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Name:	Index No.:	Class:
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PRESBYTERIAN HIGH SCHOOL



MATHEMATICS PAPER 1

4052/01

19 August 2025

Tuesday

2 hours 15 minutes

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2025 SECONDARY FOUR EXPRESS / FIVE NORMAL PRELIMINARY EXAMINATION

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

INSTRUCTIONS TO CANDIDATES:

Write your name, index number and class on the spaces provided above.
 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.

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 .

Note that all the diagrams in this paper are not drawn to scale.

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.

For Examiner's Use				
Category	Accuracy	Notations	Others	Marks Deducted
Question No.				

Total Marks
90

Setter: Mr Tan Chee Wee

Vetter: Ms Ong Bi Ru

This question paper consists of **23** printed pages (including this cover page) and **1** blank 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 $\sqrt[3]{27.38^2 - \frac{7.9}{0.021}}$.

Answer [1]

2 Simplify

(a) $4\sqrt[5]{y^6} \times y^{-1}$,

Answer [1]

(b) $5x - 7 - 9x + 3x - 2$.

Answer [1]

- 3 (a) Expand and simplify $(p+2)(1+3p-p^2)$.

Answer [2]

- (b) Write as a single fraction in its simplest form $\frac{3}{(5-2x)^2} - \frac{1}{5-2x}$.

Answer [2]

- 4 (a) Express 504 as a product of its prime factors.

Answer [1]

- (b) Find the smallest positive integer value of k such that $\sqrt[3]{504k}$ is an integer.

Answer $k =$ [1]

- (c) The highest common factor (HCF) of two numbers is 84. The lowest common multiple (LCM) of the two numbers is 504. Both numbers are more than 100. Find the two numbers.

Answer and [2]

5 It is given that x pencils cost y dollars and 4 cents.

(a) Find the cost of one pencil in cents.

Answercents [1]

(b) Write down an expression for the number of pencils that could be bought for t dollars.

Answer [1]

6 Given that $A : B = \frac{1}{6} : \frac{1}{5}$ and $B : C = 3 : 7$, find $A : C$ as a ratio of two integers.

Answer : [2]

- 7 Find the smallest integer that satisfies $6y - 3 > 17$.

Answer [2]

- 8 The force F , between two particles is inversely proportional to the square of the distance between them. The force is 64 units when the distance between the particles is r metres. Find the force when the distance between the particles is reduced by 20%.

Answerunits [2]

9 The distance between Earth and Venus is 150.4 million kilometres.

(a) Express 150.4 million in standard form.

Answer [1]

(b) A space shuttle can travel 7500 metres in 1 second.

(i) Find the speed, in kilometres per hour, of the space shuttle.

Answerkm/h [1]

(ii) Find the number of days the space shuttle will take to travel from Earth to Venus.

Give your answer to the nearest whole number.

Answerdays [2]

- 10 Given that $3a + 5c = \frac{3-c}{2b}$, make c the subject of the equation.

Answer [3]

- 11 The scale of a map is given as 1: 50000.

(a) A road on the map is 16 cm long. Find the actual length of a road in kilometres.

Answerkm [1]

(b) A lake has an area of 40 km². Find the area of the lake on the map in square centimetres.

Answer cm² [2]

- 12 The frequency table shows the masses of 50 students from Class A.

Mass (m kg)	$20 < m \leq 30$	$30 < m \leq 40$	$40 < m \leq 50$	$50 < m \leq 60$	$60 < m \leq 70$
Frequency	2	11	20	12	5

- (a) Calculate the mean mass of the students from Class A. .

Answerkg [1]

- (b) Calculate the standard deviation for the mass of students in class A. .

Answerkg [1]

- (c) Explain why the value of the mean calculated in **part (a)** is only an estimate.

Answer

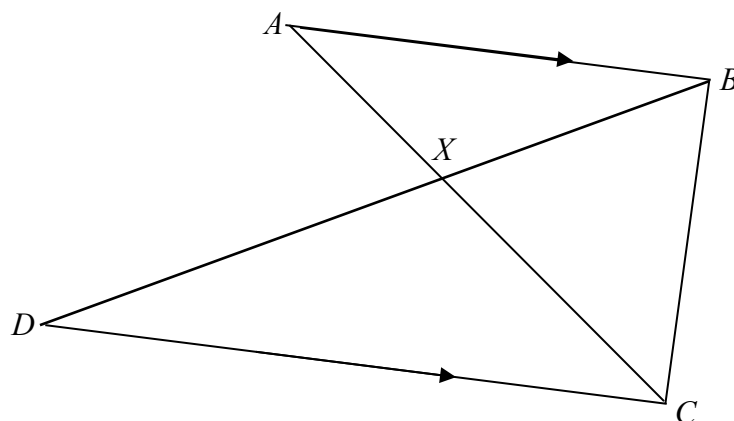
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[1]

- 13 In the diagram, AB is parallel to DC . AC and BD meet at X .



- (a) Show that triangle ABX and triangle CDX are similar.
Give a reason for each statement you make.

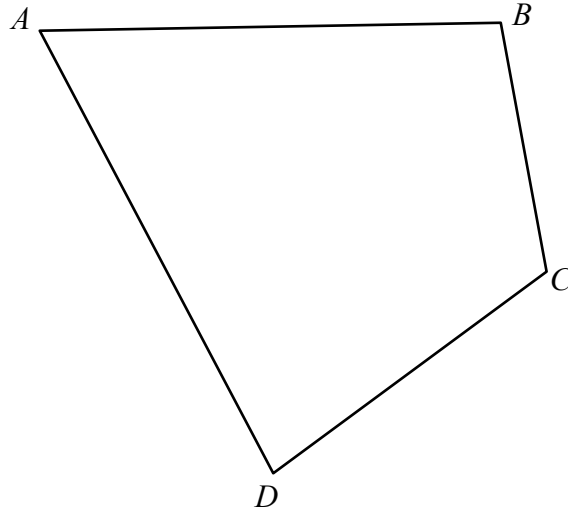
Answer

[2]

- (b) $AB = 16$ cm, $AX = 8$ cm, $XC = 12$ cm.
Given that $BD = 28$ cm, find BX .

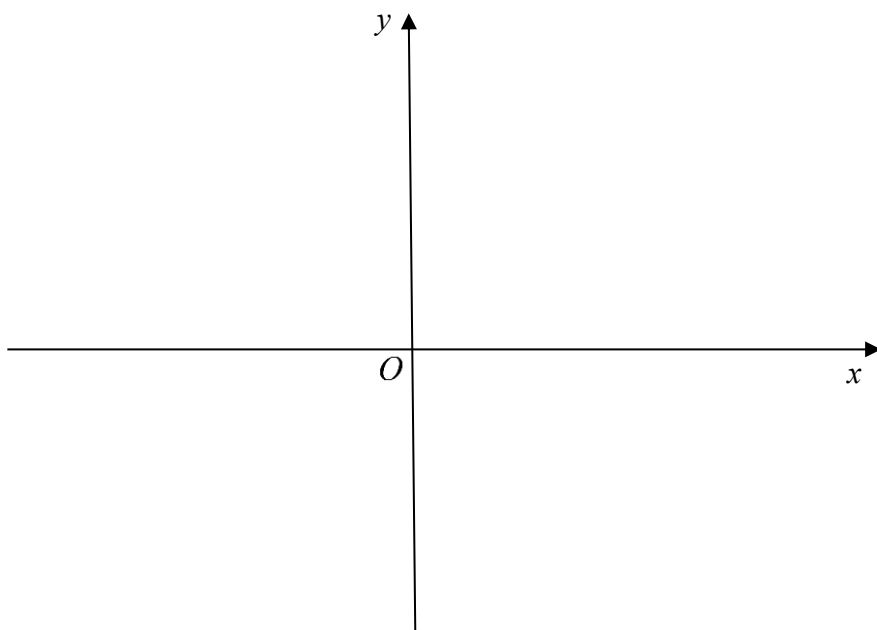
Answer $BX = \dots\dots\dots$ cm [2]

- 14 The diagram shows a quadrilateral playground $ABCD$.



- (a) Construct the perpendicular bisector of AB . [1]
- (b) Construct the bisector of angle BCD . [1]
- (c) Shade the region inside $ABCD$ that is closer to CD than BC and closer to B than A . [1]

- 15 (a) Sketch the graph of $y = (x+4)(x-8)$ on the axes below.
Indicate clearly the values where the graph crosses the x and y axes.



[2]

- (b) Use the graph in **part (a)** to explain whether the graph of $y = (x+4)(x-8) + 26$ cuts the x -axis.

Answer

.....

.....

.....

[1]

16 A, B and C are points $(-4, 3)$, $(1, 9)$ and $(0, 2)$ respectively.

(a) Find the length of AB .

Answer $AB = \dots\dots\dots$ units [2]

(b) Find the equation of the line that passes through B and has the same gradient as AC .

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

- 17 Given that $2x - y = 8$ and $xy = 4$, without solving for x and y , find the value of $4x^2 + y^2$.

Answer [2]

- 18 Factorise completely $18ac - 8c + 27ab - 12b$.

Answer [2]

- 19 The first four terms in a sequence of numbers, $T_1, T_2, T_3, T_4 \dots$ are given below.

$$T_1 = 2^0 + 1$$

$$T_2 = 2^1 + 3$$

$$T_3 = 2^2 + 5$$

$$T_4 = 2^3 + 7$$

.

.

- (a) Write down T_5 .

Answer [1]

- (b) Express T_n in terms of n .

Answer [2]

- (c) Hence show that $T_n - T_{n-1} = 2^{n-2} + 2$.

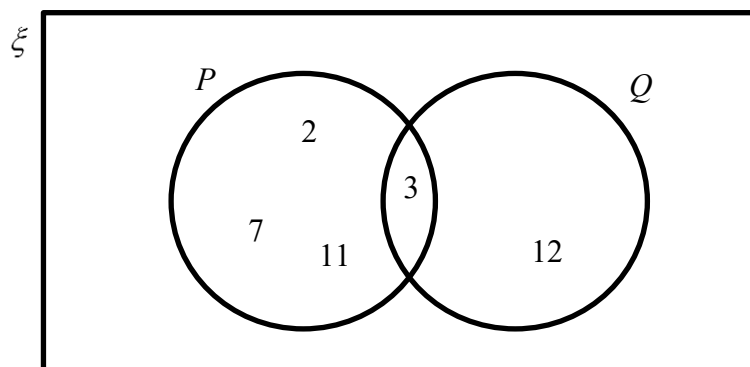
Answer

20 $\xi = \{\text{integers } x : 1 \leq x \leq 15\}$

$P = \{\text{prime numbers}\}$

$Q = \{\text{multiples of 3}\}$

Some of the elements of P and Q have been filled in the Venn diagram.



(a) **Complete** the Venn diagram above by filling in all the missing elements.

[2]

(b) List the elements in $P' \cap Q$.

Answer [1]

(c) Use one of the symbols below to complete each statement.

$\emptyset$ $\in$ $\notin$ $\subset$ $\not\subset$

(i) $P \cap Q \neq$ [1]

(ii) $\{2, 3, 7\}$ P [1]

(iii) 2 Q [1]

- 21 A bakery produces cheesecakes, fruit cakes and red velvet cakes. The number of cakes sold on a particular weekend is given by the matrix **G**.

$$\mathbf{G} = \begin{matrix} & \begin{matrix} \text{cheese} & \text{fruit} & \text{red velvet} \end{matrix} \\ \begin{pmatrix} 15 & 20 & 14 \\ 12 & 18 & 10 \end{pmatrix} & \begin{matrix} \text{Saturday} \\ \text{Sunday} \end{matrix} \end{matrix}$$

A cheesecake is sold for \$ x , a fruit cake is sold for \$ $(x-8)$ and a red velvet cake is sold for \$ $(x-3)$.

- (a) Represent this information in a 3×1 matrix, **J**.

Answer **J** = [1]

- (b) Find in terms of x , the matrix **K** = **GJ**.

Answer **K** = [2]

- (c) State what the elements of **K** represent.

.....

 [1]

- (d) The total amount of money collected by the bakery from the sales of all the cakes on this particular weekend is \$5676, find the value of x .

Answer x = [2]

- 22** Box X contains 4 balls numbered 1, 2, 3 and 4.
 Box Y contains another 4 balls numbered 1, 3, 5 and 6.
 In a game, May drew a ball at random from each box, and the sum of both numbers is obtained.

(a) Complete the possibility diagram below.

		Box Y			
Box X	+	1	3	5	6
	1	2			7
	2		5		
	3			8	
	4		7		10

[2]

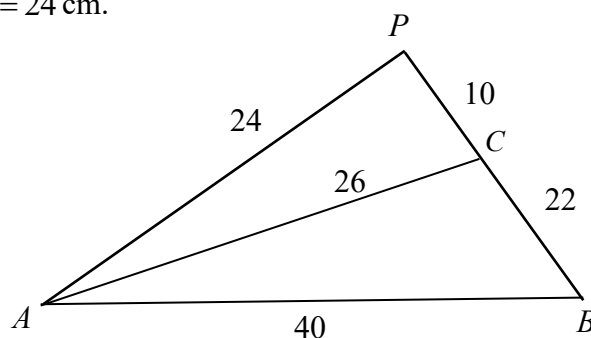
(b) Find the probability that the sum obtained is 6.

Answer [1]

- (c)** Box Z contains 4 balls numbered 10, 20, 30 and 40. Albert drew a ball at random from each of the boxes X , Y and Z , and the sum of all three numbers is obtained.
 Find the probability that the sum obtained is more than 30 but less than 36.

Answer [2]

- 23 In triangle ABC , $AB = 40$ cm, $BC = 22$ cm and $AC = 26$ cm. P is a point on BC produced, where $CP = 10$ cm and $AP = 24$ cm.



- (a) Explain why angle APB is a right angle.

Answer

- (b) Express the following as a fraction in its lowest term

[1]

- (i) $\tan \angle ABP$,

Answer [1]

- (ii) $\cos \angle ACB$.

Answer [1]

- (c) A circle passes through the points A , P and B . John said that the radius of the circle is 16 cm. Do you agree with him?

.....

[2]

- 24 Eighteen students took a test.

Their scores are shown in the stem-and-leaf diagram below.

Stem	Leaf
0	3 5 8
1	0 1 2 2 3 p 6 7 7 7 9
2	1 8 8 9

Key 1|3 means 13

- (a) Given that the median score is 15, find

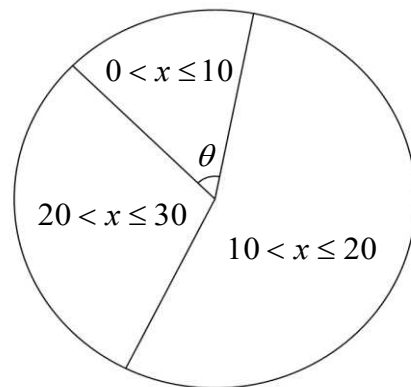
(i) the modal score,

Answer [1]

(ii) the value of p .

Answer [1]

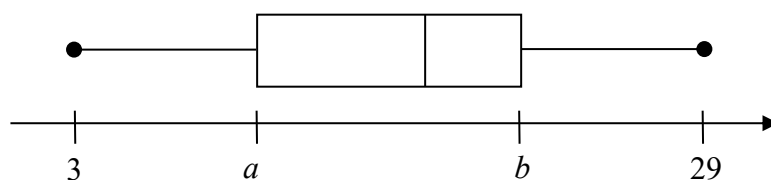
- (b) These students are grouped into three groups based on their scores, x . This is represented on the pie chart below. Find the value of θ .



Answer $\theta =$ [1]

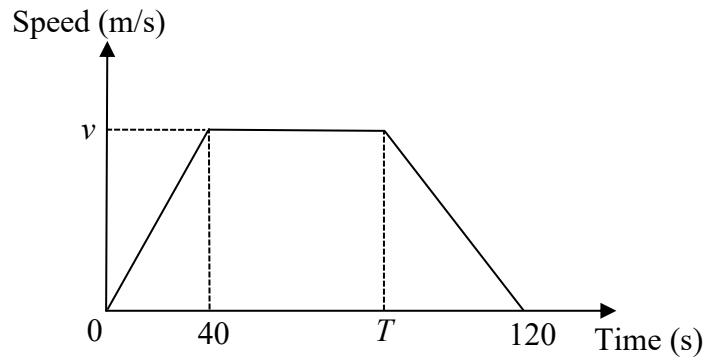
- (c) The above data is represented on a box-and-whisker plot shown below.

Find the value of a and of b .



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

- 25** The diagram below shows the speed-time graph of a bus journey.
 The bus accelerated from rest at 0.5 m/s^2 to a speed of $v \text{ m/s}$ in 40 seconds, and travelled at this speed until T seconds before it came to a stop at 120 seconds.
 The total distance travelled for the whole journey was 1500 m.
 The area beneath the speed-time graph represents the distance travelled by the bus.



Find the value of

- (a)** v ,

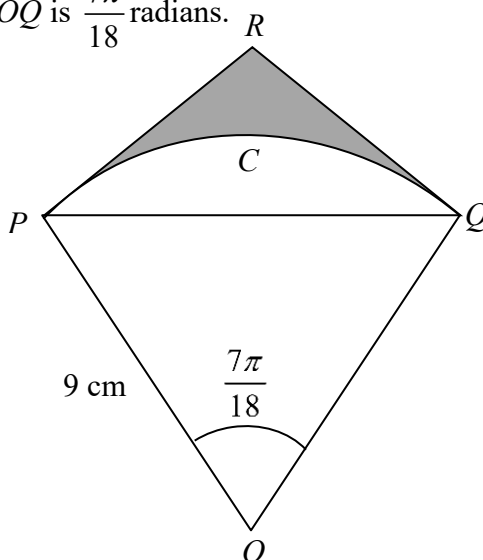
Answer $v = \dots\dots\dots$ [1]

- (b)** T .

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

- 26 PCQ is an arc of a circle, centre O , of radius 9 cm.

The tangents at P and Q meet at R . Angle POQ is $\frac{7\pi}{18}$ radians.



- (a) Show that angle $PRQ = \frac{11\pi}{18}$ radians.

Answer

[1]

- (b) Find the length of arc PCQ .

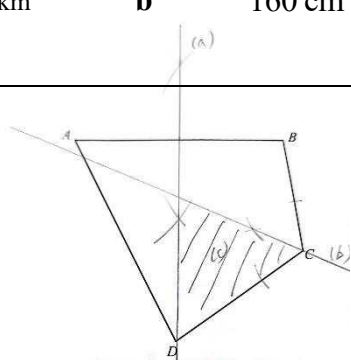
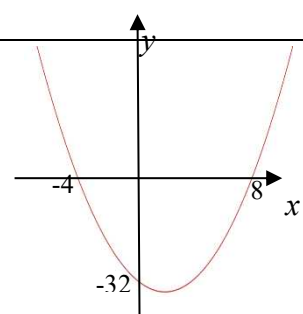
Answercm [1]

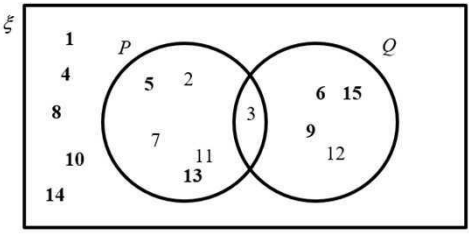
- (c) Find the area of the shaded region.

Answer cm² [3]

END OF PAPER

Answer Key

1	7.20	2	a $4y^{\frac{1}{5}}$ b $-x-9$
3	a $2+7p+p^2-p^3$ b $\frac{2x-2}{(5x-2)^2}$	4	a $2^3 \times 3^2 \times 7$ b 147 c 168, 252
5	a $\frac{100y+4}{x}$ b $\frac{100tx}{100y+4}$	6	5:14
7	4	8	100
9	a 1.504×10^8 bi 27000 km/h bii 232	10	$c = \frac{3-6ab}{10b+1}$
11	a 8 km b 160 cm^2	12	a 46.4 b 10.0 c The exact/actual mass of each student is not known
14		15	 b y -intercept of $y = (x+4)(x-8)$ is -32 , therefore y -intercept of $y = (x+4)(x-8)+26$ is -6 which is below the x-axis, therefore y cuts the x-axis at two points.
13	a $\angle ABX = \angle CDX$ (alt $\angle$ s, $AB \parallel CD$) $\angle AXB = \angle CXD$ (vert. oppo $\angle$) $\triangle ABX$ is similar to $\triangle CDX$ (AA Similarity) b 11.2	16	a 7.81 b $y = -0.25x + 9.25$
17	80	18	$(9a-c)(2c+3b)$

19	a $T_5 = 2^4 + 9$ b $2^{n-1} + 2n - 1$	20	 b 6,9,12,15 ci $\emptyset$ cii $\subset$ ciii $\notin$
21	a $\mathbf{J} = \begin{pmatrix} x \\ x-8 \\ x-3 \end{pmatrix}$ b $\mathbf{K} = \begin{pmatrix} 49x-202 \\ 40x-174 \end{pmatrix}$ c It represents the total amount collected from the sales of cheesecake, fruit cakes and red velvet cakes sold on Saturday and Sunday respectively. d $x = 68$	22	a $\frac{1}{8}$ b $\frac{3}{32}$
23	a $AP^2 + BP^2 = 24^2 + 32^2 = 1600$ $AB^2 = 20^2 = 1600$ Since $AB^2 = AP^2 + PB^2$, by converse of Pythagoras theorem, $\angle APB$ is a right angle bi $\frac{3}{4}$ ii $-\frac{5}{13}$ c No. The diameter is AB as it is right angle in a semicircle and radius is 20 cm	24	bi 17 ii $p = 4$ c 80 d $a = 11, b = 19$
25	a 20 b 70	26	b 11.0 cm c 7.24 cm^2

Name:	Index No.:	Class:
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MATHEMATICS
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2025 SECONDARY FOUR EXPRESS / FIVE NORMAL PRELIMINARY EXAMINATION

SUGGESTED ANSWERS

Setter: Mr Tan Chee Wee
 Vetter: Ms Ong Bi Ru

Mathematical Formulae

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

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

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

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 $\sqrt[3]{27.38^2 - \frac{7.9}{0.021}}$.

7.20

Answer [1]

2 Simplify

(a) $4\sqrt[5]{y^6} \times y^{-1},$

$$4y^{\frac{6}{5}} \times y^{-1}$$

$$4y^{\frac{1}{5}}$$

Answer [1]

(b) $5x - 7 - 9x + 3x - 2.$

$$-x - 9$$

Answer [1]

- 3 (a) Expand and simplify $(p+2)(1+3p-p^2)$.

$$(p+2)(1+3p-p^2) = p+3p^2-p^3+2+6p-2p^2$$

$$(p+2)(1+3p-p^2) = 2+7p+p^2-p^3$$

Answer [2]

- (b) Write as a single fraction in its simplest form $\frac{3}{(5-2x)^2} - \frac{1}{5-2x}$.

$$\frac{3}{(5-2x)^2} - \frac{1}{5-2x} = \frac{3-(5-2x)}{(5-2x)^2}$$

$$\frac{3}{(5-2x)^2} - \frac{1}{5-2x} = \frac{2x-2}{(5-2x)^2}$$

Answer [2]

- 4 (a) Express 504 as a product of its prime factors.

$$504 = 2^3 \times 3^2 \times 7$$

Answer [1]

- (b) Find the smallest value of k such that $\sqrt[3]{504k}$ is an integer.

$$k = 3 \times 7^2 = 147$$

Answer $k =$ [1]

- (c) The highest common factor (HCF) of two numbers is 84. The lowest common multiple (LCM) of the two numbers is 504. Both numbers are more than 100. Find the two numbers.

168
252

Answer and [2]

5 It is given that x pencils cost y dollars and 4 cents.

(a) Find the cost of one pencil in cents.

$$\frac{100y + 4}{x}$$

Answercents [1]

(b) Write down an expression for the number of pencils that could be bought for t dollars.

$$\begin{aligned} 100t \div \frac{100y + 4}{x} &= 100t \times \frac{x}{100y + 4} \\ &= \frac{100tx}{100y + 4} \end{aligned}$$

/

Answer [1]

6 Given that $A : B = \frac{1}{6} : \frac{1}{5}$ and $B : C = 3 : 7$, find $A : C$ as a ratio of two integers.

$$A : B = \frac{1}{6} : \frac{1}{5}$$

$$A : B = \frac{15}{6} : \frac{15}{5}$$

$$A : B = \frac{5}{2} : 3 \quad \text{or} \quad A : B = 5 : 6$$

$$A : C = \frac{5}{2} : 7$$

$$A : C = 5 : 14$$

Answer : [2]

- 7 Find the smallest integer that satisfies $6y - 3 > 17$.

$$6y - 3 > 17$$

$$6y > 20$$

$$y > \frac{20}{6}$$

$$\text{Smallest } y = 4$$

Answer [2]

- 8 The force F , between two particles is inversely proportional to the square of the distance between them. The force is 64 units when the distance between the particles is r metres. Find the force when the distance between the particles is reduced by 20%.

$$F = \frac{k}{r^2}$$

$$64 = \frac{k}{r^2}$$

$$F = \frac{k}{(0.8r)^2}$$

$$F = \frac{k}{0.64r^2}$$

$$F = \frac{64}{0.64}$$

$$F = 100 \text{ units}$$

Answerunits [2]

- 9 The distance between Earth and Venus is 150.4 million kilometres.

(a) Express 150.4 million in standard form.

$$150.4 \times 10^6 = 1.504 \times 10^8 \text{ km}$$

Answer [1]

(b) A space shuttle can travel 7500 metres in 1 second.

(i) Find the speed, in kilometres per hour, of the space shuttle.

$$\begin{aligned} & \frac{7500 \div 1000}{1 \div 3600} \\ &= 27000 \text{ km/h} \end{aligned}$$

Answerkm/h [1]

(ii) Find the number of days the space shuttle will take to travel from Earth to Venus.

Give your answer to the nearest whole number.

$$\begin{aligned} & \frac{1.504 \times 10^8}{27000} \div 24 \\ & 232 \text{ days} \end{aligned}$$

Answerdays [2]

- 10** Given that $3a + 5c = \frac{3-c}{2b}$, make c the subject of the equation.

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

$$6ab + 10bc = 3 - c$$

$$10bc + c = 3 - 6ab$$

$$c(10b + 1) = 3 - 6ab$$

$$c = \frac{3 - 6ab}{10b + 1}$$

Answer [3]

- 11** The scale of a map is given as 1: 50000.

- (a)** A road on the map is 16 cm long. Find the actual length of a road in kilometres.

$$1 \text{ cm} : 50000 \text{ cm}$$

$$1 \text{ cm} : 0.5 \text{ km}$$

$$16 \text{ cm} : 8 \text{ km}$$

Answerkm [1]

- (b)** A lake has an area of 40 km². Find the area of the lake on the map in square centimetres.

$$1 \text{ cm} : 0.5 \text{ km}$$

$$1 \text{ cm}^2 : 0.25 \text{ km}^2$$

$$\frac{40}{0.25} \text{ cm}^2 : 40 \text{ km}^2$$

$$160 \text{ cm}^2 : 40 \text{ km}^2$$

Answer cm² [2]

- 12 The frequency table shows the masses of 50 students from Class A.

Mass (m kg)	$20 < m \leq 30$	$30 < m \leq 40$	$40 < m \leq 50$	$50 < m \leq 60$	$60 < m \leq 70$
Frequency	2	11	20	12	5

- (a) Calculate the mean mass of the students from Class A.

$$\text{mean} = \frac{2 \times 25 + 11 \times 35 + 20 \times 45 + 12 \times 55 + 5 \times 65}{50}$$

$$\text{mean} = 46.4 \text{ kg}$$

Answerkg [1]

- (b) Calculate the standard deviation for the mass of students in class A.

$$= \sqrt{\frac{2 \times 25^2 + 11 \times 35^2 + 20 \times 45^2 + 12 \times 55^2 + 5 \times 65^2}{50} - (46.4)^2}$$

$$= 10.0 \text{ kg}$$

Answerkg [1]

- (c) Explain why the value of the mean calculated in **part (a)** is only an estimate.

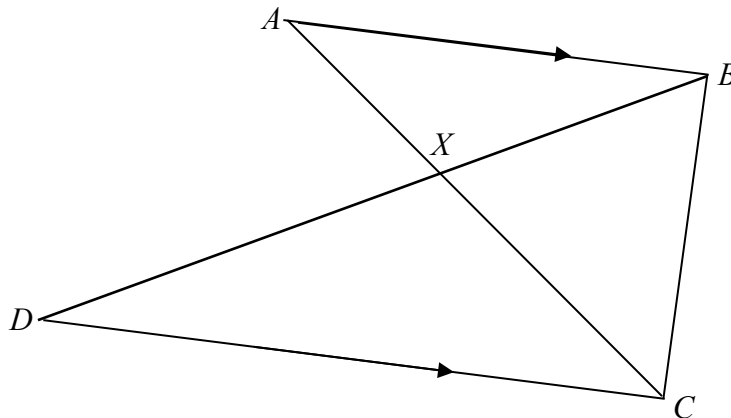
Answer

... The exact/actual mass of each student is not known

.....

..... [1]

- 13 In the diagram, AB is parallel to DC . AC and BD meet at X .



- (a) Show that triangle ABX and triangle CDX are similar.
Give a reason for each statement you make.

Answer

$$\angle ABX = \angle CDX \text{ (alt } \angle \text{ s, } AB \parallel CD)$$

$$\angle AXB = \angle CXD \text{ (vert. oppo } \angle \text{)}$$

$\triangle ABX$ is similar to $\triangle CDX$ (AA Similarity) [-1 m if test not stated]

[2]

- (b) $AB = 16$ cm, $AX = 8$ cm, $XC = 12$ cm.
Given that $BD = 28$ cm, find BX .

$$\frac{BX}{AX} = \frac{DX}{CX}$$

$$\frac{BX}{8} = \frac{28 - BX}{12}$$

$$12BX = 224 - 8BX$$

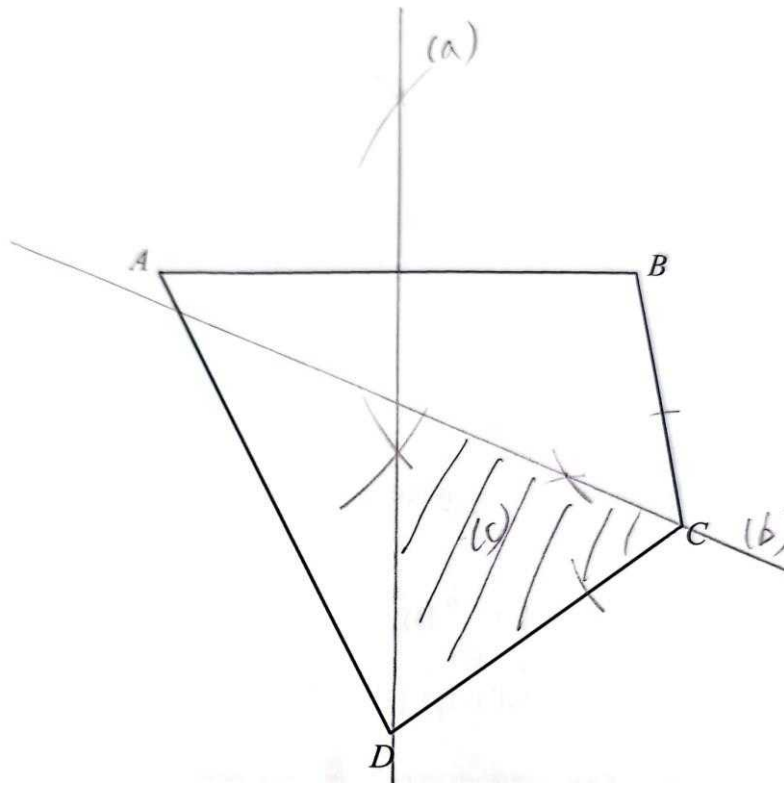
$$20BX = 224$$

$$BX = 11.2 \text{ cm}$$

$$\text{or } BX = \frac{8}{12+8} \times 28$$

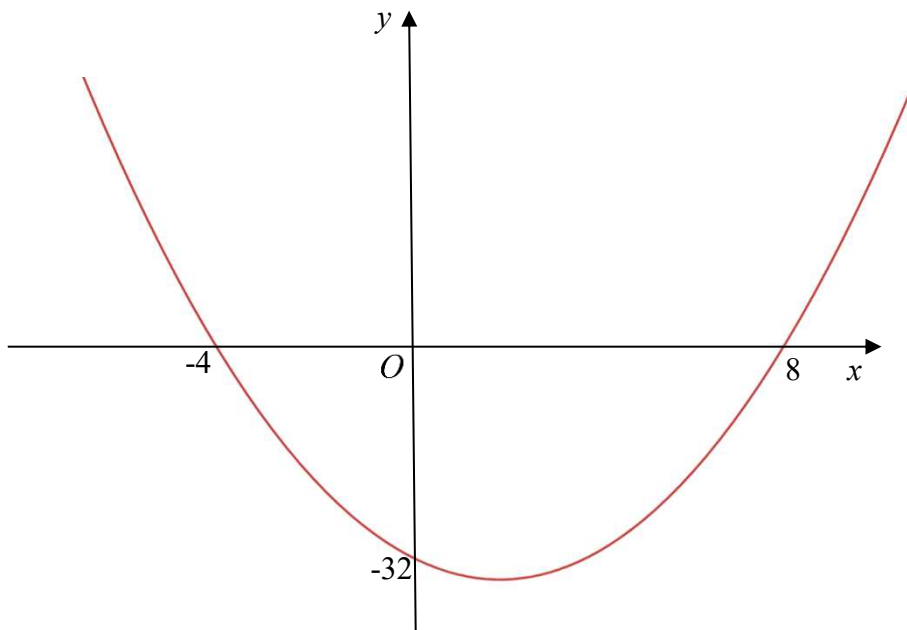
Answer $BX = \dots\dots\dots$ cm [2]

14 The diagram shows a quadrilateral playground $ABCD$.



- (a) Construct the perpendicular bisector of AB . [1]
- (b) Construct the bisector of angle BCD . [1]
- (c) Shade the region inside $ABCD$ that is closer to CD than BC and closer to B than A . [1]

- 15 (a) Sketch the graph of $y = (x+4)(x-8)$ on the axes below.
Indicate clearly the values where the graph crosses the x and y axes.



[2]

- (b) Use the graph in **part (a)** to explain whether the graph of $y = (x+4)(x-8) + 26$ cuts the x -axis.

Answer

y -intercept of $y = (x+4)(x-8)$ is -32 , therefore y -intercept of $y = (x+4)(x-8) + 26$ is -6 which is below the x -axis, therefore y **cuts** the x -axis at two points.

Or

Minimum value of $y = (x+4)(x-8)$ is -36 , therefore **minimum** value of $y = (x+4)(x-8) + 26$ is -10 which is below the x -axis, therefore y **cuts** the x -axis at two points because its vertex lies below the x -axis.

[1]

.....

16 A, B and C are points $(-4, 3)$, $(1, 9)$ and $(0, 2)$ respectively.

(a) Find the length of AB .

$$AB = \sqrt{(1 - (-4))^2 + (9 - 3)^2}$$

$$AB = 7.81$$

Answer $AB = \dots\dots\dots$ units [2]

(b) Find the equation of the line that passes through B and has the same gradient as AC .

$$m_{AC} = \frac{2 - 3}{0 - (-4)} = -0.25$$

$$y = -0.25x + c$$

$$9 = -0.25 + c$$

$$c = 9.25$$

$$y = -0.25x + 9.25$$

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

- 17 Given that $2x - y = 8$ and $xy = 4$, without solving for x and y , find the value of $4x^2 + y^2$.

$$(2x - y)^2 = 8^2$$

$$4x^2 - 4xy + y^2 = 64$$

$$4x^2 + y^2 = 64 + 4xy$$

$$4x^2 + y^2 = 64 + 4(4)$$

$$4x^2 + y^2 = 80$$

Answer [2]

- 18 Factorise completely $18ac - 8c + 27ab - 12b$.

$$\begin{aligned} &18ac - 8c + 27ab - 12b \\ &= 2c(9a - 4) + 3b(9a - 4) \\ &= (9a - 4)(2c + 3b) \end{aligned}$$

Answer [2]

- 19 The first four terms in a sequence of numbers, $T_1, T_2, T_3, T_4 \dots$ are given below.

$$T_1 = 2^0 + 1$$

$$T_2 = 2^1 + 3$$

$$T_3 = 2^2 + 5$$

$$T_4 = 2^3 + 7$$

.

.

- (a) Write down T_5 .

$$T_5 = 2^4 + 9$$

Answer [1]

- (b) Express T_n in terms of n .

$$T_n = 2^{n-1} + 2n - 1$$

Answer [2]

- (c) Hence show that $T_n - T_{n-1} = 2^{n-2} + 2$.

Answer

$$T_n - T_{n-1} = 2^{n-1} + 2n - 1 - (2^{n-2} + 2(n-1) - 1)$$

$$T_n - T_{n-1} = 2^{n-1} + 2n - 1 - 2^{n-2} - 2n + 2 + 1$$

$$T_n - T_{n-1} = 2^{n-1} - 2^{n-2} + 2$$

$$T_n - T_{n-1} = 2^{n-2}(2 - 1) + 2$$

$$T_n - T_{n-1} = 2^{n-2} + 2$$

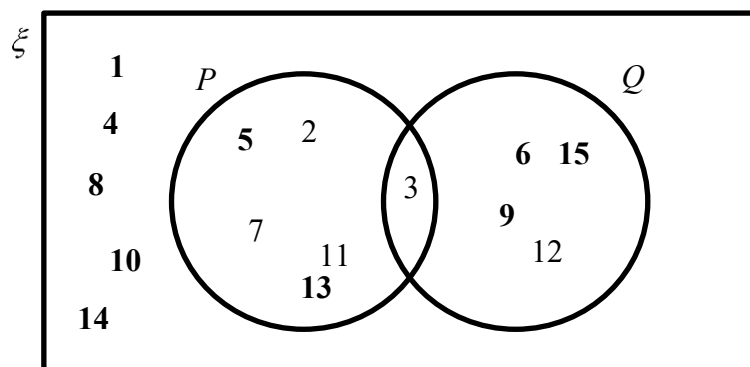
[2]

20 $\xi = \{\text{integers } x : 1 \leq x \leq 15\}$

$P = \{\text{prime numbers}\}$

$Q = \{\text{multiples of 3}\}$

Some of the elements of P and Q have been filled in the Venn diagram.



(a) **Complete** the Venn diagram above by filling in all the missing elements.

[2]

(b) List the elements in $P' \cap Q$.

6, 9, 12, 15

Answer [1]

(c) Use one of the symbols below to complete each statement.

$\emptyset$ $\in$ $\notin$ $\subset$ $\not\subset$

(i) $P \cap Q \neq \emptyset$ [1]

(ii) $\{2, 3, 7\}$ $\subset$ P [1]

(iii) 2 $\notin$ Q [1]

- 21 A bakery produces cheesecakes, fruit cakes and red velvet cakes. The number of cakes sold on a particular weekend is given by the matrix $\mathbf{G}$.

$$\mathbf{G} = \begin{matrix} & \begin{matrix} \text{cheese} & \text{fruit} & \text{red velvet} \end{matrix} \\ \begin{pmatrix} 15 & 20 & 14 \\ 12 & 18 & 10 \end{pmatrix} & \begin{matrix} \text{Saturday} \\ \text{Sunday} \end{matrix} \end{matrix}$$

A cheesecake is sold for \$ x , a fruit cake is sold for \$ $(x-8)$ and a red velvet cake is sold for \$ $(x-3)$.

- (a) Represent this information in a 3×1 matrix, $\mathbf{J}$.

$$\mathbf{J} = \begin{pmatrix} x \\ x-8 \\ x-3 \end{pmatrix}$$

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

- (b) Find in terms of x , the matrix $\mathbf{K} = \mathbf{GJ}$.

$$\mathbf{K} = \begin{pmatrix} 15 & 20 & 14 \\ 12 & 18 & 10 \end{pmatrix} \begin{pmatrix} x \\ x-8 \\ x-3 \end{pmatrix} = \begin{pmatrix} 15x + 20(x-8) + 14(x-3) \\ 12x + 18(x-8) + 10(x-3) \end{pmatrix}$$

$$\mathbf{K} = \begin{pmatrix} 49x - 202 \\ 40x - 174 \end{pmatrix}$$

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

- (c) State what the elements of $\mathbf{K}$ represent.

It represents the **total amount** collected from the **sales** of cheesecake, fruit cakes and red velvet cakes sold on Saturday and Sunday respectively.

.....
 [1]

- (d) The total amount of money collected by the bakery from the sales of all the cakes on this particular weekend is \$5676, find the value of x .

$$\begin{aligned} 49x - 202 + 40x - 174 &= 5676 \\ 89x &= 6052 \\ x &= 68 \end{aligned}$$

Answer $x =$ [2]

- 22** Box X contains 4 balls numbered 1, 2, 3 and 4.
 Box Y contains another 4 balls numbered 1, 3, 5 and 6.
 In a game, May drew a ball at random from each box, and the sum of both numbers is obtained.

(a) Complete the possibility diagram below.

Box X		Box Y				
		+	1	3	5	6
		1	2	4	6	7
		2	3	5	7	8
		3	4	6	8	9
		4	5	7	9	10

[2]

(b) Find the probability that the sum obtained is 6.

$$P(\text{total is 6}) = \frac{2}{16} = \frac{1}{8}$$

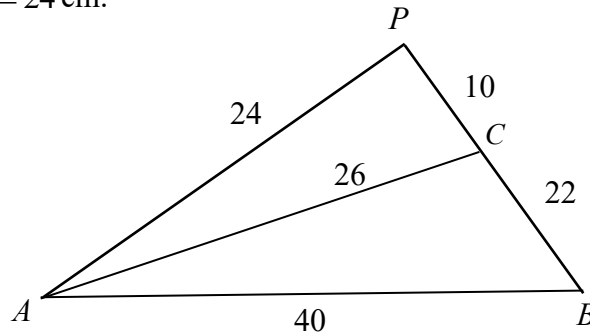
Answer [1]

(c) Box Z contains 4 balls numbered 10, 20, 30 and 40. Albert drew a ball at random from each of the boxes X , Y and Z , and the sum of all three numbers is obtained.
 Find the probability that the sum obtained is more than 30 but less than 36.

$$= \frac{6}{64} = \frac{3}{32}$$

Answer [2]

- 23 In triangle ABC , $AB = 40$ cm, $BC = 22$ cm and $AC = 26$ cm. P is a point on BC produced, where $CP = 10$ cm and $AP = 24$ cm.



- (a) Explain why angle APB is a right angle.

Answer

$$AP^2 + BP^2 = 24^2 + 32^2 = 1600$$

$$AB^2 = 40^2 = 1600$$

Since $AB^2 = AP^2 + PB^2$, by converse of Pythagoras theorem, $\angle APB$ is a right angle

[1]

- (b) Express the following as a fraction in its lowest term

- (i) $\tan \angle ABP$,

$$\tan \angle ABP = \frac{24}{32}$$

$$\tan \angle ABP = \frac{3}{4}$$

Answer [1]

- (ii) $\cos \angle ACB$.

$$\cos \angle ACB = -\cos \angle ACP$$

$$\cos \angle ACB = -\frac{10}{26}$$

$$\cos \angle ACB = -\frac{5}{13}$$

Answer [1]

- (c) A circle passes through the points A , P and B . John said that the radius of the circle is 16 cm. Do you agree with him?

No. The diameter is AB as it is right angle in the semicircle () and hence the radius is 20 cm

.....

.....

[2]

- 24 Eighteen students took a test.

Their scores are shown in the stem-and-leaf diagram below.

Stem	Leaf
0	3 5 8
1	0 1 2 2 3 <i>p</i> 6 7 7 7 9
2	1 8 8 9

Key 1|3 means 13

- (a) Given that the median score is 15, find

(i) the modal score,

17

Answer [1]

(ii) the value of p .

$$\frac{10 + p + 16}{2} = 15$$

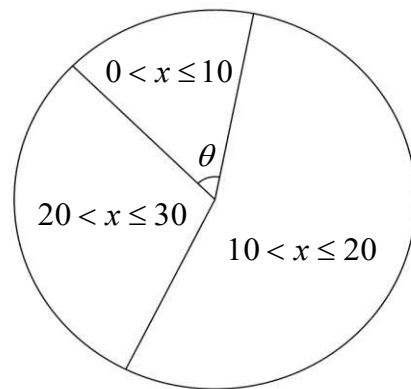
$$p = 4$$

Answer [1]

- (b) These students are grouped into three groups based on their scores, x . This is represented on the pie chart below. Find the value of θ .

$$\theta = \frac{4}{18} \times 360^\circ$$

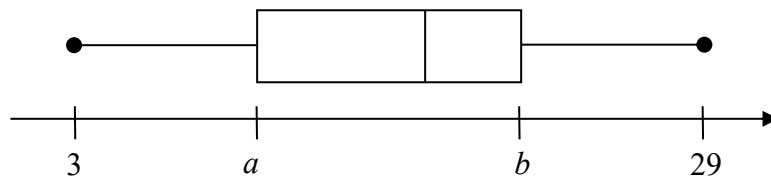
$$\theta = 80^\circ$$



Answer $\theta =$ [1]

- (c) The above data is represented on a box-and-whisker plot shown below.

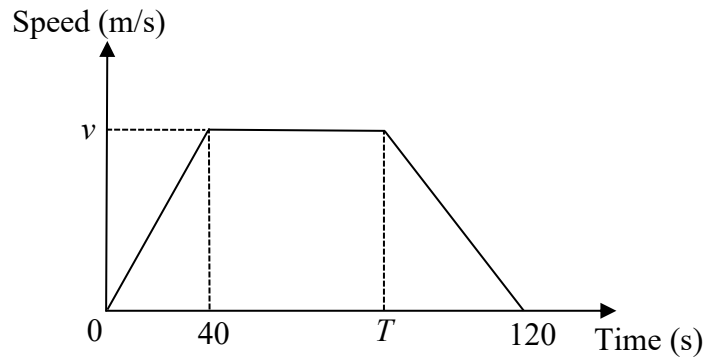
Find the value of a and of b .



$$a = 11, b = 19$$

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

- 25** The diagram below shows the speed-time graph of a bus journey.
 The bus accelerated from rest at 0.5 m/s^2 to a speed of $v \text{ m/s}$ in 40 seconds, and travelled at this speed until T seconds before it came to a stop at 120 seconds.
 The total distance travelled for the whole journey was 1500 m.
 The area beneath the speed-time graph represents the distance travelled by the bus.



Find the value of

- (a) v ,
 $\frac{v}{40} = 0.5$
 $v = 20$

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

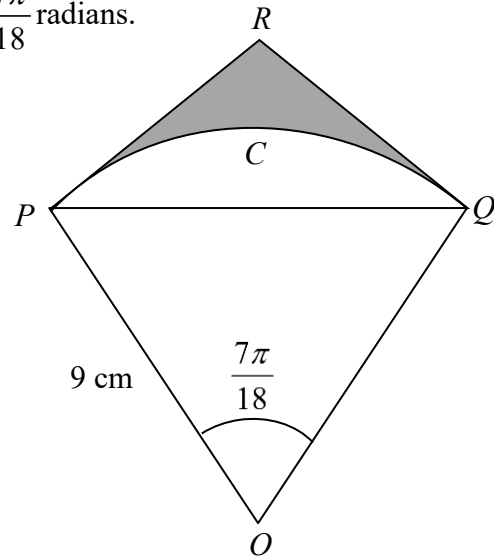
- (b) T .

$$\begin{aligned} \frac{1}{2}(120 + T - 40)(20) &= 1500 \\ (80 + T)(20) &= 3000 \\ 80 + T &= 150 \\ T &= 70 \end{aligned}$$

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

- 26 PCQ is an arc of a circle, centre O , of radius 9 cm.

The tangents at P and Q meet at R . Angle POQ is $\frac{7\pi}{18}$ radians.



- (a) Show that angle $PRQ = \frac{11\pi}{18}$ radians.

Answer

$$\angle PRQ = 2\pi - \frac{\pi}{2} - \frac{\pi}{2} - \frac{7\pi}{18}$$

$$\angle PRQ = \frac{11\pi}{18} \text{ (shown)}$$

[1]

- (b) Find the length of arc PCQ .

$$\text{arc } PCQ = \frac{7\pi}{18} \times 9$$

$$\text{arc } PCQ = 11.0 \text{ cm}$$

Answercm [1]

- (c) Find the area of the shaded region.

$$\tan\left(\frac{7\pi}{36}\right) = \frac{PR}{9}$$

$$PR = 9 \tan\left(\frac{7\pi}{36}\right)$$

$$\text{Area} = 2 \times \frac{1}{2} \times 9 \times 9 \tan\left(\frac{7\pi}{36}\right) - \frac{1}{2} \times 9^2 \times \frac{7\pi}{18}$$

$$\text{Area} = 7.24 \text{ cm}^2$$

Answer cm² [3]

END OF PAPER

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Name:	Register Number:	Class:
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PRESBYTERIAN HIGH SCHOOL



**MATHEMATICS
PAPER 2**

4052/02

21 August 2025

Thursday

2 hours 15 minutes

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2025 SECONDARY FOUR EXPRESS/ FIVE NORMAL PRELIMINARY EXAMINATION

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

INSTRUCTIONS TO CANDIDATES:

Write your name, index number and class on the spaces provided above.
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.

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 .

Note that all the diagrams in this paper are not drawn to scale.

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.

	<i>For Examiner's Use</i>										
Qn	1	2	3	4	5	6	7	8	9	10	Marks Deducted
Marks											

Category	Accuracy	Notations	Others
Question			

TOTAL MARKS
90

Setter: Ms Ong Bi Ru

Vetter: Mr Tan Chee Wee

This paper consists of **25** printed pages (including this cover page) and **1** blank 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

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

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

TURN OVER FOR QUESTION 1

1 (a) Solve $\frac{x-3}{5} + \frac{x}{7} - 1 = 0$.

Answer $x =$ [2]

(b) Simplify $\frac{10x^2}{y} \div \frac{2y^3}{x^2y}$.

Answer [1]

(c) Simplify $\frac{18a^2-2}{15a^2+7a-4}$.

Answer [3]

(d) Given the equation $q^2 + 6q - 20 = 0$.

(i) Express $q^2 + 6q - 20 = 0$ in the form $(q + m)^2 + n = 0$.

Answer [2]

(ii) Hence, solve for q , giving your answers correct to 2 decimal places.

Answer $q =$ or [2]

- 2 (a) Linus invests a sum of money at 7% per annum simple interest. At the end of n years, the amount is more than twice the initial sum of money. Find the minimum integer value of n .

Answer [3]

- (b) Marcus wants to invest \$12,000 for 4 years and is exploring two investment options with different compounding frequencies.

Option A

6.5% annual interest
compounded monthly

Option B

6.8% annual interest
compounded half yearly

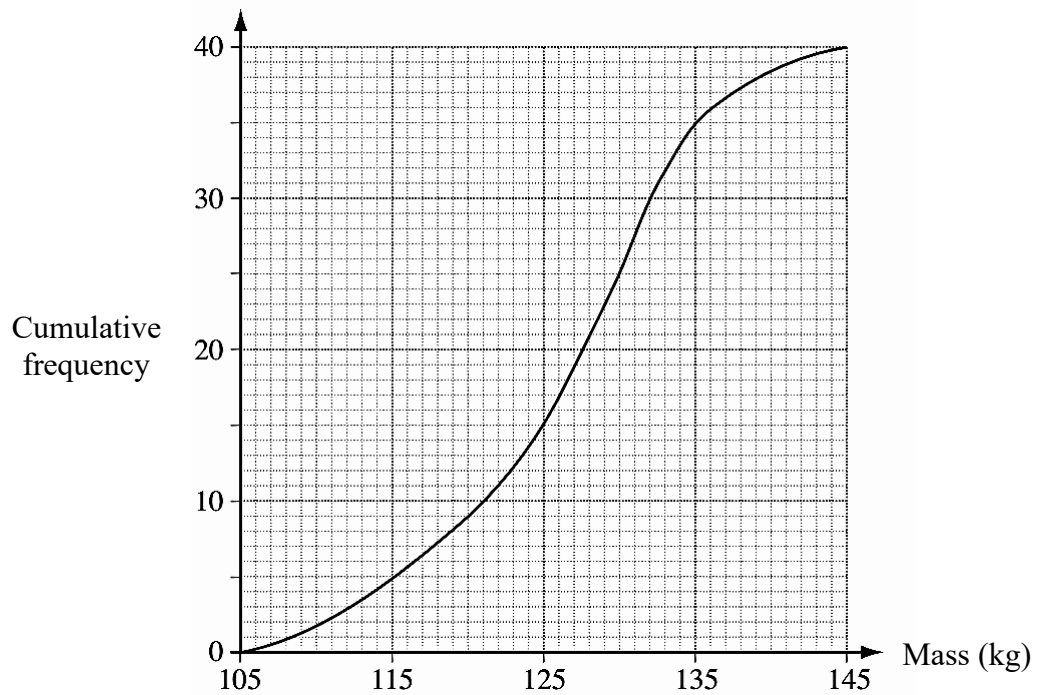
Determine which option Marcus should choose. Justify your reasons with calculations.

Answer Option [3]

- (c) A group of students travelled to Malaysia. They exchanged Singapore dollars (SGD) to Malaysian ringgit (MYR) at a rate of SGD 1 = MYR 3.20. They spent MYR 2525 on accommodation and food. They also bought 80 litres of fuel at MYR 2.50 per litre. They exchanged the remaining MYR at a rate of SGD 1 = MYR 3.25 and received SGD 60. Calculate the amount of SGD they exchanged at the start of their trip.

Answer SGD [3]

- 3 The cumulative frequency curve below shows the distribution of masses of adults **before** a weight loss programme. The programme has 40 adults.



(a) Using the graph,

- (i) find the number of adults who had a mass between 115 kg and 125 kg,

Answer adults [1]

- (ii) estimate the 90th percentile,

Answer kg [1]

- (iii) calculate the interquartile range.

Answer kg [2]

- (b) Two adults were selected at random before the programme. Find the probability that
- (i) at least one of the two adults was heavier than 135 kg,

Answer [2]

- (ii) one of the two adults was heavier than 120 kg and the other was not.

Answer [2]

- (c) The weight of these 40 adults are taken again **after** the weight loss programme. The details are shown below:

Median	25 th percentile	75 th percentile
115 kg	110 kg	119 kg

Make a comparison between the before and after programme to determine if the programme is effective.

Answer

.....

.....

.....[1]

- 4 (a) Complete the table of values for $y = \frac{3x^3}{10} - x + 1$.

x	-3	-2	-1	0	1	2	3
y	p	0.6	1.7	1	0.3	1.4	6.1

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

- (b) On the grid opposite, draw the graph of $y = \frac{3x^3}{10} - x + 1$ for $-3 \leq x \leq 3$. [3]

- (c) The equation $k = \frac{3x^3}{10} - x + 1$ has 2 solutions in the range $-3 \leq x \leq 3$.

Write down the value(s) of k .

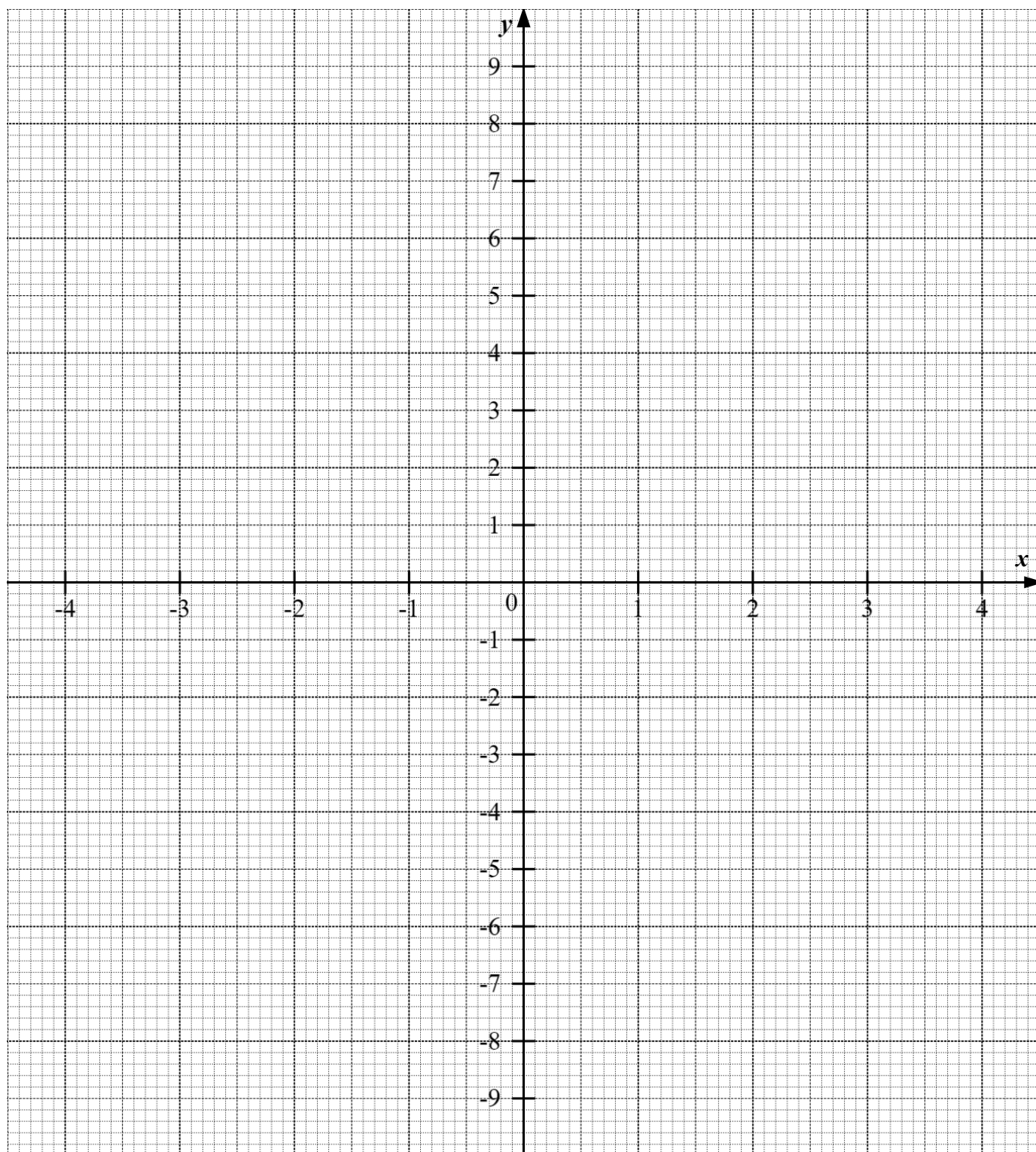
Answer $k = \dots\dots\dots$ [1]

- (d) By drawing a tangent, find the gradient of the curve at $x = 1.6$.

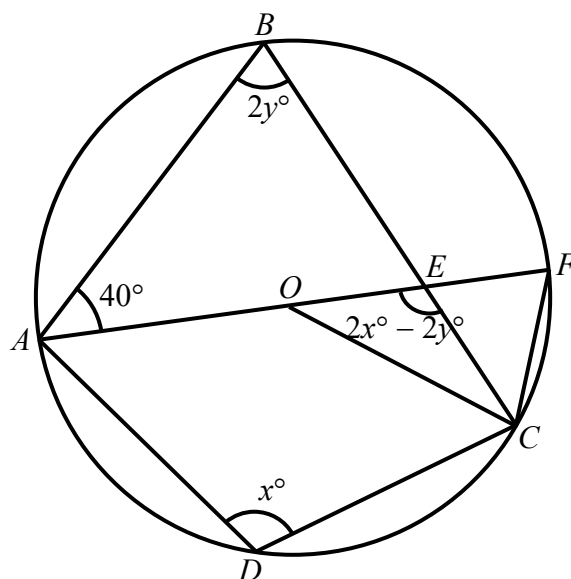
Answer $\dots\dots\dots$ [2]

- (e) By drawing a suitable straight line on the grid, solve the equation $3x^3 - 30x - 20 = 0$.

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



- 5 (a) In the diagram, the points A, B, C, D and F lie on the circle with centre O . AF is the diameter and CEB is a straight line, $\angle AEC = 2x^\circ - 2y^\circ$, $\angle ABC = 2y^\circ$, $\angle ADC = x^\circ$ and $\angle BAE = 40^\circ$.



Give a reason why

(i) $x + 2y = 180$,

Answer [1]

(ii) $2y + 40 = 2x - 2y$.

Answer [1]

- (b) Solve the two equations in **part (a)** simultaneously.

Answer $x =$

$y =$ [3]

- (c) Hence, calculate, stating reasons,

(i) $\angle AOC$,

Answer [2]

(ii) $\angle ACB$.

Answer [2]

- 6 (a)(i) Each interior angle of a regular polygon is y° . Find the number of sides of the polygon. Give your answer in terms of y .

Answer $^\circ$ [2]

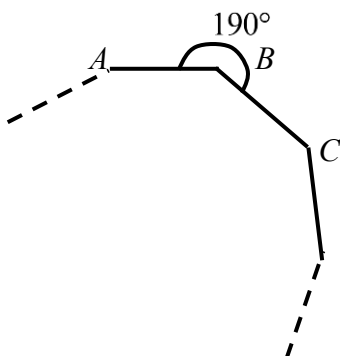
- (ii) Hence, explain whether it is possible for the value of y to be 20.

Answer

.....

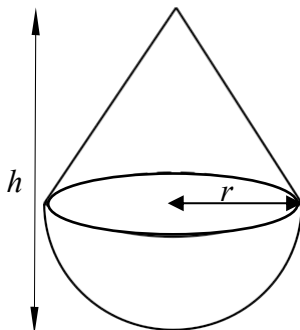
[2]

- (b) A , B and C are three vertices of an n -sided polygon. Given that the reflex angle $ABC = 190^\circ$ and all the other exterior angles are all equal to 35° each. Find n .



Answer $n =$ [3]

- 7 (a) The diagram shows a solid formed by joining a cone and a hemisphere at their circular bases. The radius of the circular base is r and the total height of the solid is h .



- (i) Write an expression for the height of the cone in terms of r and h .

Answer [1]

- (ii) If $r = 5$ cm and $h = 12$ cm, calculate the volume of the solid, giving your answer in terms of π .

Answer [2]

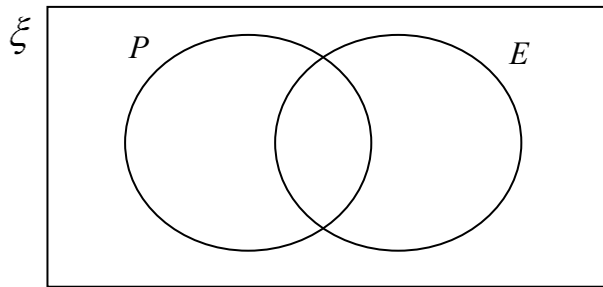
- (b) $\xi = \{\text{all quadrilaterals}\}$
 $P = \{\text{quadrilaterals with at least one pair of parallel sides}\}$
 $E = \{\text{quadrilaterals with diagonals that intersect at right angles}\}$

K is a kite.

R is a rhombus.

T is a trapezium.

On the Venn Diagram below, write K , R and T in the appropriate subsets. [2]



8 (a) The point A is $(2, -3)$ and the point B is $(7, 4)$.

(i) Express $\overrightarrow{AB}$ as a column vector.

Answer [1]

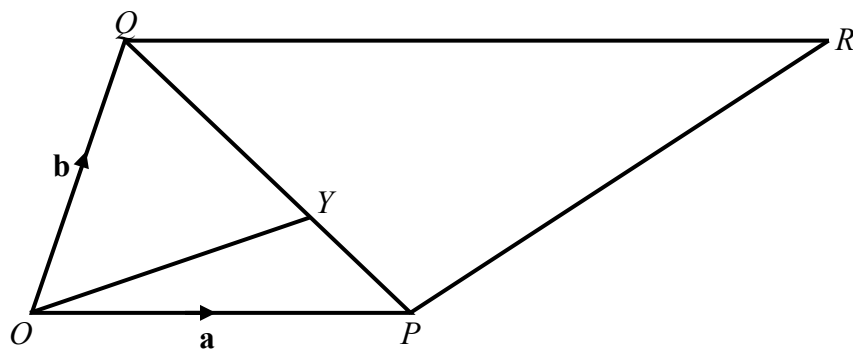
(ii) Find $|\overrightarrow{AB}|$.

Answer [2]

(iii) C is the point such that $\overrightarrow{AC} = 3\overrightarrow{AB}$.
Find the coordinates of C .

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

(b)



In the diagram, $\overrightarrow{OP} = \mathbf{a}$, $\overrightarrow{OQ} = \mathbf{b}$, $\overrightarrow{PY} = \frac{1}{3}\overrightarrow{PQ}$ and $\overrightarrow{QR} = 2\overrightarrow{OP}$.

(i) Express each of the following in terms of $\mathbf{a}$ and $\mathbf{b}$.

(a) $\overrightarrow{OR}$

Answer [1]

(b) $\overrightarrow{PY}$

Answer [1]

(c) $\overrightarrow{OY}$

Answer [1]

- (ii) What can you deduce about O , Y and R ? Explain.

Answer

.....

.....

.....

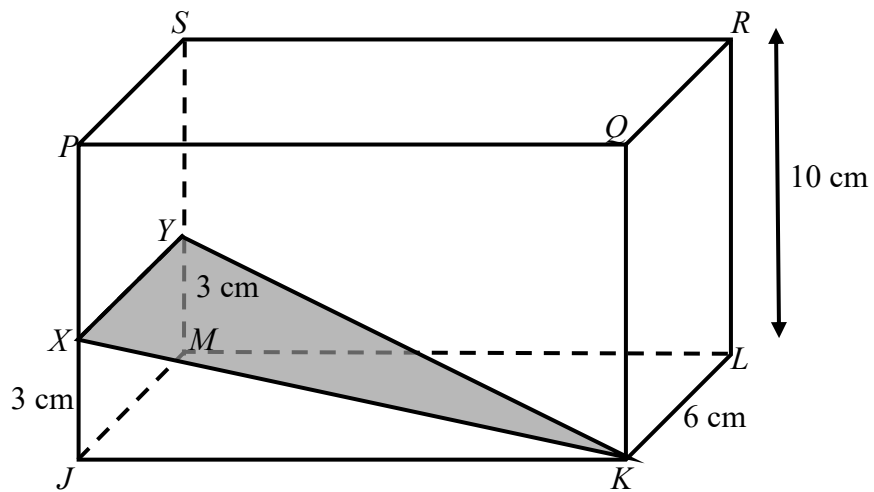
.....

.....[2]

- (iii) Find $\frac{\text{area of triangle } OPY}{\text{area of triangle } OQY}$.

Answer [1]

- 9 (a) The figure shows a sloping triangle XYK in a cuboid. The cuboid has a base width of 6 cm and height 10 cm. $XJ = YM = 3$ cm.



- (i) Given that $YK = \sqrt{369}$ cm, explain why $XK = \sqrt{333}$ cm.

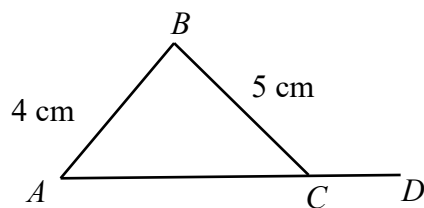
Answer

[2]

- (ii) Suppose $JK = 18$ cm, find $\angle XPK$, to the nearest degree.

Answer° [3]

- (b) In the diagram, ACD is a straight line. $AB = 4$ cm, $BC = 5$ cm and $\sin \angle BCD = \frac{3}{4}$.



- (i) Find angle ABC .

Answer $^{\circ}$ [3]

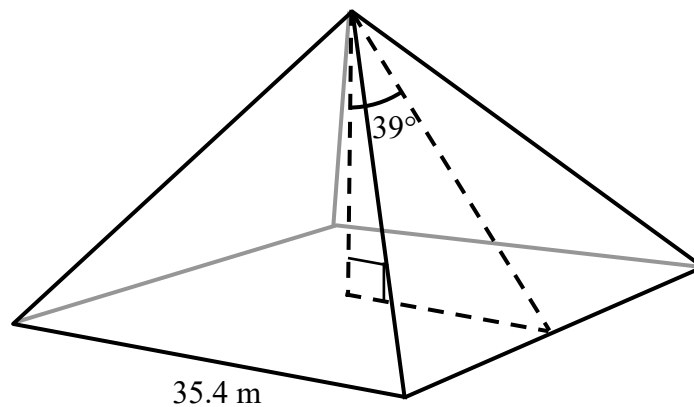
- (ii) Hence find the area of triangle ABC .

Answer cm^2 [1]

10



The photograph above shows the picture of the Louvre Pyramid in Paris. The angle formed by the slant height and vertical height of the pyramid is 39° . The Louvre Pyramid can be modelled by a square pyramid with base length 35.4 m as shown in the figure below.



- (a) Show that the slant height of the pyramid is 28.126 m, correct to 3 decimal places.

Answer

- (b) Calculate the total surface area of the four lateral faces of the pyramid.

Answer m² [2]

- (c) The Louvre Pyramid was constructed using glass panels and steel rods. Information on the construction materials used is as follows:

- 90% of the four lateral faces of the pyramid is covered with glass panels.
- The glass panels have uniform thickness of 21 mm.
- The density of the glass used for the panels is 2790 kg/m^3 .

$$\left[\text{Density} = \frac{\text{Mass}}{\text{Volume}} \right]$$
- The total mass of steel rods used is 95 tonnes. [1 tonne = 1000 kg]

A geometrically similar replica of the Louvre Pyramid is being constructed using the same materials and will be displayed on a raised platform for an exhibition.

The raised platform must be large enough to fit the base of the replica.

The base length of the replica pyramid is 4 metres.

The exhibition organisers need to select a suitable material for the raised platform.

The maximum load capacity and price of different materials for the raised platform are shown in the table below.

Platform material	Solid Hardwood	Marble	Concrete
Maximum load capacity	250 kg	500 kg	700 kg
Approx cost	\$8.50 per kg	\$300 per m^2	\$220 per 1.5 m by 1.5 m slab

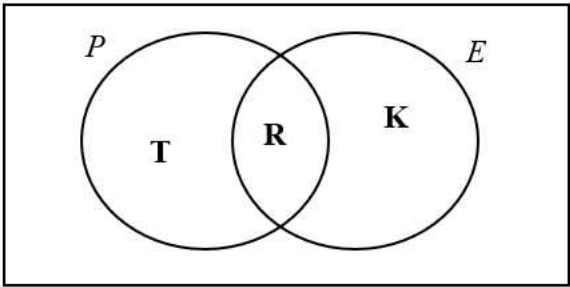
* Concrete is sold in standard slab units, which are not designed to be cut or resized.

Make a recommendation to the exhibition organisers on the choice of material for the raised platform. Justify your recommendation and show your calculations clearly.

.....
.....[7]

END OF PAPER

No	Answer Key
1a	$x = 4\frac{2}{3}$ <i>accept</i> $\frac{14}{3}$
1b	$\frac{5x^4}{y^3}$
1c	$\frac{6a+2}{5a+4}$
1di	$(q+3)^2 - 29 = 0$
1dii	$q = 2.38516$ or $q = -8.39$ $q = 2.39$
2a	n=15
2b	Option B
2c	912.50SGD
2ai	10
3aii	136
3aiii	11kg
3bi	$\frac{37}{156}$
3bii	$\frac{93}{260}$
3c	The median is 127.5kg before the programme and 115kg after the programme. This shows the adults participating in the event is lighter after the programme. In conclusion, the programme is effective.
4a	<u>-4.1</u>
4b	<u>Graph</u>
4c	$k = 1.70$, $k = 0.30$
4d	1.33
4e	$x = -2.7, -0.7$
5ai	Angles in opp segment
5aii	Sum of exterior angles or angle sum of triangle and adjacent angles on a straight line
5b	$x = 100, y = 40$
5ci	160°
5cii	50°
6ai	$n = \frac{360}{180 - y}$
6aii	Since n is not an integer, it is not possible.
6b	$n = 11$
7ai	$h - r$
7aii	$\frac{425\pi}{3}$ or $141\frac{2}{3}\pi$

7b	ξ 
8ai	$\begin{pmatrix} 5 \\ 7 \end{pmatrix}$
8aii	8.60units
8aiii	$C(17,18)$
8bia	$2\bar{a} + \bar{b}$
8bib	$\frac{1}{3}(\bar{b} - \bar{a})$
8bic	$\frac{1}{3}\bar{b} + \frac{2}{3}\bar{a}$
8bii	Hence $\overrightarrow{OY}$ and $\overrightarrow{OR}$ are parallel vectors are in the same direction. Since they share the common point Y they lie on the same straight line.
8biii	$\frac{1}{2}$
9ai	$369 - 6^2 = XK^2$ M1 $XK^2 = 333$ $XK = \sqrt{333}$ (shown) A1
9aii	60.9°
9bi	61.8°
9bii	8.81cm^2
10a	$\sin 39^\circ = \frac{35.4 \div 2}{l}$ $l = \frac{17.7}{\sin 39^\circ}$ $= 28.126$ (to 3 d.p.)
10b	1990m^2
10c	I would recommend using concrete for the raised platform as the mass of the replica is within the load capacity of concrete and concrete would be cheaper than marble

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Name:	Register Number:	Class:
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PRESBYTERIAN HIGH SCHOOL



**MATHEMATICS
PAPER 2**

4052/02

21 August 2025

Thursday

2 hours 15 minutes

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2025 SECONDARY FOUR EXPRESS/ FIVE NORMAL PRELIMINARY EXAMINATION

SUGGESTED ANSWERS

Setter: Ms Ong Bi Ru
Vetter: Mr Tan Chee Wee

This paper consists of **23** printed pages (including this cover page) and **1** blank 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

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

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

TURN OVER FOR QUESTION 1

1 (a) Solve $\frac{x-3}{5} + \frac{x}{7} - 1 = 0$.

Answer :

$$\frac{7(x-3)}{35} + \frac{5x}{35} = 1$$

$$7x - 21 + 5x = 35$$

$$12x = 56$$

$$x = 4\frac{2}{3}$$

$$\text{accept } \frac{14}{3}$$

Answer $x =$ [2]

(b) Simplify $\frac{10x^2}{y} \div \frac{2y^3}{x^2y}$.

Answer :

$$\frac{5x^4}{y^3}$$

Answer [1]

(c) Simplify $\frac{18a^2 - 2}{15a^2 + 7a - 4}$.

Answer :

$$\frac{2(9a^2 - 1)}{(3a - 1)(5a + 4)}$$

$$= \frac{2(3a + 1)(3a - 1)}{(5a + 4)(3a - 1)}$$

$$= \frac{6a + 2}{5a + 4}$$

Answer [3]

(d) Given the equation $q^2 + 6q - 20 = 0$.

(i) Express $q^2 + 6q - 20 = 0$ in the form $(q + m)^2 + n = 0$.

Answer :

$$q^2 + 6q + \left(\frac{6}{2}\right)^2 - \left(\frac{6}{2}\right)^2 - 20 = 0$$

$$(q + 3)^2 - 9 - 20 = 0$$

$$(q + 3)^2 - 29 = 0$$

Answer [2]

(ii) Hence, solve for q , giving your answers correct to 2 decimal places.

Answer :

$$q = 2.38516 \quad \text{or} \quad q = -8.39$$

$$q = 2.39$$

Answer $q =$ or [2]

- 2 (a) Linus invests a sum of money at 7% per annum simple interest. At the end of n years, the amount is more than twice the initial sum of money. Find the minimum integer value of n .

Answer :

Let the principal be P

Total amount = $Pr t + P$

After n years

$$\text{Amount} = P \left(1 + \frac{7n}{100} \right)$$

$$P \left(1 + \frac{7n}{100} \right) > 2P$$

$$\left(1 + \frac{7n}{100} \right) > 2$$

$$0.07n > 1$$

$$n > 14.285$$

$$n = 15$$

OR

$$\frac{Pr n}{100} > P$$

$$rn > 100$$

$$7n > 100$$

$$n > 14.2857$$

$$n = 15$$

Answer [3]

- (b) Marcus wants to invest \$12,000 for 4 years and is exploring two investment options with different compounding frequencies.

Option A

6.5% annual interest
compounded monthly

Option B

6.8% annual interest
compounded half yearly

Determine which option Marcus should choose. Justify your reasons with calculations.

Answer :

Option A

$$12000\left(1 + \frac{0.065}{12}\right)^{12 \times 4}$$

$$= \$15552.25$$

Option B

$$12000\left(1 + \frac{0.068}{2}\right)^{2 \times 4}$$

$$= \$15679.98$$

Answer: Option B

- (c) A group of students travelled to Malaysia. They exchanged Singapore dollars (SGD) to Malaysian ringgit (MYR) at a rate of SGD 1 = MYR 3.20. They spent MYR 2525 on accommodation and food. They also bought 80 litres of fuel at MYR 2.50 per litre. They exchanged the remaining MYR at a rate of SGD 1 = MYR 3.25 and received SGD 60. Calculate the amount of SGD they exchanged at the start of their trip.

Answer :

Fuel cost

$$= 80 \times 2.50$$

$$= 200 \text{ MYR}$$

Total Spending

$$= 2525 + 200 + (3.25 \times 60)$$

$$= 2920 \text{ MYR}$$

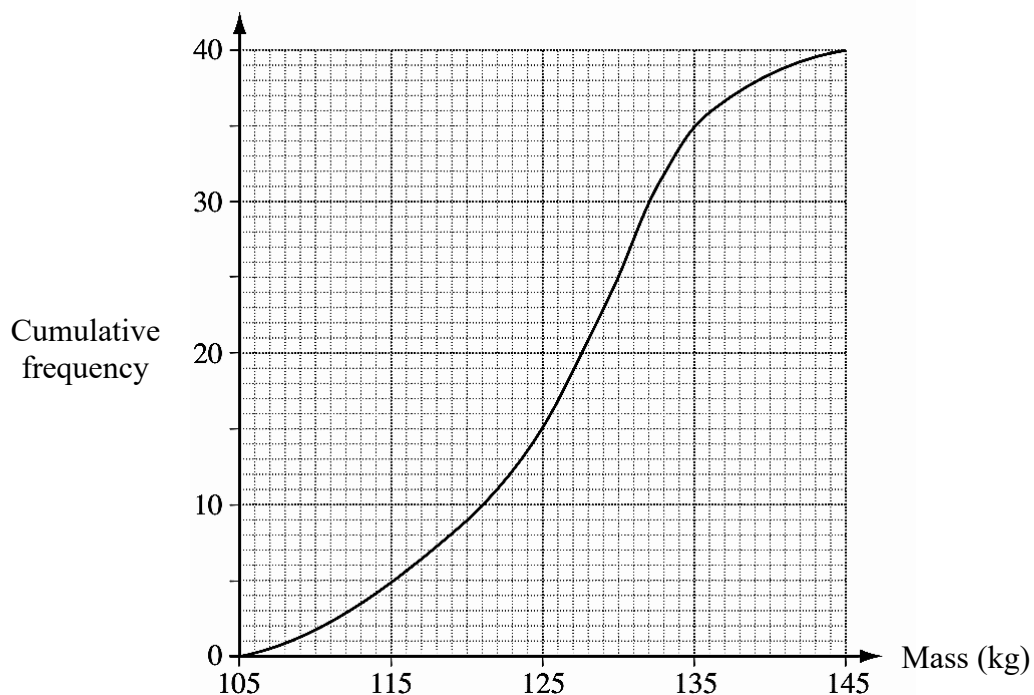
Initial SGD

$$= 2920 \div 3.20$$

$$= 912.50 \text{ SGD}$$

Answer SGD..... [3]

- 3 The cumulative frequency curve below shows the distribution of masses of adults **before** a weight loss programme. The programme has 40 adults.



(a) Using the graph,

- (i) find the number of adults who had a mass between 115 kg and 125 kg,

Answer 10 adults [1]

- (ii) estimate the 90th percentile.

Answer 136 kg [1]

- (iii) calculate the interquartile range.

Answer :
 $132 - 121$
 $= 11\text{kg}$

Answer kg [2]

- (b) Two adults were selected at random before the programme. Find the probability that
- (i) at least one of the two adults was heavier than 135 kg,

Answer :

$P(\text{both are less than or equal to } 135\text{kg})$

$$= \frac{35}{40} \times \frac{34}{39}$$

$$= \frac{119}{156}$$

$P(\text{at least one of the two adults has a mass of more than } 135\text{kg})$

$$= 1 - \frac{119}{156}$$

$$= \frac{37}{156}$$

Answer kg [2]

- (ii) one of the two adults was heavier than 120 kg and the other was not.

Answer :

$$\frac{9}{40} \times \frac{31}{39} \times 2$$

$$= \frac{93}{260}$$

Answer kg [2]

- (c) The weight of these 40 adults are taken again **after** the weight loss programme. The details are shown below:

Median	25 th percentile	75 th percentile
115 kg	110 kg	119 kg

Make a comparison between the before and after programme to determine if the programme is effective.

Answer :

The median is 127.5kg before the programme and 115kg after the programme.

This shows the adults participating in the event is lighter after the programme.

In conclusion, the programme is effective.

B1

- 4 (a) Complete the table of values for $y = \frac{3x^3}{10} - x + 1$.

x	-3	-2	-1	0	1	2	3
y	p	0.6	1.7	1	0.3	1.4	6.1

Answer $p = \dots -4.1 \dots$ [1]

- (b) On the grid opposite, draw the graph of $y = \frac{3x^3}{10} - x + 1$ for $-3 \leq x \leq 3$. [3]

- (c) The equation $k = \frac{3x^3}{10} - x + 1$ has 2 solutions in the range $-3 \leq x \leq 3$.

Write down the value(s) of k .

Answer $k = 1.70, k = 0.30 \dots$ [1]

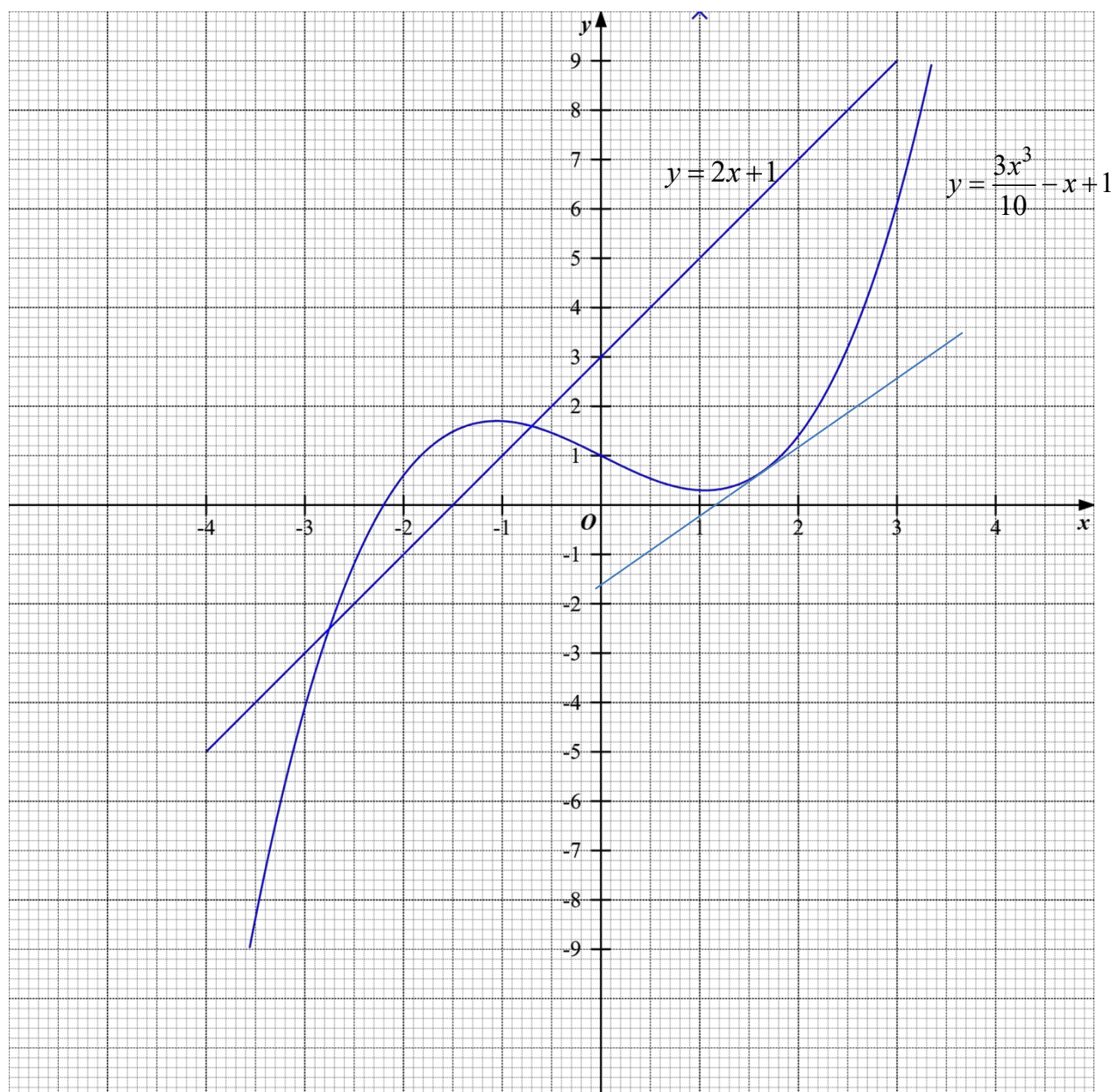
- (d) By drawing a tangent, find the gradient of the curve at $x = 1.6$.

Answer 1.33 $\dots$ [2]

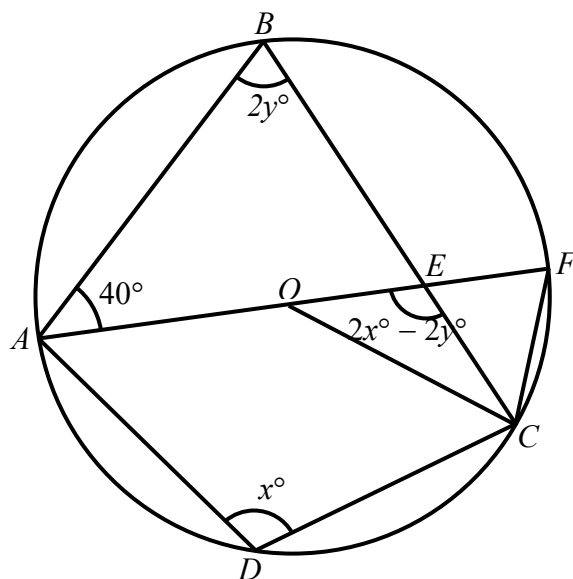
- (e) By drawing a suitable straight line on the grid, solve the equation $3x^3 - 30x - 20 = 0$.

$\frac{3x^3}{10} - x + 1 = 2x + 3$ $x = -2.7, -0.7$

Answer $x = \dots$ [3]



- 5 (a) In the diagram, the points A, B, C, D and F lie on the circle with centre O . AF is the diameter and CEB is a straight line, $\angle AEC = 2x - 2y^\circ$, $\angle ABC = 2y^\circ$, $\angle ADC = x^\circ$ and $\angle BAE = 40^\circ$.



Give a reason why

(i) $x + 2y = 180$,

Answer Angles in opp segment () [1]

(ii) $2y + 40 = 2x - 2y$.

Answer Sum of exterior angles or angle sum of triangle and adjacent angles on a straight line [1]

- (b) Solve the two equations in **part (a)** simultaneously.

$$\begin{aligned}x &= 100 \\ y &= 40\end{aligned}$$

Answer $x =$

$y =$ [3]

- (c) Hence, calculate, stating reasons,

- (i) $\angle AOC$,

$$\angle ABC$$

$$= 40 \times 2$$

$$= 80^\circ$$

$$\angle AOC$$

$$= 80^\circ \times 2 \quad (\text{angles in the centre is twice the angles at the circumference})$$

$$= 160^\circ$$

Answer [2]

(ii) $\angle ACB$.

$$\begin{aligned}\angle ECF & \quad (\text{angles in the same segment}) \\ &= 40^\circ \\ \angle ACB & \\ &= 90^\circ - 40^\circ \quad (\text{angles in semi circle}) \\ &= 50^\circ\end{aligned}$$

Answer [2]

- 6 (a)(i) Each interior angle of a regular polygon is y° . Find the number of sides of the polygon. Give your answer in terms of y .

$$\begin{aligned}\frac{(n-2) \times 180}{n} &= y \\ ny &= 180n - 360 \\ 180n - ny &= 360 \\ n(180 - y) &= 360 \\ n &= \frac{360}{180 - y}\end{aligned}$$

Answer $^\circ$ [2]

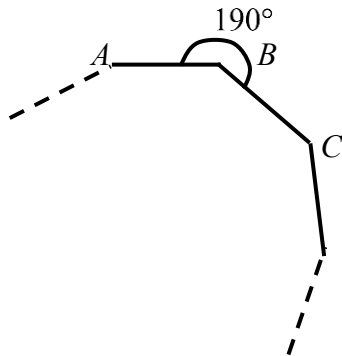
- (ii) Hence, explain whether it is possible for y to be 20.

$$\text{when } y = 20, n = \frac{9}{4}.$$

Since n is not an integer, it is not possible.

Answer $^\circ$ [2]

- (c) A , B and C are three vertices of an n -sided polygon. Given that the reflex angle $ABC = 190^\circ$ and all the other exterior angles are all equal to 35° each. Find n .



$$\angle ABC$$

$$= 360^\circ - 190^\circ$$

$$= 170^\circ$$

$$\text{Ext angle}$$

$$= 180^\circ - 170^\circ$$

$$= 10^\circ$$

$$(n-1)35^\circ + 10^\circ = 360^\circ$$

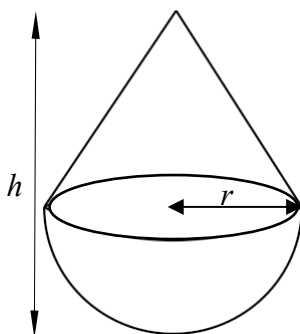
$$35n - 35 + 10 = 360$$

$$35n = 360 + 25$$

$$n = 11$$

Answer [3]

- 7 (a) The diagram shows a solid formed by joining a cone and a hemisphere at their circular bases. The radius of the circular base is r and the total height of the solid is h .



- (i) Write an expression for the height of the cone in terms of r and h .

$$h - r$$

Answer [1]

- (ii) If $r = 5$ cm and $h = 12$ cm, calculate the volume of the solid, giving your answer in terms of π .

Total volume

$$\begin{aligned} &= \frac{1}{3} \pi (5)^2 (7) + \frac{2}{3} \pi (5)^3 \\ &= \frac{425\pi}{4} \text{ or } 141\frac{2}{3} \pi \text{ cm}^3 \end{aligned}$$

Answer [2]

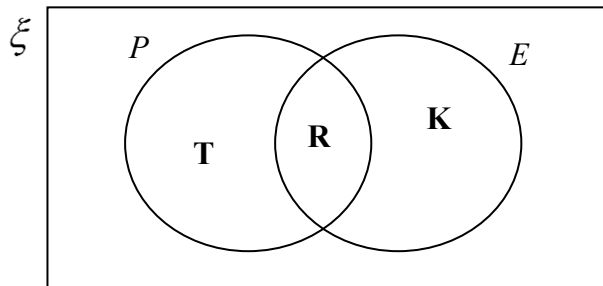
- (b) $\xi = \{\text{all quadrilaterals}\}$
 $P = \{\text{quadrilaterals with at least one pair of parallel sides}\}$
 $E = \{\text{quadrilaterals with diagonals that intersect at right angles}\}$

K is a kite.

R is a rhombus.

T is a trapezium.

On the Venn Diagram below, write K , R and T in the appropriate subsets. [2]



8 (a) The point A is $(2, -3)$ and the point B is $(7, 4)$.

(i) Express $\overrightarrow{AB}$ as a column vector.

$$\begin{pmatrix} 5 \\ 7 \end{pmatrix}$$

Answer [1]

(ii) Find $|\overrightarrow{AB}|$.

$$\begin{aligned} & \sqrt{5^2 + 7^2} \\ &= \sqrt{74} \\ &= 8.60 \text{ units} \end{aligned}$$

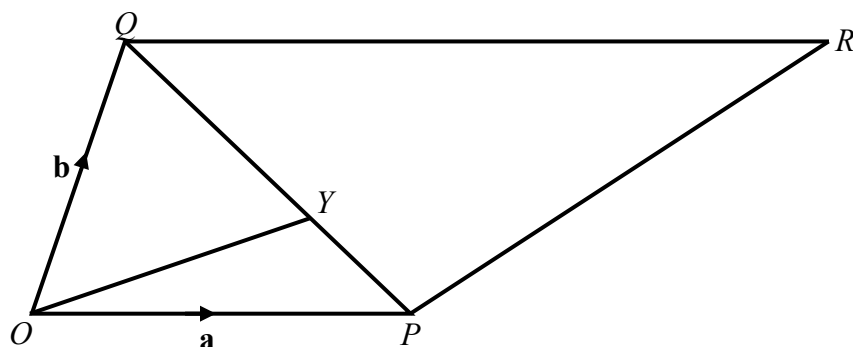
Answer [2]

(iii) C is the point such that $\overrightarrow{AC} = 3\overrightarrow{AB}$.
Find the coordinates of C .

$$\begin{aligned} \overrightarrow{AC} &= \overrightarrow{OC} - \overrightarrow{OA} \\ &= \begin{pmatrix} x \\ y \end{pmatrix} - \begin{pmatrix} 2 \\ -3 \end{pmatrix} \\ \begin{pmatrix} x-2 \\ y+3 \end{pmatrix} &= 3 \begin{pmatrix} 5 \\ 7 \end{pmatrix} \\ x-2 &= 15 \\ y+3 &= 21 \\ x &= 17 \\ y &= 18 \\ C &= (17, 18) \end{aligned}$$

Answer [2]

(b)



In the diagram, $\overrightarrow{OP} = \mathbf{a}$, $\overrightarrow{OQ} = \mathbf{b}$, $\overrightarrow{PY} = \frac{1}{3}\overrightarrow{PQ}$ and $\overrightarrow{QR} = 2\overrightarrow{OP}$.

(i) Express each of the following in terms of $\mathbf{a}$ and $\mathbf{b}$.

(a) $\overrightarrow{OR}$

$$2\mathbf{a} + \mathbf{b}$$

Answer [1]

(b) $\overrightarrow{PY}$

$$\frac{1}{3}(\mathbf{b} - \mathbf{a})$$

Answer [1]

(c) $\overrightarrow{OY}$

$$\frac{1}{3}\mathbf{b} + \frac{2}{3}\mathbf{a}$$

Answer [1]

- (ii) What can you deduce about O , Y and R ? Explain.

Since

$$\overrightarrow{OY} = \frac{1}{3} \overrightarrow{OR} \quad \text{M1}$$

Hence $\overrightarrow{OY}$ and $\overrightarrow{OR}$ are parallel vectors are in the same direction.

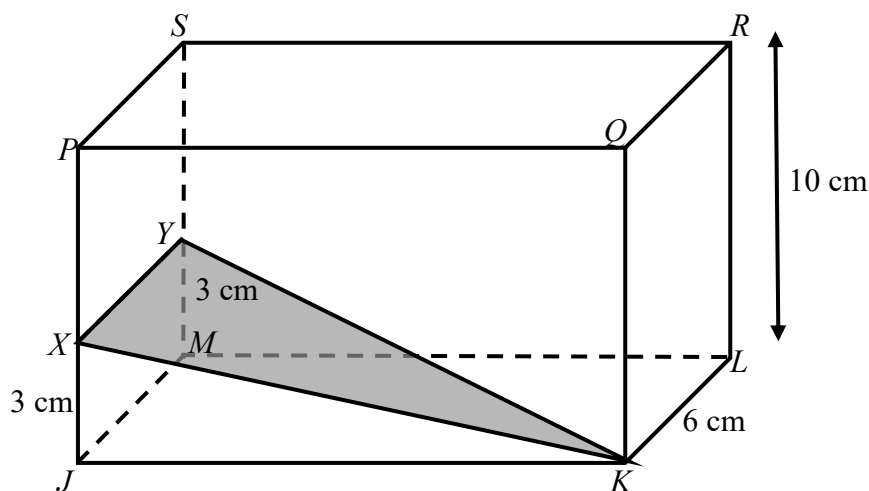
Since they share the common point Y they lie on the same straight line. A1

- (iii) Find $\frac{\text{area of triangle } OPY}{\text{area of triangle } OQY}$.

$$\frac{1}{2}$$

Answer [1]

- 9 (a) The figure shows a sloping triangle XYK in a cuboid. The cuboid has a base width of 6 cm and height 10 cm. $XJ = YM = 3$ cm.



- (i) Given that $YK = \sqrt{369}$ cm, explain why $XK = \sqrt{333}$ cm.

Answer

$$369 - 6^2 = XK^2$$

$$XK^2 = 333$$

$$XK = \sqrt{333} \text{ (shown)}$$

[2]

(ii) Suppose $JK = 18$ cm, find $\angle XPK$, to the nearest degree.

PK

$$= \sqrt{10^2 + 18^2}$$

$$= \sqrt{424}$$

$$333 = 7^2 + 424 - 2(7)(\sqrt{424}) \cos \angle XPK$$

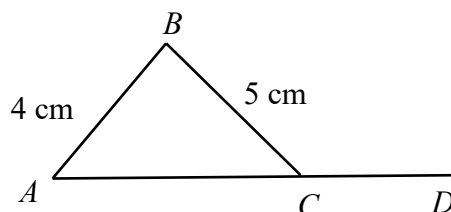
$$\angle XPK = 61^\circ \text{ (nearest degree)}$$

$$\text{Or } \tan \angle XPK = \frac{18}{10}$$

$$\begin{aligned} \angle XPK &= \tan^{-1}\left(\frac{18}{10}\right) \\ &= 61^\circ \end{aligned}$$

Answer [3]

(b) In the diagram, ACD is a straight line. $AB = 4$ cm, $BC = 5$ cm and $\sin \angle BCD = \frac{3}{4}$.



(i) Find angle ABC .

$$\angle BCA = \sin^{-1}\left(\frac{3}{4}\right)$$

$$\angle BCA = 48.5903^\circ$$

$$\frac{\sin 48.5903^\circ}{4} = \frac{\sin \angle CAB}{5}$$

$$\angle CAB = 69.6356^\circ$$

$$\angle ABC$$

$$= 180^\circ - 69.6356^\circ - 48.5903^\circ$$

$$= 61.8^\circ$$

Answer [3]

(ii) Hence find the area of triangle ABC .

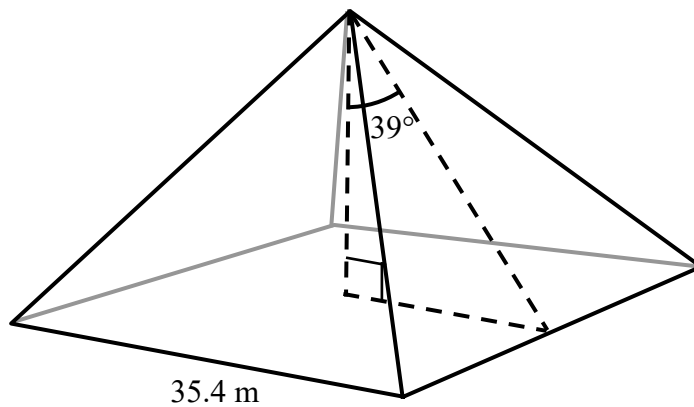
$$0.5 \times 4 \times 5 \times \sin \angle ABC$$

$$= 8.81 \text{ cm}^2$$

10



The photograph above shows the picture of the Louvre Pyramid in Paris. The angle formed by the slant height and vertical height of the pyramid is 39° . The Louvre Pyramid can be modelled by a square pyramid with base length 35.4 m as shown in the figure below.



- (a) Show that the slant height of the pyramid is 28.126 m, correct to 3 decimal places.

$$\sin 39^\circ = \frac{35.4 \div 2}{l}$$

$$\begin{aligned} l &= \frac{17.7}{\sin 39^\circ} \\ &= 28.126 \text{ (to 3 d.p.)} \end{aligned}$$

Answerm [2]

- (b) Calculate the total surface area of the four lateral faces of the pyramid.

$$\begin{aligned}
 &\text{Total external surface area of glass} \\
 &= \left(\frac{1}{2} \times 35.4 \times 28.126 \right) \times 4 \\
 &= 1991.32 \\
 &= 1990 \text{ m}^2 \text{ (3 s.f.)}
 \end{aligned}$$

Answerm² [2]

- (c) The Louvre Pyramid was constructed using glass panels and steel rods. Information on the construction materials used is as follows:

- 90% of the four lateral faces of the pyramid is covered with glass panels.
 - The glass panels have uniform thickness of 21 mm.
 - The density of the glass used for the panels is 2790 kg/m³.
- [Density = $\frac{\text{Mass}}{\text{Volume}}$]
- The total mass of steel rods used is 95 tonnes. [1 tonne = 1000 kg]

A geometrically similar replica of the Louvre Pyramid is being constructed using the same materials and will be displayed on a raised platform for an exhibition.

The raised platform must be large enough to fit the base of the replica.

The base length of the replica pyramid is 4 metres.

The exhibition organisers need to select a suitable material for the raised platform.

The maximum load capacity and price of different materials for the raised platform are shown in the table below.

Platform material	Solid Hardwood	Marble	Concrete
Maximum load capacity	250 kg	500 kg	700 kg
Approx cost	\$8.50 per kg	\$300 per m ²	\$220 per 1.5 m by 1.5 m slab

* Concrete is sold in standard slab units, which are not designed to be cut or resized.

Make a recommendation to the exhibition organisers on the choice of material for the raised platform. Justify your recommendation and show your calculations clearly.

$$\text{Total surface area of glass panels} = 0.9 \times 1991.32 = 1792.19$$

$$\text{Volume of glass panels} = 1792.19 \times 0.021 = 37.636 \text{ m}^3$$

$$\text{Mass of glass panels} = 37.636 \times 2790 = 105004 \text{ kg}$$

$$\text{Total mass of Louvre Pyramid} = 105004 + 95000 = 200004 \text{ kg}$$

$$\text{Mass of replica} = \left(\frac{4}{35.4}\right)^3 \times 200004 = 288.542 \text{ kg}$$

$$\text{Min cost of 9 concrete slabs} = 9 \times 220 = \$1980$$

$$\text{Min cost of } 16 \text{ m}^2 \text{ of marble} = 16 \times 300 = \$4800$$

I would recommend using concrete for the raised platform as the mass of the replica is within the load capacity of concrete and concrete would be cheaper than marble.

[7]

END OF PAPER