

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

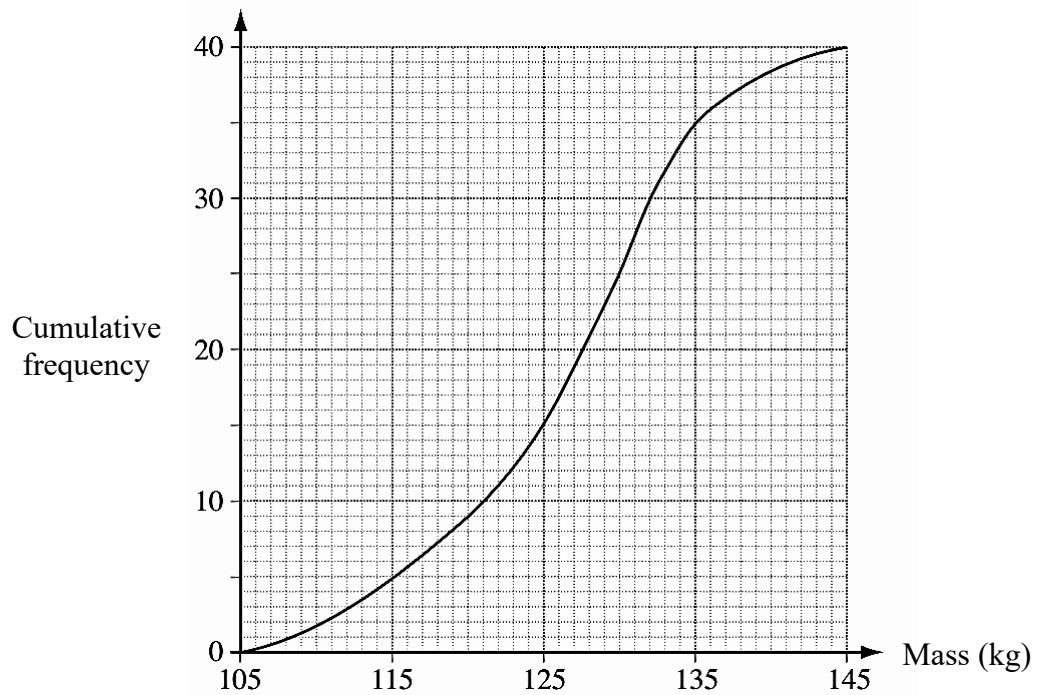
Determine which option Marcus should choose. Justify your reasons with calculations.

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 .

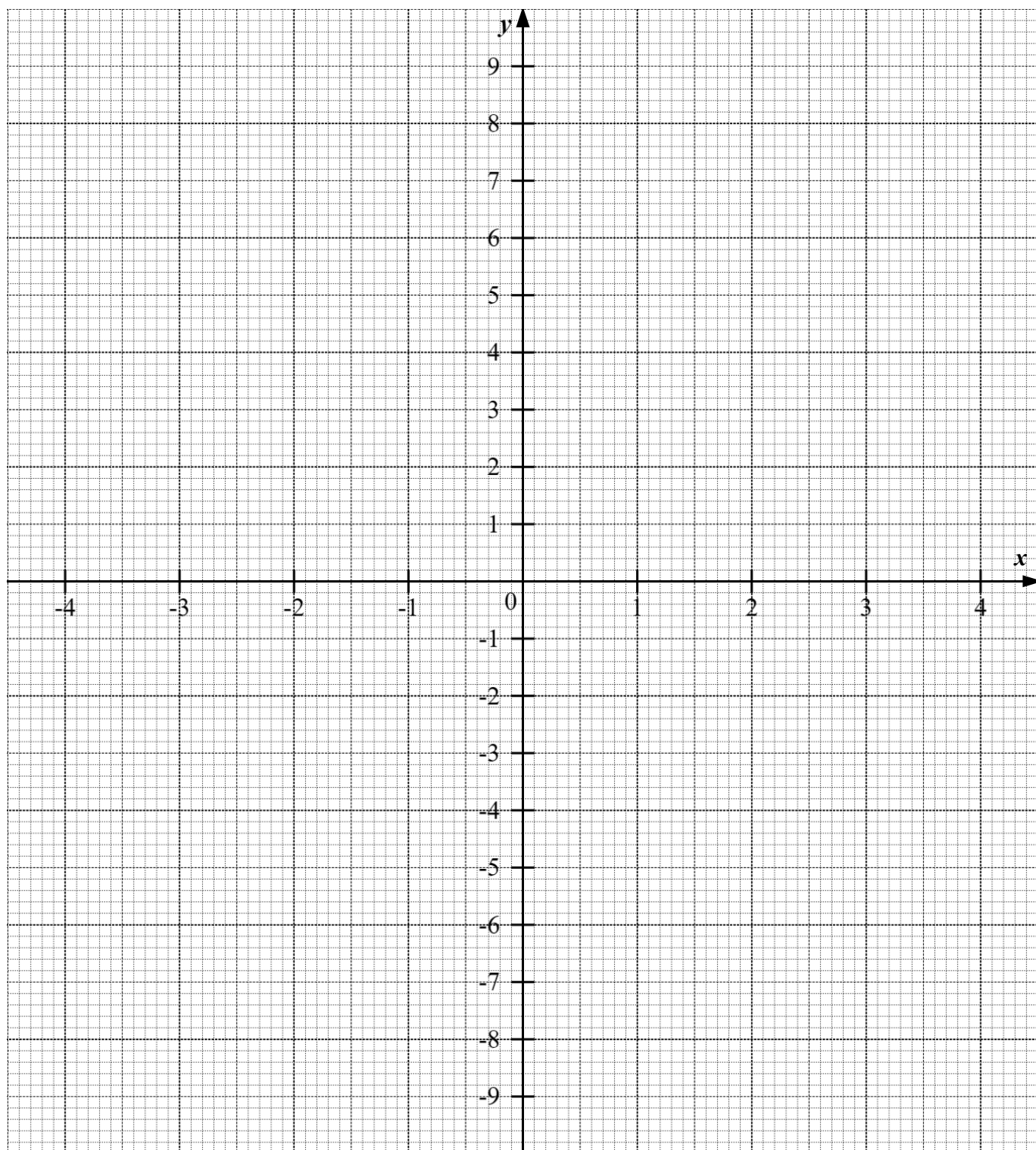
Answer $k = \dots\dots\dots$ [1]

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

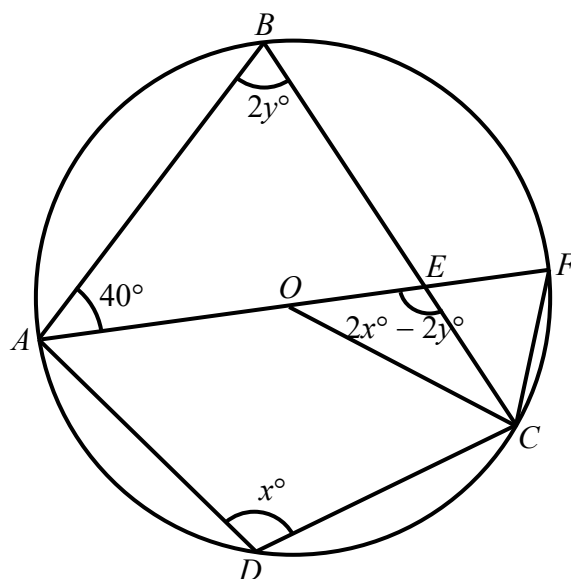
Answer $\dots\dots\dots$ [2]

- (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]

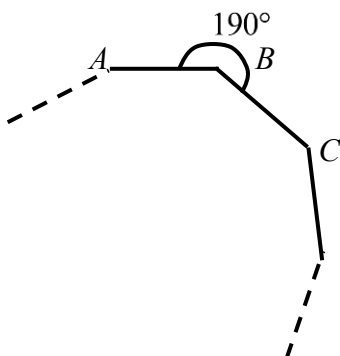
- (ii) Hence, explain whether it is possible for the value of y to be 20.

Answer

.....

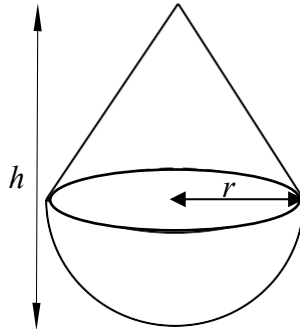
[2]

- (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]

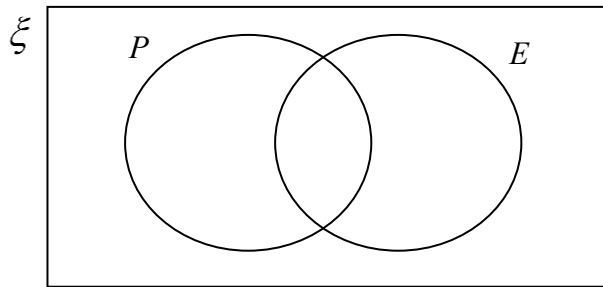
- (b) $\xi = \{\text{all quadrilaterals}\}$
 $P = \{\text{quadrilaterals with at least one pair of parallel sides}\}$
 $E = \{\text{quadrilaterals with diagonals that intersect at right angles}\}$

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]

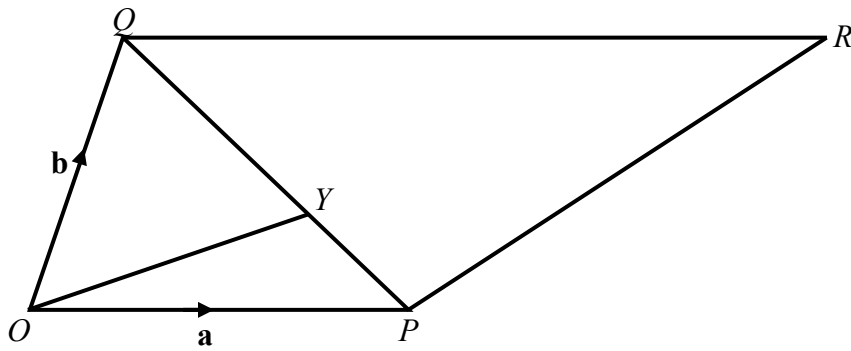
(ii) Find $|\overrightarrow{AB}|$.

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 **a** and **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

.....

.....

.....

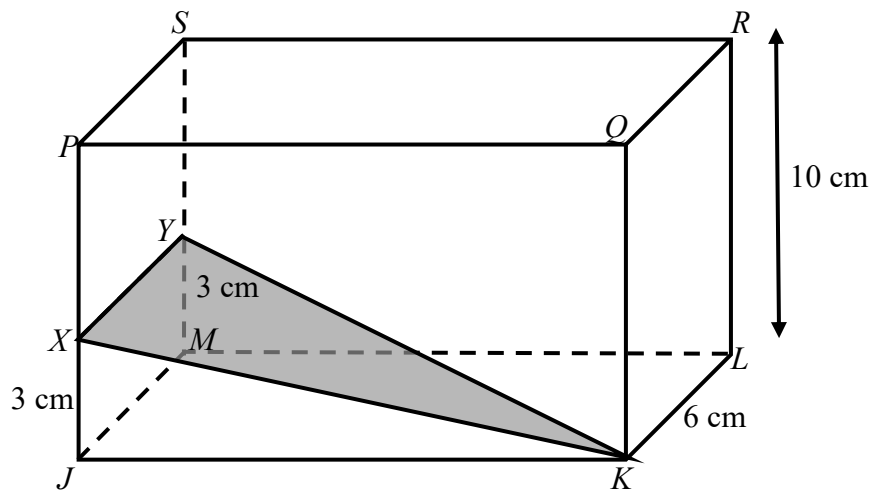
.....

.....[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.

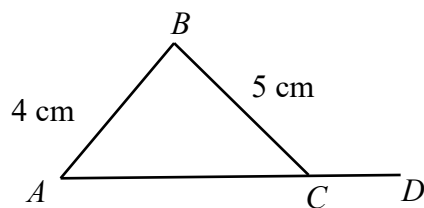
Answer

[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° [3]

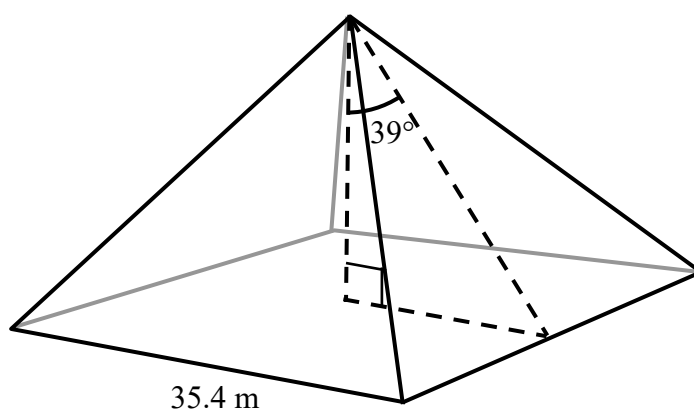
- (ii) Hence find the area of triangle ABC .

Answercm² [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 .
- $$[\text{Density} = \frac{\text{Mass}}{\text{Volume}}]$$
- 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

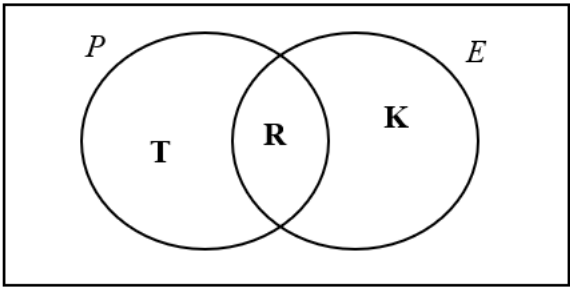
* Concrete is sold in standard slab units, which are not designed to be cut or resized.

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

.....
.....[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	$2\tilde{a} + \tilde{b}$
8bib	$\frac{1}{3}(\tilde{b} - \tilde{a})$
8bic	$\frac{1}{3}\tilde{b} + \frac{2}{3}\tilde{a}$
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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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

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

$$= 2920 \text{ MYR}$$

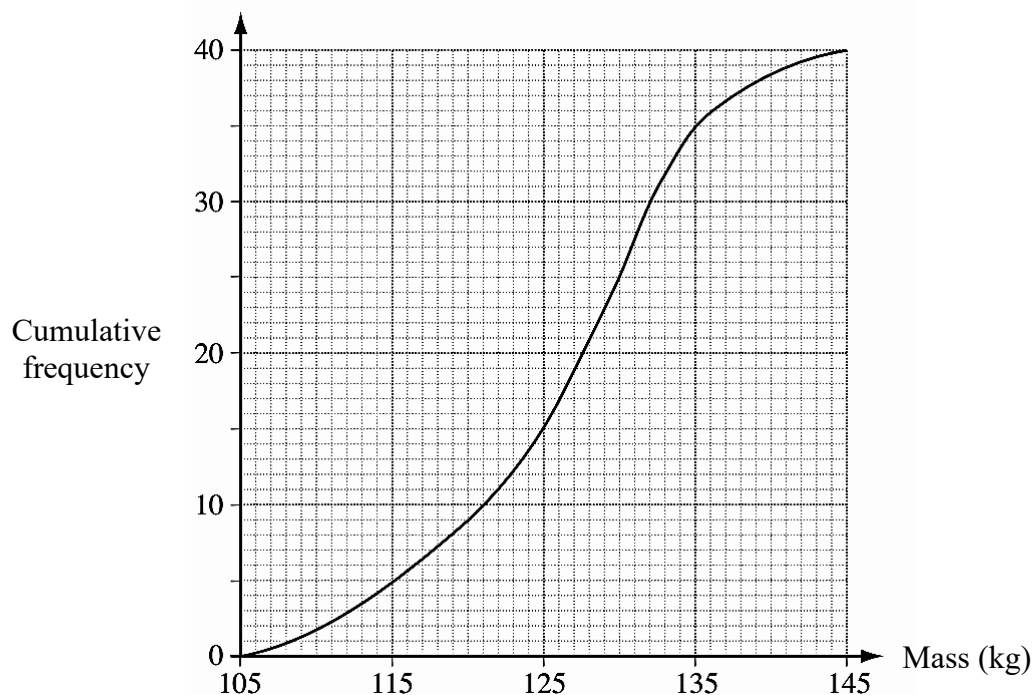
Initial SGD

$$= 2920 \div 3.20$$

$$= 912.50 \text{ SGD}$$

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 :

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

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

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

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

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

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

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]

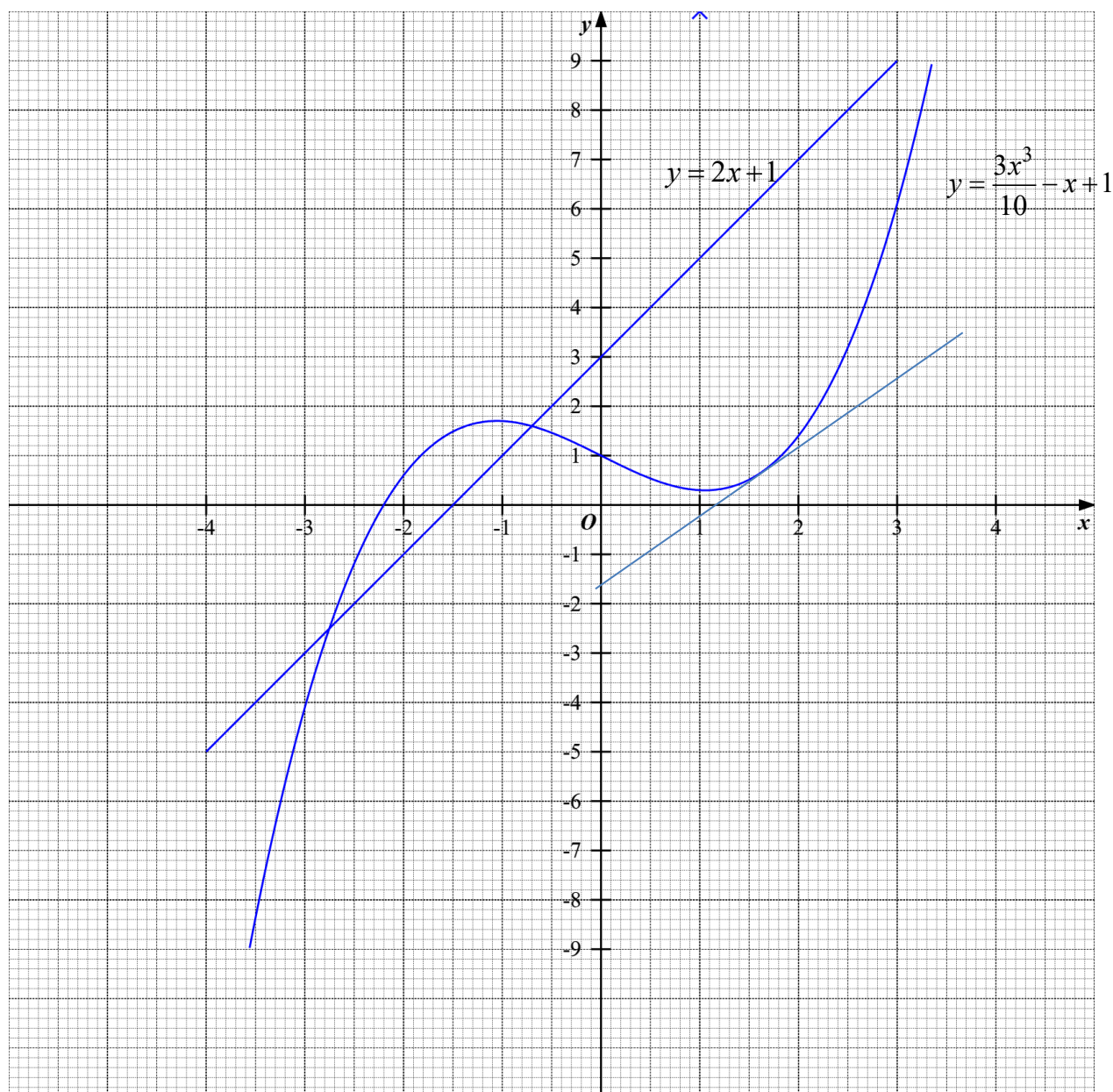
- (d) By drawing a tangent, find the gradient of the curve at $x = 1.6$.

Answer 1.33 $\dots$ [2]

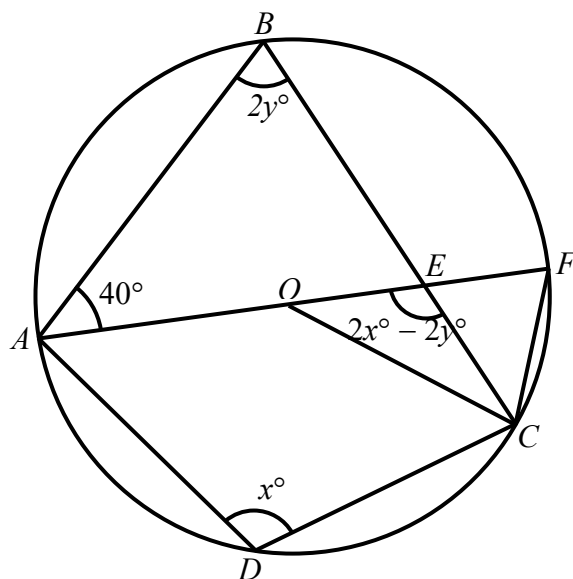
- (e) By drawing a suitable straight line on the grid, solve the equation $3x^3 - 30x - 20 = 0$.

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

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]

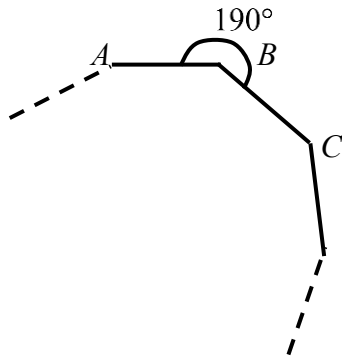
- (ii) Hence, explain whether it is possible for y to be 20.

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

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 .



$$\angle ABC$$

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

$$= 170^\circ$$

$$\text{Ext angle}$$

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

$$= 10^\circ$$

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

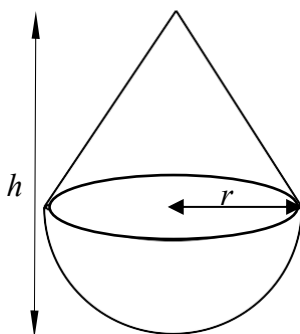
$$35n - 35 + 10 = 360$$

$$35n = 360 + 25$$

$$n = 11$$

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

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

Answer [2]

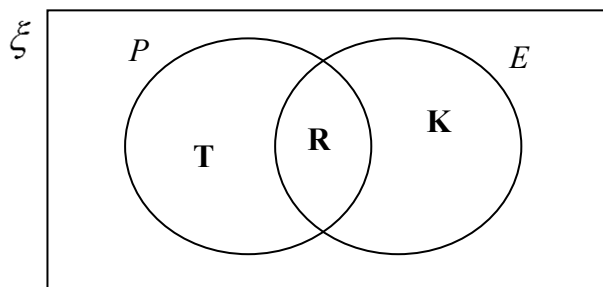
- (b) $\xi = \{\text{all quadrilaterals}\}$
 $P = \{\text{quadrilaterals with at least one pair of parallel sides}\}$
 $E = \{\text{quadrilaterals with diagonals that intersect at right angles}\}$

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 $|\overrightarrow{AB}|$.

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

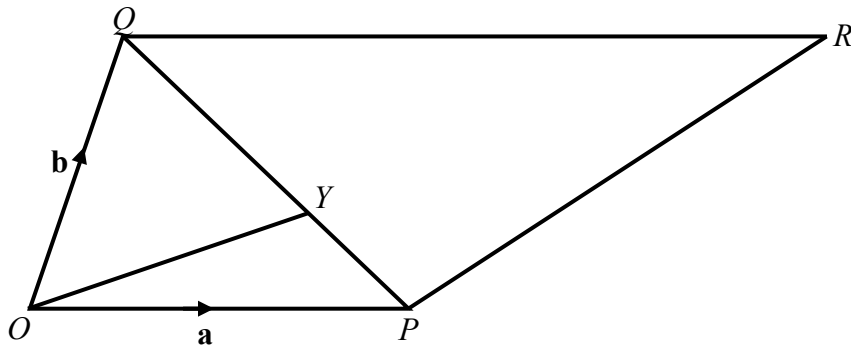
Answer [2]

(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.

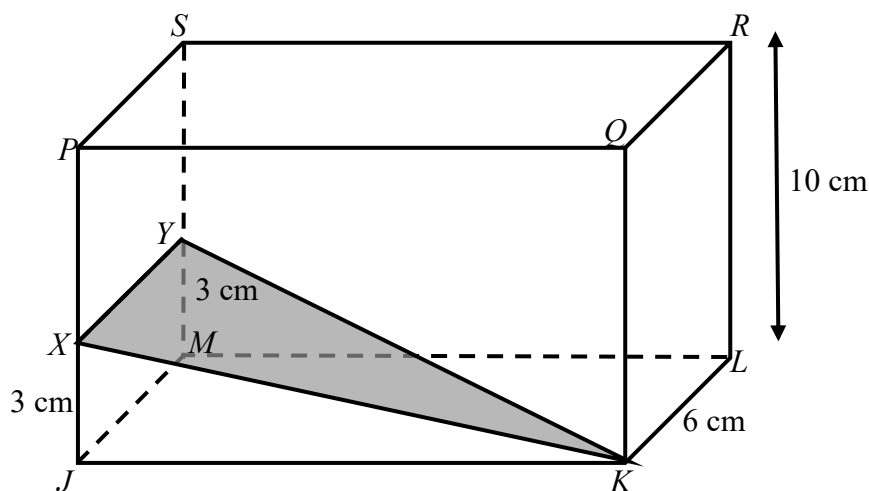
Since they share the common point Y they lie on the same straight line. A1

- (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

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

$$= \sqrt{424}$$

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

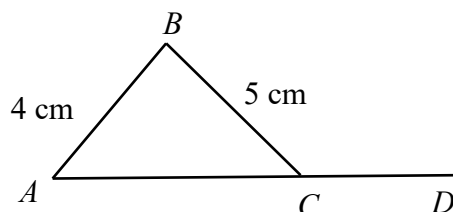
$$\angle XPK = 61^\circ \text{ (nearest degree)}$$

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

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

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 .

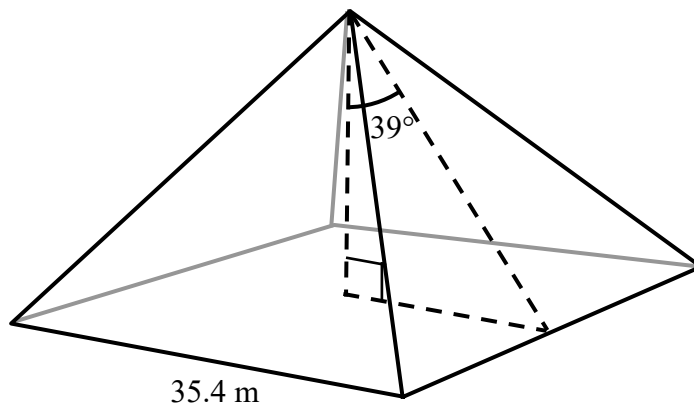
$$0.5 \times 4 \times 5 \times \sin \angle ABC$$

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

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