(\frac{11}{24}\right)\left(\frac{10}{23}\right) - \left(\frac{13}{25}\right)\left(\frac{12}{24}\right)\left(\frac{11}{23}\right)$ or P(BBG)+P(BGB)+P(GBB)+P(GGB)+P(GBG)+P(BGG) $= \left(\frac{12}{25}\right)\left(\frac{11}{24}\right)\left(\frac{13}{23}\right) \times 3 + \left(\frac{13}{25}\right)\left(\frac{12}{24}\right)\left(\frac{12}{23}\right) \times 3$	
		$= 0.78$ or $\left(\frac{39}{50}\right)$	

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Qn		Steps/Answer	Remarks
1	(a)	USD $= \frac{10000}{x}$	
	(b)	$\frac{10000}{x-0.030} - \frac{10000}{x} = 166$	
		$10000x - 10000(x-0.030) = 166x(x-0.030)$	
		$166x^2 - 4.98x - 300 = 0$	
		$83x^2 - 2.49x - 150 = 0$	
	(c)	$x = \frac{2.49 \pm \sqrt{(-2.49)^2 - 4(83)(-150)}}{2(83)}$	
		$x = 1.359$ or $x = -1.329$	
	(d)	$\frac{20000}{1.359 - 0.030}$	
		= USD 15 049	Accept 15 048
2	(ai)	$s = [5 - 3(-3)^2] \div (-3)^2$ $s = -2\frac{4}{9}$ or $s = -\frac{22}{9}$	Cannot accept 3 sf
	(aii)	$sq^2 = r - 3q^2$	
		$sq^2 + 3q^2 = r$	
		$q^2(s+3) = r$	
		$q = \pm\sqrt{\frac{r}{(s+3)}}$	
	(b)(i)	$(7n-1)^2 - (n-1)^2$ $= [(7n-1) + (n-1)][(7n-1) - (n-1)]$ $= 6n(8n-2)$	
		$= 12n(4n-1)$	$= 12(4n^2 - n)$ is also accepted
	(b)(ii)	$\frac{p - 3n + 12n^2 - 4np}{(7n+1)^2 - (n-1)^2}$	
		$= \frac{p(1-4n) - 3n(1-4n)}{12n(4n-1)}$	
		$= \frac{(3n-p)(4n-1)}{12n(4n-1)}$	
		$= \frac{3n-p}{12n}$	

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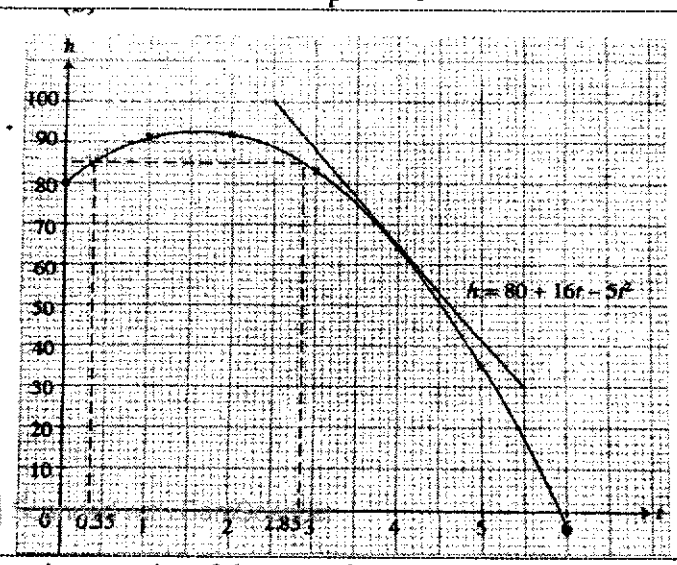
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3	(a)	One possible answer • $ET = AT$ (tangents from external points are equal) • TO is common • $OE = OA$ (radii of circle) Triangle TOA is congruent to triangle TOE (SSS test)	
		Another possible answer • angle TAO = angle $TEO = 90°$ (tangent perpendicular to radius) • TO is common • $OE = OA$ (radii of circle) Triangle TOA is congruent to triangle TOE (RHS test)	
	(bi)	angle $AOT = (180 - 90 - 32)° = 58°$ (tangent perpendicular to radius)	
		angle $ABF = \frac{1}{2}$angle AOT $\frac{1}{2}(58°) = 29°$ (angle at centre is twice angle at circumference)	
		angle OFG = angle $ABF = 29°$ (alternate angles, OF //BA)	
	(bii)	angle ACF = angle ABF =29° (angles in the same segment)	
		angle $CAE = 180 - 90 - 29 = 61°$ (OT is perpendicular bisector of chord AE)	
		angle $CDE = 180 - 61 = 119°$ (angles in opposite segments)	
	(c)	As angle OET and angle OAT are right-angles, by the property of **right angle in a semicircle**, OT is a diameter and points E and A will lie on the circumference. $OETA$ are thus four points on the circumference of this circle. Or Angle AOE + angle $ATE = (58 \times 2) + (32 \times 2) = 180°$ Angle OET + angle $OAT = 180°$. By the property of **angles in opposite segments,** $OETA$ are thus four points on the circumference of this circle.	
4	(a)(i)	$\overrightarrow{AB} = 2b - a$	
	(a)(ii)	$\overrightarrow{BC} = -\frac{3}{4}\overrightarrow{BA} = -\frac{3}{4}(2b - a)$	
		$\overrightarrow{OC} = \overrightarrow{OB} + \overrightarrow{BC} = 2b - \frac{3}{4}(2b - a) = \frac{3}{4}a + \frac{1}{2}b$	
	(b)(i)	$\overrightarrow{OP} = \overrightarrow{OB} + \overrightarrow{BP} = 2b + 3a$	
	(b)(ii)	$\overrightarrow{OP} = 3a + 2b$. $\overrightarrow{OC} = \frac{1}{4}(3a + 2b)$	
		As $\overrightarrow{OC} = \frac{1}{4}\overrightarrow{OP}$,	
		and O is a common point, O, C and P lie on a straight line.	

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	(ci)	3:1	
	(cii)	$OAC : OAB : OAD$ 1 : 4 2 : 1 4 : 2 Therefore, $OAC : OAD$ is 1 : 2.	
5	(a)	$p = -4$	
	(b)		
	(c)	The maximum point of the curve is 93m.	±1m
	(d)	2.9 – 0.3 = 2.6	±0.2s
	(e)	Tangent drawn correctly	
		–24 (±4)	
		m/s	

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6	(a)	volume of water $= \pi(10^2)(80) + (\frac{2}{3})(\pi)(10^3)$		
		$= 8666\frac{2}{3}\pi$		
	(b)	Capacity of one conical cup $= (\frac{1}{3})(\pi)(3^2)(5.3)$		
		$= 50\ cm^3$		
			<u>Alternative</u>	
	(c)	Volume of water remaining after dispensing 250 cups $= 8666\frac{2}{3}\pi - (250 \times \frac{1}{3}\pi(3^2)(5.3)$	Volume of water dispensed for 250 cups $= 250 \times 15.9\pi$	
		$= 4691\frac{2}{3}\pi$ or 14739 cm^2.		
		Volume of water in cylinder $= 4691\frac{2}{3}\pi - \frac{2}{3}\pi(10^3)$	Height of water dispensed for 250 cups $= \frac{250 \times 15.9\pi}{100\pi}$	
		$= 4025\pi$ or 12645 cm^2.		
		Height of water in cylindrical section $= \frac{4025\pi}{\pi(10^2)}$ or $\frac{12645}{\pi(10^2)}$	Height of water remaining in dispenser $= 90 - \frac{125}{\pi}$	
		$= 40.25$ or 40.250		
		Height of water remaining in dispenser $= 40.25+10$ or $40.250+10$		
		$= 50.25$ cm or 50.3 cm	$= 50.2$ (3sf)	
	(d)	Slant height of cup $= \sqrt{3^2 + 5.3^2}$ $= 6.0902$		
		Curved surface area of cup $= \pi(3)(6.0902)$ $= 57.399\ cm^2$		
		250 cups will cost $57.399 \times 250 \times 0.003$		
		$= 43$ cents		Accept 44 cents

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7	(a)	$18.5 \times 7500 \div 100000$ 1.3875 km	M1 A1	c.a.o.
	(b)	$6^2 = 7^2 + 5.5^2 - 2(7)(5.5)\cos\angle PQR$	M1	Or equivalent method leading to the correct bearing
		$\cos\angle PQR = \frac{-43.25}{-77}$	M1	
		$angle\ PQR = 55.827°$	M1	
		Bearing of Q from R is (180+55.827) = 235.8°	A1	
	(c)	Area of $QPR = \frac{1}{2}(7 \times 75)(5.5 \times 75)\sin 5\,5.827°$	√M2	
		$= 89\,585\ m^2$		
		$= 89\,600\ m^2$	A1	
	(d)	Let shortest distance from R to PQ be X.		
		$\sin\angle PQR = \frac{RX}{QR}$		
		$\sin 5\,5.827° = \frac{RX}{412.5}$	M1	Or equivalent method
		$RX = 341.28m$	M1	
		Let greatest angle of elevation be y.		
		$\tan y = \frac{75}{their\ RX}$	M1	
		y=12.4°	A1	

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8	(ai)	15 marks	
	(aii)	18 – 12	
		6 marks	
	(b)	20.5 marks	
	(c)	Marks (x): $4 \le x < 10$ | $10 \le x < 15$ | $15 \le x < 20$ | $20 \le x < 24$ Number of students: 6 | 14 | 14 | 6	
	(ci)	$\frac{(6\times7)+(14\times12.5)+(14\times17.5)+(6\times22)}{40} = 14.85$	
	(cii)	4.62	
		Alternative answer	
	(c)	Marks (x): $4 \le x < 10$ | $10 \le x < 15$ | $15 \le x < 20$ | $20 \le x < 24$ Number of students: 7 | 13 | 14 | 6	
	(ci)	$\frac{(6\times7)+(14\times12.5)+(14\times17.5)+(6\times22)}{40} = 14.7125$	
	(cii)	4.76	
	(d)	15	
	(e)	The students performed better in Mathematics as the median score (15 marks) was higher than Chemistry's (14 marks) The students performed more consistently in Chemistry as the interquartile range (3 marks) is lower than Mathematics (6 marks)	

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Anglo-Chinese School (Barker Road)

Mathematics Paper 2 Marking Scheme
Secondary 4 Express / 5 Normal Academic
Preliminary Exams 2024

9	(a)	$\$4100\left(1+\frac{4}{100}\right)^5 = \$4988$	
		= $5000	
	(b)	Justification: Choose the highest COE price recorded in the past 12 months to cover the worst-case scenario	
			EV 60kWh
		Cost price of car	$(100,000+105,000 – 30,000 =$175,000
		Minimum downpayment	$40\% \times \$175{,}000 = \$70{,}000$
			1998cc petrol car
		Cost price of car	$(110,000+150,000) = $260,000
		Minimum downpayment	$30\% \times \$260{,}000 = \$78{,}000$
		6 months of Lee's salary	$= 6 \times \$5000 = \$30{,}000$
		Savings – downpayment	EV 60kWh: $(105,000 – 70,000) = $35,000 1998cc petrol car: $(105,000 – 78,000) = $27,000
		conclusion	Lee can only afford the downpayment for the EV 60kWh. ($35,000 – $30,000 = $5000)
	(c)	To determine is Lee can afford the car in Jan 2024.	
		i) Road Tax	$[250 + 3.75(60 - 30)] \times 0.7826 \div 6$ = $47.246
		ii) Loan amount	175000 – 70000 = $105,000
		Interest	$\frac{105{,}000 \times 2.78 \times 7}{100} = \$20{,}433$
		(iii) Monthly Instalment	$(105{,}000 + 20{,}433) \div 84$ =$1493.25
		iv) Other costs (monthly basis)	$\frac{4700}{12} + 600 = \$991.667$
		Total monthly expense	$2532.1625
		Spare cash for the month	5000 – 2700 = $2300
		v) Affordability Spare cash – total monthly expenses	2300 – 2532.1625 = – $232.1625 Lee would not be able to afford the car.
			However, if we take into consideration that Lee still has $5,000 remaining after making the downpayment in part (b), with $30,000 already set aside, he would be able to afford the car

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