Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

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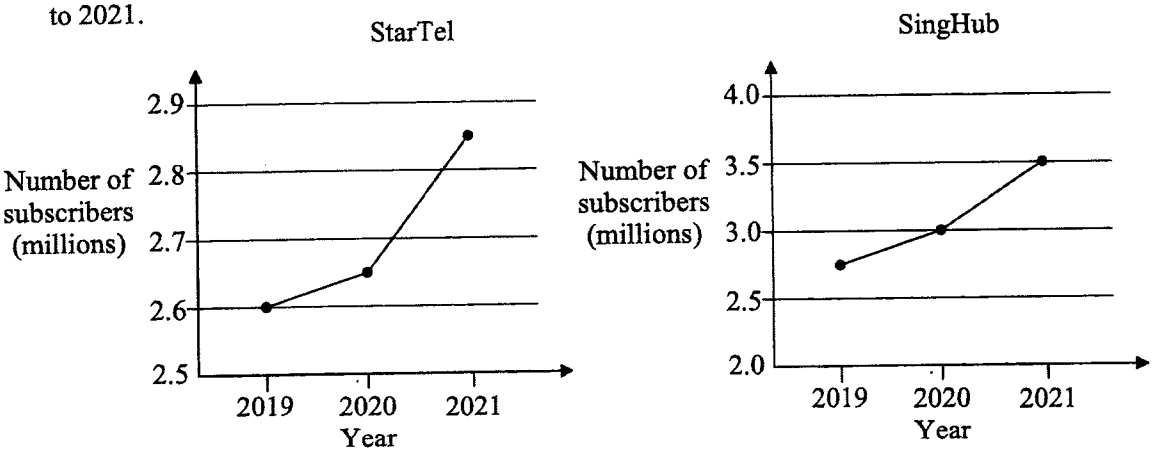
Answer **all** the questions.

1 Calculate $\sqrt{-\frac{35}{27}-\left(\frac{-11^2}{81}\right)}$.

Answer ..... [1]

---

2 These charts show the number of subscribers for two telcommunication companies from 2019 to 2021.



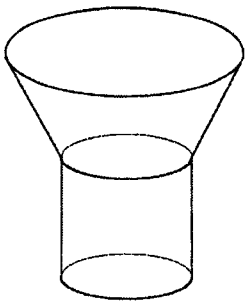
Explain why the charts give the impression that StarTel has a higher increase in the number of subscribers compared with SingHub from 2019 to 2021.

Answer .....

..... [1]

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3



The diagram shows a container made from a cylinder and a frustum.
Water is poured into this container.

(a) Which of these diagrams represents the graph of d, the depth of water in centimetres, against t, the time in seconds?

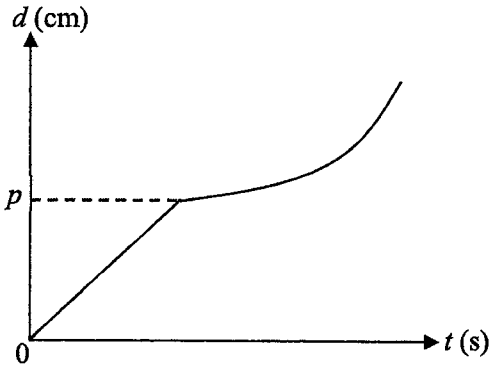


Diagram 1

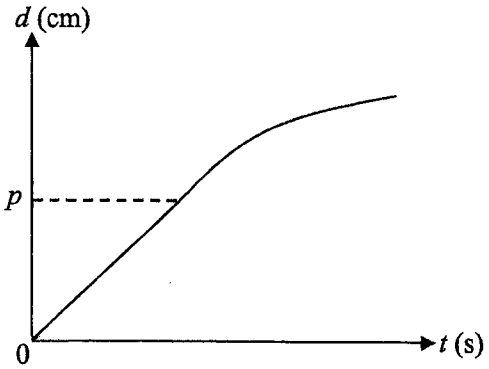


Diagram 2

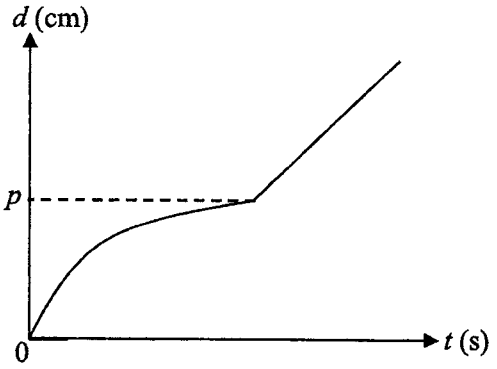


Diagram 3

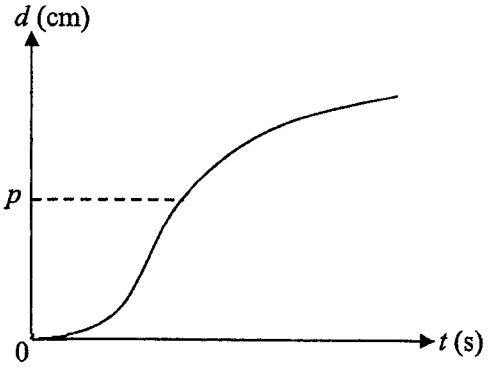


Diagram 4

Answer Diagram ..... [1]

(b) What does the value p in the graph represent?

Answer .....

..... [1]

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4 **(a)** Express $4+7x-x^2$ in the form $-(x-h)^2+k$.

Answer ..... [2]

(b) Write down the maximum value of $4+7x-x^2$.

Answer ..... [1]

---

5 A box contains 6 red cubes, 10 blue cubes and n yellow cubes.

(a) A cube is chosen from the box at random and then replaced.
Write down, in terms of n, the probability that it is **not** a red cube.

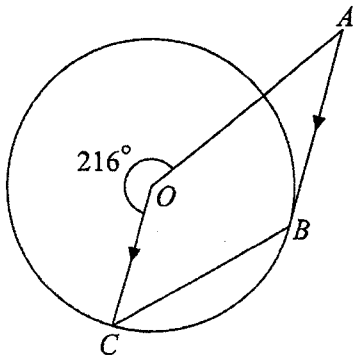
Answer ..... [1]

(b) Given that another n red cubes are added into the box, the probability of not choosing a red cube is now $\frac{9}{16}$. Find the total number of cubes in the box.

Answer ..... cubes [3]

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6



In the diagram, AB is a tangent to a circle, centre O.
C is a point on the circumference of the circle such that OC is parallel to AB.
Reflex angle $AOC = 216°$. Find angle AOB.

Answer Angle AOB = ... ° [3]

---

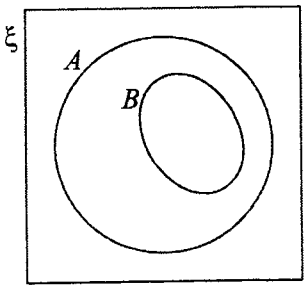
7 Solve the equation $\frac{3-2x}{4} = 6 - \frac{x+5}{7}$.

Answer x = ... [3]

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

Answer



[1]

(b) $\xi = \{\text{integers } x : 1 \leq x \leq 100\}$
$A = \{\text{perfect squares}\}$
$B = \{\text{odd numbers}\}$
$C = \{\text{integers ending with 3}\}$

(i) List the elements in $A \cap B$.

Answer ..... [1]

(ii) Find the number of elements in $B' \cap C$.

Answer ..... [1]

---

9 In a sequence, the same number is added each time to obtain the next term.
The first five terms of the sequence are

$$11, \ x, \ y, \ z, \ 27, \ \ldots$$

(a) Find the values of x, y, and z.

Answer $x =$ .....

$y =$ .....

$z =$ ..... [2]

(b) Write down an expression, in terms of n, for the nth term of this sequence.

Answer ..... [1]

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10 **(a)** Given that $x^n = 10$, find the value of $2x^{-3n}$.

Answer ..... [1]

(b) Simplify $\left(\frac{8m^3}{n^{-6}}\right)^{\frac{1}{3}} \div \frac{m^{-4}}{n^3}$.

Answer ..... [2]

---

11 Given that $y = \sqrt{9-4x}$,

(a) find the value of y when $x = -10$,

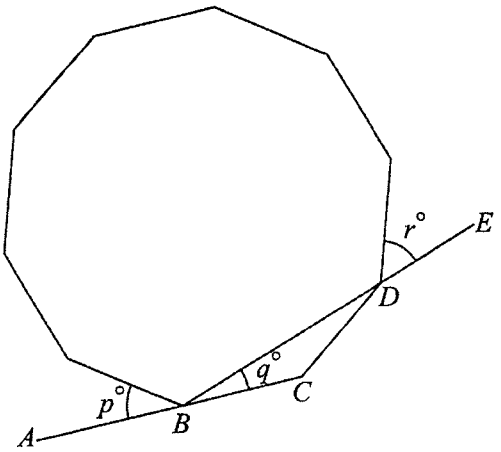
Answer $y =$ ..... [1]

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

Answer $x =$ ..... [2]

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12



The diagram shows a regular decagon. The side BC is produced to A and BDE is a straight line. Find the values of p, q and r.

Answer p = ...

q = ...

r = ... [3]

---

13 The table shows the number of hours spent on social media by 100 people who responded to a survey.

Number of hours	1	2	3	4	5
Number of people	19	x	26	13	y

(a) If the mode is 2 hours, write down the smallest value of x and the corresponding value of y.

Answer x = ...

y = ... [2]

(b) If the median is 2.5 hours, find the value of y.

Answer y = ... [1]

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14 In January 2020, the exchange rate between US dollars and Singapore dollars is US$1 = S$1.3453.

(a) Mr Lim invested US$5000 in an account paying compound interest at 2.5% per year. Calculate the amount of US dollars in the account after two years.

Answer US$ ..... [2]

In January 2022, the exchange rate between Singapore dollars and US dollars is S$1 = US$0.7415.

(b) Mr Lim exchanged all the US dollars in the account to Singapore dollars. Did he make a gain or loss? Show your working clearly.

Answer ..... [3]

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15 An area of 36 cm^2 on the map represents an actual area of 9 km^2.

(a) The scale of the map is in the form 1 : n. Find n.

Answer $n =$ .....[2]

(b) Calculate the length of a road on the map, in centimetres, which has an actual length of 1.64 km.

Answer ..... cm [2]

---

16 **(a)** Simplify $(2a-3)^2-4a(a-4)$.

Answer ..... [2]

(b) Factorise completely $14x^2-7xy+3ay-6ax$.

Answer ..... [2]

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17 **(a)** Express 1188 as the product of its prime factors.

Answer ..... [1]

(b) The number $1188m$ is a perfect cube.
Find the smallest positive integer value of m.

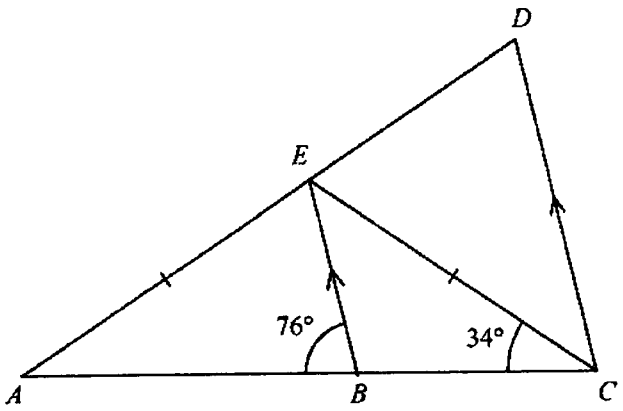
Answer ..... [1]

(c) Find the greatest integer that will divide both 1188 and 360 exactly.

Answer ..... [1]

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18 In the diagram, AED and ABC are straight lines.
$AE = EC$ and BE is parallel to CD.



(a) Complete these statements.

(i) Angle ECD = ... ° because .....

..... [2]

(ii) Angle EDC = ... ° because .....

..... [2]

(b) Complete the statement.

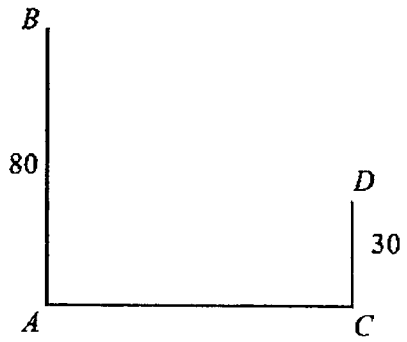
..... is the longest side of the triangle EDC because

.....

..... [1]

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19

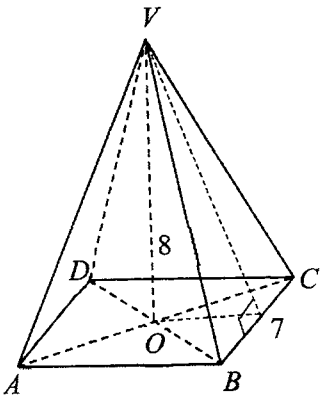


In the diagram, CD is a building directly opposite a tower AB, both which are built on horizontal ground, AC.
AB is 80 m high and CD is 30 m high.
The angle of elevation of B from C is $50.6°$.
Calculate the angle of elevation of the top of the tower from the point D.

Answer .....° [4]

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20 The figure below shows a square pyramid. VO is vertical to the base $ABCD$, $VO = 8$ cm and $BC = 7$ cm.



(a) Find the total surface area of the pyramid.

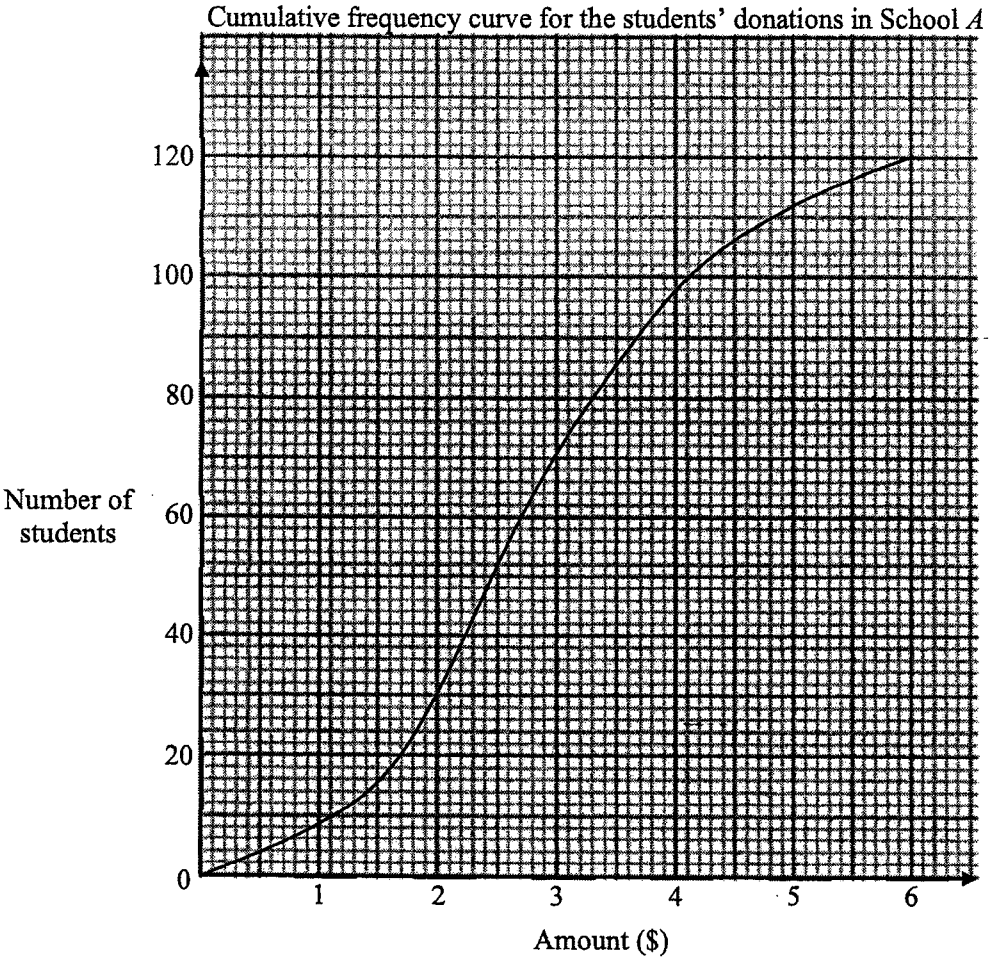
Answer ..... cm^2 [3]

(b) The pyramid is melted and recast into spheres.
The radius of each sphere is 2 mm.
Find the maximum number of spheres that can be recast from the pyramid.

Answer ..... spheres [4]

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21 The donations by a group of students in School *A* for the victims of a recent volcanic eruption were recorded.
The cumulative frequency curve below shows the distribution of the donations.



Use your graph to estimate

(a) the median of the donations,

Answer $ ..... [1]

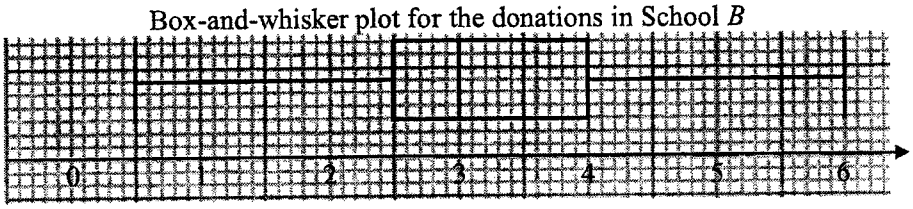
(b) the interquartile range.

Answer $ ..... [2]

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(c) The box-and-whisker plot below shows the distribution of donations collected from students in School *B*.

Box-and-whisker plot for the donations in School *B*



Amount ($)

Which school is more generous in the donations? Justify your answer with 2 reasons.

Answer .....

.....

.....

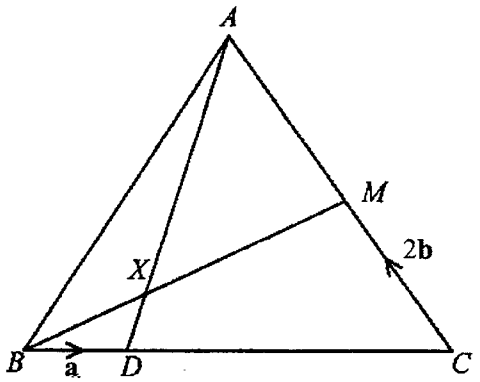
.....

.....

..... [2]

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22 In the diagram, $BC = 4BD$ and $DA = 5DX$.
M is the midpoint of AC.
$\overrightarrow{BD} = \mathbf{a}$ and $\overrightarrow{CM} = 2\mathbf{b}$.



(a) Express, as simply as possible, in terms of **a** and/or **b**,

(i) $\overrightarrow{DC}$,

Answer $\overrightarrow{DC}$ = ... [1]

(ii) $\overrightarrow{DA}$,

Answer $\overrightarrow{DA}$ = ... [1]

(iii) $\overrightarrow{DX}$.

Answer $\overrightarrow{DX}$ = ... [1]

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(b) Show that $\overrightarrow{BX} = \frac{4}{5}(2\mathbf{a} + \mathbf{b})$.

Answer

[1]

(c) Express $\overrightarrow{BM}$ in terms of **a** and **b**, as simply as possible.

Answer ..... [1]

(d) Find

(i) $\frac{BX}{BM}$,

Answer ..... [1]

(ii) $\frac{\text{area of triangle } ABX}{\text{area of triangle } AMX}$,

Answer ..... [1]

(iii) $\frac{\text{area of triangle } ABX}{\text{area of triangle } ABC}$.

Answer ..... [1]

End of Paper

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

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

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

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

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1 **(a)** Express as a single fraction in its simplest form $\frac{9x-2}{x^2-4x+4}+\frac{2}{x-2}$.

Answer ..... [3]

(b) Solve these simultaneous equations.

$$5x-2y=18$$
$$8x+3y=4$$

Answer $x=$ .....

$y=$ ..... [3]

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(c) Simplify $\dfrac{9x^2-4}{3x^2-7x-6} \div (2-3x)$.

Answer ..... [3]

(d) Given that $8^{1-2x} = 32^{3-x} \times \left(\dfrac{1}{2}\right)^0$, find the value of x.

Answer $x =$ ..... [3]

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(e) **(i)** Solve the inequalities $1-(5-2x)<\frac{1}{2}(3x+1)\leq\frac{4x+2}{5}$.

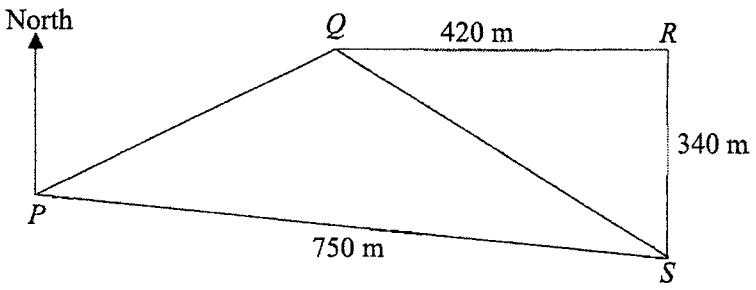
Answer ..... [3]

(ii) Hence write down the largest value of x which satisfies the inequalities.

Answer $x=$ ..... [1]

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2 Four points P, Q, R and S lie on level ground.
P is 750 m and on a bearing of 280° from S.
Q is 420 m due west of R and S is 340 m due south of R.



(a) Find

(i) the distance QS,

Answer ..... m [1]

(ii) the distance PQ.

Answer ..... m [4]

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(b) Given that angle PQS is obtuse, find the bearing of P from Q.

Answer ..... ° [4]

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3 Nancy makes T-shirts.
The matrix **M** shows the number of T-shirts of different sizes she makes in one week.

$$\mathbf{M} = \begin{array}{c} \begin{matrix} \text{small} & \text{medium} & \text{large} \end{matrix} \\ \begin{pmatrix} 0 & 3 & 4 \\ 10 & 15 & 1 \end{pmatrix} \end{array} \begin{matrix} \\ \text{Men} \\ \text{Women} \end{matrix}$$

(a) Nancy sells all of these T-shirts to a shop.
She charges \$6 for each small-sized T-shirt, \$8 for each medium-sized T-shirt and \$10 for each large-sized T-shirt.
Represent these amounts in a 3×1 column matrix **N**.

Answer **N** = [1]

(b) **(i)** Evaluate the matrix **P** = **MN**.

Answer **P** = [1]

(ii) State what the elements of **P** represent.

Answer .....

.....

..... [1]

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(c) The shopkeeper sells all sizes of men's T-shirts at \$10 each.
He sells all sizes of women's T-shirts at \$11.50 each.

(i) Evaluate $\begin{pmatrix}10 & 11.5\end{pmatrix}\begin{pmatrix}0 & 3 & 4\\ 10 & 15 & 1\end{pmatrix}$.

Answer ..... [1]

(ii) Using matrix multiplication, find the total amount of money that the shopkeeper receives.

Answer \$ ..... [2]

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4 **(a)** The table shows some values for $y = \frac{x^3}{4} - x + 1$.

x	-3	-2	-1	0	1	2	3
y	-2.75	1	1.75	1	0.25	1	b

Find the value of b.

Answer $b =$ ..... [1]

(b) Using a scale of 2 cm to represent 1 unit for both the axes, draw the graph of $y = \frac{x^3}{4} - x + 1$ for $-3 \leq x \leq 3$. [3]

(c) On the same grid, draw the graph of $y = \frac{1}{3}x + 1$. [2]

(d) Use your graph to find the value(s) of x where $y = \frac{1}{3}x + 1$ crosses $y = \frac{x^3}{4} - x + 1$.

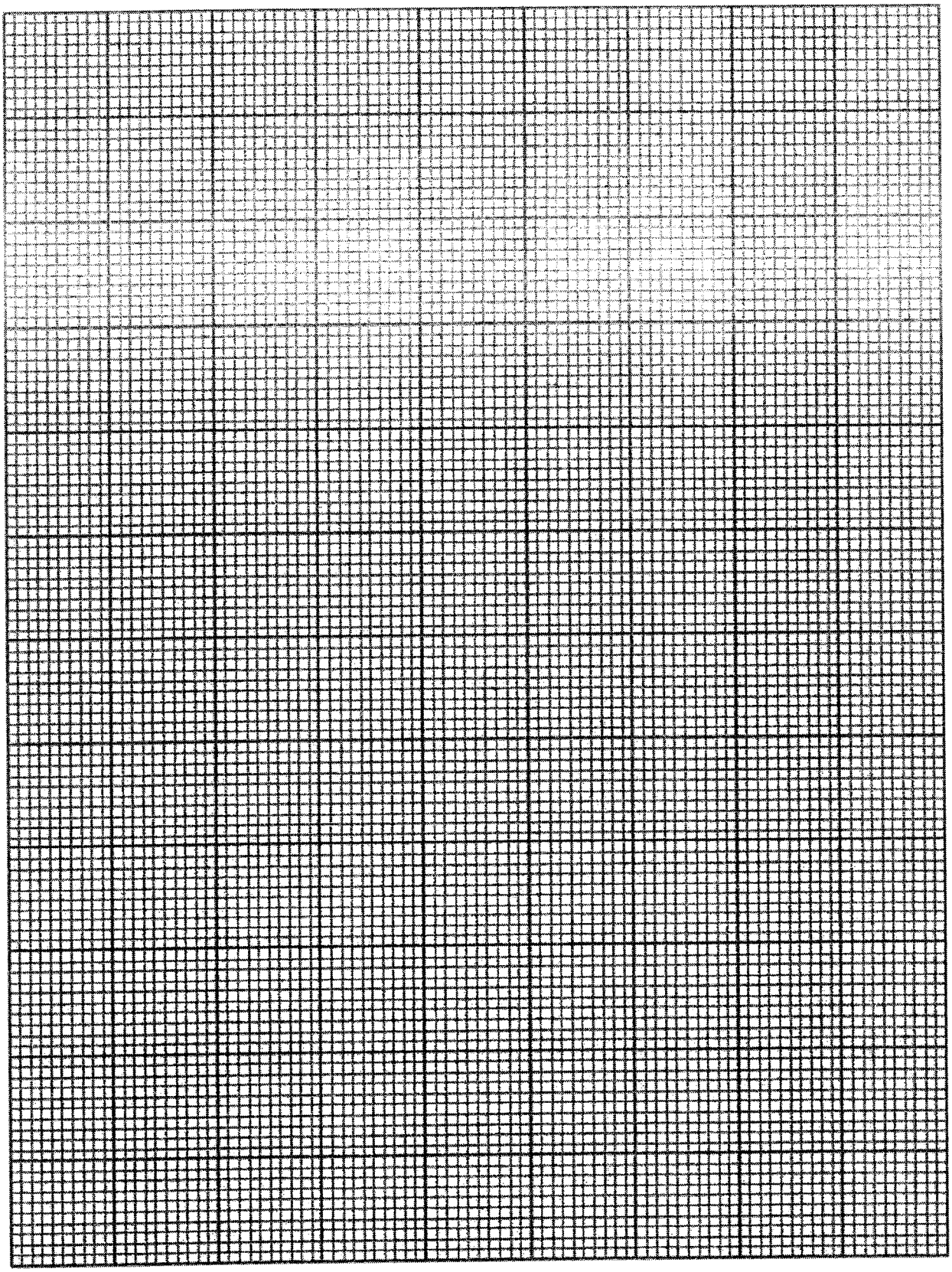
Answer ..... [2]

(e) The value(s) of x where $y = \frac{1}{3}x + 1$ crosses $y = \frac{x^3}{4} - x + 1$ are the solutions of the equation $Ax^3 = Bx$.
Find the value of A and of B, where A and B are integers.

Answer $A =$ .....

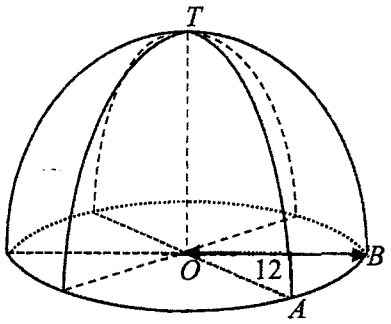
$B =$ ..... [2]

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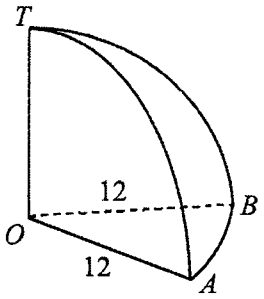


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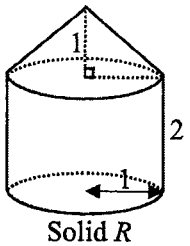
5 Solid P is a metal hemisphere of radius 12 cm and centre O which stands on a horizontal table. It is sliced into 6 equal pieces by cutting vertically downwards through radius OT, as indicated in the diagram. Solid Q is one of these 6 slices. Solid R is made up of a metal cylinder of base radius 1 cm and height 2 cm, surmounted by a cone of base radius 1 cm and height 1 cm.



Solid P



Solid Q



Solid R

Assuming there is no wastage of material, calculate

(a) (i) the volume of solid Q,

Answer ..... cm^3 [3]

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(ii) the total **curved** surface area of solid R.

Answer ..... cm^2 [2]

(b) Solid Q is then melted and made into many pieces of solid R.

(i) Calculate the volume of solid R.

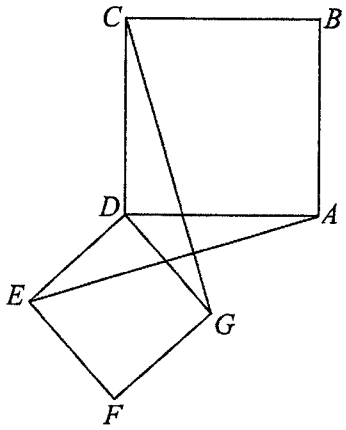
Answer ..... cm^3 [2]

(ii) Hence, calculate the number of **complete** solid R that can be obtained.

Answer ..... solid R [2]

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6 (a)



In the diagram, *ABCD* and *DEFG* are squares.

(i) Show that angle *ADE* = angle *CDG* .

Answer

[1]

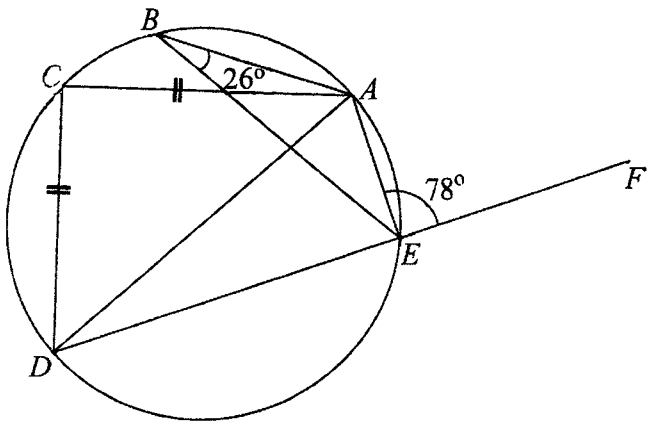
(ii) Show that triangle *ADE* is congruent to triangle *CDG*.
Give a reason for each statement you make.

Answer

[2]

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(b)



In the diagram, $CA = CD$, angle $ABE = 26°$ and angle $AEF = 78°$.
DEF is a straight line.

Find, giving reason(s) for each answer,

(i) angle ADE,

Answer Angle ADE = ... ° [1]

(ii) angle CDA,

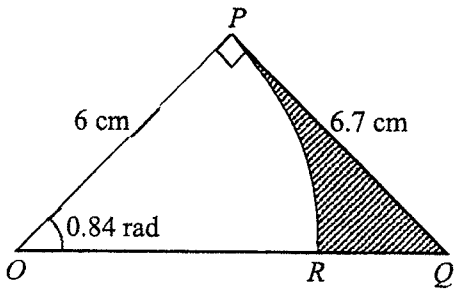
Answer Angle CDA = ... ° [3]

(iii) angle CAE.

Answer Angle CAE = ... ° [1]

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7



The diagram shows a right-angled triangle OPQ.
OPR is a sector of a circle with centre O and of radius 6 cm.
It is given that angle $POQ = 0.84$ radian and $PQ = 6.7$ cm.

(a) Express 0.84 radian in degrees.

Answer ..... ° [1]

(b) Find the perimeter of the shaded region.

Answer ..... cm [4]

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TURN OVER FOR QUESTION 8

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8

Mass (x kg)	Frequency
$1 \leq x < 2$	2
$2 \leq x < 3$	a
$3 \leq x < 4$	8
$4 \leq x < 5$	7

The masses of some durians from shop A are recorded in the table above.

(a) Given that the estimated mean mass of the durians is 3.5 kg, find the value of a.

Answer $a =$ ..... [2]

(b) **(i)** Calculate an estimate of the standard deviation.

Answer ..... kg [1]

(ii) Explain why your answer to part **(b)(i)** is only an **estimate** of the standard deviation.

Answer .....

..... [1]

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(c) The same number of durians from shop *B* were weighed and the masses have the following mean and standard deviation.

Mean (kg)	4.4
Standard Deviation (kg)	1.2

Make two comparisons between the masses of durians from shop *A* and shop *B*.

1 .....

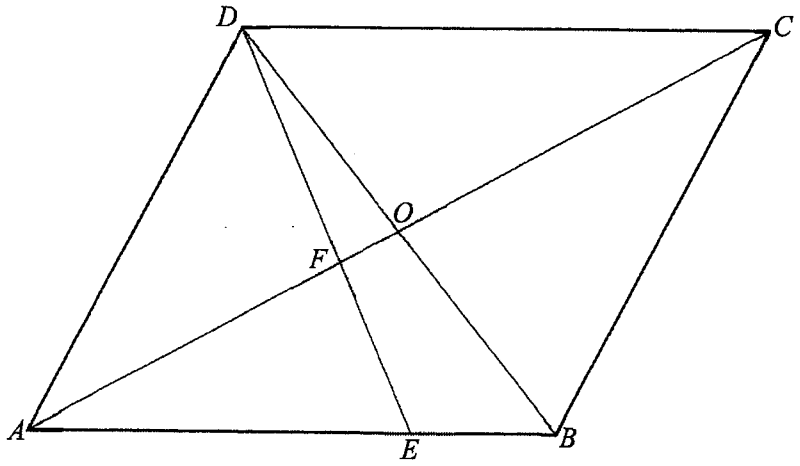
.....

2 .....

..... [2]

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9



$ABCD$ is a parallelogram whose diagonals, AC and BD, intersect at O.
E is a point on AB such that $AE = 2EB$. DE intersects AC at F.
It is given that O is the point $(0, 0)$. D is the point $(-4, 5)$ and A is the point $(-7, -5)$.

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

Answer $\overrightarrow{AD} = \begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [2]

(ii) Find $\left|\overrightarrow{AD}\right|$.

Answer ..... units [2]

(b) Given that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$, express the following vectors in terms of $\mathbf{a}$ and/or $\mathbf{b}$, giving each of your answers in its simplest form.

(i) $\overrightarrow{AC}$

Answer $\overrightarrow{AC}$ = ... [1]

(ii) $\overrightarrow{CD}$

Answer $\overrightarrow{CD}$ = ... [1]

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(c) Show that $\overrightarrow{DE} = \frac{1}{3}(5\mathbf{b} + \mathbf{a})$.

Answer

[2]

(d) It is given that $\overrightarrow{FA} = \frac{4}{5}\overrightarrow{OA}$.

By finding $\overrightarrow{DF}$, show that D, E and F lie on the same straight line.

Answer

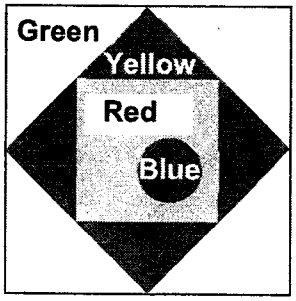
[3]

(e) Find the numerical value of $\frac{\text{area of triangle } AEF}{\text{area of triangle } CDF}$.

Answer ..... [1]

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10



At a game stall, a target board, 1 metre by 1 metre, has four colours as shown. It is made up of three squares and a circle of radius 0.2 metre.
It is assumed that all darts hit the board.

A dart is thrown at the board.

(a) **(i)** Find the probability of hitting the green area.

Answer ..... [1]

(ii) Find, in terms of π, the probability of hitting the blue area.

Answer ..... [1]

(iii) Given that the probability of the dart hitting the yellow area is $\frac{1}{4}$, show that the probability of a dart hitting the red area is $\frac{25-4\pi}{100}$.

Answer

[2]

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(b) If two darts are thrown simultaneously, find the probability

(i) of both darts hitting the green area,

Answer ..... [1]

(ii) of both darts separately hitting green and yellow areas,

Answer ..... [2]

(iii) that at least one of the darts hit the yellow area.

Answer ..... [2]

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11 Glen and Jane are on a holiday in Germany.
They are planning a trip from Berlin to Munich.
They need to be in Munich latest by 4 p.m. and can choose to travel by train or bus.
They plan to keep their travelling time and cost to the minimum.

Information that Glen and Jane need is shown in the **Travel Information** table below.

Travel Information

Part of train timetable

Berlin (*Depart*)	09 27	11 22	12 44	14 53
Train Fare (*Per Pax*)	SGD 68	SGD 88	SGD 78	SGD 58

* Distance from Berlin to Munich is 584.6 km.
* Average train speed is 94.8 km/h.

Part of bus timetable

Depart from Berlin	07 40	07 50	08 15
via	Wunsiedel	Bayreuth	Dresden
Arrive in Munich	16 25	15 30	16 15

Expected average speed of bus on this journey is 45 miles per hour.

For each traveller, the bus fare is charged based on the following:
- SGD 8 online booking surcharge
- SGD 0.05 per kilometre for the journey

* 1 mile is equivalent to 1.6093 kilometres.

(a) Find the distance, in miles, between Berlin and Munich.

Answer ..... miles [1]

(b) Calculate the time taken, in hours and minutes, for the train journey.

Answer ..... hours ..... minutes [2]

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(c) Showing clearly all the calculations for the travelling costs and travelling time, recommend the mode of transport from Berlin to Munich for the couple.

Give one advantage and one disadvantage for your recommended choice of transport.

Answer

I would recommend the couple to travel by .....

Advantage: .....

Disadvantage: ..... [7]

End of Paper

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