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SECONDARY 4

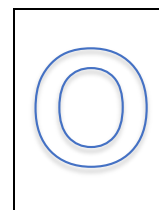
G3 Express Exam Paper

G3 E-Math
(Full Paper)

1	Canberra Sec	Prelim
2	Dunman Sec	Prelim
3	Evergreen Sec	Prelim
4	Ngee Ann Sec	Prelim
5	Riverside Sec	Prelim
6	Presbyterian	Prelim
7	St Patrick	Prelim
8	Yishun Town	Prelim



CANBERRA SECONDARY SCHOOL



2026 Preliminary Examination

Secondary Four Express/Five Normal (Academic)

MATHEMATICS

4052/01

13 Aug 2026

2 hours 15 minutes

1130h – 1345h

Name: _____ () Class: _____

READ THESE INSTRUCTIONS FIRST

Write your full name, class and index number on all work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

Calculators should be used 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, unless the question requires the answer in terms of π .

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

The total number of marks for this paper is 90.

FOR MARKER'S USE		
	Marks Awarded	Max Marks
Total		90

HOM: *Striving for Accuracy*

"The quality of an individual is reflected in the standards they set for themselves." - Ray Kroc

This question paper consists of **19** printed pages including the cover page.

Setter: Mr Edwin Cheong

Mathematical Formulae

Compound interest

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

Mensuration

$$\text{Curved Surface area of a cone} = \pi r l$$

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

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

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

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

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

Trigonometry

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

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

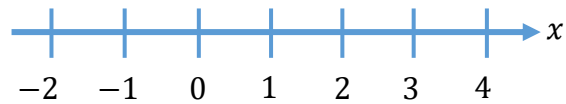
Statistics

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

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

Answer **all** the questions.

- 1 Represent the inequality $-1 \leq x < 4$, on the number line below.



[1]

-
- 2 Simplify

(a) $2x - 4 + x - 3 - 4x$,

Answer [1]

(b) $\frac{9(x+2)}{4} + \frac{5x}{6} - \frac{3x-5}{12}$.

Answer [3]

- 3 The cash price of a computer is \$3000.
Adeline buys the computer on hire purchase.
She pays a deposit of \$2000 plus 36 equal monthly payments of \$34.50.

(a) Calculate the total cost Adeline has to pay by hire purchase.

Answer \$ [1]

(b) Find the rate of simple interest charged per annum.

Answer [2]

- 4 Consider the pattern:

Row	Mathematical sentence	Sum	No. of odd integers
1	$1 + 3$	4	2
2	$1 + 3 + 5$	9	3
3	$1 + 3 + 5 + 7$	16	4
4	$1 + 3 + 5 + 7 + 9$	25	5
:	:		:
n	$1 + 3 + 5 + \dots + k$	S	

- (a) Is it possible to have a sum of 200?
Explain your answer.

Answer

..... [1]

(b) Express k in terms of n .

Answer [1]

(c) How many odd integers are there from 1 to 49?

Answer [1]

5 Factorise

(a) $2m^2 - 7mn + 6n^2$

Answer [2]

(b) $x^3 - x^2 - xy^2 + y^2$

Answer [2]

6 $y = \frac{x-z}{2x+1}$

(a) Find y when $x = 6.7$ and $z = 3$.

Give your answer to 2 significant figures.

Answer [2]

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

Answer [3]

7 The dimensions of a rectangular box are 60 cm by 54 cm by 42 cm.
The box is to be filled with identical cubes of k cm so that there will be no empty space.

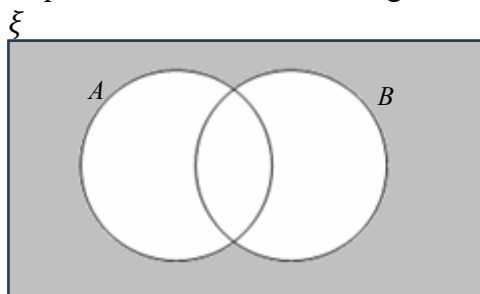
(a) Find the largest value of k .

Answer $k =$ cm [2]

- (b) Using your answer in (a), find the total number of cubes the box can hold.

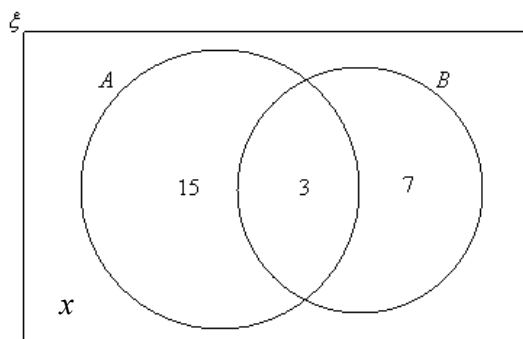
Answer [2]

- 8 (a) Express in set notation, the region shaded in the Venn diagram below.



Answer [1]

- (b) A and B are subsets of ξ .
The number of elements in the subsets is shown in the Venn diagram.
Given that $n(\xi) = 35$, find the value of x .

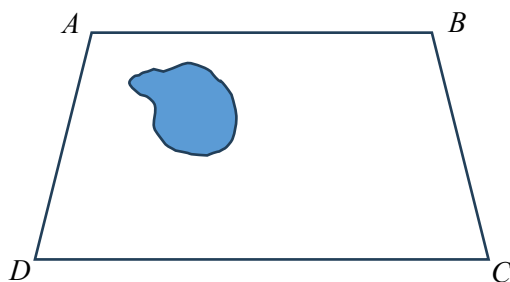


Answer $x =$ [1]

- 9 Expand and simplify $(3x - 2)(2x^2 - 3x + 5)$.

Answer [2]

- 10 The diagram represents a **scale drawing** of a plot of land, $ABCD$.
 CD is 12 km.



- (a) Express the scale of the map in $1 : n$.

Answer [1]

- (b) The area of the lake on the map is 1.65 cm^2 .
 Calculate the actual area of the lake in km^2 .

Answer km^2 [2]

- 11 Solve these simultaneous equations.

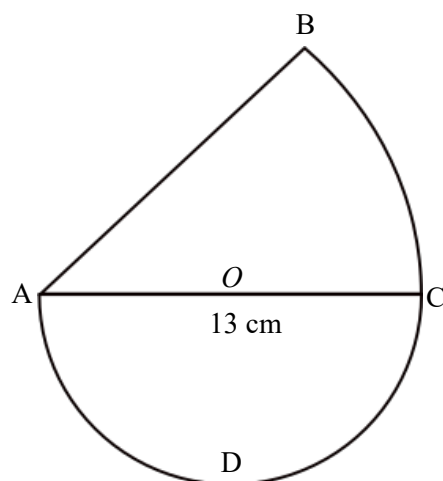
$$\begin{aligned} 2x + y &= 11 \\ 3x - 2y &= 4 \end{aligned}$$

You must show your working.

Answer $x =$

$y =$ [3]

- 12 The circular arc BC is part of a circle centre A .
 The centre of semicircle ACD is O .
 The diameter of the semicircle, AC is 13 cm.
 $\angle BAC = 0.96$ radians.



- (a) Show that the arc length BC is 12.48 cm.

[1]

- (b) Find the perimeter of $ABCD$.

Answer cm [2]

- 13 (a) The total population of Singapore is estimated to be 5906000 in 2026.
 Express this number in standard form.

Answer [1]

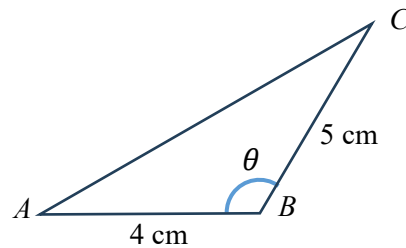
- (b) The Gross Domestic Product (GDP) of Singapore in 2026 is estimated to be 659.6 billion dollars.
 Express this figure in standard form.

Answer [1]

- (c) The GDP is the average income per person multiply by the total population.
 Calculate the average income per person correct to the nearest hundred dollars.

Answer [1]

- 14** In the diagram, $\sin \theta = \frac{3}{5}$ and θ is obtuse.
Find



- (a) the area of $\triangle ABC$,

Answer [1]

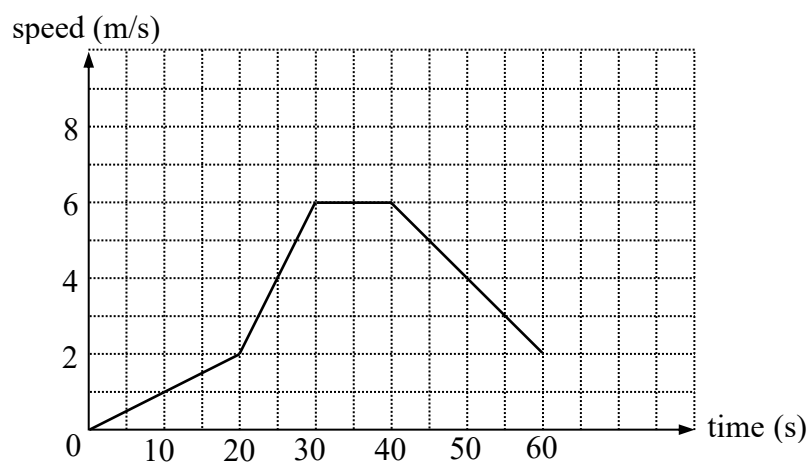
- (b) the numerical value of $\cos \theta$, without the use of calculator.

Answer [2]

- 15** Solve the equation $x^2 + 2x - 7 = 0$ by completing the square.
Give your solutions correct to 2 decimal places.

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

- 16 The diagram shows the speed-time graph of a particle over a period of 60 seconds.



Calculate

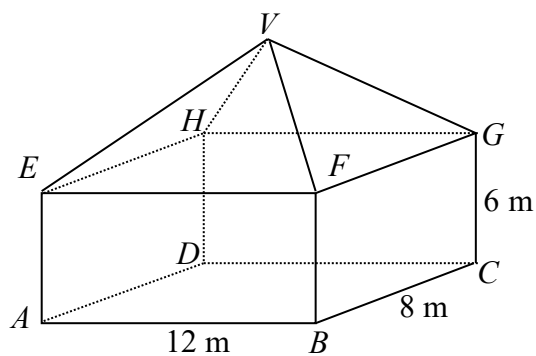
- (a) the acceleration of the particle in the last 10 second,

Answer m/s^2 [2]

- (b) the total distance travelled in 60 seconds.

Answer m [2]

17



The diagram shows a greenhouse made of glass.
 It consists of a regular pyramid, $VEFGH$, attached to a cuboid $ABCDEFGH$.
 The dimension of the cuboid is $12\text{m} \times 8\text{m} \times 6\text{m}$ and $\angle EVF = 80^\circ$.
 Calculate

(a) length VF ,

Answer m [2]

(b) $\angle GAF$,

Answer [2]

(c) the height of the greenhouse.

Answer m [2]

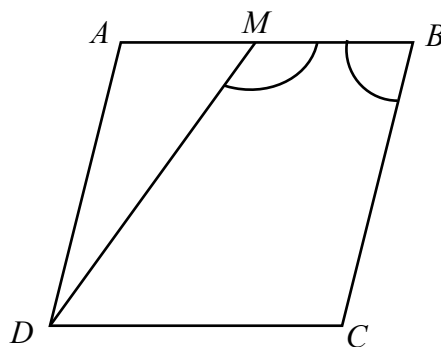
- 18** Bryan deposited \$20 000 into an account paying compound interest at $x\%$ per annum. After 4 years, he has \$21861.67 in his account.
Find x .

Answer [3]

- 19** In the diagram, $ABCD$ is a rhombus and M is a point on AB .

The ratio $\angle ABC : \angle BMD = 4: 11$.

$$\angle ACB = 64^\circ$$



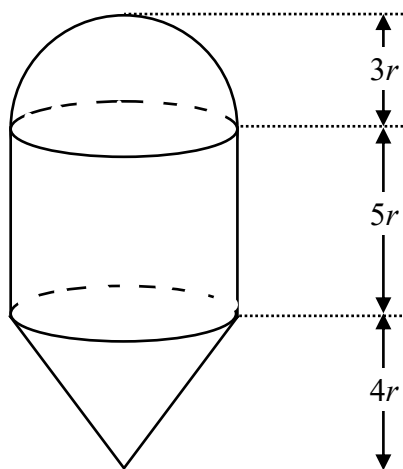
- (a)** Find $\angle ABC$.

Answer [2]

- (b)** Find $\angle ADM$.

Answer [3]

- 20 A solid is made up of a hemisphere, a cylinder and a cone, each having the same radius. The height of the hemisphere, cylinder and cone is $3r$, $5r$ and $4r$ respectively.



Find, in terms of π and r , the total surface area of the solid.

Answer [3]

- 21 The sum of 3 numbers p , q and r is 171 and $p^2 + q^2 + r^2 = 10\,145$. Find the standard deviation of the 3 numbers.

Answer [2]

22 Simplify $\frac{3t^2 + 8t - 16}{2t^2 - 32}$.

Answer [3]

23 The rate of exchange between Singapore dollar (S\$) and Japanese Yen (¥) is S\$1 to ¥125.60.

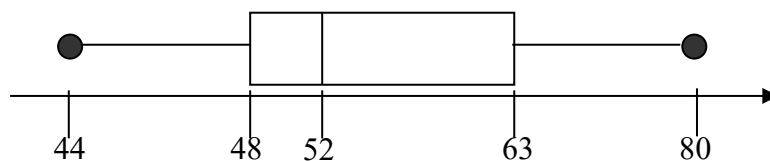
- (a) The cost of a car rental for one week is ¥158,636.
Find the cost of the car rental in Singapore dollar to the nearest cent.

Answer [1]

- (b) The rate of exchange between Singapore dollar (S\$) and Korean won (₩) is S\$1 to ₩1154. How much Korean won can be exchanged with 1 Japanese yen?

Answer [2]

- 24 The box and whisker plot shows the weight distribution of 40 students.



- (a) How many students weigh at most 48kg?

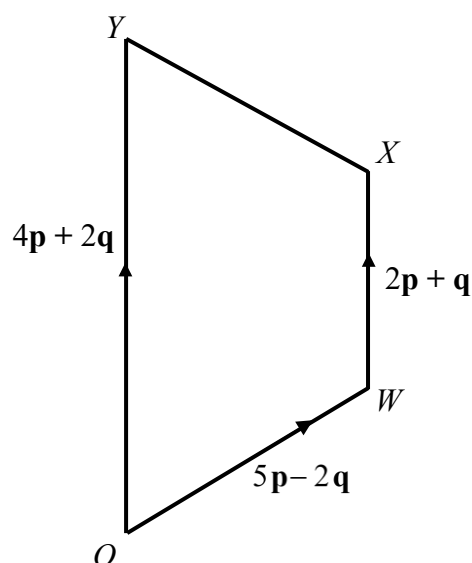
Answer [2]

- (b) It was found that the weighing scale is faulty.
It overweighs by one kilogram.
Explain what will happen to the median and the interquartile range after the reading is corrected.

Answer

..... [2]

- 25 In the diagram, $OWXY$ is a quadrilateral, $\overrightarrow{OW} = 5\mathbf{p} - 2\mathbf{q}$, $\overrightarrow{OY} = 4\mathbf{p} + 2\mathbf{q}$ and $\overrightarrow{WX} = 2\mathbf{p} + \mathbf{q}$.



- (a) If M is a point such that $\overrightarrow{OM} = 10\mathbf{p} - 4\mathbf{q}$, explain why O , W and M lie on a straight line.

[2]

- (b) Is $\triangle OYM$ similar to $\triangle WXM$? Explain your answer.

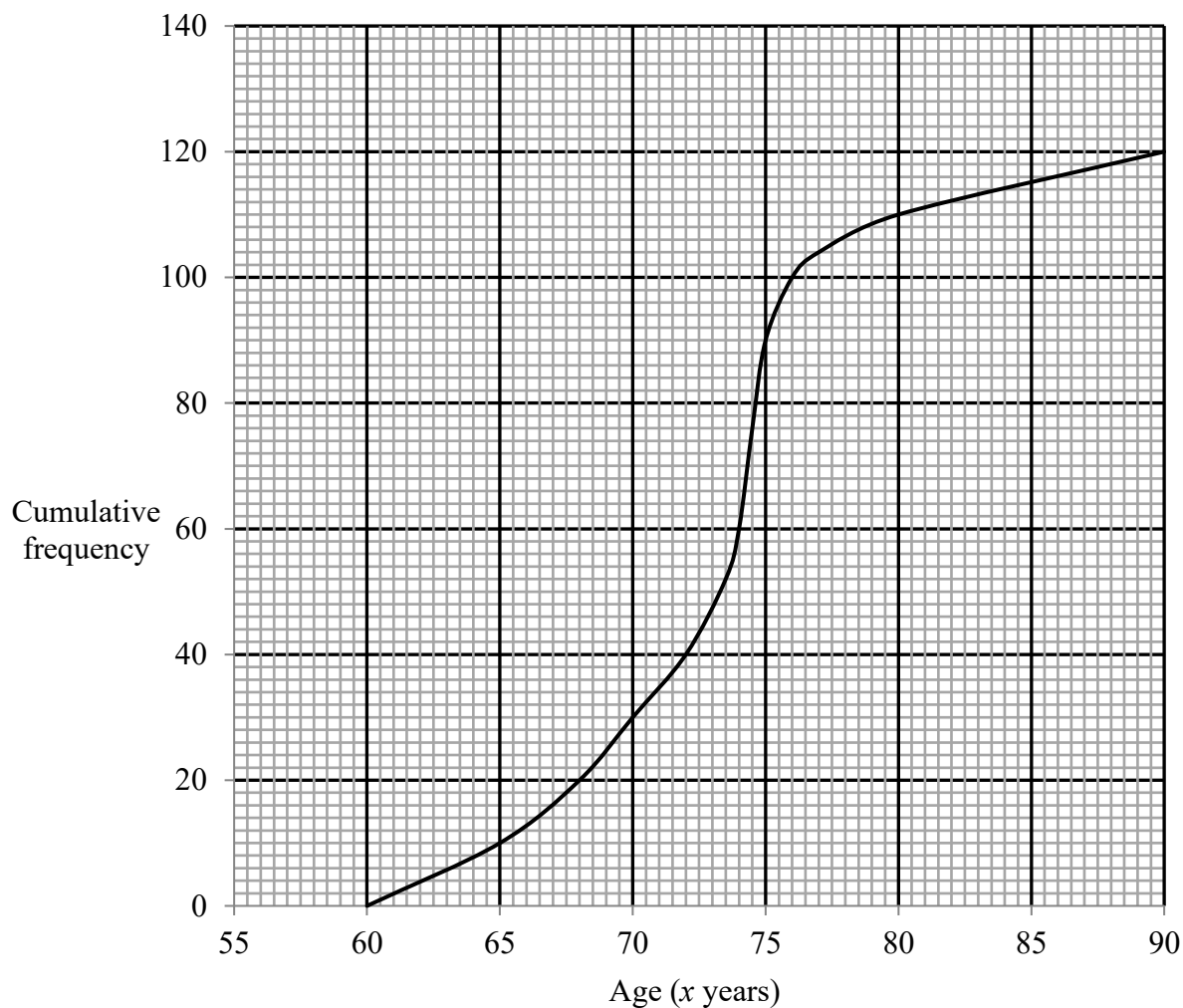
Answer

.....

.....

[2]

- 26 The cumulative frequency curve below shows the distribution of ages of 120 elderly residents in an estate in Singapore recorded in 2025.



(a) Use the curve to estimate

(i) the median age,

Answer [1]

(ii) the interquartile range.

Answer [2]

- (b) The retirement age has been raised to 64 on 1 July 2026.
What percentage of elderly are retirees?

Answer [2]

- (c) Naval Base Residents' Network (RN) plans to start a programme to help the elderly residents in the estate.

The RN decides to focus on a selected group of elderly residents who are similar in age with the range of their ages not greater than 5 years.

Emily claims that the ages of the selected group should be from 71 to 76 years old to extend the help to the maximum number of elderly residents possible.

Do you agree with her?

Justify your decision.

Answer because

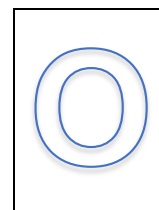
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..... [2]

End of Paper



CANBERRA SECONDARY SCHOOL



2026 Preliminary Examination

Secondary Four Express/Five Normal (Academic)

MATHEMATICS

4052/02

14 Aug 2026

2 hours 15 minutes

0815h – 1030h

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Setter: Ms Diyanah

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Statistics

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Answer all the questions.

- 1 (a) Simplify $\left(\frac{9a^8}{b^6}\right)^{\frac{1}{2}}$, giving your answer in positive index.

Answer [2]

(b) $\frac{2^k}{\sqrt{8}} = 4^{k-1}$

Use the laws of indices to find the value of k .

Answer $k =$ [3]

(c) Simplify $\frac{15c^2d}{8} \div \frac{45c^3}{16d^2}$.

Answer [2]

(d) Simplify $\frac{2x-1}{x+3} - \frac{3}{x-2} + 2$ as a single fraction in its simplest form.

Answer [3]

- 2 (a) The equation of line L is $3y = 2x + 9$.
- The equation of line M is $5y = kx + 7$, where k is a constant.
- Line L and line M intersect at the point $(3, p)$ where p is a constant.
- Find the value of k and the value of p .

Answer $k = \dots\dots\dots$

$p = \dots\dots\dots$ [3]

- (b) A is the point $(4, a)$ where $a < 0$.
- B is the point $(16, 5)$.
- The length of line AB is 15 units.
- Find the value of a .

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

- 3 A school organized a Sports and Wellness Day for their Secondary 4 students. As part of the event, students participated in a 2.4 km run.

The table below summarises the times taken by the Secondary 4 boys to complete the run.

Time (t min)	$10 \leq t < 12$	$12 \leq t < 14$	$14 \leq t < 16$	$16 \leq t < 18$	$18 \leq t < 20$
Frequency	8	22	35	25	x

- (a) Given that the estimated mean time is 15.14 min, show that the value of x is 10. [2]

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

Answer min [1]

- (c) The mean time for Secondary 4 girls to complete the run was 15.8 min and the standard deviation was 2.4 min.

Make 2 comparisons between the times for Secondary 4 boys and girls.

.....

.....

.....

.....

..... [2]

- (d) At the end of the Sports and Wellness Day, each participant was allowed to select a prize voucher from a prize box. The prize box contained 8 drink vouchers, 5 snack vouchers and 7 stationery vouchers.

One voucher was selected at random. Find the probability that the selected voucher was not a snack voucher.

Answer [1]

- (e) Two vouchers were selected at random, without replacement.

Find the probability that both vouchers selected were drink vouchers.

Answer [2]

- 4 A community club is organising a sports carnival for children.
Children can choose to participate in one of three events – badminton, table tennis or floorball.

Matrix E shows the number of boys and girls in each category for the age group 7 to 10 years old.

$$E = \begin{matrix} & \begin{matrix} \text{Boys} & \text{Girls} \end{matrix} \\ \begin{pmatrix} 6 & 8 \\ 9 & 5 \\ 4 & 10 \end{pmatrix} & \begin{matrix} \text{Badminton} \\ \text{Table Tennis} \\ \text{Floorball} \end{matrix} \end{matrix}$$

Matrix F shows the number of boys and girls in each category for the age group 11 to 14 years old.

$$F = \begin{matrix} & \begin{matrix} \text{Boys} & \text{Girls} \end{matrix} \\ \begin{pmatrix} 12 & 9 \\ 7 & 13 \\ 11 & 6 \end{pmatrix} & \begin{matrix} \text{Badminton} \\ \text{Table Tennis} \\ \text{Floorball} \end{matrix} \end{matrix}$$

- (a) Evaluate the matrix $T = E + F$.

Answer [1]

- (b) Each participant is charged an entry fee. The entry fee is \$28 for badminton, \$24 for table tennis and \$20 for floorball.
Represent the fees in a 1×3 matrix C .

Answer $C = \dots\dots\dots (\dots\dots\dots)$ [1]

- (c) Evaluate the matrix $\mathbf{M} = \mathbf{CT}$ and state what the elements in matrix $\mathbf{M}$ represent.

Answer $\mathbf{M} = \begin{pmatrix} & & \\ & & \\ & & \end{pmatrix}$ [2]

.....

..... [1]

- (d) Calculate the total amount of entry fees collected for the sports carnival.

Answer \$ [1]

- (e) The community club has decided to organise a similar sports carnival for teenagers aged 15 to 18 years old. As compared to the fees for children aged 7 to 14 years old, the entry fees for teenagers are increased by 15% for badminton, 10% for table tennis and 20% for floorball.

Using matrix multiplication, calculate the entry fees for teenagers for each category. Give your answer in matrix form.

Answer [2]

- 5 The variables x and y are connected by the equation $y = \frac{1}{2}x^3 + \frac{1}{5x}$.

Some corresponding values of x and y , correct to 1 decimal place, are given in the table below.

x	-2	-1	-0.5	-0.1	0.1	0.5	1	2
y	p	-0.7	-0.5	-2.0	2.0	0.5	0.7	4.1

- (a) Calculate the value of p .

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

- (b) On the axes given on page 11, draw the graph of $y = \frac{1}{2}x^3 + \frac{1}{5x}$. [2]

- (c) Using your graph, find the value of y when $x = -1.1$.

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

- (d) By drawing a tangent, find the gradient of the curve at $x = 1.5$.

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

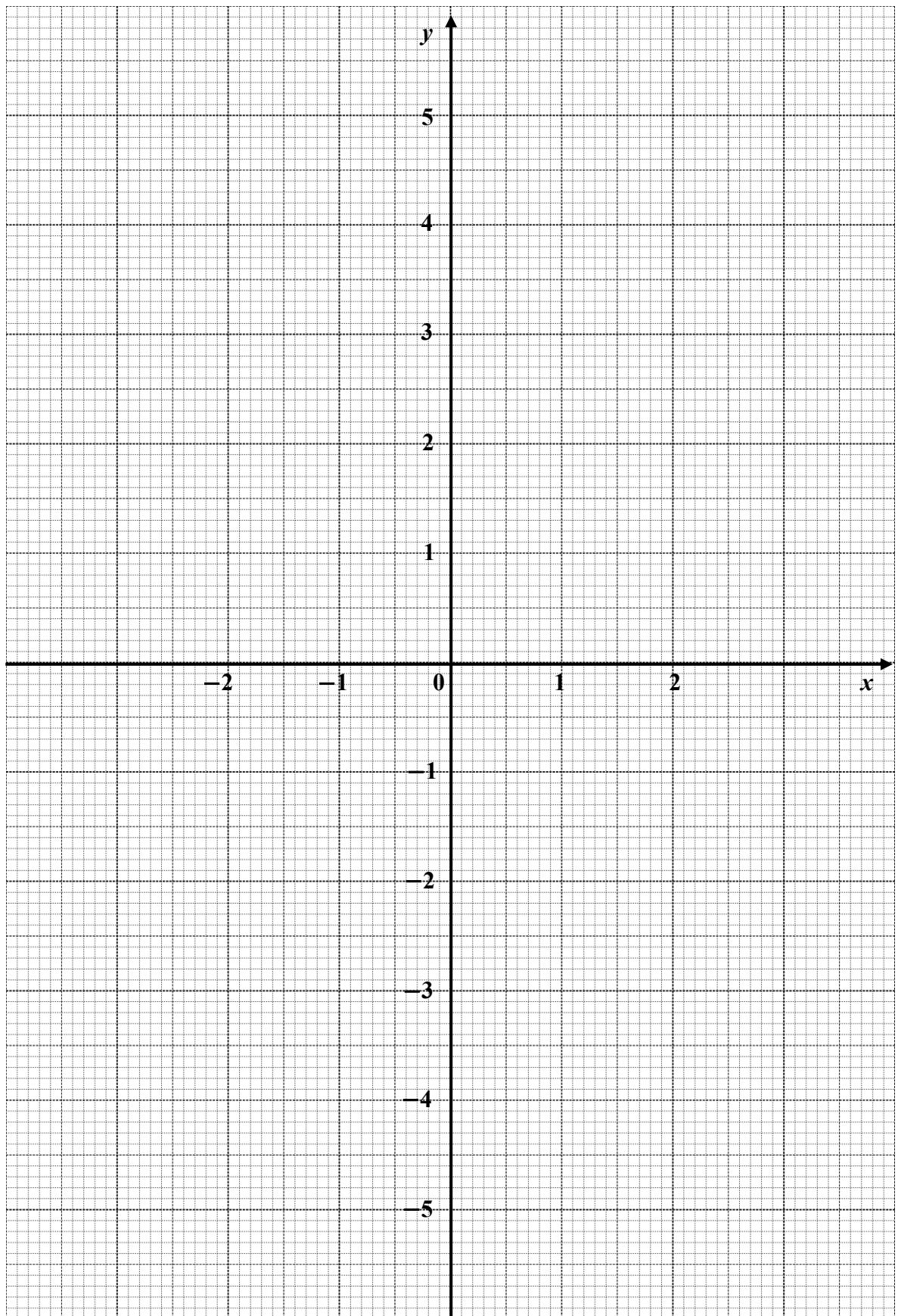
- (e) By drawing a suitable straight line, find the solution of $\frac{1}{2}x^3 + \frac{1}{5x} + 2.5x + 5 = 0$.

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

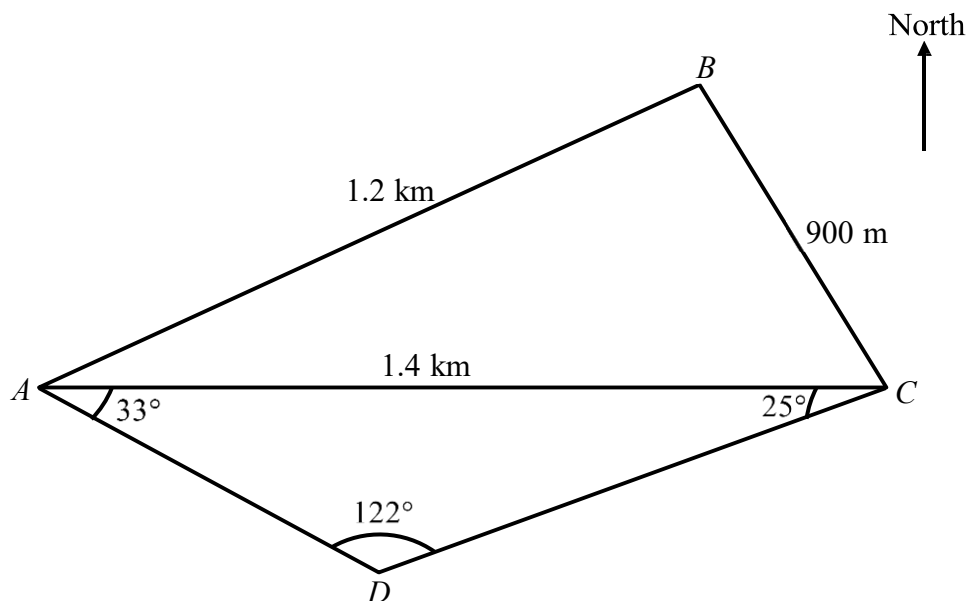
- (f) Explain why the curve does not touch the y -axis.

.....

..... [1]



6



ABC and ADC are two walking routes around an island.

$AB = 1.2$ km, $AC = 1.4$ km and $BC = 900$ m.

Angle $ADC = 122^\circ$, angle $DAC = 33^\circ$ and angle $ACD = 25^\circ$.

(a) Calculate angle BAC .

Answer [3]

- (b) Calculate the shortest distance from D to a point along the path AC .

Answer km [3]

- (c) A drone is hovering vertically above point D at a height of 300 m. Find the largest angle of depression from the drone to a point along path AC .

Answer [2]

- (d) A is due west of C . Find the bearing of A from B .

Answer [1]

- 7 In March, the price of oranges was \$ x per kg.
In April, the price of oranges decreased by \$2.50 per kg.
With \$180, Sarah could buy 3 kg more oranges in April than in March.

- (a) Write down an expression, in terms of x , the mass of oranges that can be bought for \$180 in March.

Answer kg [1]

- (b) Write down an expression, in terms of x , the mass of oranges that can be bought for \$180 in April.

Answer kg [1]

- (c) Form an equation in terms of x and show that it reduces to $6x^2 - 15x - 900 = 0$. [3]

- (d) Solve the equation $6x^2 - 15x - 900 = 0$. Give your answers correct to 2 decimal places.

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

- (e) Find the price of the oranges per kg in April.

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

- (f) Find the percentage decrease in price in April compared to March.

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

8 (a) The position vector of point X is $\begin{pmatrix} 8 \\ -4 \end{pmatrix}$.

The position vector of point Y is $\begin{pmatrix} 6 \\ 4 \end{pmatrix}$.

(i) Find the vector that represents the translation from X to Y .

Answer $\begin{pmatrix} \\ \end{pmatrix}$ [1]

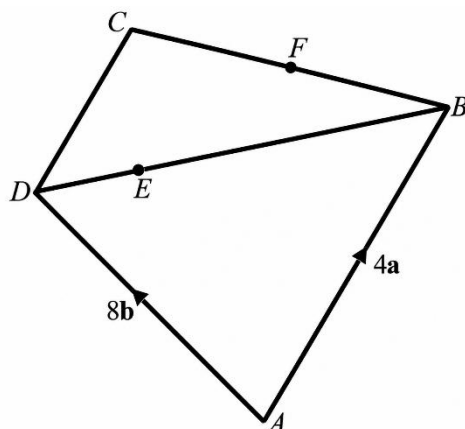
(ii) Find the magnitude of $\overrightarrow{XY}$.

Answer units [2]

(iii) Z has coordinates $(-1, k)$ and lies on the line XY produced.
Find the position vector of point Z .

Answer $\begin{pmatrix} \\ \end{pmatrix}$ [2]

(b)



In the diagram, $\overrightarrow{AB} = 4\mathbf{a}$, $\overrightarrow{AD} = 8\mathbf{b}$ and $\overrightarrow{EF} = 2(\mathbf{a} - \mathbf{b})$.

E is the point on BD such that $BE : BD = 3 : 4$.

F is the midpoint of BC .

- (i) Express $\overrightarrow{BE}$ in terms of $\mathbf{a}$ and $\mathbf{b}$, as simply as possible.

Answer [2]

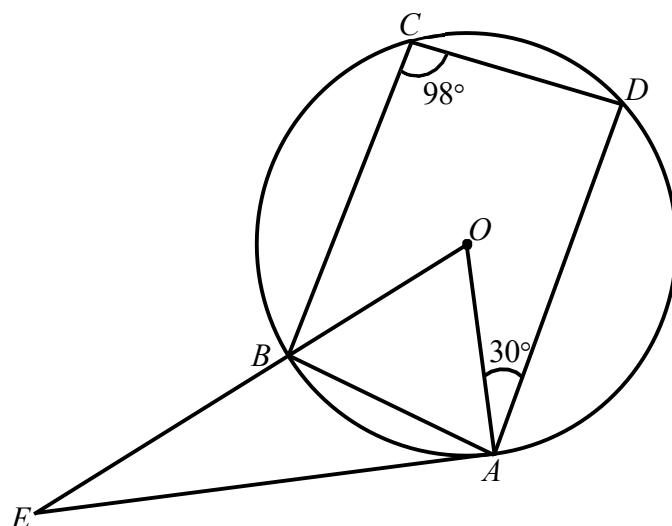
- (ii) Express $\overrightarrow{BC}$ in terms of $\mathbf{a}$ and $\mathbf{b}$, as simply as possible.

Answer [2]

- (iii) What type of quadrilateral is $ABCD$?
Justify your answer using vectors.

$ABCD$ is a because

..... [3]



A , B , C and D are points on the circumference of a circle with centre O .

AE is a tangent to the circle at A and OE is a straight line that passes through the circle at point B .

Angle BCD is 98° and angle OAD is 30° .

(a) Find the following angles.

(i) Angle BAD .

Answer [1]

(ii) Angle BOA .

Answer [1]

(iii) Angle OEA .

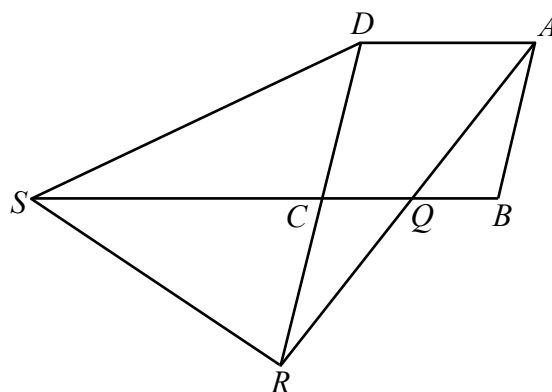
Answer [1]

- (iv) Explain why a semicircle with OE as diameter passes through point A .

.....

 [1]

- (b) $ABCD$ is a rhombus and $RD = SC$.
 SCB , DCR and AQR are straight lines.
 The diagram is not drawn to scale.

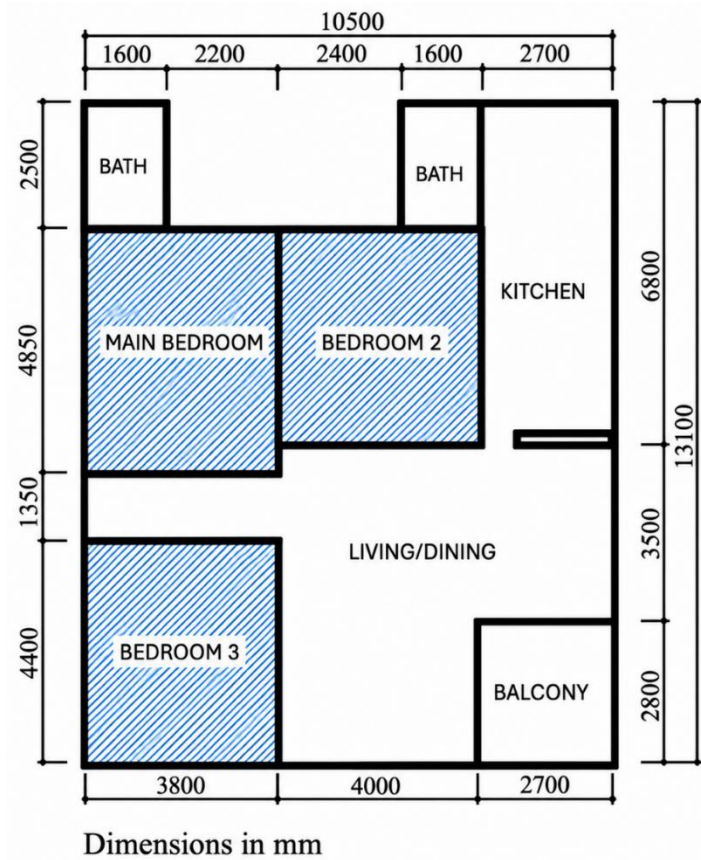


Prove that triangles SCD and RDA are congruent.

.....

 [3]

- 10 Samantha owns a renovation company that specialises in vinyl flooring installation. A homeowner wishes to replace the flooring in all three bedrooms of the apartment shown below.



- (a) Show that the total floor area of the three bedrooms is 52.35 m^2 .

Answer m^2 [3]

- (b) Samantha receives the following quotation.

Item	Description	Unit Cost
Vinyl planks	0.18 m $\times$ 1.22 m	\$68 per box
	12 planks per box	
Skirting boards	2.4 m per piece	\$8.50 per piece

Vinyl planks and skirting boards are sold in whole boxes and by pieces respectively.

Skirting boards are installed around the perimeter of the three bedrooms, excluding the three bedroom door openings. Each door opening is 0.8 m wide.

Cost	Amount
Labour	\$35 per hour per installer
Number of installers	3
Working hours	8 hours per day
Duration	2 days
Total transportation cost	\$180
Disposal of old flooring	\$250

Additional information: $1 \text{ m}^2 = 10.764 \text{ ft}^2$

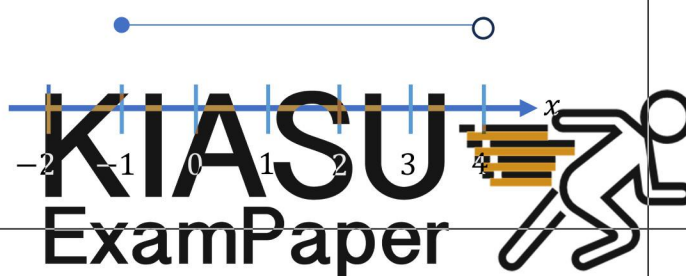
Samantha wants to make a 20% profit. Calculate the minimum price per square foot Samantha should charge.

[7]

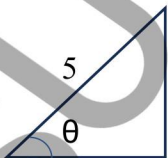
[Continue your workings here]

End of Paper

Solutions to 2026 4E/5N Prelims

Question No.	Solutions	Marks
1	$-1 \leq x < 4$ 	B1
2(a)	$-x - 7$	B1
2(b)	$\frac{9(x+2)}{4} + \frac{5x}{6} - \frac{3x-5}{12}$ $\frac{27(x+2) + 10x - 3x + 5}{12}$ $\frac{27x + 54 + 7x + 5}{12}$ $\frac{34x + 59}{12}$	M1 (common denominator) M1 A1
3(a)	\$3242	B1
3(b)	$\frac{PRT}{100} = \$242$ $Rate = \frac{\$242 \times 100}{1000 \times 3} = 8.07\%$	M1 A1
4(a)	No, it is not possible. 200 is not a square number	B1
4(b)	$k = 2n + 1$	B1
4(c)	$2n + 1 = 49$ $n = 24$ Number of odd number is 25	

5(a)	$(2m - 3n)(m - 2n)$	M1 (any method) A1
5(b)	$x^2(x - 1) - y^2(x - 1)$ $(x^2 - y^2)(x - 1)$ $(x - y)(x + y)(x - 1)$	M1 A1
6(a)	$y = \sqrt{\frac{x - z}{2x + 1}}$ $y = \frac{6.7 - 3}{2(6.7) + 1} = 0.26$	M1 (correct substitution) A1
6(b)	$y = \frac{x - z}{2x + 1}$ $y + 2xy = x - z$ $y + z = x - 2xy$ $y + z = x(1 - 2y)$ $x = \frac{y + z}{(1 - 2y)}$	M1 M1 A1
7(a)	6 cm	M1 for finding HCF A1
7(b)	Number of cubes = $\frac{60}{6} \times \frac{54}{6} \times \frac{42}{6} = 630$	M1 A1
8(a)	$(A \cup B)' \text{ or } A' \cap B'$	B1
8(b)	$35 - 15 - 3 - 7 = 10$	B1
9	$6x^3 - 9x^2 + 15x - 4x^2 + 6x - 10$ $6x^3 - 13x^2 + 21x - 10$	M1 A1
10(a)	6 cm : 12 km	B1

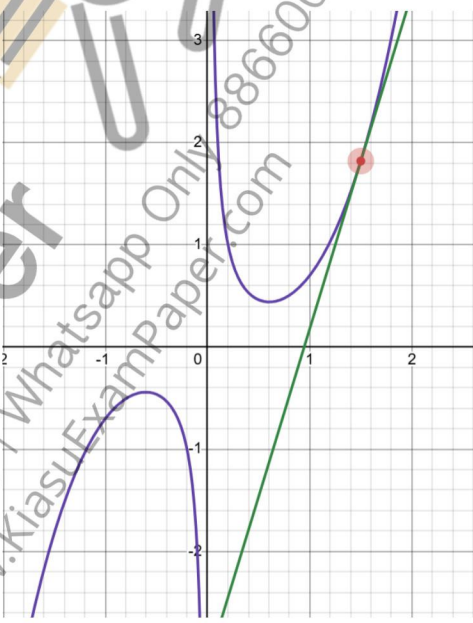
	$1 \text{ cm} : 2 \text{ km}$ $1:200000$	
10(b)	$1 \text{ cm}^2 : 4 \text{ km}^2$ $1.65 \text{ cm}^2 : 6.6 \text{ km}^2$	M1 for area scale A1
11	$x = \frac{26}{7}$ $y = \frac{25}{7}$	M1 for substitution or elimination method A2
12(a)	$r\theta = 13 \times 0.96 = 12.48$	B1
12(b)	$Perimeter = AB + BC + CA$ $13 + 12.48 + \pi(6.5)$ $= 45.9 \text{ cm}$	M1 A1
13(a)	5.906×10^6	B1
13(b)	6.596×10^{11}	B1
13(c)	111700	B1
14(a)	$\frac{1}{2} \times 4 \times 5 \times \frac{3}{5} = 6$	B1
14(b)	$\sin \theta = \sin(180^\circ - \theta)$  $\cos \theta = -\frac{4}{5}$	M1 A1
15	$x^2 + 2x - 7 = 0$ $(x+1)^2 - 1^2 - 7 = 0$ $(x+1)^2 = 8$ $x+1 = \pm\sqrt{8}$ $x = 1.83 \text{ or } x = -3.83$	M1 A2

16(a)	$acceleration = \frac{-2m/s}{10s} = -0.2m/s^2$	M1 A1
16(b)	Total distance travelled $= \left(\frac{1}{2} \times (60 + 40) \times 2\right) + \left(\frac{1}{2} \times (40 + 10) \times 4\right)$ $= 200$	M1 A1
17(a)	$\sin 40^\circ = \frac{6}{VF}$ $VF = \frac{6}{\sin 40^\circ} = 9.3343 = 9.33 (3sf)$	M1 A1
17(b)	$\tan \angle GAF = \frac{6}{\sqrt{6^2 + 12^2}}$ $\angle GAF = 30.807^\circ = 30.8 (1dp)$	M1 A1
17(c)	$height = 6 + \sqrt{9.3303^2 - (6^2 + 4^2)}$ $= 11.9 \text{ m}$	M1 A1
18	$21861.67 = 20000 \left(1 + \frac{x}{100}\right)^4$ $1 + \frac{x}{100} = 1.0225$ $x = 2.25\%$	M1 M1 A1
19(a)	$\angle BAC = \angle BCA = 64^\circ (Rhombus)$ $\angle ABC = 180^\circ - 64^\circ - 64^\circ = 52^\circ$	M1 (property of Rhombus) A1
19(b)	$4x = 52^\circ$ $11x = 143^\circ$ $\angle ADM = 52^\circ - 37^\circ$ $= 15^\circ$	M1 (ratio) M1 (property of Rhombus) A1
20	Slant height of cone $= \sqrt{(3r)^2 + (4r)^2} = 5r$ Total surface area $= 2\pi(3r)^2 + 2\pi(3r)(5r) + \pi(3r)(5r)$ $= 18\pi r^2 + 30\pi r^2 + 15\pi r^2 = 63\pi r^2$	M1 M1 for any curve surface A1
21	$\sqrt{\frac{10145^2}{3} - \left(\frac{171}{3}\right)^2} = 11.5$	M1 A1

22	$\frac{(3t - 4)(t + 4)}{2(t^2 - 16)}$ $\frac{3t - 4}{2(t - 4)}$	M1 each for numerator and denominator A1
23(a)	$\frac{158636}{125.60} = S\1263.03 (to nearest cent)	
23(b)	$S\$1 = 1154$ won $S\$1 = ¥125.60$ $¥1 = \frac{1}{125.60} = \frac{1154}{125.60}$ $= 9.19$ won	M1 A1
24(a)	Lower quartile = 48 kg 25% of 40 students = 10	M1 A1
24(b)	The median is reduced to 51 kg, and the interquartile range remains the same.	B2
25(a)	$\vec{OW} = 5\mathbf{p} - 2\mathbf{q}$ $\vec{OM} = 10\mathbf{p} - 4\mathbf{q} = 2\vec{OW}$ Since $\vec{OM} // \vec{OW}$ and has a common point O , O, W and M lies on a straight line	B1 for parallel lines B1 for common point O
25(b)	$\vec{OY} // \vec{WX} \therefore \angle MWX = \angle MOY$ (corresponding $\angle$ s) $\vec{OM} = 2\vec{OW}$ $\vec{OY} = 2\vec{WX}$ $\therefore$ by SAS, $\triangle OYM$ similar to $\triangle WXM$	M1 A1
26(ai)	74	B1
26(aii)	$75 - 70$ $= 5$	M1 for either UQ or LQ A1
26(b)	$\frac{120 - 8}{120} \times 100 = 93.3\%$	M1 B1
26(c)	I agree with her. The maximum number of elderly residents is obtained from the steepest portion of the curve The number of elderly from 70-75 and 72-77 is only 60 and 64 respectively	M1 for agree M1 for comparison of ranges stating steepest portion.

Question	Solutions	Marks
1a	$\left(\frac{9a^8}{b^6}\right)^{\frac{1}{2}}$ $= \frac{(9a^8)^{\frac{1}{2}}}{(b^6)^{\frac{1}{2}}}$ $= \frac{3a^4}{b^3}$	B1 for 3 B1 for $\frac{a^4}{b^3}$
1b	$\frac{2^k}{(2^3)^{\frac{1}{2}}} = (2^2)^{\frac{k-1}{2}}$ $\frac{2^k}{2^{\frac{3}{2}}} = 2^{2k-2}$ $2^{k-\frac{3}{2}} = 2^{2k-2}$ $k - \frac{3}{2} = 2k - 2$ $k = \frac{1}{2}$	M1 M1 A1
1c	$\frac{15c^2d}{8} \times \frac{16d^2}{45c^3}$ $= \frac{2d^3}{3c}$	M1 A1
1d	$\frac{(2x-1)(x-2) - 3(x+3) + 2(x+3)(x-2)}{(x+3)(x-2)}$ $= \frac{2x^2 - 5x + 2 - 3x - 9 + 2x^2 + 2x - 12}{(x+3)(x-2)}$ $= \frac{4x^2 - 6x - 19}{(x+3)(x-2)}$	M1 M1 A1
2a	$3p = 2(3) + 9$ $p = 5$ $5(5) = 3k + 7$ $k = 6$	M1 or equivalent A1 A1

2b	$15 = \sqrt{(16-4)^2 + (5-a)^2}$ $15^2 = 12^2 + (5-a)^2$ $(5-a)^2 = 81$ $a = -4 \text{ or } 14$ Since $a < 0$, $a = -4$.	M1 M1 A1
3a	$\frac{8(11) + 22(13) + 35(15) + 25(17) + 19x}{8 + 22 + 35 + 25 + x} = 15.14$ $1324 + 19x = 1362.6 + 15.14x$ $3.86x = 38.6$ $x = 10$	M1 A1
3b	2.18 min	B1
3c	The Secondary 4 boys had a lower mean time of 15.14 min compared to the Secondary 4 girls' mean time of 15.80 min, indicating that the boys were faster on average. The Secondary 4 boys had a smaller standard deviation of 2.18 min compared to the Secondary 4 girls' standard deviation of 2.40 min, indicating that the boys' timings were more consistent.	B1 B1
3d	$\frac{15}{20}$ $= \frac{3}{4}$	B1
3e	$\frac{8}{20} \times \frac{7}{19}$ $= \frac{14}{95}$	M1 A1
4a	$\begin{pmatrix} 18 & 17 \\ 16 & 18 \\ 15 & 16 \end{pmatrix}$	B1
4b	$(28 \quad 24 \quad 20)$	B1

4c	$\begin{pmatrix} 18 & 17 \\ 28 & 24 & 20 \end{pmatrix} \begin{pmatrix} 1 \\ 16 & 18 \\ 15 & 16 \end{pmatrix}$ $= (1188 \quad 1228)$ The element represents the total entry fees collected from boys and girls respectively.	M1 (can award ECF) A1 B1
4d	$\begin{pmatrix} 1188 & 1228 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$ $= (2416)$ $\therefore \$2416$	B1
4e	$\begin{pmatrix} 1.15 & 0 & 0 \\ 28 & 24 & 20 \end{pmatrix} \begin{pmatrix} 0 & 1.10 & 0 \\ 0 & 0 & 1.20 \end{pmatrix}$ $= (32.2 \quad 26.4 \quad 24)$	M1 A1
5a	$p = -4.1$	B1
5b	Correct Points Smooth Curve 	B1 B1
5c	$y = -0.9 (\pm 0.25)$	B1
5d	Drawing the tangent correctly Gradient = 3.28 (± 2)	M1 A1

5e	$y = -2.5x - 5$ $x = -1.4 (\pm 0.1)$	M1 A1
5f	The curve is undefined at $x = 0$.	B1
6a	$0.9^2 = 1.2^2 + 1.4^2 - 2(1.2)(1.4) \cos \angle BAC$ $\angle BAC = \cos^{-1} \left(\frac{0.9^2 - 1.2^2 - 1.4^2}{-2(1.2)(1.4)} \right)$ $\angle BAC = 39.57121$ $\angle BAC \approx 39.6^\circ$	M1 M1 A1
6b	$\frac{AD}{\sin 25^\circ} = \frac{1.4}{\sin 122^\circ}$ $AD = 0.697679 \text{ km}$ Let DX be the shortest distance from D to AC . $\sin 33^\circ = \frac{DX}{0.697679}$ $DX = 0.379983$ $DX \approx 0.380 \text{ km}$ OR $\frac{CD}{\sin 33^\circ} = \frac{1.4}{\sin 122^\circ}$ $CD = 0.899117$ Let DX be the shortest distance from D to AC . $\sin 25^\circ = \frac{DX}{0.899117}$ $DX = 0.379983$ $DX \approx 0.380 \text{ km}$	M1 M1 A1 M1 M1 A1
6c	Let θ be the angle of depression. $\tan \theta = \frac{0.3}{0.379983}$ $\theta = 38.2914$ $\theta \approx 38.3^\circ$	M1 (can award ECF) A1

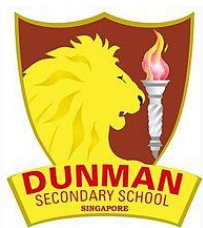
6d	$180^\circ + (90^\circ - 39.57^\circ)$ $= 230.43^\circ$ $\approx 230.4^\circ$ OR $270^\circ - 39.57^\circ$ $= 230.43^\circ$ $\approx 230.4^\circ$	B1
7a	$\frac{180}{x}$ kg	B1
7b	$\frac{180}{x - 2.50}$ kg	B1
7c	$\frac{180}{x - 2.50} - \frac{180}{x} = 3$ $180x - 180(x - 2.50) = 3x(x - 2.50)$ $180x - 180x + 450 = 3x^2 - 7.5x$ $450 = 3x^2 - 7.5x$ $6x^2 - 15x - 900 = 0$ (shown)	M1 A1
7d	$x = \frac{-(-15) \pm \sqrt{(-15)^2 - 4(6)(-900)}}{2(6)}$ $= 13.5611$ or -11.061 ≈ 13.56 or -11.06	M1 A1, A1
7e	$13.5611 - 2.50$ $= 11.0611$ $\approx \$11.06$	B1
7f	$\frac{2.50}{13.5611} \times 100\%$ $= 18.4351$ $\approx 18.4\%$	M1 A1
8ai	$\begin{pmatrix} -2 \\ 8 \end{pmatrix}$	B1
8aia	$\sqrt{(-2)^2 + 8^2}$ $= 8.2462$ ≈ 8.25 units	M1 A1

8aiii	Grad of ZY = Grad of XY $\frac{k-4}{-1-6} = \frac{8}{-2}$ $\frac{k-4}{-7} = -4$ $k = 32$ $\overrightarrow{OZ} = \begin{pmatrix} -1 \\ 32 \end{pmatrix}$	M1 A1
8bi	$\overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD}$ $\overrightarrow{BD} = -4\mathbf{a} + 8\mathbf{b}$ $= 8\mathbf{b} - 4\mathbf{a}$ $\overrightarrow{BE} = \frac{3}{4}(8\mathbf{b} - 4\mathbf{a})$ $= 6\mathbf{b} - 3\mathbf{a}$	M1 A1 (accept 3 (2b - a))
8bii	$\overrightarrow{BF} = \overrightarrow{BE} + \overrightarrow{EF}$ $\overrightarrow{BF} = 6\mathbf{b} - 3\mathbf{a} + 2\mathbf{a} - 2\mathbf{b}$ $= 4\mathbf{b} - \mathbf{a}$ $\overrightarrow{BC} = 2 \times \overrightarrow{BF}$ $= 8\mathbf{b} - 2\mathbf{a}$	M1 (can award ECF) A1 (accept 2 (4b - a))
8biii	$\overrightarrow{DC} = \overrightarrow{DB} + \overrightarrow{BC}$ $= 4\mathbf{a} - 8\mathbf{b} + 8\mathbf{b} - 2\mathbf{a}$ $= 2\mathbf{a}$ $\overrightarrow{AB} = 4\mathbf{a}$ $= 2(2\mathbf{a})$ $= 2\overrightarrow{DC}$ $ABCD$ is a trapezium because $\overrightarrow{AB} = 2\overrightarrow{DC}$. AB is parallel to DC and there is 1 only pair of parallel side.	B1 B1 B1

9ai	$\angle BAD = 180^\circ - 98^\circ$ $= 82^\circ$ (angles in opposite segments)	B1
9aii	$\angle BAO = 82^\circ - 30^\circ$ $= 52^\circ$ $\angle BOA = 180^\circ - 2(52^\circ)$ $= 76^\circ$ (isosceles triangle)	B1
9aiii	$\angle OEA = 180^\circ - 90^\circ - 76^\circ$ $= 14^\circ$ (sum of angles in a triangle)	B1
9aiv	Since angle $CAE = 90^\circ$ (tangent perpendicular to radius), it forms a right angle in a semicircle and therefore a circle with diameter OE will pass through A .	B1
9b	$SC = RD$ (given) $\angle SCD = \angle RDA$ (alternate angles) $CD = DA$ (sides of a rhombus are equal) By SAS congruency test, triangle SCD is congruent to triangle RDA .	M1 M1 A1
10a	Main Bedroom $= 3.8 \times 4.85$ $= 18.43 \text{ m}^2$ Bedroom 2 Width $= 2.4 + 1.6 = 4.0 \text{ m}$ Length $= 6.8 - 2.5 = 4.3 \text{ m}$ Area $= 4.0 \times 4.3$ $= 17.20 \text{ m}^2$ Bedroom 3 $= 3.8 \times 4.4$ $= 16.72 \text{ m}^2$ Total area $= 18.43 + 17.20 + 16.72$ $= 52.35 \text{ m}^2$ (shown)	M2 for either of the 2 bedrooms (Can be either in m^2 or mm^2) A1

10b	Area of 1 vinyl plank $= 0.18 \times 1.22$ $= 0.2196 \text{ m}^2$ Area covered by 1 box $= 0.2196 \times 12$ $= 2.6352 \text{ m}^2$ Number of boxes needed $= 52.35 \div 2.6352$ $= 19.8657$ $= 20 \text{ boxes}$ Cost of vinyl $= 20 \times 68$ $= \\$1360$ Total perimeter of bedrooms: Main Bedroom $= 2(3.8 + 4.85)$ $= 17.3 \text{ m}$ Bedroom 2 $= 2(4.0 + 4.3)$ $= 16.6 \text{ m}$ Bedroom 3 $= 2(3.8 + 4.4)$ $= 16.4 \text{ m}$ Total perimeter $= 17.3 + 16.6 + 16.4$ $= 50.3 \text{ m}$ Subtract 3 door openings: $= 50.3 - 3(0.8)$ $= 47.9 \text{ m}$ Number of skirting boards $= 47.9 \div 2.4$ $= 19.958$ $= 20 \text{ pieces}$	M1 M1 M1
-----	--	-------------------------------

Cost of skirting $= 20 \times 8.50$ $= \\$170$ Labour cost $= 35 \times 3 \times 8 \times 2$ $= \\$1680$ Other costs $= 180 + 250$ $= \\$430$ Total cost $= 1360 + 170 + 1680 + 430$ $= \\$3640$ Selling price with 20% profit $= 3640 \times 1.2$ $= \\$4368$ Area in square feet $= 52.35 \times 10.764$ $= 563.50 \text{ ft}^2$ Price per square foot $= 4368 \div 563.50$ $= \\$7.75$ Samantha should charge minimally \$7.75 per square foot.	M1 M1 M1 M1 A1
Calculate the number of boxes of vinyl correctly. Calculate the cost of the vinyl planks correctly. Calculate the number (or cost) of skirting boards correctly (including subtracting the door openings and rounding up). Calculate the labour cost correctly. Calculate the total project cost correctly (including transport and disposal). Calculate the selling price after adding 20% profit correctly. Calculate the price per square foot correctly.	M1 M1 (can award ECF) M1 M1 M1 (can award ECF) M1 (can award ECF) A1



DUNMAN SECONDARY SCHOOL

CANDIDATE
NAME

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CLASS

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INDEX
NUMBER

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PRELIMINARY EXAMINATION 2026 SECONDARY 4 EXPRESS/ 5 NORMAL ACADEMIC

MATHEMATICS

4052/01

Paper 1

18 August 2026
2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Calculator Model

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.

Total Marks

Mathematical Formulae*Compound interest*

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Answer **all** the questions.

1 Simplify.

(a) $5 - 3(2x + 1)$

Answer [1]

(b) $(2a^4)^3 + (a^2)^6$

Answer [2]

(c) $\frac{14x^5y}{9a^2} \div \frac{21xy^3}{6a^4}$

Answer [2]

- 2 252 boys and 280 girls signed up to participate in a leadership camp.
The participants are to form as many groups as possible such that each group has the same number of boys and the same number of girls.

(a) Find the greatest number of groups that can be formed.

Answer [2]

(b) Hence, find the number of boys and the number of girls in each group.

Answer boys = , girls = [1]

- 3 Factorise $6k^2ab - 2kb + 1 - 3ka$.

Answer [2]

4

$$a = \frac{5 - b^2}{5c}$$

- (a) Find a when $b = 4.23$ and $c = -204$.
Give your answer correct to 2 significant figures.

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

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

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

5

- Solve the equation $x^2 - 7x + 4 = 0$ by completing the square.
Give your solutions correct to two decimal places.

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

- 6 Mr Wee invests in an account that pays 2.2% per year compound interest.
He leaves the money in the account for 8 years.
At the end of 8 years there is \$6545.91 in the account.

Calculate the total amount of interest Mr Wee earned over the 8 years.

Answer \$ [3]

- 7 Express as a single fraction in its simplest form $\frac{3-2x}{2x} + \frac{5}{16} - \frac{6-3x}{4x}$.

Answer [3]

- 8 The table represents the monthly salary of workers in a company.

Monthly salary (\$)	3500	4000	5000	6000	30 000
Number of workers	4	x	12	3	1

- (a) The monthly mean salary of the workers is \$5680.

Show that $x = 5$.

Answer

[3]

- (b) Find the median monthly salary of the workers.

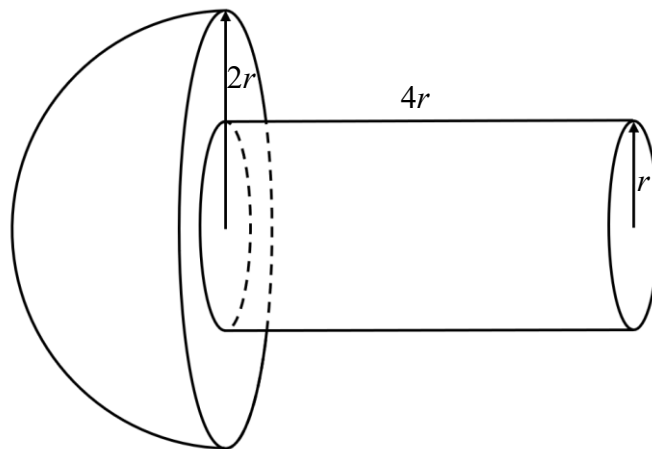
Answer \$ [1]

- (c) Explain whether the mean or the median is the more appropriate measure of central tendency of the workers' monthly salaries.

.....

..... [1]

- 9 A solid consists of a cylinder and a hemisphere.
The cylinder has radius r cm and length $4r$ cm.
The hemisphere has radius $2r$ cm.



The total surface area of the solid is twice the total surface area of a solid cone with radius r cm and slant height l cm .

Find l in terms of r .

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

10 24 students participated in a science competition.

One of the 24 students is selected at random.

The probability that it is a boy who won a prize is $\frac{1}{6}$.

Two of the girls are selected at random.

The probability that they did not win a prize is $\frac{1}{7}$.

Complete the table of information about the 24 students who participated in the competition.

	Won a prize	Did not win a prize
Boys		5
Girls		

- 11** The strength, S units, of a magnetic signal at a point is inversely proportional to the cube of the distance, d cm, from the transmitter.

(a) When $S = 100$, $d = 3$.

Find S when $d = 5$.

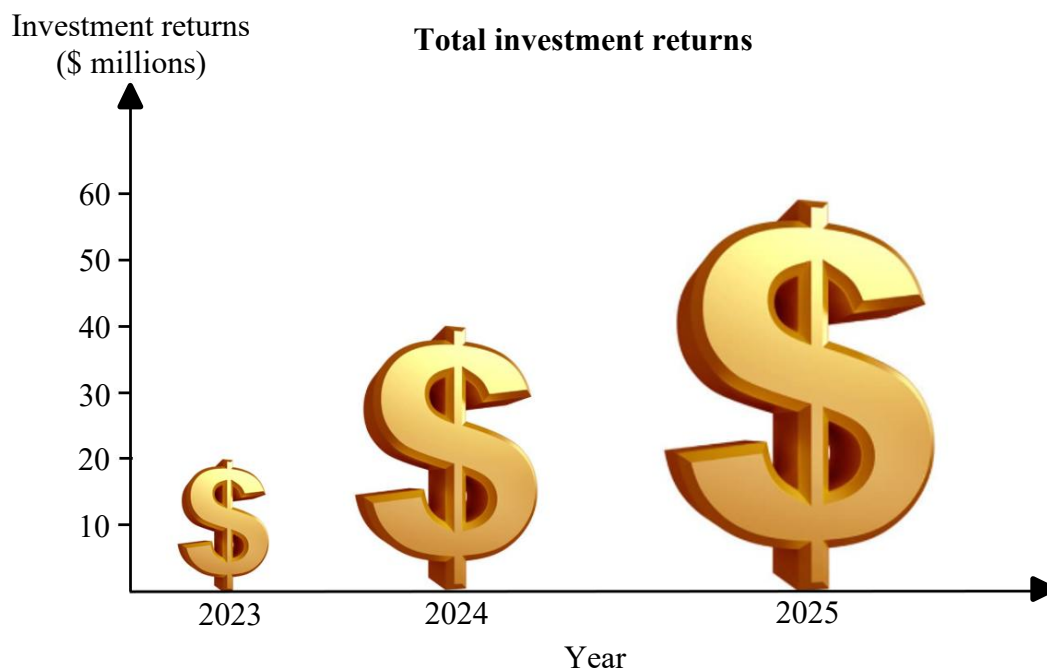
Answer $S = \dots\dots\dots$ [2]

(b) When the value of d is reduced to 25% of its original value, S changes by a factor of m .

Find m .

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

- 12 An investment company published a graph on their website to show the total investment returns they have earned for their clients for each of the last three years.

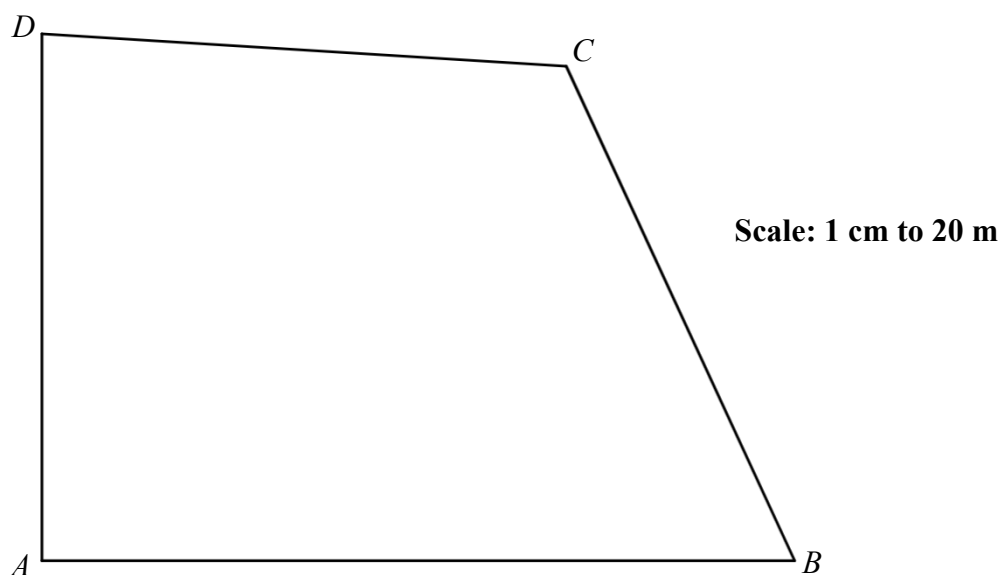


State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph.

.....

..... [2]

- 13 The diagram shows a park in the shape of a quadrilateral $ABCD$.

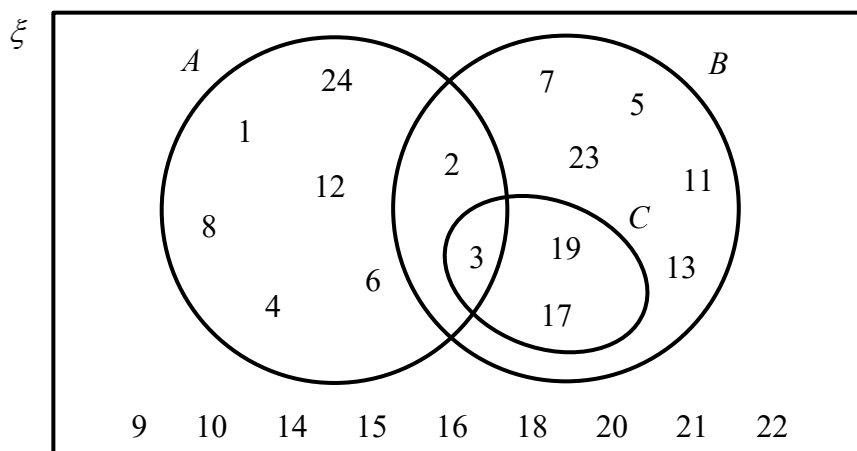


- (a) Construct the perpendicular bisector of AB . [1]
- (b) Construct the bisector of angle ABC . [1]
- (c) A statue S is to be built in the park.
The statue is equidistant from A and B and equidistant from AB and CB .
Mark and label point S on the diagram. [1]
- (d) A running track is to be built in the park.
Every part of the track is equidistant from point S .
The track meets AB and BC at X and Y respectively.
Calculate the length, in metres, of the running track.

Answer m [2]

14 $\xi = \{\text{integers } x : 1 \leq x \leq 24\}$

This Venn diagram shows the elements of ξ and three sets A , B and C .



(a) Describe the elements of set A .

.....
 [1]

(b) Fill in an appropriate set notation to complete the statement.

12 B [1]

(c) Find the number of elements in $(A \cap B) \cup (A \cap B')$.

Answer [1]

15 Let A be the set of integers and B be the set of rational numbers.
 Alice claims that $B \subset A$.

Do you agree with Alice? Explain your answer.

.....
 [2]

- 16** The first four terms of a sequence are given below.

$$T_1 = (2-1)^2 + 5 = 6$$

$$T_2 = (4-1)^2 + 9 = 18$$

$$T_3 = (6-1)^2 + 13 = 38$$

$$T_4 = (8-1)^2 + 17 = 66$$

- (a)** Find T_5 .

Answer [1]

- (b)** Show that the n th term of the sequence, T_n , is given by $4n^2 + 2$.

Answer

[3]

- (c)** T_k and T_{k+1} are consecutive terms in the sequence.

Find and simplify an expression, in terms of k , for $T_{k+1} - T_k$.

Answer [2]

- (d)** Explain why two consecutive terms of the sequence cannot have a difference of 10.

.....

..... [1]

- 17 Solve these simultaneous equations.

$$4x + 7y = 3$$

$$6x - 8y = 23$$

You must show your working.

Answer $x = \dots\dots\dots$

$y = \dots\dots\dots$ [3]

-
- 18 For each of the statements, state whether it is **true** or **false** in the table.
If you have written false, give an example to justify your answer.

Let n be a non-zero integer for each of the statements in the table.

Statement	True or False	Example (if false)
$2n + 1$ is always odd.		
The product of two irrational numbers is always irrational		
$\frac{1}{n} \geq \frac{1}{n^2}$		

[3]

19 The equation of line L is $3y = 4x + 12$.

(a) A point M on the line is thrice as far from the x -axis than the y -axis.

Find the coordinates of point M .

Answer (..... ,) [2]

(b) The line intersects the x -axis at point K .

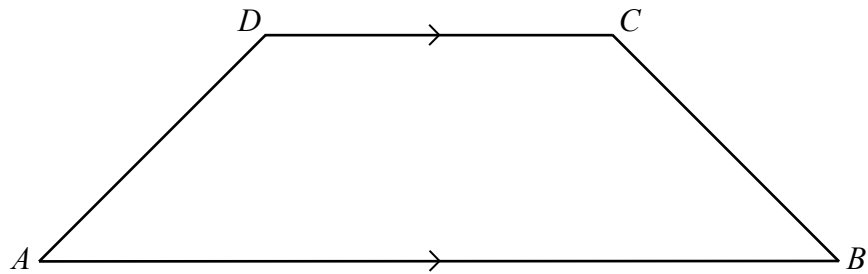
Find the length of MK .

Answer units [3]

20 In a regular polygon, the ratio interior angle : exterior angle = 3 : 2.

Calculate the number of sides of the polygon.

Answer [3]

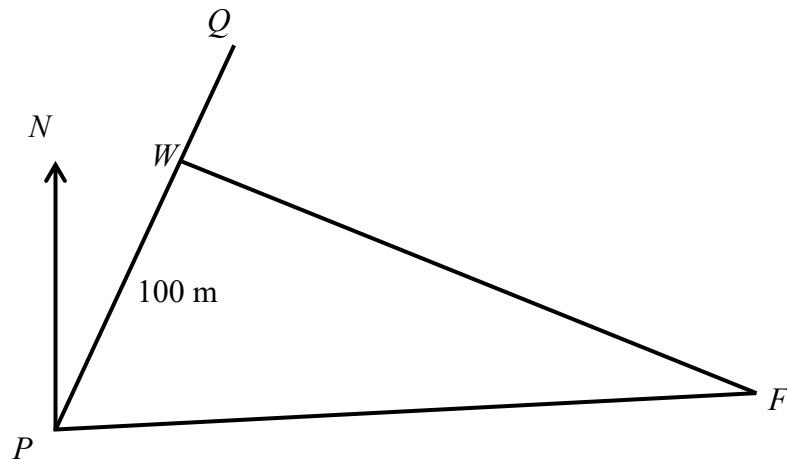


$ABCD$ is a trapezium.
Angle DAB and angle ABC are equal.

Show that $AD = BC$.

Answer

[3]



A fire outbreak is reported in a building located at point F .
 The fire department responded and parked their fire engine at point P .
 The fire hydrant is located 100 m away at point W .
 Angle $PWF = 90^\circ$.
 The bearing of F from P is 084° .
 The bearing of W from P is 020° .

- (a) Find the bearing of W from F .

Answer [2]

- (b) Find WF .

Answer m [2]

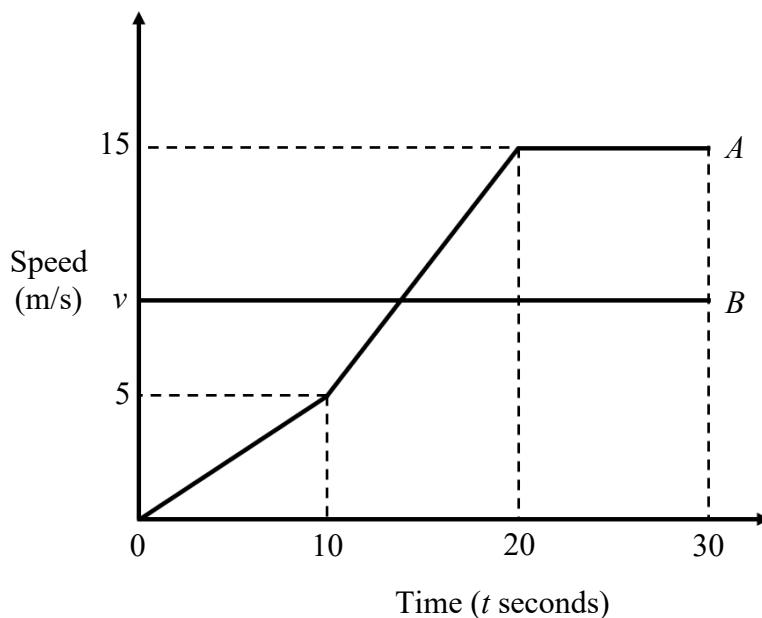
The fire outbreak is located 8 m above point F .

A firefighter of height 1.7 m walks along PQ and stops at a point that is nearest to point F .

- (c) Find the angle of elevation of the fire from the top of the firefighter's head.

Answer [2]

- 23** The diagram shows the speed-time graph for two cyclists, A and B , travelling along the same road in the same direction.
 A accelerates from rest for 10 seconds, accelerates further for the next 10 seconds, before travelling at a constant speed of 15 m/s.
 B travels at a constant speed of v m/s.



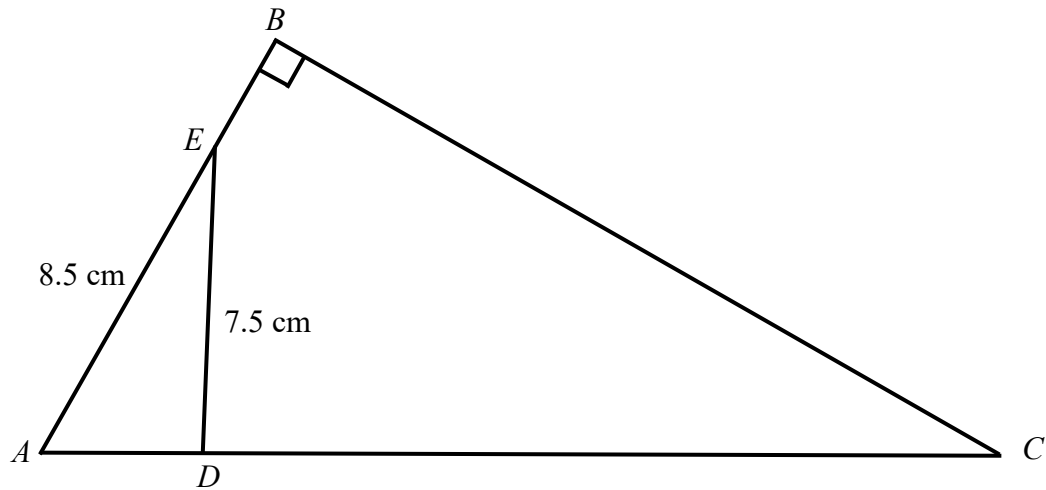
- (a)** Calculate the acceleration of A at $t = 12$.

Answer m/s² [1]

- (b)** The area beneath each speed-time graph represents the distance travelled by each cyclist. The two cyclists travelled the same distance after 30 seconds.

Find the value of v .

Answer $v =$ [3]



In the diagram, $AE = 8.5$ cm, $DE = 7.5$ cm and angle $ABC = 90^\circ$.
 AEB and ADC are straight lines.
 Triangle ABC is similar to triangle ADE .

- (a) Show that $AD = 4$ cm.

Answer

[2]

- (b) Find the exact value of $\sin \angle AED + \cos \angle BED$.

Answer [3]

END OF PAPER

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DUNMAN SECONDARY SCHOOL

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PRELIMINARY EXAMINATION 2026 SECONDARY 4 EXPRESS / 5 NORMAL ACADEMIC

MATHEMATICS

Paper 2

4052/02

25 August 2026

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Calculator Model

Answer **all** questions.

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, unless the question requires the answer in terms of π .

Total Marks

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

TURN OVER FOR QUESTION 1

Answer **all** the questions.

- 1 (a) Find all the integers that satisfy the inequality $5 \leq 2x - 7 < 11$.

Answer [3]

- (b) Factorise $80x^2 - 45y^2$.

Answer [2]

- (c) Solve $\frac{18}{5-3x} = 4$.

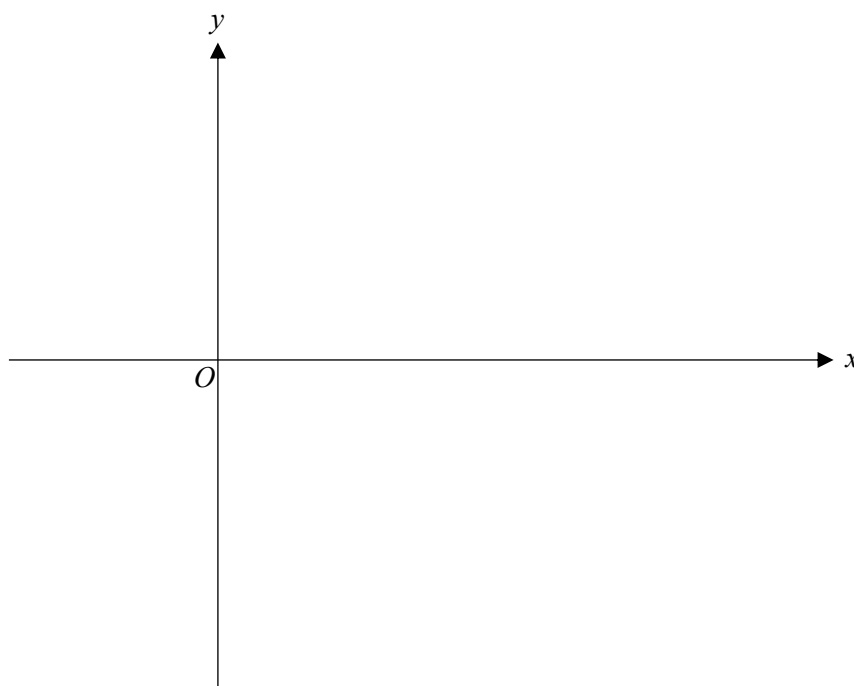
Answer $x =$ [2]

- (d) (i) Express $(x-3)^2 - 4$ in the form $(x-a)(x-b)$.

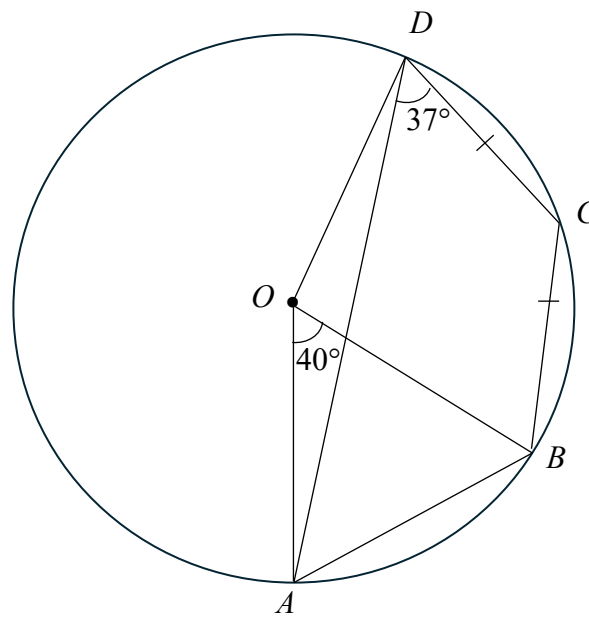
Answer[2]

- (ii) Sketch the graph of $y = (x-3)^2 - 4$ on the axes below.
Indicate clearly the coordinates of the points where the graph crosses the axes and the turning point.

Answer



[3]



The diagram shows a circle $ABCD$, centre O .

$BC = CD$.

Angle $AOB = 40^\circ$ and angle $ADC = 37^\circ$.

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

Answer Angle $BCD = \dots\dots\dots$ [3]

- (b) Find angle BOD .
Give a reason for each step of your working.

Answer Angle $BOD = \dots\dots\dots$ [2]

- (c) The radius of the circle is 7 cm.
Calculate the area of the minor segment $ABCD$.

Answer cm^2 [4]

- 3 A tour agency sold tour packages to Japan and Korea during a weekend travel fair.
 The usual cost of each Japan package is \$3700.
 The usual cost of each Korea package is \$3000.
 This information can be represented by the matrix $\mathbf{C} = \begin{pmatrix} 3700 & 3000 \end{pmatrix}$.
 The tour agency gave a 5% discount to all the tour packages sold during the travel fair.
 The discounted costs of the packages can be represented by the matrix $\mathbf{D}$, where $\mathbf{D} = k\mathbf{C}$.

The number of tour packages sold to each of the destinations during the travel fair is shown in the table below.

Destination	Number of Packages sold		
	Fri	Sat	Sun
Japan	23	18	39
Korea	17	31	44

- (a) Represent the number of tour packages sold in a 2×3 matrix $\mathbf{N}$.

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

- (b) State the value of k .

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

- (c) Evaluate the matrix $\mathbf{R} = \mathbf{DN}$.

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

- (d) State what the elements of **R** represent.

.....

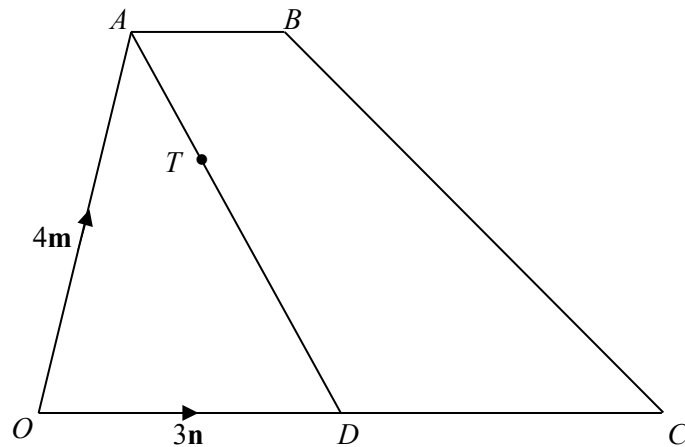
.....

..... [1]

- (e) In addition to the sales made at the travel fair, the agency sold 132 Japan tour packages and 95 Korea tour packages that month without any discount given.

Calculate the percentage of the month's overall sales revenue that came from the travel fair.

Answer % [4]



$OABC$ is a trapezium.
 OC is parallel to AB and D is the midpoint of OC .
 $\overrightarrow{OA} = 4\mathbf{m}$ and $\overrightarrow{OD} = 3\mathbf{n}$.
 $3AB = 2OD$.

- (a) Express $\overrightarrow{OB}$, as simply as possible, in terms of $\mathbf{m}$ and $\mathbf{n}$.

Answer $\overrightarrow{OB} = \dots\dots\dots$ [2]

T is a point on AD such that $AT : AD = 2 : 5$.

- (b) Show that O , T and B are collinear.

Answer

- 5 Tap A takes x hours to fill a swimming pool.
Tap B fills the same pool 2 hours faster than Tap A.
Tap A and Tap B can fill up the swimming pool in 4 hours if they are both turned on together.

- (a) Write down an equation to represent this information and show that it reduces to
$$x^2 - 10x + 8 = 0$$
.

Answer

[3]

- (b) Solve the equation $x^2 - 10x + 8 = 0$, giving your solutions correct to two decimal places.

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

- (c) Calculate how long it would take Tap B to fill the tank alone.
Give your answer in hours and minutes, correct to the nearest minute.

Answer $\dots\dots\dots$ hours $\dots\dots\dots$ minutes [1]

- 6 (a) The table of values for $y = \frac{5}{x} + 2x - 4$ is given below.

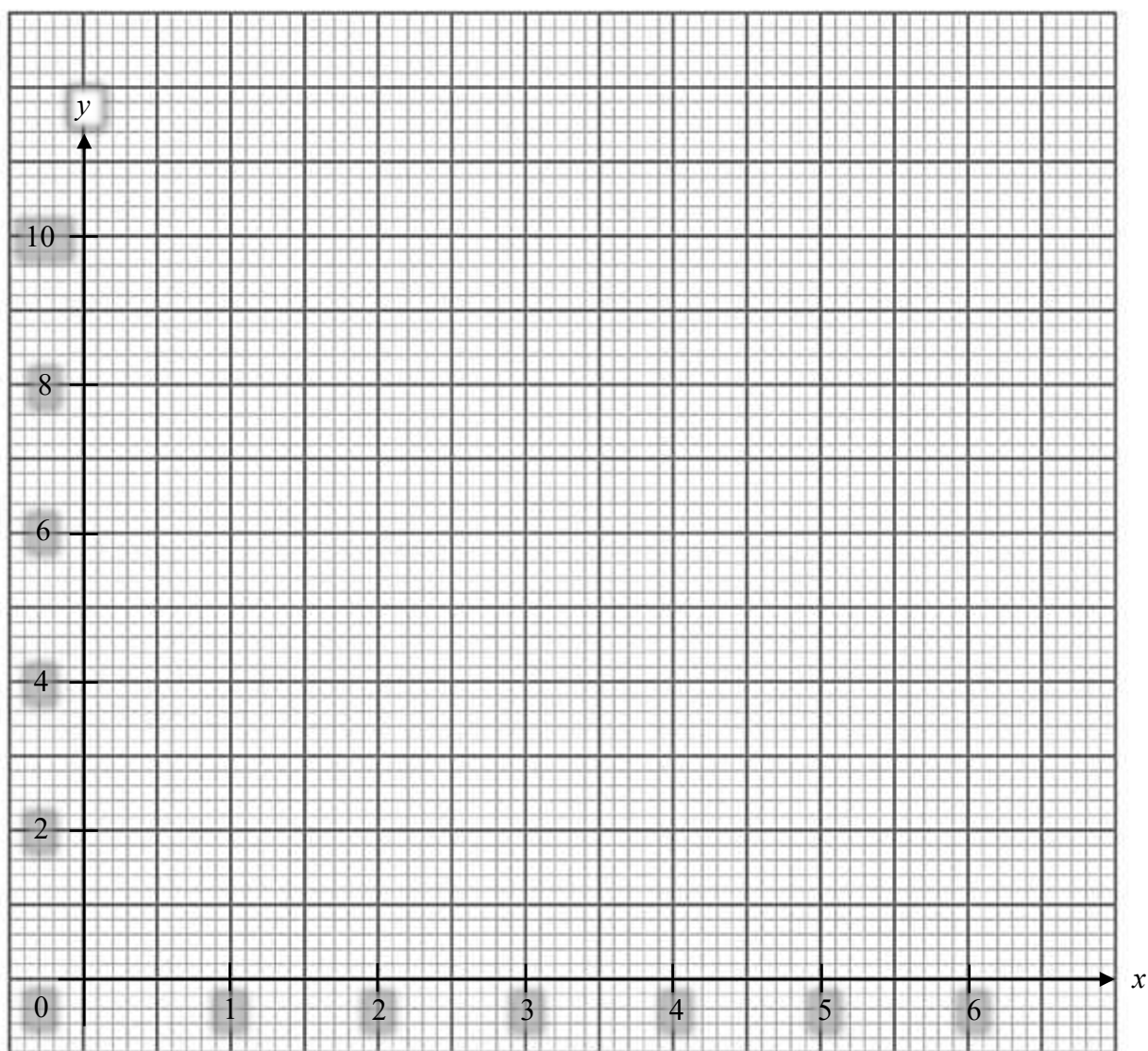
Values are given to one decimal place where appropriate.

x	0.5	1	1.5	2	2.5	3	4	5	6
y	7	3	p	2.5	3	3.7	5.3	7	8.8

Find the value of p .

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

- (b) On the grid below, draw the graph of $y = \frac{5}{x} + 2x - 4$ for $0.5 \leq x \leq 6$.



[3]

- (c) The equation $x^2 - 9x + 5 = 0$ can be solved by finding the points of intersection of the straight line $y = ax + b$ and the curve $y = \frac{5}{x} + 2x - 4$.

- (i) Find the values of a and b .

Answer $a = \dots\dots\dots$

$b = \dots\dots\dots$ [3]

- (ii) On the same grid, draw the straight line $y = ax + b$. [2]

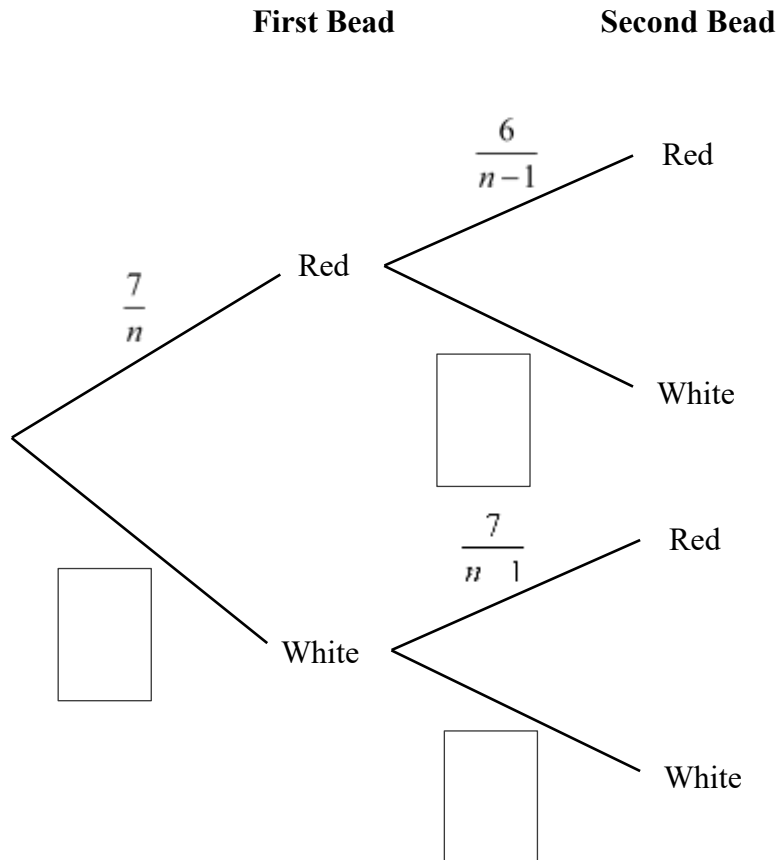
- (iii) Hence, from the graph, state the solution of $x^2 - 9x + 5 = 0$ for $0.5 \leq x \leq 6$.

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

- 7 A bag contains n beads.
 7 of the beads are red and the rest are white.
 There are more white beads than red beads.
 Two beads are taken from the bag, at random, without replacement.

(a) Complete the tree diagram.

Answer



[3]

- (b) The probability that both beads taken are of the same colour is $\frac{11}{18}$.

Show that $n^2 - 37n + 252 = 0$.

Answer

[3]

- (c) By factorising $n^2 - 37n + 252 = 0$, find the values of n .

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

- (d) Explain why one of the solutions in **part (c)** must be rejected.

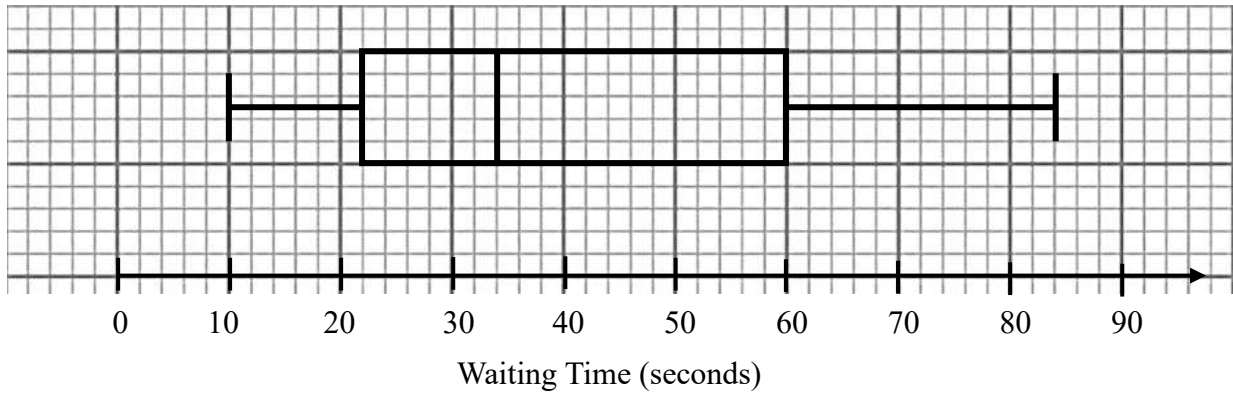
.....

..... [1]

- (e) Find, as a fraction in its simplest form, the probability that at least one of the two beads chosen is white colour.

Answer [1]

- 8** A survey was carried out among the residents of HDB Block 301 Dunman Hill Road to find out about the waiting times, in seconds, for the lift during peak hours.
The box-and-whisker plot below represents these waiting times.



- (a)** State
- (i)** the median waiting time,

Answer seconds [1]

- (ii)** the interquartile range of the waiting times.

Answer seconds [1]

- (b)** 30 residents surveyed experienced a waiting time of more than 1 minute.

Calculate the total number of residents surveyed in Block 301.

Answer residents [1]

- (c) A similar survey was also carried out at the next block, Block 302.
The table shows the waiting times of the residents surveyed.

Waiting Time (t seconds)	$0 < t \leq 15$	$15 < t \leq 30$	$30 < t \leq 45$	$45 < t \leq 60$	$60 < t \leq 75$	$75 < t \leq 90$
Number of residents	8	27	10	13	5	2

- (i) Find the interval that contains the median waiting time for the lift at Block 302 during peak hours.

Answer $< t \leq$ [1]

- (ii) Calculate an estimate of the mean waiting time.

Answer seconds [1]

- (iii) Calculate an estimate of the standard deviation of the waiting time.

Answer seconds [1]

- (iv) The lift is considered more efficient if the average waiting time is shorter.

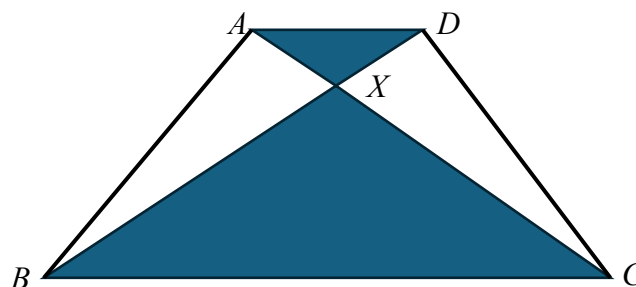
Make a comment comparing the efficiency of the lifts at the two blocks during peak hours.

.....

.....

..... [1]

- 9 In the diagram below, $ABCD$ is a trapezium such that AD is parallel to BC . Lines AC and BD intersect at point X .



- (a) Show that triangle CBX is similar to triangle ADX .

Answer

[2]

- (b) The ratio $AD : BC = 2 : 5$.

Find the ratio of

- (i) area of triangle ADX : area of triangle CBX ,

Answer : [1]

- (ii) area of triangle ABD : area of triangle ABC ,

Answer : [1]

- (iii) area of triangle ABX : area of trapezium $ABCD$.

Answer : [2]

- (c) Given that the area of triangle ABX is 8 cm^2 , find the area of the shaded region.

Answer cm^2 [2]

- (d) State an additional condition for triangle BAX and triangle CDX to be congruent.
Support your answer with reasons.

Answer [2]

10 Green Delights Cafe allows customers to create their own healthy salad bowl where they choose :

- 1 base,
- 2 toppings,
- 1 main and
- 1 dressing.

GREEN DELIGHTS CAFÉ

1 STEP 1: Choose Your Foundation Bowl		BASES (CHOOSE 1)			Energy (kcal)	Protein (g)	Sodium (mg)	2 STEP 2: Add Your Main		MAIN (CHOOSE 1)			Energy (kcal)	Protein (g)	Sodium (mg)
		Brown Rice	250	6.5	5			Grilled Salmon Fillet	130	22.0	90				
		Romaine Lettuce	20	1.2	10			Smoked Duck Slices	210	18.0	450				
		Quinoa	220	8.0	5			Teriyaki Chicken	160	20.0	380				
		Soba Noodles	190	5.5	40			Tofu Medley	110	9.0	20				
		TOPPINGS (CHOOSE 2)			Energy (kcal)	Protein (g)	Sodium (mg)			DRESSING (CHOOSE 1)			Energy (kcal)	Protein (g)	Sodium (mg)
			Hard-boiled Egg	70	6.0	60				Balsamic Vinaigrette	45	0.2	120		
			Roasted Corn	65	2.0	5				Creamy Caesar	160	1.0	310		
			Parmesan Cheese	40	3.5	150				Sesame Ginger	90	0.5	250		
			Avocado Slices	120	1.5	5				Honey Mustard	120	0.3	280		
			Sunflower Seeds	80	2.5	2									

- (a) Karen selected romaine lettuce, parmesan cheese, sunflower seeds, smoked duck slices with creamy caesar dressing for her own salad bowl combination.

- (i) Calculate the total protein content in Karen's choice of salad bowl.

Answer g [1]

- (ii) Calculate the amount of energy (in kcal) Karen will gain from her choice of salad bowl.

Answer kcal [1]

- (b) Propose the ingredients to select for a healthy salad bowl that offers the lowest amount of sodium content possible.

.....

.....

..... [2]

The cafe also offers a few specialty bowl combinations.



- (c) A dish that meets the following three key nutritional standards is awarded a "Healthy Choice Label" by the Health Promotion Board.

Nutritional Category	Standard Requirement (per meal)
Energy	Between 500 kcal and 700 kcal
Protein	At least 25 g
Sodium	No more than 600 mg

The cafe would like to obtain the "Healthy Choice Label" for its chef's recommendation "Signature Wellness Bowl".

However, the chef commented that it did not meet the nutritional standards requirements.

Show that the chef's comment is correct and state which requirement(s) are not met.

Suggest 1 replacement (either base, topping, main or dressing) to the combination so that it will meet all the nutritional standards requirements.

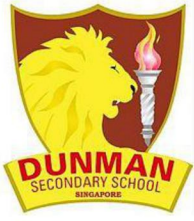
Support your answers with appropriate calculations.

Answer Space for Question 10c

.....

..... [6]

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MATHEMATICS

Paper 1

4052

18 August 2026
2 hours 15 minutes

Solutions

(Updated 1 Dec 2022 by HOD/Math aligned to Marking Scheme for Specimen Papers 4049)

Question	Answer	Marker's Comment/Reminders for students
1(a)	$2 - 6x$	<u>Student's Performance (P):</u> okay <u>Common Mistakes (CM):</u> - Factorise form instead of expanded form - Did not expand properly, take $5 - 3$ as a bracket and expanded in using distributive law. - Did not change the sign to be -3 <u>Reminders for students (R):</u> - Be careful with sign change.
1(b)	$(2a^4)^3 + (a^2)^6$ $= 8a^{12} + a^{12}$ $= 9a^{12}$	P Okay CM Did not apply law of indices properly and obtain $2a^{12}$ instead of $2^3 a^{12}$. R Need to apply law of indices properly
1(c)	$\frac{14x^5y}{9a^2} \div \frac{21xy^3}{6a^4}$ $= \frac{4x^{5-1}a^{4-2}}{9y^{3-1}}$ $= \frac{4x^4a^2}{9y^2}$	P Well done CM - Students who applied cancellation method did not cancel properly hence resulting in mistake. - Students who applied law of indices or cancellation properly, lost marks when transferring the final answer as they transferred the powers wrongly. R - Be careful when transferring final answer or from line to line. - Need to combine the coefficient of the terms together instead of leaving as 2 coefficient in product form.

2(a)	HCF(252, 280) = 28	P Okay CM Students fail to recognise the question as a HCF question. R To put in effort to understand the phrasing for HCF and LCM questions
2(b)	boys = 9, girls = 10	P Okay
3	$1 + 6k^2ab - 2kb - 3ka$ $= -2kb(-3ka + 1) - 3ka + 1$ $= (1 - 3ka)(1 - 2kb)$	P Okay CM - Fail to recognise this is a factorisation by grouping question - After factorising, the plus or minus sign is missed out, change the whole expression to example be a product of 3 terms. $1 + 6k^2ab - 2kb - 3ka$ $= -2kb(-3ka + 1)(-3ka + 1)$ R To be careful in doing factorisation of negative factors.

4(a)	$a = \frac{5 - (4.23)^2}{5(-204)}$ $= 0.013 \text{ (2 s.f.)}$	P Well done CM - Fail to show the working of substituting the values into the expression - Round off to 1 sf / 2 dp thinking it is 2 sf. R - To check the marks allocated to the question to determine if there is a need to show basic working like substituting in of values. - To revise significant number concept
4(b)	$5ca = 5 - b^2$ $b^2 = 5 - 5ca$ $b^2 = \pm\sqrt{5 - 5ca}$	P Okay CM - Miss out the plus/minus sign after square root both sides. - Some students went to square root both side when one side is $-b^2$ R NIL

5	$\left(x - \frac{7}{2}\right)^2 - \left(\frac{7}{2}\right)^2 + 4 = 0$ $x - \frac{7}{2} = \pm \sqrt{\frac{33}{4}}$ $x = 6.37 \text{ or } x = 0.63$	P Not too well CM - Went to solve using formula even though complete the square method was stated. - Transit from expression to solving equation cost them to lose marks. Example $x^2 - 7x + 4$ $\left(x - \frac{7}{2}\right)^2 - \frac{33}{4}$ $\left(x - \frac{7}{2}\right)^2 = \frac{33}{4}$ - Left one answer in 3 sf / 3 dp instead of the required 2 dp. R Try not to jump steps and present workings clearly.
6	$\$6545.91 = P \left(1 + \frac{2.2}{100}\right)^8$ $P = \$5500.00$ $I = \$1045.91$	P Well done CM R Leave intermediate working to 5 sf. It is best to use the whole value.

7	$= \frac{24 - 16x + 5x - 24 + 12x}{16x}$ $= \frac{1}{16}$	P Well done CM • Forget to simplify $\frac{x}{16x}$ • Did not choose the LCM for the common denominator. Many made the denominator to $128x^2$ which causes a lot of careless mistakes when simplifying the numerator. R Always simplify denominator to the LCM Remember that $\frac{6-3x}{4x} = \frac{-(6-3x)}{4x}$, the negative is for all the terms in the numerator.
---	---	--

8(a)	$\frac{122\,000 + 4000x}{20 + x} = 5680$ $122\,000 + 4000x = 5680(20 + x)$ $x = 5$	P Well done for (a) and (b).
8(b)	\$5000	
8(c)	Median. \$30 000 salary is an outlier/extreme value that affects the mean but not the median.	CM - students don't understand that median and mean are both measurements for averages of a data. - Explanation is vague and does not use the context of the question to justify why median should be used. R - For explanation question, we need to be specific to the context of the question. We need to quote the outlier value.
9	S.A. of solid = $2\pi(2r)^2 + \pi(2r)^2 - \pi r^2$ $+ 2\pi r(4r) + \pi r^2$ $= 20\pi r^2$ $20\pi r^2 = 2 \times (\pi r^2 + \pi r l)$ $l = 9r$	P - Poorly done CM - many students wrongly thinks that $\frac{1}{2} \times 4\pi r^2$ is the surface area of the hemisphere including the flat circular surface, - many students forget to minus the circle of the cylinder in contact with the hemisphere. R - Note down or annotate the diagram first to keep in mind the surfaces exposed.

10	$\frac{b}{24} = \frac{1}{6}$ $b = 4$ $\frac{x}{15} \times \frac{x-1}{14} = \frac{1}{7}$ $x^2 - x - 30 = 0$ $x = -5 \text{ (rej.) or } x = 6$ No. of girls that did not win a prize = 6 No. of girls that won a prize = 9	P - Poorly done. Many left blank or simply guessed the numbers. CM - Many students did not check that their final answer does not tally to 24 total students. - Students did not understand how to even start the question. R - Each sentence gives an important clue. The line “one of the 24 students” and “two of the girls” gives important clue of the denominator of the probability. When you are stuck with a word based question without algebra, sometimes you have to use the strategy of letting something to be x. in this case we let x to be the number of girls that did not win.
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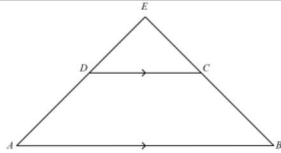
11(a)	$k = 2700$ $S = 21.6$	P Well done for (a), poorly done for (b).
11(b)	$m = 64$	CM - Students forget the formula of inversely proportional. - Students did not understand “reduced to 25%”. R - For part (b) type of question, you can let d_1 and S_1.
12	The increase in area is not (directly) proportional to the height. This may mislead the readers that the total investment returns in 2025 is more than 3 times that in 2023.	P - Okay CM - Students did not answer the question. There are two parts. 1) to state misleading feature. 2) to explain how it will mislead the reader. - Students talk about the inconsistent intervals of the \$ sign on the x-axis. Just like for bar graph, the bars need not be spaced equally apart as they are categorical. R - Take note of the best way to explain using proportionality.

13(a) 13(b) 13(c)	The diagram shows a park in the shape of a quadrilateral $ABCD$. Scale: 1 cm to 20 m Construct the perpendicular bisector of AB.	P - Below average CM - Missing arcs for both (a) and (b) - Arcs drawn too small. - Arcs are not erased properly causing duplicate of arcs. - Pencil lead too thick which affects accuracy. R - This is a routine question that is easy to score. Please relook on the necessary skills to draw bisectors.
13(d)	radius = 3.2 ± 0.1 Length of running track = $2\pi((3.2 \pm 0.1) \times 20) = 390 - 415$ (3 s.f.)	
14(a)	Factors of 24	P - Well done for (a) and (c). Average for (b) CM - Students drew $\neq$ R - For (c) you may shade the diagram with a pencil lightly to find the region of interest.
14(b)	$\neq$	
14(c)	8	

15	Disagree There are elements in set B that are not in A. For example, $\frac{1}{2} \in B$ but $\frac{1}{2} \notin A$.	P - Below average CM - Students did not understand the difference between rational numbers and integers is. - Many explain that they are different set and hence Alice is incorrect. This type of explanation is too vague. R - When we disagree with a statement, the best way to explain is to state a counter example.
16(a)	$T_5 = (10-1)^2 + 21 = 102$	P - Generally well done for (a) and (b) - Okay for (c) CM - Some students don't know what T_{k+1} meant. - For (c), there are many errors in presentation which led to careless mistakes. Many students missed out the brackets $T_{k+1} - T_k = 4k^2 + 8k + 6 - (4k^2 + 2)$ R - Remember to use brackets when adding or subtracting expression with more than 1 terms
16(b)	$T_n = (2n-1)^2 + (4n+1)$ $= 4n^2 + 2$	
16(c)	$T_{k+1} = 4(k+1)^2 + 2$ $T_{k+1} - T_k = 4k^2 + 8k + 6 - (4k^2 + 2)$ $= 8k + 4$	
16(d)	When $8k + 4 = 10$ $k = 0.75$ Since k is not a positive integer, two consecutive terms of the sequence cannot have a difference of 10.	

17	Correct method to get rid of 1 variable using either substitution or elimination. $x = 2.5, y = -1$	P Mostly well done CM Elimination method: 1. Students do not multiply the entirety of the equation. 2. When subtracting, forget to change signs. R Check whether the values attained work with the given equations												
18	<table border="1"> <thead> <tr> <th>Statement</th><th>True or False</th><th>Example (if false)</th></tr> </thead> <tbody> <tr> <td>$2n + 1$ is always odd.</td><td>True</td><td></td></tr> <tr> <td>The product of two irrational numbers is always irrational</td><td>False</td><td> $\sqrt{2} \times 2\sqrt{2} = 4$ or $\sqrt{2} \times \sqrt{2} = 2$ </td></tr> <tr> <td>$\frac{1}{n} \geq \frac{1}{n^2}$</td><td>False</td><td> $\frac{1}{-1} \not\geq \frac{1}{(-1)^2}$ </td></tr> </tbody> </table>	Statement	True or False	Example (if false)	$2n + 1$ is always odd.	True		The product of two irrational numbers is always irrational	False	$\sqrt{2} \times 2\sqrt{2} = 4$ or $\sqrt{2} \times \sqrt{2} = 2$	$\frac{1}{n} \geq \frac{1}{n^2}$	False	$\frac{1}{-1} \not\geq \frac{1}{(-1)^2}$	Very few scored full marks, most scored at least 1. CM Did not read instructions properly; i.e. gave example when true or tried to use words to justify. For the middle statement, some used numbers that would appear to be irrational but wrote in decimal, eg. 0.514594376. Others used $\sqrt{1}$ as an irrational number. For the last statement, many students tried to claim it was false by substituting positive integers and claiming they could not be equal, ignoring the possibility of $n = 1$. R Test each statement with a few values, eg. Positive integers, negative integers, zero.
Statement	True or False	Example (if false)												
$2n + 1$ is always odd.	True													
The product of two irrational numbers is always irrational	False	$\sqrt{2} \times 2\sqrt{2} = 4$ or $\sqrt{2} \times \sqrt{2} = 2$												
$\frac{1}{n} \geq \frac{1}{n^2}$	False	$\frac{1}{-1} \not\geq \frac{1}{(-1)^2}$												

19(a)	$\text{Sub } M(a, 3a)$ $M(2.4, 7.2) \text{ or } M\left(2\frac{2}{5}, 7\frac{1}{5}\right)$	P Poorly done for (a), slightly better for (b) CM (a) Students either - Substituted incorrect values that fit the question, eg. (4,12) - Misunderstood the question and put M(3a,a) (b) Students substituted x=0 instead of y=0. R For (a), substitute values to check your answer. For (b), commit the distance formula to memory. Overall, students need better understanding of what x & y coordinates entail.
19(b)	$K(-3, 0)$ $\sqrt{(7.2-0)^2 + (2.4-(-3))^2}$ =9 units	
20	$5x = 180^\circ$ Exterior angle = 72° $\text{no. of sides} = \frac{360}{72}$ = 5	P Above average. CM Not being able to equate int+ext angles=180. Getting confused with the ratio; i.e. 3 int. angle=2ext. angle. Giving answers with decimals/fractions. R Using your answers, check whether the ratio remains true. Need to remember the formulas associated with polygons(int and ext angles).



$\angle EDC = \angle DAB$ (corr $\angle s$, $AB \parallel DC$)

$\angle ECD = \angle CBA$ (corr $\angle s$, $AB \parallel DC$)

$\therefore \triangle EDC$ is an isos. $\triangle$

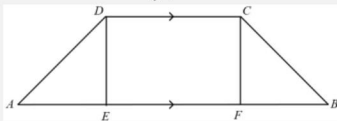
hence,

$EA = EB$ ($\because \triangle EAB$ is an isos. $\triangle$)

$EA - ED = EB - EC$ ($\because \triangle EDC$ is an isos. $\triangle$)

$AD = BC$

Alternatively,



$\angle DAE = \angle CBF$ (given)

$\angle AED = \angle CFB = 90^\circ$

$DE = CF$ (height of trapezium)

$\therefore \triangle ADE \equiv \triangle BCF$ (AAS)

$\therefore AD = BC$

Alternatively,

$$\sin \angle DAE = \frac{h}{AD}$$

$$\sin \angle CBF = \frac{h}{BC}$$

Since $\angle DAE = \angle CBF$,

$$\frac{h}{AD} = \frac{h}{BC}$$

$\therefore AD = BC$

P

Below average. Many do not get the full marks.

CM

Assuming that the following is sufficient proof: Since

$\angle CDA = 180^\circ - \angle DAB$ (int $\angle s$, $DC \parallel AB$)

$\angle DCB = 180^\circ - \angle ACB$ (int $\angle s$, $DC \parallel AB$)

$\angle CDA = 180^\circ - \angle DAB = 180^\circ - \angle ACB = \angle DCB$

then $AD = BC$.

Alternatively, using the fact that $AD = BC$ as part of their working.

Overall, incorrect reasonings given when writing statements, eg. $DE = CF$ (dist. between $\parallel$ lines) and wrong proof of similarity/congruence given.

R

Recall what is necessary to prove similarity/congruence.

21

22(a)	$\angle WFF_N = 70^\circ$ (alt $\angle$ s, $WW_N \parallel FF_N$) Or $\angle F_SFP = 84^\circ$ (alt $\angle$, $PN_p \parallel FN_F$) Or $\angle WFF_W = 20^\circ$ Bearing of W from $F = 290^\circ$	P Slightly below average. Quite a few left part (c) blank. CM Students were not able to mark out the bearings correctly, sometimes going counter-clockwise. Some did not label their statements so it was difficult to understand their working.
22(b)	$\angle WPF = 84^\circ - 20^\circ$ $= 64^\circ$ $\angle WFP = 180^\circ - 90^\circ - 64^\circ$ ($\angle$ s sum of Δ) $= 26^\circ$ $\frac{\sin 26^\circ}{100} = \frac{\sin 64^\circ}{WF}$ $WF = 205\text{m}$ (3 s.f.) Alternatively, $\tan 64^\circ = \frac{FW}{200}$ $FW = 205\text{ m}$	Some thought $\angle WPF = 84^\circ$. For part (c), some had trouble identifying the shortest distance as WF. Some also misunderstood what the angle of elevation entailed and that they had to subtract the man's height. R Revise angle properties and trigonometric ratios. Drawing additional lines of the diagram will help but labelling the points is necessary to keep track of calculations.
22(c)	$\tan \theta = \frac{8 - 1.7}{205.030}$ $\theta = 1.8^\circ$	

23(a)	$a = 1 \text{ m/s}^2$	P
23(b)	$30v = \frac{1}{2}(10)(5) + \frac{1}{2}(5+15)(10) + 10(15)$ $v = 9\frac{1}{6} \text{ m/s or } 9.17 \text{ m/s (3 s.f.)}$	(a) Average (b) Above average. Most can at least attain 2 marks. CM (a) Did not know to find the gradient of the line. (b) Could not calculate the area under the graph properly, either missing out parts or using the wrong formula. R Use a pencil to divide up the area under the graph and label the different sections. Then when calculating, make sure each section is accounted for.
24(a)	Triangle ABC is similar to triangle ADE $\therefore \angle ADE = \angle ABC = 90^\circ$ By Pythagoras' Theorem, $AD = \sqrt{8.5^2 - 7.5^2}$ $= 4 \text{ cm}$	P (a) Well done, most got this correct. (b) Below average. CM Use of non-exact values. Students tried to find the value of angle AED.
24(b)	$\sin \angle AED = \frac{4}{8.5}$ $= \frac{8}{17}$ $\cos \angle BED = -\cos \angle AED$ $= -\frac{7.5}{8.5}$ $= -\frac{15}{17}$ $\sin \angle AED + \cos \angle BED = \frac{8}{17} - \frac{15}{17}$ $= -\frac{7}{17}$	Mistaking $\cos \angle BED$ for $\sin \angle AED$ R Underline keywords in the question to focus on.



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MATHEMATICS

Paper 2

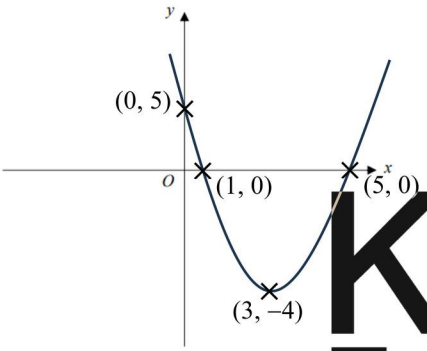
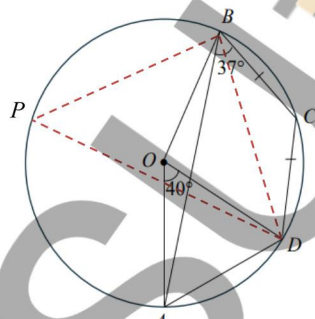
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25 August 2026
2 hours 15 minutes

Solutions

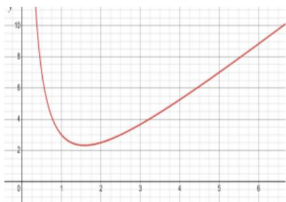
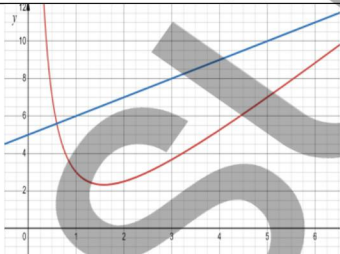
(Updated 1 Dec 2022 by HOD/Math aligned to Marking Scheme for Specimen Papers)

Qn	Answer	Markers' Comments
1a	$5 \leq 2x - 7$ and $2x - 7 < 11$	Common Mistake Left answer as inequalities instead of the digits.
	$2x \geq 12$ $2x < 18$	
	$x \geq 6$ $x < 9$	
	$6 \leq x < 9$	
	The integers are 6, 7 and 8	
1b	$80x^2 - 45y^2$	Common Mistake Did not factorise the second time.
	$= 5(16x^2 - 9y^2)$	
	$= 5(4x - 3y)(4x + 3y)$	
1c	$\frac{18}{5-3x} = 4$	Did well Common Mistake Final answer left in 3 sf instead of exact value form.
	$18 = 20 - 12x$	
	$\frac{18}{5-3x} = 4$	
	$18 = 20 - 12x$	
	$12x = 2$	
	$x = \frac{1}{6}$	
1d (i)	$(x-3)^2 - 4$	Common Mistake Turn expression into equation suddenly and start solving.
	$= x^2 - 6x + 9 - 4$	
	$= x^2 - 6x + 5$	
	$= (x-1)(x-5)$	

Qn	Answer	Markers' Comments
1c(ii)		Common Mistake Did not label the coordinates of the points.
2a	$\angle ABD = 20^\circ$ (angle at circum = $\frac{1}{2} \times$ angle at centre) $\angle CBD = 37^\circ - 20^\circ$ $= 17^\circ$ $\angle BCD = 180^\circ - 2(17^\circ)$ (angle sum of isos triangle BCD) $= 146^\circ$	(a) & (b) Below average achieved full marks, most attained at least 1. CM Could not correctly identify cyclic quad. Gave incorrect reasons. Assumed that since $OA=OB=OC=OD$, angle $AOD=DOC=COB$. Assumed BD cut angle ABC in half.
2b	 Let P be a point on the circle. $\angle BPD = 180^\circ - 146^\circ$ (angles in opposite segments) $= 34^\circ$ $\angle BOD = 34^\circ \times 2$ (angle at centre = $2 \times$ angle at circum) $= 68^\circ$	R Revise the correct statements to write for reasoning. Draw lines to help solve the question.

Qn	Answer	Markers' Comments
2c	$\angle AOB = 68^\circ + 40^\circ$ $= 108^\circ$	P Slightly below average. CM Students could not identify the area the question required them to find, eg, finding area of sector OAD and subtracting triangle OAD and repeating this for ODC and OCB. R Using a pencil, shade the area you need find.
	Area of sector $OADC$ $= \frac{108}{360} \times \pi(7^2)$ $= 46.1814 \text{ cm}^2$	
	Area of triangle AOB $= \frac{1}{2}(7^2)\sin 108^\circ$ $= 23.300 \text{ cm}^2$	
	Area of segment $= 46.1819 - 23.300$ $= 22.9 \text{ cm}^2$ (3 sig fig)	
3a	$\begin{pmatrix} 23 & 18 & 39 \\ 17 & 31 & 44 \end{pmatrix}$	P Fairly well done.
3b	$k=0.95$	CM Drew a 3x2 matrix instead of 2x3.
3c	D $= 0.95(3700 \quad 3000)$ $= (3515 \quad 2850)$	When multiplying matrices, did not end up with a 1x3 matrix.
	R $= (3515 \quad 2850) \begin{pmatrix} 23 & 18 & 39 \\ 17 & 31 & 44 \end{pmatrix}$ $= (129295 \quad 151620 \quad 262485)$	R Write out the order of the matrices, so you can check what the end result should look like.
3d	The elements of R represents the total cost of the discounted packages sold at the travel fair on Friday, Saturday and Sunday respectively .	P Below average. CM Respectively(o.e.) not used or used in the wrong place, eg. Fri, sat, sun for Japan and Korea respectively. R Specifying what each element represents, using the numerical values, can be clearer.
3e	Total cost of packages sold outside of travel fair $= 132(\$3700) + 95(\$3000)$ $= \$773400$	P Well done CM
	Total cost of packages sold during travel fair $= \$129295 + \$151620 + \$262485$ $= \$ 543400$	
	Month's total sales	

Qn	Answer	Markers' Comments
	$= \$773400 + \543400 $= \$1316800$ Percentage of month's overall sales $= \frac{543400}{1316800} \times 100\%$ $= 41.3\%$ (3 sig. fig.)	Used the wrong values when calculating %, despite already finding the correct values beforehand. R Read the question carefully and write out what needs to be found in words.
4a	$\overline{AB} = \frac{2}{3} \overline{OD}$ $= 2n$ $\overline{OB} = \overline{OA} + \overline{AB}$ $= 4m + 2n$	P (a) Above average (b) Below average CM Did not represent vectors correctly. Assumed O, T and B were collinear.
4b	$\overline{AD} = 3n - 4m$ $\overline{AT} = \frac{2}{5}(3n - 4m)$ $\overline{OT} = \overline{OA} + \overline{AT}$ $= 4m + \frac{2}{5}(3n - 4m)$ $= \frac{3}{5}(4m + 2n)$ $= \frac{3}{5} \overline{OB}$ Since $\overline{OT} = \frac{3}{5} \overline{OB}$ and O is the common point, therefore O, T and B are collinear.	Did not reference a common point when trying to prove (b). Mistook the ratio of AT:AD as AT:TD. R When finding a vector using 2 or more other vectors, make sure they add up to each other, eg. $\overline{AT} = \overline{AO} + \overline{OT}$.
5a	$\frac{1}{x} + \frac{1}{x-2} = \frac{1}{4}$ $\frac{2x-2}{x(x-2)} = \frac{1}{4}$ $4(2x-2) = x(x-2)$ $8x-8 = x^2-2x$ $x^2-10x+8=0$ (shown)	P (a) Poor (b) and (c) well done. CM (a) Did not find the inverse of x and (x-2) to form the equation. (b) did not write out the general formula with substituted values, left answers in 3 s.f. instead of 2 d.p. (c) did not round to the nearest minute.

Qn	Answer	Markers' Comments
5b	$x = \frac{-(-10) \pm \sqrt{(-10)^2 - 4(1)(8)}}{2(1)}$ $x = 9.12 \text{ or } 0.88 \text{ (2 dec. places)}$	R For (a), try to think in terms of rate, i.e. how much of the pool per hour. For (b), look at the marks given. For 3 marks, you should not just be giving the answers without showing adequate working.
5c	Time Taken $= 9.123 - 2$ $= 7.123 \text{ hours}$ $= 7 \text{ hours } 7 \text{ minutes}$	
6a	$p = 2.3$	Well Done.
6b		Generally ok Common Mistakes Most students are able to draw the curve but need to practice more to draw it smoothly and not in segments. Few students did not plot all the points or plot with dots (some points cannot be seen)
6c(i)	$ax + b = \frac{5}{x} + 2x - 4$ $ax^2 + bx = 5 + 2x^2 - 4x$ $(2 - a)x^2 - (4 + b)x + 5 = 0$ $2 - a = 1 \quad \text{and} \quad 4 + b = 9$ $a = 1 \quad \quad \quad b = 5$	
6c(ii)	 Alternative Method $x^2 - 9x + 5 = 0$ $x - 9 + \frac{5}{x} = 0$ $\frac{5}{x} + 2x - 4 = x + 5$ $a = 1 \text{ and } b = 5$	Some line (ecf) drawn is not according to the equation obtained in 6c(i)
6c(iii)	From the graph, $x = 0.6$	

Qn	Answer	Markers' Comments
7a	First Bead Second Bead	Quite Well Done. Common mistakes Students did not consider the reduction of total number of bead for the probability of the 2nd bead.
7b	$\frac{7}{n} \left(\frac{6}{n-1} \right) + \frac{n-7}{n} \left(\frac{n-8}{n-1} \right) = \frac{11}{18}$ $\frac{42 + (n-7)(n-8)}{n(n-1)} = \frac{11}{18}$	Most students are able to formulate the equation but unable to simplify the equation. Common mistakes Students confuse simplifying of multiplication of algebraic fraction with addition of fractions A number of students made the following mistake $\frac{7}{n} \left(\frac{6}{n-1} \right) = \frac{(7n)(6(n-1))}{n(n-1)}$
	$18(42 + n^2 - 15n + 56) = 11n(n-1)$	
	$18(42 + n^2 - 15n + 56) = 11n(n-1)$ $7n^2 - 259n + 1764 = 0$ $n^2 - 37n + 252 = 0 \text{ (shown)}$	
7c	$(n-9)(n-28) = 0$	
	$n = 9 \text{ or } 28$	
7d	Since there are more white beads than red beads, if $n = 9$, then there is only 2 white beads which is less than the red beads. Therefore, $n \neq 9$	Some students state there is only 2 white beads so $n \neq 9$ but did not state the condition.
7e	P(at least 1 of the 2 beads is white colour) $= 1 - \frac{7}{28} \left(\frac{6}{27} \right)$ $= \frac{17}{18}$	Generally ok
8a(i)	34 seconds	Generally ok few students misread as 32

Qn	Answer	Markers' Comments
8a(ii)	ITQ = 60 – 22 = 38	Generally ok
8b	Total number of residents = 30 × 4 = 120	Generally ok Some students unable to relate the 30 residents to the upper quartile of 25%
8c(i)	$15 < t \leq 30$	Generally ok
8c(ii)	Estimated mean waiting time = $\frac{7.5(8) + 22.5(27) + 37.5(10) + 52.5(13) + 67.5(5) + 82.5(2)}{8 + 27 + 10 + 13 + 5 + 2}$ = 34.269 = 34.3 (3 sig. fig)	Generally ok Some students noted the wrong mid-value of each interval and therefore did not get the correct mean and SD.
8c(iii)	Standard Deviation = $\sqrt{\frac{100406.25}{65} - 34.269^2}$ = 19.2 (3 sig. fig.)	
8c(iv)	The lift at Blk 302 is more efficient because the median waiting time is in the interval of $15 \leq t \leq 30$ is shorter than the median waiting time of Blk 301 which is 34s.	Common mistake 1. Students compare the mean of 1 block with the median of another block 2. Students did not state the median waiting times of both blocks. 3. Students did not make comparison of the waiting times stated. 4. Students make wrong conclusion by stating that the block with longer waiting time is more efficient.
9a	$\angle ADX = \angle CBX$ (alt $\angle$, AD//BC) $\angle AXD = \angle CXB$ (vert. opp $\angle$ s) $\triangle CBX$ is similar to $\triangle ADX$ (AA Similarity test)	Students should state the angles according to the 2 triangles $\triangle CBX$ and $\triangle ADX$
9b(i)	Area of $\triangle DAX$: Area of $\triangle BCX$ = 4:25	Students are unable to differentiate similar triangles from triangles with same height.
9b(ii)	Note that $\triangle ABD$ and $\triangle ABC$ are triangles of the same height. Area of $\triangle ABD$: Area of $\triangle ABC$ = AD : BC = 2 : 5	

Qn	Answer	Markers' Comments
9b(iii)	Let p be the number of units representing area of $\triangle ABX$ in comparison with $\triangle DAX$ and $\triangle BCX$ Area of $\triangle ABD$: Area of $\triangle ABC$ = Area of $(\triangle ABX + \triangle DAX)$: Area of $(\triangle ABX + \triangle BCX)$ $= 4 + p : 25 + p$ $\frac{4+p}{25+p} = \frac{2}{5}$ $20 + 5p = 50 + 2p$ $3p = 30$ $p = 10$ area of triangle ABX : area of trapezium $ABCD$ $= 10 : (10+10+4+25)$ $= 10 : 49$	Very poor presentation of working. Students calculate the area of triangles based on the units in the ratio. The actual areas of the triangles cannot be calculated. Calculations are very messy with no order how the ratio is obtained. Ratios are written without indicating any length of the figure. Some students gave the answer without any working. Do note for a 2-mark question, working is necessary.
9c	10 units rep 8 cm^2 Area of shaded region $= \frac{8}{10} \times (4+25)$ $= 23.2 \text{ cm}^2$	Very poor presentation of working. Students unable to relate the ratio to the given area.
9d	AB = DC is the additional condition Then AX = DX and BX = CX Therefore triangle BAX and triangle CDX will be congruent. (SSS)	Very poor presentation of working. Condition must be stated first before proving that the 2 triangles are congruent. Many students prove the congruency of the triangles without clearly indicating the condition. A number of students stated more than 1 condition. Students unable to present the subsequent results based on the condition set.
10a(i)	Total protein content $= 1.2 + 3.5 + 18 + 2.5 + 1.0$ $= 26.2 \text{g}$	Well Done
10a(ii)	Amount of energy $= 20 + 40 + 80 + 210 + 160$ $= 510 \text{ kCal}$	Well Done
10b	Base : Brown Rice or Quinoa Toppings : Sunflower seeds and (Roasted Corn or Avocado Slices) Main : Tofu Medley Dressing : Balsamic Vinagrette	Well Done

Qn	Answer				Markers' Comments																												
10c	<table><tr><th>Ingredients of Signature Wellness Bowl</th><th>Energy</th><th>Protein</th><th>Sodium</th></tr><tr><td>Brown Rice</td><td>250</td><td>6.5</td><td>5</td></tr><tr><td>Smoked Duck</td><td>210</td><td>18</td><td>450</td></tr><tr><td>Hard-Boiled Egg</td><td>70</td><td>6</td><td>60</td></tr><tr><td>Roasted Corn</td><td>65</td><td>2.0</td><td>5</td></tr><tr><td>Creamy Caesar</td><td>160</td><td>1.0</td><td>310</td></tr><tr><td>Total</td><td>755</td><td>33.5</td><td>830</td></tr></table>	Ingredients of Signature Wellness Bowl	Energy	Protein	Sodium	Brown Rice	250	6.5	5	Smoked Duck	210	18	450	Hard-Boiled Egg	70	6	60	Roasted Corn	65	2.0	5	Creamy Caesar	160	1.0	310	Total	755	33.5	830	Generally well done Most students are able to present the calculation of the energy, protein and sodium content in a tabulated manner. A number of student failed to indicate the requirements not met. Some just indicate with a ✕ or ✓ beside their calculation. Do note this is not a proper conclusion.			
	Ingredients of Signature Wellness Bowl	Energy	Protein	Sodium																													
	Brown Rice	250	6.5	5																													
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	Creamy Caesar	160	1.0	310																													
	Total	755	33.5	830																													
	The Chef's comment is correct as the total energy gained is 755kCal and the sodium content 830mg have exceeded the standard requirements of between 500 kCal and 700kCal amount of energy and less than 600mg of sodium				A number of students selected Tofu Medley as the replacement as they did not calculate the change in the protein content which failed the standard. A number of students did not calculate the new energy, protein and sodium content to support their choice of replacement.																												
<table><tr><th>Ingredients</th><th>Energy</th><th>Protein</th><th>Sodium</th></tr><tr><td>Brown Rice</td><td>250</td><td>6.5</td><td>5</td></tr><tr><td>Grilled Salmon Fillet</td><td>130</td><td>22</td><td>90</td></tr><tr><td>Hard-Boiled Egg</td><td>70</td><td>6</td><td>60</td></tr><tr><td>Roasted Corn</td><td>65</td><td>2.0</td><td>5</td></tr><tr><td>Creamy Caesar</td><td>160</td><td>1.0</td><td>310</td></tr><tr><td>Total</td><td>675kCal</td><td>37.5</td><td>470mg</td></tr></table>	Ingredients	Energy	Protein	Sodium		Brown Rice	250	6.5	5	Grilled Salmon Fillet	130	22	90	Hard-Boiled Egg	70	6	60	Roasted Corn	65	2.0	5	Creamy Caesar	160	1.0	310	Total	675kCal	37.5	470mg				
Ingredients	Energy	Protein	Sodium																														
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Creamy Caesar	160	1.0	310																														
Total	675kCal	37.5	470mg																														
Replace the main smoked duck slices with grilled salmon fillet. The amount of energy gained is reduced to 675kCal and the amount of sodium content is also reduced to 470mg and keeping the amount of protein above 25g.																																	

Candidate's name: _____ () Class: _____



Evergreen Secondary School
Preliminary Examination 2026

Mathematics Paper 1 (4052/1)
Secondary Four (G3) / Five

Date: 12 August 2026
Duration: 2 hour 15 minutes
Marks: 90

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
You may use a HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

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 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, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

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

For Examiner's Use

Mathematical Formula

Compound Interest

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

Mensuration

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

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

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

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

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

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

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

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 questions.

- 1** In Portugal, Miguel buys a book about planets. The book costs €34.95.
In England the same book costs £27.50. The exchange rate is £1 = €1.17.
Calculate the difference in pounds (£) between the cost of the book in Portugal and England.

Answer: £ _____

[2]

- 2** Explain why $(x-2)^4(x^2-4x+4)$ is both a perfect square and a perfect cube when x is an integer.

Answer: _____

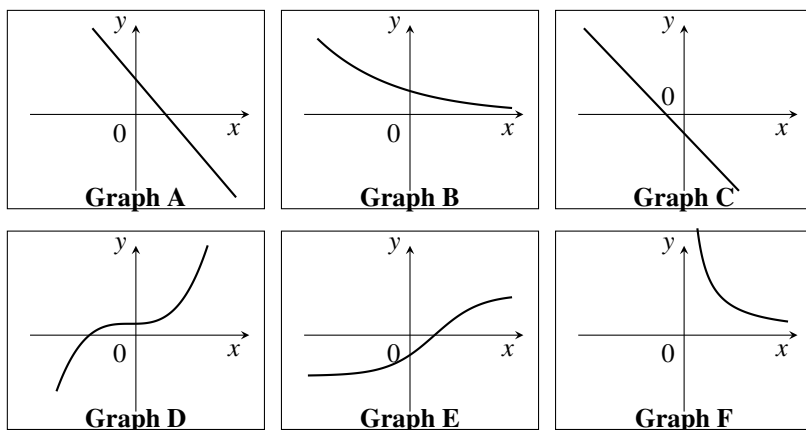
[2]

- 3** Find the area of the smallest circle passing through the points $(2,4)$ and $(5,1)$.
Express your answer in terms of π .

Answer: _____

[2]

5



Select the graph that best shows that

- (a) y is inversely proportional to x

Answer: Graph _____

[1]

- (b) $y = x^n + c$, where n is an odd integer greater than 1 and c is a constant.

Answer: Graph _____

[1]

6 Rearrange the formula

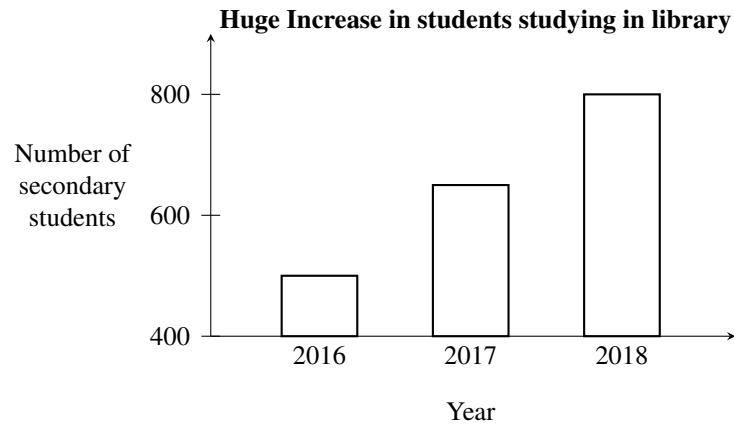
$$p = \frac{1}{2} \sqrt{\frac{q-4}{1+2q}}$$

to make q the subject.

Answer: $q =$ _____

[3]

- 7 The graph below shows the number of secondary school students studying in the library between 2016 and 2018.



- (a) State one way in which the graph is misleading and explain why it is misleading.

Answer: _____

[2]

- (b) Do you agree that the percentage of secondary school students studying in the library has been increasing between years 2016 to 2018?

Explain your answer.

Answer: _____

[1]

8 A train 220m long passes through a tunnel 4.8km long.

The average speed of the train is 31 km/h.

(a) Change 31 km/h into m/s

Answer: _____ m/s

[1]

(b) Calculate the time taken from the train to pass completely through the tunnel.

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

Answer: _____ minutes _____ seconds

[2]

9 Solve the equation

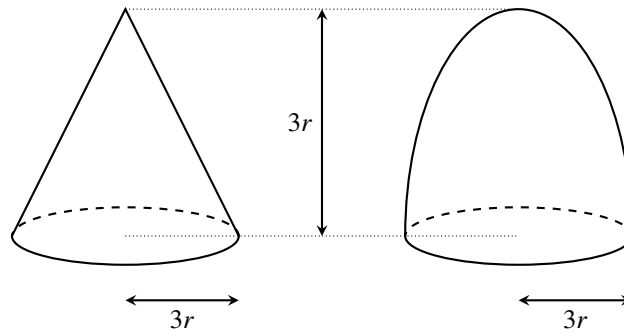
$$\frac{9x}{x^2 - 9} - \frac{3}{x + 3} = 1$$

Show all your working. Give your solutions to 2 decimal places.

Answer: $x =$ _____ or _____

[4]

10 Complete the following statement. You are to show your working clearly.



The combined volumes of a cone of height $3r$ and radius $3r$ and a hemisphere of radius $3r$ is equal to the volume of a cylinder of radius _____ and height _____.

[3]

11 Mrs Teo wishes to open an account with a bank by investing \$5000 for 5 years.

Bank A offers 3% per annum, compounded half-yearly.

Bank B offers $r\%$ per annum simple interest.

Given that both banks offer the same amount of interest at the end of 5 years, find the value of r .

Answer: $r =$ _____

[3]

12

- (a) Expand and simplify $(2x - 1)(2 - 3x) - 3x(2x - 5)$

Answer: _____

[2]

- (b) Factorise completely $24ab - 4ac + pc - 6pb$

Answer: _____

[2]

13

- (a) Given that $a = 3^x$, express 9^{x-1} in terms of a .

Answer: _____

[2]

- (b) Simplify $(16p^4q^{-2})^{\frac{3}{2}} \div (p^{-6}q^9)$ express your answers in positive indices.

Answer: _____

[2]

- 14 The table below shows the mass of 500 packets of 1 kg chocolate packed by machine A.

Mass (x grams)	$980 < x \leq 990$	$990 < x \leq 1000$	$1000 < x \leq 1010$	$1010 < x \leq 1020$
Frequency	74	178	182	66

- (a) Calculate an estimate of the mean mass. Leave your answer to 1 decimal place.

Answer: _____ [1]

- (b) Calculate an estimate of the standard deviation

Answer: _____ [1]

- (c) The mean and standard deviation of mass of chocolate packed by machine B is given below.

Mean (grams)	1000.2
Standard Deviation (grams)	12.5

If you are the owner of the chocolate distribution business, which machine will you buy? Explain your reason.

Answer: _____

[2]

15 The marked price of a graphical calculator is 40% more than its cost price. The calculator is sold at a discount of 20% on the marked price, and the profit made is \$18.

Find the marked price of the graphical calculator.

Answer: \$ _____

[2]

16

(a) Solve the inequalities $8 + x < 10 + \frac{3}{2}x \leq 15.5 - 2x$

Answer: _____

[3]

(b) Write down the largest rational number that satisfies $8 + x < 10 + \frac{3}{2}x \leq 15.5 - 2x$

Answer: $x =$ _____

[1]

17 The lowest common multiples of two integers, 440 and B is 1320.

- (a) Express 440 as the product of its prime factors, giving your answer in index form.

Answer: [1]

- (b) If B is 6, find the highest common factor of 440 and B .

Answer: [1]

- (c) If the highest common factor 440 and B is 55, find the smallest possible B .

Answer: [1]

- (d) Find the smallest positive integer h for which $\frac{42}{h}$ is a factor of 440.

Answer: $h =$ [1]

- (e) Jane has 440 five-centimetre cubes. She makes them into a cuboid. All the sides of the cuboid are greater than 20 cm. determine the dimensions of the cuboid.

Answer: cm by cm by cm [1]

18 Two similar prisms, made of the same material, have masses 135 g and 320 g, the surface area of the smaller prism is 40.5 cm^2 and volume of the larger prism is 576 cm^3 . Determine

- (a) the surface area of the larger prism,

Answer: cm^2 [2]

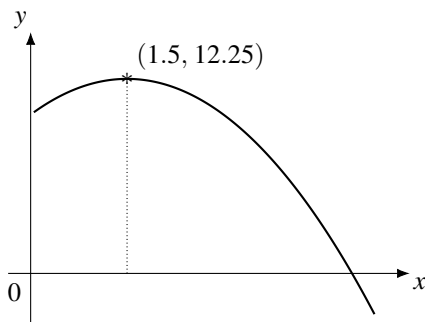
- (b) the cost of painting the larger prism if it costs \$48.60 to paint the smaller prism.

Answer: \$ [1]

- (c) The cross-sectional area of the smaller prism if it has a height of 12 cm.

Answer: cm^2 [2]

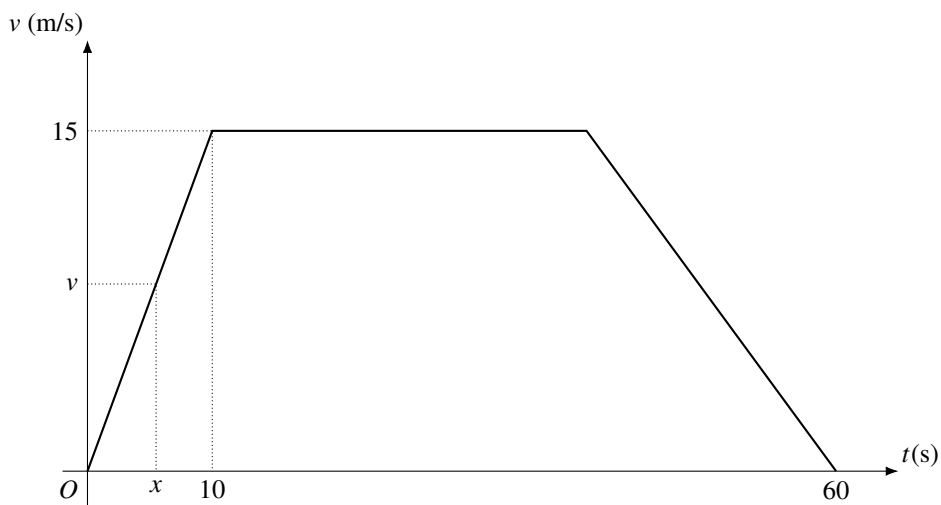
19 The diagram shows part of the curve $y = ax^2 + bx + 10$. The coordinates of the maximum point is (1.5, 12.25). Find the value of a and of b .



Answer: $a =$ $b =$ [3]

20 The diagram shows the speed-time graph of a lorry. The lorry starts from rest and accelerates uniformly to a speed of 15m/s in 10 seconds. The lorry then travels at a constant speed for some time before it decelerates uniformly at 0.75 m/s^2 until it comes to rest.

The whole journey takes one minute.



- (a) Given that the speed after x seconds is $v \text{ m/s}$, express v in terms of x .

Answer: $v = \dots\dots\dots$ [1]

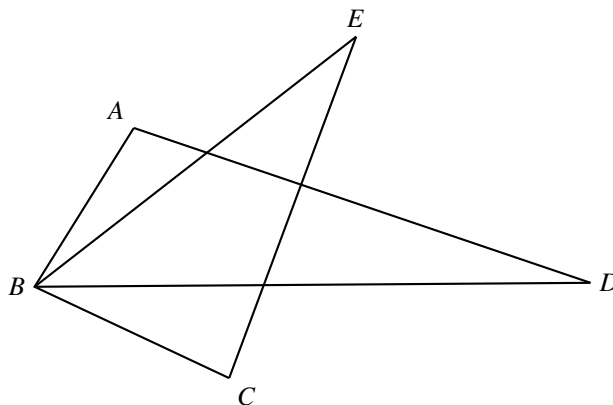
- (b) For how long does the lorry travel at the maximum speed?

Answer: $\dots\dots\dots \text{ s}$ [2]

- (c) Calculate the total distance travelled by the lorry during this 1 minute journey.

Answer: $\dots\dots\dots \text{ m}$ [2]

21 In the diagram, $BA = BC$, angle $ABE =$ angle CBD and angle $BEC =$ angle BDA . Explain why triangles ABD and CBE are congruent.



Answer: _____

 _____ [2]

- (b) Given further that angle $ABE =$ angle BEC , what type of quadrilateral is $ABCE$? Justify your answer.

Answer: Quadrilateral $ABCE$ is a

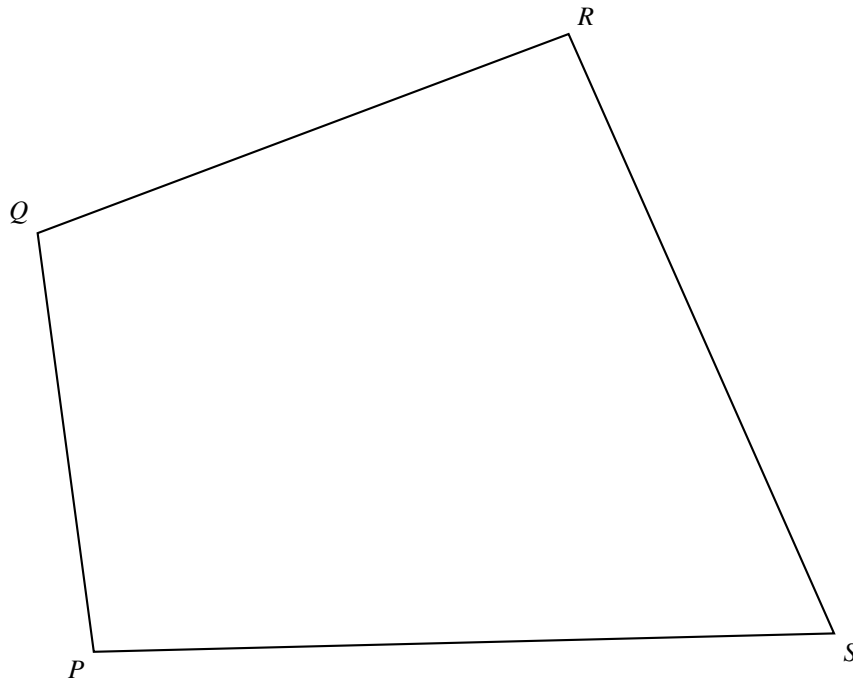
 _____ [2]

22 In the diagram $PQRS$ represents a plot of land. A multi-storey carpark is to be built within $PQRS$ with the following conditions:

- nearer to PS than PQ ,
- nearer to P than S and
- nearer to Q than P .

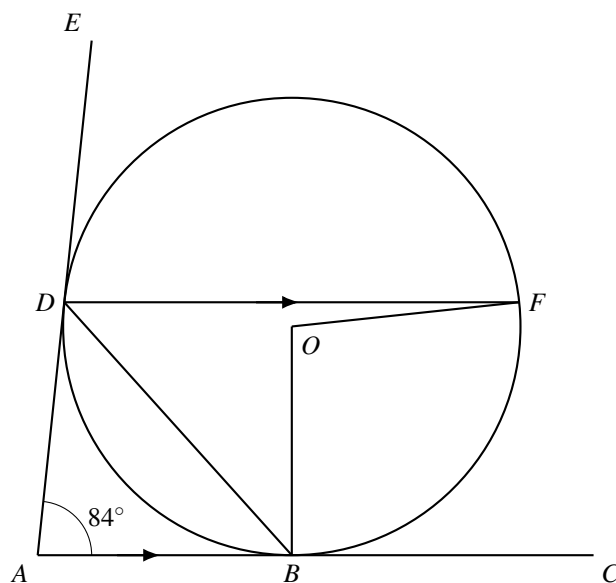
Shade the region where the carpark is to be built.

[4]



23 In the figure below, ABC and ADE are tangents to the circle with centre O .

Given that DF is parallel to ABC and angle $DAB = 84^\circ$, stating your reasons clearly, find



(a) angle ADB

Answer: angle $ADB = \dots\dots\dots$ [1]

(b) angle BOF

Answer: angle $BOF = \dots\dots\dots$ [2]

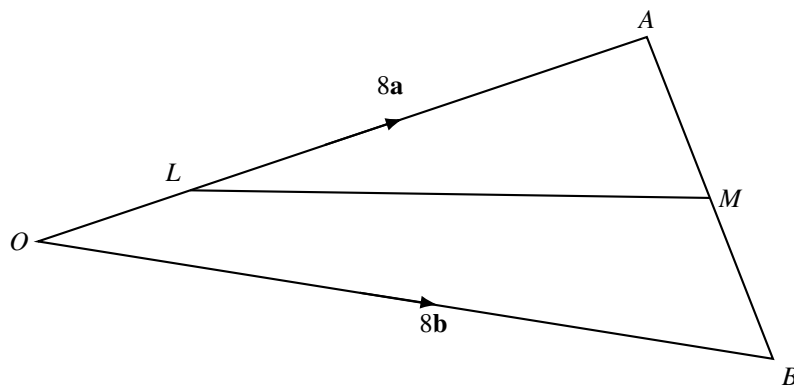
(c) angle FBC ,

Answer: angle $FBC = \dots\dots\dots$ [2]

(d) angle DFO .

Answer: angle $DFO = \dots\dots\dots$ [2]

24



$\vec{OA} = 8\mathbf{a}$ and $\vec{OB} = 8\mathbf{b}$. Given $BM = MA$ and $\vec{OL} = \frac{1}{4}\vec{OA}$

- (a) Write each of the following in terms of $\mathbf{a}$ and $\mathbf{b}$.
Give your answers in their simplest form.

(i) $\vec{BM}$

Answer: $\vec{BM} = \dots\dots\dots$ [1]

(ii) $\vec{OM}$

Answer: $\vec{OM} = \dots\dots\dots$ [1]

(iii) $\vec{LM}$

Answer: $\vec{LM} = \dots\dots\dots$ [1]

- (b) Find $\vec{OP}$ such that $\vec{LP} = 3\vec{LM}$

Answer: $\vec{OP} = \dots\dots\dots$ [2]

- (c) Explain why $\vec{OP}$ is not parallel to $\vec{OM}$

Answer: _____
_____ [1]

- (d) Find $\frac{\text{Area of triangle } ALM}{\text{Area of triangle } AOB}$

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

25 A box of chocolate contains 7 dark chocolates and 5 milk chocolates. Lee takes a chocolate, selected at random, from the box and eats it.

Wong then takes a chocolate, selected at random, from the box.

- (i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

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

- (a) Lee and Wong both picked dark chocolates

Answer: [1]

- (b) Lee and Wong picked at most one milk chocolate in total.

Answer: [2]

Candidate's name: _____ () Class: _____



Evergreen Secondary School
Preliminary Examination 2026

Mathematics Paper 2 (4052/02)
Secondary Four (G3) / Five

Date: 18 August 2026
Duration: 2 hours 15 minutes
Marks: 90

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
You may use a HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

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 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, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

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

For Examiner's Use

Mathematical Formula

Compound Interest

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

Mensuration

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

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

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

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

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

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

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

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) Write

$$\frac{3}{x^2 - 6x + 8} + \frac{1}{4 - x} - 1$$

as a single fraction in its simplest form.

Answer _____

[3]

(b) Find all the integers that satisfy the inequality

$$-4 \leq \frac{1 - 3x}{5} < \frac{2}{3}.$$

Answer $x =$ _____

[3]

(c) Express $11 - 5x + x^2$ in the form $p + (x + q)^2$.

Answer _____

[2]

(d) It is given that $A = 50p^3q - 2pq$.

(i) Factorise A completely.

Answer _____

[2]

(ii) Express q in terms of A and p .

Answer $q =$ _____

[1]

2

$$\vec{AB} = \begin{pmatrix} -7 \\ 3 \end{pmatrix} \quad \text{and the point } A \text{ is } (-3, 5).$$

- (a) Find an equation for the line passes through A and is parallel to AB .

Give your answer in the form $ax + by = c$, where a , b and c are integers.

Answer _____

[2]

- (b) The equation of the line q is $3y - 4x + 26 = 0$. O is the origin.

The product (gradient of q) $\times$ (gradient of OP) $= -1$.

Write down the equation of line OP

Answer _____

[2]

- (c) The position vector of T is $\begin{pmatrix} k \\ 7 \end{pmatrix}$ and length of the line segment AT is equal to length of AB .

Find the possible value(s) of k .

Answer $k =$ _____

[3]

3

- (a) A fruit stall sells three types of fruit packs.

Each fruit pack contains apples and oranges.

Pack 1 contains 12 apples and 8 oranges.

Pack 2 contains 9 apples and 6 oranges.

Pack 3 contains 5 apples and 4 oranges.

This information can be represented by the matrix

$$\mathbf{N} = \begin{pmatrix} 12 & 8 \\ 9 & 6 \\ 5 & 4 \end{pmatrix}.$$

The price of an apple is \$ x . The price of an orange is \$ y .

- (i) Represent the fruit prices in a 2×1 column matrix $\mathbf{P}$ in terms of x and of y .

Answer $\mathbf{P} =$ _____ [1]

- (ii) Find the matrix $\mathbf{M} = \mathbf{NP}$, leaving your answers in terms of x and of y .
State what the elements of $\mathbf{M}$ represent.

Answer $\mathbf{M} =$ _____ [1]

[1]

- (b) Pack 1 is \$6.37 more than Pack 2.

Pack 3 is sold at \$11.50.

Using the answer in **a(ii)**, form two equations in x and y to represent this information.

Find the value of x and of y .

Answer $x =$ _____ $y =$ _____

[4]

(c) In the second week of the month, 6705 packs of fruits were sold.

The sales was decreased by 36% compared with the first week of the month.

Calculate the number of packs of fruits sold in the first week of the month.

Answer _____ packs

[2]

(d) On a particular day, fruits were sold in the following ratios:

$$\text{morning sales : afternoon sales} = 2\frac{1}{3} : 5$$

$$\text{morning sales : night sales} = 6\frac{1}{4} : 13$$

Find the ratio night sales : afternoon sales : morning sales that day.

Give your answer in its simplest form.

Answer _____ : _____ : _____

[2]

4

(a) A dome contains 2.5×10^{100} identical regular triangular glass panels.

(i) If the area of a single panel is 285 cm^2 , find the length of the triangular glass panel.

Answer _____ cm [2]

(ii) Calculate the total surface area of the dome in standard form.

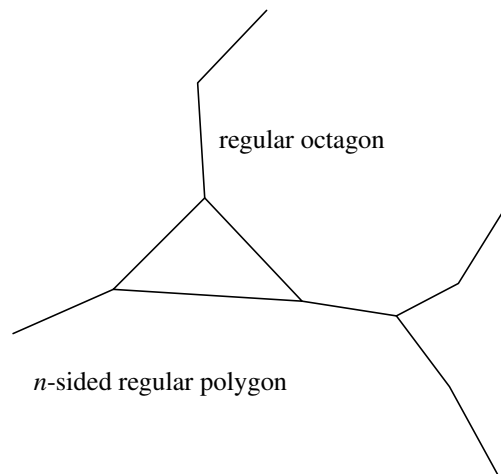
Answer _____ cm^2 [2]

(b) A contractor is designing a glass panel using a regular triangle, a regular octagon and a regular n -sided polygon.

The diagram shows an incomplete figure made up of a 3-sided regular polygon, a regular octagon and a n -sided regular polygon.

The three polygons fit together without any gaps or overlaps.

Find the value of n .



Answer $n =$ _____ [2]

5

(a)

$$\xi = \{\text{integers } x : 2 \leq x < 16\}$$

$$A = \{\text{multiples of 4}\}$$

$$B = \{\text{factors of 60}\}$$

(i) Using set notation write down a statement to describe the set of $A \cap B$.

Answer: _____

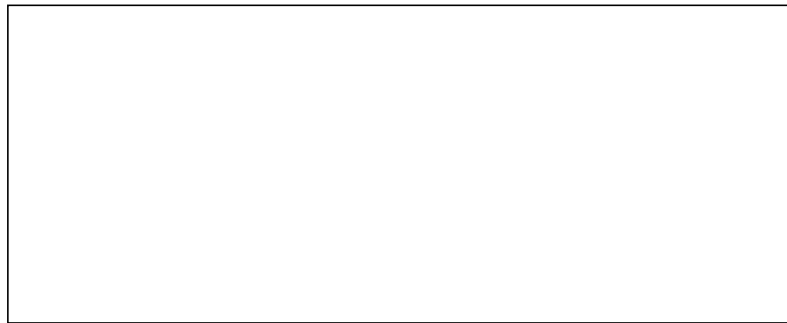
[1]

(ii) In the space below,

- Complete the Venn diagram to represent set A and set B .
- Shade the region on your diagram which represents $A' \cap B$.

Answer

ξ



[2]

(iii) A number, q , is chosen at random from the set $A' \cap B$.

Find the probability that $q \notin A' \cap B$.

Answer _____

[1]

(b) A class has 40 students.

(i) There are y number of students who study both Biology and Physics.

Two of the students are selected at random.

The probability that they study both Biology and Physics is $\frac{63}{130}$.

Write down an equation to represent this information and show that it simplifies to

$$y^2 - y - 756 = 0.$$

Answer

[2]

(ii) Solve the equation $y^2 - y - 756 = 0$ using factorization method.

Answer $y =$ _____

[2]

(iii) One of the students from the class is selected at random.

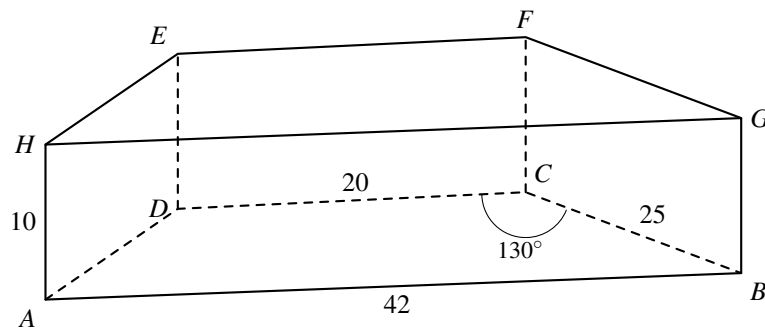
The probability that it is a student who does not study Physics is $\frac{1}{8}$.

Complete the table of information about the class of 40 students.

	Physics	Not Physics
Biology		
Not Biology		3

[2]

- 6** The diagram shows a building in the form of trapezoidal prism.
The base $ABCD$ is on flat ground.
 $ABGH$, $BCFG$, $ADEH$ and $DCFE$ are vertical rectangular planes.
 $AB = 42$ m, $BC = 25$ m, $CD = 20$ m, $AH = 10$ m and angle $DCB = 130^\circ$,
 AB is parallel to DC .



- (a) Calculate the length AC .

[2]

Answer _____ m

- (b) Given that C is due north of A .
Find the bearing of B from A .

[3]

Answer _____ °

(c) Calculate the volume of the prism.

[3]

Answer _____ m^3

(d) An object moves along AB .
Calculate the angle of depression of the object from E .

[3]

Answer _____ $^\circ$

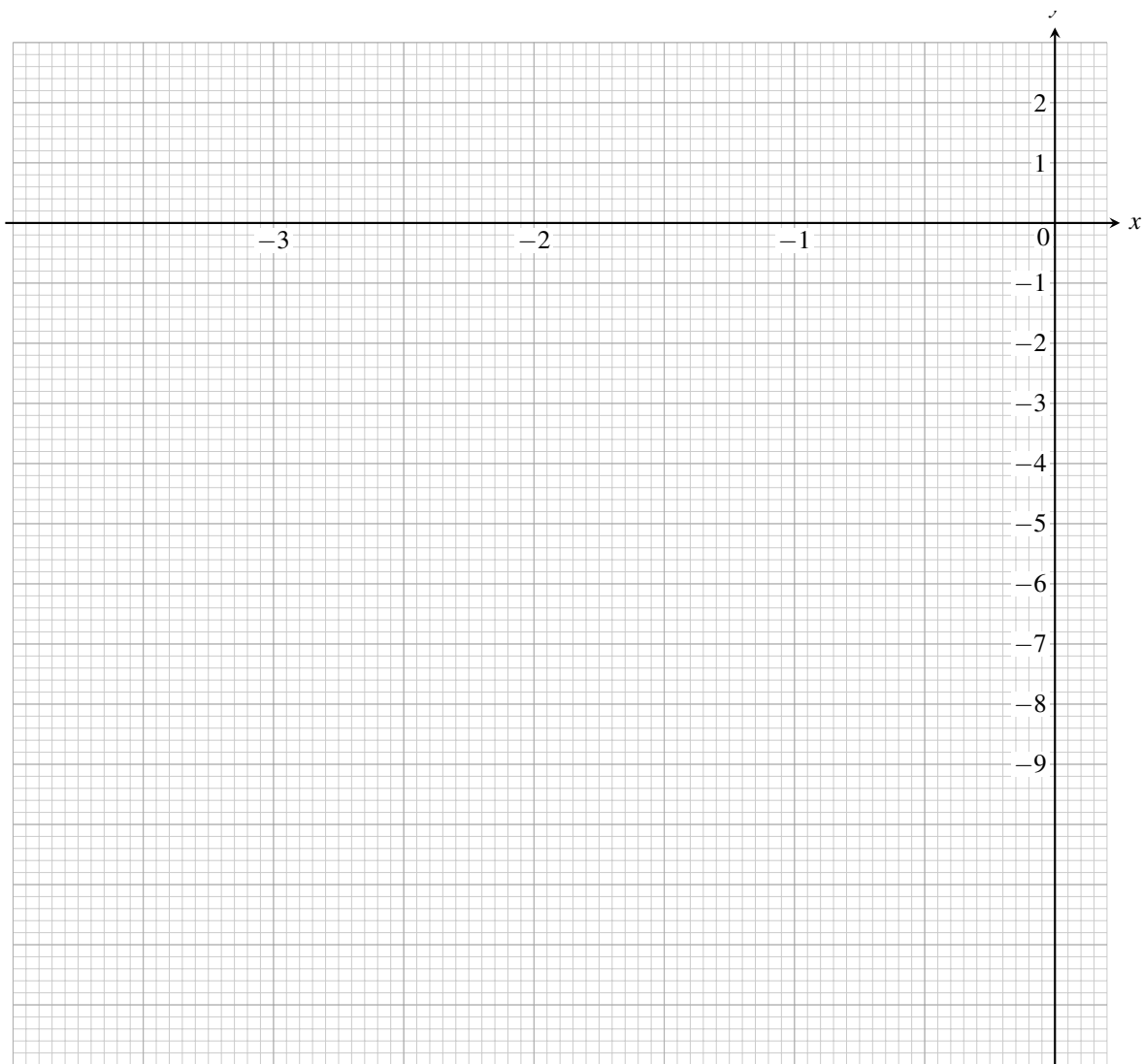
- 7 (a) Complete the table of values for $y = 3x - \frac{2}{x^2} + 2$, $x \neq 0$. Give your answer correct to 1 decimal place.

x	-3.5	-3	-2.5	-2	-1	-0.5
y						

[1]

- (b) On the grid, draw the graph of $y = 3x - \frac{2}{x^2} + 2$ for $-3.5 \leq x \leq -0.5$.

[2]



- (c) The equation $k = 3x - \frac{2}{x^2} + 2$ has only 1 solution for $-3.5 \leq x < 0$. [1]
Use your graph to find the value of k .

Answer $k =$ _____

- (d) By drawing a suitable tangent, estimate the gradient of the curve where $x = -2$. [2]

Answer _____

- (e) (i) On the same grid, draw the graph of $2y - x = -8$ for $-4 \leq x \leq 0$. [1]

- (ii) Show that the points of intersection of the line and the curve gives the solutions of the equation
 $5x^3 + 12x^2 - 4 = 0$

Answer: [1]

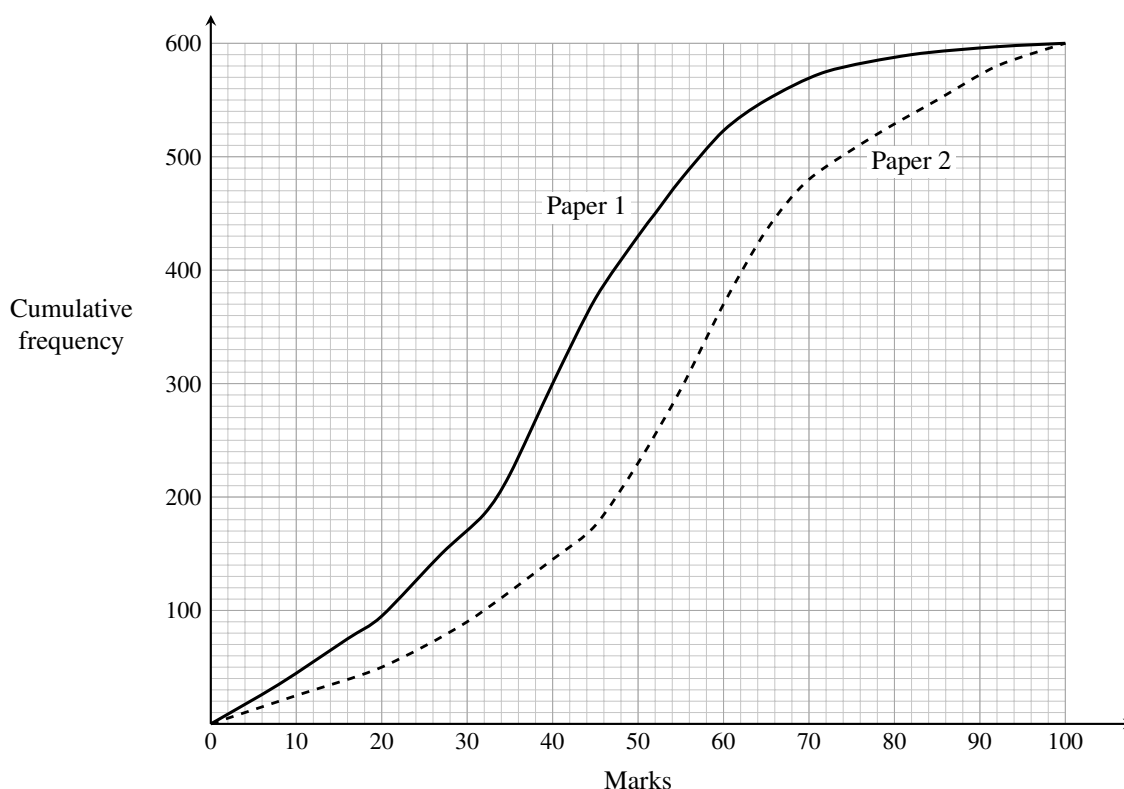
- (iii) Use your graph to solve $5x^3 + 12x^2 - 4 = 0$. [2]

Answer $x =$ _____

- (f) By drawing a suitable straight line on the grid, solve the inequality $3x^3 + 6x^2 > 2$. [2]

Answer _____

8 Six hundred candidates took an examination which consisted of two papers.
Each paper was marked out of 100.
The diagram shows, on the same grid, the cumulative frequency for Paper 1 and Paper 2.



- (a) Use the cumulative frequency curve for Paper 1 to find an estimate of
- (i) the median, Answer _____ marks [1]
- (ii) the interquartile range. Answer _____ marks [2]
- (b) Two of the candidates are chosen at random. [2]
Use the diagram to estimate the probability that one candidate scored more than 40 marks in Paper 1 and another candidate scored 30 marks or less in Paper 2.

Answer _____

- (c) (i) Use the information from the cumulative frequency diagram to complete the grouped frequency table of the marks scored in Paper 2, [1]

Marks (x)	$0 \leq x < 30$	$30 \leq x < 60$	$60 \leq x < 90$	$90 \leq x < 100$
No. of candidates	90	280		30

- (ii) Find the interval that contains the median mark. [1]

Answer _____ $\leq x <$ _____

- (d) A candidate scored 60 on Paper 1. [1]
Using both graphs, estimate this candidate's mark on Paper 2.

Answer _____ marks

- (e) Below are three statements. [3]
For each statement, write whether you agree or disagree and give a mathematical reason for each answer.

Statement	Agree/Disagree	Mathematical Reason
Paper 1 is easier than Paper 2.		
The marks for Paper 1 shows less variation than Paper 2.		
The range of marks for Paper 2 is 100.		

9 Ahmad is a first-time homebuyer who decides to purchase a condominium priced at \$2.5 million. To finalize the purchase, he must adhere to the following financial terms:

- **Downpayment:** 25% of the property's total purchase price must be paid upfront in cash.
- **Bank Loan:** The remaining outstanding amount will be financed using a fixed-rate bank mortgage.
- **Loan Terms:** The bank offers a flat annual interest rate of 1.45% with a repayment period spanning over 10 years.

(a) Calculate the monthly installment payment.

[2]

Answer \$_____

(b) To purchase the condominium, Ahmad has to pay \$4 500 lawyer's fee and Buyer's Stamp Duty (BSD).

The partially completed table shows the amount of BSD on Ahmad's property.

Purchase/Market Value (\$)	BSD Rate (%)	Amount Payable on Ahmad's property purchase (\$)
First 180 000	1	1 800
Next 180 000	2	3 600
Next 640 000	3	19 200
Next 500 000	4	20 000
Next 1 500 000	5	...
Remaining Amount	6	...

(i) Calculate the total BSD on Ahmad's condominium purchase.

[2]

Answer \$_____

(c) Calculate the total amount of money Ahmad has to pay to purchase this condominium.

[1]

Answer \$_____

- (d) Ahmad rents out the whole condominium at an estimated market rental of \$4 500 a month with the help of a property agent.
For every two-year contract, Ahmad needs to pay the property agent a fee equivalent to 1 month rental.
In addition, he needs to pay annual property tax based on the formula shown in the table below.

Non-owner-occupied residential tax rates

Annual Value (\$)	Property Tax Rates (%)	Property Tax Payable (\$)
First 30 000	12	3 600
Next 15 000	20	3 000
First 45 000	-	6 600
Next 15 000	28	4 200
First 60 000		10 800
Above 60 000	36	

Extracted from <https://www.iras.gov.sg/taxes/property-tax/property-owners/property-tax-rates>

Annual Value (AV) refers to the estimated gross annual rent of the property if it were to be rented out.
Annual property tax payable is calculated by multiplying the AV of the property with the Property Tax rates.

On top of paying the annual property tax, he has to pay **monthly maintenance fee of \$700**.

Based on the current trend, the value of this property will **appreciate at 0.9% compounded quarterly**.

Ahmad plans to rent out this property for 10 years before selling it. When selling the property, he must pay 1% of the selling price as commission to his agent. He also must pay legal fees of \$2 500 (Transfer of ownership and other legal documents) when selling his condominium.

Ahmad says:

*My monthly rent remains constant for 10 years for every two-year contract.
I will make a profit of at least \$1 200 000 in 10 years.*

Using Ahmad's assumption, justify with calculations whether he is correct.

Answer

Answer



Mathematics Paper 1 – Worked Solutions

Singapore–Cambridge GCE O-Level Mathematics, Syllabus 4052

Essential working is shown throughout. Handwritten responses in the source were checked and corrected where necessary. Unless stated otherwise, non-exact answers are given to 3 significant figures and angles to 0.1° .

Paper 1 solutions

Question-paper page 3

- 1 Since £1 = €1.17,

$$\text{cost in Portugal} = £ \left(\frac{34.95}{1.17} \right) = £29.871 \dots$$

$$\text{Difference} = 29.871 \dots - 27.50 = 2.371 \dots$$

2

so

Also,

$$(x-2)^6 = ((x-2)^3)^2 = ((x-2)^2)^3.$$

When x is an integer, both $(x-2)^3$ and $(x-2)^2$ are integers. Hence the expression is both a perfect square and a perfect cube.

- 3 For the smallest circle, the two given points are the endpoints of a diameter.

$$d = \sqrt{(5-2)^2 + (1-4)^2} = \sqrt{18} = 3\sqrt{2}, \quad r = \frac{3\sqrt{2}}{2}.$$

$$\text{Area} = \pi r^2 = \pi \left(\frac{3\sqrt{2}}{2} \right)^2 = \frac{9\pi}{2} \text{ square units}.$$

Paper 1 solutions

Question-paper page 4

5

- (a) For inverse proportion, $y = \frac{k}{x}$. The matching reciprocal curve is

Graph F.

- (b) Since n is an odd integer greater than 1, $y = x^n + c$ is an increasing S-shaped curve, translated vertically by c . Hence

Graph D.

6

$$p = \frac{1}{2} \sqrt{\frac{q-4}{1+2q}}$$

$$4p^2 = \frac{q-4}{1+2q}$$

$$4p^2(1+2q) = q-4$$

$$4p^2 + 8p^2q = q-4$$

$$q(8p^2 - 1) = -4 - 4p^2$$

$$q = \frac{-4 - 4p^2}{8p^2 - 1} = \frac{4(1 + p^2)}{1 - 8p^2}.$$

Paper 1 solutions

Question-paper page 5

7

- (a) The vertical axis starts at 400 instead of 0. This truncation makes the differences in the bar heights look much larger than they really are, so the increase in the number of students is exaggerated.
- (b) No. The graph gives only the *number* of students studying in the library. To calculate the percentage for each year, the total number of secondary school students in that year is also needed. Since these totals are not given, it cannot be concluded that the percentages increased from 2016 to 2018.

Paper 1 solutions

Question-paper page 6

8

(a)

$$31 \text{ km/h} = 31 \times \frac{1000}{3600} \text{ m/s} = \frac{155}{18} \text{ m/s} = 8.61 \text{ m/s} \quad (3 \text{ s.f.})$$

- (b) For the train to pass completely through the tunnel, its front travels
 $4800 + 220 = 5020 \text{ m}.$

Hence

$$t = \frac{5020}{155/18} = 582.967 \dots \text{ s} = 9 \text{ min } 42.967 \dots \text{ s}.$$

Therefore, to the nearest second,

$$\boxed{9 \text{ minutes } 43 \text{ seconds}}.$$

- 9 The denominators require $x \neq 3$ and $x \neq -3$.

$$\begin{aligned} \frac{9x}{(x-3)(x+3)} - \frac{3}{x+3} &= 1 \\ \frac{9x - 3(x-3)}{(x-3)(x+3)} &= 1 \\ 6x + 9 &= (x-3)(x+3) \\ x^2 - 6x - 18 &= 0. \end{aligned}$$

Using the quadratic formula,

$$x = \frac{6 \pm \sqrt{(-6)^2 - 4(1)(-18)}}{2} = \frac{6 \pm \sqrt{108}}{2} = 3 \pm 3\sqrt{3}.$$

Thus, to 2 decimal places,

$$\boxed{x = 8.20 \quad \text{or} \quad x = -2.20}.$$

Paper 1 solutions

Question-paper page 7

10

$$V_{\text{cone}} = \frac{1}{3}\pi(3r)^2(3r) = 9\pi r^3,$$

$$V_{\text{hemisphere}} = \frac{2}{3}\pi(3r)^3 = 18\pi r^3.$$

Therefore,

$$V_{\text{combined}} = 9\pi r^3 + 18\pi r^3 = 27\pi r^3.$$

For a cylinder of radius r and height h ,

$$\pi r^2 h = 27\pi r^3 \implies h = 27r.$$

Hence the cylinder has

$$\boxed{\text{radius } r \quad \text{and height } 27r}.$$

Question note: the volume fixes only the product of the cylinder's base area and height, so the dimensions are not unique. The pair above is the intended source answer; for example, radius (3r) and height (3r) gives the same volume.

11 Bank A compounds half-yearly, so there are $2 \times 5 = 10$ compounding periods.

$$\begin{aligned}\text{Amount at Bank A} &= 5000 \left(1 + \frac{0.03}{2}\right)^{10} \\ &= \$5802.703\dots, \\ \text{Interest at Bank A} &= 5802.703\dots - 5000 \\ &= \$802.703\dots\end{aligned}$$

For Bank B,

$$\frac{5000 \times r \times 5}{100} = 802.703\dots$$

so

$$r = \frac{802.703\dots \times 100}{5000 \times 5} = 3.2108\dots$$

Therefore,

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Paper 1 solutions

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Question-paper page 8

12

(a)

$$\begin{aligned}(2x-1)(2-3x) - 3x(2x-5) &= (4x-6x^2-2+3x) - (6x^2-15x) \\ &= -6x^2+7x-2-6x^2+15x \\ &= \boxed{-12x^2+22x-2}.\end{aligned}$$

(b)

$$\begin{aligned}24ab-4ac+pc-6pb &= (24ab-6pb) + (-4ac+pc) \\ &= 6b(4a-p) - c(4a-p) \\ &= \boxed{(6b-c)(4a-p)}.\end{aligned}$$

13

(a) Since $a = 3^x$,

$$\begin{aligned}9^{x-1} &= (3^2)^{x-1} = 3^{2x-2} \\ &= \frac{(3^x)^2}{3^2} = \boxed{\frac{a^2}{9}}.\end{aligned}$$

(b)

$$\begin{aligned}(16p^4q^{-2})^{3/2} \div (p^{-6}q^9) &= 64p^6q^{-3} \times p^6q^{-9} \\ &= 64p^{12}q^{-12} \\ &= \boxed{\frac{64p^{12}}{q^{12}}}.\end{aligned}$$

Paper 1 solutions

Question-paper page 9

Question 14

The class midpoints are 985, 995, 1005 and 1015 grams.

(a)

$$\begin{aligned}\sum f &= 74 + 178 + 182 + 66 = 500, \\ \sum fx &= 74(985) + 178(995) + 182(1005) + 66(1015) \\ &= 499900.\end{aligned}$$

Hence,

$$\bar{x} = \frac{\sum fx}{\sum f} = \frac{499900}{500} = 999.8 \text{ g}.$$

(b)

$$\begin{aligned}\sum fx^2 &= 74(985^2) + 178(995^2) + 182(1005^2) + 66(1015^2) = 499840500. \\ \sigma &= \sqrt{\frac{\sum fx^2}{\sum f} - \bar{x}^2} \\ &= \sqrt{\frac{499840500}{500} - (999.8)^2} \\ &= 8.997 \dots = 9.00 \text{ g} \quad (3 \text{ s.f.})\end{aligned}$$

(c)

For machine A, the mean mass is 999.8 g and the standard deviation is 9.00 g. For machine B, they are 1000.2 g and 12.5 g respectively. Both mean masses are 0.2 g from the stated mass of 1000 g, but machine A has the smaller standard deviation. Its packet masses are therefore more consistent.

Choose machine A.

Paper 1 solutions

Question-paper page 10

Question 15

Let the cost price be \$x\$.

$$\begin{aligned}\text{Marked price} &= 1.40x, \\ \text{selling price} &= 0.80(1.40x) = 1.12x.\end{aligned}$$

Since the profit is \$18\$,

$$1.12x - x = 18 \implies 0.12x = 18 \implies x = 150.$$

Thus the marked price is

$$1.40(150) = \$210.$$

Question 16

(a) Solve the two parts of the compound inequality separately:

$$\begin{aligned}8 + x &\leq 10 + \frac{3}{2}x \implies -\frac{1}{2}x < 2 \implies x > -4, \\ 10 + \frac{3}{2}x &\leq 15.5 - 2x \implies \frac{7}{2}x \leq \frac{11}{2} \implies x \leq \frac{11}{7}.\end{aligned}$$

Therefore,

$$-4 < x \leq \frac{11}{7}.$$

(b) Since the upper endpoint is included and $\frac{11}{7}$ is rational,

$$x = \frac{11}{7}.$$

Paper 1 solutions

Question-paper page 11

Question 17

(a)

$$440 = 44 \times 10 = (2^2 \times 11)(2 \times 5) = \boxed{2^3 \times 5 \times 11}.$$

(b) Since $6 = 2 \times 3$,

$$\text{HCF}(440, 6) = \boxed{2}.$$

(c) For two positive integers,

$$\text{first integer} \times \text{second integer} = \text{HCF} \times \text{LCM}.$$

Thus,

$$440B = 55(1320) \Rightarrow B = \frac{55(1320)}{440} = \boxed{165}.$$

(d) Put $d = \frac{42}{h}$. Then d must divide both 42 and 440. To make $h = 42/d$ as small as possible, take the greatest possible d :

$$d = \text{HCF}(42, 440) = 2.$$

Hence,

$$h = \frac{42}{2} = \boxed{21}.$$

(e) The numbers of cubes along the three sides must each exceed $20 \div 5 = 4$, and their product is 440. The only factor triple of 440 with all three factors greater than (4) is

$$440 = 5 \times 8 \times 11,$$

the dimensions are

$$\boxed{25 \text{ cm by } 40 \text{ cm by } 55 \text{ cm}}.$$

Paper 1 solutions

Question-paper page 12

Question 18

Since the prisms are made of the same material, their volume ratio is their mass ratio. Thus the linear scale factor from the smaller prism to the larger prism is

$$k = \sqrt[3]{\frac{320}{135}} = \sqrt[3]{\frac{64}{27}} = \frac{4}{3}.$$

(a) The surface-area scale factor is $k^2 = \frac{16}{9}$. Hence,

$$40.5 \left(\frac{16}{9} \right) = \boxed{72 \text{ cm}^2}.$$

(b) The painting cost is proportional to surface area, so

$$48.60 \left(\frac{16}{9} \right) = \boxed{\$86.40}.$$

(c) The volume of the smaller prism is

$$576 \left(\frac{3}{4} \right)^3 = 576 \left(\frac{27}{64} \right) = 243 \text{ cm}^3.$$

Therefore, its cross-sectional area is

$$\frac{243}{12} = \boxed{20.25 \text{ cm}^2}.$$

Question 19

Using the maximum point, write the equation in vertex form:

$$y = a(x - 1.5)^2 + 12.25.$$

The constant term is 10. Substituting $x = 0$, $y = 10$,

$$10 = 2.25a + 12.25 \implies a = -1.$$

Then

$$y = -(x - 1.5)^2 + 12.25 = -x^2 + 3x + 10.$$

Hence,

$$a = -1, \quad b = 3.$$

Paper 1 solutions

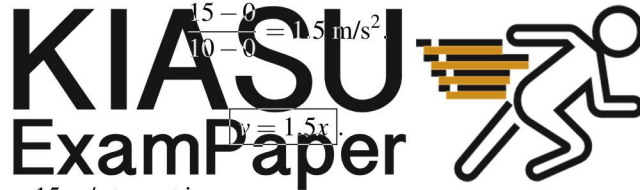
Question-paper page 13

Question 20

(a) During the first 10 seconds, the acceleration is

$$\frac{15 - 0}{10 - 0} = 1.5 \text{ m/s}^2.$$

Therefore, for $0 \leq x \leq 10$,



(b) The time taken to decelerate from 15 m/s to rest is

$$\frac{15}{0.75} = 20 \text{ s}.$$

Hence deceleration begins at $60 - 20 = 40$ s. The lorry travels at its maximum speed from $t = 10$ s to $t = 40$ s, so the duration is

$$40 - 10 = 30 \text{ s}.$$

(c) The distance travelled is the area under the speed-time graph:

$$\begin{aligned} \text{distance} &= \frac{1}{2}(10)(15) + (30)(15) + \frac{1}{2}(20)(15) \\ &= 75 + 450 + 150 \\ &= 675 \text{ m}. \end{aligned}$$

Paper 1 solutions

Question-paper page 14

Question 21

(a) The angle between BE and BD is common. Hence,

$$\begin{aligned} \angle ABD &= \angle ABE + \angle EBD, \\ \angle CBE &= \angle CBD + \angle DBE. \end{aligned}$$

Since $\angle ABE = \angle CBD$ and $\angle EBD = \angle DBE$,

$$\angle ABD = \angle CBE.$$

Also,

$$AB = CB \quad \text{and} \quad \angle BDA = \angle BEC$$

are given. Therefore,

$$\triangle ABD \cong \triangle CBE \quad (\text{AAS}).$$

(b) We are given that

$$\angle ABE = \angle BEC.$$

These are alternate interior angles made by the transversal BE . By the converse of the alternate-angles theorem,

$$AB \parallel CE.$$

Thus $ABCE$ has one pair of opposite sides parallel, so

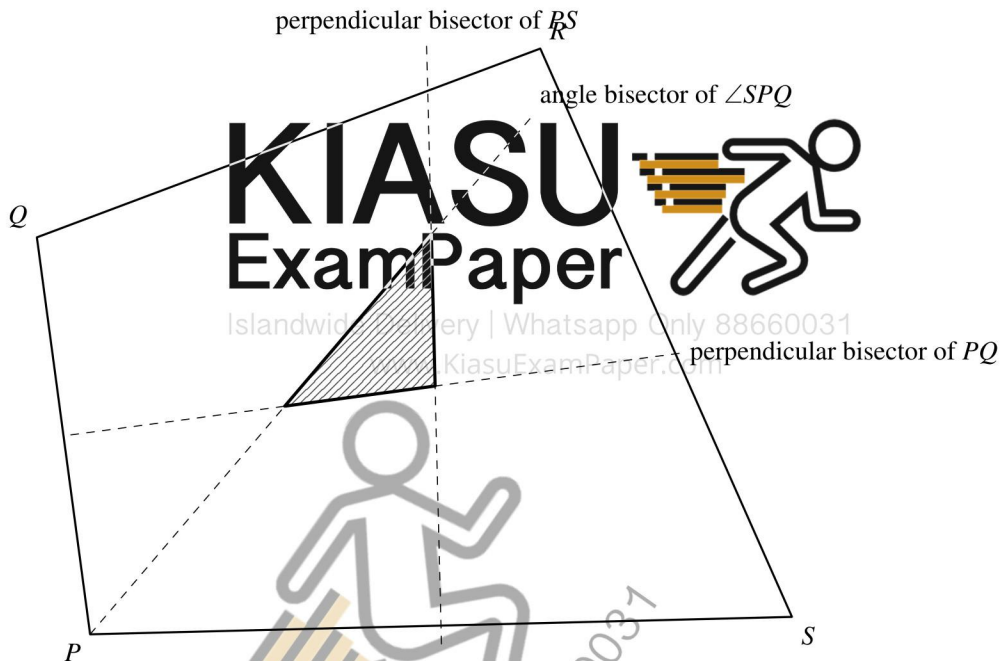
$$ABCE \text{ is a trapezium.}$$

Question 22

The three required loci are:

- the side nearer to PS of the internal bisector of $\angle SPQ$;
- the P -side of the perpendicular bisector of PS ;
- the Q -side of the perpendicular bisector of PQ .

The common region is hatched below. The dashed lines are the three locus boundaries.



Answer: the hatched triangular region.

Question 23(a)

Since AB and AD are tangents drawn from the same external point A ,

$$AB = AD.$$

Hence $\triangle ADB$ is isosceles, so its base angles are equal.

$$\begin{aligned}\angle ADB &= \frac{180^\circ - \angle DAB}{2} \\ &= \frac{180^\circ - 84^\circ}{2} \\ &= 48^\circ.\end{aligned}$$

Answer: $\angle ADB = 48^\circ$

Question 23(b)

Since $DF \parallel ABC$,

$$\angle BDF = \angle DBA = 48^\circ \quad (\text{alternate angles}).$$

The angle at the centre is twice the angle at the circumference standing on the same arc BF . Therefore

$$\begin{aligned}\angle BOF &= 2\angle BDF \\ &= 2(48^\circ) \\ &= 96^\circ.\end{aligned}$$

Answer: $\angle BOF = 96^\circ$

Question 23(c)

The angle between tangent BC and chord BF is equal to the angle in the alternate segment subtended by chord BF . Hence

$$\angle FBC = \angle BDF = 48^\circ.$$

$$\text{Answer: } \angle FBC = 48^\circ$$

Question 23(d)

Since $OB = OF$ (radii), $\triangle BOF$ is isosceles. Using $\angle BOF = 96^\circ$,

$$\begin{aligned}\angle BFO &= \frac{180^\circ - 96^\circ}{2} \\ &= 42^\circ.\end{aligned}$$

Also, since $DF \parallel BC$,

$$\angle DFB = \angle FBC = 48^\circ \quad (\text{alternate angles}).$$

Therefore

$$\begin{aligned}\angle DFO &= \angle DFB - \angle BFO \\ &= 48^\circ - 42^\circ \\ &= 6^\circ.\end{aligned}$$

$$\text{Answer: } \angle DFO = 6^\circ$$

Question 24(a)

Given $\vec{OA} = 8\mathbf{a}$, $\vec{OB} = 8\mathbf{b}$ and $BM = MA$, point M is the midpoint of AB .

(i)

$$\begin{aligned}\vec{BM} &= \frac{1}{2}\vec{BA} \\ &= \frac{1}{2}(\vec{OA} - \vec{OB}) \\ &= \frac{1}{2}(8\mathbf{a} - 8\mathbf{b}) \\ &= 4\mathbf{a} - 4\mathbf{b}.\end{aligned}$$

$$\text{Answer: } \vec{BM} = 4\mathbf{a} - 4\mathbf{b}$$

(ii)

$$\begin{aligned}\vec{OM} &= \frac{1}{2}(\vec{OA} + \vec{OB}) \\ &= \frac{1}{2}(8\mathbf{a} + 8\mathbf{b}) \\ &= 4\mathbf{a} + 4\mathbf{b}.\end{aligned}$$

$$\text{Answer: } \vec{OM} = 4\mathbf{a} + 4\mathbf{b}$$

(iii) Since $\vec{OL} = \frac{1}{4}\vec{OA} = 2\mathbf{a}$,

$$\begin{aligned}\vec{LM} &= \vec{OM} - \vec{OL} \\ &= (4\mathbf{a} + 4\mathbf{b}) - 2\mathbf{a} \\ &= 2\mathbf{a} + 4\mathbf{b}.\end{aligned}$$

$$\text{Answer: } \vec{LM} = 2\mathbf{a} + 4\mathbf{b}$$

Question 24(b)

Since $\vec{LP} = 3\vec{LM}$,

$$\begin{aligned}\vec{OP} &= \vec{OL} + \vec{LP} \\ &= 2\mathbf{a} + 3(2\mathbf{a} + 4\mathbf{b}) \\ &= 8\mathbf{a} + 12\mathbf{b}.\end{aligned}$$

Answer: $\vec{OP} = 8\mathbf{a} + 12\mathbf{b}$

Question 24(c)

$$\vec{OP} = 8\mathbf{a} + 12\mathbf{b}, \quad \vec{OM} = 4\mathbf{a} + 4\mathbf{b}.$$

For parallel vectors, one vector must be a scalar multiple of the other. Here,

$$\frac{8}{4} = 2 \quad \text{but} \quad \frac{12}{4} = 3.$$

The coefficients are not in the same ratio, so $\vec{OP}$ is not a scalar multiple of $\vec{OM}$.

Answer: $\vec{OP} \nparallel \vec{OM}$

Question 24(d)

Since $OL = \frac{1}{4}OA$,

$$AL = OA - OL = \frac{3}{4}OA.$$

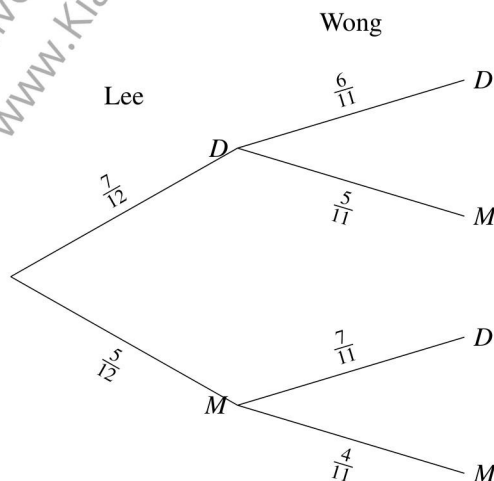
Also, M is the midpoint of AB . As A lies on AO , the perpendicular distance from M to AO is half the perpendicular distance from B to AO . Thus

$$\begin{aligned}\frac{\text{Area of } \triangle ALM}{\text{Area of } \triangle AOB} &= \frac{AL}{AO} \times \frac{\text{height from } M}{\text{height from } B} \\ &= \frac{3}{4} \times \frac{1}{2} \\ &= \frac{3}{8}.\end{aligned}$$

Answer: $\frac{3}{8}$

Question 25(i)

Let D denote a dark chocolate and M denote a milk chocolate. Since Lee eats the first chocolate, there are 11 chocolates left when Wong chooses.



Question 25(ii)(a)

$$\begin{aligned} P(DD) &= \frac{7}{12} \times \frac{6}{11} \\ &= \frac{42}{132} \\ &= \frac{7}{22}. \end{aligned}$$

Answer: $\frac{7}{22}$

Question 25(ii)(b)

“At most one milk chocolate” is the complement of both chocolates being milk.

$$\begin{aligned} P(\text{at most one } M) &= 1 - P(MM) \\ &= 1 - \left(\frac{5}{12} \times \frac{4}{11} \right) \\ &= 1 - \frac{5}{33} \\ &= \frac{28}{33}. \end{aligned}$$

Answer: $\frac{28}{33}$

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Mathematics Paper 2 – Worked Solutions

Singapore–Cambridge GCE O-Level Mathematics, Syllabus 4052

Essential working is shown throughout. Handwritten responses in the source were checked and corrected where necessary. Unless stated otherwise, non-exact answers are given to 3 significant figures and angles to 0.1° .

Paper 2 solutions

Question-paper page 3

1

(a) Since

$$x^2 - 6x + 8 = (x-2)(x-4) \quad \text{and} \quad \frac{1}{4-x} = -\frac{1}{x-4},$$

$$\frac{3}{x^2 - 6x + 8} + \frac{1}{4-x} - 1 = \frac{3}{(x-2)(x-4)} - \frac{1}{x-4} - 1$$

$$= \frac{3 - (x-2) - (x-2)(x-4)}{(x-2)(x-4)}$$

$$= \frac{-x^2 + 5x - 3}{(x-2)(x-4)}.$$

(b) Solve the two parts of the compound inequality.

$$\begin{aligned} -4 &\leq \frac{1-3x}{5} &\Rightarrow -20 &\leq 1-3x &\Rightarrow x &\leq 7, \\ \frac{1-3x}{5} &< \frac{2}{3} &\Rightarrow 3(1-3x) &< 10 &\Rightarrow x &> -\frac{7}{9}. \end{aligned}$$

Hence

$$-\frac{7}{9} < x \leq 7.$$

Therefore the integers are

$$x = 0, 1, 2, 3, 4, 5, 6, 7.$$

Paper 2 solutions

Question-paper page 4

1 (continued)

(c) Completing the square,

$$\begin{aligned} x^2 - 5x + 11 &= \left(x^2 - 5x + \frac{25}{4}\right) + 11 - \frac{25}{4} \\ &= \frac{19}{4} + \left(x - \frac{5}{2}\right)^2. \end{aligned}$$

(d) (i)

$$\begin{aligned} A &= 50p^3q - 2pq \\ &= 2pq(25p^2 - 1) \\ &= 2pq(5p-1)(5p+1). \end{aligned}$$

(ii) From the factorised form,

$$A = 2p(5p-1)(5p+1)q.$$

Therefore,

$$q = \frac{A}{2p(5p-1)(5p+1)}.$$

2

- (a) The direction vector of AB is $\begin{pmatrix} -7 \\ 3 \end{pmatrix}$, so its gradient is

$$m_{AB} = \frac{3}{-7} = -\frac{3}{7}.$$

The required line passes through $A(-3, 5)$. Thus

$$\begin{aligned} y - 5 &= -\frac{3}{7}(x + 3) \\ 7y - 35 &= -3x - 9 \end{aligned}$$

$$\boxed{3x + 7y = 26}.$$

- (b) For q ,

so $m_q = \frac{4}{3}$. Since $m_q m_{OP} = -1$,

$$m_{OP} = -\frac{1}{4/3} = -\frac{3}{4}.$$

Line OP passes through the origin, hence

$$\boxed{y = -\frac{3}{4}x}$$

or equivalently

$$\boxed{3x + 4y = 0}.$$

- (c)

$$|AB|^2 = (-7)^2 + 3^2 = 58.$$

Since $A(-3, 5)$ and $T(k, 7)$,

$$|AT|^2 = (k + 3)^2 + (7 - 5)^2 = (k + 3)^2 + 4.$$

Equating the squared lengths,

$$(k + 3)^2 + 4 = 58$$

$$(k + 3)^2 = 54$$

$$k + 3 = \pm 3\sqrt{6}.$$

Therefore,

$$\boxed{k = -3 + 3\sqrt{6} \quad \text{or} \quad k = -3 - 3\sqrt{6}}.$$

3

- (a) (i) The column matrix of fruit prices is

$$\boxed{\mathbf{P} = \begin{pmatrix} x \\ y \end{pmatrix}}.$$

- (ii)

$$\mathbf{M} = \mathbf{NP} = \begin{pmatrix} 12 & 8 \\ 9 & 6 \\ 5 & 4 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$= \begin{pmatrix} 12x + 8y \\ 9x + 6y \\ 5x + 4y \end{pmatrix}.$$

The three elements are the respective selling prices of Packs 1, 2 and 3.

- (b) Pack 1 costs \$6.37 more than Pack 2, so

$$(12x + 8y) - (9x + 6y) = 6.37 \implies 3x + 2y = 6.37. \quad (1)$$

Pack 3 costs \$11.50, so

$$5x + 4y = 11.50. \quad (2)$$

Multiplying (1) by 2 gives $6x + 4y = 12.74$. Subtracting (2),

$$x = 12.74 - 11.50 = 1.24.$$

Substituting $x = 1.24$ into (1),

$$3(1.24) + 2y = 6.37 \implies y = 1.325.$$

Therefore, as prices to the nearest cent,

$$x = 1.24, \quad y = 1.33.$$

Paper 2 solutions

Question-paper page 7

3 (continued)

- (c) Let F be the number of packs sold in the first week. After a decrease of 36%, the second-week sales are 64% of F .

$$\begin{aligned} 0.64F &= 6705 \\ F &= \frac{6705}{0.64} \\ &= 10476.5625. \end{aligned}$$

Applying the stated default accuracy,

$$10500 \text{ packs} \quad (3 \text{ s.f.}).$$

Note: the supplied figures give 10476.5625, not an exact whole-number count of packs.

- (d) Let M, A, N denote the morning, afternoon and night sales respectively.

$$M : A = 2\frac{1}{3} : 5 = \frac{7}{3} : 5 = 7 : 15,$$

and

$$M : N = 6\frac{1}{4} : 13 = \frac{25}{4} : 13 = 25 : 52.$$

Make the value representing M the same in both ratios:

$$M : A = 175 : 375, \quad M : N = 175 : 364.$$

Hence

$$N : A : M = 364 : 375 : 175.$$

Paper 2 solutions

Question-paper page 8

4

- (a) Let the side length of each regular triangular panel be s cm.

- (i) Using the area formula for a triangle,

$$\begin{aligned} \frac{1}{2}s^2 \sin 60^\circ &= 285 \\ s^2 &= \frac{570}{\sin 60^\circ} \\ s &= 25.655\dots \end{aligned}$$

Therefore,

$$s = 25.7 \text{ cm} \quad (3 \text{ s.f.}).$$

(ii)

$$\begin{aligned}\text{total surface area} &= (2.5 \times 10^{100})(285) \\ &= 712.5 \times 10^{100} \\ &= \boxed{7.125 \times 10^{102} \text{ cm}^2}.\end{aligned}$$

(b) The interior angles of a regular triangle and a regular octagon are

$$60^\circ \quad \text{and} \quad \frac{(8-2)180^\circ}{8} = 135^\circ$$

respectively. Since the three polygons meet at a point, the interior angle of the regular n -sided polygon is

$$360^\circ - 60^\circ - 135^\circ = 165^\circ.$$

For a regular n -sided polygon,

$$\begin{aligned}\frac{180^\circ - 360^\circ}{n} &= 165^\circ \\ \frac{360^\circ}{n} &= 15 \\ n &= 24.\end{aligned}$$

Hence $\boxed{n = 24}$.

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Paper 2 solutions

Question-paper page 9

5

(a) Within $\xi = \{2, 3, \dots, 15\}$,

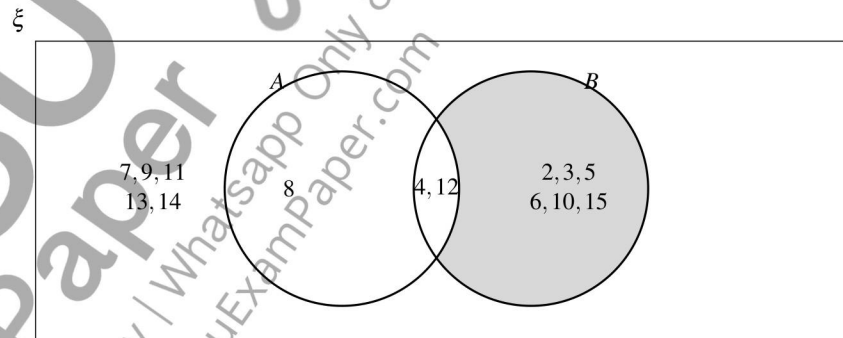
$$A = \{4, 8, 12\}, \quad B = \{2, 3, 4, 5, 6, 10, 12, 15\}.$$

(i) Hence

$$\boxed{A \cap B = \{4, 12\}},$$

the set of integers in ξ which are both multiples of 4 and factors of 60.

(ii) The completed diagram is shown below. The shaded part is $A' \cap B$.



(iii) Since q is selected from $A' \cap B$, it is impossible for $q \notin A' \cap B$. Therefore

$$\boxed{P(q \notin A' \cap B) = 0}.$$

(b)(i) There are y students in the group who study both subjects. Selecting two students without replacement gives

$$\frac{y}{40} \times \frac{y-1}{39} = \frac{63}{130}.$$

Since $40 \times 39 = 1560$,

$$\begin{aligned}\frac{y(y-1)}{1560} &= \frac{63}{130}, \\ y(y-1) &= 63 \left(\frac{1560}{130} \right) = 756,\end{aligned}$$

$$\boxed{y^2 - y - 756 = 0} \quad \text{as required.}$$

5(b) continued

(ii)

$$y^2 - y - 756 = 0,$$

$$(y - 28)(y + 27) = 0.$$

Thus $y = 28$ or $y = -27$. A number of students cannot be negative, so

$$y = 28.$$

(iii) Since $P(\text{not Physics}) = \frac{1}{8}$,

number who do not study Physics $= \frac{1}{8} \times 40 = 5$.

Of these 5 students, 3 do not study Biology. Hence

$$n(\text{Biology and not Physics}) = 5 - 3 = 2.$$

The number who study Physics is $40 - 5 = 35$. Since 28 study both subjects,

$$n(\text{not Biology and Physics}) = 35 - 28 = 7.$$

Therefore the completed table is

	Physics	Not Physics
Biology	28	2
Not Biology	7	3

Check: $28 + 2 + 7 + 3 = 40$.

6

(a) Since $AB \parallel DC$, the co-interior angles on transversal BC satisfy

$$\angle ABC + \angle DCB = 180^\circ.$$

Hence

$$\angle ABC = 180^\circ - 130^\circ = 50^\circ.$$

Applying the cosine rule in $\triangle ABC$,

$$\begin{aligned} AC^2 &= AB^2 + BC^2 - 2(AB)(BC)\cos\angle ABC \\ &= 42^2 + 25^2 - 2(42)(25)\cos 50^\circ, \\ AC &= 32.2357\dots \end{aligned}$$

Therefore

$$AC = 32.2 \text{ m} \quad (3 \text{ s.f.}).$$

(b) In $\triangle ABC$, by the sine rule,

$$\begin{aligned} \frac{\sin\angle CAB}{25} &= \frac{\sin 50^\circ}{32.2357\dots}, \\ \angle CAB &= 36.4481\dots^\circ. \end{aligned}$$

Since C is due north of A , AC is the north line at A . The line AB is $36.4481\dots^\circ$ clockwise from north. Thus the bearing of B from A is

$$036.4^\circ.$$

6 continued

- (c) The perpendicular distance between the parallel sides AB and DC is

$$h = 25 \sin(180^\circ - 130^\circ) = 25 \sin 50^\circ = 19.1511 \dots \text{ m.}$$

Hence the area of the trapezium $ABCD$ is

$$\begin{aligned} \frac{1}{2}(AB + DC)h &= \frac{1}{2}(42 + 20)(19.1511 \dots) \\ &= 593.684 \dots \text{ m}^2. \end{aligned}$$

The vertical height of the prism is $AH = 10$ m, so

$$V = 593.684 \dots (10) = 5936.84 \dots = 5.94 \times 10^3 \text{ m}^3 \quad (3 \text{ s.f.}).$$

- (d) Let P be the point on AB closest to D . Then $DP \perp AB$, and, because $AB \parallel DC$,

$$DP = 25 \sin 50^\circ = 19.1511 \dots \text{ m.}$$

Since E is vertically above D , $ED = AH = 10$ m. If θ is the greatest angle of depression, then

$$\tan \theta = \frac{ED}{DP} = \frac{10}{19.1511 \dots}, \quad \theta = 27.5720 \dots^\circ.$$

Therefore

$$\theta = 27.6^\circ.$$

Question note: The printed question omits "greatest". Without the object's position on AB , its angle of depression is not fixed. The solution above gives the intended greatest angle, attained when the object is at P .

7

- (a) Substituting each value of x into $y = 3x - \frac{2}{x^2} + 2$ gives

x	-3.5	-3	-2.5	-2	-1	-0.5
y	-8.7	-7.2	-5.8	-4.5	-3.0	-7.5

(The values of y are given to 1 decimal place, as requested.)

- (b) Plotting these points and joining them with a smooth curve gives:

$$3x - \frac{2}{x^2} + 2 > -4.$$

Draw $y = -4$. The curve lies above it for

$$-1.79 < x < -0.722.$$

Using the supplied negative- x graph gives the interval above. Over all real x , the full solution also includes $x > 0.515$, which is outside the drawn grid.

Paper 2 solutions

Question-paper page 15

8

(a) There are 600 candidates.

(i) The median corresponds to cumulative frequency

$$\frac{600}{2} = 300.$$

Reading from the Paper 1 curve at cumulative frequency 300 gives

$$40 \text{ marks}.$$

(ii) The lower and upper quartiles correspond to cumulative frequencies

$$Q_1 : \frac{600}{4} = 150, \quad Q_3 : \frac{3 \times 600}{4} = 450.$$

From the Paper 1 curve

$$Q_1 \approx 27, \quad Q_3 \approx 52.$$

Hence

$$\text{interquartile range} = Q_3 - Q_1 \approx 52 - 27 = 25 \text{ marks}.$$

(b) From the cumulative frequency curves,

$$n(\text{Paper 1 mark} > 40) = 600 - 300 = 300,$$

$$n(\text{Paper 2 mark} \leq 30) = 90.$$

Using the intended selection without replacement,

$$P = \frac{300}{600} \times \frac{90}{599} = \frac{45}{599} \approx 0.0751.$$

Question note: the two cumulative-frequency curves give only the marginal score distributions, not how the two scores overlap for each candidate. Thus an exact probability is not identifiable from the graph alone; the calculation shown is the paper's intended ordered-selection interpretation.

Paper 2 solutions

Question-paper page 16

8 (continued)

(c) (i) The missing frequency is

$$600 - 90 - 280 - 30 = 200.$$

Question note: to include a possible score of 100, the final class interval should logically read $90 \leq x \leq 100$.

(ii) The median is the 300th value. The cumulative frequencies are

$$90, \quad 90 + 280 = 370, \quad 570, \quad 600.$$

Since $90 < 300 \leq 370$, the median lies in

$$30 \leq x < 60.$$

(d) A Paper 1 mark of 60 corresponds to a cumulative frequency of about 525. Moving horizontally to the Paper 2 curve and then vertically down to the marks axis gives

$$79 \text{ marks (approximately)}.$$

(e) (i) **Disagree.** The estimated median for Paper 1 is about 40, whereas that for Paper 2 is about 55. Since candidates generally scored higher in Paper 2, the graph does not support the claim that Paper 1 was easier.

(ii) **Agree.** Paper 1 has an interquartile range of about 25 marks. From the curve, Paper 2 has an interquartile range of about 27 marks. Therefore, the middle 50% of Paper 1 marks is less spread out.

(iii) **Disagree.** A range of 100 would require the lowest mark to be 0 and the highest mark to be 100. The cumulative frequency curve does not show that any candidate scored exactly both endpoint values, so the exact range cannot be concluded to be 100.

Paper 2 solutions

Question-paper page 17

9

- (a) The downpayment and bank loan are

$$\begin{aligned}\text{downpayment} &= 0.25(2\,500\,000) = 625\,000, \\ \text{loan principal} &= 2\,500\,000 - 625\,000 = 1\,875\,000.\end{aligned}$$

Since the mortgage uses a flat annual interest rate,

$$\text{interest} = 1\,875\,000(0.0145)(10) = 271\,875.$$

Thus the total loan repayment is

$$1\,875\,000 + 271\,875 = 2\,146\,875.$$

There are $10 \times 12 = 120$ monthly instalments, so

$$\text{monthly instalment} = \frac{2\,146\,875}{120} = 17\,890.625 = \$17\,890.63.$$

- (b)(i) For a purchase price of \$2 500 000, the amount above \$1 500 000 is

$$2\,500\,000 - 1\,500\,000 = 1\,000\,000.$$

Hence the BSD is

$$\begin{aligned}\text{BSD} &= 1\,800 + 3\,600 + 19\,200 + 20\,000 + 0.05(1\,000\,000) \\ &= 1\,800 + 3\,600 + 19\,200 + 20\,000 + 50\,000 \\ &= \$94\,600.\end{aligned}$$

There is no amount charged at 6%, since the purchase price does not exceed \$3 000 000.

- (c) The total cost of purchasing the condominium includes its price, the flat-rate loan interest, BSD and the lawyer's fee:

$$\begin{aligned}\text{purchase cost} &= 2\,500\,000 + 271\,875 + 94\,600 + 4\,500 \\ &= \$2\,870\,975.\end{aligned}$$

Paper 2 solutions

Question-paper page 18

- 9(d) We first find the rental income and the costs of renting out the condominium.

Rental income

The rent is constant at \$4 500 per month, so the gross rental income over 10 years is

$$4\,500(12)(10) = \$540\,000.$$

Rental agent's fees

There are

$$\frac{10}{2} = 5$$

two-year contracts. The agent receives one month's rent for each contract, so

$$5(4\,500) = \$22\,500.$$

Property tax

The annual value is the annual gross rent:

$$\text{AV} = 4\,500(12) = \$54\,000.$$

The tax on the first \$45 000 is \$6 600. The remaining annual value is

$$54\,000 - 45\,000 = 9\,000,$$

so the annual property tax is

$$6\,600 + 0.28(9\,000) = 6\,600 + 2\,520 = \$9\,120.$$

Therefore, the property tax for 10 years is

$$9\,120(10) = \$91\,200.$$

Maintenance fees

For 10 years, the maintenance fees total

$$700(12)(10) = \$84\,000.$$

9(d) (continued)

Value of the condominium after 10 years

The stated appreciation rate for each quarterly compounding period is 0.9%, and the number of quarters is

$$10(4) = 40.$$

Here 0.9% is interpreted as the rate for each quarter, consistent with the source correction. Hence the selling price after 10 years is

$$\begin{aligned} S &= 2\,500\,000(1 + 0.009)^{40} \\ &= 2\,500\,000(1.009)^{40} \\ &= 3\,577\,557.792\dots \end{aligned}$$

Costs of selling

The selling agent's commission is

$$0.01S = 35\,775.577\dots$$

Including the legal fee, the total selling cost is

$$35\,775.577\dots + 2\,500 = \$38\,275.577\dots$$

Therefore, the net sale proceeds are

$$\begin{aligned} S - (0.01S + 2\,500) &= 3\,577\,557.792\dots - 38\,275.577\dots \\ &= \$3\,539\,282.214\dots \end{aligned}$$

The total cost of buying the condominium, including the loan interest, BSD and the purchase lawyer's fee, was found in part (c):

$$\text{purchase cost} = \$2\,870\,975.$$

9(d) (conclusion)

Collecting the results from the previous pages,

Cash inflow	Amount (\$)
Gross rental income	540 000.00
Net sale proceeds	3 539 282.21
Total cash inflow	4 079 282.21

Cash outflow	Amount (\$)
Purchase cost from part (c)	2 870 975.00
Rental agent's fees	22 500.00
Property tax	91 200.00
Maintenance fees	84 000.00
Total cash outflow	3 068 675.00

Thus

$$\begin{aligned} \text{profit} &= 4\,079\,282.214\dots - 3\,068\,675 \\ &= 1\,010\,607.214\dots \\ &\approx \$1.01 \times 10^6 \quad (3 \text{ s.f.}) \end{aligned}$$

Since

$$\$1.01 \times 10^6 < \$1.20 \times 10^6,$$

Ahmad will not make a profit of at least \$1 200 000. Therefore,

Ahmad is not correct.

Name: Register no: Class:



NGEE ANN SECONDARY SCHOOL

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PRELIMINARY EXAMINATION

MATHEMATICS

4052/01

Paper 1

25 August 2026

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the 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

Total	/90
--------------	------------

Checked by student:

Date:

Mathematical Formulae

Compound interest

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

Geometry and Measurement

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

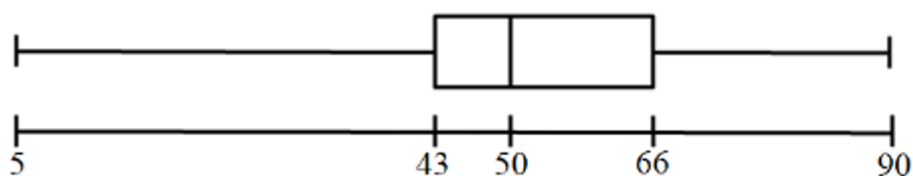
$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

Answer **all** the questions.

- 1 Expand and simplify $(3x - 2)(8x^2 - 5x + 1)$.

Answer [2]

- 2 The box-and-whisker plot shows the waiting times, in minutes, for 60 patients at a clinic.



- (a) Use the box-and-whisker plot to find the median waiting time.

Answermins [1]

- (b) Renee says, “There were almost twice as many patients who had waiting time less than 43 minutes as there were patients who had waiting time more than 66 minutes”.

Is she correct?
Give a reason for your answer.

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

- 3 A number has exactly fifteen factors.
Two of the factors are 81 and 108.

Find this number.

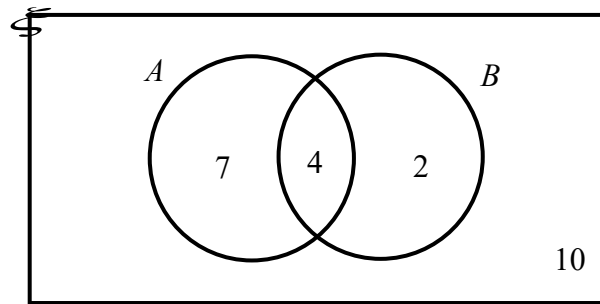
Answer [2]

- 4 The solution for the equation $\frac{3x}{4} = k - \frac{6x-5}{5}$ is twice the value of k and k is a constant.

Find the value of k .

Answer $k =$ [2]

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



Find the value of

(a) $n((A \cup B) \cap A')$

Answer [1]

(b) $n((A' \cap B) \cup (A \cap B'))$

Answer [1]

- 6 Factorise completely.

(a) $15\pi - 24\pi b + 3\pi^2$

Answer [1]

(b) $4x^2 + 9y^2 - 12xy - 64$

Answer [2]

- 7 Express as a single fraction in its simplest form $\frac{5x}{6} - \frac{3(x-1)}{4} + \frac{2x+7}{12}$.

Answer [2]

- 8 Six students took a Mathematics quiz and the marks were recorded.

9 11 10 14 11 10

- (a) Calculate the standard deviation.

Answer [1]

- (b) Two other students also took the quiz and their marks were recorded.
Both the mean mark and modal mark obtained by the eight students were 11.

Find the marks of these two students.

Answer and [2]

- 9 According to World Bank data, Singapore's population was 6.037 million in 2024. In the same year, its Gross Domestic Product (GDP) was US\$547.39 billion.

(a) Express 547.39 billion in standard form.

Answer [1]

(b) What is the GDP per person in Singapore?

Answer US\$..... [2]

-
- 10 Solve these simultaneous equations.

$$3x + 5y = 4$$

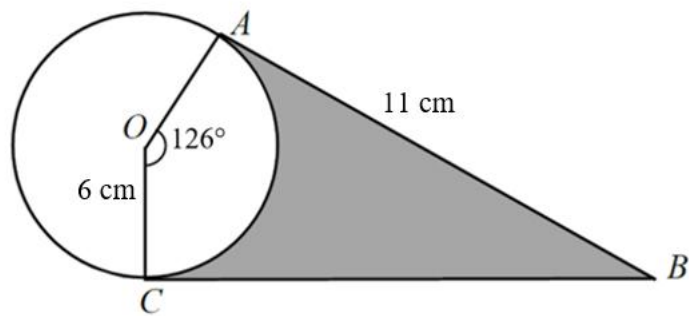
$$7x - 4y = -22$$

You must show your working.

Answer $x =$

$y =$ [3]

- 11** $OABC$ is a quadrilateral where AB and BC are tangents to a circle with centre O and radius of 6 cm.



- (a)** Explain why angle OAB is 90° .

Answer

[1]

- (b)** Calculate the shaded area.

Answer cm^2 [2]

- 12** A map has a scale of 1: 6 000 000.
The distance between Malaysia and Indonesia shown on the map is 24 cm.

(a) Calculate the actual distance, in kilometres, between Malaysia and Indonesia.

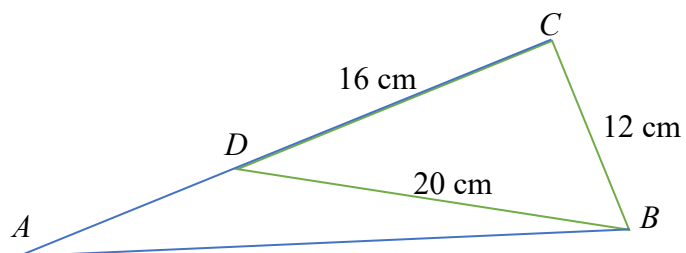
Answerkm [1]

(b) The difference in actual area between the two countries is 1 574 722 km².

Calculate the difference in area on the map.

Answercm² [2]

- 13** In triangle BCD , $BC = 12$ cm, $CD = 16$ cm and $DB = 20$ cm.
 ADC is a straight line.



- (a)** Is BC perpendicular to CD ?
 Show your working clearly.

Answer

[1]

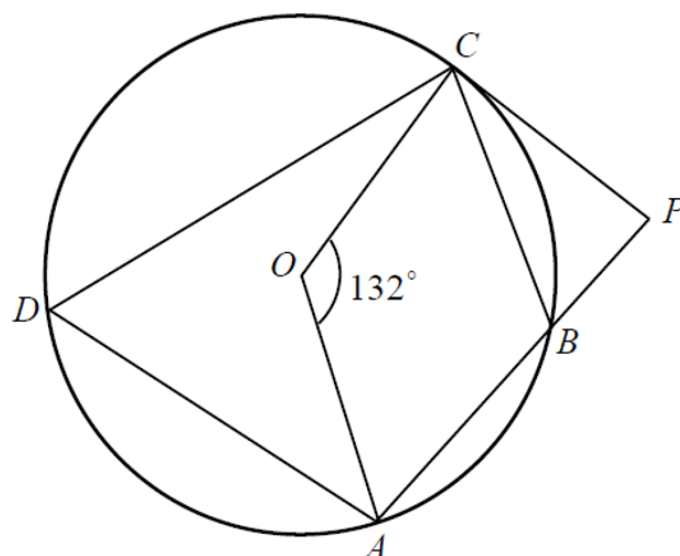
- (b)** Angle $ADB = x^\circ$

Find the exact value of $\cos x^\circ + \sin x^\circ$.

Answer [2]

14 Simplify $\frac{3x^2 + 7x - 40}{18x^3 - 128x}$.

Answer [3]



A , B , C and D are points on the circumference of a circle, centre O .

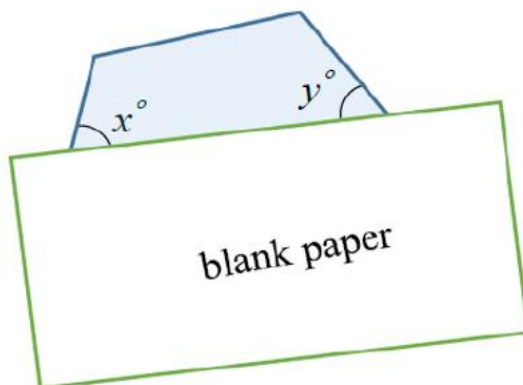
PBA is a straight line.

PC is a tangent to the circle and angle $COA = 132^\circ$.

Find angle CBP .

Give reasons for each step of your working.

Answer Angle $CBP = \dots\dots\dots$ [3]



The diagram shows a regular polygon which is partially covered with a sheet of blank paper. The sum of the angles x° and y° is 60° .

Find the number of sides of the regular polygon.

Answer [3]

- 17** Mr Fok bought a vase for \$58900.
The value of the vase appreciates by 0.1% each month.

(a) Explain why the appreciation value of the first year is not 1.2% of \$58900.

.....
.....

[1]

(b) Calculate how much the vase is worth at the end of the third year.

Answer \$..... [2]

-
- 18** Tessa buys a sofa bed using hire purchase.
She pays a deposit of 25% of the cash price plus 26 equal monthly payment of \$88.
The outstanding amount is charged at a simple interest rate of 8% per annum.

Calculate the cash price of the sofa bed.

Answer \$..... [3]

- 19 (a) 8 men working 6 hours a day, can build a cupboard in 2 days.

Find the additional number of days required to build a cupboard by 3 men working 4 hours a day at the same rate.

Answer days [2]

- (b) y^3 is inversely proportional to the square of x .
The difference between the values of y^3 when $x = 4$ and when $x = 8$ is 3.

Find the values of x when $y = 1$.

Answer $x =$ or [3]

$$\sqrt[3]{\frac{x^3 + 2y}{y}} = 2x$$

- (a) (i) Rearrange the formula to make y the subject.

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

- (ii) Find the value of y when x is -2 .

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

(b) $p = \frac{3}{q} + 2$

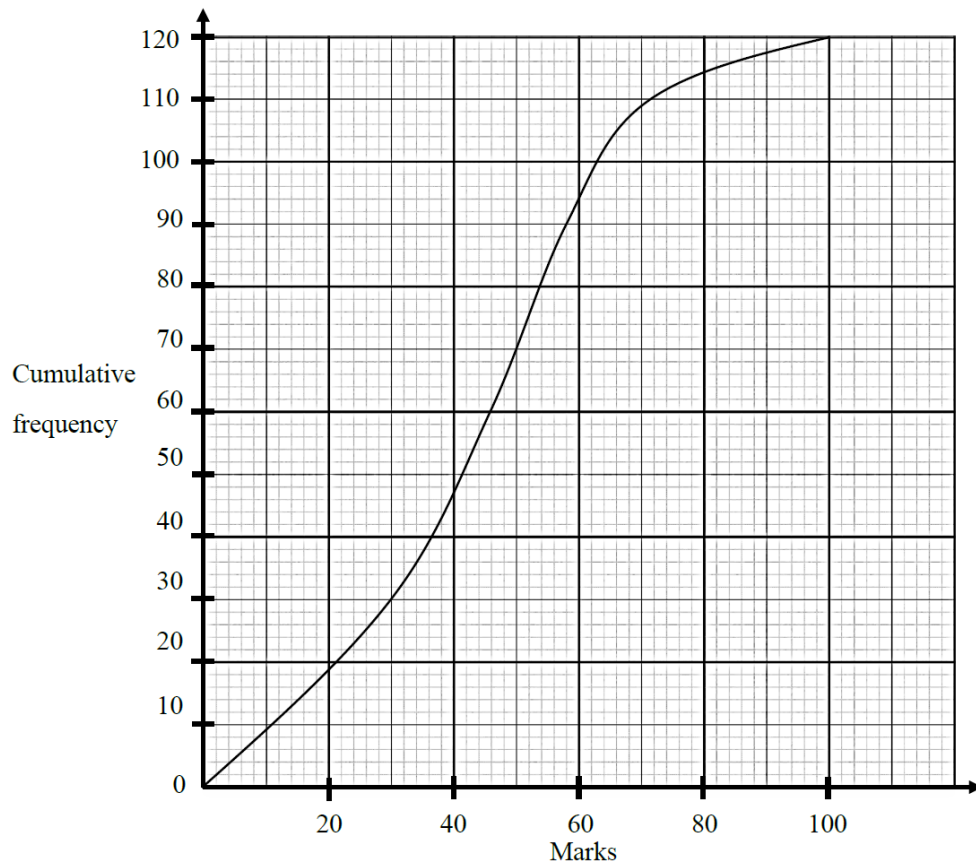
Sue claims that the value of q is undefined when $p = 3$.

Explain why she may be wrong.

.....

 [2]

- 21 The cumulative frequency diagram represents the marks scored by a group of 120 students for a Physics Weighted Assessment.



- (a) Use the diagram to find the interquartile range of the marks scored.

Answermarks [2]

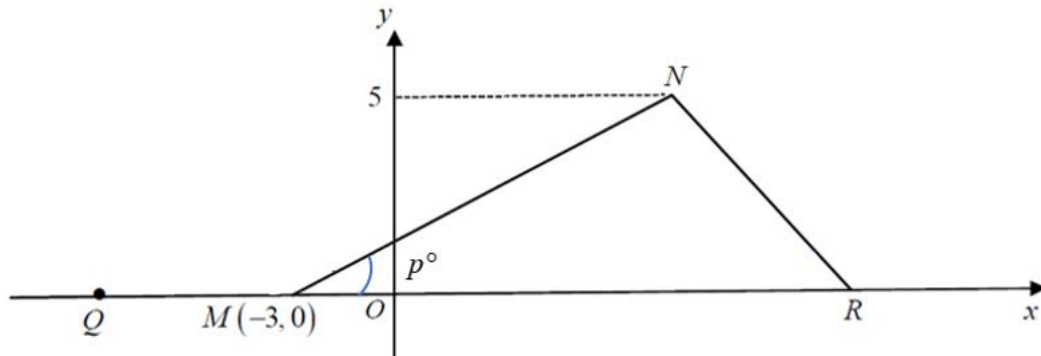
- (b) One of these students is chosen at random.

The probability that the student's mark is greater than t marks is $\frac{5}{12}$.

Find the value of t .

Answer $t =$ [2]

- 22 In triangle MNR , point M is $(-3, 0)$ and angle $NMR = p^\circ$.
 Q is a point on the negative x -axis and $\sin p^\circ = \frac{5}{13}$.



(a) Express as a fraction

(i) $\cos (180^\circ - p^\circ)$,

Answer [1]

(ii) $\tan p^\circ$.

Answer [1]

(b) The area of triangle MNR is 50 square units.

Find the coordinates of R .

Answer (.....,) [2]

23

$$y = k - (x - h)^2$$

- (a) Explain why y has its maximum value when $x = h$.

.....

.....

.....

[1]

- (b) Solve the equation $41 - 12x - x^2 = 0$ by completing the square.
Give your solution correct to 2 decimal places.

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

24 The first four terms in a sequence of numbers, $T_1, T_2, T_3, T_4, \dots$ are given as shown.

$$T_1 = 1 + 2 + 4 = 7$$

$$T_2 = 2 + 5 + 9 = 16$$

$$T_3 = 4 + 8 + 16 = 28$$

$$T_4 = 8 + 11 + 25 = 44$$

(a) Find an expression, in terms of n , for the n th term, T_n , of the sequence.

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

(b) Show that $T_n - T_{n-1} = 2^{n-2} + 2n + 4$.

Answer

[3]

- (c) Hence, explain why the difference between consecutive terms in the sequence is always an even number.

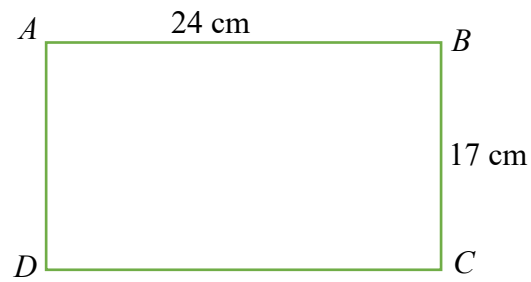
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[1]

25 (a)

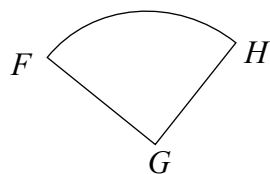


The diagram shows a sheet of rectangular paper $ABCD$ measured 24 cm by 17 cm . The sides AD and BC are joined together to form an open cylinder.

Find the volume of the cylinder, in terms of π .

Answer cm^3 [2]

(b)

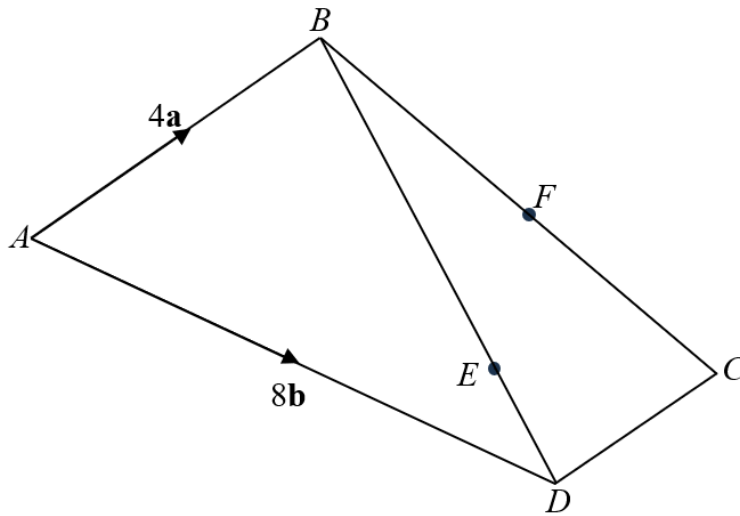


The diagram shows a piece of card in the shape of a quadrant with centre G .
 FG and GH are joined together to form a cone.

The curved surface area of the cone is $72\frac{1}{4}\pi \text{ cm}^2$.

Find the volume of the cone.

Answer cm^3 [4]



$ABCD$ is a quadrilateral.

E is the point on BD such that $BE : BD = 3 : 4$.

F is the midpoint of BC .

$\overrightarrow{AB} = 4\mathbf{a}$, $\overrightarrow{AD} = 8\mathbf{b}$ and $\overrightarrow{EF} = 2(\mathbf{a} - \mathbf{b})$.

- (a) Express $\overrightarrow{BE}$ in terms of $\mathbf{a}$ and $\mathbf{b}$, as simply as possible.

Answer [2]

- (b) Express $\overrightarrow{BC}$ in terms of $\mathbf{a}$ and $\mathbf{b}$, as simply as possible.

Answer [2]

- (c) What type of quadrilateral is $ABCD$?
Explain your answer using vectors.

$ABCD$ is a because

..... [3]

END OF PAPER

BLANK PAPER

Name: Register no: Class:



NGEE ANN SECONDARY SCHOOL

O

PRELIMINARY EXAMINATION

MATHEMATICS

4052/02

Paper 2

26 August 2026

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the 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

Total	/90
--------------	------------

Checked by student:

Date:

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

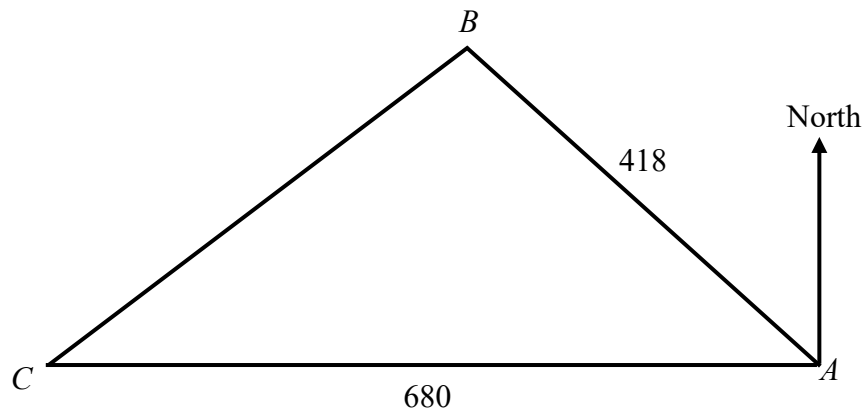
Statistics

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

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

Answer **all** the questions.

1



Points A , B and C are on horizontal ground.

$AB = 418$ m and $AC = 680$ m.

B is on a bearing of 312° from A .

C is due west of A .

(a) Show that $BC = 463.3$ m, correct to one decimal place.

Answer

[2]

- (b) A surveyor is standing at point A and operates a drone hovering vertically above point C .
The surveyor's eye level is 1.74 m above the ground.
The angle of elevation of the drone from the surveyor's eye level is 16.5° .

Estimate the height of the drone above the ground at point C .
Give your answer to one decimal place.

Answerm [2]

- (c) The surveyor receives the following instructions.

Maintaining the same height above the ground, navigate the drone to a point T within triangle ABC such that T is equidistant from points B and C , and is also equidistant from the lines AC and BC .

Using geometrical constructions, locate and label point T on the diagram on the previous page.

[3]

- (d) The surveyor receives further clarification about the location of T .

T is on a bearing of x° from C .
 $CT = y$ m.

By calculation, find the values of x and y .
Do not obtain your answers by measurement from the diagram.

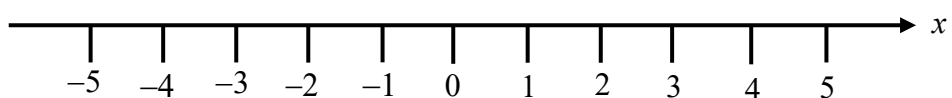
Answer $x = \dots\dots\dots$

$y = \dots\dots\dots$ [5]

- 2 (a) (i) Solve the inequality $-8 < -5x - 3 \leq 12$.

Answer [2]

- (ii) Represent your answer to **part (a)(i)** on this number line.



[1]

- (b) Simplify $25p^{-1} \times \frac{1}{5(-q)^4} \div \frac{5}{pq^4}$.

Answer [2]

- (c) Evaluate $\frac{7^{r+2} - 6(7^{r+1})}{7^r}$.

Answer [2]

(d) Write as a single fraction in its simplest form $\frac{3}{2a-b} - \frac{5a+8b}{4a^2+4ab-3b^2}$.

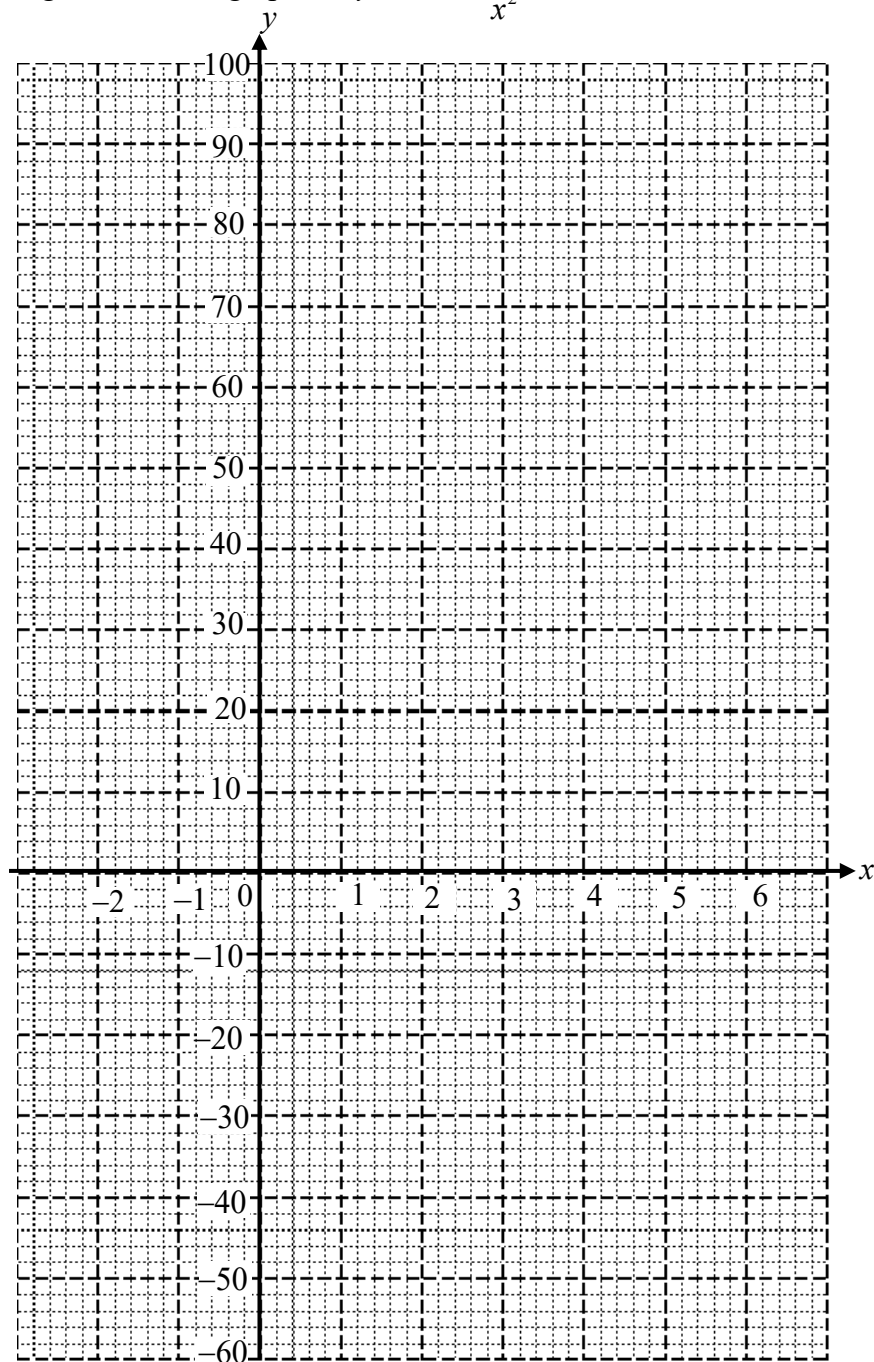
Answer [3]

- 3 (a) (i) Complete the table of values for $y = 100 - \frac{120}{x^2}$.

x	-2	-1	1	2	3	4	5	6
y		-20	-20	70	86.7	92.5	95.2	96.7

[1]

- (ii) On the grid, draw the graph of $y = 100 - \frac{120}{x^2}$ for $-2 \leq x \leq 6$.



[3]

- (iii) By drawing a tangent, estimate the gradient of the curve at $x = 3.5$.

Answer [2]

- (b) Carl has two types of power banks, Power Bank *A* and Power Bank *B*, for charging his mobile phone.

- (i) Using Power Bank *A*, the battery percentage, $y\%$, of Carl's mobile phone after x hours of charging is given by the function $y = 100 - \frac{120}{x^2}$, $x \geq 2$.

What does your answer to **part (a)(iii)** tell you about Power Bank *A*?

.....

..... [1]

- (ii) The solutions to the equation $x^3 - 5x^2 + 12 = 0$ represent the charging durations for which Power Bank *A* and Power Bank *B* charge Carl's phone to the same battery percentage.
Carl has only 4 hours to charge his mobile phone.

By drawing a suitable straight line on the grid, determine whether Carl should use Power Bank *A* or Power Bank *B*.

Answer

[4]

4 (a) $\overrightarrow{PQ} = \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ and $\overrightarrow{QR} = \frac{1}{2} \begin{pmatrix} 9 \\ -3 \end{pmatrix}$.

Explain why the points P , Q and R are collinear.

.....

.....

.....

[2]

(b) The coordinates of Q are $(0, 1)$.

Show that P lies on the x -axis.

Answer

[2]

- (c) The lengths of PR and PQ are in the ratio $1 : n$.

Find the value of n .

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

- (d) A point, S , is positioned such that the area of triangle PRS is 10 units^2 .

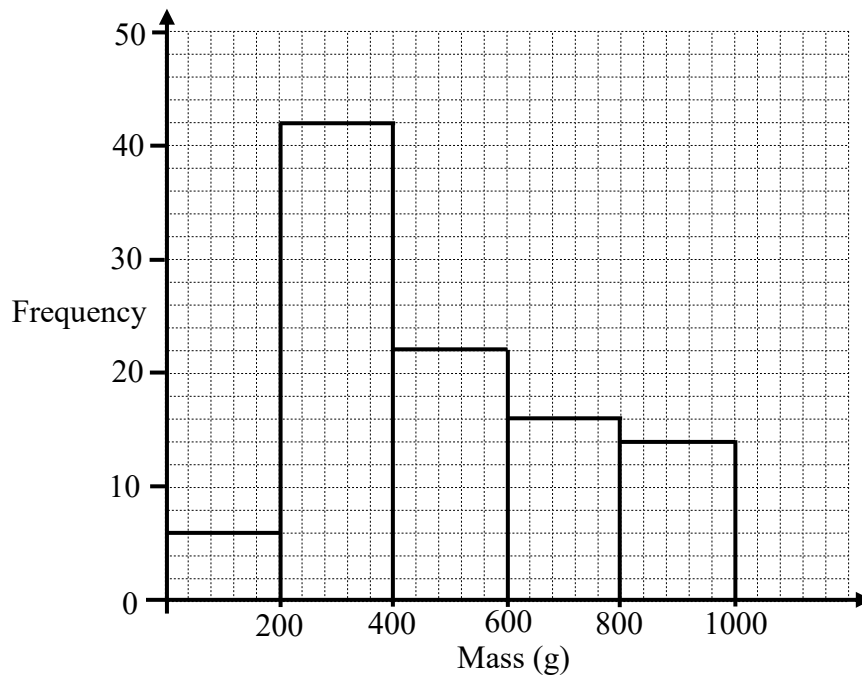
Find the area of triangle PQS .

Answer $\dots\dots\dots \text{units}^2$ [2]

- 5 A sustainability club measures the amount of food waste generated on a particular day by 100 households.

(a) The histogram shows the distribution of food waste generated by the households.

Most households generated less than 400g of food waste that day.



- (i) State one misleading feature of the histogram and explain how it could affect the reader's interpretation of the data.

.....

 [1]

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

Answerg [1]

- (iii) Calculate an estimate of the standard deviation of the masses.

Answerg [1]

- (iv) The club forgot to include the food waste generated by one household.
The household generated 420g of food waste that day.
The club updates the histogram to include this household and recalculates the estimated mean using the grouped data.
The club expects the estimated mean to decrease.

Without calculation, explain whether the club is correct.

.....
.....
.....

[1]

- (b) The club also surveys 80 households from two residential blocks, Block *A* and Block *B*.
Each household is classified according to the main type of food waste it threw away.
The frequency table summarises the data collected.

	Block <i>A</i>	Block <i>B</i>
Cooked Food	22	29
Uncooked Scraps	17	12

- (i) Two households in Block *A* are chosen at random.

Find the probability that both households threw away cooked food.

Answer [2]

- (ii) Three households that threw away uncooked scraps are chosen at random.

Find the probability that exactly one of the households is from Block *B*.

Answer [2]

- 6 An empty water tank has a capacity of 4.8 m^3 .
 An inlet pipe pumps water into the tank at a constant rate of $x \text{ cm}^3/\text{s}$.
 On a particular day, the tank took 1 hour 40 minutes longer than usual to fill because of a crack at the bottom of the tank.
 Water leaked through the crack at a constant rate of $1500 \text{ cm}^3/\text{s}$.

(a) Show that $x^2 - 1500x - 1200000 = 0$.

Answer

[4]

(b) Solve the equation $x^2 - 1500x - 1200000 = 0$.
 Give your solutions correct to two decimal places.

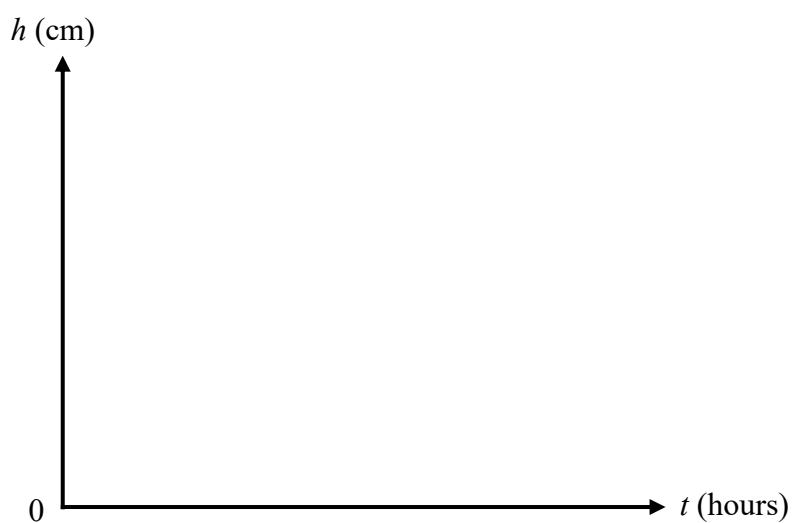
Answer $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

- (c) Hence calculate the time taken to fill the tank on that day.
Give your answer in hours and minutes, correct to the nearest minute.

Answer hours minutes [2]

- (d) The water tank is in the shape of an inverted cone with a height of 200 cm.

On the axes, sketch a graph to show the relationship between the height of the water, h cm, and the time, t hours, as the tank was filled that day.



[1]

7 A café offers the following menu.

Main Dish	Price
Chicken Burger	\$5.80
Vegan Burger	\$4.80

Drink	Price
Apple Juice	\$2.00
Orange Juice	\$2.00

Soup	Price
Chicken Soup	\$2.20
Mushroom Soup	\$2.80
Onion Soup	\$3.00

Set Meal	Price
Chicken Set Meal (Chicken Burger + Chicken Soup + a drink)	\$8.80
Vegan Set Meal (Vegan Burger + Mushroom Soup + a drink)	\$8.50

(a) A customer orders the vegan set meal.

- (i) Find the percentage saving when the customer orders the set meal instead of ordering the items separately.

Answer% [2]

- (ii) The customer receives an $x\%$ discount as a member of the café's loyalty programme.
The total bill, inclusive of a 10% service charge and 9% Goods and Services Tax (GST), is \$9.70.

Find x .

Give your answer to the nearest whole number.

Answer $x =$ [3]

(b) Every month, the café owner reviews the cost and selling prices of the set meals.

The owner uses a 1×2 matrix **D** to represent the new cost prices of the two set meals.

D = **PC**, where

$$\mathbf{P} = \begin{pmatrix} 1.2 & 1.4 & 1.3 \end{pmatrix} \text{ and } \mathbf{C} = \begin{matrix} & \begin{matrix} \text{Chicken} & \text{Vegan} \end{matrix} \\ \begin{pmatrix} 2.20 & 1.80 \\ 0.85 & 1.10 \\ 0.40 & 0.40 \end{pmatrix} & \begin{matrix} \text{Main Dish} \\ \text{Soup} \\ \text{Drinks} \end{matrix} \end{matrix}$$

C represents the original cost prices of the main dish, soup and drink for each set meal.

(i) State what the elements of **P** represent.

.....
 [1]

(ii) Evaluate the matrix **D**.

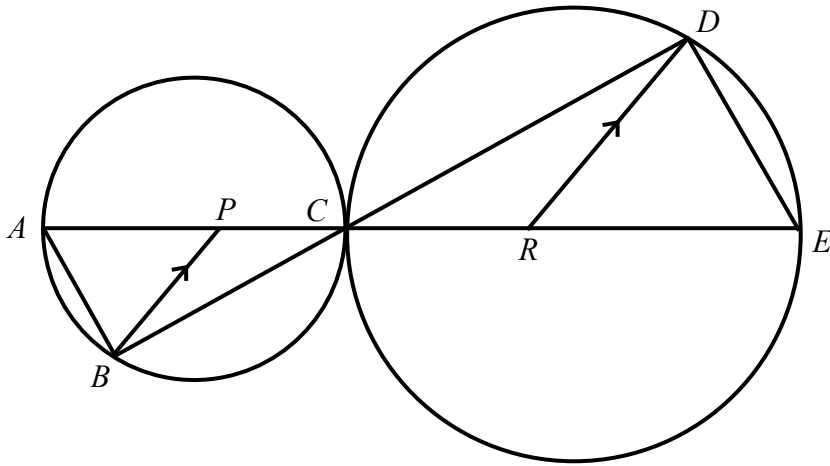
Answer **D** = [2]

(iii) The owner revises the selling price if the percentage profit from selling a set meal is less than 90%.

Determine whether the owner should revise the selling price of the Chicken Set Meal.
 Justify your answer with working.

Answer

[3]



The diagram shows two circles that touch at C .
 A , B and C are points on the smaller circle, diameter APC .
 C , D and E are points on the larger circle, diameter CRE .
 $APCRE$ and BCD are straight lines.
Angle $PBC = 0.37$ rad and angle $CRD = 2.27$ rad.
 BP is parallel to DR .

- (a) Identify another pair of parallel lines.
Give a reason for each statement you make.

.....
.....
.....

[2]

- (b) Show that triangle ABP is similar to triangle EDR .
Give a reason for each statement you make.

.....
.....
.....

[3]

- (c) Let O be the centre of the smaller circle.
The radius of the smaller circle is 8 cm.

- (i) Show that angle $BOC = 2.138$ rad, correct to three decimal places.

Answer

[3]

- (ii) Hence calculate the length of the minor arc BC .

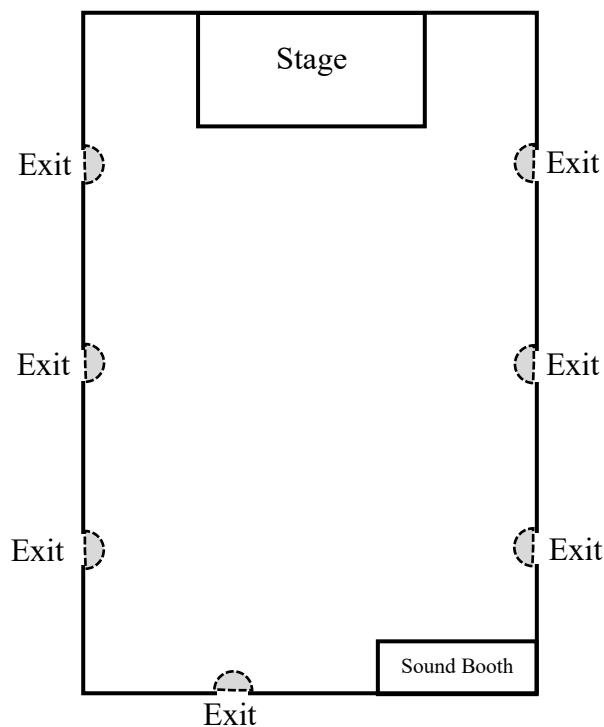
Answercm [1]

- 9 Nate plans a charity concert in the school hall.
The school provides him with the following information to determine the maximum number of concert tickets that can be sold.

Safety directives

- To ensure safe emergency evacuation, there must be a semicircular clear zone with a radius of 1 m in front of each exit.
- The usable area excludes the stage, the sound booth and the clear zones.
- Standing Zone: maximum crowd density is 1.4 persons per m^2 of usable area.
- Seated Zone: maximum crowd density is 1.0 persons per m^2 of usable area.

Floor plan of the hall drawn accurately to a scale of 1 : 400



- (a) Find the maximum number of standing concert tickets that can be sold.
Give your answer correct to the nearest whole number.

Answer [4]

Nate considers two ticketing options and their associated logistical costs.

Ticketing Option 1: Pure Standing Setup

- Standing tickets: \$18 per ticket

Ticketing Option 2: Hybrid Setup (Seated + Standing)

- The usable area is divided into three distinct zones: the Seated Zone that is nearest the stage, followed by the Safety Zone, then the Standing Zone.
- The Safety Zone is a horizontal strip, 1.2 m wide, separating the Seated Zone from the Standing Zone.
- After excluding the Safety Zone, the remaining usable area is divided in the ratio 3 : 2 between the Seated Zone and the Standing Zone respectively.
- Seated tickets: \$32 per ticket
- Standing ticket: \$15 per ticket

Logistical Costs

- Fixed setup cost: The logistics team charges a fixed fee of \$1500 for Option 1. This fee is 20% higher for Option 2 due to the additional logistics required for chair installation.
- Transaction fee: A fee of \$1.50 is charged by the online ticketing vendor for every ticket sold.

- (b) Determine the option that Nate should select.
Justify the decision you make and show your calculations clearly.

Answer

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Ngee Ann Secondary School
 Secondary 4&5 Elementary Mathematics-O
 2026 Prelim paper 1
Marking Scheme

Qn No.	Qn Part	Solutions	Marks (Remarks)	Total
1		$(3x-2)(8x^2-5x+1)$ $= 24x^3 - 15x^2 + 3x - 16x^2 + 10x - 2$ $= 24x^3 - 31x^2 + 13x - 2$	M1: Expansion A1	[2]
2	(a)	50 mins	B1	[1]
	(b)	She is incorrect as the number of patients who have waiting time less than 43 minutes is the same/equal as the number of patients who have waiting time more than 66 minutes.	B1	[1]
3		$81 = 3^4$ $108 = 2^2 \times 3^3$ LCM: $2^2 \times 3^4 = 324$	M1: either prime factorisation A1	[2]
4		$\frac{3(2k)}{4} = k - \frac{6(2k)-5}{5}$ $30k = 20k - 48k + 20$ $58k = 20$ $k = \frac{10}{29}$	M1: substitute x with 2k A1	[2]
5	(a)	2	B1	[1]
	(b)	9	B1	[1]
6	(a)	$15\pi - 24\pi b + 3\pi^2$ $= 3\pi(5 - 8b + \pi)$	B1	[1]
	(b)	$4x^2 + 9y^2 - 12xy - 64$ $= (2x - 3y)^2 - 64$ $= (2x - 3y - 8)(2x - 3y + 8)$	M1: $(2x - 3y)^2$ A1	[2]

7		$\frac{5x}{6} - \frac{3(x-1)}{4} + \frac{2x+7}{12}$ $= \frac{10x}{12} - \frac{9(x-1)}{12} + \frac{2x+7}{12}$ $= \frac{10x - 9x + 9 + 2x + 7}{12}$ $= \frac{3x + 16}{12}$	M1: common denominator A1	[2]
8	(a)	1.57 (3 sf)	B1	[1]
	(b)	11 and 12	B1 (B1)	[2]
9	(a)	547.39 billion $= 547.39 \times 10^9$ $= 5.4739 \times 10^{11}$	B1	[1]
	(b)	$\frac{5.4739 \times 10^{11}}{6.037 \times 10^6}$ $= \text{USD } 90\,672.52$	M1 A1	[2]
10		$3x + 5y = 4$ $7x - 4y = -22$ $12x + 20y = 16$ $35x - 20y = -110$ $47x = -94$ $x = -2$ $y = 2$	M1: Substitution/ Elimination A1 A1	[3]
11	(a)	Angle OAB is 90° because tangent is perpendicular to the radius.	B1	[1]
	(b)	Area of quadrilateral - Area of sector $= 6 \times 11 - \frac{126}{360} \times \pi (6)^2$ $= 26.4 \text{ cm}^2$	M1: either area A1	[2]
12	(a)	1 cm is to 60 km 24 cm is to 1440 km	B1	[1]
	(b)	1 cm^2 is to 3600 km^2 $1574722 \div 3600 = 437.4227778$ $= 437 \text{ cm}^2$	M1: area scale A1	[2]

13	(a)	$BD^2 = 20^2 = 400$ $BC^2 + CD^2 = 12^2 + 16^2$ $= 400$ Since $BD^2 = BC^2 + CD^2$, by Converse of Pythagoras' Theorem, it is a right angled triangle where BD is the hypotenuse. Hence BC is perpendicular to CD . OR $\cos BCD = \frac{12^2 + 16^2 - 20^2}{2(12)(16)}$ Angle BCD = 90° Hence BC is perpendicular to CD .	B1 B1	[1]
	(b)	$\cos x + \sin x$ $= -\cos CDB + \sin CDB$ $= -\frac{16}{20} + \frac{12}{20}$ $= -\frac{1}{5}$	M1: either value A1	[2]
14		$\frac{3x^2 + 7x - 40}{18x^3 - 128x}$ $= \frac{(3x-8)(x+5)}{2x(9x^2-64)}$ $= \frac{(3x-8)(x+5)}{2x(3x-8)(3x+8)}$ $= \frac{x+5}{2x(3x+8)} \text{ or } \frac{x+5}{6x^2+16x}$	M1: factorise numerator M1: factorise denominator A1	[3]
15		Angle $CDA = 132^\circ \div 2 = 66^\circ$ (angle at centre = 2 angles at circumference) Angle $CBA = 180^\circ - 66^\circ = 114^\circ$ (angles in opposite segment) Angle $CBP = 180^\circ - 114^\circ = 66^\circ$ (adjacent angles on a straight line)	B1 with reason B1 with reason B1: value of 66°	[3]

16		Size of interior angle : $(360^\circ - 60^\circ) \div 2 = 150^\circ$ Size of exterior angle: $180^\circ - 150^\circ = 30^\circ$ Number of sides: $360^\circ \div 30^\circ = 12$ sides	M1: interior angle M1: exterior angle A1	[3]
17	(a)	The principal value increases every month, hence the appreciation value is not 1.2% of \$56700.	B1	[1]
	(b)	$58900 \left(1 + \frac{0.1}{100}\right)^{36}$ $= \$61057.93$	M1 A1	[2]
18		Let x be the cash price of the sofa bed. Total amount: $0.25x + 26 \times 88$ Interest: $(0.75x)(0.08)(26/12)$ $= 0.13x$ $1.13x = 0.25x + 2288$ $0.88x = 2288$ $x = \\$2600$	M1: Interest M1: correct equation A1	[3]
19	(a)	1 cupboard : 96 man- hours $96 \div (3 \times 4) = 8$ days $8 - 2 = 6$ days	M1: total number of days A1	[2]
	(b)	$y^3 = \frac{k}{x^2}$ where k is a constant $k \left(\frac{1}{4^2} - \frac{1}{8^2} \right) = 3$ $k \left(\frac{1}{16} - \frac{1}{64} \right) = 3$ $\frac{3}{64} k = 3$ $k = 64$ $x = 8$ or -8	M1 M1: Find k A1	[3]

20	(a)(i)	$\sqrt[3]{\frac{x^3 + 2y}{y}} = 2x$ $\frac{x^3 + 2y}{y} = (2x)^3$ $x^3 + 2y = 8x^3 y$ $x^3 = 8x^3 y - 2y$ $x^3 = y(8x^3 - 2)$ $y = \frac{x^3}{8x^3 - 2}$	M1: Cube on both sides M1: Terms with y on one side A1	[3]
	(a)(ii)	$y = \frac{(-2)^3}{8(-2)^3 - 2}$ $y = \frac{4}{33}$	B1	[1]
	(c)	$p = \frac{3}{q} + 2$ $pq = 3 + 2q$ $q(p - 2) = 3$ $q = \frac{3}{p - 2}$ It is inaccurate as q is undefined only when p = 2.	B1: Make q the subject B1	[2]
21	(a)	$58 - 30 = 28$	M1: either value A1	[2]
	(b)	$\frac{7}{12} \times 120 = 70$ Score: 50	B1: 70 B1	[2]
22	(a)(i)	$-\frac{12}{13}$	B1	[1]

	(a)(ii)	$\frac{5}{12}$	B1	[1]
	(b)	$\frac{1}{2}(5)(b) = 50$ $b = 20$ $20 - 3 = 17$ $R(17, 0)$	M1 A1	[2]
23	(a)	Since $(x-h)^2$ is always positive or zero for all values of x, the maximum value of y occurs when $(x-h)^2 = 0$. Hence, the maximum value happens when $x-h=0$ or $x=h$.	B1	[1]
	(b)	$41 - 12x - x^2 = 0$ $x^2 + 12x - 41 = 0$ $(x+6)^2 - 36 - 41 = 0$ $(x+6)^2 = 77$ $(x+6) = \pm\sqrt{77}$ $x = -6 \pm \sqrt{77}$ $x = 2.77 \text{ or } -14.77$	M1 A1, A1	[3]
24	(a)	$T_n = 2^{n-1} + (3n-1) + (n+1)^2$	B1: all 3 terms correct B1: Any correct term	[2]
	(b)(ii)	$T_n - T_{n-1}$ $= 2^{n-1} + (3n-1) + (n+1)^2 - [2^{n-2} + (3(n-1)-1) + (n)^2]$ $= 2^{n-1} + 3n - 1 + n^2 + 2n + 1 - 2^{n-2} - 3n + 4 - n^2$ $= 2^{n-1} + 2n - 2^{n-2} + 4$ $= 2^{n-2}(2-1) + 2n + 4$ $= 2^{n-2} + 2n + 4$	M1: Replace n by $n-1$ M1: expansion M1	[3]

	(c)	Since the difference of the consecutive terms could be expressed as $2(2^{n-3} + n + 2)$ and n must be a natural number/ positive integer , the difference is always an even number.	B1: must take out factor of 2	[1]
25	(a)	Let r be the radius of the cylinder. $24 = 2\pi r$ $r = \frac{12}{\pi}$ Volume: $\pi \left(\frac{12}{\pi}\right)^2 (17)$ $= \frac{2448}{\pi} \text{ cm}^3$	M1: length = circumference A1	[2]
	(b)	Let the radius of circle be l and radius of the cone be r. Arc length FH: $\frac{1}{4}(2\pi l)$ $\frac{1}{4}(2\pi l) = 2\pi r$ $r = \frac{1}{4}l$ Curved surface area: $\pi \left(\frac{1}{4}l\right) l = 72\frac{1}{4}$ $l = 17$ Volume of cone: $\frac{1}{3} \pi \left(\frac{1}{4}l\right)^2 \sqrt{289 - \frac{289}{16}}$ $= 311.34438 \text{ cm}^3$ $= 311 \text{ cm}^3$	M1: arc length = circumference M1: Find l M1: height of cone A1	[4]
26	(a)	$\overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD}$ $= 8\mathbf{b} - 4\mathbf{a}$	M1: Find $\overrightarrow{BD}$	

		$\overrightarrow{BE} = \frac{3}{4}(8\mathbf{b} - 4\mathbf{a})$ $= 6\mathbf{b} - 3\mathbf{a}$	A1	[2]
	(b)	$\overrightarrow{BF} = \overrightarrow{BE} + \overrightarrow{EF}$ $= -3\mathbf{a} + 6\mathbf{b} + 2\mathbf{a} - 2\mathbf{b}$ $= 4\mathbf{b} - \mathbf{a}$ $\overrightarrow{BC} = 2(4\mathbf{b} - \mathbf{a})$ $= 8\mathbf{b} - 2\mathbf{a}$	M1: Find $\overrightarrow{BF}$ A1	[2]
	(c)	$\overrightarrow{DC} = \overrightarrow{DB} + \overrightarrow{BC}$ $= 4\mathbf{a} - 8\mathbf{b} + 8\mathbf{b} - 2\mathbf{a}$ $= 2\mathbf{a}$ Since $\overrightarrow{AB} = 2\overrightarrow{DC}$, AB is parallel to DC. ABCD is a trapezium because it has only one pair of parallel lines .	M1: Find $\overrightarrow{DC}$ M1 A1	[3]

Ngee Ann Secondary School
 Secondary 4&5 Mathematics-O
 2026 Prelim Examinations Paper 2
Marking Scheme

1(a)	$\angle BAC = 312^\circ - 270^\circ = 42^\circ$ $BC^2 = 418^2 + 680^2 - 2(418)(680)\cos 42^\circ$ $BC = \sqrt{214661.0296}$ $= 463.315$ $= 463.3 \text{ m (to 1 d.p.)}$	[M1] [M1: at least 2 d.p.] [AG]
1(b)	Let the drone be at point S. Let the point above C and at eye level of surveyor be point E. $\tan 16.5^\circ = \frac{SE}{680}$ $SE = 680 \tan 16.5^\circ$ $= 201.425...$ Height of drone above C $= 201.425 + 1.74$ $= 203.165$ $= 203.2 \text{ m (1 d.p.)}$	[M1] [A1]
1(c)		[B1: construction of perpendicular bisector] [B1: construction of angle bisector] [B1: correct identification of point T]
1(d)	$\frac{\sin \angle BCA}{418} = \frac{\sin 42^\circ}{463.315}$ $\sin \angle BCA = \frac{418 \sin 42^\circ}{463.315}$ $\angle BCA = \sin^{-1} \left(\frac{418 \sin 42^\circ}{463.315} \right)$ $= 37.1343^\circ$ Bearing of T from C	[M1] [M1]

$$= 90^\circ - \frac{37.1343^\circ}{2}$$

$$= 71.43284^\circ$$

$$= 71.4^\circ$$

[A1]

Let the foot of perpendicular from T to BC be D .

$$CD = \frac{463.315}{2}$$

[M1]

$$= 231.6575$$

$$\angle DCT = \frac{37.1343^\circ}{2}$$

$$= 18.56715^\circ$$

$$\cos 18.56715^\circ = \frac{231.6575}{CT}$$

$$CT = 244.377$$

$$= 244 \text{ m (3 s.f.)}$$



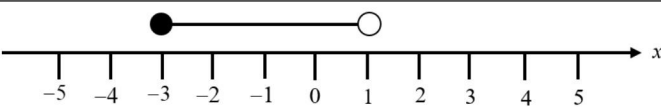
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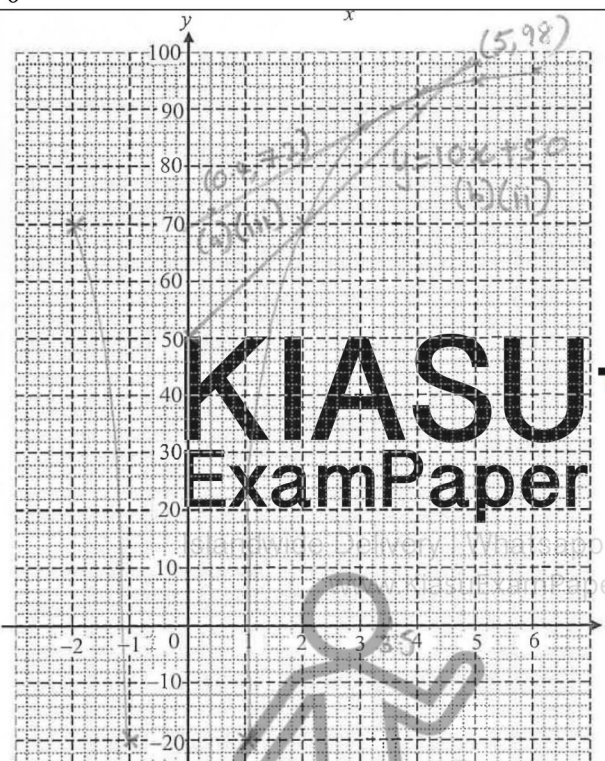
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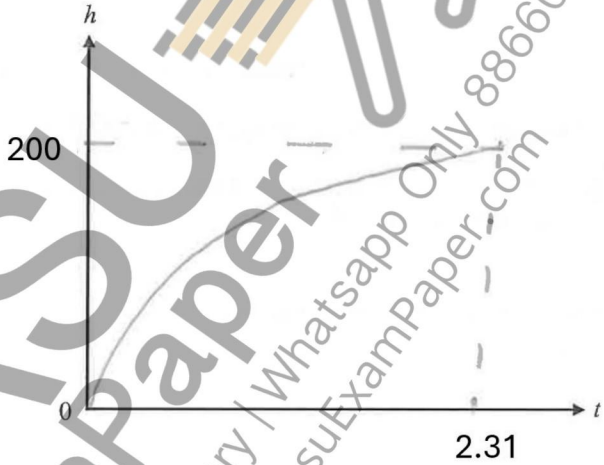
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2(a)(i)	$-8 < -5x - 3 \leq 12$ $-5 < -5x \leq 15$ $-3 \leq x < 1$	[M1] [A1]
2(a)(ii)		[B1]
2(b)	$\frac{25}{p} \times \frac{1}{5q^4} \times \frac{pq^4}{5}$ $= 1$	[M1: for $\frac{25}{p}$ or $\frac{1}{5q^4}$] [A1]
2(c)	$\frac{7^{r+1}[7-6]}{7^r}$ or $\frac{7^r[7^2-6(7)]}{7^r}$ $= 7$	[M1] [A1]
2(d)	$\frac{3}{2a-b} - \frac{5a+8b}{4a^2+4ab-3b^2}$ $= \frac{3}{2a-b} - \frac{5a+8b}{(2a-b)(2a+3b)}$ $= \frac{3(2a+3b) - (5a+8b)}{(2a-b)(2a+3b)}$ $= \frac{6a+9b-5a-8b}{(2a-b)(2a+3b)}$ $= \frac{a+b}{(2a-b)(2a+3b)}$	[M1: factorise denominator] [M1: make denominators the same] [A1]

3(a)(i)	70	[B1]
3(a)(ii)	 [B1: 7 points plotted correctly] [B1: All points plotted correctly] [B1: Smooth curve passing through all points]	
3(a)(iii)	Estimated gradient $= \frac{98 - 72}{5 - 0.4}$ $= 5.65 \text{ (3 s.f.)}$	[M1: drawing of tangent] [A1: accept 5.2 to 6.0]
3(b)(i)	At/After <u>3.5 h</u> of charging, Power Bank <i>A</i> 's rate of charging is <u>5.65% per hour</u> .	[B1: allow for ecf]
3(b)(ii)	$x^3 - 5x^2 + 12 = 0$ $x - 5 + \frac{12}{x^2} = 0$ $10x - 50 + \frac{120}{x^2} = 0$ $10x + 50 = 100 - \frac{120}{x^2}$ Draw $y = 10x + 50$ Since the <u>battery percentage after 4h is higher with Power Bank <i>A</i> (92.5% > 90%)</u>, Carl should charge his phone using <u>Power Bank <i>A</i></u>.	[M1] [M1: drawing of line on diagram] [M1: or any reasonable explanation] [A1]

4(a)	$\overrightarrow{QR} = -\frac{3}{2} \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ $= -\frac{3}{2} \overrightarrow{PQ}$ Since $\overrightarrow{QR} = -\frac{3}{2} \overrightarrow{PQ}$, $QR \parallel PQ$, and they <u>have a common point Q</u>, the points P, Q and R are collinear.	[B1] [B1: with conclusion]
4(b)	$\overrightarrow{PQ} = \overrightarrow{OQ} - \overrightarrow{OP}$ $\overrightarrow{OP} = \overrightarrow{OQ} - \overrightarrow{PQ}$ $= \begin{pmatrix} 0 \\ 1 \end{pmatrix} - \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ $= \begin{pmatrix} 3 \\ 0 \end{pmatrix}$ Since the <u>y-coordinate of P is 0</u>, P lies on the x-axis.	[M1] [M1: with conclusion]
4(c)	$\overrightarrow{PR} = \overrightarrow{PQ} + \overrightarrow{QR}$ $= \begin{pmatrix} -3 \\ 1 \end{pmatrix} - \frac{3}{2} \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ $= -\frac{1}{2} \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ $= -\frac{1}{2} \overrightarrow{PQ}$ So, $\overrightarrow{PR} = \frac{1}{2} \overrightarrow{PQ}$, that means $\frac{ \overrightarrow{PR} }{ \overrightarrow{PQ} } = \frac{1}{2}$. $\overrightarrow{PR} : \overrightarrow{PQ} = 1 : 2$ $n = 2$	[M1: accept other reasonable methods, e.g. use of diagram] [A1]
4(d)	$\frac{\text{Area of } \triangle PQS}{\text{Area of } \triangle PRS} = \frac{PQ}{PR}$ $\frac{\text{Area of } \triangle PQS}{10} = \frac{2}{1}$ Area of $\triangle PQS = 20 \text{ units}^2$	[M1] [A1]

5(a)(i)	The <u>title</u> is misleading because it interprets the data for the reader and is <u>biased</u> . In fact, less than 50% of the households (48%) generated less than 400g of food waste that day.	[B1: accept other reasonable answers]
5(a)(ii)	480 g	[B1]
5(a)(iii)	234 g (3 s.f.)	[B1]
5(a)(iv)	In calculating the new estimated mean, the amount of food waste contributed by the additional household, 420g, will be estimated to be 500 g > 480 g . The new estimated mean will be higher than the original one, thus the club is incorrect .	[B1: accept other reasonable answers]
5(b)(i)	$\frac{22}{39} \times \frac{21}{38}$ $= \frac{77}{247}$	[M1] [A1]
5(b)(ii)	$3 \left(\frac{12}{29} \times \frac{17}{28} \times \frac{16}{27} \right)$ $= \frac{272}{609}$	[M1: for the working in bracket] [A1]

6(a)	$4.8 \text{ m}^3 = 4800000 \text{ cm}^3$ Time taken to fill tank without leak $= \frac{4800000}{x} \text{ s}$ Time taken to fill tank with leak $= \frac{4800000}{x-1500} \text{ s}$ $\frac{4800000}{x-1500} - \frac{4800000}{x} = 6000$ $800x - 800(x-1500) = x(x-1500)$ $1200000 = x^2 - 1500x$ $x^2 - 1500x - 1200000 = 0 \text{ (shown)}$	[M1] [M1: finding difference in time, i.e. LHS of equation] [M1: removing denominator] [A1] [AG]
6(b)	$x^2 - 1500x - 1200000 = 0$ $x = \frac{-(-1500) \pm \sqrt{(-1500)^2 - 4(1)(-1200000)}}{2}$ $x = 2077.59 \text{ or } -577.59 \text{ (2 d.p.)}$	[M1] [A1, A1]
6(c)	Time taken to fill tank that day $= \frac{4800000}{2077.59 - 1500}$ $= 8310.39 \text{ s}$ $= 2 \text{ h } 19 \text{ min (nearest minute)}$	[M1] [A1]
6(d)		[B1: correct shape of curve; labeling of axes not necessary]

7(a)(i)	Cost without set meal = $4.80 + 2.80 + 2.00$ = \$9.60 Percentage savings = $\frac{9.60 - 8.50}{9.60} \times 100\%$ = 11.5% (3 s.f.)	[M1] [A1]
7(a)(ii)	$\left(1 - \frac{x}{100}\right)(1.1)(1.09)(8.5) = 9.7$ $1 - \frac{x}{100} = \frac{9.7}{10.1915}$ $\frac{x}{100} = 1 - \frac{9.7}{10.1915}$ $x = 4.8226$ $x = 5$ (nearest whole number)	[M1: correctly accounting for service charge and GST] [M1: correctly accounting for discount] [A1]
7(b)(i)	The elements of P suggest that the cost of main dish, soup and drinks have <u>increased by 20%, 40% and 30% respectively</u>.	[B1: accept other reasonable answer]
7(b)(ii)	$(1.2 \quad 1.4 \quad 1.3) \begin{pmatrix} 2.20 & 1.80 \\ 0.85 & 1.10 \\ 0.40 & 0.40 \end{pmatrix}$ = (4.35 4.22)	[B1; B1]
7(b)(iii)	Percentage profit = $\frac{8.8 - 4.35}{4.35} \times 100\%$ = 102% (3 s.f.) Since <u>102% > 90%</u>, the owner <u>should not</u> revise the selling price of the Chicken Set Meal.	[M1] [A1] [A1: include justification and conclusion]

8(a)	$\angle ABC = \angle CDE = \frac{\pi}{2}$ rad (right $\angle$ in a semicircle) $AB \parallel DE$ because $\angle ABC$ and $\angle CDE$ are <u>alternate angles</u> .	[B1: reason] [B1: correct pair of parallel lines and reason]
8(b)	$\angle CDR = \angle PBC = 0.37$ rad (alt. $\angle$ s) $A: \angle ABP = \angle EDR = \left(\frac{\pi}{2} - 0.37\right)$ rad $\angle BPC = \angle CRD = 2.27$ rad (alt. $\angle$ s) $A: \angle APB = \angle ERD = (\pi - 2.27)$ rad (adj. $\angle$ s on a st. line) By AA, triangle ABP is similar to triangle EDR .	[B1: any correct value for pair of angles, i.e. $\angle APB$ and $\angle ERD$ or $\angle ABP$ and $\angle EDR$] [B1: any correct reason] [B1]
8(c)(i)	$\angle BAC = \pi - \angle ABP - \angle APB$ ($\angle$ sum of Δ) $= \pi - \left(\frac{\pi}{2} - 0.37\right) - (\pi - 2.27)$ $= 1.06920$ $\angle BOC = 2 \times 1.06920 \dots$ ($\angle$ at centre = 2 $\angle$ at circumference) $= 2.1384 \dots$ rad $= 2.138$ rad (3 d.p.)	[M1: reason not needed] [M1: reason not needed] [A1: at least 4 d.p.] [AG]
8(c)(ii)	Arc length $= (8)(2.138 \dots)$ $= 17.1$ cm (3 s.f.)	[B1]

9(a)	Area of hall = $(9 \times 4) \times (6 \times 4)$ $= 864 \text{ m}^2$ Area of stage = $(1.5 \times 4) \times (3 \times 4)$ $= 72 \text{ m}^2$ Area of sound booth = $(0.7 \times 4) \times (2.1 \times 4)$ $= 23.52 \text{ m}^2$ Area of clear zones = $\pi(1)^2 \times 3.5$ $= 10.99557 \text{ m}^2$ Total usable area = $864 - 72 - 23.52 - 10.99557$ $= 757.48443 \text{ m}^2$ Maximum number of standing tickets = 757.48443×1.4 $= 1060.478$ $= 1060$ (nearest whole number)	[M1: area of clear zones] [M1: subtraction] [M1] [A1]
9(b)	Option 1: Revenue = 1060×18 $= \\$19080$ Cost = $1500 + 1072 \times 1.5$ $= \\$3108$ Profit = $19080 - 3108$ $= \\$15972$ Option 2: Usable area excluding safety zone $= 757.48443 - 1.2 \times (6 \times 4)$ $= 728.68443 \text{ m}^2$ Usable area for Seated Zone = $\frac{3}{5} \times 728.68443$ $= 437.21 \text{ m}^2$ Maximum number of seated tickets = 437.21×1 $= 437$ (nearest whole number) Usable area for Standing Zone = $\frac{2}{5} \times 728.68443$ $= 291.47 \text{ m}^2$ Maximum number of standing tickets = 291.47×1.4 $= 408.058$ $= 408$ (rounded down for safety) Revenue = $437 \times 32 + 408 \times 15$ $= \\$20104$ Cost = $1.2 \times 1500 + (442 + 412) \times 1.5$	[M1: correct finding of revenue/cost] [M1] [M1] [M1: correct usable area for Seated or Standing Zone] [M1: correct maximum number of seated or standing tickets]

= \$3081 Profit = $20104 - 3081$ = \$17023 Since $\\$17023 > \\15972, Nate should select Option 2 to maximise profit and raise more funds for charity.	[M1: correct finding of revenue/cost] [A1: correct justification and conclusion]
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NAME:

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PRELIMINARY EXAMINATION 2026

SUBJECT : MATHEMATICS
SUBJECT CODE /PAPER : 4052/01
LEVEL/STREAM : Sec 4 Express, 5 Normal (Academic)
DURATION : 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

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 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 1 decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination fasten all your work securely together.

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

The total of the marks for this paper is 90.

Submit Part A and Part B separately.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Part A
Answer **all** the questions.

- 1 **(a)** Express 0.000156 in standard form.

Answer [1]

- (b)** Work out $(8.3 \times 10^{150}) - (6.5 \times 10^{149})$.

Give your answer in standard form.

Answer [1]

-
- 2 The bearing of Q from P is 072° .

Find the bearing of P from Q .

Answer [2]

- 3 Given that $8^{y+1} = 32^3$, find y .

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

- 4 $\sin\left(\frac{x}{2}\right)^\circ = 0.6$

Find two possible values of x in the range $0 \leq x \leq 360$.

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [2]

- 5 Expand and simplify $(2x-3)(x+5)-(x-1)^2$.

Answer

Answer [3]

-
- 6 A collector has a collection of Pokémon cards.
34% of the cards are 'Common' rarity.
Of the remaining cards, 60% are 'Rare' rarity.
The other 132 cards are 'Legendary' rarity.
Calculate the total number of cards in the collection.

Answer cards [3]

7 The sum of the interior angles of a regular polygon is 2340° .

(a) Find the number of sides of the polygon.

Answer sides [2]

(b) Hence, find the size of each exterior angle of the polygon.

Answer [1]

8 $p = \frac{2x+8}{x+1}$

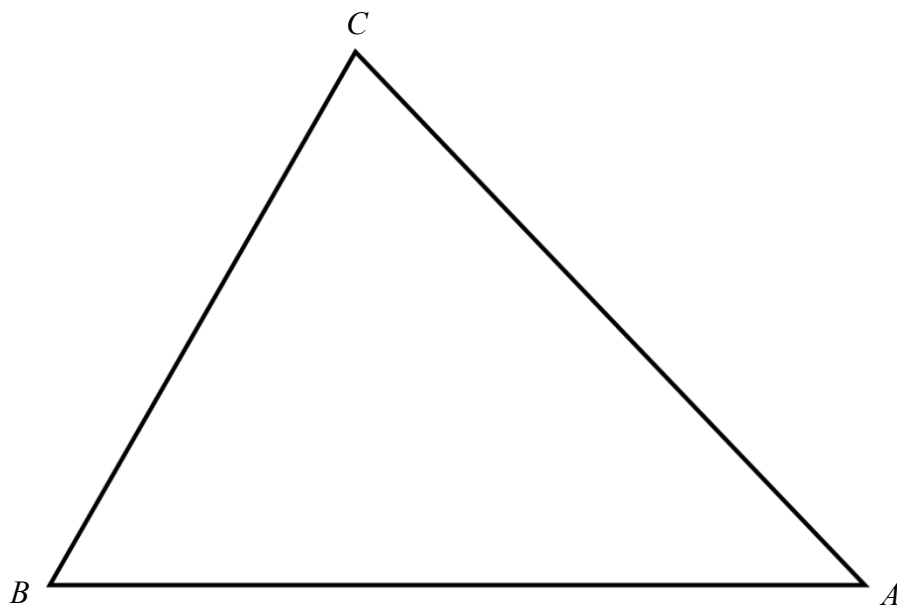
(a) Make x the subject of the formula.

Answer $x =$ [2]

(b) Hence, find the value of x when $p = 3$.

Answer $x =$ [1]

- 9 The diagram shows triangle ABC .



(a) Construct the perpendicular bisector of AB . [1]

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

(c) A point P lies inside the triangle such that P is nearer to A than to B , and nearer to BA than to BC .

Shade the region in which P must lie. [1]

- 10** The intensity of light, I lux, received from a light source is inversely proportional to the square of the distance, d metres, from the source. The distance from the source is increased by 60% of its original value. Calculate the percentage reduction in the intensity of light.

Answer% [3]

- 11** The stem-and-leaf diagram shows the reaction times, in seconds, of 12 drivers when responding to an unexpected hazard during a driving assessment.

2		3	5	8			
3		1	2	5	<i>c</i>	8	9
4		1	4	7			

Key: 3 | 1 represents 3.1 seconds

The median of the data is 3.65.

Find

- (a)** the interquartile range of reaction times,

Answer seconds [1]

- (b)** the value of *c*.

Answer c = [2]

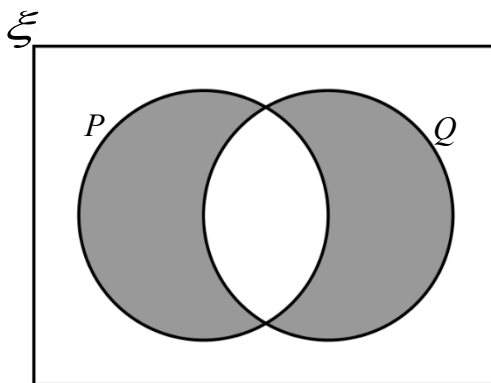
- 12** A company manufactures two geometrically similar replica of World Cup trophies: a standard replica and a large replica.
- The amount of gold plating needed for the large replica is 4 times the amount of gold plating needed for the standard replica.
- (a)** Find the ratio of the height of the standard replica to the height of the large replica.

Answer : [1]

- (b)** The standard replica has a mass of 300 g.
- Calculate the mass of the large replica.

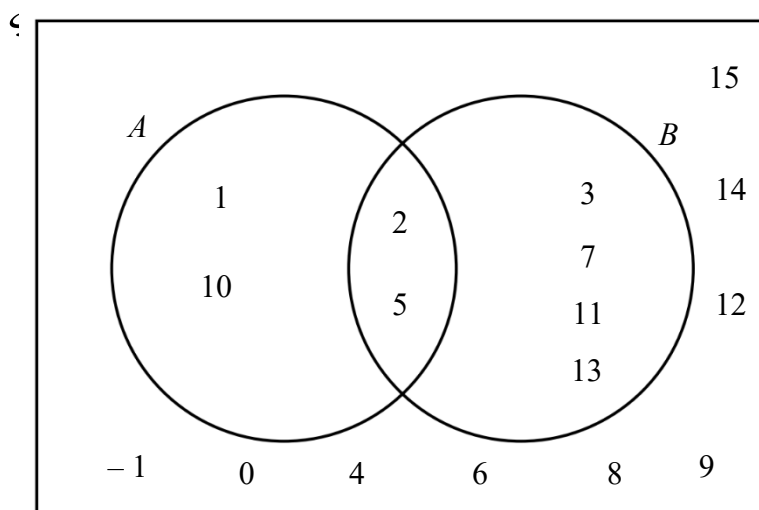
Answer g [2]

- 13 (a) Use set notation to describe the shaded region.



Answer [1]

- (b) The Venn diagram shows the universal set and the elements in each of its subsets.



- (i) Describe the elements of set A .

Answer

.....

 [1]

- (ii) List the elements in $A' \cap B'$.

Answer $A' \cap B' = \dots\dots\dots$ [1]

- (iii) Find $n\left[(A \cap B') \cup (A' \cap B)\right]$.

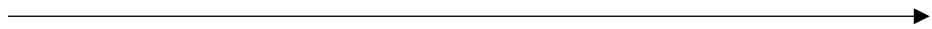
Answer $n\left[(A \cap B') \cup (A' \cap B)\right] = \dots\dots\dots$ [1]

- 14 (a) Solve the inequality $\frac{x+2}{4} \leq 5-2x < 13$.

Answer [3]

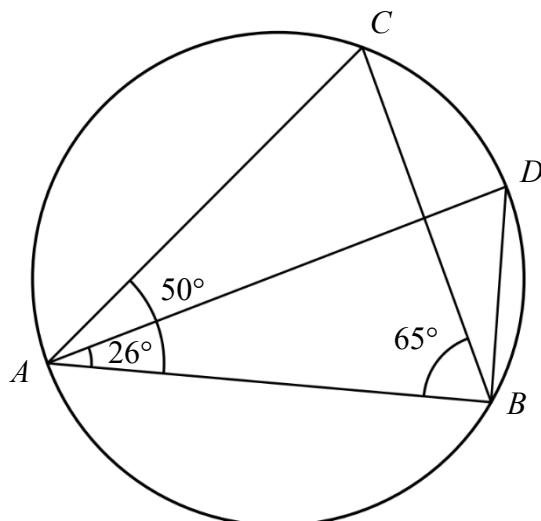
- (b) Represent your answer on the number line below.

Answer



[1]

- 15** A, B, C and D lie on a circle, with C and D on the same side of chord AB .
Angle $CAB = 50^\circ$, angle $ABC = 65^\circ$ and angle $DAB = 26^\circ$.



- (a)** Find angle ADB .
Give a reason for each step of your working.

Answer angle $ADB = \dots\dots\dots$ [2]

- (b)** Explain why AD does not pass through the centre of the circle.

Answer

.....

 [2]

16 5 cm on a map represents 2 km.

(a) Write the scale of the map in the form 1 : n .

Answer 1 : [1]

(b) An actual river is 12 km long.

Find the length, in centimetres, representing it on the map.

Answer cm [1]

(c) The area of a forest measures 8 cm² on the map.

Find the actual area of the forest, in square kilometres.

Answer km² [2]

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PRELIMINARY EXAMINATION 2026

SUBJECT : MATHEMATICS

SUBJECT CODE /PAPER : 4052/01

LEVEL/STREAM : Sec 4 Express, 5 Normal (Academic)

Part B

Answer all questions.

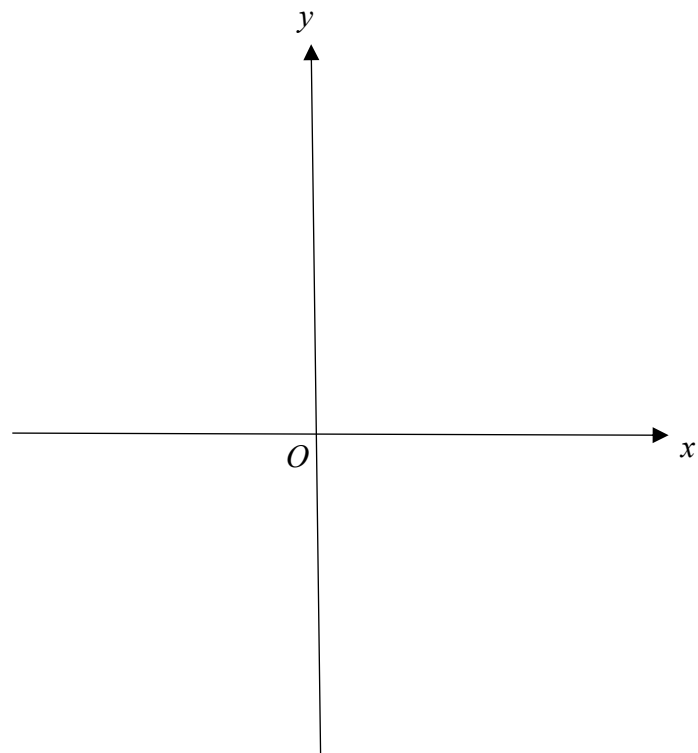
17 $y = -x^2 + 8x + 3$

- (a) Express y in the form $a(x-h)^2 + k$, where a , h and k are constants.

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

- (b) Hence, sketch the graph of $y = -x^2 + 8x + 3$, showing the coordinates of the turning point and the y -intercept.

Answer



[2]

18 The first four terms of a sequence of fractions are $\frac{2}{3}$, $\frac{5}{8}$, $\frac{8}{13}$ and $\frac{11}{18}$.

(a) Write down the next term in the sequence.

Answer..... [1]

(b) Find, in terms of n , an expression for the n th term, T_n .

Answer $T_n =$ [1]

(c) Determine, showing your working, whether $\frac{503}{800}$ can be a term of this sequence.

Answer

[2]

19 Factorise completely

(a) $6x^2 + x - 12,$

Answer [2]

(b) $6x^2 - 9x + 4xy - 6y.$

Answer [2]

20 Mr Tan invests \$12 000 at a rate of 8% per annum, interest compounded quarterly.

(a) Explain why the interest earned after 1 year is not equal to 8% of \$12 000.

Answer

.....
.....
.....
.....

[1]

(b) Calculate the amount of interest Mr Tan will receive from the investment at the end of 4 years.

Answer \$ [3]

- 21** The list shows the number of laps completed by a swimmer over 8 training sessions, given in ascending order:

$$p \quad 2p \quad 16 \quad 19 \quad 23 \quad 27 \quad 30 \quad \frac{q}{2}$$

The mean number of laps is 21.

The range of the data is 29.

Form two equations in p and q , and hence find the value of p and of q .

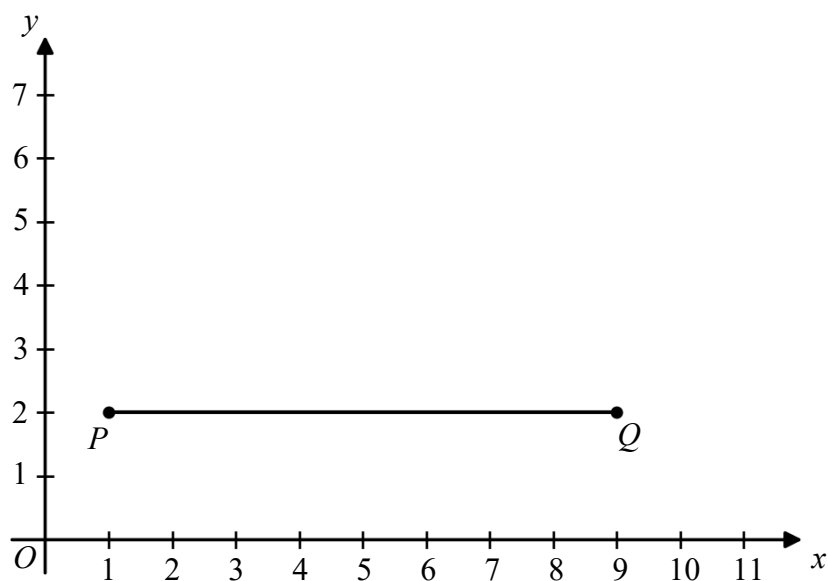
Answer

Answer $p = \dots\dots\dots, q = \dots\dots\dots$ [4]

- 22** The coordinates of P are $(1, 2)$ and Q are $(9, 2)$.

A line passes through Q with gradient $\frac{5}{2}$.

This line intersects the line $x = 11$ at point R .



- (a)** Find the coordinates of R .

Answer (.....,) [2]

- (b) P , Q and R are three vertices of parallelogram $PQRS$.
Find the coordinates of S .

Answer (.....,) [1]

- (c) Calculate the area of parallelogram $PQRS$.

Answer units² [1]

- 23 (a) (i) Write 216 as a product of its prime factors.

Answer $216 = \dots\dots\dots$ [1]

- (ii) The highest common factor of two numbers is 12.
The lowest common multiple of the two numbers is 216.
Both numbers are greater than 15.
Find the two numbers.

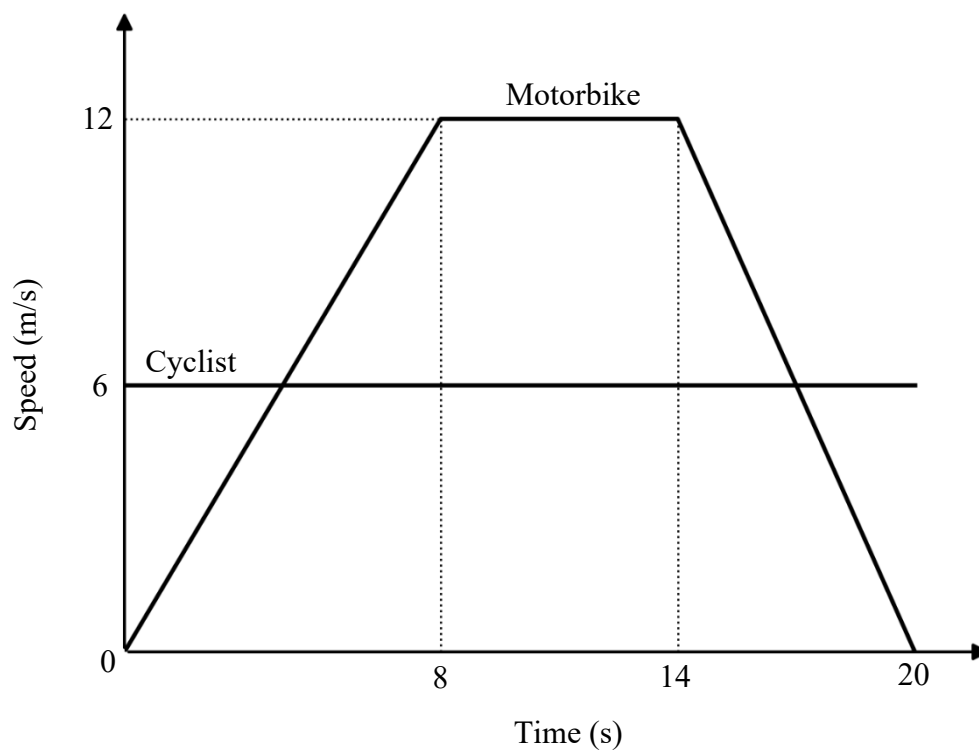
Answer $\dots\dots\dots$ and $\dots\dots\dots$ [2]

- (b) Written as a product of its prime factors, $1728 = 2^6 \times 3^3$.

The number $1728 \div \frac{p^2}{q}$ is a perfect square, where p and q are
prime numbers, $p < q$.
Find the value of p and of q .

Answer $p = \dots\dots\dots$, $q = \dots\dots\dots$ [2]

- 24 The diagram shows speed-time graphs for a motorbike and a cyclist, travelling along the same road in the same direction.



- (a) Find the acceleration of the motorbike during the first 6 seconds.

Answer m/s^2 [1]

- (b) Without further calculation, state and explain whether the magnitude of the deceleration in the last stage is greater than, less than, or equal to the acceleration in the first stage.

Answer

The magnitude of the deceleration is greater than / less than / equal to the acceleration in the first stage because

.....

.....

..... [1]

- (c) When $t = 0$, the motorbike is 12 m behind the cyclist.

When $t = T$, the motorbike passes the cyclist.

Find the value of T .

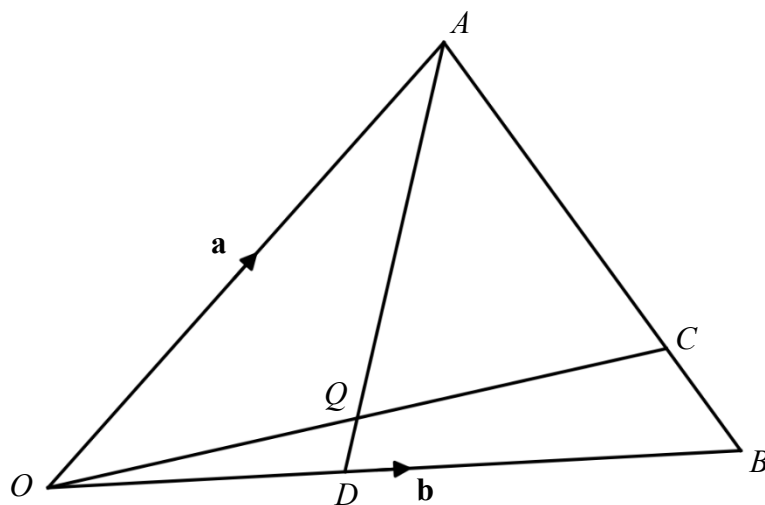
Answer $T =$ [3]

25 OAB is a triangle.

$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

C is the point on AB such that $AC : CB = 3 : 1$.

D is the point on OB such that $OD : DB = 3 : 4$.



(a) Find, in terms of $\mathbf{a}$ and $\mathbf{b}$,

(i) $\overrightarrow{AB}$,

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

(ii) $\overrightarrow{OC}$,

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

(iii) $\overrightarrow{OD}$.

Answer $\overrightarrow{OD} = \dots\dots\dots$ [1]

(b) Q is a point on OC such that $\overrightarrow{OQ} = \frac{1}{8}\mathbf{a} + \frac{3}{8}\mathbf{b}$.

(i) Show that A , Q and D are collinear. [3]

(ii) Find the ratio of the area of triangle OAQ to the area of triangle ODQ .

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

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NAME:

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RIVERSIDE SECONDARY SCHOOL



PRELIMINARY EXAMINATION 2026

SUBJECT : MATHEMATICS
SUBJECT CODE /PAPER : 4052/02
LEVEL/STREAM : Sec 4 Express & 5 Normal (Academic)
DURATION : 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

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 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 1 decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination fasten all your work securely together.

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

The total of the marks for this paper is 90.

Submit Part A and Part B separately.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Part A

Answer **all** the questions.

1 (a) Simplify $\frac{19a^6b^0c^2}{35c^5} \div \frac{9a^2b^4}{14c}$.

Answer [2]

(b) Simplify $\left(\frac{12x^{-4}y^6}{27}\right)^{-\frac{1}{2}}$ and write your answer in positive index notation.

Answer [2]

(c) Given that $2^{x+1} = 2^x + 32$, find x .

Answer $x =$ [2]

- (d) Write as a single fraction in its simplest form $\frac{x+2}{x-3} - \frac{60}{2x^2-18}$.

Answer [4]

- (e) Explain why, for all integer values of n , $n(n^2-1)$ is always even.

Answer

.....

..... [2]

- 2 (a) A quadratic equation has solutions $x = p$ and $x = -2p$, where p is a positive integer. Write the equation in the form $x^2 + bx + c = 0$, where b and c are expressed in terms of p .

Answer [2]

- (b) A quadratic curve intersects the x -axis at $x = 2 + \sqrt{a}$ and $2 - \sqrt{a}$. Find the equation of its line of symmetry.

Answer [1]

- (c) (i) A straight line passes through $P(-5, 9)$ and $Q(-9, 3)$. Find the column vector $\overrightarrow{PQ}$.

Answer $\overrightarrow{PQ} =$ [2]

- (ii) Write down another column vector that is parallel to $\overrightarrow{PQ}$.

Answer [1]

- 3 (a) During the World Cup, merchandise such as jerseys and caps are sold.

Game 1 sold 12 000 jerseys and 4000 caps.

Game 2 sold 9000 jerseys and 5600 caps.

Game 3 sold 11800 jerseys and 3000 caps.

The number sold, in thousands, are shown in the matrix

$$\mathbf{W} = \begin{pmatrix} 12 & 4 \\ 9 & 5.6 \\ 11.8 & 3 \end{pmatrix}$$

A jersey is priced at \$80 and a cap at \$30.

- (i) Represent the price of the merchandise in a 2×1 column matrix $\mathbf{P}$.

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

- (ii) Evaluate the matrix $\mathbf{T} = \mathbf{WP}$.

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

- (iii) Explain what the elements in $\mathbf{T}$ represent.

Answer
..... [1]

- (b) The remaining stock consists of 7000 jerseys and 8000 caps.

After a storewide discount was applied, the sale of the remaining stock is represented by the matrix equation

$$d \begin{pmatrix} 7 & 8 \end{pmatrix} \begin{pmatrix} 80 & 0 \\ 0 & 30 \end{pmatrix} = \begin{pmatrix} 448 & 192 \end{pmatrix},$$

where d is a constant.

Find the percentage discount given by the store.

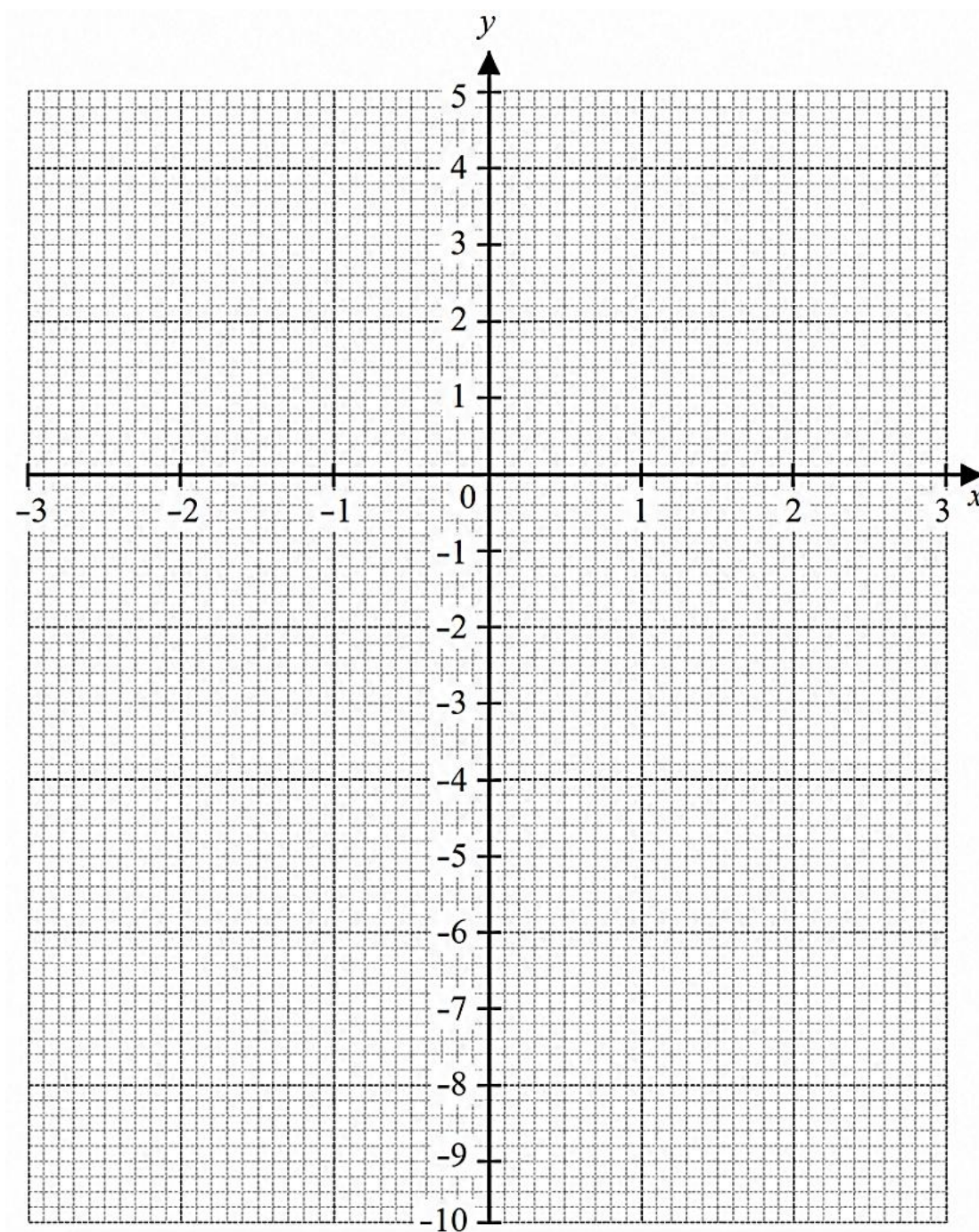
Answer% [4]

- 4 (a) (i) Complete the table of values below for $y = \frac{1}{2}x^3 - \frac{1}{2}x^2 - 2x + 2$.

x	-3	-2	-1	0	1	2	3
y	-10	0		2	0	0	5

[1]

- (ii) On the grid, draw the graph of $y = \frac{1}{2}x^3 - \frac{1}{2}x^2 - 2x + 2$ for $-3 \leq x \leq 3$.



[3]

- (iii) The water quality level of a pond over a 3-week period is modelled by the curve $y = \frac{1}{2}x^3 - \frac{1}{2}x^2 - 2x + 2$, where x represents the time in weeks.

The minimum safe level for fish to survive is given by the line $y = 2 - x$.

On the same grid, draw the line $y = 2 - x$.

[1]

- (iv) From the graph, write down the value(s) of x where the water quality equals the minimum safe level.

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

- (v) The fish are safe when the water quality is above the minimum safe level. Use your graph to find the range of values of x for which the fish are safe.

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

- (b) The graph of $y = ka^x$, where k and a are positive integers, passes through the points $(0, 4)$ and $(3, 32)$. Find the value of k and of a .

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

$a = \dots\dots\dots$ [1]

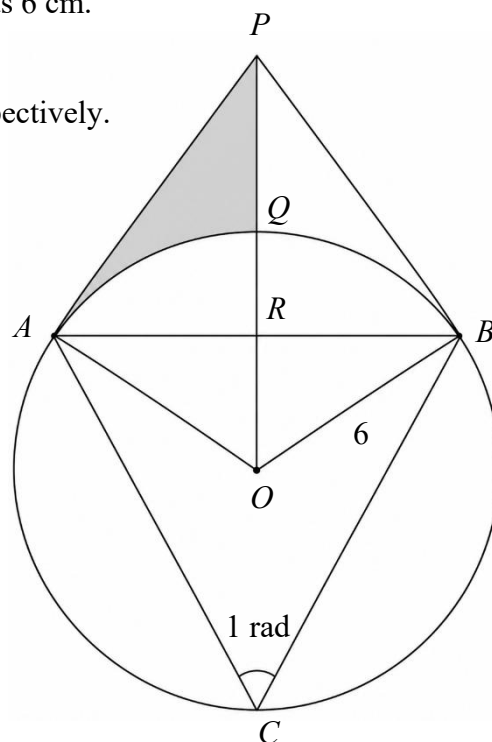
- 5 The diagram shows a circle with centre O and radius 6 cm.

A, Q, B and C lie on the circle.

PA and PB are tangents to the circle at A and B respectively.

O, R, Q and P lie on a straight line.

Angle $ACB = 1$ radian.



- (a) Show that triangle AOP is congruent to triangle BOP .
Give a reason for each statement you make.

Answer

.....

.....

.....

.....[3]

- (b) State the value of angle AOB in radians.
Give a reason for your answer.

Answer Angle $AOB = \dots\dots\dots$ radians

Reason:[2]

- (c) Find the area of the shaded region.

Answer cm^2 [4]

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Part B continues on Page 13

NAME:

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PRELIMINARY EXAMINATION 2026

SUBJECT : MATHEMATICS

SUBJECT CODE /PAPER : 4052/02

LEVEL/STREAM : Sec 4 Express & 5 Normal (Academic)

Part B

Answer **all** the questions.

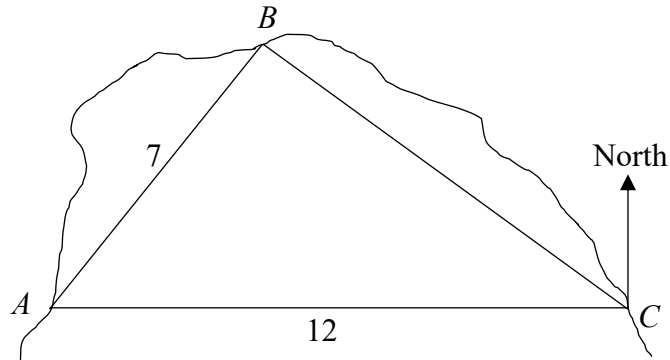
Part B
Answer **all** the questions.

- 6** Triangle ABC is the boundary of a nature reserve.
 A , B and C are three points on level ground.

$$AB = 7 \text{ km.}$$

C is 12 km due east of A .

The area of the nature reserve is 33 km^2 .



- (a) (i)** Show that angle $BAC = 51.8^\circ$.

Answer

[3]

- (ii)** Calculate the length of BC .

Answerkm [2]

- (iii) the bearing of B from C .

Answer° [3]

- (b) An observation deck is 60 m above point B .

- (i) A path is to be built from B to a point on AC , across the nature reserve.
Find the shortest possible length of the path.

Answerkm [2]

- (ii) A visitor is at the top of the observation tower.
Find the greatest angle of depression from the top of the tower to a point on AC .

Answer [2]

- 7 Ryan cycles 4 km from his home to a convenience store at an average speed of x km/h. He spends 20 minutes in the store before cycling back home along the same route, at an average speed of 2.5 km/h slower. The total time taken, including the time spent in the store, is 1 hour.

(a) Show that $2x^2 - 29x + 30 = 0$.

Answer

[5]

- (b) Solve the equation $2x^2 - 29x + 30 = 0$.
Give your solutions correct to three decimal places.

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

- (c) Explain why one of your answers in **part (b)** cannot be accepted.

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

- (d) Calculate Ryan's average speed when cycling home from the convenience store.

Answer $\dots\dots\dots$ km/h [2]

- 8** In a Hyrox Fitness Challenge, the official finish times of 150 participants from Regent Polytechnic were recorded.

(a) The table shows the time, t minutes, taken by the participants.

Time, t minutes	$50 < t \leq 70$	$70 < t \leq 90$	$90 < t \leq 110$	$110 < t \leq 130$	$130 < t \leq 150$
Frequency	12	29	x	39	21

(i) Find the value of x .

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

(ii) Calculate an estimate of the mean time taken.

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

(iii) Calculate an estimate of standard deviation of the times taken.

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

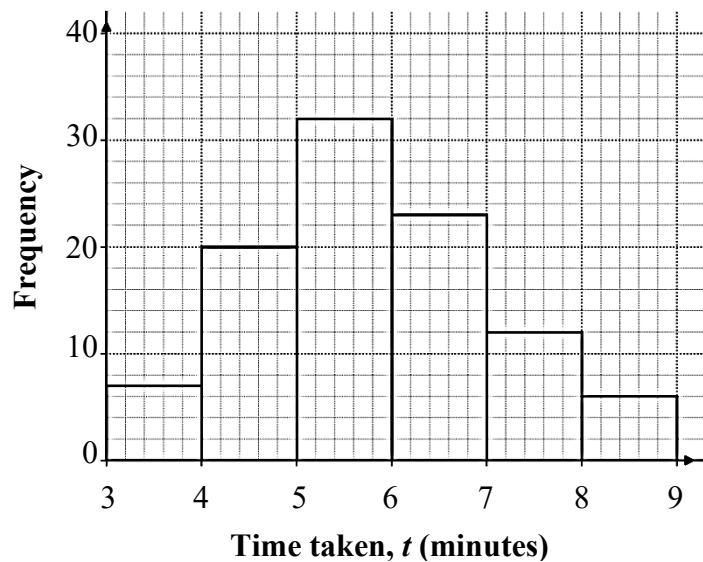
(iv) Another set of 150 participants from Summit Polytechnic have an estimated mean finish time of 99.5 minutes and standard deviation of 25.6 minutes.

A commentator says that participants from Summit Polytechnic performed better than those in Regent Polytechnic.

Explain why this comment is not fully justified.

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

- (b) The histogram shows the distribution of time, t minutes, taken by 100 participants in a SkiErg challenge.



A participant who completes the SkiErg Challenge in at most 5 minutes is called a fast finisher.

- (i) Two participants are selected at random for an interview.
Find the probability that both participants are fast finisher.

Answer [2]

- (ii) Three participants are selected randomly for a photoshoot.
Find the probability that at least one of them is a fast finisher.

Answer [2]

- (iii) A coach claims that the number of participants who completed the SkiErg Challenge in less than 5.5 minutes is greater than the number who took more than 6.5 minutes.

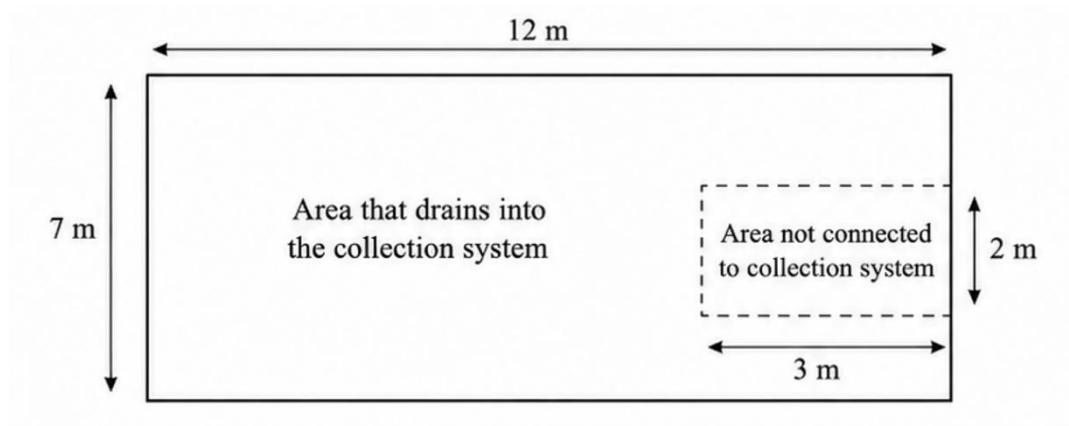
Explain why his conclusion cannot be made from the histogram.

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

- 9 A team at EcoFlow Dynamics is designing a rainwater collection system to water its vegetable garden.

The diagram shows the roof that drains into the rainwater collection system.

The rectangular section shown by the dashed lines is not connected to the collection system.



Top-down view of roof

It is known that 1 mm of rain falling on 1 m^2 of roof produces 1 litre of water.

During a heavy shower, 15 mm of rain falls evenly on the roof.
Only 82% of the rainwater falling on the collecting area is collected.

The vegetable garden requires 170 litres of water each day.
The tank must provide enough water for 5 consecutive days without rain.
For safety reasons, the amount of water in the tank must not exceed 90% of its capacity.

The team has a total budget of \$800, which includes the cost of the tank and its installation.

Use $\pi = 3.142$.

Tank	Shape and internal dimensions	Cost of tank	Installation cost
A	Cylinder of diameter 1.0 m and height 1.1 m	\$620	\$130
B	Cuboid of length 1.1 m, width 1.0 m and height 1.1 m	\$680	\$120
C	Cylinder of diameter 1.2 m and height 0.9 m	\$710	\$80

- (a) Calculate the amount of water collected during the heavy shower.

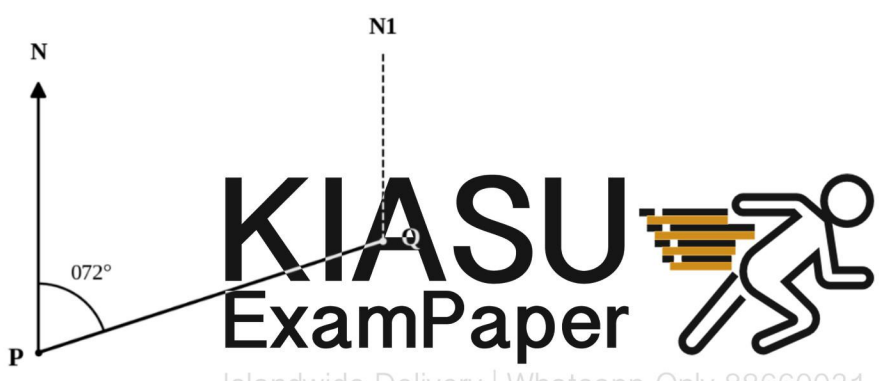
Answerlitres [4]

- (b) Using the information given and your answer to **part (a)**, suggest a suitable tank for the rainwater collection system.

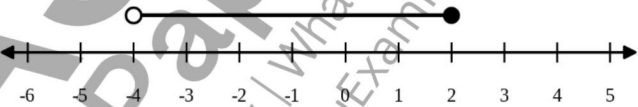
Justify your decision with calculations.

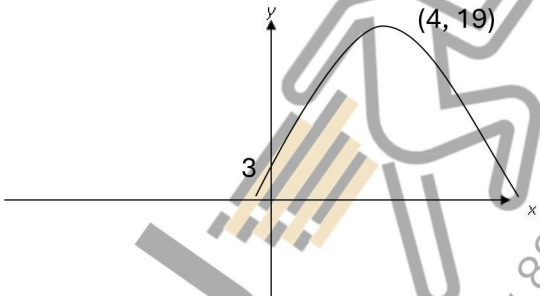
Answer

2026 Mathematics Paper 1 Solutions

Q	Solutions
1a	1.56×10^{-4}
1b	7.65×10^{150}
2	 $\angle N_1PQ = 108^\circ$ (int. angles) Bearing $= 360^\circ - 108^\circ$ (angles at a pt) $= 252^\circ$
3	$8^{y+1} = 32^3$ $2^{3y+3} = 2^{15}$ $3y + 3 = 15$ $3y = 12$ $y = 4$
4	$\frac{x}{2} = 36.8699$ or 143.1301 $x = 73.7$ or 286.3 (1 d.p.)
5	$(2x-3)(x+5) - (x-1)^2$ $= 2x^2 + 7x - 15 - (x^2 - 2x + 1)$ $= x^2 + 9x - 16$
6	Let T be the total number of cards. Common cards $= 0.34T$ Remaining cards $= 0.66T$ Legendary cards $= 0.4(0.66T)$ $0.4(0.66T) = 132$ $0.264T = 132$ $T = 500$ Alternative Method

	$\frac{33}{125} \text{ units} - 132$ $1 \text{ unit} - 132 \div \frac{33}{125}$ $1 \text{ unit} = 500$
7a	$180(n-2) = 2340$ $180n - 360 = 2340$ $180n = 2700$ $n = 15$
7b	$\frac{360}{15} = 24^\circ$
8a	$p = \frac{2x+8}{x+1}$ $p(x+1) = 2x+8$ $px + p = 2x+8$ $px - 2x = 8 - p$ $x(p-2) = 8 - p$ $x = \frac{8-p}{p-2}$
8b	$x = \frac{8-3}{3-2}$ $x = 5$
9	

10	$I = \frac{k}{d^2}$ $I_{new} = \frac{k}{(1.6d)^2} = \frac{k}{2.56d^2} = 0.390625I$ $\frac{I - 0.390625I}{I} \times 100\% = 60.9\% \text{ (3 s.f.)}$
11a	1.05 seconds
11b	$\frac{3.5 + 3.c}{2} = 3.65$ $3.5 + 3.c = 7.3$ $3.c = 3.8$ $c = 8$
12a	$\sqrt{\frac{4}{1}} = 2:1$ $\therefore 1:2$
12b	Mass Ratio = 1:8 Large mass = $300 \times 8 = 2400g$
13a	$(P \cup Q) \cap (P \cap Q)'$
13bi	A is the set of positive integers that are factors of 10 .
13bii	$\{-1, 0, 4, 6, 8, 9, 12, 14, 15\}$
13biii	6
14a	$\frac{x+2}{4} \leq 5 - 2x < 13$ $x+2 \leq 20 - 8x \text{ and } -2x < 8$ $\therefore -4 < x \leq 2$
14b	
15a	$\angle ACB$ $= 180^\circ - 50^\circ - 65^\circ \text{ (}\angle \text{ sum of } \Delta \text{)}$ $= 65^\circ$ $\angle ADB = 65^\circ \text{ (}\angle \text{s in the same segment)}$

15b	$\angle ABD$ $= 180^\circ - 26^\circ - 65^\circ$ ($\angle$ sum of Δ) $= 89^\circ$ Since $89^\circ \neq 90^\circ$, by converse of angle in a semicircle property, AD does not pass through the centre of the circle.
16a	1 : 40000
16b	30 cm
16c	1 cm : 0.4 km $1 \text{ cm}^2 : 0.16 \text{ km}^2$ Actual area $= 8 \times 0.16$ $= 1.28 \text{ km}^2$
17a	$y = -(x^2 - 8x) + 3$ $y = -[(x - 4)^2 - 16] + 3$ $y = -(x - 4)^2 + 19$
17b	
18a	$\frac{14}{23}$
18b	$\frac{3n-1}{5n-2}$
18c	$\frac{3n-1}{5n-2} = \frac{503}{800}$ $800(3n-1) = 503(5n-2)$ $206 = 115n$ $n = 1.79\dots$ As n is not a positive integer, $\frac{503}{800}$ is not a term of the sequence.
19a	$(3x-4)(2x+3)$

19b	$6x^2 - 9x + 4xy - 6y$ $= 3x(2x - 3) + 2y(2x - 3)$ $= (3x + 2y)(2x - 3)$
20a	The first year's interest is more than 8% of \$12 000 because the interest is compounded every quarter , so the principal amount increases every quarter .
20b	$A = (12000) \left(1 + \frac{8 \div 4}{100} \right)^{4 \times 4}$ $I = (12000) \left(1 + \frac{8 \div 4}{100} \right)^{4 \times 4} - 12000$ $I = 4473.43 \text{ (2 d.p.)}$
21	$6p + q = 106$ $q - 2p = 58$ By substitution or elimination, $p = 6, q = 70$
22a	$y = \frac{5}{2}x + c$ $2 = \frac{5}{2}(9) + c$ $c = 2 - \frac{45}{2}$ $c = -\frac{41}{2}$ $y = \frac{5}{2}(11) - \frac{41}{2}$ $y = 7$ $\therefore R(11, 7)$
22b	$(3, 7)$
22c	40 units ²
23a	$216 = 2^3 \times 3^3$
23b	24,108
23c	$1728 \div \frac{p^2}{q}$ $= 2^6 \times 3^3 \times \frac{q}{p^2}$ $p = 2, q = 3$
24a	1.5 m/s ²
24b	Greater. The speed change is the same (0 to 12 m/s) but occurs over a shorter time (6 s vs 8 s), giving a larger rate of change .

24c	Motorbike's distance travelled during T seconds $= 48 + 12(t - 8)$ Cyclist's distance travelled during T seconds $= 12 + 6t$ $12 + -48 = 12 + 6t$ $t = 10$
25ai	$\vec{AB} = b - a$
25aii	$\vec{OC}$ $= a + \frac{3}{4}(b - a)$ $= \frac{1}{4}a + \frac{3}{4}b$
25aiii	$\vec{OD}$ $= \frac{3}{7}b$
25bi	$\vec{AD}$ $= \vec{OD} - \vec{OA}$ $= \frac{3}{7}b - a$ $= -a + \frac{3}{7}b$ $\vec{AQ}$ $= \vec{OQ} - \vec{OA}$ $= \frac{1}{8}a + \frac{3}{8}b - a$ $= -\frac{7}{8}a + \frac{3}{8}b$ $= \frac{7}{8}\left(-a + \frac{3}{7}b\right)$ $= \frac{7}{8}\vec{AD}$ As $\vec{AQ} = \frac{7}{8}\vec{AD}$ and A is a common point, A, Q and D are collinear.
25bii	$AQ : QD = 7 : 1$

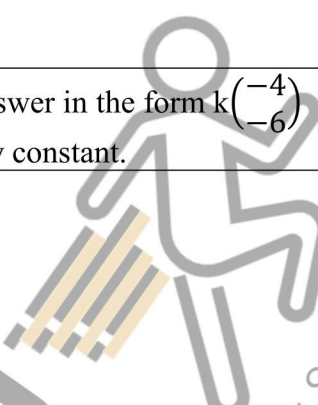
2026 E Math Prelims P2 Solutions

Qn	Solution
1(a)	$\frac{19a^6b^0c^2}{35c^5} \div \frac{9a^2b^4}{14c}$ $= \frac{19a^6c^2}{35c^5} \times \frac{14c}{9a^2b^4}$ $= \frac{38a^4}{45b^4c^2}$
1(b)	$\left(\frac{12x^{-4}y^6}{27} \right)^{\frac{1}{2}}$ $= \left(\frac{27}{12x^{-4}y^6} \right)^{\frac{1}{2}}$ $= \left(\frac{9x^4}{4y^6} \right)^{\frac{1}{2}}$ $= \frac{3x^2}{2y^3}$
1(c)	$2^{x+1} = 2^x + 32$ $2(2^x) = 2^x + 32$ $2^x = 32$ $x = 5$
1(d)	$\frac{x+2}{x-3} - \frac{60}{2x^2-18}$ $= \frac{x+2}{x-3} - \frac{60}{2(x^2-9)}$ $= \frac{x+2}{x-3} - \frac{30}{(x^2-9)}$ $= \frac{(x+2)}{x-3} - \frac{30}{(x-3)(x+3)}$ $= \frac{(x+2)(x+3) - 30}{(x-3)(x+3)}$ $= \frac{x^2 + 5x - 24}{(x-3)(x+3)}$ $= \frac{(x+8)(x-3)}{(x-3)(x+3)}$ $= \frac{x+8}{x+3}$
(e)	The numbers $n(n^2 - 1) = n(n-1)(n+1)$ are consecutive integers. Among any two consecutive integers, one is even. Therefore, at least one of the factors is even in $n(n^2 - 1)$. Hence, $n(n^2 - 1) = n(n-1)(n+1)$ is always even. Alternatively,

	accept if students explicitly mention that if n is <u>odd</u> /even, then (n-1) and (n+1) is <u>even</u> /odd. Therefore $n(n^2 - 1) = n(n-1)(n+1)$ is always even .
2(a)	$(x - p)(x + 2p) = 0$ $x^2 + 2px - px - 2p^2 = 0$ $x^2 + px - 2p^2 = 0$
(b)	$\frac{(2 + \sqrt{a}) + (2 - \sqrt{a})}{2}$ $= 2$
(ci)	$\vec{PQ}$ $= \begin{pmatrix} -9 \\ 3 \end{pmatrix} - \begin{pmatrix} -5 \\ 9 \end{pmatrix}$ $= \begin{pmatrix} -4 \\ -6 \end{pmatrix}$
(cii)	Accept any answer in the form $k \begin{pmatrix} -4 \\ -6 \end{pmatrix}$ Where k is any constant.

KIASU 
ExamPaper

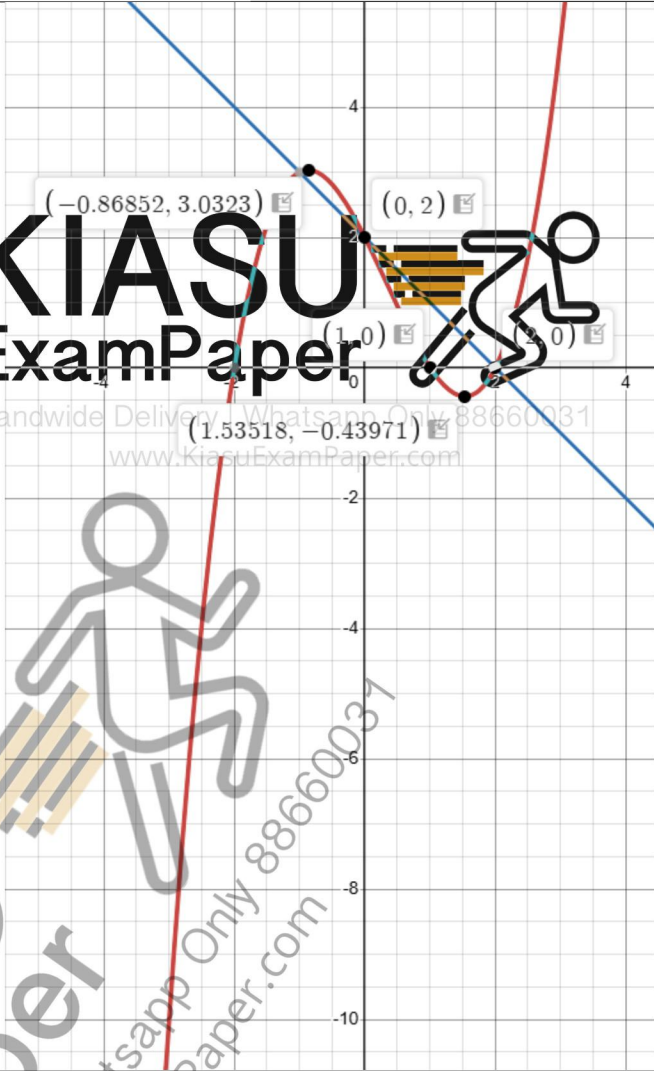
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2026 E Math Prelims P2 Solutions

3(ai)	$\mathbf{P} = \begin{pmatrix} 80 \\ 30 \end{pmatrix}$
(ii)	$\mathbf{T}$ $= \mathbf{WP}$ $= \begin{pmatrix} 12 & 4 \\ 9 & 5.6 \\ 11.8 & 3 \end{pmatrix} \begin{pmatrix} 80 \\ 30 \end{pmatrix}$ $= \begin{pmatrix} 1080 \\ 888 \\ 1034 \end{pmatrix}$
(iii)	The elements represent the <u>total merchandise revenue, in thousands of dollars, for each game respectively.</u> Or \$1080000, \$888000, \$1034000 are the total revenue collected from game 1,2 and 3 respectively.
(b)	$d \begin{pmatrix} 7 & 8 \\ 0 & 30 \end{pmatrix} \begin{pmatrix} 80 & 0 \\ 0 & 30 \end{pmatrix} = \begin{pmatrix} 448 & 192 \end{pmatrix}$ $(7d \quad 8d) \begin{pmatrix} 80 & 0 \\ 0 & 30 \end{pmatrix} = \begin{pmatrix} 448 & 192 \end{pmatrix}$ $\begin{pmatrix} 560d & 240d \end{pmatrix} = \begin{pmatrix} 448 & 192 \end{pmatrix}$ $560d = 448$ $d = 0.8$ <i>Discount</i> $= 1 - 0.8$ $= 0.2$ Hence the percentage discount given is 20%

2026 E Math Prelims P2 Solutions

4(ai)	$y = \frac{1}{2}(-1)^3 - \frac{1}{2}(-1)^2 - 2(-1) + 2$ $y = -\frac{1}{2} - \frac{1}{2} + 2 + 2$ $y = 3$
4(aii) (iii)	
(iv)	$x = 0, 2$
(v)	$x > 2$
(b)	$y = ka^x$ $4 = ka^0$ $k = 4$ $a = 2$
(5)(a)	$AO = BO$ (radius) $AP = BP$ (tangents from external point) PO is common side Hence $\triangle AOP \equiv \triangle BOP$ (SSS)
5(b)	2 radians Angle at center = twice angle at circumference

5(c)

$$\angle AOP = 1 \text{ rad}$$

Since $\triangle OAP$ is a right angled triangle,

$$\tan \angle AOP = \frac{AP}{AO}$$

$$\tan(1 \text{ rad}) = \frac{AP}{6}$$

$$AP = 6 \tan(1 \text{ rad})$$

$$AP = 9.344446348$$

$$\text{Area } \triangle OAP = \frac{1}{2} \times 6 \times 9.344446348$$

$$\text{Area } \triangle OAP = 28.03333904 \text{ cm}^2$$

Area of Sector AOQ

$$= \frac{1}{2} (6)^2 (1)$$

$$= 18 \text{ cm}^2$$

Shaded region APQ

$$= \text{Area } \triangle OAP - \text{Area of Sector } AOQ$$

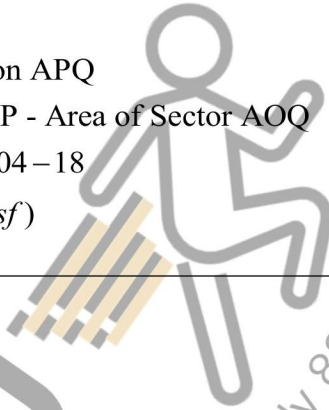
$$= 28.03333904 - 18$$

$$= 10.0 \text{ cm}^2 (3 \text{ sf})$$

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2026 E Math Prelims P2 Solutions

6(ai)	$33 = \frac{1}{2}(7)(12)\sin BAC$ $\sin BAC = \frac{33}{42}$ $BAC = \sin^{-1}\left(\frac{33}{42}\right)$ $BAC = 51.7867893$ $BAC = 51.8^\circ (3sf)$
(ii)	$BC^2 = 7^2 + 12^2 - 2(7)(12)\cos 51.8$ $BC = \sqrt{7^2 + 12^2 - 2(7)(12)\cos 51.8}$ $BC = 9.439671053cm$ $BC = 9.44cm(3sf)$
(iii)	$\frac{\sin \angle BAC}{BC} = \frac{\sin \angle ACB}{AB}$ $\frac{\sin 51.8}{9.439671053} = \frac{\sin \angle ACB}{7}$ $9.439671053 \sin \angle ACB = 7 \sin (51.8)$ $\angle ACB = 35.64442002^\circ$ $\angle ACB = 35.6^\circ (1dp)$ Bearing B from C $= 270 + 35.6$ $= 305.6^\circ$
(b)i	$Area = 33$ $\frac{1}{2} \times 12 \times height = 33$ $height = \frac{33}{6} = 5.5km$
(bii)	$\tan \theta = \frac{0.06}{5.5}$ $\theta = \tan^{-1}\left(\frac{0.06}{5.5}\right)$ $\theta = 0.6^\circ (1dp)$

7(a)	$\text{Time taken to store} = \frac{4}{x}h$ $\text{Time taken to home} = \frac{4}{x-2.5}h$ $\text{Total time on the road} = 60 - 20 = 40 \text{ min} = \frac{2}{3}h$ $\frac{4}{x} + \frac{4}{x-2.5} = \frac{2}{3}$ $\frac{4(x-2.5) + 4x}{x(x-2.5)} = \frac{2}{3}$ $12(x-2.5) + 12x = 2x(x-2.5)$ $24x - 30 = 2x^2 - 5x$ $2x^2 - 29x + 30 = 0 \text{ (shown)}$
7(b)	$2x^2 - 29x + 30 = 0$ $x = \frac{-(-29) \pm \sqrt{(-29)^2 - 4(2)(30)}}{2(2)}$ $x = 1.121 \text{ or } 13.379 \text{ (3dp)}$
7(c)	Reject 1.121, since $1.121 - 2.5$ would give a negative return speed.
7(d)	$2x^2 - 29x + 30 = 0$ $x = 13.379 \text{ or } 1.121 \text{ (reject)}$ $x - 2.5 = 13.379 - 2.5$ $\text{return speed} = 10.9 \text{ km/h (3sf)}$

8(a)i	$x = 49$
(ii)	Mean $\frac{15560}{150}$ $= 103.733333..$ $= 104 \text{ min s (3sf)}$
(iii)	$\sqrt{\frac{(60^2 \times 12) + (80^2 \times 29) + (100^2 \times 49) + (120^2 \times 39) + (140^2 \times 21)}{150} - \left(\frac{15560}{150}\right)^2}$ $= \sqrt{\frac{1692000}{150} - \left(\frac{15560}{150}\right)^2}$ $= \sqrt{\frac{1692000}{150} - \left(\frac{15560}{150}\right)^2}$ $= 22.8 \text{ min s (3sf)}$
(iv)	99.5 < 103.7: Summit Polytechnic participants were faster on average. 25.6 > 22.9: Regent Polytechnic participants were more consistent. therefore it is not justifiable as it depends on whether average speed or consistency is considered as the criteria for "better" performance across the group.

(bi)	$\frac{27}{100} \times \frac{26}{99}$ $= \frac{39}{550}$
(ii)	$1 - \left(\frac{73}{100} \times \frac{72}{99} \times \frac{71}{98} \right)$ $= \frac{8292}{13475}$
(iii)	Histogram shows grouped data, not the exact finishing . The exact numbers on each side of 5.5 and 6.5 cannot be determined from the histogram.



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2026 E Math Prelims P2 Solutions

9(a)

Area of whole roof = $12 \times 7 = 84$

Area not connected = $3 \times 2 = 6$

Collecting area = $84 - 6 = 78$

Since 1mm of rain on 1m^2 gives 1litre of water,

15 mm of rain on 78m^2 gives:

$78 \times 15 = 1170$ litres

Only 82% is collected:

Volume collected

$= 0.82 \times 1170$

$= 959.4$ litres



(b)

Water needed for 5 days

$$= 5 \times 170$$

$$= 850 \text{ litres}$$

Since $959.4 \geq 850$, one heavy shower collects enough water to meet this requirement.

Volume of Tank A

$$= \pi r^2 h$$

$$= 3.142 \times 0.5^2 \times 1.1$$

$$= 0.86405 \text{ m}^3$$

$$= 864 \text{ litres (3 s.f.)}$$

With safety feature, volume

$$= 90\% \times 864.05$$

$$= 777.6 < 850$$

$\therefore$ Tank A is not suitable as there are not enough for 5 days without rain

Volume of Tank B

$$= 1.1 \times 1.0 \times 1.1$$

$$= 1.21 \text{ m}^3$$

$$= 1210 \text{ litres}$$

With safety feature, volume

$$90\% \times 1210 = 1089 \geq 850$$

$\therefore$ Tank B is suitable

Volume of Tank C

$$= 3.142 \times 0.6^2 \times 0.9$$

$$= 1.018 \text{ m}^3$$

$$= 1018 \text{ litres (4 s.f.)}$$

With safety feature, volume

$$90\% \times 1018.008 = 916.2 \geq 850$$

$\therefore$ Tank C is suitable

Budget Check

$$\text{Tank B: } \$680 + \$120 = \$800 \leq \$800$$

$$\text{Tank C: } \$710 + \$80 = \$790 \leq \$800$$

Both B and C satisfy the capacity and budget requirements.

Tank C is recommended since

it is \$10 cheaper (\$790 vs \$800).

Name:	Register Number:	Class:
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PRESBYTERIAN HIGH SCHOOL



**MATHEMATICS
PAPER 1**

4052/01

17 August 2026

Monday

2 hours 15 min

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2026 SECONDARY FOUR EXPRESS / FIVE NORMAL (ACADEMIC) PRELIMINARY EXAMINATION

1

$$V = \frac{pq}{1 - \sqrt{r}}$$

Calculate the value of V when $p = 0.05$, $q = 2.17$ and $r = 8.7$.

Answer [1]

- 2 The table below shows the materials needed to make one batch of concrete. Each batch of concrete has volume 0.15 m^3 .

Material	Amount per batch
Cement	25 kg
Sand	60 kg
Gravel	90 kg
Water	12 litres

- (a) How many batches of concrete can a builder make with 175 kg of cement?

Answer [1]

- (b) Another builder has 240 kg of cement, 108 litres of water and 540 kg of each of the other materials.

- (i) Find the maximum volume of concrete he can make.

Answer m^3 [2]

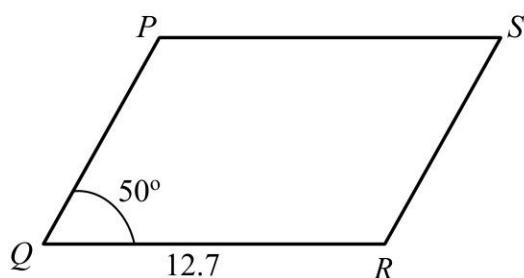
- (ii) Calculate the amount of water he needs to use to make this maximum volume.

Answer litres [1]

- 3 A company borrowed a sum of money at a simple interest rate of 3.5 % per year.
After 5 years, the total amount owed was \$4465.
Calculate the amount borrowed.

Answer \$ [2]

4



$PQRS$ is a parallelogram with an area of 52.6 cm^2 .
 $QR = 12.7 \text{ cm}$ and angle $PQR = 50^\circ$.
Find the length of RS .

Answer cm [3]

- 5 A car travels a distance of 362 km at a speed of 84 km/h.
Both the distance and the speed are rounded to 1 significant figure before the journey time is calculated.
Without doing any calculations, state whether the calculated journey time is greater than or less than the actual journey time. Explain your answer.

Answer

.....

.....

[1]

- 6** **(a)** Given that $\sqrt[3]{8^k} = 2^{3k} - 2^{3k-1}$, find k .

Answer $k =$ [2]

- (b)** Factorise completely $24mn - 16m - 42n + 28$.

Answer [2]

- (c)** Expand and simplify $(5 - 3x)(2x^2 + 4x - 1)$.

Answer [2]

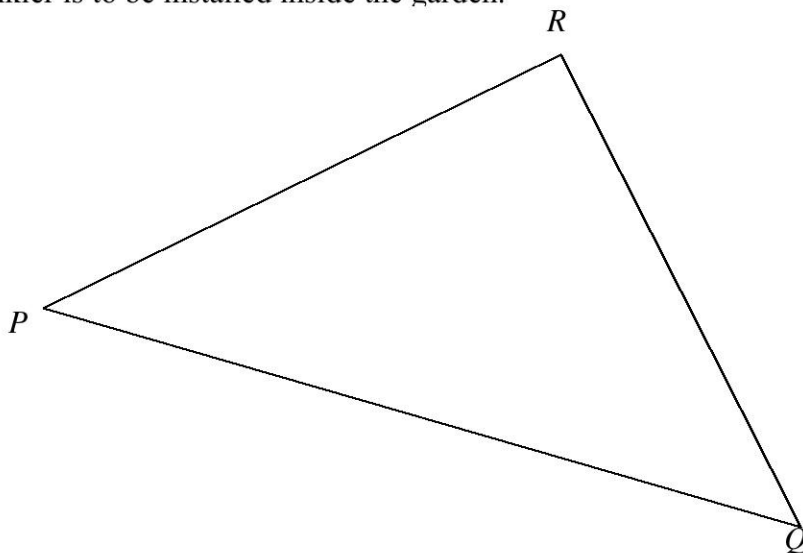
7 (a) Solve the inequalities $-\frac{65}{3} \leq \frac{5(-5x-1)}{6} < \frac{55}{4}$.

Answer [3]

(b) Given that x is a perfect square, write down all the possible values of x .

Answer [1]

- 8 The diagram shows a triangular garden PQR .
A sprinkler is to be installed inside the garden.



- (a) Construct the bisector of angle RQP . [1]
- (b) Construct the perpendicular bisector of QR . [1]
- (c) The sprinkler is to be placed nearer to PQ than to RQ , and nearer to Q than to R .
Shade the region inside the garden where the sprinkler can be placed. [1]

- 9 Rearrange the formula $\frac{2a+3}{5-a} = m - \frac{1}{3}$ to make a the subject.

Answer $a =$ [3]

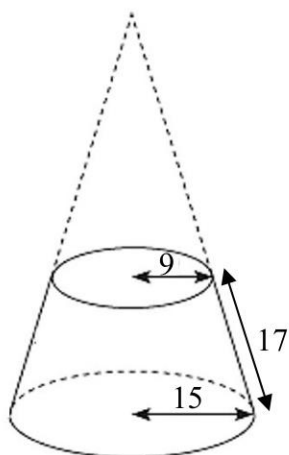
- 10 The **sum** of the first n terms of a linear sequence is $\frac{1}{2}n(7n-3)$.

(a) Find the first 3 terms of the sequence.

Answer,, [2]

(b) Find, in terms of n , an expression for the n th term of the sequence.

Answer [1]



The diagram shows a frustum which is part of a right circular cone.
The frustum has a slant height of 17 cm.
The top of the frustum is a circle of radius 9 cm and the base is a circle of radius 15 cm.
Find the volume of the frustum.

Answer cm³ [4]

- 12 (a) Use prime factors to explain why 96×45 is **not** a perfect square.

.....
.....
..... [2]

- (b) The number $96 \times 45 \div \frac{m}{n}$ is a perfect cube where m and n are prime numbers.

Find the value of m and the value of n .

Answer $m =$
 $n =$ [2]

- (c) The number $S = 2^5 \times 3^3 \times 5$.
The lowest common multiple (LCM) of 45, 96 and P is S .
 P is between 30 and 300.
Give a possible value of P .

Answer $P =$ [1]

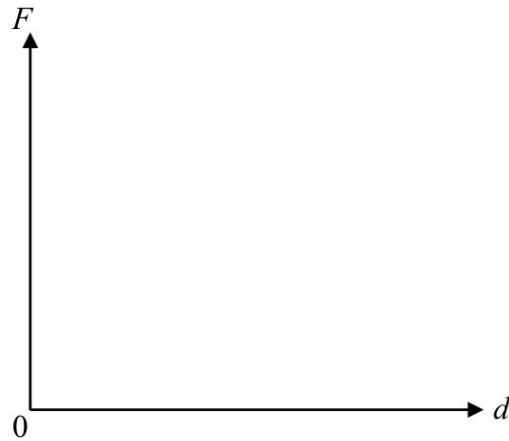
-
- 13 Given that $2m - 1 = (2n + 5)^2$, where n is a positive integer.
Show that m is an integer.

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

- 14** The force, F , between two objects is inversely proportional to the square of the distance, d , between them.

(a) Sketch the graph of F against d .

Answer



[1]

- (b)** The distance between the objects is increased by 30%.
Calculate the percentage reduction in the force between the objects.

Answer % [2]

- 15 (a)** The retail price of a refrigerator is \$4 800.
During a promotional sale, a discount of 15% is offered.
The refrigerator is sold at a profit of 20%.
Calculate the cost price of the refrigerator.

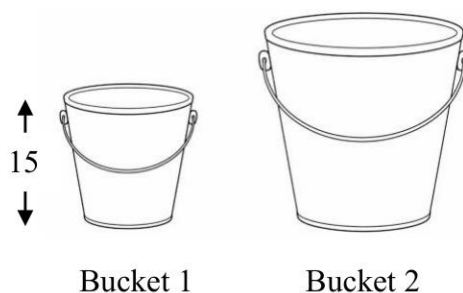
Answer \$ [2]

- (b)** The price of a tablet in France is €1004.96.
The same tablet is 12% cheaper in France than in Singapore.
The price of the tablet in Singapore is \$1690.
Find the exchange rate between Singapore dollars (\$) and euros (€).
Give your answer in the form \$1 = € x .

Answer [2]

- 16** Given that $x^2 - 14x + p$ is a perfect square, find the value of p .
Show your working.

Answer $p =$ [2]



The diagram shows two geometrically similar empty buckets.

The height of the smaller bucket is 15 cm, and the base area of the larger bucket is 686 cm^2 .

Water is poured into both buckets at the same constant rate.

The smaller bucket takes $\frac{1}{8}$ of the time the larger bucket takes to fill completely.

(a) Find the height of the larger bucket.

Answer cm [2]

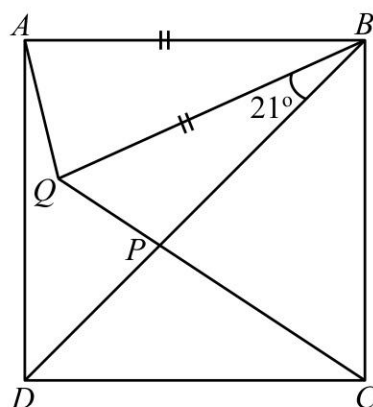
(b) Find the base area of the smaller bucket.

Answer cm^2 [2]

- 18** A bag contains 12 blue marbles, 8 red marbles and 10 green marbles.
 After p green marbles are removed from the bag, the probability of choosing a green marble is now $\frac{3}{13}$.
 Find the value of p .

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

19



The diagram shows a square $ABCD$.
 QPC and BPD are straight lines.
 $BA = BQ$ and angle $PBQ = 21^\circ$.
 Find angle DCQ .

Answer Angle $DCQ = \dots\dots\dots$ [2]

- 20 (a) Write 9.6×10^{-13} in the form $A \times 10^{-12}$.

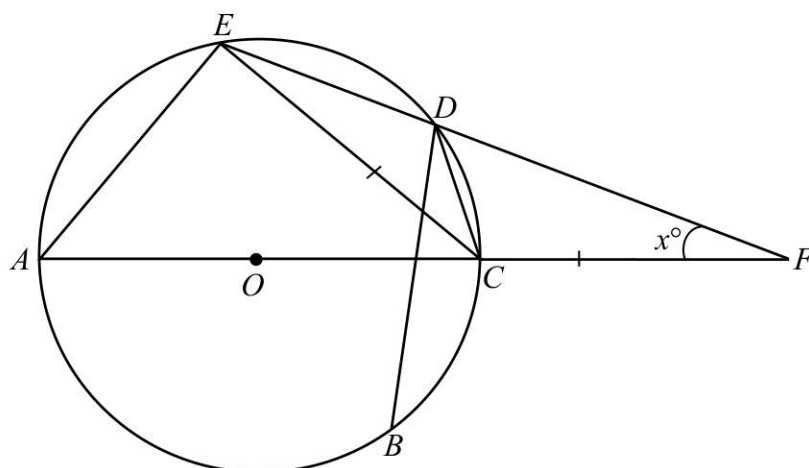
Answer [1]

- (b) Work out $(9.1 \times 10^{-12}) + (9.6 \times 10^{-13})$.

Give your answer in standard form.

Answer [1]

21



A, B, C, D and E are points on the circle, centre O .

AC is the diameter.

AC and ED are extended to meet at F .

$CE = CF$ and angle $AFD = x^\circ$.

- (a) Show that angle $DBC = x^\circ$.
Give a reason for each step of your working.

[2]

- (b) Find, in terms of x , angle ACD .
Give a reason for each step of your working.

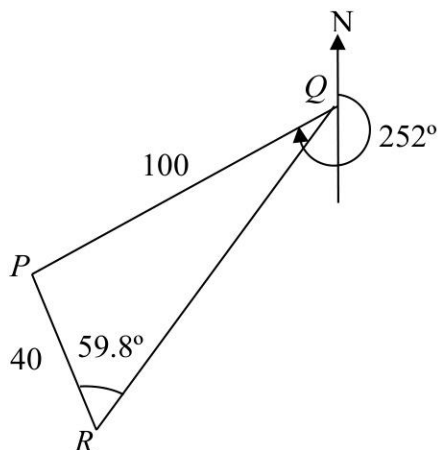
Answer Angle $ACD =$ [2]

22 Solve the equation $\frac{2x}{x+3} - \frac{5}{2x-1} - 3 = 0$.

Show all your working.

Give your solutions correct to 2 decimal places.

Answer $y =$ [5]



P , Q and R are three points on horizontal ground.
 $PQ = 100$ m and the bearing of P from Q is 252° .
 $PR = 40$ m and angle $PRQ = 59.8^\circ$.

- (a) Find the bearing of Q from P .

Answer [1]

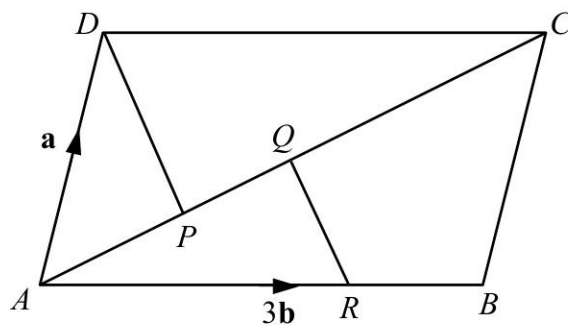
- (b) A lifeguard stands on top of an 8-metres high watchtower at P .
 A jogger walks along the straight path from R to Q .

- (i) Calculate the shortest distance from P to RQ .

Answer m [2]

- (ii) Calculate the greatest angle of depression from the lifeguard to the jogger.

Answer [2]



$ABCD$ is a parallelogram.

Q is the midpoint of AC and P is the midpoint of AQ .

R is the point on AB such that $AR = 2RB$.

$\overrightarrow{AD} = \mathbf{a}$ and $\overrightarrow{AB} = 3\mathbf{b}$.

- (a) Express $\overrightarrow{DP}$, as simply as possible, in terms of $\mathbf{a}$ and $\mathbf{b}$.

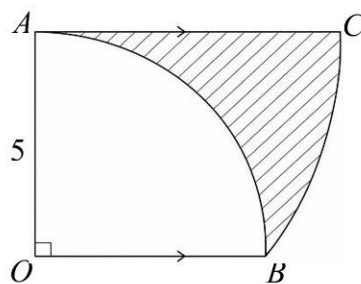
Answer [2]

(b) Explain why $\overline{DP}$ is parallel to $\overline{QR}$.

.....

.....

[2]



The diagram shows a quadrant AOB of a circle with centre O and radius 5 cm.
 AC is parallel to OB and angle $AOB = 90^\circ$.
 BC is an arc of another circle with centre A .

- (a) Find the length of arc BC .

Answer cm [3]

- (b) Find the shaded area.

Answer cm^2 [3]

26 $(x - 1)$ $(x + 2)$ $(x - 2)$ $(x + 8)$ $(x - 1)$ $(x + 5)$ $(x + 4)$ $(x + 6)$

The list shows the masses, in kg, of 8 parcels handled by delivery company *A*.
The sum of the mode and the median of the masses is 36kg.

- (a) Show that $x = 17$.

Answer

[3]

- (b) Calculate the mean and standard deviation of the masses of the 8 parcels handled by delivery company *A*.

Answer

mean = kg

Standard deviation = kg [2]

- (c) Delivery company *B* handled another 8 parcels.
The mean mass of the parcels was 18 kg and the standard deviation was 3.12 kg.
By commenting on the (1.) the means and (2.) the standard deviations, compare the distributions of the parcel masses handled by delivery company *A* and *B*.

1.

.....

2.

.....

[2]

Name:	Register Number:	Class:
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PRESBYTERIAN HIGH SCHOOL

**MATHEMATICS
PAPER 2**

19 August 2026



Wednesday

4052/02

2 hours 15 minutes

Setter: Mr Gregory Quek

[Turn over

1 **(a)** Solve $\frac{2}{3-5x} = \frac{5}{x}$.

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

(b) Factorise completely $8a^3b - 18ab^3$.

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

- (c) Solve these simultaneous equations.

$$3x - 2y = 13$$

$$5x - 3y = 21$$

You must show your working.

Answer $x = \dots\dots\dots$

$y = \dots\dots\dots$ [3]

- (d) Write $\frac{13+7x}{(x-2)(2x+5)} + \frac{3}{2-x}$ as a single fraction in its simplest form.

Answer $\dots\dots\dots$ [3]

[Turn over

2 (a) Simplify $\left(\frac{z^{506} \times z^{507}}{z^0}\right)^2$.

Answer [2]

(b) Wilfred invests \$200 000 in a bank.

The bank pays compound interest at an annual rate of

1.2% for the first year,

$r\%$ for each subsequent year.

Given that there is a total amount of \$212 646.50 in the bank at the end of 3 years,
find the value of r .

Answer $r =$ [3]

- (c) There are only black pens, blue pens and green pens in a shop.

The ratio of the number of black pens to blue pens is 3 : 4.

The ratio of the number of blue pens to green pens is 5 : 3.

There are more than 150 pens in the shop.

What is the least possible number of green pens in the shop?

Answer pens [3]

- 3 (a) A manufacturing firm purchases a laser-cutting machine.
The value of the machine, V (in thousands of dollars), after t years is modelled by

$$V = 500 \times (0.8)^t.$$

Find the initial value of the laser-cutting machine.

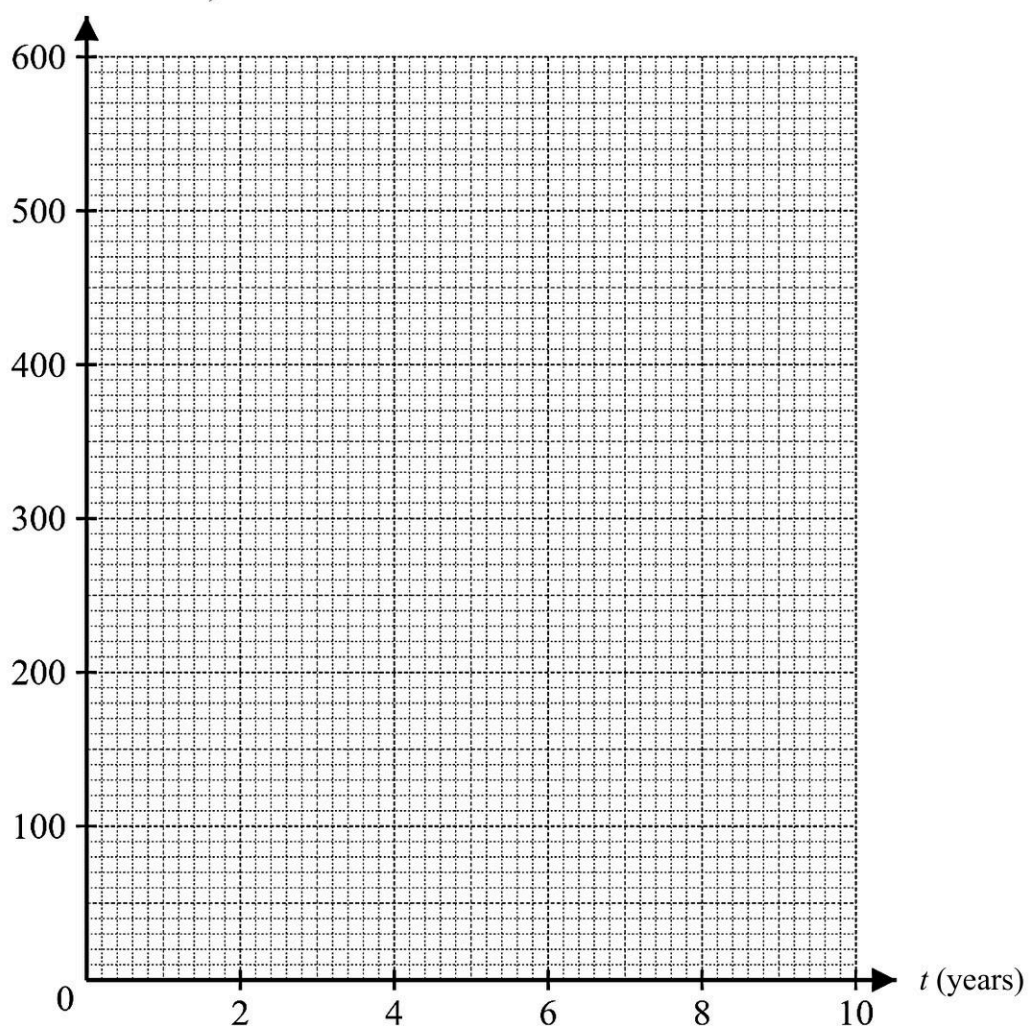
Answer \$ [1]

- (b) On the grid below, draw the graph of $V = 500 \times (0.8)^t$ for $2 \leq t \leq 10$.

t	2	4	6	8	10
V	320	205	131	83.9	53.7

V (thousand dollars)

[3]



- (c) By drawing a tangent, work out an estimate for the gradient of the graph when $t = 5$.

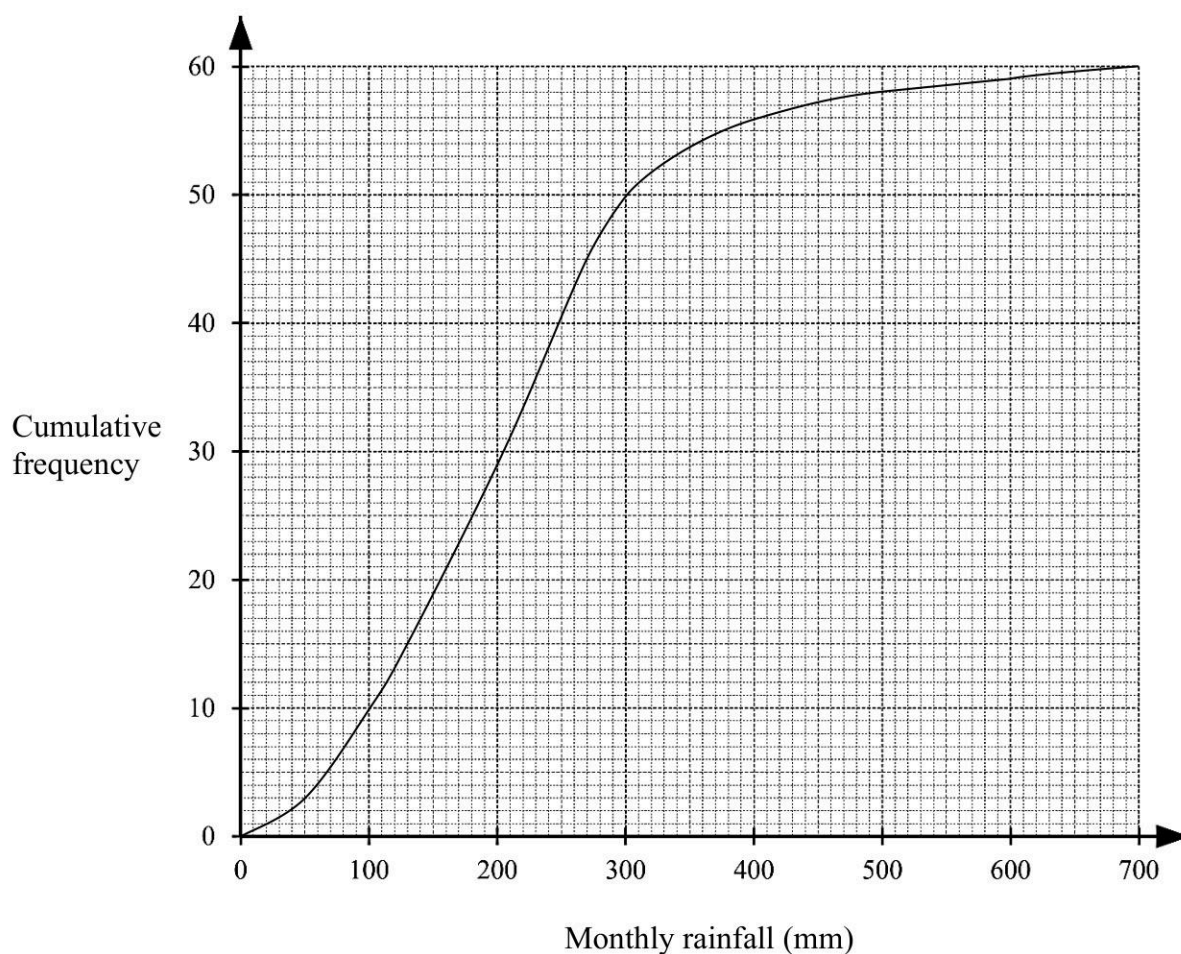
Answer [2]

- (d) Given that another graph of $y = 90 \times a^{-x}$ where $a > 0$, passes through $\left(3, \frac{45}{4}\right)$,
find the value of a .

Answer $a =$ [3]

[Turn over]

- 4 The National Environment Agency records the monthly rainfall (in mm) in Singapore. The cumulative frequency diagram represents the monthly rainfall from 2021 to 2025.



(a) Use the diagram to estimate

(i) the median monthly rainfall,

Answer mm [1]

(ii) the interquartile range of the monthly rainfall.

Answer mm [2]

- (b) A monthly rainfall of 50 mm and below is classified as extremely dry in Singapore. Based on the data provided for the period 2021 to 2025, calculate the probability that a randomly selected month is **not** classified as extremely dry.

Answer [2]

- (c) The rainfall measurements, in mm, for the first five months of 2026 are recorded as

9.4 mm, 202.2 mm, 38.2 mm, 179.8 mm, and 185.2 mm.

By considering the inclusion of these five new data points into the original dataset, explain how the median will change. Justify your reasons.

.....
.....
..... [2]

- 5 (a) $\mathcal{E} = \{\text{integers } x : 1 \leq x \leq 15\}$
 $A = \{\text{multiples of } 2\}$
 $B = \{\text{factors of } 24\}$

(i) Explain why it is **not** true that $B \subset A$.

.....

..... [1]

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

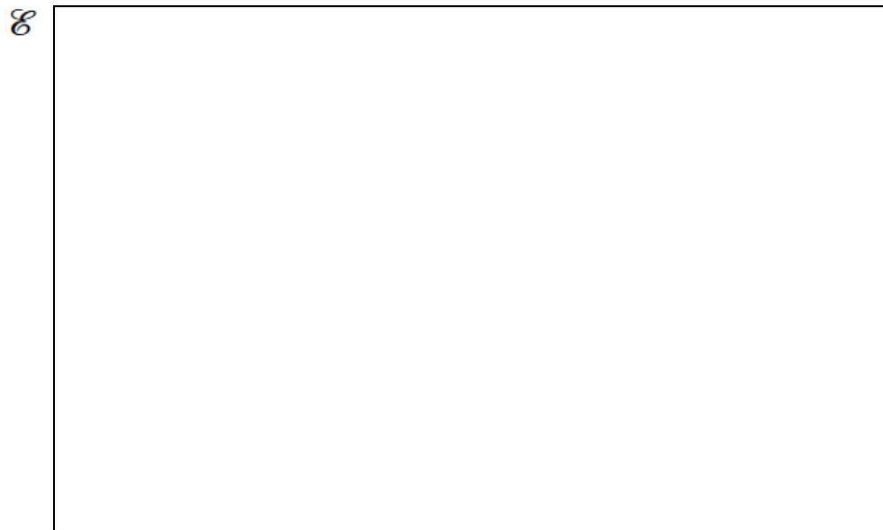
Answer [1]

(b) Set X and set Y are such that $X \cap Y = \emptyset$.

In the space below,

(i) complete the Venn diagram to represent set X and set Y ,

(ii) shade the region on your diagram which represents $(X \cup Y)'$.

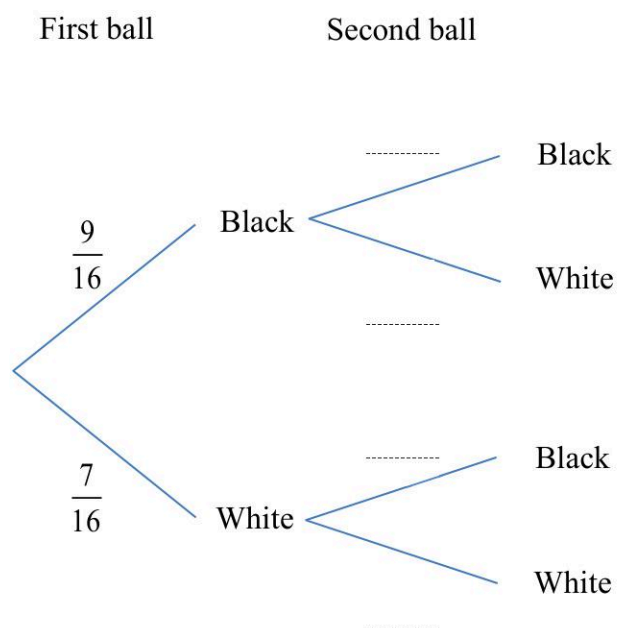


[2]

- (c) A bag contains 16 balls.
 9 of the balls are black and the rest are white.
 One ball is taken at random from the bag.
 If the ball is black, it is **not** put back into the bag.
 If the ball is white, it is put back into the bag.

A second ball is then taken at random from the bag.
 Part of the tree diagram that represents these outcomes is drawn below.

- (i) Complete the tree diagram.



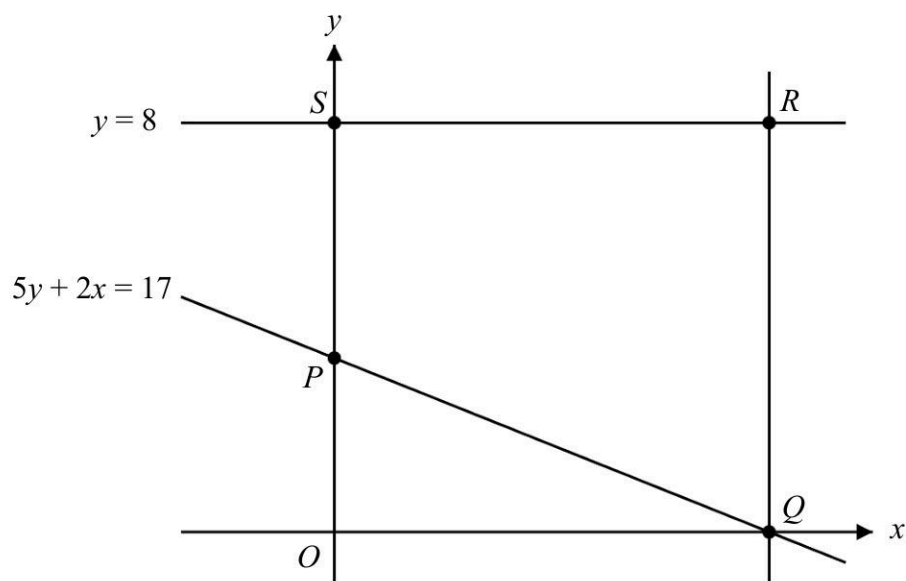
[2]

- (ii) Find, as a fraction in its simplest form, the probability that the two balls are of different colours.

Answer [2]

[Turn over

- 6 The diagram shows a sketch of the line $5y + 2x = 17$ and the line $y = 8$.



The line $5y + 2x = 17$ meets the axes at P and Q .

The line $y = 8$ passes through the points S and R .

RQ is parallel to the y -axis.

- (a) Find the coordinates of Q .

Answer $Q = (\dots\dots\dots, \dots\dots\dots)$ [1]

- (b) Write down the equation of the line parallel to PQ and passing through the point S .

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

- (c) The length of PQ is $\sqrt{k}$ units.
Find the value of k .

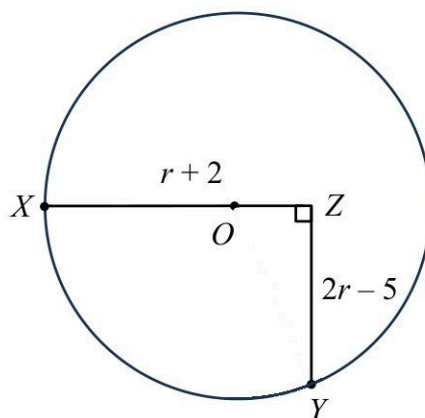
Answer $k = \dots\dots\dots$ [2]

- (d) The diagram represents a map where the quadrilateral $PQRS$ represents a nature park.
Given that the actual area of the nature park is $(1.73502 \times 10^6) \text{ m}^2$, find the actual distance of RQ in kilometres.

Answer $RQ = \dots\dots\dots$ km [4]

[Turn over

7 (a)



X and Y are points on a circle, centre O with radius r cm.
 $XZ = (r + 2)$ cm, $YZ = (2r - 5)$ cm and angle $XZY = 90^\circ$.

(i) Form a quadratic equation in terms of r and show that it reduces to

$$3r^2 - 20r + 29 = 0.$$

Answer

[3]

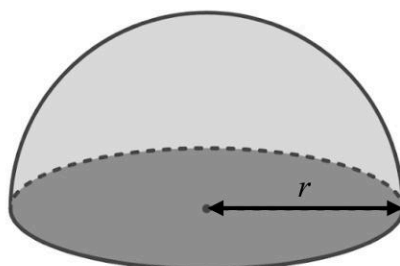
(ii) Solve the equation $3r^2 - 20r + 29 = 0$.

Answer r or [3]

(iii) Explain why one of the solutions in **part (a)(ii)** cannot be the radius.

..... [1]

(b)

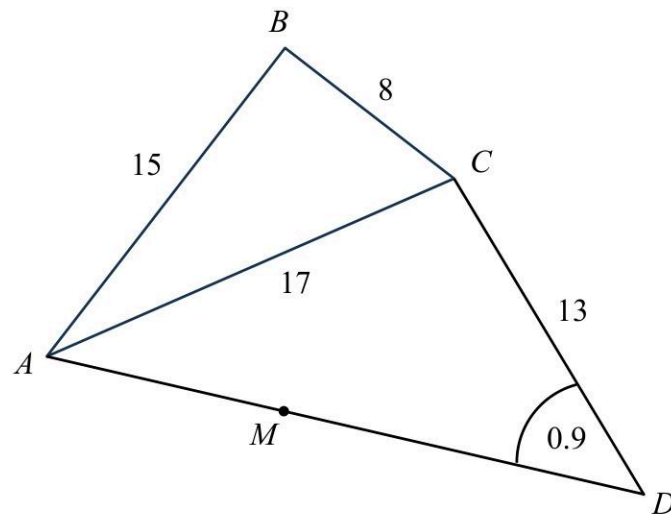


The diagram shows a solid hemisphere of radius r cm.

Given that the solid hemisphere is melted down and recast to form a solid cone with radius $\frac{3}{4}r$ cm and height h cm, express h in terms of r .

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

[Turn over



The diagram shows a quadrilateral, $ABCD$.

$AB = 15$ cm, $BC = 8$ cm, $AC = 17$ cm, $CD = 13$ cm and angle $ADC = 0.9$ radians.

The point M lies on AD such that $AM : MD = 3 : 4$.

- (a) Show that angle $ABC = \frac{\pi}{2}$ radians.

Answer

- (b)** Find the size of angle ACD .

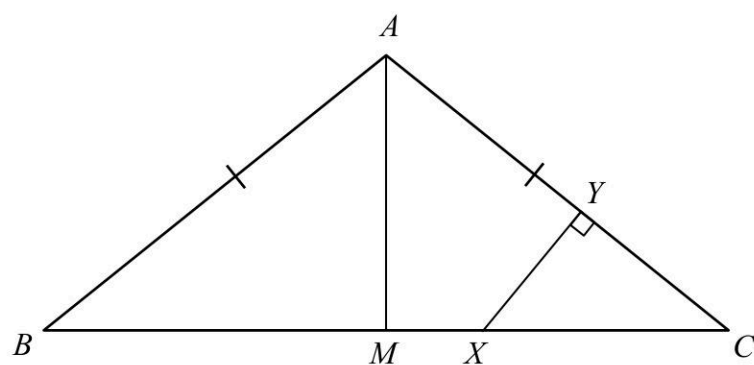
Answer Angle $ACD = \dots\dots\dots$ [3]

- (c)** Find the area of triangle AMC .

Answer $\dots\dots\dots \text{cm}^2$ [2]

[Turn over

9 (a)



In the diagram, ABC is a triangle where $AB = AC$ and M is the midpoint of BC . XY is perpendicular to AC .

(i) Show that triangles ACM and XCY are geometrically similar.

Answer

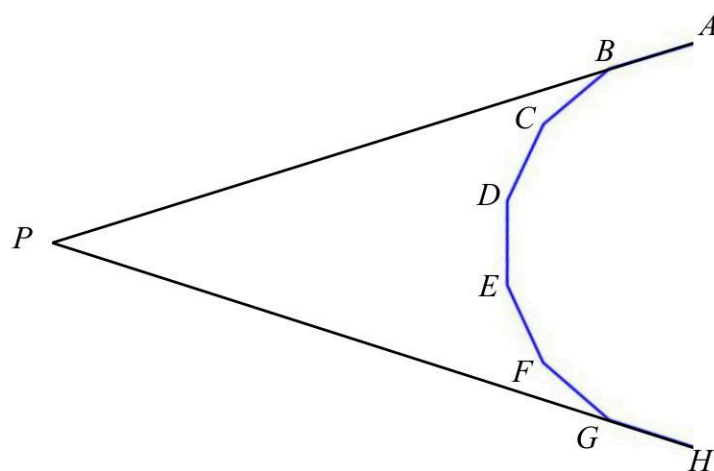
(ii) $AB = 20$ cm, $XY = 5$ cm and angle $XCY = 30^\circ$.

Find the value of $\frac{\text{area of } \triangle XCY}{\text{area of } \triangle ABC}$.

Answer [3]

[Turn over

9 (b)



$ABCDEFGH$ is part of a regular n -sided polygon.

Each exterior angle of the polygon is $2x^\circ$ and each interior angle is $13x^\circ$.

ABP and HGP are straight lines.

(i) Find the size of each interior angle of the n -sided polygon.

Answer $^\circ$ [2]

(ii) Find the size of angle BPG .

Answer Angle $BPG =$ $^\circ$ [4]

- 10** Singapore relies on four water sources for its water supply.
It comprises water from local catchment, imported water, recycled water and desalinated water.

Recycled water (R) and desalinated water (D) are produced at five water plants respectively.
The matrix **M** shows information about the production capacity for each water plant, measured in million gallons per day (mgd).

$$\mathbf{M} = \begin{array}{cc} & \begin{array}{cc} \text{R} & \text{D} \end{array} \\ \begin{pmatrix} 20 & 30 \\ 35 & 70 \\ 50 & 30 \\ 50 & 30 \\ 50 & 30 \end{pmatrix} & \begin{array}{l} \text{Plant 1} \\ \text{Plant 2} \\ \text{Plant 3} \\ \text{Plant 4} \\ \text{Plant 5} \end{array} \end{array}$$

- (a) Evaluate the matrix $\mathbf{K} = \mathbf{TMS}$, where $\mathbf{T} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \end{pmatrix}$ and $\mathbf{S} = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$.

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

- (b) State what the element(s) of matrix **K** represent.

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

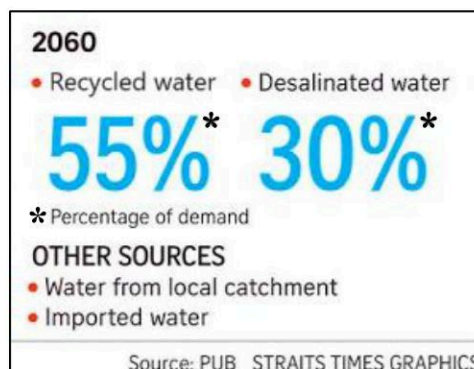
[Turn over

- (c) The four water sources supply Singapore's daily water demand of 440 million gallons a day (mgd).

If a pie chart is drawn to represent these four water sources, calculate the sum of the angle of the sectors representing the water from local catchment and imported water.

Answer ° [2]

- (d) In 2060, Singapore's daily water demand will be double that of the value in **part (c)**. To meet this demand, the production of recycled water and desalinated water must reach the target percentages shown below.



Hence, Singapore plans to raise the production capacity of its water plants as follows:

Recycled water

- Plant 1 will increase its capacity by 150%, while the other plants remain unchanged.
- A new Plant 6, with the same production capacity as Plant 5, will be built.
- A new Plant 7, with a production capacity 1.5 times that of Plant 6, will be built.

Desalinated water

- All existing plants will remain unchanged.
- A new Plant 6, with a production capacity 1.2 times that of Plant 2 will be built.

Using the given information, justify with calculations whether the new production capacities will meet the respective target percentages set for 2060.

Answer

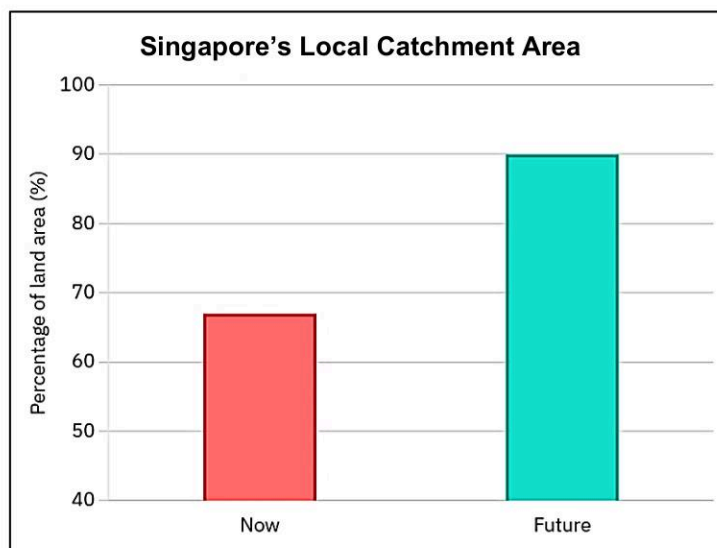
.....

..... [5]

[Turn over

- (e) In order to increase its water supply, Singapore aims to expand its local catchment area.

The bar chart compares the percentage of Singapore's land area used as local catchment. However, the chart is misleading.



Suggest one adjustment to the chart to avoid misinterpretation of the data. Justify your reason.

.....

.....

..... [2]

END OF PAPER

Name:	Register Number:	Class:
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**MATHEMATICS
PAPER 1**

4052/01

17 August 2026

Monday

2 hours 15 min

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2026 SECONDARY FOUR EXPRESS / FIVE NORMAL (ACADEMIC)

PRELIMINARY EXAMINATION

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ANSWERS

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1

$$V = \frac{pq}{1 - \sqrt{r}}$$

Calculate the value of V when $p = 0.05$, $q = 2.17$ and $r = 8.7$.

$$V = \frac{(0.05)(2.17)}{1 - \sqrt{8.7}} = -0.0557 \quad (3\text{s.f.})$$

Answer [1]

- 2 The table below shows the materials needed to make one batch of concrete. Each batch of concrete has volume 0.15 m^3 .

Material	Amount per batch
Cement	25 kg
Sand	60 kg
Gravel	90 kg
Water	12 litres

- (a) How many batches of concrete can a builder make with 175 kg of cement?

$$\text{No of batches} = \frac{175}{25} = 7$$

Answer [1]

- (b) Another builder has 240 kg of cement, 108 litres of water and 540 kg of each of the other materials.

- (i) Find the maximum volume of concrete he can make.

$$\text{Since limiting material is gravel, no of batches} = \frac{540}{90} = 6$$

$$\text{Max volume} = 6 \times 0.15 = 0.9 \text{ m}^3$$

Answer m^3 [2]

- (ii) Calculate the amount of water he needs to use to make this maximum volume.

$$\text{Amt} = 6 \times 12 = 72 \text{ litre}$$

Answer litres [1]

- 3 A company borrowed a sum of money at a simple interest rate of 3.5 % per year.
After 5 years, the total amount owed was \$4465.
Calculate the amount borrowed.

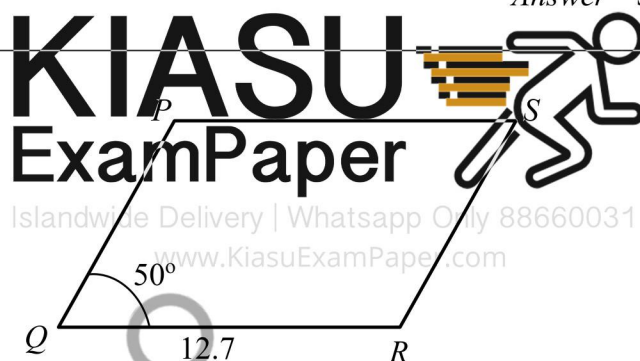
$$4465 = P + \frac{P(3.5)(5)}{100}$$

$$4465 = 1.175P$$

$$P = \$3800$$

Answer \$ [2]

4



$PQRS$ is a parallelogram with an area of 52.6 cm^2 .

$QR = 12.7 \text{ cm}$ and angle $PQR = 50^\circ$.

Find the length of RS .

$$h = \frac{52.6}{12.7} = 4.1417$$

$$\sin 50^\circ = \frac{4.1417}{RS}$$

$$RS = \frac{4.1417}{\sin 50^\circ} = 5.41 \text{ cm (3 s.f)}$$

OR

$$\frac{1}{2}(RS)(12.7)\sin 50^\circ \times 2 = 52.6$$

$$RS = \frac{52.6}{12.7 \sin 50^\circ} = 5.41 \text{ cm (3 s.f)}$$

Answer cm [3]

- 5 A car travels a distance of 362 km at a speed of 84 km/h.
Both the distance and the speed are rounded to 1 significant figure before the journey time is calculated.
Without doing any calculations, state whether the calculated journey time is greater than or less than the actual journey time. Explain your answer.

Answer The calculated journey time is **greater than** the actual journey time.

The **distance is rounded up** while the **speed is rounded down** so $\frac{\text{distance}}{\text{speed}}$ becomes

larger resulting in a longer calculated time. [1]

- 6 (a) Given that $\sqrt[3]{8^k} = 2^{3k} - 2^{3k-1}$, find k .

$$\sqrt[3]{8^k} = 2^{3k} - 2^{3k-1}$$

$$(2^{3k})^{\frac{1}{3}} = 2^{3k} - 2^{3k} (2^{-1})$$

$$2^k = 2^{3k} \left(1 - \frac{1}{2}\right)$$

$$2^k = 2^{3k-1}$$

$$k = 3k - 1$$

$$k = \frac{1}{2}$$

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Answer $k =$ [2]

- (b) Factorise completely $24mn - 16m - 42n + 28$.

$$24mn - 16m - 42n + 28$$

$$= 2(12mn - 8m - 21n + 14)$$

$$= 2[4m(3n - 2) - 7(3n - 2)]$$

$$= 2(3n - 2)(4m - 7)$$

OR

$$24mn - 16m - 42n + 28$$

$$= 4m(6n - 4) - 7(6n - 4)$$

$$= (6n - 4)(4m - 7)$$

$$= 2(3n - 2)(4m - 7)$$

Answer [2]

- (c) Expand and simplify $(5 - 3x)(2x^2 + 4x - 1)$.

$$(5 - 3x)(2x^2 + 4x - 1)$$

$$= 10x^2 - 6x^3 + 20x - 12x^2 - 5 + 3x$$

$$= -6x^3 - 2x^2 + 23x - 5$$

Answer [2]

7 (a) Solve the inequalities $-\frac{65}{3} \leq \frac{5(-5x-1)}{6} < \frac{55}{4}$.

$$-\frac{65}{3} \leq \frac{5(-5x-1)}{6} \qquad \frac{5(-5x-1)}{6} < \frac{55}{4}$$

$$-130 \leq 5(-5x-1) \qquad 10(-5x-1) < 165$$

$$-26 \leq -5x - 1 \quad \text{or} \quad -5x - 1 < 16\frac{1}{2}$$

$$-25 \leq -5x$$

$$x \leq 5 \qquad -5x < 17\frac{1}{2}$$

$$\therefore -3\frac{1}{2} < x \leq 5 \quad / \quad -\frac{7}{2} < x \leq 5$$

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www.KiasuExamPaper.com *Answer*

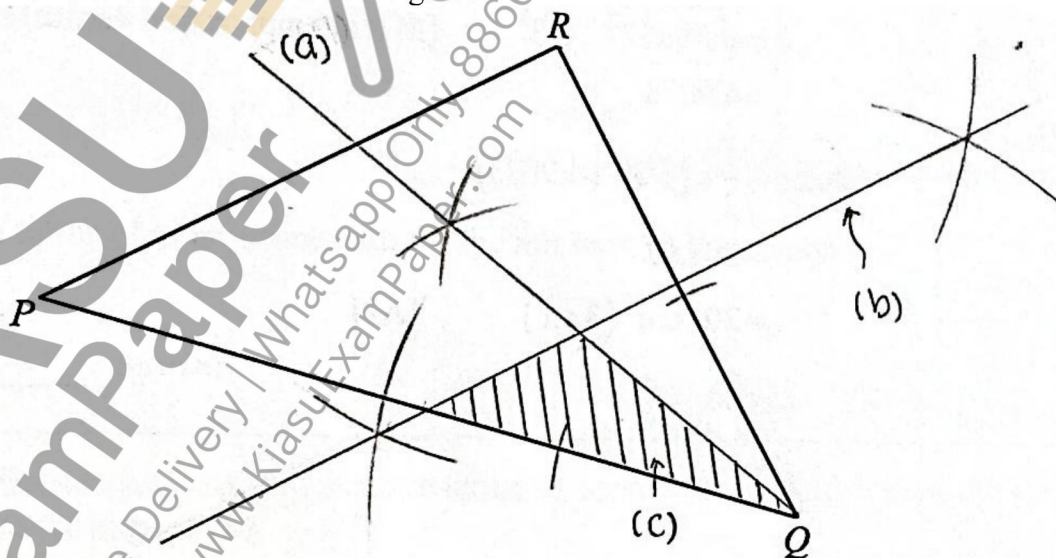
Answer [3]

(b) Given that x is a perfect square, write down **all** the possible values of x .

0, 1, 4

Answer [1]

8 The diagram shows a triangular garden PQR .
A sprinkler is to be installed inside the garden.



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

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

(c) The sprinkler is to be placed nearer to PQ than to RQ , and nearer to Q than to R . Shade the region inside the garden where the sprinkler can be placed. [1]

- 9 Rearrange the formula $\frac{2a+3}{5-a} = m - \frac{1}{3}$ to make a the subject.

$$\frac{2a+3}{5-a} = m - \frac{1}{3}$$

$$\frac{2a+3}{5-a} = \frac{3m-1}{3}$$

$$3(2a+3) = (3m-1)(5-a)$$

$$6a+9 = 15m-5-3ma+a$$

$$5a+3ma = 15m-14$$

$$a(5+3m) = 15m-14$$

$$a = \frac{15m-14}{5+3m}$$

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www.KiasuExamPaper.com Answer $a =$ [3]

- 10 The **sum** of the first n terms of a linear sequence is $\frac{1}{2}n(7n-3)$.

- (a) Find the first 3 terms of the sequence.

$$T_1 = 2$$

$$T_2 = 11 - 2 = 9$$

$$T_3 = 27 - 11 = 16$$

Answer 2....., 9....., 16..... [2]

- (b) Find, in terms of n , an expression for the n th term of the sequence.

Answer $7n-5$ [1]



The diagram shows a frustum which is part of a right circular cone.

The frustum has a slant height of 17 cm.

The top of the frustum is a circle of radius 9 cm and the base is a circle of radius 15 cm.
Find the volume of the frustum.

Let the height of the frustum be h cm.

Let the height of the cone be H cm.

$$h = \sqrt{17^2 - 16^2} = \sqrt{253}$$

$$\frac{H}{H - \sqrt{253}} = \frac{15}{9}$$

$$9H = 15H - 15\sqrt{253}$$

$$6H = 15\sqrt{253}$$

$$H = \frac{15\sqrt{253}}{6}$$

volume of frustum

$$= \frac{1}{3} \pi (15)^2 \left(\frac{15\sqrt{253}}{6} \right) - \frac{1}{3} \pi (9)^2 \left(\frac{15\sqrt{253}}{6} - \sqrt{253} \right)$$

$$= 9369.39 - 2023.79$$

$$= 7345.60$$

$$= 7350 \text{ cm}^3 \text{ (3 s.f.)} \quad [\text{A1}]$$

Answer cm³ [4]

- 12 (a) Use prime factors to explain why 96×45 is **not** a perfect square.

$$96 \times 45 = (2^5 \times 3) \times (3^2 \times 5) = 2^5 \times 3^3 \times 5$$

Since the index of all the prime factors are **odd**, 96×45 is **not** a perfect square.

[2]

- (b) The number $96 \times 45 \div \frac{m}{n}$ is a perfect cube where m and n are prime numbers.

Find the value of m and the value of n .

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Answer $m = 5$

$n = 2$ [2]

- (c) The number $S = 2^5 \times 3^3 \times 5$.
The lowest common multiple (LCM) of 45, 96 and P is S .
 P is between 30 and 300.
Give a **possible** value of P .

$$S = 2^5 \times 3^3 \times 5, 45 = 3^2 \times 5, 96 = 2^5 \times 3$$

$$P = 3^3 \times 2 = 54 / 3^3 \times 2^2 = 108 / 3^3 \times 2^3 = 216 / 3^3 \times 5 = 135 / 3^3 \times 2 \times 5 = 270$$

Answer $P = 54/ 108/ 135/ 216/ 270$ [1]

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

Show that m is an integer.

$2n + 5$ is odd so $(2n + 5)^2$ is odd. $(2n + 5)^2 + 1$ is **even** and $2m$ is even. m is an integer.

or

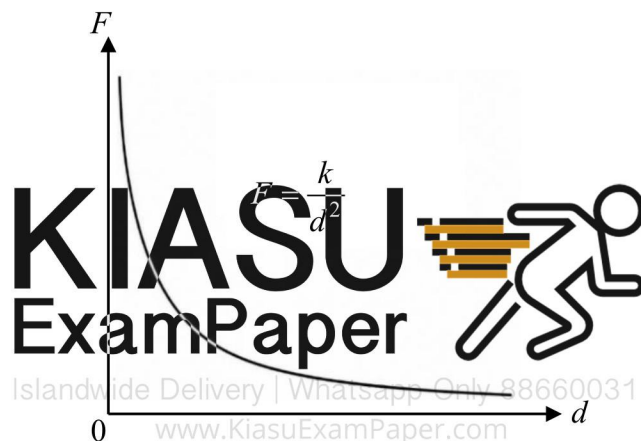
$2m - 1 = 4n^2 + 20n + 25$, $2m = 4n^2 + 20n + 26$, $m = 2n^2 + 10n + 13$. Since n is a positive integer, $2n^2 + 10n + 13$ is a **positive integer**. m is an integer.

[1]

- 14 The force, F , between two objects is inversely proportional to the square of the distance, d , between them.

(a) Sketch the graph of F against d .

Answer



[1]

- (b) The distance between the objects is increased by 30%.
Calculate the percentage reduction in the force between the objects.

$$\text{new distance} = 1.3d$$

$$\text{new force} = \frac{k}{(1.3d)^2}$$

$$\% \text{ change} = \frac{\frac{k}{(1.3d)^2} - \frac{k}{d^2}}{\frac{k}{d^2}} \times 100\%$$

$$= -40.8\% \text{ (3 s.f.)}$$

$$\% \text{ reduction} = 40.8\%$$

Answer % [2]

- 15 (a) The retail price of a refrigerator is \$4 800.
During a promotional sale, a discount of 15% is offered.
The refrigerator is sold at a profit of 20%.
Calculate the **cost price** of the refrigerator.

$$\text{Selling price after discount} = 4800 \times 0.85 = \$4080$$

$$\text{Cost price} = 4080 \times \frac{100}{120} = \$3400$$

Answer \$ [2]

- (b) The price of a tablet in France is €1004.96.
The same tablet is 12% cheaper in France than in Singapore.
The price of the tablet in Singapore is \$1690.
Find the exchange rate between Singapore dollars (\$) and euros (€).
Give your answer in the form \$1 = €.....

Method 1:

$$\text{SG price in Euro} = \frac{1004.96}{0.88} = €1142$$

$$\text{Exchange rate} = \frac{1142}{1690} = 0.67573$$

$$\$1 = €0.68 \text{ (2 d.p.)}$$

Method 2:

$$\text{Price in France (S\$)} = 0.88 \times 1690 = \$1487.20 \quad [\text{M1}]$$

$$\text{Exchange rate} = \frac{1004.96}{1487.20} = 0.67573$$

$$\$1 = €0.68 \text{ (2 d.p.)}$$

Answer [2]

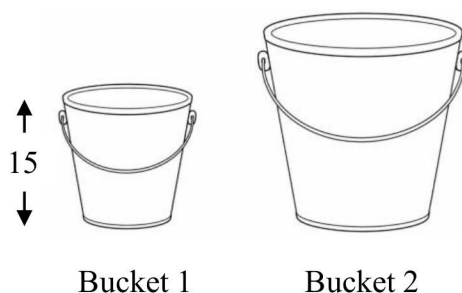
- 16 Given that $x^2 - 14x + p$ is a perfect square, find the value of p .
Show your working.

$$x^2 - 14x + p = x^2 - 14x + \left(\frac{-14}{2}\right)^2 - \left(\frac{-14}{2}\right)^2 + p$$

$$-\left(\frac{-14}{2}\right)^2 + p = 0$$

$$p = 49$$

Answer $p =$ [2]



The diagram shows two geometrically similar empty buckets.

The height of the smaller bucket is 15 cm, and the base area of the larger bucket is 686 cm².

Water is poured into both buckets at the same constant rate.

The smaller bucket takes $\frac{1}{8}$ of the time the larger bucket takes to fill completely.

- (a) Find the height of the larger bucket.

$$\frac{V_{\text{big}}}{V_{\text{small}}} = \frac{h_{\text{big}}}{h_{\text{small}}}$$

$$\frac{8}{1} = \left(\frac{h_{\text{big}}}{15} \right)^3$$

$$h_{\text{big}} = \sqrt[3]{8} \times 15$$

$$= 30 \text{ cm}$$

Answer cm [2]

- (b) Find the base area of the smaller bucket.

$$\frac{A_{\text{small}}}{686} = \left(\frac{1}{2} \right)^2$$

$$A_{\text{small}} = \left(\frac{1}{2} \right)^2 \times 686$$

$$= 171.5 \text{ cm}^2$$

Answer cm² [2]

- 18 A bag contains 12 blue marbles, 8 red marbles and 10 green marbles.
After p green marbles are removed from the bag, the probability of choosing a green marble is now $\frac{3}{13}$.

Find the value of p .

$$\frac{10-p}{30-p} = \frac{3}{13}$$

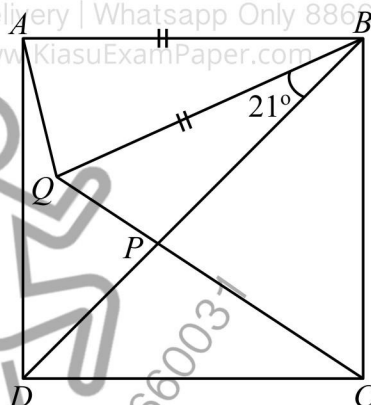
$$130 - 13p = 90 - 3p$$

$$10p = 40$$

$$p = 4$$

KIASU ExamPaper  Answer $p = \dots\dots\dots$ [2]

19



The diagram shows a square $ABCD$.

QPC and BPD are straight lines.

$BA = BQ$ and angle $PBQ = 21^\circ$.

Find angle DCQ .

Since $BA = BQ$ and $BC = BA$, $\triangle BQC$ is an isosceles triangle.

$$\angle BCQ = \frac{180^\circ - (21^\circ + 45^\circ)}{2}$$

$$= 57^\circ$$

$$\angle DCQ = 90^\circ - 57^\circ$$

$$= 33^\circ$$

Answer Angle $DCQ = \dots\dots\dots$ [2]

- 20 (a) Write 9.6×10^{-13} in the form $A \times 10^{-12}$.

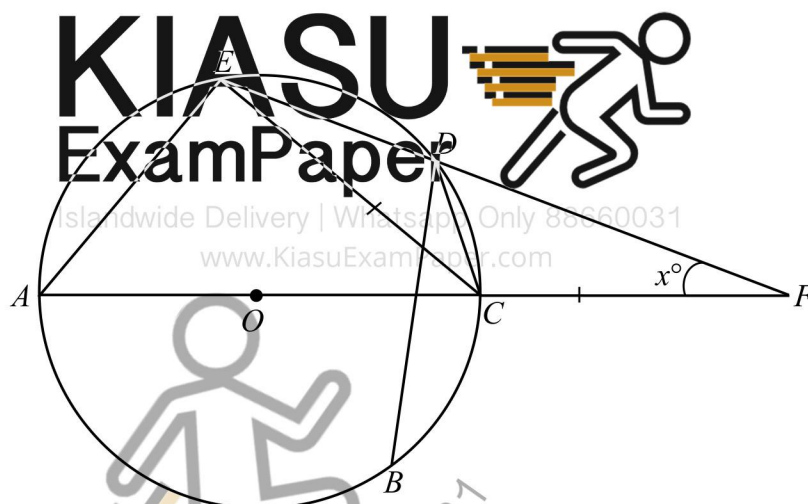
Answer 0.96×10^{-12} [1]

- (b) Work out $(9.1 \times 10^{-12}) + (9.6 \times 10^{-13})$.

Give your answer in standard form.

Answer 1.006×10^{-11} [1]

21



A, B, C, D and E are points on the circle, centre O .
 AC is the diameter.
 AC and ED are extended to meet at F .
 $CE = CF$ and angle $AFD = x^\circ$.

- (a) Show that angle $DBC = x^\circ$.
 Give a reason for each step of your working.

$$\angle DEC = x^\circ \quad (\text{base } \angle \text{s of isos } \triangle)$$

$$\angle DBC = x^\circ \quad (\angle \text{s in same segment})$$

[2]

- (b) Find, in terms of x , angle ACD .
 Give a reason for each step of your working.

$$\angle AEC = 90^\circ \quad (\angle \text{ in a semicircle})$$

$$\angle ACD = 180^\circ - (90^\circ + x^\circ) \quad (\angle \text{s in opp segment})$$

$$= 90^\circ - x^\circ \quad [\text{A1}]$$

Answer Angle $ACD =$ [2]

22 Solve the equation $\frac{2x}{x+3} - \frac{5}{2x-1} - 3 = 0$.

Show all your working.

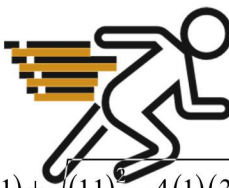
Give your solutions correct to 2 decimal places.

$$\frac{2x}{x+3} - \frac{5}{2x-1} - 3 = 0$$

$$\frac{2x(2x-1)}{(x+3)(2x-1)} - \frac{5(x+3)}{(x+3)(2x-1)} - \frac{3(x+3)(2x-1)}{(x+3)(2x-1)} = 0$$

$$4x^2 - 2x - 5x - 15 - 6x^2 - 15x + 9 = 0$$

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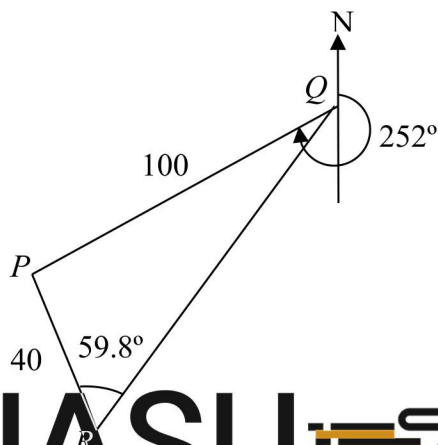
$$x = \frac{-(-11) \pm \sqrt{(-11)^2 - 4(1)(3)}}{2(1)}$$

$$= -0.27984 \quad \text{or} \quad -10.7201$$

$$= -0.28 \quad \text{or} \quad -10.72 \quad (2 \text{ d.p.})$$

Answer y = [5]

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P , Q and R are three points on horizontal ground.

$PQ = 100$ m and the bearing of R from Q is 252° .

$PR = 40$ m and angle $PRQ = 59.8^\circ$.

- (a) Find the bearing of Q from P .

$$252^\circ - 180^\circ = 72^\circ$$

$$\text{Bearing of } Q \text{ from } P = 072^\circ$$

Answer [1]

- (b) A lifeguard stands on top of an 8-metres high watchtower at P .
A jogger walks along the straight path from R to Q .

- (i) Calculate the shortest distance from P to RQ .

Let d be the shortest distance.

$$\sin 59.8^\circ = \frac{d}{40}$$

$$\begin{aligned} d &= 40 \sin 59.8^\circ \\ &= 34.5709 \\ &= 34.6 \text{ m (3 s.f)} \end{aligned}$$

Answer m [2]

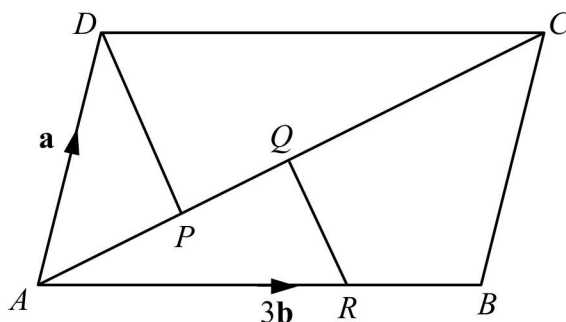
- (ii) Calculate the greatest angle of depression from the lifeguard to the jogger.

Let θ be the angle of depression.

$$\tan \theta = \frac{8}{34.5709}$$

$$\begin{aligned} \theta &= 13.0293 \\ &= 13.0^\circ \text{ (1 d.p)} \end{aligned}$$

Answer [2]



$ABCD$ is a parallelogram.

Q is the midpoint of AC and P is the midpoint of AQ .

R is the point on AB such that $AR = 2RB$.

$\overrightarrow{AD} = \mathbf{a}$ and $\overrightarrow{AB} = 3\mathbf{b}$.

- (a) Express $\overrightarrow{DP}$, as simply as possible, in terms of $\mathbf{a}$ and $\mathbf{b}$.

$$\overrightarrow{AP} = \frac{1}{4} \overrightarrow{AC}$$

$$= \frac{1}{4} (\mathbf{a} + 3\mathbf{b})$$

$$\overrightarrow{DP} = -\mathbf{a} + \frac{1}{4} (\mathbf{a} + 3\mathbf{b})$$

$$= -\frac{3}{4} \mathbf{a} + \frac{3}{4} \mathbf{b}$$

$$= \frac{3}{4} (\mathbf{b} - \mathbf{a})$$

Answer [2]

- (b) Explain why $\overrightarrow{DP}$ is parallel to $\overrightarrow{QR}$.

Since $AR = 2RB$, $\overrightarrow{AR} = 2\mathbf{b}$.

$$\overrightarrow{QR} = \overrightarrow{QA} + \overrightarrow{AR}$$

$$= -\frac{1}{2}(\mathbf{a} + 3\mathbf{b}) + 2\mathbf{b}$$

$$= -\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$$

$$= \frac{1}{2}(\mathbf{b} - \mathbf{a})$$

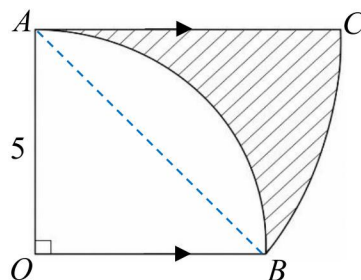
$$\overrightarrow{DP} = \frac{3}{4}(\mathbf{b} - \mathbf{a})$$

$$= \frac{3}{2} \left[\frac{1}{2}(\mathbf{b} - \mathbf{a}) \right]$$

$$= \frac{3}{2}\overrightarrow{QR}$$

Since $\overrightarrow{DP} = \frac{3}{2}\overrightarrow{QR}$, $\overrightarrow{DP}$ is parallel to $\overrightarrow{QR}$.

[2]



The diagram shows a quadrant AOB of a circle with centre O and radius 5 cm.
 AC is parallel to OB and angle $AOB = 90^\circ$
 BC is an arc of another circle with centre A .

- (a) Find the length of arc BC .

$$AB = \sqrt{5^2 + 5^2} = \sqrt{50}$$

$$\text{arc length} = \frac{1}{8} \times 2\pi(\sqrt{50})$$

$$= 5.55 \text{ cm (3s.f.)}$$

Answer cm [3]

- (b) Find the shaded area.

$$\text{area of sector } ABC = \frac{1}{8} \times \pi(\sqrt{50})^2$$

$$\text{area of segment} = \frac{1}{4} \times \pi(5)^2 - \frac{1}{2}(5)^2$$

$$\text{shaded area} = \text{area of sector } ABC - \text{area of segment}$$

$$= \frac{1}{8} \times \pi(\sqrt{50})^2 - \left(\frac{1}{4} \times \pi(5)^2 - \frac{1}{2}(5)^2 \right)$$

$$= 12.5 \text{ cm}^2$$

Answer cm^2 [3]

26 $(x-1)$ $(x+2)$ $(x-2)$ $(x+8)$ $(x-1)$ $(x+5)$ $(x+4)$ $(x+6)$

The list shows the masses, in kg, of 8 parcels handled by delivery company A.
The sum of the mode and the median of the masses is 36kg.

- (a) Show that $x = 17$.

Answer

Rearranging:

$(x-2), (x-1), (x-1), (x+2), (x+4), (x+5), (x+6), (x+8)$

$$\text{mode} = (x-1), \text{median} = \frac{(x+2) + (x+4)}{2} = x+3$$

$$x-1 + x+3 = 36$$

$$2x = 34$$

$$x = 17$$

[3]

- (b) Calculate the mean and standard deviation of the masses of the 8 parcels handled by delivery company A.

Masses: 15, 16, 16, 19, 21, 22, 23, 25

$$\text{Mean} = \frac{157}{8} = 19.625 \text{ kg}$$

$$\text{SD} = 3.4618 = 3.46 \text{ kg}$$

Answer

mean = kg

Standard deviation = kg [2]

- (c) Delivery company B handled another 8 parcels.

The mean mass of the parcels was 18 kg and the standard deviation was 3.12 kg.

By commenting on the (1.) the **means** and (2.) the **standard deviations**, **compare** the distributions of the parcel masses handled by delivery company A and B.

1. Delivery company A has a **higher mean** than delivery company B so the parcels handled by delivery company are **heavier** on average.

2. Delivery company B has a **smaller SD** than delivery company A so the parcel masses are **less spread/ more consistent**.

[2]

Name:	Register Number:	Class:
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PRESBYTERIAN HIGH SCHOOL



**MATHEMATICS
PAPER 2**

4052/02

19 August 2026

Wednesday

2 hours 15 minutes

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ANSWERS

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Setter: Mr Gregory Quek

[Turn over

1 (a) Solve $\frac{2}{3-5x} = \frac{5}{x}$.

$$\begin{aligned}\frac{2}{3-5x} &= \frac{5}{x} \\ 2x &= 5(3-5x) \\ 2x &= 15 - 25x \\ 27x &= 15 \\ x &= \frac{15}{27} = \frac{5}{9}\end{aligned}$$

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

(b) Factorise completely $8a^3b - 18ab^3$.

$$\begin{aligned}8a^3b - 18ab^3 \\ &= 2ab(4a^2 - 9b^2) \\ &= 2ab(2a - 3b)(2a + 3b)\end{aligned}$$

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

- (c) Solve these simultaneous equations.

$$3x - 2y = 13$$

$$5x - 3y = 21$$

You must show your working.

$$9x - 6y = 39 \dots\dots\dots(3)$$

$$10x - 6y = 42 \dots\dots\dots(4)$$

$$(4) - (3):$$

$$10x - 9x = 42 - 39$$

$$x = 3$$

$$y = -2$$

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Answer $x = \dots\dots\dots$

$y = \dots\dots\dots$ [3]

- (d) Write $\frac{13+7x}{(x-2)(2x+5)} + \frac{3}{2-x}$ as a single fraction in its simplest form.

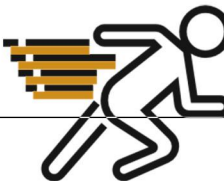
$$\begin{aligned} & \frac{13+7x}{(x-2)(2x+5)} + \frac{3}{2-x} \\ &= \frac{13+7x}{(x-2)(2x+5)} - \frac{3}{(x-2)} \\ &= \frac{13+7x}{(x-2)(2x+5)} - \frac{3(2x+5)}{(x-2)(2x+5)} \\ &= \frac{13+7x-6x-15}{(x-2)(2x+5)} \\ &= \frac{x-2}{(x-2)(2x+5)} \\ &= \frac{1}{2x+5} \end{aligned}$$

Answer $\dots\dots\dots$ [3]

[Turn over

2 (a) Simplify $\left(\frac{z^{506} \times z^{507}}{z^0}\right)^2$.

$$\begin{aligned} & \left(\frac{z^{506} \times z^{507}}{z^0}\right)^2 \\ &= \left(\frac{z^{1013}}{1}\right)^2 \\ &= z^{2026} \end{aligned}$$

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Answer [2]

(b) Wilfred invests \$200 000 in a bank.

The bank pays compound interest at an annual rate of

1.2% for the first year,

$r\%$ for each subsequent year.

Given that there is a total amount of \$212 646.50 in the bank at the end of 3 years, find the value of r .

$$A_1 = P \left(1 + \frac{r}{100}\right)^n$$

$$A_1 = 200000 \left(1 + \frac{1.2}{100}\right)$$

$$A_1 = \$202400$$

$$A_3 = P \left(1 + \frac{r}{100}\right)^n$$

$$212646.50 = 202400 \left(1 + \frac{r}{100}\right)^2$$

$$\sqrt{1.050625} = 1 + \frac{r}{100}$$

$$r = (1.025 - 1) \times 100 = 2.5$$

Answer $r =$ [3]

- (c) There are only black pens, blue pens and green pens in a shop.

The ratio of the number of black pens to blue pens is 3 : 4.

The ratio of the number of blue pens to green pens is 5 : 3.

There are more than 150 pens in the shop.

What is the least possible number of green pens in the shop?

Method 1

Black : Blue : Green

$$3 : 4$$

$$5 : 3$$

$$15 : 20 : 12$$

$\Rightarrow$ total number of pens is a multiple of 47 and more than 150.

$$\Rightarrow \text{total number of pens} = 47 \times 4 = 188$$

$$\text{Least possible number of green pens} = 12 \times 4 = 48$$

Method 2

Black : Blue : Green

$$3 : 4$$

$$5 : 3$$

$$47 \times 4 = 188$$

$$\text{Let } 15u + 20u + 12u > 150$$

$$47u > 150$$

$$u > 3\frac{9}{47}$$

$$\text{Least possible number of green pens} = 12 \times 4 = 48$$

Answer pens [3]

- 3 (a) A manufacturing firm purchases a laser-cutting machine.
The value of the machine, V (in thousands of dollars), after t years is modelled by

$$V = 500 \times (0.8)^t.$$

Find the initial value of the laser-cutting machine.

$$\text{Let } t = 0, V = 500 \times (0.8)^0 = 500$$

$$\text{Initial value} = 500 \times 1000 = \$500000$$

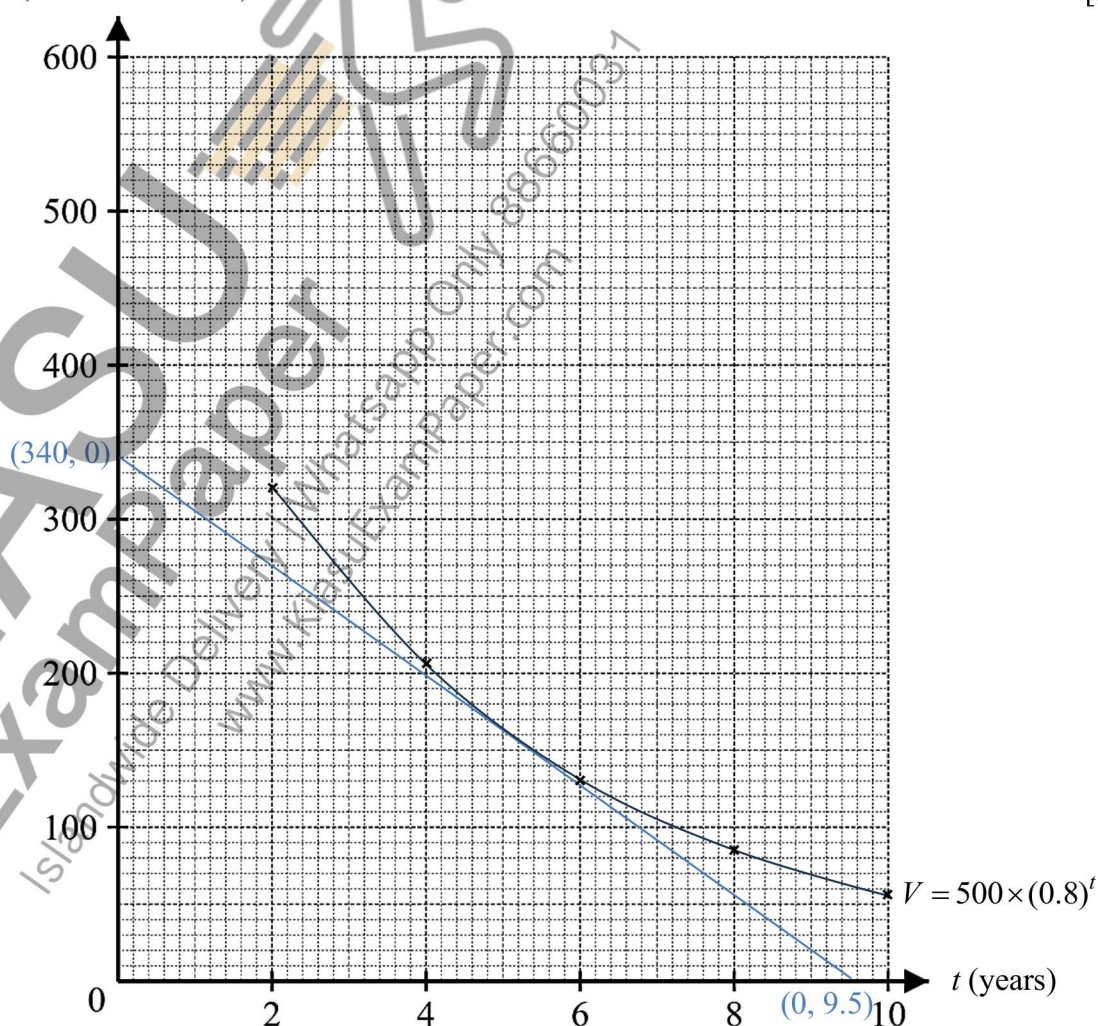
Answer \$ [1]

- (b) On the grid below, draw the graph of $V = 500 \times (0.8)^t$ for $2 \leq t \leq 10$.

t	2	4	6	8	10
V	320	205	131	83.9	53.7

V (thousand dollars)

[3]



- (c) By drawing a tangent, work out an estimate for the gradient of the graph when $t = 5$.

Draw a tangent at $t = 5$

$$\text{Gradient} = \frac{340 - 0}{0 - 9.5} = -35.789 \approx -35.8 \text{ (3sf)}$$



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Answer [2]

- (d) Given that another graph of $y = 90 \times a^{-x}$ where $a > 0$, passes through $\left(3, \frac{45}{4}\right)$, find the value of a .

$$y = 90 \times a^{-x}$$

$$\frac{45}{4} = 90 \times a^{-3}$$

$$\frac{45}{4} = \frac{90}{a^3}$$

$$a^3 = 8$$

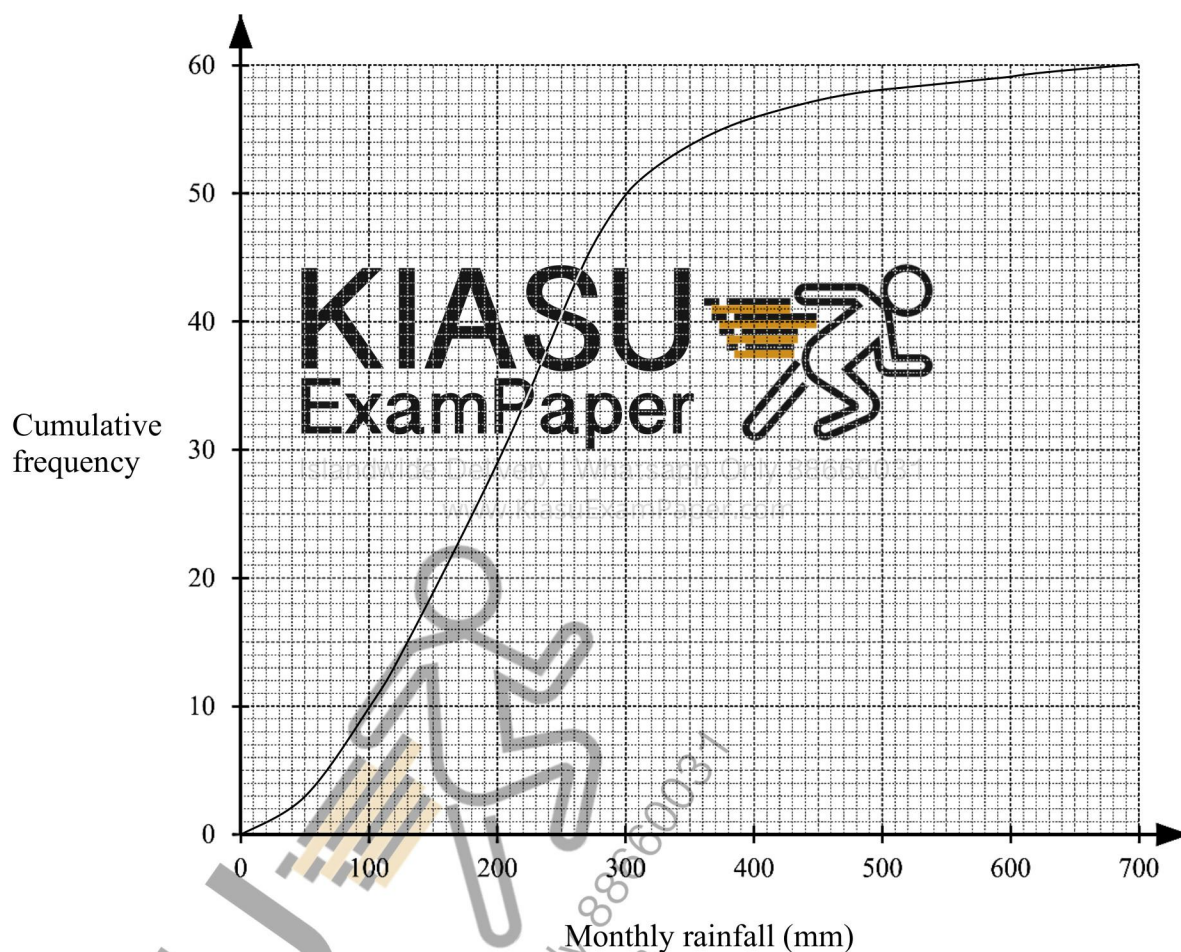
$$a^3 = 2^3$$

$$a = 2$$

Answer $a =$ [3]

[Turn over]

- 4 The National Environment Agency records the monthly rainfall (in mm) in Singapore. The cumulative frequency diagram represents the monthly rainfall from 2021 to 2025.



(a) Use the diagram to estimate

(i) the median monthly rainfall,

Median = 205 mm

Answer mm [1]

(ii) the interquartile range of the monthly rainfall.

$Q_1 = 130$
 $Q_3 = 270$
 IQR = 140 mm

Answer mm [2]

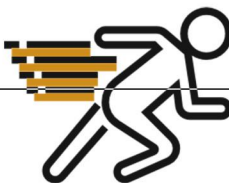
- (b) A monthly rainfall of 50 mm and below is classified as extremely dry in Singapore. Based on the data provided for the period 2021 to 2025, calculate the probability that a randomly selected month is **not** classified as extremely dry.

No. of months classified as extremely dry = 3

$$\text{Probability} = \frac{60 - 3}{60} = \frac{57}{60}$$

$$\text{Probability} = \frac{19}{20}$$

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- (c) The rainfall measurements, in mm, for the first five months of 2026 are recorded as
9.4 mm, 202.2 mm, 38.2 mm, 179.8 mm, and 185.2 mm.

By considering the inclusion of these five new data points into the original dataset, explain how the median will change. Justify your reasons.

The new median will be **less than** the original median.

All the measurements are **below/smaller/lesser than the original median**, therefore the median will shift towards a value lower than 205 mm.

- 5 (a) $\mathcal{E} = \{\text{integers } x : 1 \leq x \leq 15\}$
 $A = \{\text{multiples of 2}\}$
 $B = \{\text{factors of 24}\}$

(i) Explain why it is **not** true that $B \subset A$.

1 and 3 are elements of set B but not elements of set A .

[1]

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

$A \cup B = \{1, 2, 3, 4, 6, 8, 10, 12, 14\}$

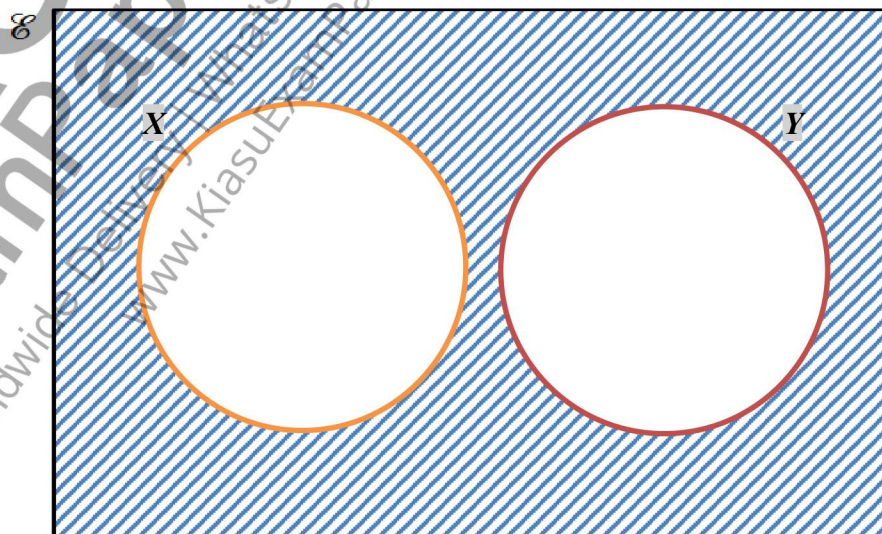
Answer [1]

(b) Set X and set Y are such that $X \cap Y = \emptyset$.

In the space below,

(i) complete the Venn diagram to represent set X and set Y ,

(ii) shade the region on your diagram which represents $(X \cup Y)'$.

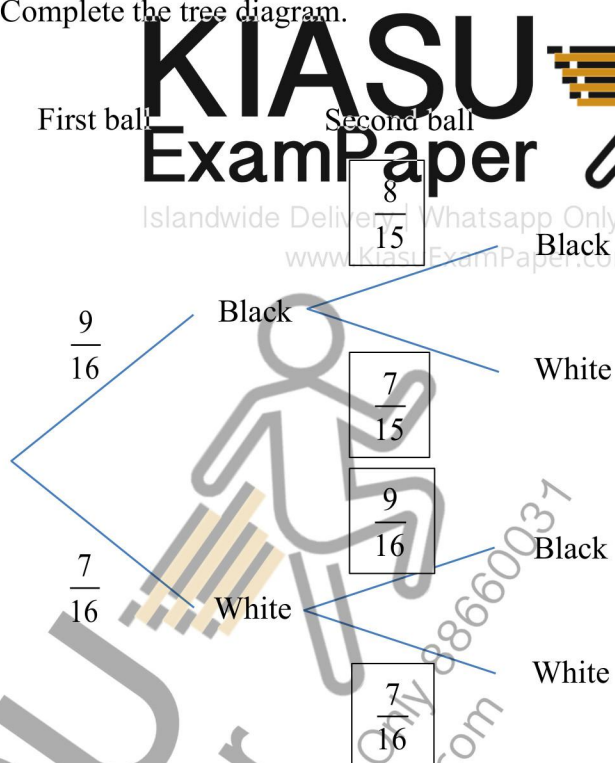


[2]

- (c) A bag contains 16 balls.
 9 of the balls are black and the rest are white.
 One ball is taken at random from the bag.
 If the ball is black, it is **not** put back into the bag.
 If the ball is white, it is put back into the bag.

A second ball is then taken at random from the bag.
 Part of the tree diagram that represents these outcomes is drawn below.

- (i) Complete the tree diagram.



[2]

- (ii) Find, as a fraction in its simplest form, the probability that the two balls are of different colours.

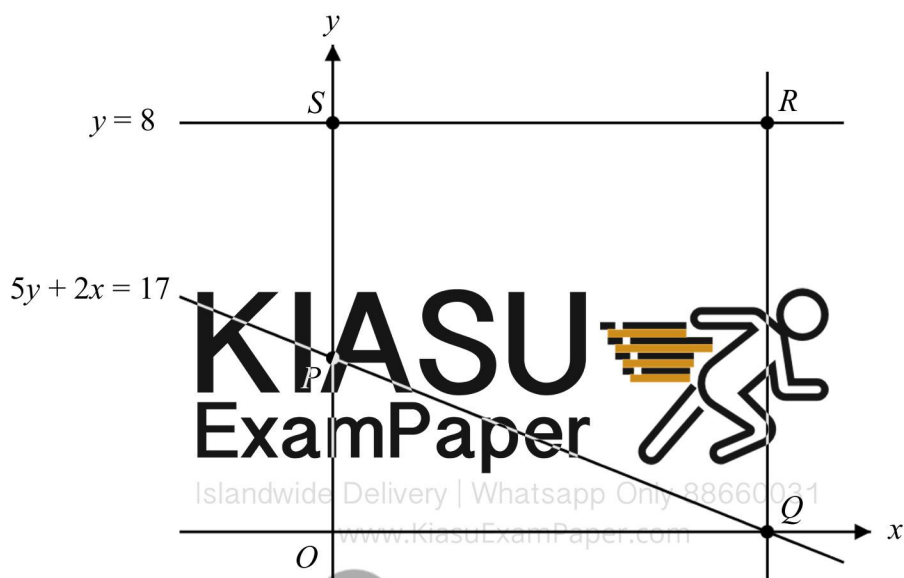
$$P(\text{different colour}) = \left(\frac{9}{16} \times \frac{7}{15} \right) + \left(\frac{7}{16} \times \frac{9}{16} \right)$$

$$P(\text{different colour}) = \frac{651}{1280}$$

Answer [2]

[Turn over]

- 6 The diagram shows a sketch of the line $5y + 2x = 17$ and the line $y = 8$.



The line $5y + 2x = 17$ meets the axes at P and Q .

The line $y = 8$ passes through the points S and R .

RQ is parallel to the y -axis.

- (a) Find the coordinates of Q .

$$Q = (8.5, 0)$$

Answer $Q = (\dots\dots\dots, \dots\dots\dots)$ [1]

- (b) Write down the equation of the line parallel to PQ and passing through the point S .

$$\begin{aligned} 5y + 2x &= 17 \\ \text{gradient} &= -\frac{2}{5} \\ \therefore y &= -\frac{2}{5}x + 8 \end{aligned}$$

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

- (c) The length of PQ is $\sqrt{k}$ units.

Find the value of k .

$$PQ = \sqrt{(0 - 8.5)^2 + (3.4 - 0)^2}$$

$$PQ = \sqrt{83.81}$$

$$\therefore k = 83.81$$



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

- (d) The diagram represents a map where the quadrilateral $PQRS$ represents a nature park. Given that the actual area of the nature park is $(1.73502 \times 10^6) \text{ m}^2$, find the actual distance of RQ in kilometres.

$$\text{Area of } PQRS = \frac{1}{2} \times (4.6 + 8) \times 8.5$$

$$\text{Area of } PQRS = 53.55 \text{ units}^2$$

$$53.55 \text{ units}^2 : 1.73502 \times 10^6 \text{ m}^2$$

$$1 \text{ unit}^2 : 32400 \text{ m}^2$$

$$\sqrt{1 \text{ unit}^2} : \sqrt{32400 \text{ m}^2}$$

$$1 \text{ unit} : 180 \text{ m}$$

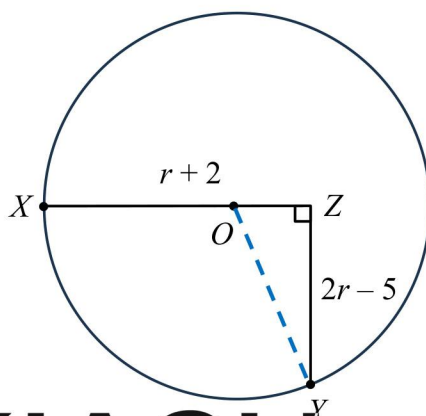
$$RQ = 8 \times 180 \text{ m} = 1440 \text{ m}$$

$$RQ = 1.44 \text{ km}$$

Answer $RQ = \dots\dots\dots$ km [4]

[Turn over]

7 (a)



X and Y are points on a circle, centre O with radius r cm.
 $XZ = (r + 2)$ cm, $YZ = (2r - 5)$ cm and angle $XZY = 90^\circ$.

- (i) Form a quadratic equation in terms of r and show that it reduces to
 $3r^2 - 20r + 29 = 0$.

Answer

$$OZ = (r + 2) - r = 2 \text{ cm}$$

By Pythagoras Theorem,

$$OZ^2 + ZY^2 = OY^2$$

$$2^2 + (2r - 5)^2 = r^2$$

$$4 + (4r^2 - 20r + 25) = r^2$$

$$4 + 4r^2 - 20r + 25 - r^2 = 0$$

$$3r^2 - 20r + 29 = 0$$

[3]

- (ii) Solve the equation $3r^2 - 20r + 29 = 0$.

$$r = \frac{-(-20) \pm \sqrt{(-20)^2 - 4(3)(29)}}{2(3)}$$

$$r = \frac{20 \pm \sqrt{52}}{6}$$

$$r = 4.5351 \text{ or } 2.1314$$

$$r \approx 4.54 \text{ or } 2.13$$

Answer r or [3]

(iii) Explain why one of the solutions in **part (a)(ii)** cannot be the radius.

$r = 2.13$ cannot be the radius because the length of YZ cannot be negative.

..... [1]

(b)



The diagram shows a solid hemisphere of radius r cm.

Given that the solid hemisphere is melted down and recast to form a solid cone with radius $\frac{3}{4}r$ cm and height h cm, express h in terms of r .

$$V_{\text{hemisphere}} = \frac{1}{2} \times \frac{4}{3} \pi r^3$$

$$V_{\text{cone}} = \frac{1}{3} \pi \left(\frac{3}{4}r \right)^2 h$$

$$\frac{1}{3} \pi \left(\frac{3}{4}r \right)^2 h = \frac{1}{2} \times \frac{4}{3} \pi r^3$$

$$\frac{1}{3} \left(\frac{9}{16} \right) \pi r^2 h = \frac{2}{3} \pi r^3$$

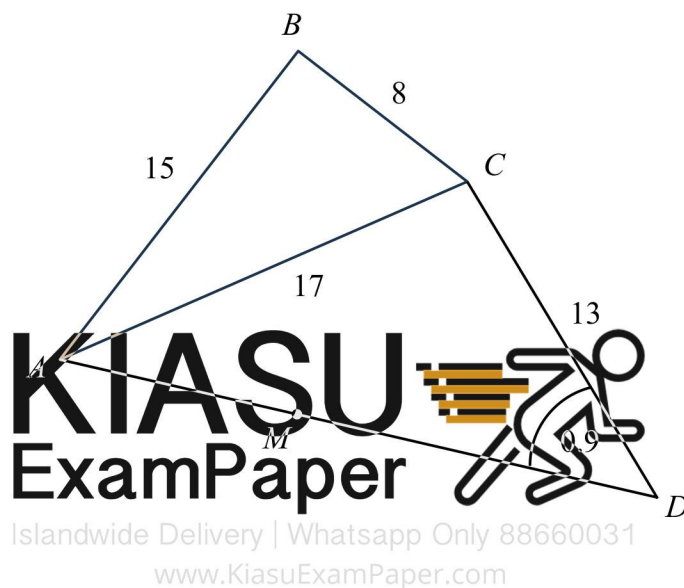
$$\frac{3}{16} \pi r^2 h = \frac{2}{3} \pi r^3$$

$$\frac{2}{16} \pi r^3$$

$$h = \frac{\frac{2}{3} \pi r^3}{\frac{3}{16} \pi r^2} = \frac{32}{9} r$$

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

[Turn over



The diagram shows a quadrilateral, $ABCD$.

$AB = 15$ cm, $BC = 8$ cm, $AC = 17$ cm, $CD = 13$ cm and angle $ADC = 0.9$ radians.

The point M lies on AD such that $AM : MD = 3 : 4$.

- (a) Show that angle $ABC = \frac{\pi}{2}$ radians.

Answer

Method 1

$$AB^2 + BC^2 = 15^2 + 8^2 = 289$$

$$AC^2 = 17^2 = 289$$

Since $AB^2 + BC^2 = AC^2$,

by the converse of Pythagoras Theorem,

angle $ABC = \frac{\pi}{2}$ radians.

Method 2

$$\cos \angle ABC = \frac{15^2 + 8^2 - 17^2}{2(15)(8)} = 0$$

$$\angle ABC = \cos^{-1} 0 = \frac{\pi}{2} \text{ radians}$$

- (b) Find the size of angle ACD .

$$\frac{\sin \angle CAD}{13} = \frac{\sin 0.9}{17}$$

$$\sin \angle CAD = \frac{13 \sin 0.9}{17} = 0.5990146$$

$$\angle CAD = \sin^{-1} \left(\frac{13 \sin 0.9}{17} \right) = \sin^{-1} (0.5990146)$$

$$\angle CAD = 0.64227 \text{ radians}$$

$$\angle ACD = \pi - 0.9 - 0.64227$$

$$\angle ACD = 1.5993 \approx 1.60 \text{ radians (3sf)}$$



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Answer Angle $ACD = \dots\dots\dots$ [3]

- (c) Find the area of triangle AMC .

$$\text{Area of triangle } ADC = \frac{1}{2}(17)(13) \sin 1.5993$$

$$\text{Area of triangle } ADC = 110.455 \text{ cm}^2$$

Since $AM : MD = 3 : 4$,

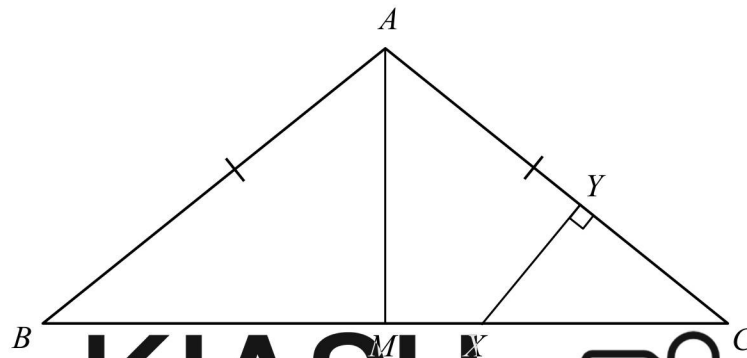
$$\text{Area of triangle } AMC = \frac{3}{7} \times \left[\frac{1}{2}(17)(13) \sin 1.5993 \right]$$

$$\text{Area of triangle } AMC = 47.337 \approx 47.3 \text{ cm}^2 \text{ (3sf)}$$

Answer cm^2 [2]

[Turn over

9 (a)



In the diagram, ABC is a triangle where $AB = AC$ and M is the midpoint of BC . XY is perpendicular to AC .

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(i) Show that triangles ACM and XCY are geometrically similar.

Answer

$$\angle XYZ = 90^\circ$$

(given)

$$\angle AMC = 90^\circ$$

(perpendicular bisector of BC)

$$\Rightarrow \angle XYZ = \angle AMC$$

$$\angle XCY = \angle ACM$$

(common angle)

$\triangle ACM$ and $\triangle XCY$ are geometrically similar. (AA similarity)

(ii) $AB = 20$ cm, $XY = 5$ cm and angle $XCY = 30^\circ$.

Find the value of $\frac{\text{area of } \triangle XCY}{\text{area of } \triangle ABC}$.

Method 1

$$\sin 30^\circ = \frac{5}{XC} \quad \text{or} \quad \sin 30^\circ = \frac{AM}{20}$$

$$XC = 10 \quad AM = 10$$

By similar triangles,

$$\frac{\text{area of } \triangle XCY}{\text{area of } \triangle AMC} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$\frac{\text{area of } \triangle XCY}{\text{area of } \triangle ABC} = \frac{1}{4+4} = \frac{1}{8}$$



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Method 2

$$\tan 30^\circ = \frac{5}{YC} \quad \text{or} \quad \sin 30^\circ = \frac{AM}{20}$$

$$YC = 5\sqrt{3} \quad AM = 10$$

$$BM = \sqrt{20^2 - 10^2} = \sqrt{300}$$

$$\frac{\text{area of } \triangle XCY}{\text{area of } \triangle ABC}$$

$$= \frac{\frac{1}{2} \times 5\sqrt{3} \times 5}{2 \left[\frac{1}{2} \times \sqrt{300} \times 10 \right]}$$

$$= \frac{1}{8}$$

$$\frac{\text{area of } \triangle XCY}{\text{area of } \triangle ABC}$$

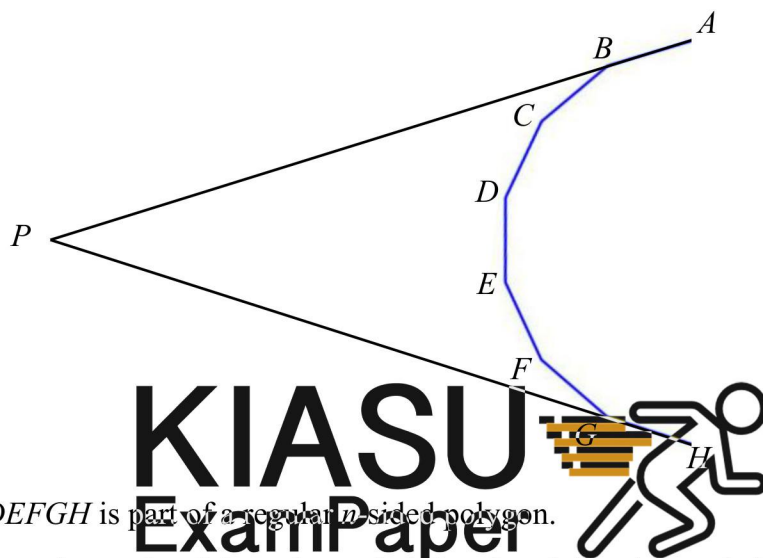
$$= \frac{\frac{1}{2} \times 5\sqrt{3} \times 5}{\frac{1}{2} (20)(20) \sin 120^\circ}$$

$$= \frac{1}{8}$$

Answer [3]

[Turn over

9 (b)



$ABCDEFGH$ is part of a regular n -sided polygon.

Each exterior angle of the polygon is $2x^\circ$ and each interior angle is $13x^\circ$.

ABP and HGP are straight lines.

(i) Find the size of each interior angle of the n -sided polygon.

$$13x + 2x = 180^\circ$$

$$x = \frac{180^\circ}{15} = 12^\circ$$

$$\text{Interior angle} = 13 \times 12^\circ = 156^\circ$$

Answer $^\circ$ [2]

(ii) Find the size of angle BPG .

$$\angle \text{sum of } PBCDEFG = (7 - 2) \times 180^\circ = 900^\circ$$

$$\text{reflex } \angle BCD = 360^\circ - 156^\circ = 204^\circ$$

$$\angle BPG = 900^\circ - (4 \times 204^\circ) - (2 \times 24^\circ)$$

$$\angle BPG = 36^\circ$$

$$\angle \text{sum of } ABCDEFGH = (8 - 2) \times 180^\circ = 1080^\circ$$

$$\angle PAH + \angle PHA = 1080^\circ - (6 \times 156^\circ) = 144^\circ$$

$$\angle BPG = 180^\circ - 144^\circ$$

$$\angle BPG = 36^\circ$$

$$\angle \text{sum of } BCDEFG = (6 - 2) \times 180^\circ = 720^\circ$$

$$\angle CBG + \angle FGB = 720^\circ - (4 \times 156^\circ) = 96^\circ$$

$$\angle BPG = 180^\circ - 96^\circ - 24^\circ - 24^\circ$$

$$\angle BPG = 36^\circ$$

Count the turns needed to go from side AB to side GH

$\Rightarrow$ 6 turns (at B, C, D, E, F, G), each turning 24°

$$\text{Total turn} = 6 \times 24^\circ = 144^\circ$$

Since 144° is more than 90° , the actual angle between the two lines (the acute one, which is $\angle BPG$) is the supplement:

$$\angle BPG = 180^\circ - 144^\circ$$

$$\angle BPG = 36^\circ$$

- 10 Singapore relies on four water sources for its water supply.
It comprises water from local catchment, imported water, recycled water and desalinated water.

Recycled water (R) and desalinated water (D) are produced at five water plants respectively.
The matrix **M** shows information about the production capacity for each water plant, measured in million gallons per day (mgd).

$$\mathbf{M} = \begin{matrix} & \begin{matrix} \text{R} & \text{D} \end{matrix} \\ \begin{pmatrix} 20 & 30 \\ 35 & 70 \\ 50 & 30 \\ 50 & 30 \\ 50 & 30 \end{pmatrix} & \begin{matrix} \text{Plant 1} \\ \text{Plant 2} \\ \text{Plant 3} \\ \text{Plant 4} \\ \text{Plant 5} \end{matrix} \end{matrix}$$

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- (a) Evaluate the matrix **K** = **TMS**, where **T** = $\begin{pmatrix} 1 & 1 & 1 & 1 & 1 \end{pmatrix}$ and **S** = $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$.

Method 1

$$\mathbf{K} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} 20 & 30 \\ 35 & 70 \\ 50 & 30 \\ 50 & 30 \\ 50 & 30 \end{pmatrix} \begin{pmatrix} 1 \\ -1 \end{pmatrix} = \begin{pmatrix} 205 & 190 \end{pmatrix} \begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

$$\mathbf{K} = (205 - 190) = (15)$$

Method 2

$$\mathbf{K} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} 20 & 30 \\ 35 & 70 \\ 50 & 30 \\ 50 & 30 \\ 50 & 30 \end{pmatrix} \begin{pmatrix} 1 \\ -1 \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} -10 \\ -35 \\ 20 \\ 20 \\ 20 \end{pmatrix}$$

$$\mathbf{K} = (-10 - 35 + 20 + 20 + 20) = (15)$$

Answer **K** =

[2]

- (b) State what the element(s) of matrix **K** represent.

The element of matrix **K** represents the **difference in total production capacity between recycled water and desalinated water**.

[1]

[Turn over

- (c) The four water sources supply Singapore's daily water demand of 440 million gallons a day (mgd).

If a pie chart is drawn to represent these four water sources, calculate the sum of the angle of the sectors representing the water from local catchment and imported water.

$$\text{Required angle} = \frac{440 - 205 - 190}{440} \times 360^\circ$$

$$\text{Required angle} = 36.818 \approx 36.8^\circ \text{ (1dp)}$$

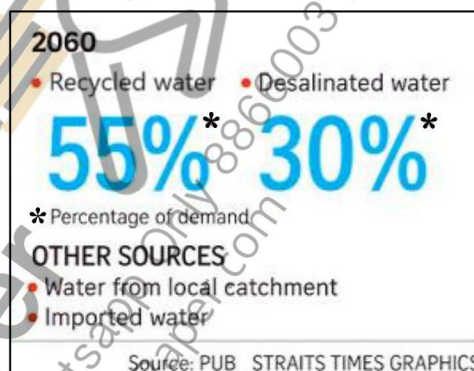
$$\text{Required angle} = \frac{205 + 190}{440} \times 360^\circ = 323.181^\circ$$

$$\text{Required angle} = 360 - 323.181 \approx 36.8^\circ \text{ (1dp)}$$

Answer ° [2]

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- (d) In 2060, Singapore's daily water demand will be double that of the value in **part (c)**. To meet this demand, the production of recycled water and desalinated water must reach the target percentages shown below.



Hence, Singapore plans to raise the production capacity of its water plants as follows:

Recycled water

- Plant 1 will increase its capacity by 150%, while the other plants remain unchanged.
- A new Plant 6, with the same production capacity as Plant 5, will be built.
- A new Plant 7, with a production capacity 1.5 times that of Plant 6, will be built.

Desalinated water

- All existing plants will remain unchanged.
- A new Plant 6, with a production capacity 1.2 times that of Plant 2 will be built.

Using the given information, justify with calculations whether the new production capacities will meet the respective target percentages set for 2060.

Answer

Method 1

Daily water demand in 2060 = $440 \times 2 = 880$ mgd

Total production capacity (Recycled water)
 $= (20 \times 250\%) + 35 + 50 + 50 + 50 + (50) + (50 \times 1.5) = 360$ mgd

Total production capacity (Desalinated water)
 $= 30 + 30 + 30 + 30 + 70 + (70 \times 1.2) = 274$ mgd

% Recycled water = $\frac{360}{880} \times 100 = 40.909\% < 55\%$

% Desalinated water = $\frac{274}{880} \times 100 = 31.136\% > 30\%$

The production capacity of **recycled water cannot meet the target of 55%**,
 whereas the production capacity of **desalinated water can meet the target of 30%**.

Method 2

Daily water demand in 2060 = $440 \times 2 = 880$ mgd

B1 (find demand in 2060)

Total production capacity (Recycled water)
 $= (20 \times 250\%) + 35 + 50 + 50 + 50 + (50) + (50 \times 1.5) = 360$ mgd

Total production capacity (Desalinated water)
 $= 30 + 30 + 30 + 30 + 70 + (70 \times 1.2) = 274$ mgd

Recycled water target = $880 \times 55\% = 484$ mgd > 360 mgd

Desalinated water target = $880 \times 30\% = 264$ mgd < 274 mgd

The production capacity of **recycled water cannot meet the target of 55%**,
 whereas the production capacity of **desalinated water can meet the target of 30%**.

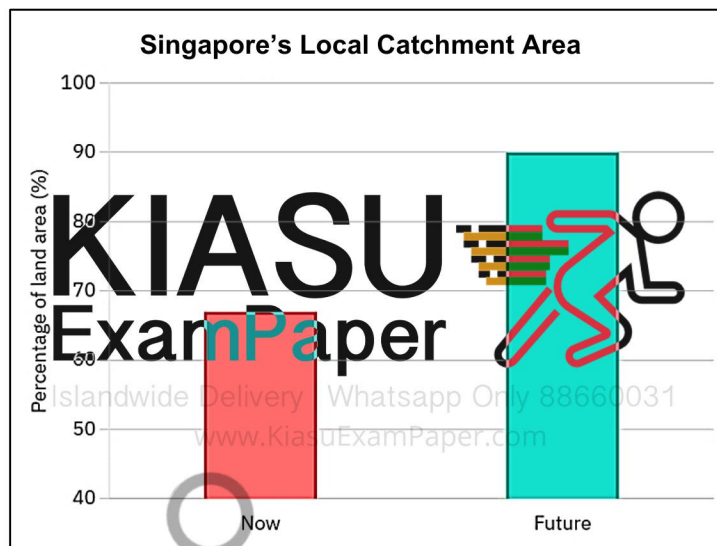
.....

..... [5]

[Turn over

- (e) In order to increase its water supply, Singapore aims to expand its local catchment area.

The bar chart compares the percentage of Singapore's land area used as local catchment. However, the chart is misleading.



Suggest one adjustment to the chart to avoid misinterpretation of the data. Justify your reason.

1. Redraw the **vertical axis** such that it **starts from zero**.
2. So that:
 - **It does not exaggerate the increase** in the percentage of land area,
 - **The bar heights are proportional to the actual percentages**, giving a fair comparison.

[2]

END OF PAPER

NAME	FORM CLASS	ACAD CLASS



ST. PATRICK'S SCHOOL PRELIMINARY EXAMINATION 2026

SUBJECT : Mathematics
(4052/01)

DATE : 17 August 2026

LEVEL : Secondary 4EXP/5NA

DURATION : 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your Name, Form Class and Acad Class in the spaces at the top of the page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

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			
Type of Penalties		Question Number	
Presentation	−1		
	−2		
			90

This paper consists of 23 printed pages including this cover page.

Mathematical Formulae

Compound Interest

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

Mensuration

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

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

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

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

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

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

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

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 $\sqrt[3]{15.6^2 - \frac{9.4}{0.028}}$.

Answer [1]

2 Simplify.

(a) $2p^4 \times 6p^{-5}$

Answer [1]

(b) $4(3x - 2) - 5$

Answer [1]

3 (a) Express 0.00047 in standard form.

Answer [1]

(b) Express 1 km as a percentage of 0.4 nm, where $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$.
Give your answer in standard form.

Answer % [1]

- 4 The magnetic force, F , between two magnets is inversely proportional to the square of the distance, d , between them.

At a certain distance the force is 0.8 N.

Find the increase in the magnetic force when the distance is halved.

Answer N [2]

- 5 A bag of sand has a mass of x kg and a bag of cement has a mass of y kg.
Two bags of sand have a mass that is 10 kg more than one bag of cement.
A delivery of 4 bags of sand and 3 bags of cement has a total mass of 220 kg.
Find the value of x and y .

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

- 6 A toy building block is a cuboid measuring 24 mm by 16 mm by 10 mm.
Identical blocks are stacked together to form a cube.
Find the length of the smallest possible cube that can be formed, and the number of blocks needed.

Answer length of cube mm
Number of blocks [3]

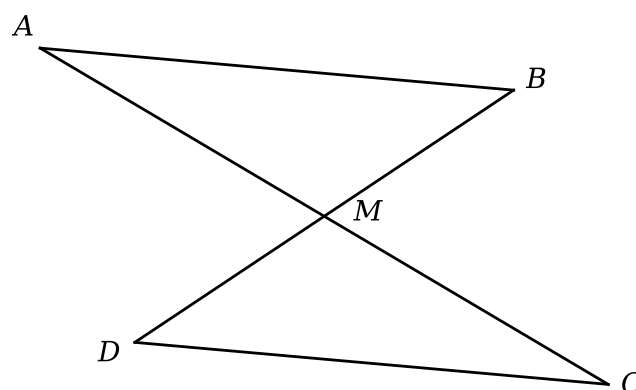
- 7 In Class A, the ratio of boys to girls is 5 : 2.
In Class B, the ratio of boys to girls is 7 : 4.
The two classes have the same number of boys.
Express as a fraction, the total number of girls in both classes.

Answer [3]

- 8 Solve the equation $3x^2 - 7x + 1 = 0$, giving your answers correct to 2 decimal places.

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

- 9 In the diagram, AC and BD intersect at M .
 M is the midpoint of both AC and BD .
Show that AB is parallel to CD .



Answer

.....
.....
.....
.....
..... [3]

- 10** The table shows the times, t minutes, taken by 40 students to complete a Mathematics quiz.

Time, t (minutes)	Frequency
$30 \leq t < 40$	6
$40 \leq t < 50$	10
$50 \leq t < 60$	16
$60 \leq t < 70$	8

- (a)** Calculate an estimate for

- (i)** the mean time,

Answer min [1]

- (ii)** the standard deviation of the times.

Answer min [1]

- (b)** Each recorded time was 5 minutes less than the actual time, so 5 minutes is added to each time to correct it.

Explain how the mean and standard deviation of the corrected times compare with the values in **(a)**.

.....
 [2]

- 11** Two fair four-sided dice, each with faces numbered 1, 2, 3 and 4, are thrown. The two numbers shown are multiplied to give the score.

In a game, Aisha wins if the score is even and Ben wins if the score is odd.

- (a)** Explain why the game is unfair.

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

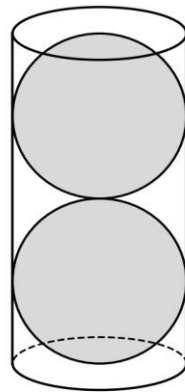
- (b)** Aisha claims that she is twice as likely to win as Ben. Determine whether Aisha is correct.

.....
.....
.....
.....
..... [2]

-
- 12** The area of triangle PQR is 67.67 cm^2 . Given that $QP = 9.8 \text{ cm}$ and $QR = 15 \text{ cm}$, find the possible values of angle PQR .

Answer Angle $PQR = \dots\dots\dots$ or $\dots\dots\dots$ [3]

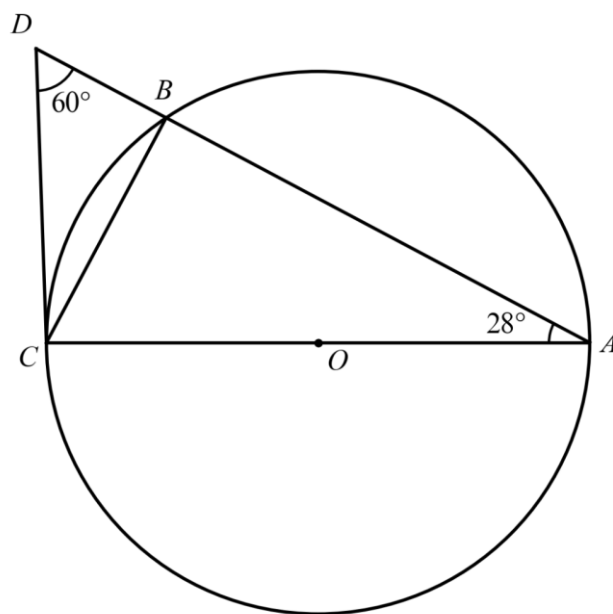
- 13** A closed cylinder fits two identical spheres exactly, as shown. Each sphere touches the curved surface of the cylinder, and the spheres touch each other and the two flat ends.



Find the fraction of the volume of the cylinder that is **not occupied by the spheres**, giving your answer in its simplest form.

Answer [3]

- 14 A , B and C are points on a circle with centre O . AOC and ABD are straight lines, Angle $CAB = 28^\circ$ and Angle $BDC = 60^\circ$.



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

Answer Angle $DCB = \dots\dots\dots$ [2]

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

Answer

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

- 15 The diagram shows the first three figures in a sequence. Each figure is a large square made up of unit squares, with a shaded square block at its centre.

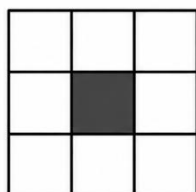


Figure 1

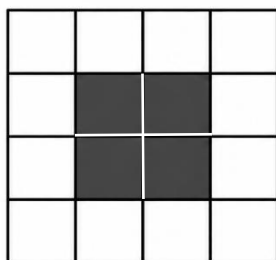


Figure 2

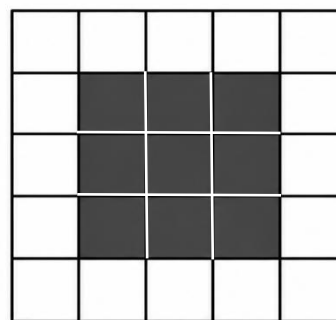


Figure 3

Figure number, n	1	2	3	4
Number of shaded squares	1	4	9	
Number of unshaded squares	8	12	16	

- (a) Complete the table for Figure 4. [1]
- (b) Write down an expression, in terms of n , for the number of unshaded squares in Figure n .

Answer [1]

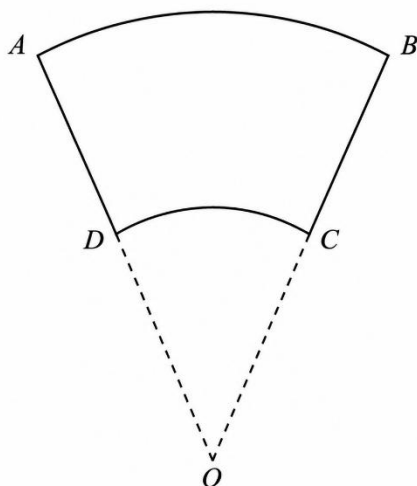
- (c) One figure in the sequence has 96 unshaded squares.
Find the number of **shaded** squares in this figure.

Answer [2]

- 16** The figure shows a region $ABCD$ bounded by two arcs, that share the same center O , and the straight edges AD and BC .

$OA = 2 OD$, angle $DOB = 1.2$ radians, and the perimeter of $ABCD$ is 44.8 cm.

Find the area of the figure $ABCD$.



Answer cm^2 [4]

- 17 (a) Given that $3^k \times 9^3 = \frac{1}{81^k}$, find the value of k .

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

- (b) Two integers, A and B , can be written as the products of prime factors.

$$A = p \times q^2 \times 7 \quad B = p^{r+1} \times q \times 7$$

The smallest number that is divisible by both A and B is 4725.

Find p , q and r .

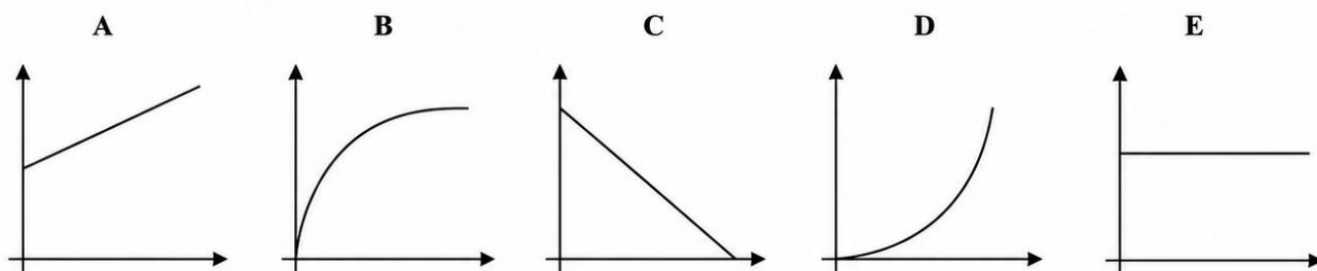
Answer $p = \dots\dots\dots$

$q = \dots\dots\dots$

$r = \dots\dots\dots$

[2]

18 The diagrams below show five different graphs, labelled **A**, **B**, **C**, **D** and **E**.



Match each situation to the graph that best represents it.

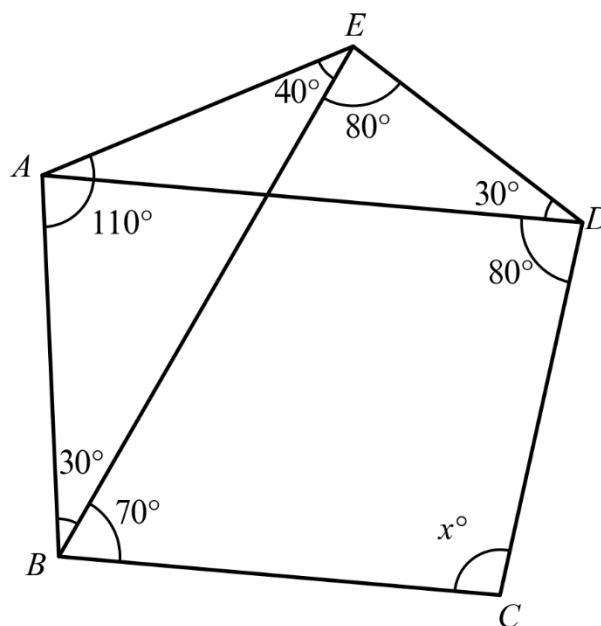
Write the correct letter in each box.

Answer

Situation	Graph
(i) The depth of water in a cylindrical tank as water is drained out at a constant rate. [depth – time graph]	
(ii) The area of a circular oil spill as its radius increases. [area – radius graph]	
(iii) The distance travelled by a car as it decelerates until it comes to a stop. [distance – time graph]	

[3]

- 19 The diagram shows an irregular pentagon $ABCDE$.



- (a) Find the value of x .

Answer [2]

- (b) Show that the points $ABCDE$ lie on the circumference of a circle.
You are expected to state any circle properties used.

Answer

.....

.....

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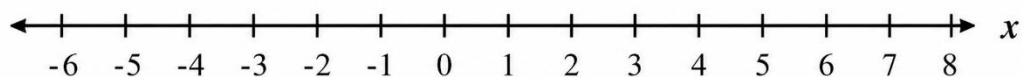
.....

[3]

- 20 (a) Solve the inequality $-15 < 3x - 3 \leq 15$.

Answer [2]

- (b) Represent your solution to part (a) on the number line below.



[1]

- (c) It is given that y is such that $2 \leq y \leq 8$.
If x and y are integers, find the smallest possible value of $y^2 - x^2$.

Answer [1]

- 21** A sculpture of height 5.3 m stands at point A in a park.
 A flower garden, F , is 12.8 m from A on a bearing of 062° .
 The scale drawing below shows the position of A and the direction of North.
Scale: 1 cm represents 2 m

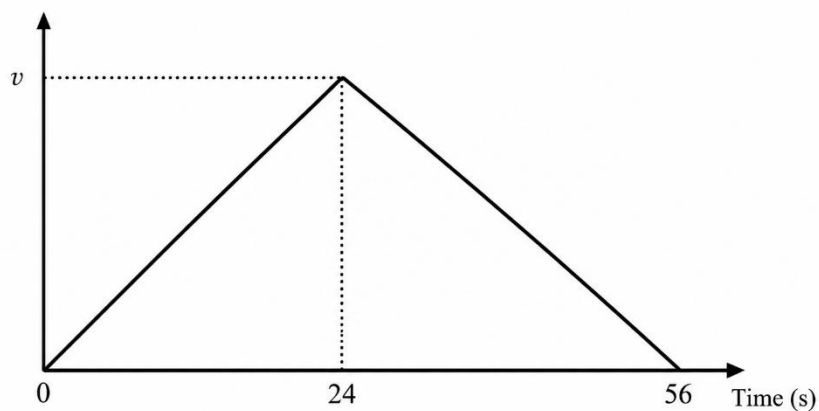


- (a) By construction, locate and mark the position of F . [1]
 (b) A playground, P , is due south of F and 16 m from A .
 By construction, locate and mark the position of P .
 Draw the paths PA and PF . [1]
 (c) Calculate the greatest angle of elevation of the top of the sculpture from the path PF .

Answer [2]

- 22 The speed-time graph shows a car's journey between two sets of traffic lights. The car accelerates uniformly from rest to a maximum speed of v m/s in 24 seconds, then decelerates uniformly to rest at 56 seconds. The car travels 672 m in total.

Speed (m/s)



- (a) Calculate the maximum speed, v .

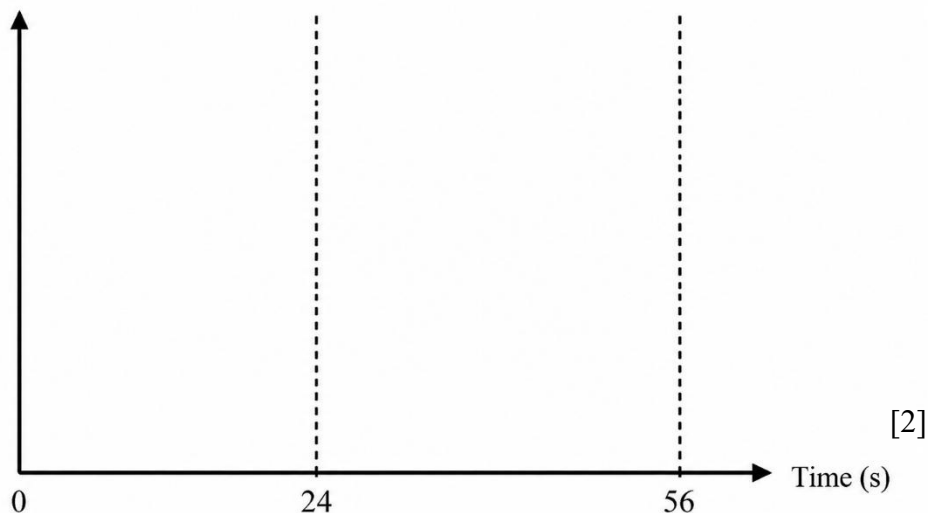
Answer m/s [1]

- (b) Calculate the deceleration of the car after 24 seconds.

Answer m/s^2 [1]

- (c) On the axes below, sketch the distance-time graph for the journey.

Distance (m)



- 23** The point $A(0, 7)$ is translated to the point B by the translation vector $\mathbf{p}$, where

$$\mathbf{p} = \begin{pmatrix} -3 \\ 5 \end{pmatrix}$$

- (a)** Find the coordinates of B .

Answer [1]

- (b)** Find $|\mathbf{p}|$.

Answer [2]

- (c)** Find the equation of line AB .

Answer [2]

24 $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 12\}$

$A = \{x : x \text{ is a multiple of } 3\}$

$B = \{x : x \text{ is a factor of } 12\}$

$C = \{x : x \text{ is a prime number greater than } 6\}$

(a) Find $n(A \cup B)'$.

Answer [1]

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

Answer [1]

(c) State whether the statement “ $9 \in A \cap B'$ ” is true or false, justifying your answer.

Answer
..... [1]

(d) An integer is chosen at random from ξ .

Event X : the chosen integer belongs to set B .

Event Y : the chosen integer belongs to set C .

Determine whether events X and Y are mutually exclusive. Give a reason for your answer.

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

25 Each day, a pump fills the same empty tank with water.

On Monday, the pump takes t minutes to fill the tank.

On Tuesday, the pump runs at a rate of 40 litres per minute and takes 6 minutes longer than on Monday.

On Wednesday, the pump runs at a rate of 60 litres per minute and takes 4 minutes less than on Monday.

- (a)** Write down expressions, in terms of t , for the volume of water in the tank, in litres, on Tuesday and on Wednesday.

Answer Tuesday : litres

Wednesday : litres [1]

- (b)** Hence form an equation in t and solve it to find the time taken on Monday.

Answer minutes [3]

- (c)** Hence find the capacity of the tank.

Answer litres [1]

- 26 A school canteen sells two meal sets, Set A and Set B.

The numbers of meal sets sold on Monday and Tuesday are represented by the matrix

$$\mathbf{Q} = \begin{array}{cc} & \begin{array}{cc} \text{Set A} & \text{Set B} \end{array} \\ \begin{bmatrix} 120 & 80 \\ 150 & 60 \end{bmatrix} & \begin{array}{l} \text{Mon} \\ \text{Tues} \end{array} \end{array}$$

where the rows represent Monday and Tuesday respectively, and the columns represent Set A and Set B respectively.

Set A costs \$4.50 and Set B costs \$6.00.

- (a) Write down a column matrix $\mathbf{P}$ to represent the prices of Set A and Set B.

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

- (b) Calculate $\mathbf{QP}$.

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

- (c) Explain what each element of the matrix $\mathbf{QP}$ represents.

Answer
..... [1]

- (d) The canteen makes a profit of 30% of the selling price of each Set A sold and 40% of the selling price of each Set B sold.

$\mathbf{R}$ is a diagonal matrix such that the elements of $\mathbf{RP}$ gives the profit made on each Set A and Set B meal sold.

- (i) State the matrix $\mathbf{R}$.

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

- (ii) Find the profit made by the canteen for each of the two days, by matrix to matrix multiplication.

Answer Profit for Monday \$

Tuesday \$ [2]

END OF PAPER

NAME	FORM CLASS	ACAD CLASS



ST. PATRICK'S SCHOOL PRELIMINARY EXAMINATION 2026

SUBJECT : Mathematics
(4052/02)

DATE : 18 August 2026

LEVEL : Secondary 4EXP/5NA

DURATION : 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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Answer **all** questions.

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

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Omission of essential working will result in loss of marks.

The total of the marks for this paper is 90 .

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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.

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For Examiner's Use			
Type of Penalties		Question Number	
Presentation	−1		
	−2		
			90

This paper consists of 21 printed pages including this cover page and 1 blank page.

Mathematical Formulae

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

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

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

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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) Express $\frac{5}{x-2} - \frac{3}{2x+1}$ as a single fraction in its simplest form.

Answer [2]

- (b) Make r the subject of the formula $V = \frac{h(R^2 + r^2)}{r^2}$.

Answer $r =$ [2]

- (c) Simplify $\frac{2x^2 - xy - 6x + 3y}{9 - x^2}$.

Answer [3]

- (d) Simplify $(2x^3y^{-2})^4 \div (8x^5y^{-3})$, giving your answer with positive indices.

Answer [2]

- 2 (a) A television has a cash price of \$2400. It can also be bought on hire purchase with a deposit of 20% of the cash price, followed by 24 monthly instalments of \$92.

(i) Calculate the total hire purchase price.

Answer \$ [2]

(ii) Calculate how much more the hire purchase price is than the cash price, giving your answer as a percentage of the cash price.

Answer % [2]

(b) After a discount of 15%, a laptop is sold for \$1734.

Calculate the original price of the laptop.

Answer \$ [2]

(c) Mark has a vintage watch valued at \$6666.

Its value appreciates at a rate of 8% per year.

- (i) Show that the value of the watch at the end of 2 years is \$7775.22, correct to the nearest cent.

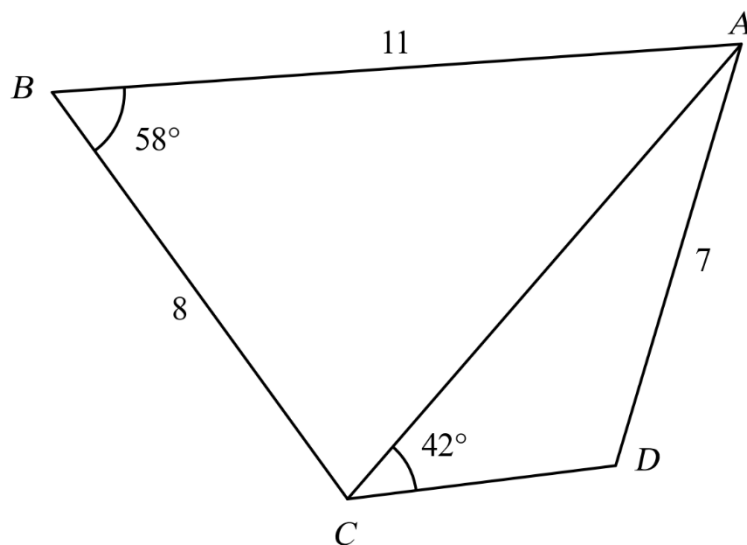
Answer

[2]

- (ii) Find the number of complete years it takes for the value of the watch to exceed \$8888 and the profit Mark will make if he sells it then.

Answeryears for a profit of \$..... [3]

- 3 The quadrilateral $ABCD$, is made up of an acute triangle ABC and an obtuse triangle ADC .
 $AB = 11$ cm, $BC = 8$ cm, $AD = 7$ cm, angle $ABC = 58^\circ$, and angle $ACD = 42^\circ$.



Find

- (a) the length of AC ,

Answer cm [3]

- (b) angle CAD ,

Answer degrees [3]

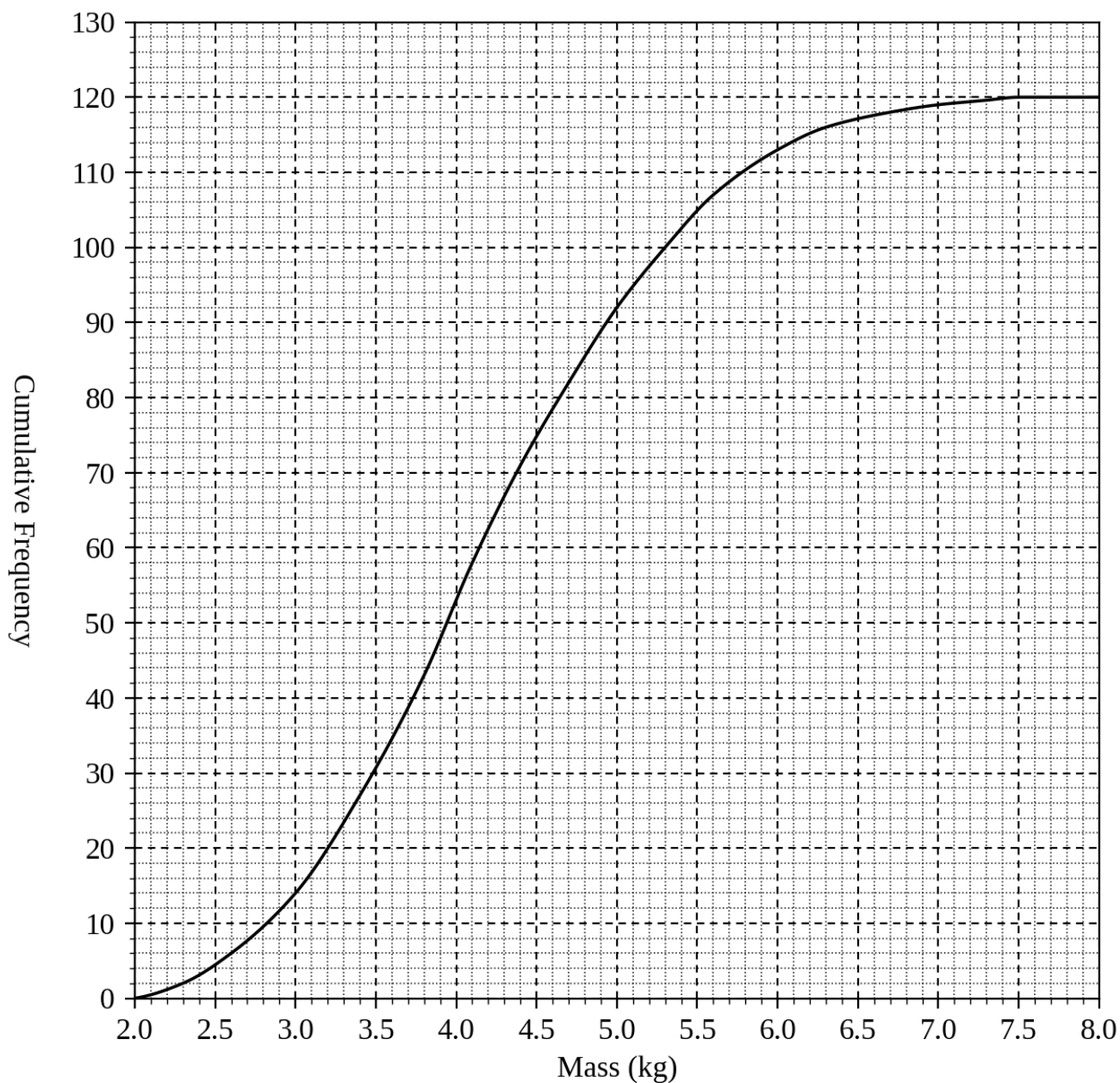
(c) the length of CD ,

Answer cm [2]

(d) the area of quadrilateral $ABCD$.

Answer cm^2 [2]

- 4 The cumulative frequency curve shows the masses, in kilograms, of the 120 watermelons in a shipment delivered to a supermarket.



(a) Use the graph to find

(i) the median,

Answer kg [1]

(ii) the interquartile range.

Answer kg [2]

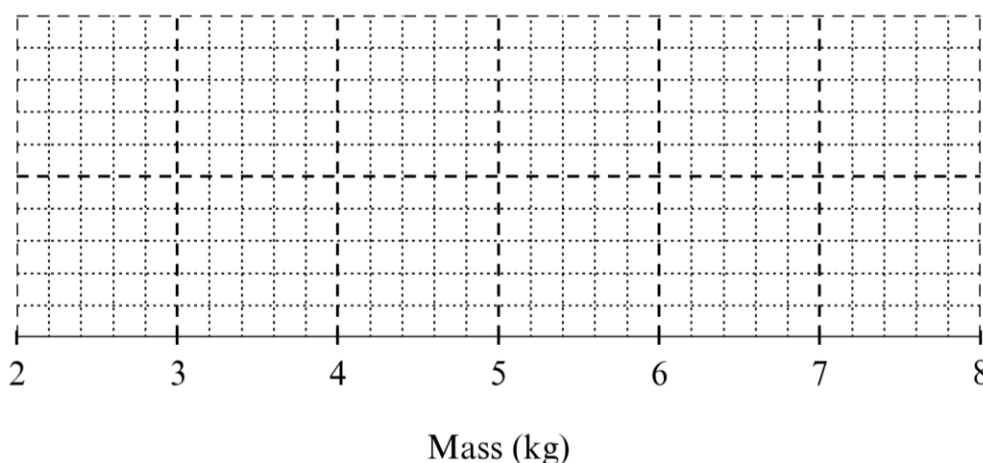
- (b) The supermarket can only sell watermelons with a mass between 3 kg and 6.5 kg. Watermelons with a mass outside this range are unpopular sizes and have to be sold at a discount.

Find the percentage of the shipment that has to be sold at a discount.

Answer % [3]

- (c) A second supplier delivers another shipment of watermelons. For this shipment, the smallest mass is 3 kg and the range is 4.5 kg. The lower quartile, median and upper quartile are 4 kg, 5 kg and 6.5 kg respectively.

Draw a box-and-whisker diagram for this shipment on the scale below.



[3]

- (d) Which shipment is more desirable for the supermarket? Justify your answer with reference to the acceptable range.

Answer

.....
 [2]

- 5 The depth of water, d metres, at a harbour entrance is modelled by

$$d = 0.1t^3 - 1.2t^2 + 3.3t + 4$$

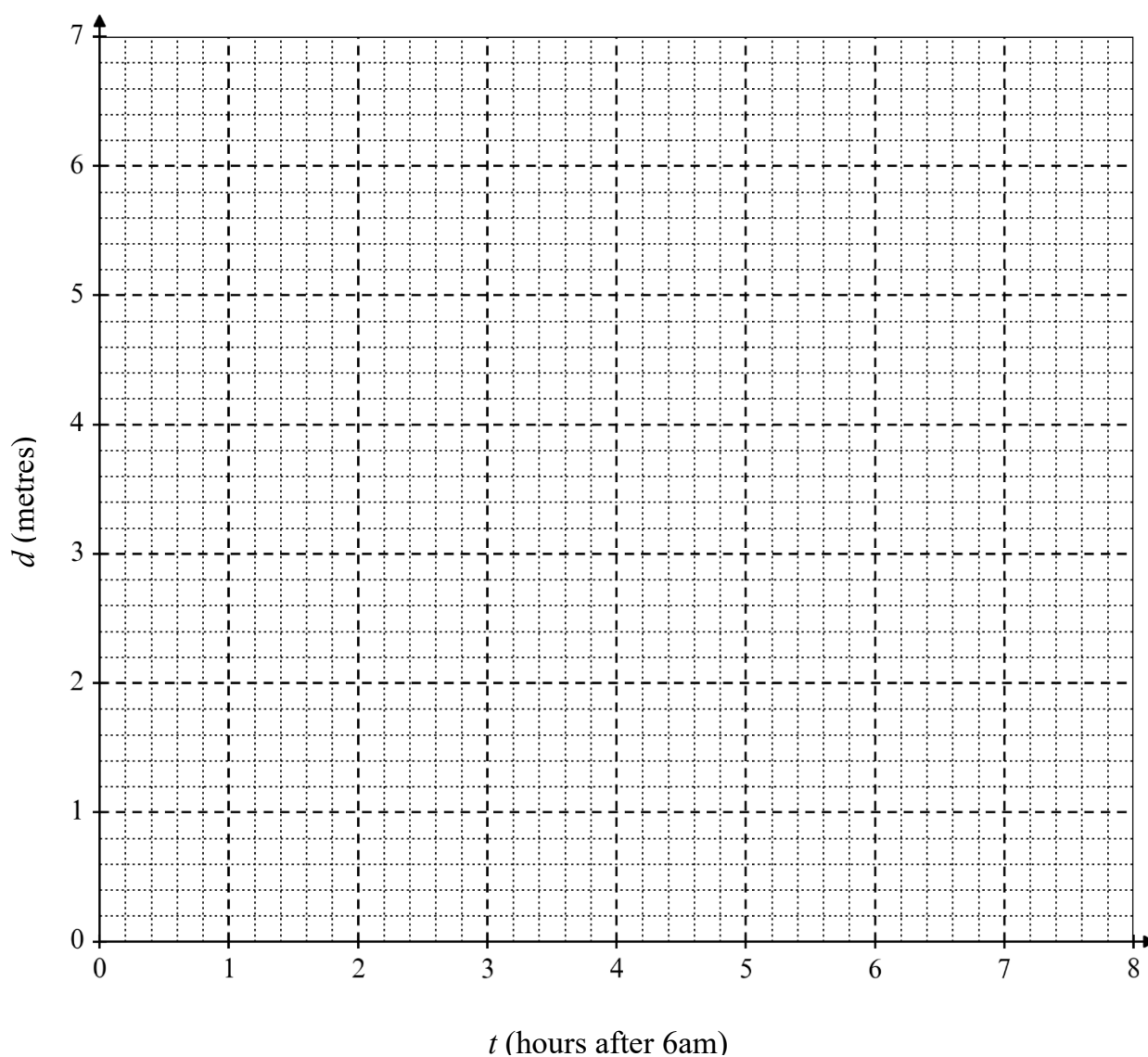
where t is the number of hours after 6 am, for $0 \leq t \leq 8$.

The table shows some values of d .

t	0	1	2	3	4	5	6	7	8
d	4	6.2	6.6		4.4	3.0	2.2	2.6	4.8

(a) Complete the table of values. [1]

(b) On the grid, draw the graph of d against t . [3]



- (c) (i) By drawing a tangent, find the gradient at $t = 5$.

Answer [2]

- (ii) Use your graph to find the minimum depth of water at the harbour entrance.

Answer m [1]

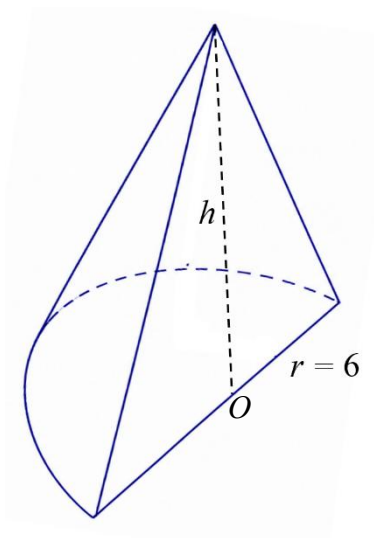
- (d) Use your graph to find the values of t for which the depth of water is decreasing.

Answer [1]

- (e) A cargo ship is being loaded at the quay. As loading continues, the depth of water the ship needs is modelled by $d = 0.2t + 2$. By drawing the line $d = 0.2t + 2$ on your grid, find the time by which the ship must leave in order to avoid becoming stranded. Give your answer as a time of day.

Answer [2]

- 6 (a) The diagram shown is a solid in the shape of half of a right cone.
The solid has height h cm, base radius 6 cm and volume $48\pi \text{ cm}^3$.



- (i) Find h .

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

- (ii) Calculate the total surface area of the solid.

Answer..... cm^2 [4]

- (b) A company sells detergent in geometrically similar containers in two sizes. The ratio of the height of the Large container to the height of the Small container is 3 : 2.

The table shows the cost of producing one filled Small container.

Component	Cost
Detergent	\$3.20
Material for the container	\$0.80
Printing the label	\$0.15

The cost of the detergent is proportional to the volume of the container.

The cost of the materials for the container is proportional to the surface area of the container.

Printing the label costs \$0.15 per container, regardless of size.

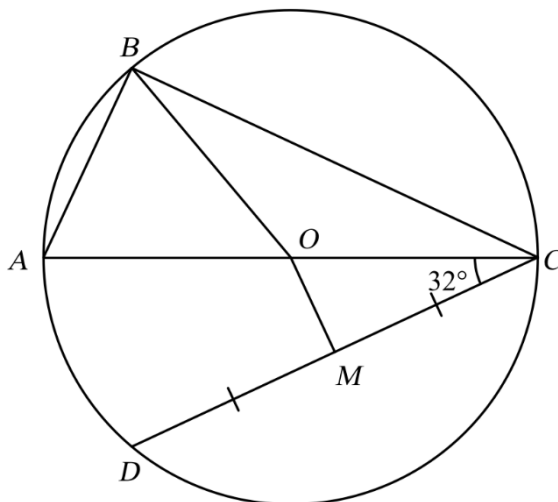
Calculate the total cost of producing one filled Large container.

Answer \$ [3]

- 7 In the diagram, AC is a diameter of the circle, with centre O , and the points A , B , C and D lie on the circle with radius of 9.2 cm.

AC bisects angle BCD . Angle $DCA = 32^\circ$

M is the point on DC such that $DM = MC$.



- (a) Find angle BOA . Give reasons for each step of your working.

Answer Angle $BOA = \dots\dots\dots$ [2]

- (b) Show that triangle COM is similar to triangle CAB .

.....

 [2]

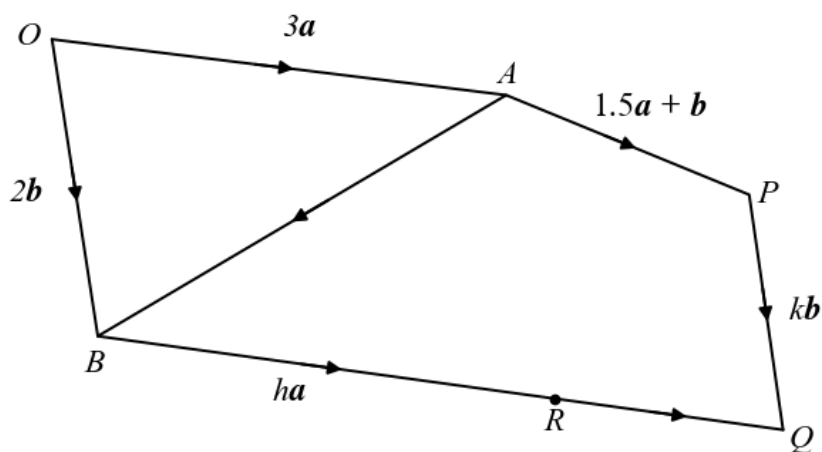
- (c) Show that $BC = DC$.

Answer

[2]

- (d) Find the shortest distance of BC from O .

Answer cm [2]



In the diagram,

$\vec{OA} = 3a$, $\vec{OB} = 2b$, $\vec{AP} = 1.5a + b$, $\vec{PQ} = kb$ and $\vec{BR} = ha$, where k and h are constants.

(a) Find, in terms of a and/or b ,

(i) $\vec{AB}$

Answer $\vec{AB} = \dots\dots\dots$ [1]

(ii) $\vec{BP}$

Answer $\vec{BP} = \dots\dots\dots$ [1]

(b) The points B , R and Q are collinear Find the value of k .

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

- (c) Given that $\overrightarrow{PR}$ is parallel to $\overrightarrow{AB}$, show that $h = 3$.

Answer

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..... [3]

- (d) Find $BR : RQ$, and hence describe the position of R on BQ .

Answer

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..... [2]

- (e) Given that the area of triangle AOB is 60 units², find the area of triangle ABR .

Answer Area = units² [2]

- 9 Based on past events, a charity fundraising carnival predicts that it will sell 2400 tickets if the ticket price is \$8. The break-even ticket price is \$8, so tickets must not be priced below this. Ticket prices are set in whole dollars.

The organising committee estimates that for every \$1 increase in the ticket price, 100 fewer tickets will be sold.

- (a) Complete the table below.

[1]

Increase in ticket price, x (\$)	New ticket price (\$)	Expected number of tickets sold	Revenue, R (\$)
0	8	2400	19 200
1	$8 + 1 = 9$	$2400 - 100(1) = 2300$	20 700
2	$8 + 2 = 10$	$2400 - 100(2) = 2200$	22 000
x	$8 + x$	$2400 - 100(x)$	

- (b) If the committee wishes to collect exactly \$23 100 from ticket sales, while maintaining an attendance of at least 2000 people, show that the ticket should be priced at \$11.

[4]

- (c) If however, the organisers wish to maximise revenue, find the ticket price they should set, and state this maximum revenue.

Answer Ticket price = \$

Maximum revenue = \$ [2]

- (d) Two corporate sponsors have each offered to support the charity, but the committee may accept only **one** of them:

Sponsor A will donate \$15 000 if at least 1900 tickets are sold.

Sponsor B will donate fifty cents for every dollar collected from ticket sales.

Determine which sponsor the committee should accept, and the ticket price it should set, in order to raise the greatest total amount for the charity.

Justify your recommendation with calculations. [4]

END OF PAPER

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St. Patrick's School – Preliminary Examination 2026
Mathematics 4052 Paper 1 – Worked Solutions

Qn	Answer	Mark
1	$\sqrt[3]{15.6^2 - \frac{9.4}{0.028}} = \sqrt[3]{-92.35}$ $= -4.52$	[1]
2(a)	$2p^4 \times 6p^{-5} = 12p^{-1}$ $= \frac{12}{p}$	[1]
2(b)	$4(3x - 2) - 5 = 12x - 8 - 5$ $= 12x - 13$	[1]
3(a)	$0.00047 = 4.7 \times 10^{-4}$	[1]
3(b)	$1 \text{ km} = 1 \times 10^3 \text{ m}$ $0.4 \text{ nm} = 4 \times 10^{-10} \text{ m}$ $\text{Percentage} = \frac{1 \times 10^3}{4 \times 10^{-10}} \times 100\%$ $= 2.5 \times 10^{14} \%$	[1]
4	$F = k/d^2$. Halving d multiplies the force by 4. $\text{New force} = 4 \times 0.8$ $= 3.2 \text{ N}$ $\text{Increase} = 3.2 - 0.8$ $= 2.4 \text{ N}$	[2]
5	$2x = y + 10 \text{ and } 4x + 3y = 220$ $4x + 3(2x - 10) = 220$ $10x - 30 = 220$ $x = 25$ $y = 2(25) - 10$ $= 40$	[3]
6	$\text{Smallest cube side} = \text{LCM}(24, 16, 10).$ $\text{Side} = 240 \text{ mm}$ $\text{Number of blocks} = \frac{240^3}{24 \times 16 \times 10}$ $= 3600$	[3]

Qn	Answer	Mark
7	Make the number of boys equal (LCM of 5 and 7 = 35): Class A → 35 : 14, Class B → 35 : 20 $\begin{aligned}\text{Total girls} &= 14 + 20 \\ &= 34 \\ \text{Total children} &= 70 + 34 \\ &= 104 \\ \text{Fraction} &= \frac{34}{104} \\ &= \frac{17}{52}\end{aligned}$	[3]
8	 $x = \frac{7 \pm \sqrt{(-7)^2 - 4(3)(1)}}{2(3)}$ $x = \frac{7 \pm \sqrt{37}}{6}$ $x = 2.18$ or $x = 0.15$	[3]
9	In $\triangle AMB$ and $\triangle CMD$: AM = CM (M is the midpoint of AC) BM = DM (M is the midpoint of BD) $\angle AMB = \angle CMD$ (vertically opposite angles) $\therefore \triangle AMB \cong \triangle CMD$ (SAS) $\therefore \angle BAM = \angle DCM$ (corresponding angles of congruent triangles) These are equal alternate angles, so $AB \parallel CD$.	[3]
10(a)(i)	Midpoints: 35, 45, 55, 65 $\begin{aligned}\text{Mean} &= \frac{6(35) + 10(45) + 16(55) + 8(65)}{40} \\ &= \frac{2060}{40} \\ &= 51.5 \text{ min}\end{aligned}$	[1]
10(a)(ii)	$\begin{aligned}\text{s.d.} &= \sqrt{\frac{109800}{40} - 51.5^2} \\ &= \sqrt{92.75} \\ &= 9.63 \text{ min}\end{aligned}$	[1]
10(b)	Adding 5 to every value increases the mean by 5, to 56.5 min. The standard deviation is unchanged (9.63 min): adding a constant does not change the spread.	[2]
11(a)	$P(\text{even score}) = 12/16 = 3/4$, $P(\text{odd score}) = 4/16 = 1/4$. $3/4 \neq 1/4$, so Aisha is more likely to win — the game is unfair.	[1]
11(b)	$P(\text{Aisha}) = 3/4$, $P(\text{Ben}) = 1/4$. $3/4 = 3 \times 1/4$, so Aisha is three times as likely to win, not twice. $\therefore$ Aisha is incorrect.	[2]

Qn	Answer	Mark
12	$\frac{1}{2}(9.8)(15) \sin \angle PQR = 67.67$ $\sin \angle PQR = 0.9207$ $\angle PQR = 67.0^\circ \text{ or } 113.0^\circ$	[3]
13	Let the sphere radius be r. Then cylinder radius = r and height = $4r$. $\text{Cylinder} = \pi r^2(4r)$ $= 4\pi r^3$ $\text{Two spheres} = 2 \times \frac{4}{3}\pi r^3$ $= \frac{8}{3}\pi r^3$ $\text{Fraction empty} = \frac{4\pi r^3 - \frac{8}{3}\pi r^3}{4\pi r^3} = \frac{1}{3}$	[3]
14(a)	$\angle ABC = 90^\circ$ (angle in semicircle) $\angle DBC = 180^\circ - 90^\circ = 90^\circ$ (angles on straight line ABD) $\angle DCB = 180^\circ - 90^\circ - 60^\circ$ $= 30^\circ$ (angle sum of $\triangle BDC$)	[2]
14(b)	If DC were a tangent at C, then $\angle DCB$ would equal $\angle BAC = 28^\circ$ (tangent-chord, alternate segment). But $\angle DCB = 30^\circ \neq 28^\circ$, so DC is not a tangent.	[1]
15(a)	Figure 4: shaded = 16, unshaded = 20.	[1]
15(b)	Unshaded in Figure $n = (n+2)^2 - n^2 = 4n + 4$.	[1]
15(c)	$4n + 4 = 96$ $n = 23$ $\text{Shaded} = 23^2$ $= 529$	[2]
16	Let $OD = r$, so $OA = 2r$. $\text{Perimeter} = 2r(1.2) + r(1.2) + r + r$ $= 5.6r$ $5.6r = 44.8$ $r = 8$ $\text{Area} = \frac{1}{2}(1.2)(16^2) - \frac{1}{2}(1.2)(8^2)$ $= 153.6 - 38.4$ $= 115.2 \text{ cm}^2$	[4]

Qn	Answer	Mark
17(a)	Write each side as a power of 3: $3^k \times 3^6 = 3^{-4k}$ $k + 6 = -4k$ $5k = -6$ $k = -\frac{6}{5}$	[2]
17(b)	$4725 = 3^3 \times 5^2 \times 7$ $\text{LCM}(A, B) = p^{r+1} \times q^2 \times 7$ $q = 5$ $p = 3$ $r + 1 = 3$ $r = 2$	[2]
18	(i) C (depth falls at a constant rate — straight line decreasing) (ii) D (area = πr^2, increasing and concave up) (iii) B (distance increases at a decreasing rate, then levels off)	[3]
19(a)	Interior angles: $A = 110^\circ$, $B = 30^\circ + 70^\circ = 100^\circ$, $E = 40^\circ + 80^\circ = 120^\circ$, $D = 30^\circ + 80^\circ = 110^\circ$. $110 + 100 + 120 + 110 + x = 540$ $x = 100$	[2]
19(b)	$\angle ABE = \angle ADE = 30^\circ$, so A, B, D, E lie on a circle (equal angles subtended by AE, angles in the same segment). In $\triangle AED$: $\angle DAE = 180^\circ - 120^\circ - 30^\circ = 30^\circ$, so $\angle DAB = 110^\circ - 30^\circ = 80^\circ$. For ABCD: $\angle DAB + \angle BCD = 80^\circ + 100^\circ = 180^\circ$, so ABCD is a cyclic quadrilateral. Hence all five points A, B, C, D, E lie on the same circle.	[3]
20(a)	$-15 < 3x - 3 \leq 15$ $-12 < 3x \leq 18$ $-4 < x \leq 6$	[2]
20(b)	Open circle at -4 , filled circle at 6 , joined by a line.	[1]
20(c)	Smallest $y^2 - x^2$: take smallest y^2 ($y = 2$) and largest x^2 ($x = 6$). $y^2 - x^2 = 2^2 - 6^2$ $= -32$	[1]
21(a)	From A, measure a bearing of 062° and mark F at 6.4 cm (12.8 m).	[1]
21(b)	P is due south of F with $AP = 8$ cm (16 m). Mark P and draw PA, PF.	[1]

Qn	Answer	Mark
21(c)	PF runs due north–south, so the shortest distance from A to PF is the easterly distance: $d = 12.8 \sin 62^\circ$ $= 11.30 \text{ m}$ Greatest angle = $\tan^{-1} \frac{5.3}{11.30}$ $= 25.1^\circ$	[2]
22(a)	$\frac{1}{2}(56)(v) = 672$ $v = 24 \text{ m/s}$	[1]
22(b)	Deceleration = $\frac{24}{56 - 24}$ $= 0.75 \text{ m/s}^2$	[1]
22(c)	0 to 24 s: curve from (0, 0), increasing gradient (concave up), reaching 288 m. 24 to 56 s: curve continues up with decreasing gradient (concave down), reaching 672 m at 56 s.	[2]
23(a)	$B = (0 - 3, 7 + 5)$ $= (-3, 12)$	[1]
23(b)	$ p = \sqrt{(-3)^2 + 5^2}$ $= \sqrt{34}$ $= 5.83$	[2]
23(c)	Gradient = $\frac{12 - 7}{-3 - 0}$ $= -\frac{5}{3}$ $y = -\frac{5}{3}x + 7$	[2]
24(a)	$A \cup B = \{1, 2, 3, 4, 6, 9, 12\}$ so $(A \cup B)' = \{5, 7, 8, 10, 11\}$ $n(A \cup B)' = 5$.	[1]
24(b)	$A' \cap B = \{1, 2, 4\}$.	[1]
24(c)	True. $9 \in A$ (multiple of 3) and $9 \notin B$ (not a factor of 12), so $9 \in B'$; hence $9 \in A \cap B'$.	[1]
24(d)	$B = \{1, 2, 3, 4, 6, 12\}$, $C = \{7, 11\}$, so $B \cap C = \emptyset$. The events cannot occur together, so X and Y are mutually exclusive.	[1]
25(a)	Tuesday: $40(t + 6)$ litres Wednesday: $60(t - 4)$ litres	[1]

Qn	Answer	Mark
25(b)	$40(t + 6) = 60(t - 4)$ $40t + 240 = 60t - 240$ $20t = 480$ $t = 24 \text{ min}$	[3]
25(c)	$\text{Capacity} = 40(24 + 6)$ $= 1200 \text{ litres}$	[1]
26(a)	$P = \begin{pmatrix} 4.50 \\ 6.00 \end{pmatrix}$	[1]
26(b)	$Q = \begin{pmatrix} 120 & 80 \\ 150 & 60 \end{pmatrix}$ $Q(P) = \begin{pmatrix} 1020 \\ 1035 \end{pmatrix}$	[1]
26(c)	Each element is the total takings from meal-set sales that day: \$1020 on Monday and \$1035 on Tuesday.	[1]
26(d)(i)	$R = \begin{pmatrix} 0.3 & 0 \\ 0 & 0.4 \end{pmatrix}$	[1]
26(d)(ii)	$RP = \begin{pmatrix} 1.35 \\ 2.40 \end{pmatrix}$ $Q(RP) = \begin{pmatrix} 120 & 80 \\ 150 & 60 \end{pmatrix} \begin{pmatrix} 1.35 \\ 2.40 \end{pmatrix}$ $= \begin{pmatrix} 354 \\ 346.50 \end{pmatrix}$ Profit: Monday \$354, Tuesday \$346.50.	[2]

St. Patrick's School – Preliminary Examination 2026
Mathematics 4052 Paper 2 – Worked Solutions

Qn	Answer	Mark
1(a)	$\frac{5}{x-2} - \frac{3}{2x+1} = \frac{5(2x+1) - 3(x-2)}{(x-2)(2x+1)}$ $= \frac{10x+5-3x+6}{(x-2)(2x+1)}$ $= \frac{7x+11}{(x-2)(2x+1)}$	[2]
1(b)	$Vr^2 = h(R^2 + r^2)$ $Vr^2 - hr^2 = hR^2$ $r^2(V-h) = hR^2$ $r^2 = \frac{hR^2}{V-h}$ $r = R\sqrt{\frac{h}{V-h}}$	[2]
1(c)	$\frac{2x^2 - xy - 6x + 3y}{9 - x^2} = \frac{x(2x - y) - 3(2x - y)}{(3 - x)(3 + x)}$ $= \frac{(2x - y)(x - 3)}{-(x - 3)(x + 3)}$ $= \frac{y - 2x}{x + 3}$	[3]
1(d)	$(2x^3y^{-2})^4 \div (8x^5y^{-3}) = \frac{16x^{12}y^{-8}}{8x^5y^{-3}}$ $= 2x^7y^{-5}$ $= \frac{2x^7}{y^5}$	[2]
2(a)(i)	Deposit = 0.20×2400 = 480 Instalments = 24×92 = 2208 Total HP price = $480 + 2208$ = \$2688	[2]
2(a)(ii)	Difference = $2688 - 2400$ = 288 Percentage = $\frac{288}{2400} \times 100\%$ = 12%	[2]

Qn	Answer	Mark
2(b)	$85\% \text{ of price} = 1734$ $\text{Original price} = \frac{1734}{0.85}$ $= \$2040$	[2]
2(c)(i)	$\text{Value} = 6666 \times 1.08^2$ $= 6666 \times 1.1664$ $= \$7775.2224$ $= \$7775.22 \text{ (nearest cent)}$	[2]
2(c)(ii)	Continue year by year from the year 3 value: End of year 3: $6666 \times 1.08^3 = 8397.24$ (< 8888) End of year 4: $6666 \times 1.08^4 = 9069.02$ (> 8888) The value first exceeds \$8888 after 4 complete years. $\text{Profit} = 9069.02 - 6666$ $= \$2403.02$	[3]
3(a)	$AC^2 = 11^2 + 8^2 - 2(11)(8) \cos 58^\circ$ $= 185 - 176 \cos 58^\circ$ $= 91.73$ $AC = 9.58 \text{ cm}$	[3]
3(b)	$\frac{\sin \angle ADC}{9.578} = \frac{\sin 42^\circ}{7}$ $\sin \angle ADC = \frac{9.578 \sin 42^\circ}{7}$ $= 0.9155$ $\angle ADC = 113.7^\circ \text{ (obtuse)}$ $\angle CAD = 180^\circ - 42^\circ - 113.7^\circ$ $= 24.3^\circ$	[3]
3(c)	$\frac{CD}{\sin \angle CAD} = \frac{7}{\sin 42^\circ}$ $CD = \frac{7 \sin 24.3^\circ}{\sin 42^\circ}$ $= 4.30 \text{ cm}$	[2]
3(d)	$\text{Area } ABC = \frac{1}{2}(11)(8) \sin 58^\circ$ $= 37.31$ $\text{Area } ACD = \frac{1}{2}(9.578)(7) \sin 24.3^\circ$ $= 13.79$ $\text{Area } ABCD = 37.31 + 13.79$ $= 51.1 \text{ cm}^2$	[2]
4(a)(i)	Median ≈ 4.1 kg (read at cumulative frequency = 60)	[1]

Qn	Answer	Mark
4(a)(ii)	$Q_1 = 3.5 \text{ kg (CF} = 30\text{)}, Q_3 = 5.0 \text{ kg (CF} = 90\text{)}$ $\begin{aligned} \text{IQR} &= Q_3 - Q_1 \\ &= 5.0 - 3.5 \\ &= 1.5 \text{ kg} \end{aligned}$	[2]
4(b)	Below 3 kg: CF at 3.0 kg ≈ 13 Above 6.5 kg: $120 - \text{CF}(6.5) = 120 - 116 = 4$ $\begin{aligned} \text{Discounted} &= 13 + 4 \\ &= 17 \end{aligned}$ $\begin{aligned} \text{Percentage} &= \frac{17}{120} \times 100\% \\ &= 14.2\% \end{aligned}$	[3]
4(c)	Five-number summary for shipment 2: minimum 3, lower quartile 4, median 5, upper quartile 6.5, maximum 7.5 (range 4.5). Box drawn from 4 to 6.5 with median line at 5; whiskers to 3 and 7.5.	[3]
4(d)	Shipment 1: within 3–6.5 kg $\approx 103/120 \approx 86\%$, so $\approx 14\%$ discounted. Shipment 2: $Q_3 = 6.5 \text{ kg}$, so 75% lie within 3–6.5 kg; 25% (above 6.5 kg) discounted. Shipment 1 is more desirable: a larger proportion ($\approx 86\%$ vs 75%) falls within the acceptable 3–6.5 kg range, so fewer melons are discounted.	[2]
5(a)	$\begin{aligned} d &= 0.1(3)^3 - 1.2(3)^2 + 3.3(3) + 4 \\ &= 5.8 \end{aligned}$	[1]
5(b)	Plot the nine points from the table. Join them with a single smooth curve.	[3]
5(c)(i)	Draw a tangent to the curve at $t = 5$. Gradient ≈ -1.2 (accept -1.0 to -1.4)	[2]
5(c)(ii)	Minimum depth $\approx 2.2 \text{ m}$ (at $t \approx 6.2$)	[1]
5(d)	Depth is decreasing for $1.8 < t < 6.2$ (approx).	[1]
5(e)	Draw the line $d = 0.2t + 2$ on the grid. It meets the curve on the falling part at $t = 5$. $t = 5$ is 5 hours after 6 am, so the ship must leave by 11 am.	[2]
6(a)(i)	$\begin{aligned} \frac{1}{2} \left(\frac{1}{3} \pi r^2 h \right) &= 48\pi \\ \frac{1}{2} \left(\frac{1}{3} \pi (6)^2 h \right) &= 48\pi \\ 6\pi h &= 48\pi \\ h &= 8 \text{ cm} \end{aligned}$	[2]

Qn	Answer	Mark
6(a)(ii)	$l = \sqrt{6^2 + 8^2}$ $= 10 \text{ cm}$ Half curved surface $= \frac{1}{2}\pi rl$ $= \frac{1}{2}\pi(6)(10)$ $= 30\pi$ Half base $= \frac{1}{2}\pi r^2$ $= \frac{1}{2}\pi(6)^2$ $= 18\pi$ Triangular face $= \frac{1}{2}(12)(8)$ $= 48$ Total surface area $= 30\pi + 18\pi + 48$ $= 199 \text{ cm}^2$	[4]
6(b)	Detergent $= 3.20 \times \left(\frac{3}{2}\right)^3$ $= 3.20 \times \frac{27}{8}$ $= \$10.80$ Material $= 0.80 \times \left(\frac{3}{2}\right)^2$ $= 0.80 \times \frac{9}{4}$ $= \$1.80$ Total $= 10.80 + 1.80 + 0.15$ $= \$12.75$	[3]
7(a)	$\angle BCA = 32^\circ$ (AC bisects $\angle BCD$) $\angle BOA = 2 \times 32^\circ$ $= 64^\circ$ ($\angle$ at centre $= 2 \times \angle$ at circumference)	[2]
7(b)	O and M are the midpoints of AC and DC, so OM $\parallel$ AD (midpoint theorem). $\angle OMC = \angle ADC = 90^\circ$ (corr. $\angle$s, OM $\parallel$ AD; $\angle$ in semicircle) $\angle OCM = \angle ACB = 32^\circ$ (AC bisects $\angle BCD$) $\therefore \triangle COM$ is similar to $\triangle CAB$ (2 pairs of equal angles)	[2]
7(c)	In $\triangle ABC$ and $\triangle ADC$: $\angle ABC = \angle ADC = 90^\circ$ ($\angle$ in semicircle) $\angle BCA = \angle DCA = 32^\circ$ (AC bisects $\angle BCD$) AC is common. $\therefore \triangle ABC \cong \triangle ADC$ (AAS) $\therefore BC = DC$	[2]
7(d)	$BC = 18.4 \cos 32^\circ$ $= 15.60 \text{ cm}$ The perpendicular from O bisects BC, so the half-chord $= 7.802 \text{ cm}$. $d = \sqrt{9.2^2 - 7.802^2}$ $= 4.88 \text{ cm (3 s.f.)}$	[2]

Qn	Answer	Mark
8(a)(i)	$\overrightarrow{AB} = 2\mathbf{b} - 3\mathbf{a}$	[1]
8(a)(ii)	$\begin{aligned}\overrightarrow{BP} &= \overrightarrow{BA} + \overrightarrow{AP} \\ &= (3\mathbf{a} - 2\mathbf{b}) + (1.5\mathbf{a} + \mathbf{b}) \\ &= 4.5\mathbf{a} - \mathbf{b}\end{aligned}$	[1]
8(b)	$\begin{aligned}\overrightarrow{OQ} &= \overrightarrow{OA} + \overrightarrow{AP} + \overrightarrow{PQ} \\ &= 3\mathbf{a} + (1.5\mathbf{a} + \mathbf{b}) + k\mathbf{b} \\ &= 4.5\mathbf{a} + (1+k)\mathbf{b} \\ \overrightarrow{BQ} &= \overrightarrow{OQ} - \overrightarrow{OB} \\ &= 4.5\mathbf{a} + (k-1)\mathbf{b}\end{aligned}$ BR = ha is parallel to a, and B, R, Q are collinear, so BQ is parallel to a. $\therefore$ coefficient of b = 0: $\begin{aligned}k - 1 &= 0 \\ k &= 1\end{aligned}$	[2]
8(c)	$\begin{aligned}\overrightarrow{OP} &= 3\mathbf{a} + (1.5\mathbf{a} + \mathbf{b}) \\ &= 4.5\mathbf{a} + \mathbf{b} \\ \overrightarrow{OR} &= \overrightarrow{OB} + \overrightarrow{BR} \\ &= h\mathbf{a} + 2\mathbf{b} \\ \overrightarrow{PR} &= \overrightarrow{OR} - \overrightarrow{OP} \\ &= (h - 4.5)\mathbf{a} + \mathbf{b}\end{aligned}$ Since PR $\parallel$ AB, PR = λ AB: $(h - 4.5)\mathbf{a} + \mathbf{b} = \lambda(2\mathbf{b} - 3\mathbf{a})$ Comparing coefficients of b: $\begin{aligned}1 &= 2\lambda \\ \lambda &= \frac{1}{2}\end{aligned}$ Comparing coefficients of a: $\begin{aligned}h - 4.5 &= -3\lambda \\ &= -1.5 \\ h &= 3\end{aligned}$	[3]
8(d)	With k = 1: $\begin{aligned}\overrightarrow{RQ} &= \overrightarrow{BQ} - \overrightarrow{BR} \\ &= 4.5\mathbf{a} - 3\mathbf{a} \\ &= 1.5\mathbf{a} \\ BR : RQ &= 3 : 1.5 \\ &= 2 : 1\end{aligned}$ R lies on BQ, two-thirds of the way from B to Q (BR is twice RQ).	[2]

Qn	Answer	Mark
8(e)	$\overrightarrow{AR} = \overrightarrow{AB} + \overrightarrow{BR}$ $= (2\mathbf{b} - 3\mathbf{a}) + 3\mathbf{a}$ $= 2\mathbf{b}$ Since $AR = 2b = OB$ and $BR = 3a = OA$, OARB is a parallelogram. Diagonal AB divides it into two equal triangles, $\triangle AOB$ and $\triangle ABR$. $\text{Area of } \triangle ABR = \text{Area of } \triangle AOB$ $= 60 \text{ units}^2$	[2]
9(a)	$x = 1$: tickets sold = 2300; $x = 2$: tickets sold = 2200. Row x: new price = $8 + x$, tickets sold = $2400 - 100x$, revenue $R = (8 + x)(2400 - 100x)$.	[1]
9(b)	$(8 + x)(2400 - 100x) = 23100$ $19200 + 1600x - 100x^2 = 23100$ $100x^2 - 1600x + 3900 = 0$ $x^2 - 16x + 39 = 0$ $(x - 3)(x - 13) = 0$ $x = 3$ or $x = 13$ $x = 3$: price = \$11, tickets = 2100 ($\geq 2000$ ✓) $x = 13$: price = \$21, tickets = 1100 ($< 2000$ ×) $\therefore$ ticket price = \$11.	[4]
9(c)	$R = (8 + x)(2400 - 100x) = 0$ when $x = -8$ or $x = 24$. Line of symmetry: $x = \frac{-8 + 24}{2}$ $= 8$ Maximum revenue is at $x = 8$, so price = $8 + 8 = \\$16$. $R_{\max} = (16)(2400 - 800)$ $= \$25\,600$	[2]
9(d)	Sponsor A (\$15 000 if ≥ 1900 tickets): $2400 - 100x \geq 1900$, so $x \leq 5$. Best $R = (13)(1900)$ $= 24700$ Total (A) = $24700 + 15000$ $= \\$39\,700$ Sponsor B (50c per \$1 of sales = $1.5R$): maximise R at $x = 8$. Total (B) = 1.5×25600 $= \\$38\,400$ $\\$39\,700 > \\$38\,400$, so accept Sponsor A and set the price at \$13.	[4]

NAME:		()
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CLASS:	
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SUBJECT TEACHER: _____



YISHUN TOWN SECONDARY SCHOOL

G3

PRELIMINARY EXAMINATION 2026

SECONDARY 4/5

MATHEMATICS G3

PAPER 1 (4052/01)

DATE : 11 August 2026

DAY : Tuesday

DURATION : 2 h 15 min

MARKS : 90

READ THESE INSTRUCTIONS FIRST

Do not turn over the cover page until you are told to do so.

Write your name, class and class index number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.

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 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, unless the question requires the answer in terms of π .

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

The total of the marks for this paper is 90.

	MARKS	
	OBTAINED	FULL
1		2
2		3
3		1
4		2
5		2
6		2
7		3
8		4
9		2
10		4
11		2
12		3
13		3
14		3
15		3
16		6
17		3
18		6
19		3
20		7
21		5
22		8
23		6
24		7
TOTAL		90

This question paper consists of **20** printed pages.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

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 Abeny, Becky and Cassidy decided to invest money in the ratio of $p : 2 : 6$.
Becky invested \$16 000 and Cassidy's investment was 20% of the total investment.
Find the value of the total investment.

Answer \$..... [2]

- 2 (a) Given that $\sin x^\circ = 0.8524$, find the two possible values for angle x , where $0 \leq x \leq 180$.

Answer $^\circ$ or $^\circ$ [2]

- (b) Convert 1.54 radians into degrees.

Answer $^\circ$ [1]

- 3 The time taken to paint a wall is inversely proportional to the number of workers.
Five workers take 14 hours.
Find the number of hours it would take for 7 workers to paint the wall.

Answer hours [1]

- 4 Given that $3^{4n-3} = 3^{2026} - 2(3^{2025})$, find the value of n .

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

- 5 Mr Wong invested \$15000 in a savings account that offers 2% interest per annum, compounded every 3 months.
Calculate the total amount of interest Mr Wong earned at the end of 5 years.

Answer \$..... [2]

- 6 (a) Given that $A = 2^{n+2} \times 3^4 \times 5$ and $B = 2^5 \times 3^{n-1} \times 7^2$ where n is a positive integer.
The greatest common factor of A and B is 48.
Find the value of n .

Answer $n =$ [1]

- (b) Explain why 1 is not a prime number.

Answer
..... [1]

-
- 7 Explain why $3^{x+2} + 5\left(\frac{1}{3}\right)^{-x} - 4\sqrt{9^x}$ is divisible by 10 for all integer values of x .

Answer

[3]

- 8 (a) Factorise completely $2x^2 + x - 6$.

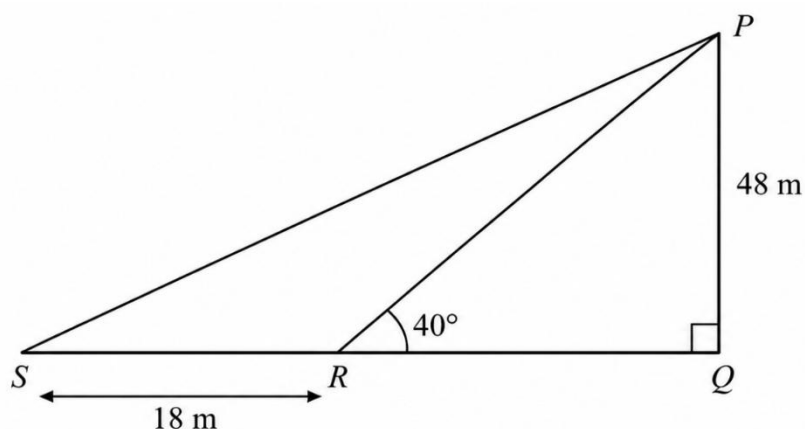
Answer [2]

- (b) Hence factorise completely $2(y-3)^2 + (y+4) - 13$.
Write your answer as simply as possible.

Answer [2]

-
- 9 Cheryl went to Europe for a holiday and bought a bag for 900 Euros.
She then sold the bag to her friend at a 15% profit.
Given that the conversion rate between Singapore dollars (\$) and Euros (€) was $\$1 = 0.67$ (€),
calculate the selling price in Singapore dollars (\$).

Answer \$..... [2]



The diagram represents a building, PQ , built on horizontal ground.

The height of the building is 48 m.

From a point R , the angle of elevation of the top of the tower is 40° .

Point S is 18 m from R and QRS is a straight line.

Calculate the angle of depression of point S from the top of the building.

Answer $^\circ$ [4]

- 11** Alex has 168 one-centimetre cubes.
 He arranges all the cubes into a cuboid.
 The perimeter of the top of the cuboid is 26 cm.
 Each side of the cuboid has a length greater than 2 cm.
 Find the height of the cuboid.

Answer [2]

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

Answer [2]

- (b)** Write down the coordinates of the minimum point of the graph of $y = x^2 + 6x + 10$.

Answer (..... ,) [1]

- 13** The curve $y = ax^2 + bx + c$ passes through the points $(-1, -16)$ and $(1, 0)$.
The equation of the line of symmetry of the curve is $x = 2$.
Find the values of a , b and c .

Answer $a = \dots\dots\dots b = \dots\dots\dots c = \dots\dots\dots$ [3]

14 Simplify $\left(\sqrt{\frac{16}{9x^8}}\right)^{-1} + \left(\frac{x^5}{32}\right)^{0.8}$.

Answer [3]

15 Factorise completely $x^3 - x^2y - xy^2 + y^3$.

Answer [3]

- 16** A bag contains n red marbles and 2 blue marbles.
 Three marbles are drawn from the bag at random, one after another without replacement.
 The probability that three of the marbles drawn are red is $\frac{1}{5}$.
- (a)** Show that n satisfies the equation $2n^2 - 9n + 4 = 0$.

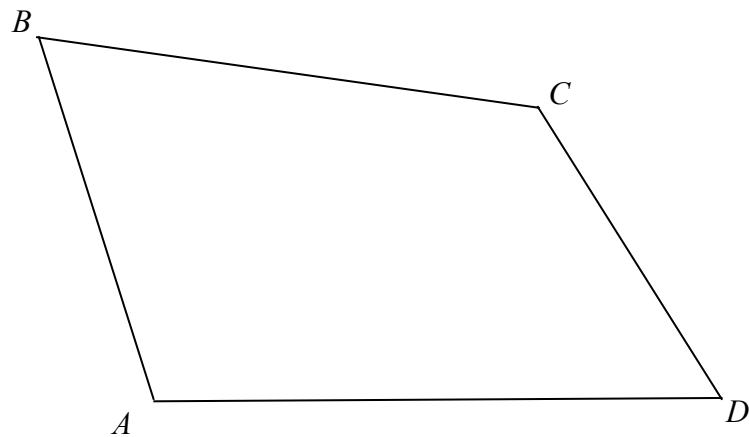
Answer

[3]

- (b)** Hence, find the probability that at least two marbles drawn are red.

Answer [3]

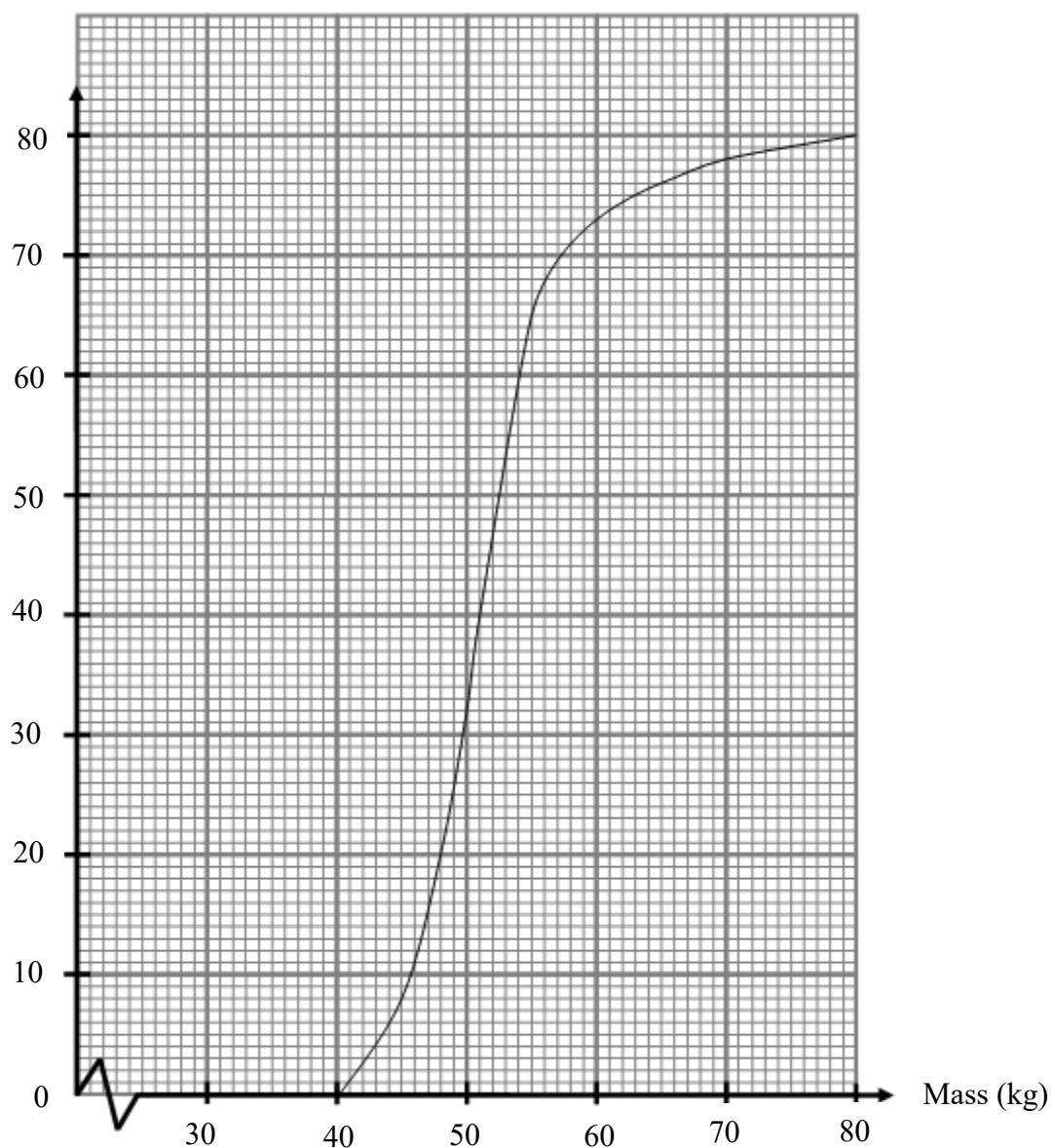
17 The diagram represents a plot of land, $ABCD$.



- (a) Construct the perpendicular bisector of AD . [1]
- (b) Construct the bisector of angle BAD . [1]
- (c) A supermarket is to be built within $ABCD$, nearer to AD than AB and nearer to A than D .
Shade the region where the supermarket is to be built. [1]

- 18** The mass of 80 students are measured and presented in the cumulative frequency diagram below.

Cumulative Frequency



Use the diagram to estimate

- (a)** the median mass of the students,

Answerkg [1]

- (b)** the interquartile range of the mass,

Answerkg [2]

- (c) the percentage of students whose mass are at least 70 kg.

Answer% [1]

- (d) One student is chosen at random.
Find the probability that the student's mass is between 45 kg and 65 kg.

Answer [2]

19 Two sets P and Q are such that $P \subset Q$.

- (a) Fill in each box with one of the following:

$\emptyset$ $\cup$ $\cap$ P Q P' Q'

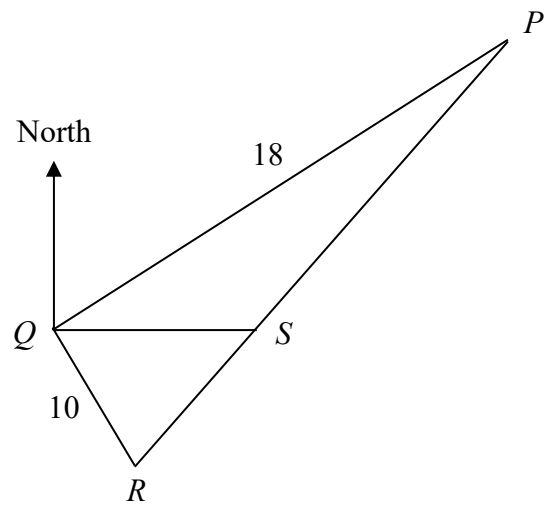
(i) $(P \cap Q)$ $(P' \cap Q) = Q$ [1]

(ii) $(P' \cup Q)' =$ [1]

- (b) Andy claims “ $A \cap B = \emptyset$, then $A \subset B'$.”
Do you agree with Andy?
Justify your answer with explanation.

Answer
..... [1]

- 20** P, Q, R, S are points on horizontal grounds.
 $PQ = 18$ km, $QR = 10$ km and the bearing of P from Q is 038° .
 S is to the East of Q .
The area of triangle SQR is half the area of triangle SQP .



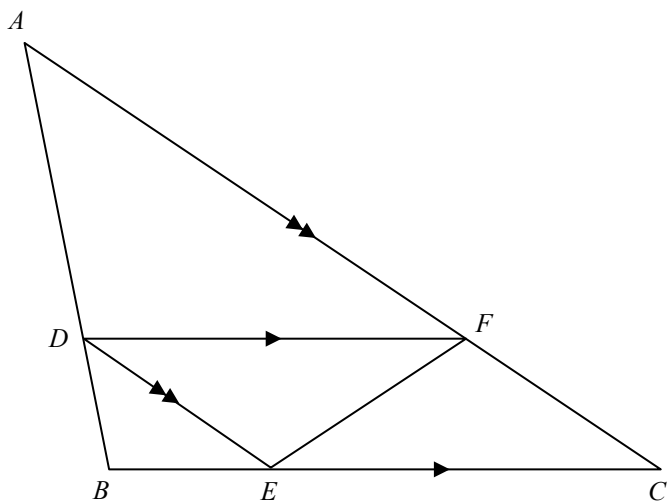
- (a)** Find the angle SQR .

Answer $^\circ$ [4]

- (b)** Calculate the distance PR .

Answerkm [3]

21 In the diagram, ABC is a triangle. DF is parallel to BC and AC is parallel to DE .



- (a) Prove that triangles ADF and ABC are similar.
Give a reason for each statement you make.

Answer

.....

.....

.....

..... [2]

- (b) Name two triangles that are congruent and show that they are congruent.
Give a reason for each statement you make.

Answer

.....

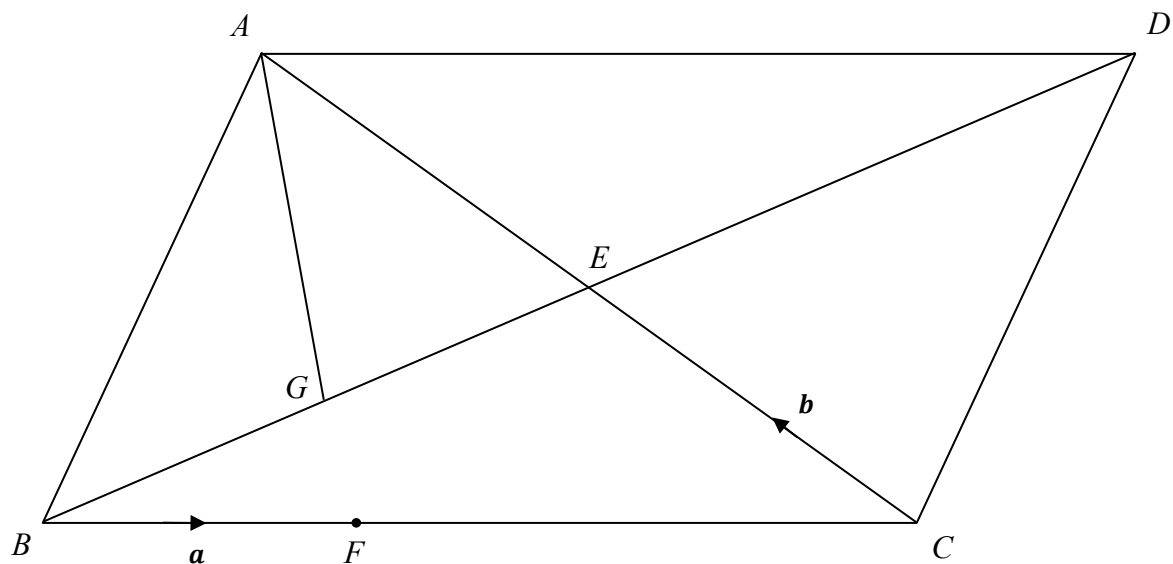
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..... [3]

- 22** In the diagram, $ABCD$ is a parallelogram.
 Diagonals AC and BD intersect at E and G is the midpoint of BE .
 F is a point of BC such that $\overrightarrow{BC} = 3\overrightarrow{BF}$.
 It is given that $\overrightarrow{BF} = \mathbf{a}$ and $\overrightarrow{CE} = \mathbf{b}$.



- (a)** Express each of the following vectors in terms of $\mathbf{a}$ and $\mathbf{b}$ as simply as possible.
- (i)** $\overrightarrow{BA}$

Answer [1]

- (ii)** $\overrightarrow{BD}$

Answer [1]

- (iii)** $\overrightarrow{AG}$

Answer [2]

- (b)** Show that points A , G and F are collinear.

Answer

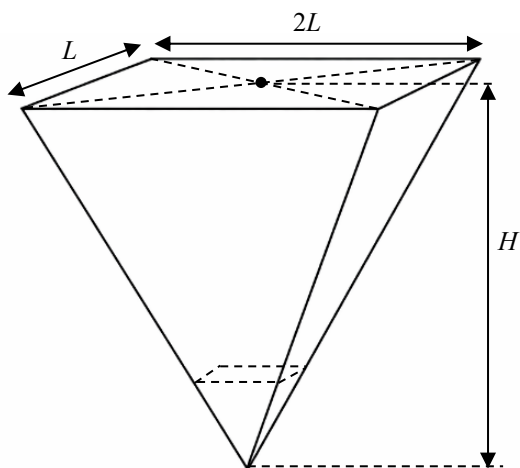
[2]

- (c)** Find the value of $\frac{\text{area of } \triangle BFG}{\text{area of } ABCD}$.

Answer [2]

- 23** A closed container is in the shape of an inverted right pyramid with a rectangular base. The dimensions of the base are $2L$ cm by L cm and the vertical height of the pyramid is H cm. The container initially contains some water.

The volume of the water is $\frac{1}{27}$ of the total capacity of the container.

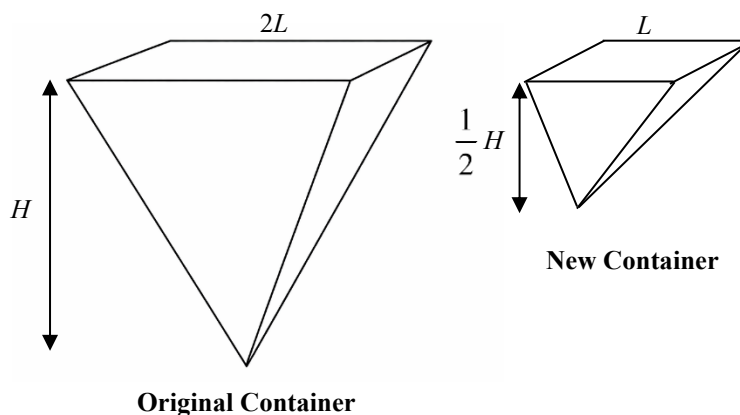


- (a)** Find the area of the rectangular surface of water, in terms of L .

- (b) The container is now inverted so that the rectangular base is at the bottom. Given that the total vertical height of the pyramid H is 90 cm, calculate the new height of the water.
Give your answers to 2 decimal places.

Answercm [3]

(c)



A new container is created, where it has a length L , and a vertical height of $\frac{1}{2}H$.

From the information given, Charles concludes that, “These two containers are similar solids.”
Justify with reason(s) if you agree with Charles claim.

Answer

..... [1]

- 24** Tickets to a concert were sold. The seats were divided into 3 sectors, A , B and C .
 On Friday, 56 Sector A tickets, 84 Sector B tickets and 78 Sector C tickets were sold.
 On Saturday, 62 Sector A tickets, 76 Sector B tickets and 95 Sector C tickets were sold.
- (a)** Represent this information in a 2×3 matrix, E .

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

- (b)** The price per ticket is \$20 for Sector A, \$15 for Sector B and \$12 for Sector C.
 Write down a column matrix F to represent the price per seat.

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

- (c)** Evaluate the matrix $G = EF$.

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

- (d)** State what each element of matrix G represents.

Answer [1]

- (e)** Using matrix multiplication, find the total amount of money collected from selling all of the tickets.

Answer \$ [2]

End of Paper

NAME:		()
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CLASS:	
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SUBJECT TEACHER: _____



YISHUN TOWN SECONDARY SCHOOL

G3

PRELIMINARY EXAMINATION 2026

SECONDARY 4/5

MATHEMATICS G3

PAPER 2 (4052/02)

DATE : 13 August 2026

DAY : Thursday

DURATION: 2 h 15 min

MARKS: 90

READ THESE INSTRUCTIONS FIRST

Do not turn over the cover page until you are told to do so.

Write your name, class and class index number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.

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 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, unless the question requires the answer in terms of π .

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

The total of the marks for this paper is 90.

	MARKS	
	OBTAINED	FULL
1		12
2		6
3		6
4		8
5		7
6		8
7		10
8		12
9		11
10		10
TOTAL		90

This question paper consists of **24** printed pages and **2** blank pages.

Mathematical Formulae*Compound Interest*

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

Mensuration

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

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

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

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

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

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

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

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 (a) Solve the equation $\frac{x+7}{x^2-9} = -2 + \frac{1}{3-x}$.

Give your solutions correct to 2 decimal places.

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [5]

(b) Solve the inequalities $\frac{2}{3} + y \leq 9 + \frac{4}{9}y < 4 + y$.

Answer [3]

(c) Given that $\frac{1}{2}b = \sqrt{\frac{4-z}{z}} + 3$,

(i) Find b when $z = 2$,

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

(ii) Rearrange the formula to make z the subject.

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

- 2 YTSS is testing two AI systems, System A and System B, tracking their response times (in seconds) to student queries.

The response times for System A are shown below:

System A

Stem	Leaf			
3	8	9		
4	1	2	5	7
5	0	3	6	
6	2	4		

Key: 4 2 represents 42 seconds

- (a) (i) Find the median response time for System A.

Answer seconds [1]

- (ii) Find the standard deviation of the response times for System A.

Answer seconds [1]

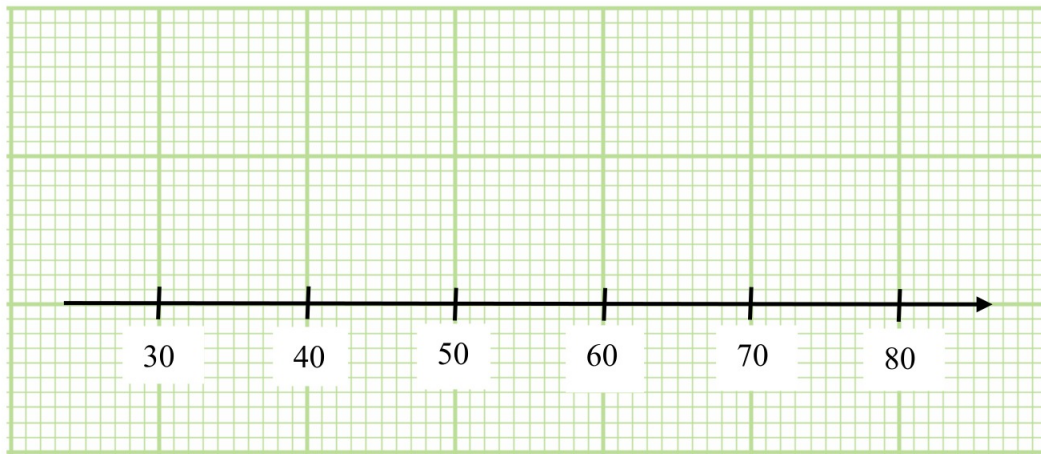
The following information is shown for System B:

System B

- Minimum = 35
- Lower Quartile = 40
- Median = 48
- Upper Quartile = 55
- Maximum = 70

(b) Construct a box-and-whisker plot for System B using the data provided.

[1]



(c) One student claims:

“System A is more consistent, but System B is faster.”

State whether you agree with this claim. Justify your answer using statistical measures.

.....

.....

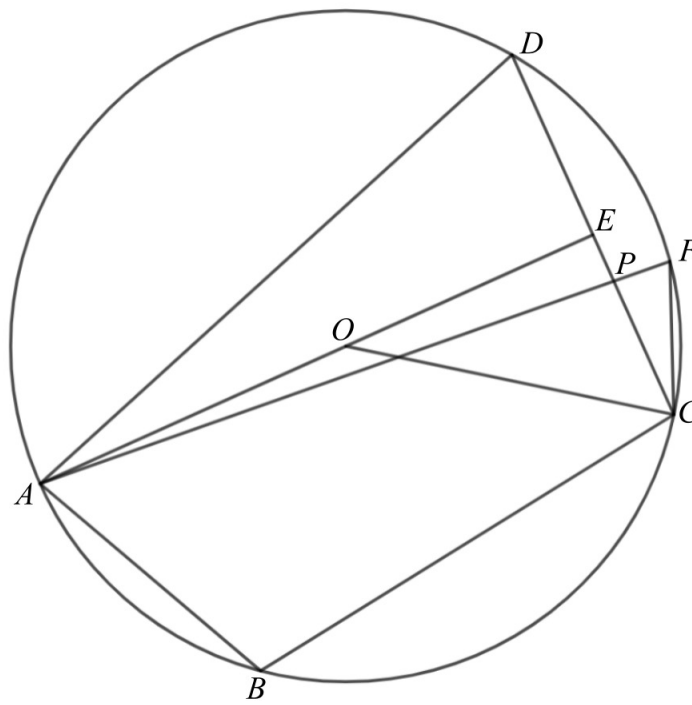
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[3]



A , B , C , D and F are points on a circle in the diagram above, O is the centre of the circle.

Line AE meets line OC at O .

The line AF cuts the line DC at P .

The ratio of angle AOC to angle ABC is $4 : 3$.

(a) Show that the angle AFC is 72° . Give a reason for each step of your working.

[2]

- (b) Find the perimeter of the major sector $ADFC$, given that the diameter of the circle with centre O is 11 cm.

Answer cm [2]

- (c) Another circle is drawn on the diagram such that line AD is its diameter. Determine whether point E lies on its circumference if $\angle DAO = 18^\circ$. Give reasons for each statement you make.

Answer

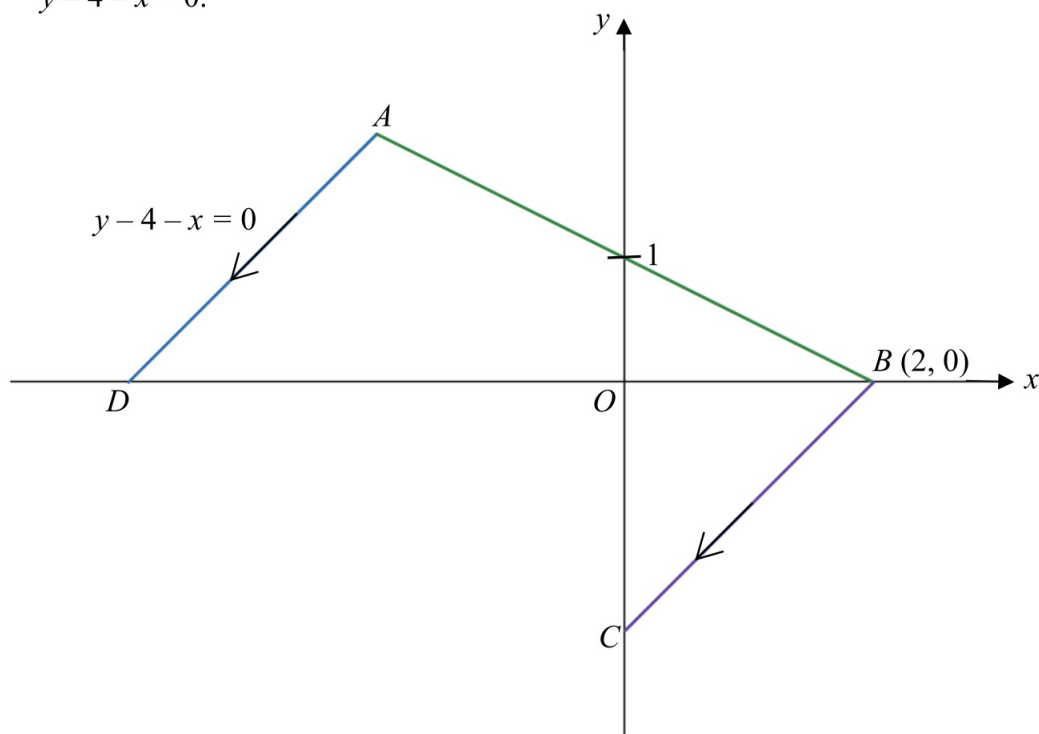
 [2]

4 Solutions to this question by accurate drawing will not be accepted.

The diagram below shows 4 points, A , B , C and D .

Points B and D lie on the x -axis and point C lies on the y -axis.
 B is the point $(2, 0)$ and AB intersects the y -axis at 1 .

It is given further that BC is parallel to AD and the equation of the line AD is $y - 4 - x = 0$.



- (a)** Find the equation of the line AB .

Answer

[2]

- (b) Show that the coordinates of A are $(-2, 2)$.

[2]

- (c) (i) Find distance AC .

Answer units [2]

- (ii) Find the shortest distance from B to AC given that the area of ABC is 6 units².

Answer units [2]

5 (a) The first four terms in a sequence are 5, 8, 11 and 14.

(i) Find the fifth term of the sequence.

Answer [1]

(ii) T_n is the n th term of the sequence.

Find an expression, in terms of n , for T_n .

Answer $T_n =$ [1]

(iii) $T_{n^2} - T_n$ is a positive integer.

Show that $T_{n^2} - T_n$ is a multiple of 3 for $n \geq a$. Hence, state the value of a .

Answer $a =$ [2]

- (b) (i) The first four terms in a different sequence are

$$\frac{5}{1}, \frac{8}{4}, \frac{11}{9}, \frac{14}{16}$$

Find P_n , the n th term of this sequence.

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

- (ii) Jenna states that $\frac{110}{289}$ is a term in the above sequence.

Do you agree with her? Show your working clearly.

.....

[1]

- (iii) Explain why $P_n \leq 5$ for all values of n .

.....

[1]

- 6** The cost, y dollars, of printing each T-shirt when x T-shirts are printed is modelled by the equation $y = 8 + \frac{400}{x}$, for $10 \leq x \leq 160$.

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

x	10	20	50	80	125	160
y	48	28	16	13	11.2	p

- (a)** Find the value of p in the table above.

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

- (b)** On the grid opposite, draw the graph of $y = 8 + \frac{400}{x}$ for $10 \leq x \leq 160$. [2]

- (c)** Use your graph to estimate the number of T-shirts that is printed if the cost of printing each T-shirt is \$20.

Answer $\dots\dots\dots$ T-shirts [1]

- (d)** By drawing a tangent, find the gradient of the curve at (40, 18).

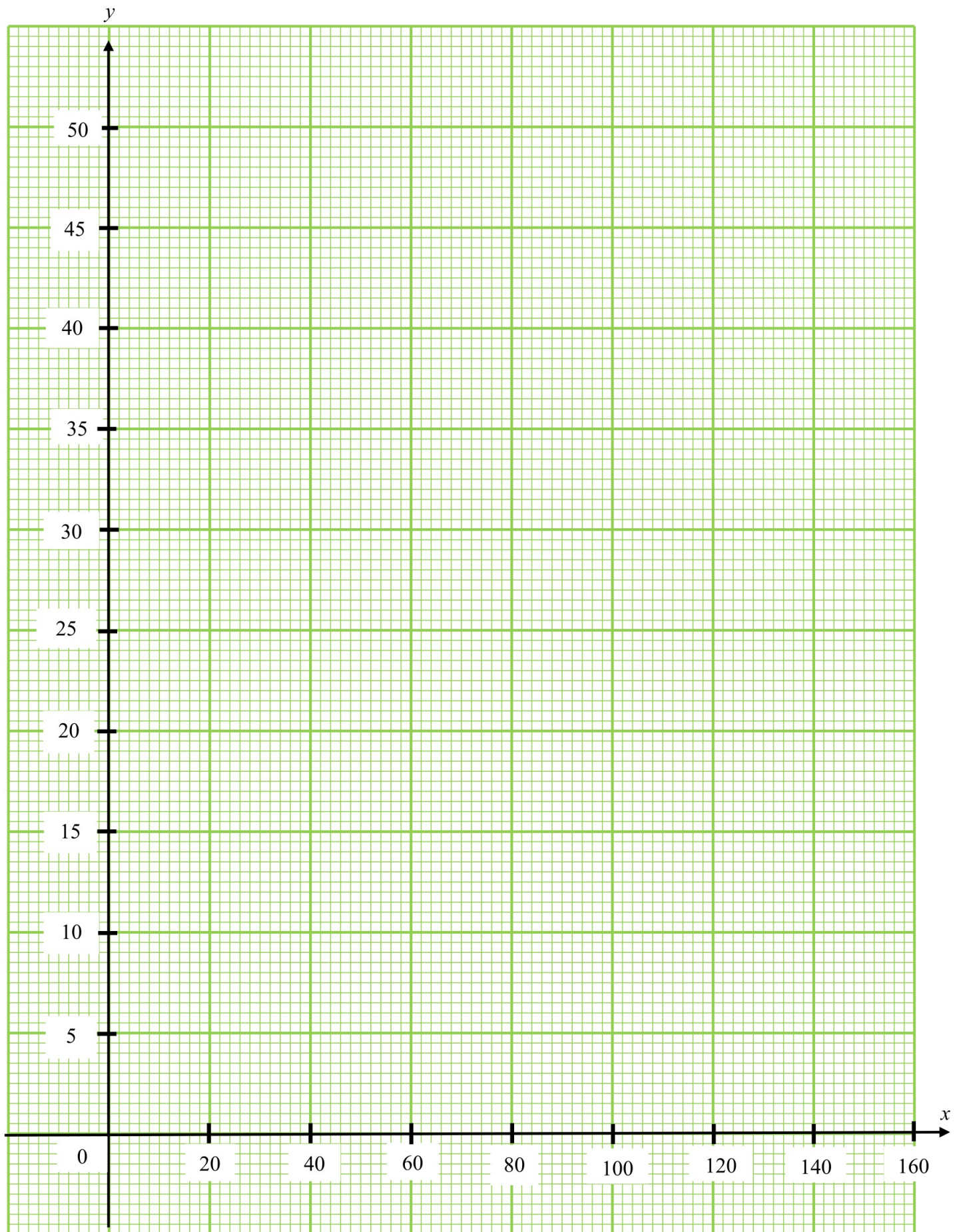
Answer $\dots\dots\dots$ [2]

- (e)** John suggests that the selling price of each T-shirt, in dollars, is modelled by $y = 30 - \frac{3}{16}x$.

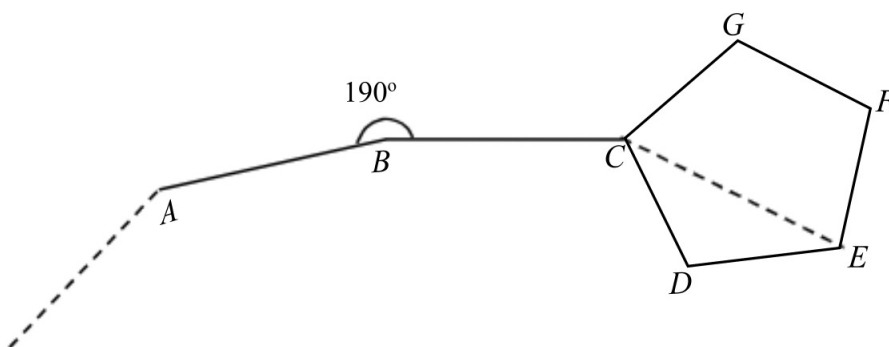
- (i)** On the same grid, draw the graph of $y = 30 - \frac{3}{16}x$ for $0 \leq x \leq 160$. [1]

- (ii)** Using your graphs, determine the range of values of x for which John will not make any loss, assuming that all of the t-shirts will be sold.

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



- 7 (a) A , B , C and E are four vertices of a n -sided polygon and reflex angle ABC is 190° . The remaining reflex angles of the n -sided polygon are each equal to 205° . A regular pentagon $CDEFG$ is placed such that one of its diagonal CE , is also one of the sides of the n -sided polygon.



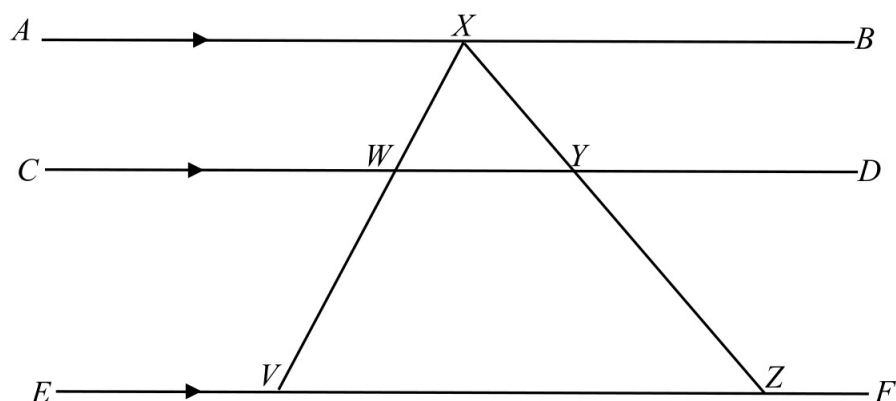
- (i) Find $\angle BCD$.

Answer $\angle BCD = \dots\dots\dots$ [3]

- (ii) Find the number of sides of the n -sided polygon.

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

- (b) In the diagram below, AB , CD and EF are parallel lines. XWV and XYZ are straight lines. The line XZ bisects angle BXW and $\angle VWY = 106^\circ$.



- (i) Show that WXY is an isosceles triangle. Give reasons for your working.

[2]

- (ii) Which is the longest side of the triangle XVZ ? Show all your necessary workings.

Answer

.....

.....

.....

.....

[2]

- 8 (a) The table shows the number of messages sent per month from June to September in 2023 in Singapore.

Month	June	July	Aug	Sep
Number of days	30	31	31	30
Number of messages sent	9.88×10^{12}	8.3×10^{11}	5.97×10^{11}	9.11×10^{12}

- (i) The population of Singapore in 2023 was 5.12×10^9 .
Calculate the mean number of messages sent per person per day from June to September in 2023.

Answer messages [2]

- (ii) Calculate the percentage decrease in the number of messages sent from July to August.

Answer% [2]

- (iii) The number of messages sent in 2025 from June to September was 12.2% more than the number of messages sent in 2023 from June to September.

Calculate the number of number of messages sent in 2025. Give your answer in standard form.

Answer messages [2]

- (b) In 2023, Singapore has a population of 5.64 million.
The land area of Singapore was 728.6 km^2 .
Find the population of Singapore per km^2 , leaving your answer as standard form.

Answer [2]

- (c) The area of the reserve on a map is 24 cm^2 , while its actual area is 6 km^2 .
(i) Find the scale of the map in the form $1 : n$.

Answer 1: [2]

- (ii) The scale of the map in (i) is reduced to $1 : 25\,000$.

Show your working clearly to determine whether the area of the reserve shown on the new map is doubled, quadrupled or remains unchanged.

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

- 9 The diagram shows a metal buoy. It is made up of a cone and a hemisphere. The cone is mounted on the base of a hemisphere with a radius of 0.6 m.

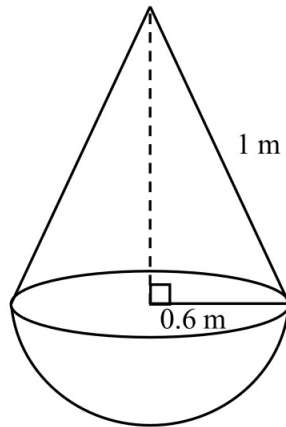


Figure 1

Given that the slant height of the cone is 1 m,

- (a) Show that the height of the buoy is 1.4 m.

- (b) Calculate the total surface area of the buoy.

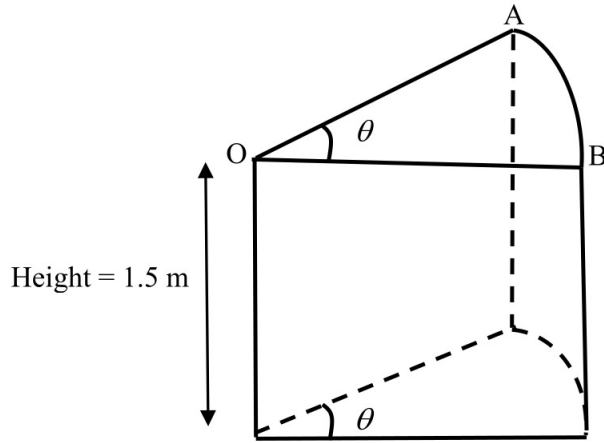
[1]

Answer m^2 [3]

- (c) Calculate the volume of the buoy, leaving your answer in terms of π .

Answer m^3 [3]

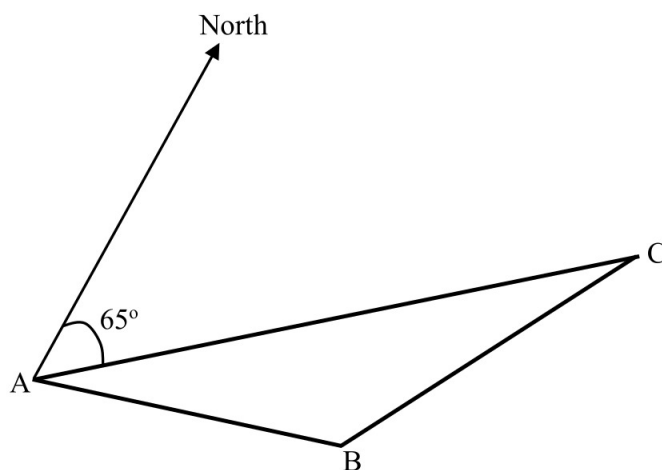
- (d) The buoy shown in Figure 1 is melted and recast into the prism shown below. The prism has height 1.5 m, and its cross-section is the sector OAB , where angle AOB is $\frac{11\pi}{30}$ radians. Assuming no material is lost during the recasting process, find the radius of the sector.



Answer m [4]

10. As a director of a medical logistics company, you are evaluating different methods of transporting emergency medical supplies from station A during adverse weather conditions. The emergency supplies must reach station C within 1 hour of dispatch.

Three stations A, B and C are located at sea. Station B is due east of station A. The bearing of C from A is 065° . The bearing of C from B is 020° . Distance between A and B is 17.6 km.



*The diagram is
not drawn to scale*

A drone travels directly from A to C. A speedboat travels from A to B, then from B to C.

A helicopter may also be used if weather conditions permit.

- (a) Calculate the direct distance AC travelled by the drone.
Give your answer correct to 5 significant figures.

Answer: km [3]

The company collected the following operational data during a trial run.

Vehicle	Maximum Speed	Actual Operating Speed	Further Information	Operating Cost
Drone	26 m/s	19 m/s due to strong wind	5 mins preparation time (loading and take-off) 42 mins maximum flying time 8 kg maximum carrying load	\$1380
Speedboat	45 km/h	40 km/h from A to B	11 mins for docking and refuelling time at B	\$860
		29 km/h from B to C due to rough sea conditions		
Helicopter	160 km/h	150 km/h	18 mins landing clearance and safety checks. - For safety reasons, helicopter operations are suspended if visibility falls below the minimum requirement of 1.8 km at any point during the journey.	\$2390

The following information is further provided:

- Current visibility fluctuates between 1.3 km and 2.0 km.
- Medical supply is 7.2 kg.
- The drone system will only be approved if **BOTH** conditions below are satisfied.

Condition 1: The drone must reduce the total delivery time by at least 50% relative to the current speedboat operation.

Condition 2: The operating cost of drone per minute should not exceed the operating cost of the speedboat per minute by \$50.

- (b) The company may choose either one of the 3 transportation methods. The company wants the fastest transportation method while keeping total operating cost to be below \$2400.

Determine which transportation method should be selected. You must show all relevant calculations and justify your conclusion clearly (other than the conditions stated above). State one assumption made in your working. [7]

Continuation of working space for question 10.

END OF PAPER

Answer Key for 2026 YTSS 4G3 Prelims Mathematics P1

1	\$240000	19(c)	I agree with Andy. Sets A and B are disjoint. B' contains every element in the universal set that is not in B . A has no elements in B so every element of A is in B' . Therefore, $A \subset B'$.
2(a)	$x = 58.5^\circ$ or $x = 121.5^\circ$		
2(b)	88.2° (1 d.p.)		
3	10	20(a)	45.2° (1 d.p.)
4	507	20(b)	21.7 km
5	\$1573.43	21(a)	Angle $ADF = \text{Angle } ABC$ (corr angles, $DF \parallel BC$) Angle $DAF = \text{Angle } BAC$ (Common angles) By AA similarity test, triangle ADF and triangle ABC are similar.
6(a)	2	21(b)	Angle $DEF = \text{Angle } CEF$ (alt angles, $DF \parallel CE$) Angle $DEF = \text{Angle } CFE$ (alt angles, $DE \parallel CF$) $EF = EF$ (Common side) By ASA congruence test, triangle CEF is congruent to triangle DFE .
6(b)	Prime numbers have only 2 distinct factors but 1 only has 1 factor.		
7	Since it is $3^x(10)$, 10 is a factor, it is divisible by 10.		
8(a)	$(2x-3)(x+2) \dots A2$		
8(b)	$(2y-9)(y-1)$		
9	SGD1544.78	22(a)(i)	$\overline{BA} = 3\overline{a} + 2\overline{b}$
10	32.5°	22(a)(ii)	$\overline{BD} = 6\overline{a} + 2\overline{b}$
11	4	22(a)(iii)	$\overline{AG} = -\frac{3}{2}(\overline{a} + \overline{b})$
12(a)	$(x+3)^2 + 1$	22(b)	Since $4\overline{AG} = 3\overline{AF}$, AG and AF are parallel with A being the common point, A, G and F are on a straight line
12(b)	$(-3, 1)$	22(c)	$\frac{1}{24}$
13	$a = -2, b = 8, c = -6$	23(a)	$\frac{2}{9}L^2$
14	$\frac{13x^4}{16}$	23(b)	1.13 cm
15	$(x+y)(x-y)^2$	23(c)	No, I do not agree as the width of the smaller container may not decrease proportionately thus it is inconclusive.
16(b)	$\frac{4}{5}$	24(a)	$E = \begin{pmatrix} 56 & 84 & 78 \\ 62 & 76 & 95 \end{pmatrix}$
18(a)	51	24(b)	$F = \begin{pmatrix} 20 \\ 15 \\ 12 \end{pmatrix}$
18(b)	6	24(c)	$G = \begin{pmatrix} 3316 \\ 3520 \end{pmatrix}$
18(c)	2.5%	24(d)	G represents the total amount of money collected through the sale of tickets for the concert on Friday and Saturday respectively.
18(d)	$\frac{17}{20}$	24(e)	\$6836
19(a)	$(P \cap Q) \cup (P' \cap Q) = Q$		
19(b)	$(P' \cup Q)' = \emptyset$		

Answer Key for 2026 YTSS 4G3 Prelims Mathematics P2

1(a)	1.56, -2.56	6(c)	34
1(b)	$9 < y \leq 15$	6(d)	-0.25
1(c)(i)	4	6(e)(ii)\	$23 \leq x \leq 94$
1(c)(ii)	$z = \frac{16}{b^2 - 8}$	7(a)(i)	119°
2(a)(i)	47	7(a)(ii)	$n = 15$
2(a)(ii)	8.60	7(b)(i)	$\angle BXZ = \angle VXZ$ (line XZ bisects angle BXW) $\angle BXY = \angle XYW$ (alt. angles, AB // CD) Hence $\angle BXY = \angle XYW$ (base angle of isosceles triangle)
2(c)	IQR_A = $56 - 41 = 15$ IQR_B = $55 - 40 = 15$ I disagree. System A is faster as the median as the median response time of 47secs is lower than system B's median which is at 48 seconds. Both systems are consistent in their data as their IQR is the same.	7(b)(ii)	Angle XWZ = $180^\circ - 106^\circ = 74^\circ$. (int angle, CD // EF) Angle BXZ = Angle XZV = 53°. (alt angle, AB // EF) XZ is the largest side of the triangle as it is opposite the largest angle.
3(b)	31.7	8(a)(i)	32.7
3(c)	Point E lies on the circumference.	8(a)(ii)	28.1%
4(a)	$y = -\frac{1}{2}x + 1$	8(a)(iii)	2.29×10^{13}
4(c)(i)	4.47 units	8(b)	7.74×10^3
4(c)(ii)	2.68 units	8(c)(i)	1 : 50 000
5(a)(i)	17	8(c)(ii)	The area of the reserve shown on the new map is quadrupled.
5(a)(ii)	$3n+2$	9(a)	$Height = \sqrt{1^2 - 0.6^2} = 0.8$ $0.8 + 0.6 = 1.4$ (shown)
5(a)(iii)	$a=2$	9(b)	4.15
5(b)(i)	$\frac{3n+2}{n^2}$	9(c)	$\frac{6}{25}\pi$
5(b)(ii)	Value of $n = 17/2$ or $-34/55$ Since n is not a positive integer, 110/289 is not a term in sequence	9(d)	$r=0.934$
5(b)(iii)	n^2 increases faster than $3n+2$, as n increases, P_n tends to 0. As $n \geq 1$, $P_n \leq \frac{3}{1} + \frac{2}{1^2} \leq 5$	10(a)	23.389 km
6(a)	10.5	10(b)	Drone should be chosen

YISHUN TOWN SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2026



Islandwide Delivery | Whatsapp Only 88660031
4052/01 — Paper 1

Step-by-Step Solutions



Secondary 4/5

Corrected and completed edition

Question 1

Let one part of the investment ratio be u . Since two parts equal \$16 000,

$$2u = 16000 \Rightarrow u = 8000.$$

Cassidy invested six parts:

$$6u = 6(8000) = 48000.$$

If this is 20% of the total investment T ,

$$0.20T = 48000 \Rightarrow T = \frac{48000}{0.20}.$$

$$\boxed{\text{Total investment} = \$240\,000}$$

Question 2

(a)

The first solution is

$$x = \sin^{-1}(0.8524) = 58.4736 \dots^\circ$$

Sine is also positive in the second quadrant, so

$$x = 180^\circ - 58.4736 \dots^\circ = 121.5263 \dots^\circ$$

$$\boxed{x = 58.5^\circ \text{ or } x = 121.5^\circ}$$

(b)

$$1.54 \text{ rad} = 1.54 \left(\frac{180^\circ}{\pi} \right) = 88.2355 \dots^\circ$$

$$\boxed{88.2^\circ}$$

Question 3

Let t be the time taken and w the number of workers. Since t is inversely proportional to w ,

$$t = \frac{k}{w}.$$

Using $t = 14$ when $w = 5$,

$$14 = \frac{k}{5} \Rightarrow k = 70.$$

For seven workers,

$$\boxed{t = \frac{70}{7} = 10 \text{ hours}}$$

Question 4

$$3^{4n-3} = 3^{2026} - 2(3^{2025}) = 3^{2025}(3 - 2) = 3^{2025}.$$

Equating indices,

$$4n - 3 = 2025 \Rightarrow 4n = 2028.$$

$$\boxed{n = 507}$$

Question 5

Interest is compounded every three months, so there are four periods per year. The rate per period is $0.02/4 = 0.005$, and five years contains $4(5) = 20$ periods. Hence

$$A = 15000 \left(1 + \frac{0.02}{4}\right)^{20} = 15000(1.005)^{20} = 16573.4336 \dots$$

The interest earned is

$$16573.4336 \dots - 15000 = 1573.4336 \dots$$

\$1573.43

Question 6

(a)

$$A = 2^{n+2} \times 3^4 \times 5, \quad B = 2^5 \times 3^{n-1} \times 7^2,$$

and $48 = 2^4 \times 3$. For the HCF to be 48,

$$\min(n+2, 5) = 4, \quad \min(4, n-1) = 1.$$

Thus $n+2 = 4$ and $n-1 = 1$, both giving

$n = 2$

(b) A prime number has exactly two distinct positive factors: 1 and itself. The number 1 has only one positive factor, namely 1.

1 is not a prime number.

Question 7

$$\begin{aligned} 3^{x+2} + 5\left(\frac{1}{3}\right)^{-x} - 4\sqrt{9^x} &= 9(3^x) + 5(3^x) - 4(3^x) \\ &= (9 + 5 - 4)3^x \\ &= 10(3^x). \end{aligned}$$

For every non-negative integer x , 3^x is an integer. The expression is therefore a multiple of 10 and is divisible by 10.

Correction. The original phrase “all integer values of x ” is false: for example, $x = -1$ gives $10/3$. The corrected question uses “all non-negative integer values of x ”.

Question 8

(a)

$$\begin{aligned} 2x^2 + x - 6 &= 2x^2 + 4x - 3x - 6 \\ &= 2x(x+2) - 3(x+2) \\ &= (2x-3)(x+2). \end{aligned}$$

$(2x-3)(x+2)$

(b) Let $x = y - 3$. Then $y + 4 = x + 7$, so

$$\begin{aligned} 2(y-3)^2 + (y+4) - 13 &= 2x^2 + x - 6 \\ &= (2x-3)(x+2). \end{aligned}$$

Substitute $x = y - 3$:

$$(2x-3)(x+2) = (2(y-3)-3)((y-3)+2).$$

$(2y-9)(y-1)$

Question 9

The selling price after the 15% profit is

$$900(1.15) = 1035 \text{ euros.}$$

Since S\$1 = EUR 0.67,

$$\text{selling price in S\$} = \frac{1035}{0.67} = 1544.776 \dots$$

$$\boxed{\text{S\$1544.78}}$$

Question 10

Let $RQ = x$ m. In right-angled triangle PQR ,

$$\tan 40^\circ = \frac{48}{x} \Rightarrow x = \frac{48}{\tan 40^\circ} = 57.204 \dots$$

Hence

$$SQ = SR + RQ = 18 + 57.204 \dots = 75.204 \dots \text{ m.}$$

Let the angle of depression of S from P be θ . This equals the angle of elevation of P from S , so

$$\tan \theta = \frac{48}{75.204 \dots}, \quad \theta = 32.548 \dots^\circ.$$

$$\boxed{32.5^\circ \text{ (3 s.f.)}}$$

Question 11

Let the integral dimensions of the top be l cm and w cm. Since its perimeter is 26 cm,

$$2(l + w) = 26 \Rightarrow l + w = 13.$$

As $l, w > 2$, the possible unordered pairs are

$$(3, 10), (4, 9), (5, 8), (6, 7).$$

The height is $h = 168/(lw)$, giving respectively

$$\frac{28}{5}, \frac{14}{3}, \frac{21}{5}, 4.$$

Because the cuboid is built from 1-cm cubes, its dimensions are integral. Only $l = 6, w = 7$ is possible.

$$\boxed{h = 4 \text{ cm}}$$

Question 12

(a) Complete the square:

$$x^2 + 6x + 10 = x^2 + 6x + 9 + 1 = (x + 3)^2 + 1.$$

$$\boxed{(x + 3)^2 + 1}$$

(b) Since $(x + 3)^2 \geq 0$, its minimum is 0 when $x = -3$. The corresponding value of y is 1.

$$\boxed{(-3, 1)}$$

Question 13

For $y = ax^2 + bx + c$, the axis of symmetry is $x = -b/(2a)$. Since the axis is $x = 2$,

$$-\frac{b}{2a} = 2 \Rightarrow b = -4a. \quad (1)$$

Using $(1, 0)$ and $(-1, -16)$,

$$a + b + c = 0, \quad (2)$$

$$a - b + c = -16. \quad (3)$$

Subtracting (3) from (2) gives $2b = 16$, so $b = 8$. Equation (1) then gives $a = -2$, and (2) gives $c = -6$.

$$\boxed{a = -2, \quad b = 8, \quad c = -6}$$

Question 14

For $x \neq 0$,

$$\left(\sqrt[4]{\frac{16}{9x^8}}\right)^{-1} = \left(\frac{4}{3x^4}\right)^{-1} = \frac{3x^4}{4}.$$

Also, since $0.8 = 4/5$,

$$\left(\frac{x^5}{32}\right)^{0.8} = \left(\frac{x^5}{2^5}\right)^{4/5} = \left(\frac{x}{2}\right)^4 = \frac{x^4}{16}.$$

Therefore

$$\frac{3x^4}{4} + \frac{x^4}{16} = \frac{12x^4 + x^4}{16} = \frac{13x^4}{16}.$$

Question 15

$$\begin{aligned} x^3 - x^2y - xy^2 + y^3 &= x^2(x - y) - y^2(x - y) \\ &= (x - y)(x^2 - y^2) \\ &= (x - y)^2(x + y). \end{aligned}$$

$$\boxed{(x - y)^2(x + y)}$$

Question 16

(a) The probability of drawing three red marbles without replacement is

$$\frac{n}{n+2} \times \frac{n-1}{n+1} \times \frac{n-2}{n}.$$

Thus

$$\frac{(n-1)(n-2)}{(n+2)(n+1)} = \frac{1}{5}.$$

Cross-multiplying and expanding,

$$5(n-1)(n-2) = (n+2)(n+1)$$

$$5n^2 - 15n + 10 = n^2 + 3n + 2 \Rightarrow 4n^2 - 18n + 8 = 0.$$

Dividing throughout by 2 gives the required result:

$$\boxed{2n^2 - 9n + 4 = 0}$$

(b) Factorising,

$$(2n-1)(n-4) = 0 \Rightarrow n = \frac{1}{2} \text{ or } n = 4.$$

Since n is an integer and at least three red marbles are required, $n = 4$. Therefore

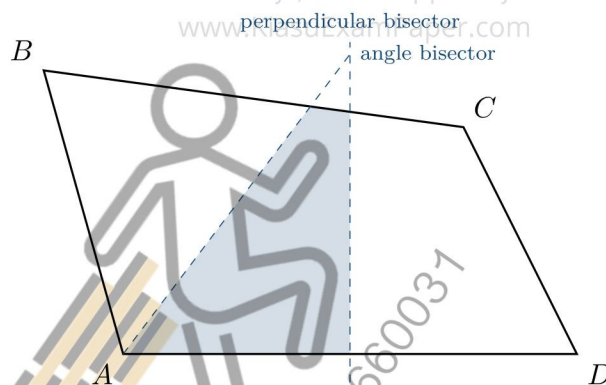
$$P(\text{exactly two red}) = 3 \left(\frac{4}{6} \times \frac{3}{5} \times \frac{2}{4} \right) = \frac{3}{5},$$

and $P(\text{three red}) = 1/5$. Hence

$$P(\text{at least two red}) = \frac{3}{5} + \frac{1}{5} = \frac{4}{5}$$

Question 17

- (a) Construct the perpendicular bisector of AD : with centres A and D , use one compass radius greater than $AD/2$ to draw arcs that meet on both sides of AD . Join the two arc-intersection points.
- (b) Construct the internal angle bisector of $\angle BAD$: draw an arc centred at A to meet AB and AD . From those two points, draw equal-radius arcs that intersect inside the angle; join that intersection to A .
- (c) A point nearer to AD than to AB lies on the AD -side of the angle bisector. A point nearer to A than to D lies on the A -side of the perpendicular bisector. Shade the intersection of these two half-regions inside $ABCD$. The boundary lines themselves are excluded by the strict word “nearer”.



Conceptual construction (not drawn to scale)

Question 18

There are 80 students.

- (a) The median is the $80/2 = 40$ th value. Reading the mass at cumulative frequency 40 gives

51 kg (approximately)

- (b) The lower quartile is read at cumulative frequency 20 and the upper quartile at cumulative frequency 60:

$$Q_1 \approx 48 \text{ kg}, \quad Q_3 \approx 54 \text{ kg}.$$

Thus

$$\text{IQR} = 54 - 48 = 6 \text{ kg}$$

- (c) At 70 kg, the cumulative frequency is approximately 78. Hence about $80 - 78 = 2$ students have mass at least 70 kg:

$$\frac{2}{80} \times 100\% = 2.5\%$$

- (d) From the graph,

$$\text{CF}(45) \approx 8, \quad \text{CF}(65) \approx 76.$$

So about $76 - 8 = 68$ students are between 45 kg and 65 kg:

$$\frac{68}{80} = \frac{17}{20} = 0.85$$

Question 19Given $P \subseteq Q$:

(a(i))

$$(P \cap Q) \cup (P' \cap Q) = (P \cup P') \cap Q = U \cap Q = Q.$$

$$\boxed{U}$$

(a(ii)) By De Morgan's law,

$$(P' \cup Q)' = P \cap Q'.$$

Since $P \subseteq Q$, no element of P is in Q' , so

$$\boxed{\emptyset}$$

(b) Agree. If $x \in A$ and $A \cap B = \emptyset$, then $x \notin B$; hence $x \in B'$. Therefore every element of A belongs to B' , so

$$\boxed{A \subseteq B'}$$

Question 20(a) Since the bearing of P from Q is 038° and QS is due east,

$$\angle SQP = 90^\circ - 38^\circ = 52^\circ.$$

Let $\theta = \angle SQR$. Given that $\text{area}(\triangle SQR) = \frac{1}{2} \text{area}(\triangle SQP)$,

$$\frac{1}{2}(QS)(10) \sin \theta = \frac{1}{2} \left[\frac{1}{2}(QS)(18) \sin 52^\circ \right].$$

Cancelling common factors,

$$10 \sin \theta = 9 \sin 52^\circ, \quad \theta = \sin^{-1} \left(\frac{9 \sin 52^\circ}{10} \right) = 45.1706 \dots^\circ.$$

The diagram determines the acute solution.

$$\boxed{45.2^\circ \text{ (1 d.p.)}}$$

(b)

$$\angle PQR = 52^\circ + 45.1706 \dots^\circ = 97.1706 \dots^\circ.$$

By the cosine rule,

$$PR^2 = 18^2 + 10^2 - 2(18)(10) \cos 97.1706 \dots^\circ,$$

$$PR = 21.6549 \dots \text{ km.}$$

$$\boxed{PR = 21.7 \text{ km (3 s.f.)}}$$

Question 21(a) Since $DF \parallel BC$,

$$\angle ADF = \angle ABC$$

(corresponding angles). Also $\angle DAF = \angle BAC$, since D, A, B and F, A, C are collinear. Hence

$$\boxed{\triangle ADF \sim \triangle ABC \text{ (AA)}}$$

(b) Since $DE \parallel CF$ and $DE \parallel CF$,

$$\angle DFE = \angle CEF, \quad \angle DEF = \angle CFE$$

(alternate angles). Also $EF = EF$, a common side. Therefore

$$\boxed{\triangle DFE \cong \triangle CEF \text{ (ASA)}}$$

Question 22

Given $\overrightarrow{BF} = \mathbf{a}$, $\overrightarrow{BC} = 3\mathbf{a}$, and $\overrightarrow{CE} = \mathbf{b}$. The diagonals of a parallelogram bisect each other, so E is the midpoint of both AC and BD .

(a(i)) Since E is the midpoint of AC ,

$$\overrightarrow{CA} = 2\overrightarrow{CE} = 2\mathbf{b}.$$

Thus

$$\overrightarrow{BA} = \overrightarrow{BC} + \overrightarrow{CA} = 3\mathbf{a} + 2\mathbf{b}$$

(a(ii))

$$\overrightarrow{BE} = \overrightarrow{BC} + \overrightarrow{CE} = 3\mathbf{a} + \mathbf{b}.$$

As E is the midpoint of BD ,

$$\overrightarrow{BD} = 2\overrightarrow{BE} = 6\mathbf{a} + 2\mathbf{b}$$

(a(iii)) Since G is the midpoint of BE ,

$$\overrightarrow{BG} = \frac{1}{2}\overrightarrow{BE} = \frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}.$$

Also $\overrightarrow{AB} = -3\mathbf{a} - 2\mathbf{b}$. Hence

$$\begin{aligned}\overrightarrow{AG} &= \overrightarrow{AB} + \overrightarrow{BG} \\ &= (-3\mathbf{a} - 2\mathbf{b}) + \left(\frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}\right) \\ &= -\frac{3}{2}(\mathbf{a} + \mathbf{b}).\end{aligned}$$

$$\overrightarrow{AG} = -\frac{3}{2}(\mathbf{a} + \mathbf{b})$$

(b)

$$\overrightarrow{AF} = \overrightarrow{AB} + \overrightarrow{BF} = -2(\mathbf{a} + \mathbf{b}).$$

Therefore

$$\overrightarrow{AG} = \frac{3}{4}\overrightarrow{AF}.$$

Since this is a positive scalar multiple and both vectors begin at A ,

$$\boxed{A, G \text{ and } F \text{ are collinear}}$$

(c) Let the perpendicular height of the parallelogram above BC be h . Since $BF = BC/3$ and G is one-quarter of the way from B to D , the perpendicular height of G above BC is $h/4$. Thus

$$\frac{\text{area}(\triangle BFG)}{\text{area}(ABCD)} = \frac{\frac{1}{2}(\frac{1}{3}BC)(\frac{1}{4}h)}{BC \cdot h}.$$

$$\boxed{\frac{1}{24}}$$

Question 23

- (a) Let the linear scale factor of the water pyramid to the whole pyramid be k . Since their volume ratio is 1 : 27,

$$k^3 = \frac{1}{27} \Rightarrow k = \frac{1}{3}.$$

The water-surface dimensions are $2L/3$ and $L/3$. Therefore

$$\text{Area} = \frac{2L}{3} \cdot \frac{L}{3} = \frac{2L^2}{9} \text{ cm}^2$$

- (b) When the container is inverted, the air above the water is a smaller similar pyramid. Its volume is $26/27$ of the container. If its height is h ,

$$\left(\frac{h}{90}\right)^3 = \frac{26}{27} \Rightarrow h = 90 \sqrt[3]{\frac{26}{27}} = 88.874862.$$

The new water depth is

$$90 - h = 1.125117 \dots = 1.13 \text{ cm (2 d.p.)}$$

- (c) The stated length and height scale factors are both $1/2$, but the width of the new container is not given. It must also be $L/2$ for all corresponding linear dimensions to have the same scale factor.

There is insufficient information to conclude that the solids are similar.

Question 24

- (a) With rows representing Friday and Saturday, and columns representing Sectors A, B, C ,

$$E = \begin{pmatrix} 56 & 84 & 78 \\ 62 & 76 & 95 \end{pmatrix}$$

- (b)

$$F = \begin{pmatrix} 20 \\ 15 \\ 12 \end{pmatrix}$$

- (c)

$$G = EF = \begin{pmatrix} 56 & 84 & 78 \\ 62 & 76 & 95 \end{pmatrix} \begin{pmatrix} 20 \\ 15 \\ 12 \end{pmatrix} = \begin{pmatrix} 56(20) + 84(15) + 78(12) \\ 62(20) + 76(15) + 95(12) \end{pmatrix} = \begin{pmatrix} 3316 \\ 3520 \end{pmatrix}.$$

- (d) The first element is the total money collected on Friday; the second is the total money collected on Saturday.

- (e)

$$\begin{pmatrix} 1 & 1 \end{pmatrix} G = \begin{pmatrix} 1 & 1 \end{pmatrix} \begin{pmatrix} 3316 \\ 3520 \end{pmatrix} = 3316 + 3520 = 6836.$$

$$\text{Total} = \$6836$$

NAME:	MARKING SCHEME	()
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CLASS:	
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SUBJECT TEACHER: _____



YISHUN TOWN SECONDARY SCHOOL

G3

PRELIMINARY EXAMINATION 2026

SECONDARY 4/5

MATHEMATICS G3

PAPER 2 (4052/02)

**KIASU
ExamPaper**

DATE : 13 August 2026

DURATION: 2 h 15 min

DAY : Thursday

MARKS: 90

READ THESE INSTRUCTIONS FIRST

Do not turn over the cover page until you are told to do so.

Write your name, class and class index number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.

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 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, unless the question requires the answer in terms of π .

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

The total of the marks for this paper is 90.

	MARKS	
	OBTAINED	FULL
1		12
2		6
3		6
4		8
5		7
6		8
7		10
8		12
9		11
10		10
TOTAL		90

This question paper consists of **24** printed pages and **2** blank pages.

Mathematical Formulae*Compound Interest*

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

Mensuration

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

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

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

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

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

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

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

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 (a) Solve the equation $\frac{x+7}{x^2-9} = -2 + \frac{1}{3-x}$.

Give your solutions correct to 2 decimal places.

$$\begin{aligned} \frac{x+7}{x^2-9} - \frac{1}{3-x} &= -2 \\ \frac{x+7}{x^2-9} + \frac{1}{x-3} &= -2 && \text{M1 for change of sign} \\ \frac{x+7}{(x+3)(x-3)} + \frac{1(x+3)}{(x-3)(x+3)} &= -2 && \text{M1 for factorising} \\ \frac{2x+10}{(x-3)(x+3)} &= -2 && \text{M1 for simplification to single fraction} \\ 2x+10 &= -2(x^2-9) \\ 2x^2+2x-8 &= 0 \\ x^2+x-4 &= 0 \\ x &= \frac{-1 \pm \sqrt{1^2 - 4(1)(-4)}}{2(1)} && \text{M1} \\ x &= 1.56, -2.56 && \text{M1 for correct answers} \end{aligned}$$

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [5]

(b) Solve the inequalities $\frac{2}{3} + y \leq 9 + \frac{4}{9}y < 4 + y$.

$$\frac{2}{3} + y \leq 9 + \frac{4}{9}y$$

$$9 + \frac{4}{9}y < 4 + y$$

$$y - \frac{4}{9}y \leq 9 - \frac{2}{3}$$

and

$$\frac{4}{9}y - y < 4 - 9$$

----- M1 for separating the inequality correctly

$$\frac{5}{9}y \leq \frac{25}{3}$$

$$-\frac{5}{9}y < -5$$

$$y \leq \frac{25}{3} \times \frac{9}{5}$$

$$y > 9$$

----- M1 for either accurate individual inequality

$$y \leq 15$$

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Answer [3]

(c) Given that $\frac{1}{2}b = \sqrt{\frac{4-z}{z}} + 3$,

(i) Find b when $z = 2$,

$$\frac{1}{2}b = \sqrt{\frac{4-2}{2}} + 3$$

$$\frac{1}{2}b = \sqrt{1} + 3$$

$$b = 4$$

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

(ii) Rearrange the formula to make z the subject.

$$\frac{b^2}{4} = \frac{4-z}{z} + \frac{3z}{z}$$

$$\frac{b^2}{4} = \frac{4+2z}{z}$$

$$zb^2 = 16 + 8z$$

$$zb^2 - 8z = 16$$

$$z(b^2 - 8) = 16$$

$$z = \frac{16}{b^2 - 8}$$

M1 for removing square root

M1 for simplification

A1

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

- 2 YTSS is testing two AI systems, System A and System B, tracking their response times (in seconds) to student queries.

The response times for System A are shown below:

System A

Stem	Leaf			
3	8	9		
4	1	2	5	7
5	0	3	6	
6	2	4		

Key: 4 | 2 represents 42 seconds

- (a) (i) Find the median response time for System A.

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----- B1
Answer 47 seconds [1]

- (ii) Find the standard deviation of the response times for System A.

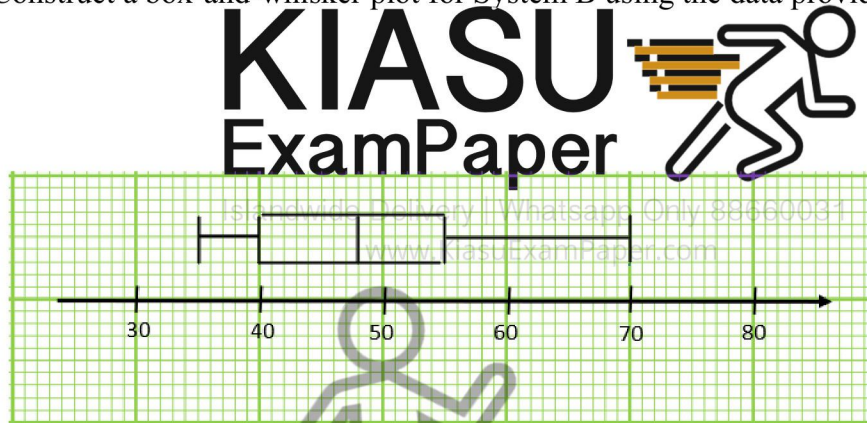
----- B1
Answer 8.60 seconds [1]

The following information is shown for System B:
System B

- Minimum = 35
- Lower Quartile = 40
- Median = 48
- Upper Quartile = 55
- Maximum = 70

- (b) Construct a box-and-whisker plot for System B using the data provided.

[1]



----- B1

- (c) One student claims:

“System A is more consistent, but System B is faster.”

State whether you agree with this claim. Justify your answer using statistical measures.

$$\text{IQR}_A = 56 - 41 = 15$$

----- M1 for IQR

$$\text{IQR}_B = 55 - 40 = 15$$

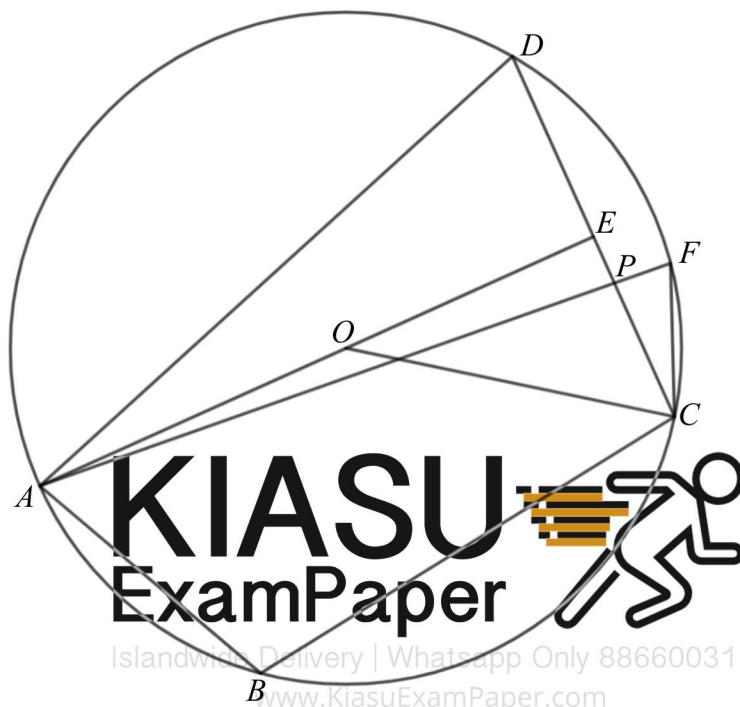
I disagree. System A is faster as the median response time of 47secs is lower than system B's median which is at 48 seconds.

B1

Both systems are consistent in their data as their interquartile range is the same.

B1

[3]



A , B , C , D and F are points on a circle in the diagram above, O is the centre of the circle.

Line AE meets line OC at O .

The line AF cuts the line DC at P .

The ratio of angle AOC to angle ABC is $4 : 3$.

- (a) Show that the angle AFC is 72° . Give a reason for each step of your working.

$$\angle AFC = 4u \div 2 = 2u (\angle \text{at centre} = 2\angle \text{at circumference})$$

$$2u + 3u = 180^\circ (\angle \text{in opp seg}) \quad \text{----- M1}$$

$$5u = 180^\circ$$

$$2u = 72^\circ (\text{shown}) \quad \text{----- A1}$$

[2]

- (b) Find the perimeter of the major sector $ADFC$, given that the diameter of the circle with centre O is 11cm.

$$\begin{aligned}\text{Arc Length} &= \frac{216}{360} \times 2\pi \left(\frac{11}{2} \right) \\ &= 20.7345\end{aligned}\quad \text{----- M1}$$

$$\begin{aligned}\text{Perimeter} &= 11 + 20.7345 \\ &= 31.7345 \\ &= 31.7\end{aligned}\quad \text{----- A1}$$

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Answer

..... cm

[2]

- (c) Another circle is drawn on the diagram such that line AD is its diameter. Determine whether point E lies on its circumference if $\angle DAO = 18^\circ$. Give reasons for each statement you make.

$$\begin{aligned}\angle AFC &= \angle ADE (\angle \text{in same seg}) \\ &= 72^\circ \\ \angle AED &= 180^\circ - 18^\circ - 72^\circ = 90^\circ\end{aligned}\quad \text{----- M1}$$

Point E lies on the circumference (angles in semicircle $= 90^\circ$) ----- A1

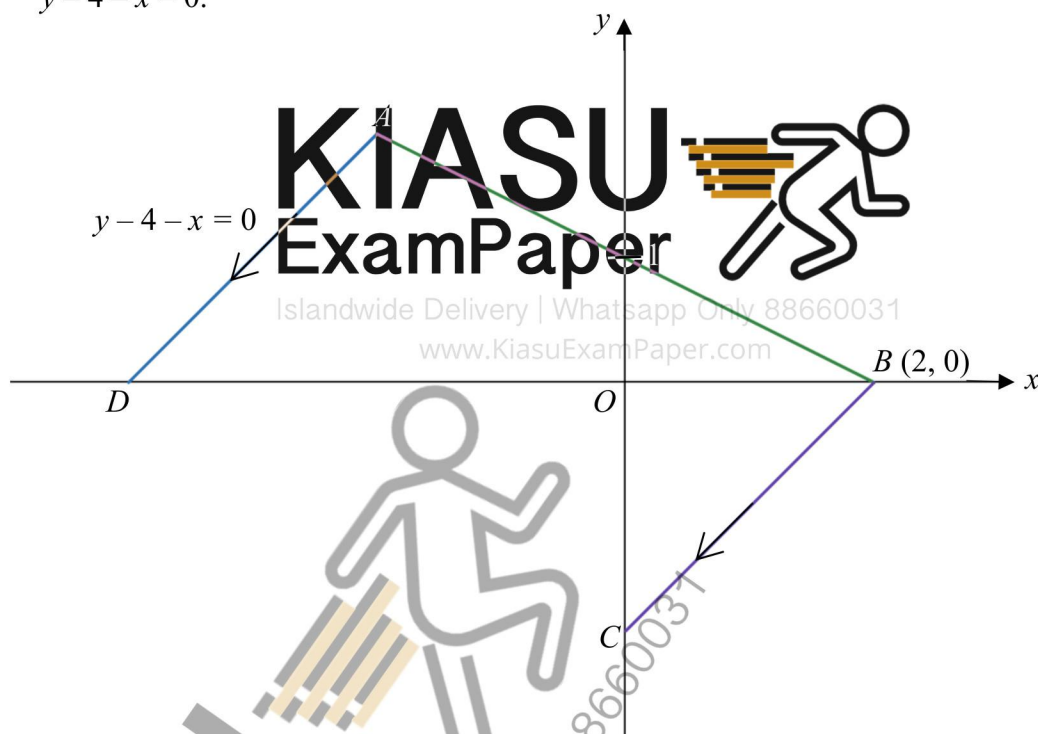
[2]

4 Solutions to this question by accurate drawing will not be accepted.

The diagram below shows 4 points, A , B , C and D .

Points B and D lie on the x -axis and point C lies on the y -axis.
 B is the point $(2, 0)$ and AB intersects the y -axis at 1 .

It is given further that BC is parallel to AD and the equation of the line AD is $y - 4 - x = 0$.



- (a)** Find the equation of the line AB .

$$\text{gradient} = \frac{1-0}{0-2} = -\frac{1}{2} \quad \text{----- M1}$$

$$y = -\frac{1}{2}x + c$$

$$0 = -\frac{1}{2}(2) + c$$

$$c = 1$$

$$y = -\frac{1}{2}x + 1 \quad \text{----- A1}$$

Answer

[2]

- (b) Show that the coordinates of A are $(-2, 2)$.

$$y = -\frac{1}{2}x + 1$$

$$y = x + 4$$

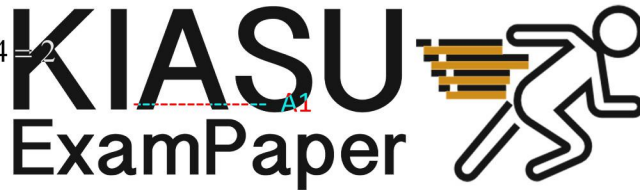
$$x + 4 = -\frac{1}{2}x + 1 \quad \text{----- M1}$$

$$\frac{3}{2}x = -3$$

$$x = -2$$

$$y = -2 + 4 = 2$$

$$(-2, 2) \quad \text{----- A1}$$



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[2]

- (c) (i) Find distance AC .

$$\text{Equation of BC: } y = x - 2$$

$$C(0, -2) \quad \text{----- M1}$$

$$AC = \sqrt{(-2 - 0)^2 + (2 - (-2))^2}$$

$$AC = \sqrt{20}$$

$$AC = 4.472134 = 4.47 \quad \text{----- A1}$$

Answer units [2]

- (ii) Find the shortest distance from B to AC given that the area of ABC is 6 units².

$$\frac{1}{2} \times \sqrt{20} \times \text{height} = 6 \quad \text{----- M1}$$

$$\text{height} = \frac{12}{\sqrt{20}} = 2.68 \quad \text{----- A1}$$

Answer units [2]

5 (a) The first four terms in a sequence are 5, 8, 11 and 14.

(i) Find the fifth term of the sequence.

17 ----- B1
 Answer [1]

(ii) T_n is the n th term of the sequence.

Find an expression in terms of n for T_n .

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$T_n = 3n + 2$ ----- B1
 Answer $T_n =$ [1]

(iii) $T_{n^2} - T_n$ is a positive integer.

Show that $T_{n^2} - T_n$ is a multiple of 3 for $n \geq a$. Hence, state the value of a .

$$T_{n^2} = 3n^2 + 2$$

$$T_{n^2} - T_n = 3n^2 + 2 - (3n + 2)$$

$$= 3n^2 - 3n$$

$$= 3n(n - 1)$$

Since 3 is a factor, $T_{n^2} - T_n$ is a multiple of 3.

$a = 2$.

----- M1

----- A1

Answer $a =$ [2]

- (b) (i) The first four terms in a different sequence are

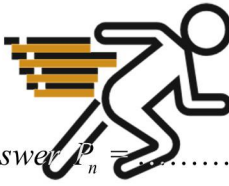
$$\frac{5}{1}, \frac{8}{4}, \frac{11}{9}, \frac{14}{16}$$

Find P_n , the n th term of this sequence.

$$\frac{3n+2}{n^2}$$

----- B1

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Answer $P_n = \dots\dots\dots$

[1]

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- (ii) Jenna states that $\frac{110}{289}$ is a term in the above sequence.

Do you agree with her? Show your working clearly.

$$\frac{3n+2}{n^2} = \frac{110}{289}$$

$$110n^2 = 867n + 578$$

$$110n^2 - 867n - 578 = 0$$

$$\text{Value of } n = 17/2 \text{ or } -34/55$$

Since n is not a positive integer, $110/289$ is not a term in the above sequence.

----- B1

[1]

- (iii) Explain why $P_n \leq 5$ for all values of n .

$$\frac{3n+2}{n^2} = \frac{3n}{n^2} + \frac{2}{n^2}$$

$$= \frac{3}{n} + \frac{2}{n^2}$$

n^2 increases faster than $3n+2$, as n increases, P_n tends to 0.

----- B1

$$\text{As } n \geq 1, P_n \leq \frac{3}{1} + \frac{2}{1^2} \leq 5$$

[1]

- 6 The cost, y dollars, of printing each T-shirt when x T-shirts are printed is modelled by the equation $y = 8 + \frac{400}{x}$, for $10 \leq x \leq 160$.

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

x	10	20	50	80	125	160
y	48	28	16	13	11.2	p

- (a) Find the value of p in the table above.

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Answer $p = \dots\dots\dots 10.5 \dots\dots\dots$ [1] ----- B1

- (b) On the grid opposite, draw the graph of $y = 8 + \frac{400}{x}$ for $10 \leq x \leq 160$. [2]

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- (c) Use your graph to estimate the number of T-shirts that is printed if the cost of printing each T-shirt is \$20.

Answer $\dots\dots\dots 34 \dots\dots\dots$ T-shirts [1] ----- B1

- (d) By drawing a tangent, find the gradient of the curve at (40, 18).

----- M1 for tangent drawn

Answer $\dots\dots\dots -0.25 \dots\dots\dots$ [2] ----- B1

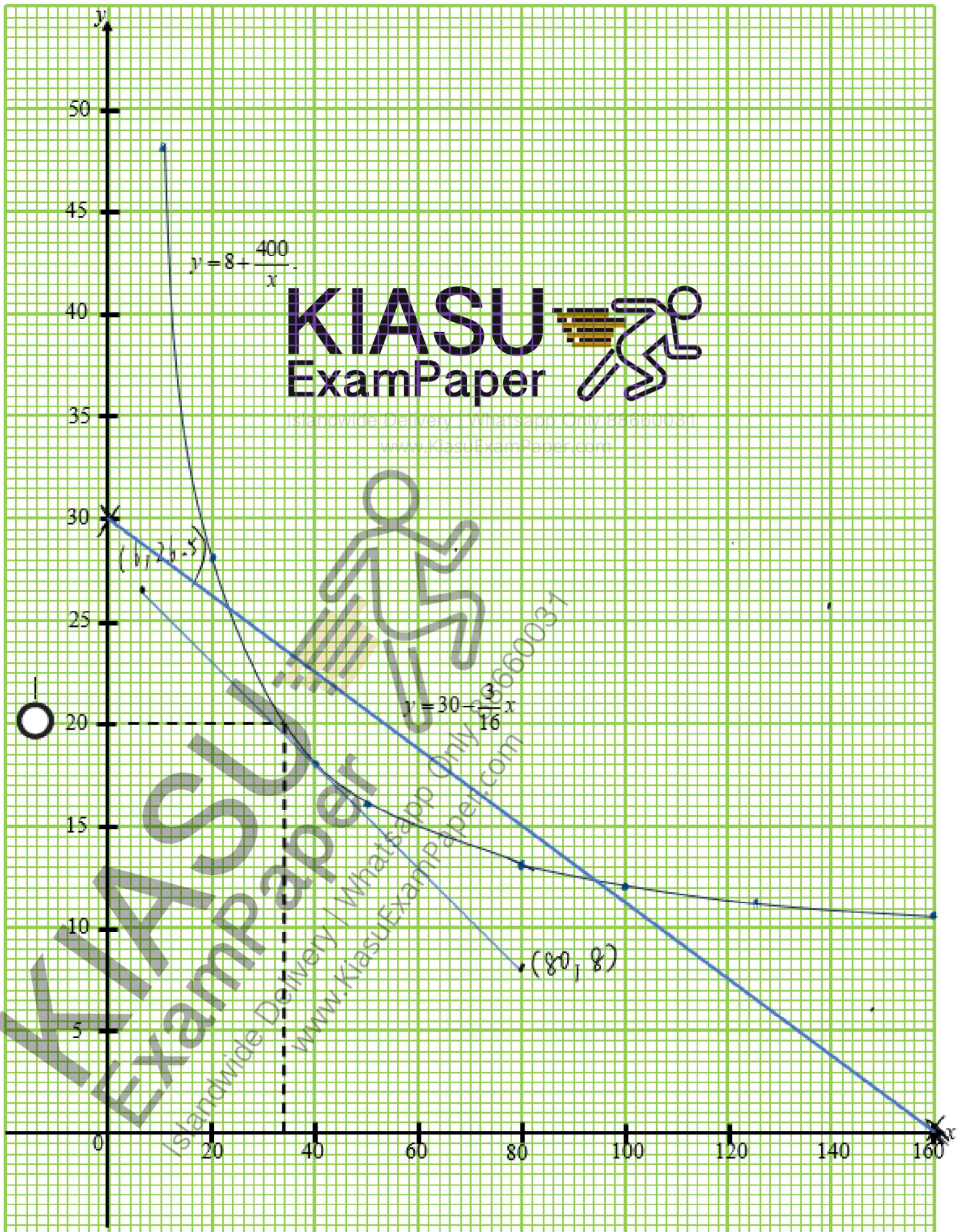
- (e) John suggests that the selling price of each T-shirt, in dollars, is modelled by

$$y = 30 - \frac{3}{16}x.$$

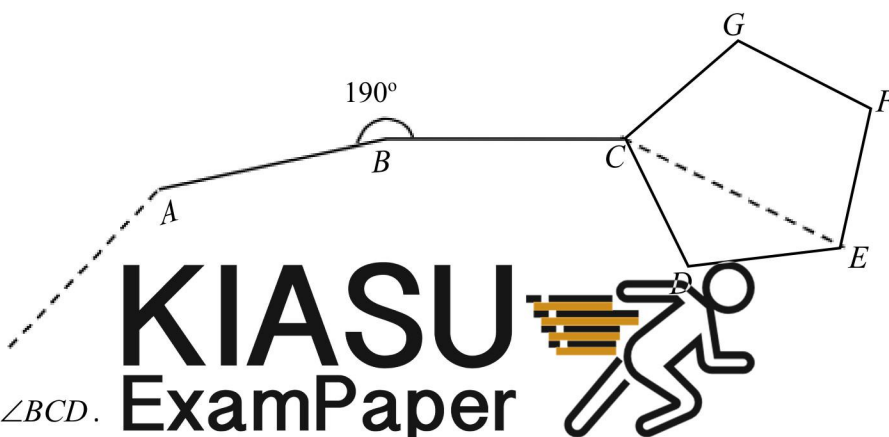
- (i) On the same grid, draw the graph of $y = 30 - \frac{3}{16}x$ for $0 \leq x \leq 160$. [1]

- (ii) Using your graphs, determine the range of values of x for which John will not make any loss, assuming that all of the t-shirts will be sold.

Answer $\dots\dots\dots 23 \leq x \leq 94 \dots\dots\dots$ [1] ----- B1



- 7 (a) A, B, C and E are four vertices of a n -sided polygon and reflex angle ABC is 190° . The remaining reflex angles of the n -sided polygon are each equal to 205° . A regular pentagon $CDEFG$ is placed such that one of its diagonal CE , is also one of the sides of the n -sided polygon.



- (i) Find $\angle BCD$.

$$\angle BCE = 360^\circ - 205^\circ = 155^\circ$$

----- M1

$$\angle CDE = \frac{(5-2) \times 180^\circ}{5} = 108^\circ$$

----- M1

$$\angle DCE = \frac{180^\circ - 108^\circ}{2} = 36^\circ$$

$$\angle BCD = 155^\circ - 36^\circ = 119^\circ$$

----- A1

Answer $\angle BCD = \dots\dots\dots$ [3]

- (ii) Find the number of sides of the n -sided polygon.

$$1^{\text{st}} \text{ Exterior angle} = 190^\circ - 180^\circ = 10^\circ$$

----- M1 for either correct exterior angle

$$2^{\text{nd}} \text{ Exterior angle} = 180^\circ - 155^\circ = 25^\circ$$

$$25^\circ (n-1) + 10^\circ = 360^\circ$$

----- M1

$$n = 15 \text{ sides}$$

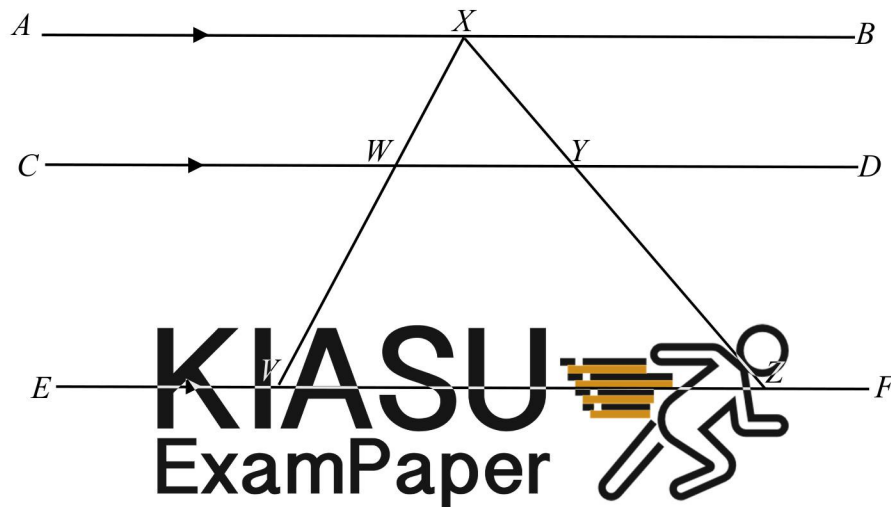
----- A1

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

(b)

17

In the diagram below, AB , CD and EF are parallel lines. XWV and XYZ are straight lines. The line XZ bisects angle BXW and $\angle VWY = 106^\circ$.



(i) Show that WXY is an isosceles triangle. Give reasons for your working.

$\angle BXZ = \angle VXZ$ (line XZ bisects angle BXW)

$\angle BXY = \angle XYW$ (alt. angles, $AB \parallel CD$)

----- M1 for either reasons given

Hence $\angle WXY = \angle XYW$ (base angle of isosceles triangle)

----- A1

[2]

(ii) Which is the longest side of the triangle XVZ ? Show all your necessary workings.

Angle $XVZ = 180^\circ - 106^\circ = 74^\circ$. (int angle, $CD \parallel EF$)

----- M1 for either accurate angle

Angle $BXZ = \text{Angle } XZV = 53^\circ$. (alt angle, $AB \parallel EF$)

XZ is the largest side of the triangle as it is opposite the largest angle.

----- A1

[2]

- 8 (a) The table shows the number of messages sent per month from June to September in 2023 in Singapore.

Month	June	July	Aug	Sep
Number of days	30	31	31	30
Number of messages sent	9.88×10^{12}	8.3×10^{11}	5.97×10^{11}	9.11×10^{12}

- (i) The population of Singapore in 2023 was 5.12×10^9 .
Calculate the mean number of messages sent per person per day from June to September in 2023.

$$\frac{9.88 \times 10^{12} + 8.3 \times 10^{11} + 5.97 \times 10^{11} + 9.11 \times 10^{12}}{30 + 31 + 31 + 30}$$

$$= 1.673524 \times 10^{11} \quad \text{M1}$$

$$\text{Mean} = \frac{1.673524 \times 10^{11}}{5.12 \times 10^9}$$

$$= 32.68$$

$$= 32.7 \quad \text{A1}$$

Answer messages [2]

- (ii) Calculate the percentage decrease in the number of messages sent from July to August.

$$\frac{8.3 \times 10^{11} - 5.97 \times 10^{11}}{8.3 \times 10^{11}} \times 100\% = 28.1\% \quad \text{A1}$$

M1 for fraction

Answer% [2]

- (iii) The number of messages sent in 2025 from June to September was 12.2% more than the number of messages sent in 2023 from June to September.

Calculate the number of number of messages sent in 2025. Give your answer in standard form.

$$\frac{112.2}{100} \times (9.88 \times 10^{12} + 8.3 \times 10^{11} + 5.97 \times 10^{11} + 9.11 \times 10^{12}) \quad \text{M1}$$

$$= 2.29 \times 10^{13} \quad \text{A1}$$

Answer messages [2]

- (b) In 2023, Singapore has a population of 5.64 million.
The land area of Singapore was 728.6 km^2 .
Find the population of Singapore per km^2 , leaving your answer as standard form.

$$728.6 \text{ km}^2 \text{ --- } 5.64 \times 10^6$$

$$1 \text{ km}^2 \text{ --- } \frac{5.64 \times 10^6}{728.6} \text{ --- M1}$$

$$= 7.74 \times 10^3 \text{ --- A1}$$

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Answer

[2]

- (c) The area of the reserve on a map is 24 cm^2 , while its actual area is 6 km^2 .

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

$$24 \text{ cm}^2 \text{ --- } 6 \text{ km}^2$$

$$1 \text{ cm}^2 \text{ --- } 0.25 \text{ km}^2$$

$$1 \text{ cm} \text{ --- } 0.5 \text{ km} \text{ --- M1}$$

$$1 \text{ cm} \text{ --- } 50000 \text{ cm}$$

$$1 : 50000 \text{ --- A1}$$

Answer 1: [2]

- (ii) The scale of the map in (i) is reduced to $1 : 25000$.

Show your working clearly to determine whether the area of the reserve shown on the new map is doubled, quadrupled or remains unchanged.

$$1 \text{ cm} \text{ --- } > 0.25 \text{ km}$$

$$1 \text{ cm}^2 \text{ --- } > 0.0625 \text{ km}^2 \text{ --- M1}$$

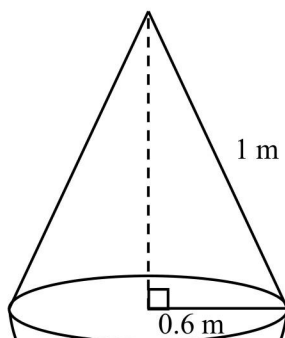
$$6 \div 0.0625 = 96 \text{ cm}^2$$

$$96 \div 24 = 4 \text{ --- A1}$$

The area of the reserve shown on the new map is quadrupled.

[2]

- 9 The diagram shows a metal buoy. It is made up of a cone and a hemisphere. The cone is mounted on the base of a hemisphere with a radius of 0.6 m.



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Figure 1

Given that the slant height of the cone is 1 m,

- (a) Show that the height of the buoy is 1.4 m.

$$\text{Height} = \sqrt{1^2 - 0.6^2} = 0.8$$

$$0.8 + 0.6 = 1.4(\text{shown}) \quad \text{----- B1}$$

- (b) Calculate the total surface area of the buoy.

$$2\pi r^2 + \pi r l$$

$$= 2\pi(0.6)^2 + \pi(0.6)(1)$$

$$= 4.15$$

----- M1 each for accurate surface area

----- A1

Answer m² [3]

- (c) Calculate the volume of the buoy, leaving your answer in terms of π .

$$\text{vol. cone} = \frac{1}{3}\pi(0.6)^2(0.8) = \frac{12}{125}\pi$$

$$\text{vol. hemisphere} = \frac{2}{3}\pi(0.6)^3 = \frac{18}{125}\pi$$

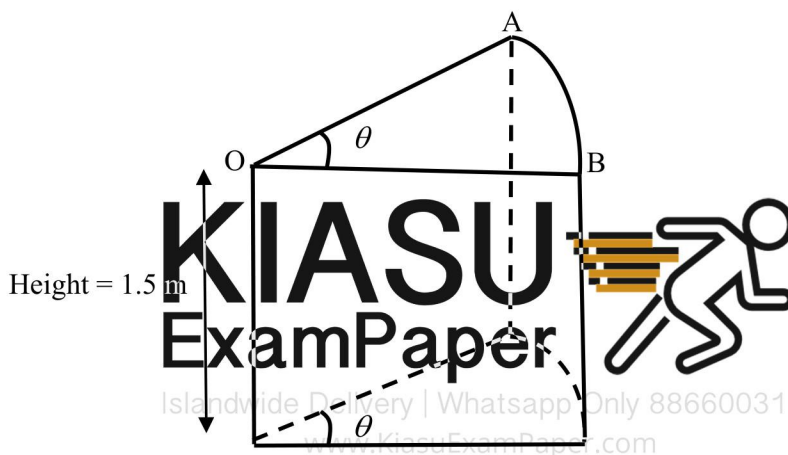
----- M1 each for
accurate volume

$$\text{Total} = \frac{12}{125}\pi + \frac{18}{125}\pi = \frac{6}{25}\pi$$

----- A1

Answer m³ [3]

- (d) The buoy shown in Figure 1 is melted and recast into the prism shown below. The prism has height 1.5 m, and its cross-section is the sector OAB , where angle AOB is $\frac{11\pi}{30}$ radians. Assuming no material is lost during the recasting process, find the radius of the sector.



$$\text{vol_prism} = \text{base_area} \times \text{height}$$

$$\frac{6}{25}\pi = \frac{1}{2}r^2 \left(\frac{11}{30}\pi \right) \times 1.5 \quad \text{----- M1}$$

$$\frac{6}{25}\pi = \frac{11}{40}\pi r^2$$

$$\frac{6}{25} = \frac{11}{40}r^2 \quad \text{----- M1 for simplification}$$

$$r^2 = \frac{48}{55} \quad \text{----- M1}$$

$$r = 0.934.$$

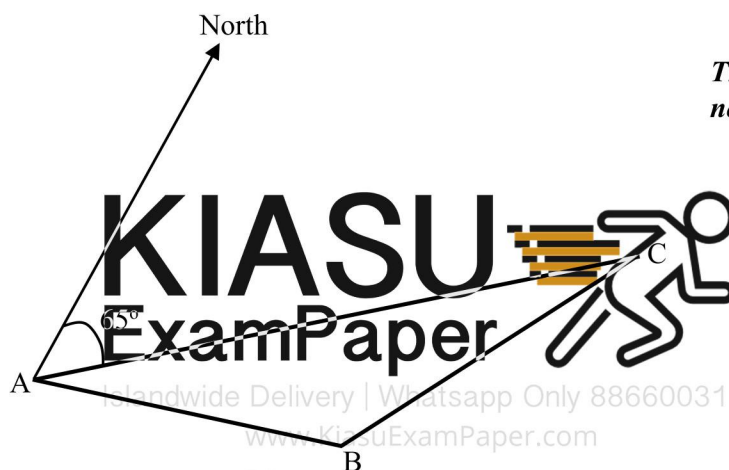
$$(\text{reject } r = -0.934 \text{ as } r > 0) \quad \text{----- A1 (must show reject)}$$

Answer m

[4]

10. As a director of a medical logistics company, you are evaluating different methods of transporting emergency medical supplies from station A during adverse weather conditions. The emergency supplies must reach station C within 1 hour of dispatch.

Three stations A, B and C are located at sea. Station B is due east of station A. The bearing of C from A is 065° . The bearing of C from B is 020° . Distance between A and B is 17.6 km.



*The diagram is
not drawn to scale*

A drone travels directly from A to C. A speedboat travels from A to B, then from B to C.

A helicopter may also be used if weather conditions permit.

- (a) Calculate the direct distance AC travelled by the drone.

Give your answer correct to 5 significant figures.

$$\angle ACB = 180^\circ - 110^\circ - 25^\circ = 45^\circ \quad \text{----- M1}$$

$$\frac{AC}{\sin 110^\circ} = \frac{17.6}{\sin 45^\circ} \quad \text{----- M1}$$

$$AC = \frac{17.6}{\sin 45^\circ} \times \sin 110^\circ$$

$$AC = 23.389098$$

$$AC = 23.389 \text{ km (5s.f.)} \quad \text{----- A1}$$

Answer: km [3]

The company collected the following operational data during a trial run.

Vehicle	Maximum Speed	Actual Operating Speed	Further Information	Operating Cost
Drone	26 m/s	19 m/s due to strong wind	5 mins preparation time (loading and take-off) 42 mins maximum flying time 8 kg maximum carrying load	\$1380
Speedboat	45 km/h	40 km/h from A to B	11 mins for docking and refuelling time at B	\$860
		29 km/h from B to C due to rough sea conditions		
Helicopter	160 km/h	150 km/h	18 mins landing clearance and safety checks. For safety reasons, helicopter operations are suspended if visibility falls below the minimum requirement of 1.8 km at any point during the journey.	\$2390

The following information is further provided:

- Current visibility fluctuates between 1.3 km and 2.0 km.
- Medical supply is 7.2 kg.
- The drone system will only be approved if **BOTH** conditions below are satisfied.

Condition 1: The drone must reduce the total delivery time by at least 50% relative to the current speedboat operation.

Condition 2: The operating cost of drone per minute should not exceed the operating cost of the speedboat per minute by \$50.

- (b) The company may choose either one of the 3 transportation methods. The company wants the fastest transportation method while keeping total operating cost to be below \$2400.

Determine which transportation method should be selected. You must show all relevant calculations and justify your conclusion clearly (other than the conditions stated above). State one assumption made in your working. [7]

Drone

$$19m/s = 68.4km/h$$

Time taken from A to B:

$$\frac{23.389}{68.4}$$

$$= 20.516 \text{ min s}$$

Total time taken

$$= 20.516 + 5$$

$$= 25.516 \text{ mins } (< 42 \text{ mins})$$

Speedboat

$$\frac{BC}{\sin 25^\circ} = \frac{17.6}{\sin 45^\circ}$$

$$BC = \frac{17.6}{\sin 45^\circ} \times \sin 25^\circ$$

$$BC = 10.519 \text{ cm}$$

Time taken from A to B:

$$\frac{17.6}{40}$$

$$= 26.4 \text{ min s}$$

Time taken from B to C:

$$\frac{10.519}{29}$$

$$= 21.763 \text{ min s}$$

Total time taken

$$= 26.4 + 21.763 + 11$$

$$= 59.163 \text{ mins}$$

Helicopter

Not selected as the visibility is not consistently above 1.8m for the current situation.

% time reduction:

$$\frac{59.163 - 25.516}{59.163} \times 100\%$$

$$= 56\% (> 50\%)$$

Additional \$ per min saved:

$$\frac{1380 - 860}{59.163 - 25.516}$$

$$= 15.45 (< \$50)$$

The drone system should be selected as:

- can deliver the package within 1 hour
- total cost is below \$2400
- it is faster compared to the speedboat.
- More reliable than the helicopter given the adverse weather conditions.

----- A1 for any reason stated why drone should be chosen.

Other acceptable assumptions given:

- The drone travels in a linear pathway
- The vehicles travel at constant speed
- The drone is assumed to maintain stable GPS connection throughout

----- A1 for each valid assumption

Continuation of working space for question 10.

END OF PAPER

