

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

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

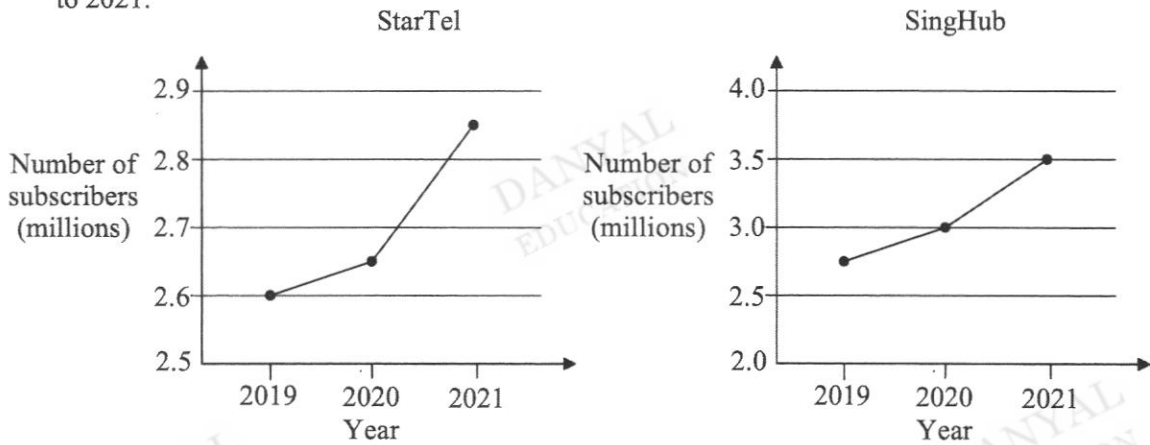
$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

Answer **all** the questions.

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

Answer [1]

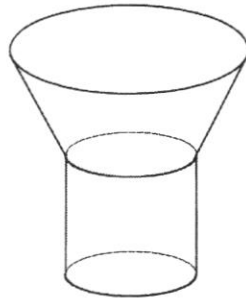
- 2 These charts show the number of subscribers for two telcommunication companies from 2019 to 2021.



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]

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?

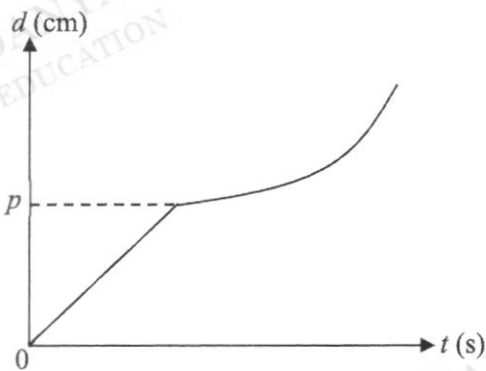


Diagram 1

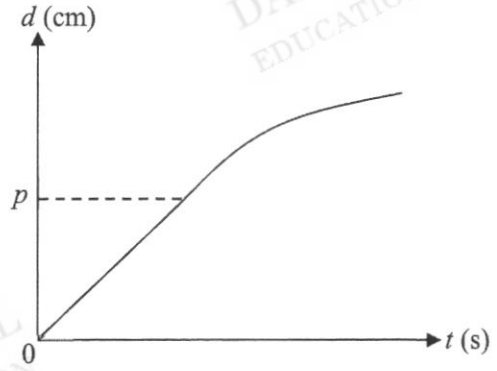


Diagram 2

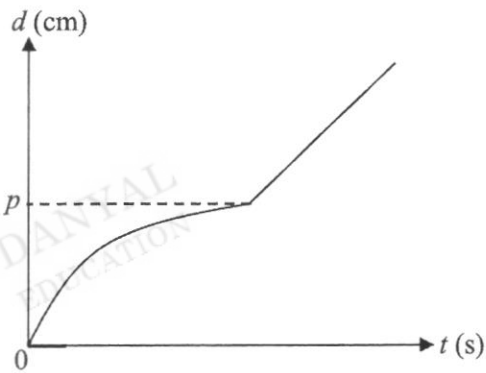


Diagram 3

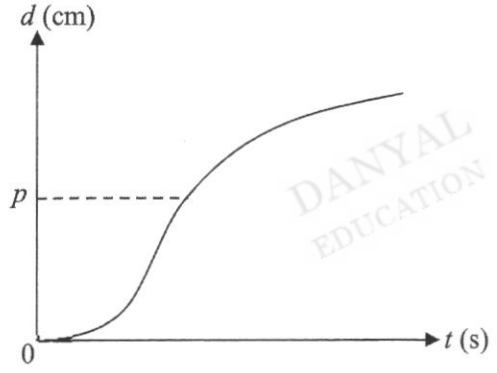


Diagram 4

Answer Diagram [1]

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

Answer
..... [1]

- 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.

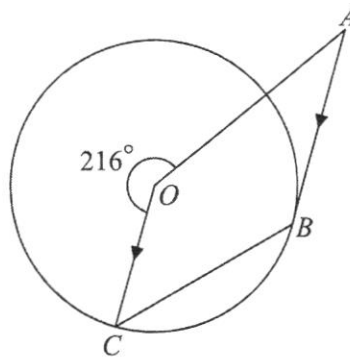
- (a) A cube is chosen from the box at random and then replaced.
Write down, in terms of n , the probability that it is **not** a red cube.

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]

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 $AOC = 216^\circ$. Find angle AOB .

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Answer Angle $AOB = \dots\dots\dots^\circ$ [3]

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

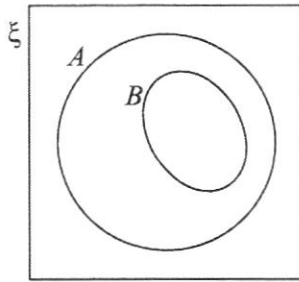
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Answer $x = \dots\dots\dots$ [3]

- 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, ...

- (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 n th term of this sequence.

Answer [1]

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

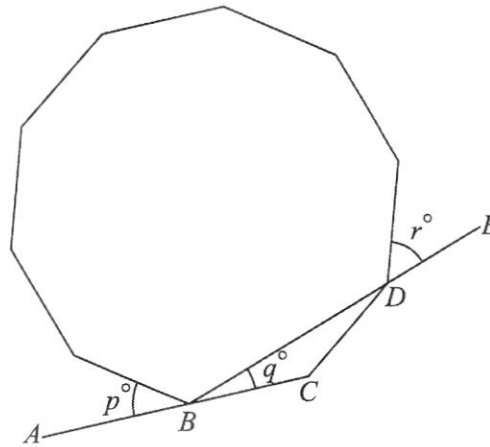
(a) find the value of y when $x = -10$,

Answer $y =$ [1]

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

Answer $x =$ [2]

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 .

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Answer $p = \dots\dots\dots$

$q = \dots\dots\dots$

$r = \dots\dots\dots$ [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 $x = \dots\dots\dots$

$y = \dots\dots\dots$ [2]

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

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

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]

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

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

Answer $\dots\dots\dots \text{ cm}$ [2]

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

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

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

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

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

Answer [1]

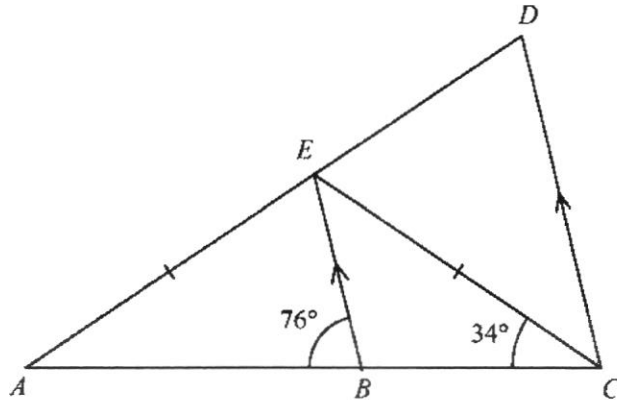
- (b) The number $1188m$ is a perfect cube.
Find the smallest positive integer value of m .

Answer [1]

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

Answer [1]

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



(a) Complete these statements.

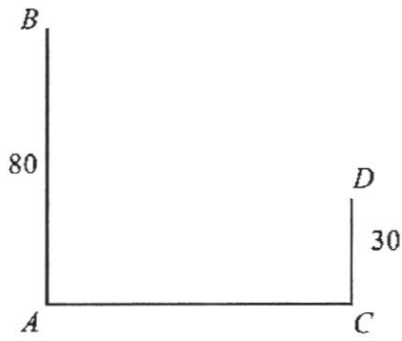
(i) Angle $ECD = \dots\dots\dots^\circ$ because $\dots\dots\dots$
 $\dots\dots\dots$ [2]

(ii) Angle $EDC = \dots\dots\dots^\circ$ because $\dots\dots\dots$
 $\dots\dots\dots$ [2]

(b) Complete the statement.

$\dots\dots\dots$ is the longest side of the triangle EDC because
 $\dots\dots\dots$
 $\dots\dots\dots$ [1]

19



In the diagram, CD is a building directly opposite a tower AB , both which are built on horizontal ground, AC .

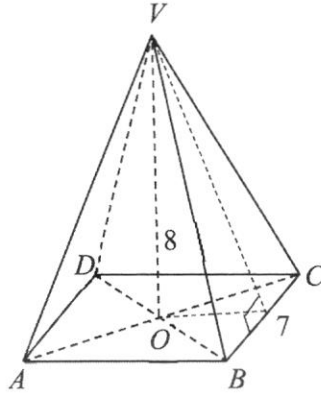
AB is 80 m high and CD is 30 m high.

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 $^\circ$ [4]

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



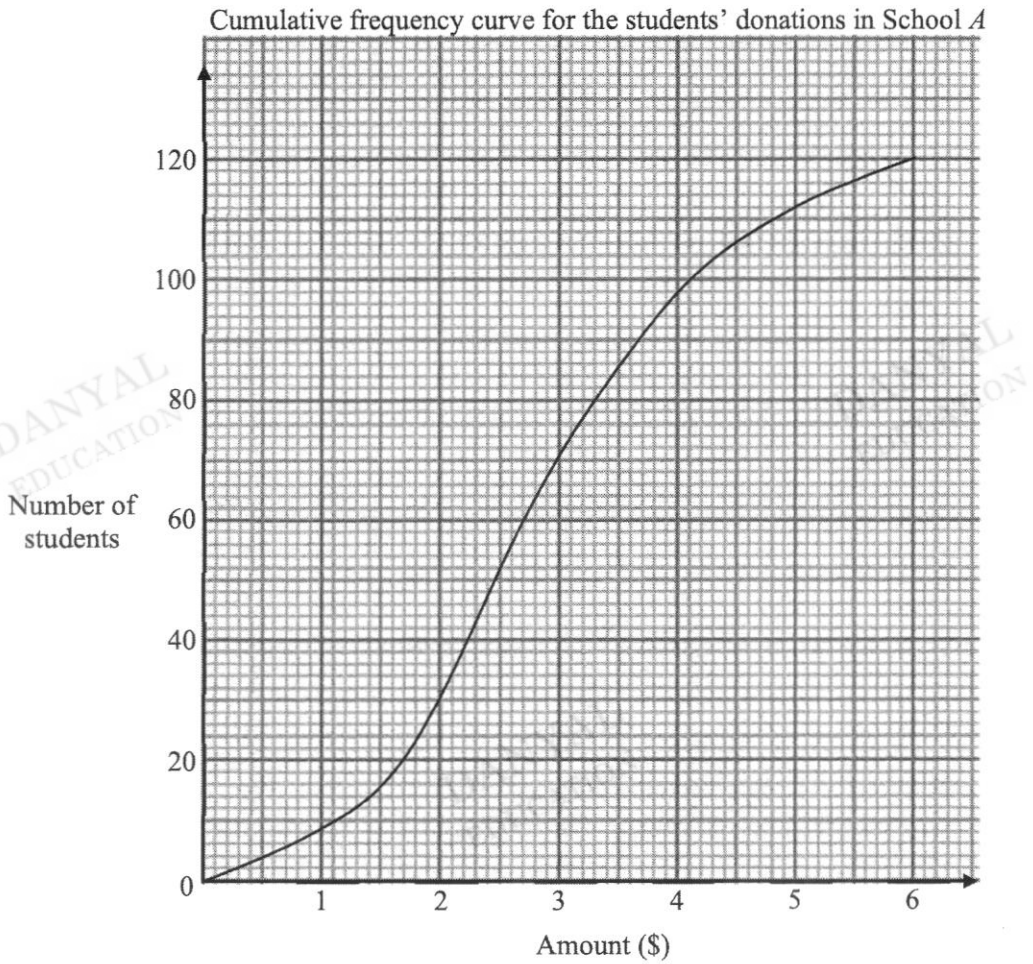
- (a) Find the total surface area of the pyramid.

Answer cm² [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]

- 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

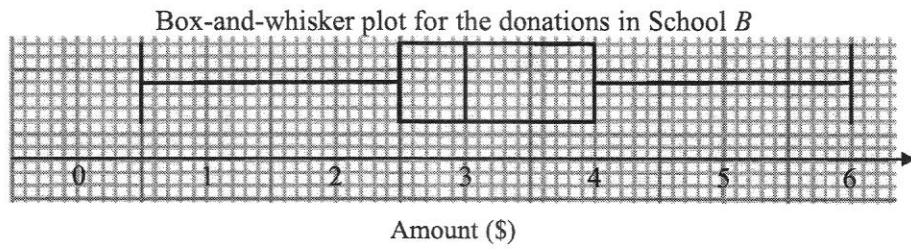
- (a) the median of the donations,

Answer \$ [1]

- (b) the interquartile range.

Answer \$ [2]

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



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

Answer

.....

.....

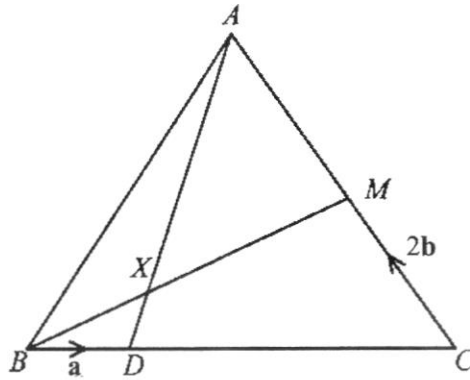
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.....

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..... [2]

- 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 \mathbf{a} and/or \mathbf{b} ,

(i) \overrightarrow{DC} ,

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

(ii) \overrightarrow{DA} ,

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

(iii) \overrightarrow{DX} .

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

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

Answer

[1]

- (c) Express \overline{BM} in terms of \mathbf{a} and \mathbf{b} , as simply as possible.

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Answer [1]

- (d) Find

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

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Answer [1]

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

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Answer [1]

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

Answer [1]

End of Paper

Mathematical Formulae*Compound interest*

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

2

- 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]

3

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

Answer [3]

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

Answer $x =$ [3]

4

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

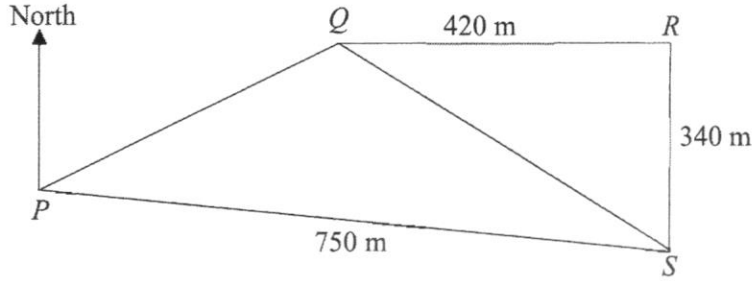
Answer [3]

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

Answer $x =$ [1]

5

- 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]

6

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

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Answer ° [4]

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

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

- (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]

8

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

Answer [1]

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

Answer \$ [2]

- 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 $b = \dots\dots\dots$ [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 $y = \frac{x^3}{4} - x + 1$.

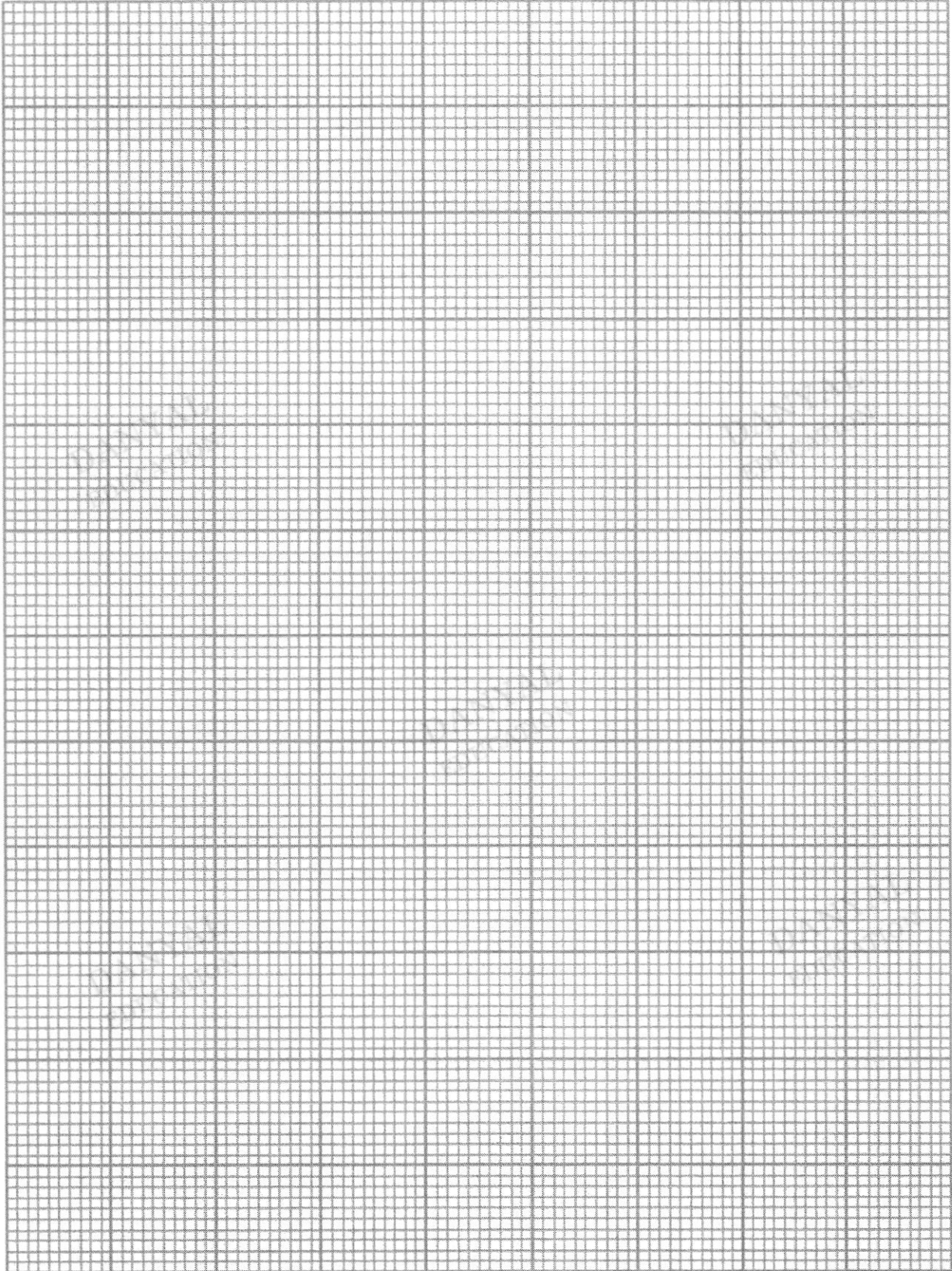
Answer $\dots\dots\dots$ [2]

- (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 $Ax^3 = Bx$.

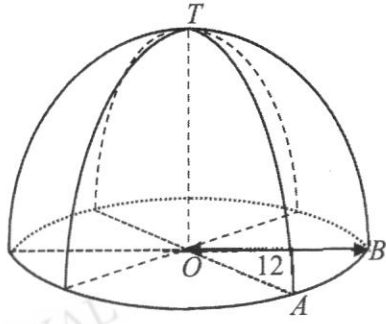
Find the value of A and of B , where A and B are integers.

Answer $A = \dots\dots\dots$

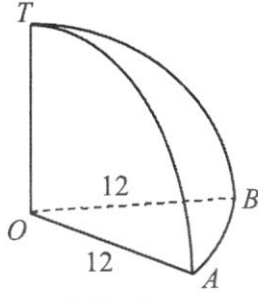
$B = \dots\dots\dots$ [2]



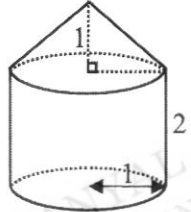
- 5 Solid P is a metal hemisphere of radius 12 cm and centre O which stands on a horizontal table. It is sliced into 6 equal pieces by cutting vertically downwards through radius OT , as indicated in the diagram. Solid Q is one of these 6 slices. Solid R is made up of a metal cylinder of base radius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

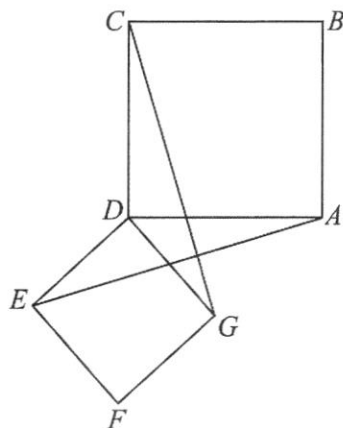
Answer cm^3 [2]

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

Answer solid R [2]

13

6 (a)



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

(i) Show that angle $ADE = \text{angle } CDG$.

Answer

[1]

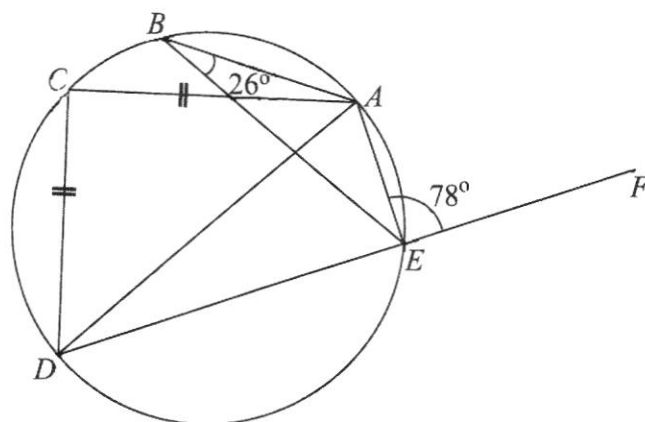
(ii) Show that triangle ADE is congruent to triangle CDG .
Give a reason for each statement you make.

Answer

[2]

14

(b)



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

Find, giving reason(s) for each answer,

(i) angle ADE ,

Answer Angle $ADE = \dots\dots\dots^\circ$ [1]

(ii) angle CDA ,

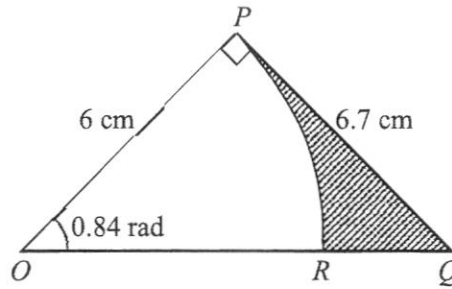
Answer Angle $CDA = \dots\dots\dots^\circ$ [3]

(iii) angle CAE .

Answer Angle $CAE = \dots\dots\dots^\circ$ [1]

7

15



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^o [1]

- (b) Find the perimeter of the shaded region.

Answer cm [4]

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

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

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

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

Answer $\dots\dots\dots$

$\dots\dots\dots$ [1]

18

- (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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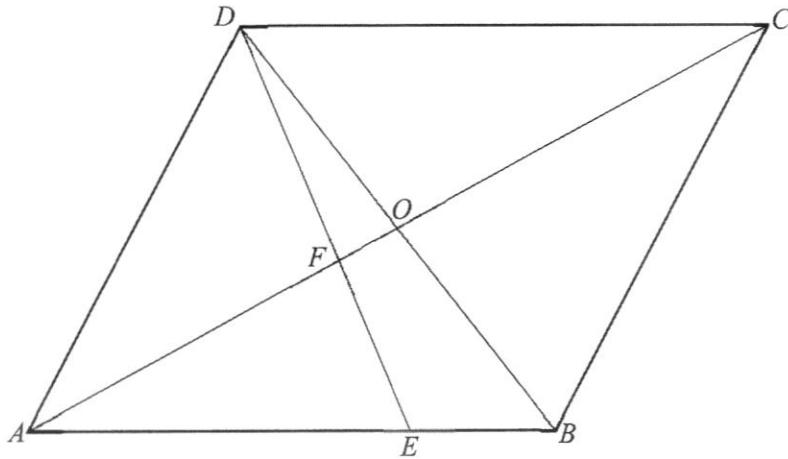
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$ABCD$ is a parallelogram whose diagonals, AC and BD , intersect at O .
 E is a point on AB such that $AE = 2EB$. DE intersects AC at F .

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

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

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 $\overrightarrow{AC} = \dots\dots\dots$ [1]

(ii) \overrightarrow{CD}

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

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

Answer

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[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.

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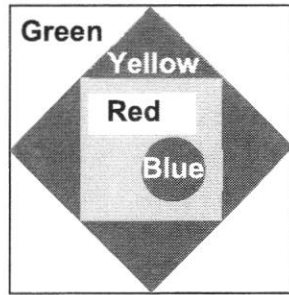
[3]

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

Answer

[1]

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]

22

- (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]

- 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

| <u>Part of train timetable</u> | | | | | |
|---|-----------|--------|--------|--------|--------|
| 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. | | | | | |

| <u>Part of bus timetable</u> | | | |
|--|-----------|----------|---------|
| 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: | | | |
| <ul style="list-style-type: none"> • 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]

- (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

DANYAL
EDUCATION

DANYAL
EDUCATION

DANYAL
EDUCATION

DANYAL
EDUCATION

DANYAL
EDUCATION

I would recommend the couple to travel by

Advantage:

Disadvantage: [7]

End of Paper

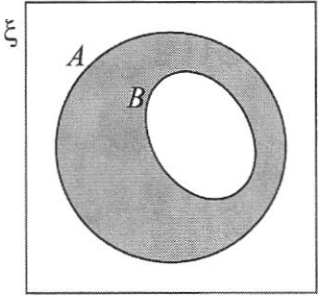
Answer key

| | |
|-------|--|
| 1a | $\frac{11x-6}{(x-2)^2}$ |
| 1b | $x=2, y=-4$ |
| 1c | $\frac{-1}{x-3}$ or $\frac{1}{3-x}$ |
| 1d | $x=-12$ |
| 1e | $x \leq -\frac{1}{7}$ |
| 1f | $x = -\frac{1}{7}$ |
| 2ai | 540m |
| 2aii | 381 m |
| 2b | 236.6° |
| 3a | $\begin{pmatrix} 6 \\ 8 \\ 10 \end{pmatrix}$ |
| 3bi | $\begin{pmatrix} 64 \\ 190 \end{pmatrix}$ |
| 3bii | The elements represent the total amount collected from the sales of men's and womens' t-shirts respectively . |
| 3ci | (115 202.5 51.5) |
| 3cii | $(115 \ 202.5 \ 51.5) \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} = (369)$ |
| 4a | $b = 4.75$ |
| 4d | $-2.4 \leq x_1 \leq -2.2, x_2 = 0, 2.2 \leq x_3 \leq 2.4$ |
| 4e | $A=3, B = 16$ |
| 5ai | 603 cm^3 |
| 5aii | 17.0 cm^2 |
| 5bi | 7.33 cm^3 |
| 5bii | 82 |
| 6ai | $\angle ADE = 90^\circ + \angle ADG$ $\angle CDG = 90^\circ + \angle ADG$ $\therefore \angle ADE = \angle CDG$ |
| 6aii | $AD = CD$ (sides of square $ABCD$) $\angle ADE = \angle CDG$ [from 6(a)(i)] $DE = DG$ (sides of square $DEFG$) $\therefore \triangle ADE \cong \triangle CDG$ (SAS) |
| 6bi | $\angle ADE = 26^\circ$ (\angle s in same segment) |
| 6bii | 51° |
| 6biii | 103° |

| | |
|--------|---|
| 7a | 48.1° |
| 7b | 14.7 cm |
| 8a | $a = 3$ |
| 8bi | 0.949 kg |
| 8bii | The mid-values of the masses are used instead as the exact masses were not known. |
| 8c | The masses of durians from shop <i>B</i> are heavier (or have higher mass) than shop <i>A</i> because the mean mass of durians from shop <i>B</i> (4.4kg) is greater than shop <i>A</i> (3.5kg). The masses of durians from shop <i>B</i> have a greater spread than shop <i>A</i> because the standard deviation of the masses of durians from shop <i>B</i> (1.2kg) is greater than shop <i>A</i> (0.949kg). |
| 9ai | $\begin{pmatrix} 3 \\ 10 \end{pmatrix}$ |
| 9aia | 10.4 units |
| 9bi | $-2a$ |
| 9bii | $a - b$ |
| 9d | $\overline{DF} = \frac{1}{5}(5b + a)$ $\overline{DE} = \frac{1}{3}(5b + a)$ Since $\overline{DF} = k\overline{DE}$, \overline{DF} is parallel to \overline{DE} and <i>D</i> is a common point, hence <i>D</i> , <i>E</i> , and <i>F</i> lie on the same straight line. |
| 9e | $\frac{4}{9}$ |
| 10ai | $\frac{1}{2}$ |
| 10aia | $\frac{\pi}{25}$ or 0.04π |
| 10bi | $\frac{1}{4}$ |
| 10bii | $\frac{1}{4}$ |
| 10biii | $\frac{7}{16}$ |
| 11a | 363 miles |
| 11b | 6 hrs 10 mins |
| 11c | <u>Recommend Bus</u> Advantage: Lower cost by bus (\$71.52) than train (\$136) Disadvantage: Longer travelling time by bus (7 hours 40 min) than train (6 hours 10 min) OR <u>Recommend Train</u> Advantage: Shorter travelling time by train (6 hours 10 min) than bus (7 hours 40 min) Disadvantage: Higher cost by train (\$136) than bus (\$71.52) |

2022 Sec 4E5N/4NA(OOS)
EM PRELIM P1
Marking Scheme with Marker's Report

| Solutions: | | |
|------------|--|--|
| 1 | $\sqrt{-\frac{35}{27} - \left(\frac{-11}{81}\right)^2} = \frac{4}{9}$ | |
| 2 | Different scales used for the vertical axes. | |
| 3a | Diagram 2 | |
| 3b | Height of cylindrical part of the container / Depth of water when the cylindrical part of the container is fully filled up | |
| 4a | $4 + 7x - x^2 = -(x^2 - 7x - 4)$ $= -\left[x^2 - 7x + \left(\frac{-7}{2}\right)^2 - \left(\frac{-7}{2}\right)^2 - 4\right]$ $= -\left[\left(x - \frac{7}{2}\right)^2 - \frac{65}{4}\right]$ $= -\left(x - \frac{7}{2}\right)^2 + \frac{65}{4}$ | |
| 4b | Max value = $\frac{65}{4}$ | |
| 5a | $\frac{10+n}{16+n}$ | |
| 5b | $\frac{10+n}{16+2n} = \frac{9}{16}$ $160 + 16n = 144 + 18n$ $2n = 16$ $n = 8$ <p>Total number of cubes = 32</p> | |
| 6 | $\angle AOC = 360^\circ - 216^\circ \text{ (}\angle \text{ at a point)}$ $= 144^\circ$ $\angle BOC = \angle OBA$ $= 90^\circ \text{ (tan } \perp \text{ radii, alt. } \angle \text{s. } OC \parallel AB)$ $\angle AOB = 144^\circ - 90^\circ$ $= 54^\circ$ | |
| 7 | $\frac{3-2x}{4} = 6 - \frac{x+5}{7}$ $\frac{3-2x}{4} = \frac{42-x-5}{7}$ $21-14x = 148-4x$ $10x = -127$ $x = -12.7$ | |

| Solutions: | | | |
|------------|---|--|--|
| 8a |  | | |
| 8b | 1, 9, 25, 49, 81 | | |
| 8c | 0 | | |
| 9a | $x = 15, y = 19, z = 23$ | | |
| 9b | $4n + 7$ or $11 + 4(n - 1)$ | | |
| 10a | $2x^{-3n} = 2(x^n)^{-3}$ $= \frac{2}{1000}$ $= \frac{1}{500} \quad \text{or} \quad 0.02 \quad \text{o.e}$ | | |
| 10b | $\left(\frac{8m^3}{n^{-6}}\right)^{\frac{1}{3}} \div \frac{m^{-4}}{n^3} = \frac{2m}{n^{-2}} \times \frac{n^3}{m^{-4}}$ $= 2m^5 n^5$ | | |
| 11a | 7 | | |
| 11b | $y = \sqrt{9 - 4x}$ $y^2 = 9 - 4x$ $4x = 9 - y^2$ $x = \frac{9 - y^2}{4} \quad \text{or} \quad x = -\frac{y^2 - 9}{4} \quad \text{or} \quad x = \frac{(3 + y)(3 - y)}{4}$ | | |
| 12 | $p = \frac{360}{10} = 36$ $q = \frac{36}{2} = 18$ $r = 36 + 18 = 54$ | | |
| 13a | smallest $x = 27$ corresponding $y = 15$ | | |
| 13b | $y = 50 - (26 + 13)$ $= 11$ | | |
| 14a | $\text{Total in US\$} = 5000 \left(1 + \frac{2.5}{100}\right)^2$ $= 5253.125$ | | |

| Solutions: | | | |
|--------------|--|--|--|
| | $= \text{US\$}5253.13$ | | |
| 14b | <p>In Jan 2020, $\text{US\\$}5000 = 1.3453 \times 5000$ $= \text{S\\$}6726.50$</p> <p>In Jan 2022, $\text{US\\$}5253.125 = 5253.125 \div 0.7415$ $= \text{S\\$}7084.46$</p> <p>Mr Lim made a gain</p> | | |
| 15a | <p>$\sqrt{36} \text{ cm} : \sqrt{9} \text{ km}$ $6\text{cm} : 3\text{km}$ $6\text{cm} : 300000\text{cm}$ $1:50000$</p> <p>$n = 50000$</p> | | |
| 15b | <p>$1.64 \text{ km} = 164000 \text{ cm}$ Length of road $= \frac{164000}{50000}$ $= 3.28 \text{ cm}$</p> | | |
| 16a | <p>$(2a - 3)^2 - 4a(a - 4)$ $= 4a^2 - 12a + 9 - 4a^2 + 16a$ $= 4a + 9$</p> | | |
| 16b | <p>$14x^2 - 7xy + 3ay - 6ax$ $= 7x(2x - y) + 3a(y - 2x)$ $= 7x(2x - y) - 3a(2x - y)$ $= (7x - 3a)(2x - y)$ or any equivalent form</p> | | |
| 17a | $1188 = 2^2 \times 3^3 \times 11$ | | |
| 17b | <p>$m = 2 \times 11^2$ $= 242$</p> | | |
| 17c | <p>$360 = 2^3 \times 3^2 \times 5$ HCF of 360 and 1188 $= 2^2 \times 3^2$ $= 36$</p> | | |
| 18ai | <p>$\angle ECD = 76^\circ - 34^\circ$ $= 42^\circ$ $\angle EBA = \angle DCA$ (Corresponding Angles, $BE \parallel CD$)</p> <p>Or $\angle BED = \angle ECD$, Alternate Angles, $BE \parallel CD$</p> | | |
| 18aii | $\angle EDC = 180^\circ - 34^\circ - 76^\circ$ | | |

Solutions:

$$= 70^\circ$$

Angle sum of triangle

18b EC is the longest side because it is opposite the largest interior angle.

$$\angle EDC = 70^\circ$$

$$\angle CED = 68^\circ$$

$$\angle ECD = 42^\circ$$

Or

$$\frac{EC}{\sin \angle EDC} = \frac{DC}{\sin \angle DEC} = \frac{ED}{\sin \angle ECD}$$

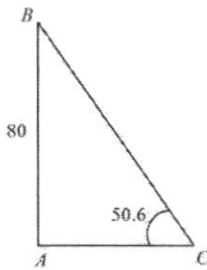
$$\frac{EC}{\sin 70^\circ} = \frac{DC}{\sin 68^\circ} = \frac{ED}{\sin 42^\circ}$$

Since

$$\sin 70^\circ > \sin 68^\circ > \sin 42^\circ$$

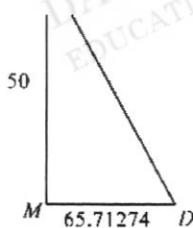
$$EC > DC > ED$$

19



$$\frac{AB}{AC} = \tan 50.6^\circ$$

$$AC = \frac{80}{\tan 50.6^\circ} = 65.71274$$



$$\frac{50}{65.71274} = \tan x^\circ$$

$$x^\circ = \tan^{-1} \frac{50}{65.71274}$$

$$= 37.267^\circ$$

$$= 37.3^\circ \text{ (1d.p.)}$$

| Solutions: | | | |
|------------|--|--|--|
| 20a | $VX^2 = OX^2 + VO^2$ (Pythagoras' Theorem) $VX = \sqrt{3.5^2 + 8^2}$ $VX = \sqrt{76.25}$ or 8.7321 (5 s.f.) Total surface area of the pyramid = $4\left(\frac{1}{2} \times 7 \times \sqrt{76.25}\right) + 7^2$ $= 171.2497444$ $= 171 \text{ cm}^2$ (correct to 3 s.f.) | | |
| 20b | $\text{Vol. of the Pyramid} = \frac{1}{3} \times 7^2 \times 8$ $= 130\frac{2}{3} \text{ cm}^3$ $\text{Vol. of 1 sphere} = \frac{4}{3} \times \pi \times (0.2)^3$ $= \frac{4}{375} \pi \text{ cm}^3$ or $\frac{32}{3} \pi \text{ mm}^3$ Maximum number of spheres $= 130\frac{2}{3} \div \frac{4}{375} \pi$ $= 3899.29$ (5 s.f.) $= 3899$ (round down) | | |
| 21i | \$2.70 | | |
| 21ii | IQR = \$3.70-\$2.00 \$1.70 | | |
| 21iii | <p>Acceptable Answers</p> <p>School B, since the <u>median of donations of School B (\$3.00) is higher the median of donations of School A (\$2.70).</u></p> <p>School B has a lower interquartile range of (\$1.30) compared to School A (\$1.70), <u>donations are more consistent/less widespread with the greater donations than School A.</u></p> <p>School B has a higher upper quartile (\$4) than School A (\$3.60), <u>so 25% of students in School B donated \$4 of more compared to less than 25% of students in School A.</u></p> | | |

| Solutions: | | | |
|------------|--|--|--|
| 22ai | $\overrightarrow{DC} = 3\mathbf{a}$ | | |
| 22aii | $\begin{aligned}\overrightarrow{DA} &= \overrightarrow{DC} + \overrightarrow{CA} \\ &= 3\mathbf{a} + 2\overrightarrow{CM} \\ &= 3\mathbf{a} + 4\mathbf{b}\end{aligned}$ | | |
| 22aii | $\begin{aligned}\overrightarrow{DX} &= \frac{1}{5}\overrightarrow{DA} \\ &= \frac{1}{5}(3\mathbf{a} + 4\mathbf{b})\end{aligned}$ | | |
| 22b | $\begin{aligned}\overrightarrow{BX} &= \overrightarrow{BD} + \overrightarrow{DX} \\ &= \mathbf{a} + \frac{1}{5}(3\mathbf{a} + 4\mathbf{b}) \\ &= \mathbf{a} + \frac{3}{5}\mathbf{a} + \frac{4}{5}\mathbf{b} \\ &= \frac{8}{5}\mathbf{a} + \frac{4}{5}\mathbf{b} \\ &= \frac{4}{5}(2\mathbf{a} + \mathbf{b}) \\ \\ \overrightarrow{BX} &= \frac{4}{5}(2\mathbf{a} + \mathbf{b}) \text{ (Shown)}\end{aligned}$ | | |
| 22c | $\begin{aligned}\overrightarrow{BM} &= \overrightarrow{BC} + \overrightarrow{CM} \\ &= 4\mathbf{a} + 2\mathbf{b} \\ &= 2(2\mathbf{a} + \mathbf{b})\end{aligned}$ | | |
| 22di | $\frac{BX}{BM} = \frac{ \frac{4}{5}(2\mathbf{a} + \mathbf{b}) }{ 2(2\mathbf{a} + \mathbf{b}) } = \frac{2}{5}$ | | |
| 22dii | $\frac{\text{area of } \triangle ABX}{\text{area of } \triangle AMX} = \frac{\frac{1}{2} \times BX \times \perp h}{\frac{1}{2} \times MX \times \perp h} = \frac{BX}{MX} = \frac{2}{3}$ | | |
| 22iii | $\frac{\text{area of } \triangle ABX}{\text{area of } \triangle ABC} = \frac{\text{area of } \triangle ABX}{\text{area of } \triangle ABM} \times \frac{\text{area of } \triangle ABM}{\text{area of } \triangle ABC} = \frac{2}{5} \times \frac{1}{2} = \frac{1}{5}$ | | |

2022 Sec 4E5N/4NA(OOS)
EM Prelim P2
Marking Scheme with Marker's Report

| Solution: | | |
|-----------|---|--|
| 1a | $\frac{9x-2}{x^2-4x+4} + \frac{2}{x-2}$ $= \frac{9x-2}{(x-2)^2} + \frac{2}{x-2} \quad \text{--- factorization of denominator}$ $= \frac{9x-2}{(x-2)^2} + \frac{2(x-2)}{(x-2)^2} \quad \text{--- correct denom. \& numerator}$ $= \frac{11x-6}{(x-2)^2}$ | |
| 1b | <p>Any method to solve either substitution or elimination</p> <p>$x=2, y=-4$ --- A1 each</p> | |
| 1c | $\frac{(3x+2)(3x-2)}{(3x+2)(x-3)} \times \frac{1}{(2-3x)}$ $= \frac{-(3x+2)(2-3x)}{(3x+2)(x-3)} \times \frac{1}{(2-3x)}$ $= \frac{-1}{x-3} \quad \text{or} \quad \frac{1}{3-x}$ | |
| 1d | $(2^3)^{1-2x} = (2^5)^{3-x}$ <p>Comparing indices:-</p> $3(1-2x) = 5(3-x)$ $3-6x = 15-5x$ $x = -12$ | |
| 1e | $1-5+2x < \frac{3}{2}x + \frac{1}{2} \quad ; \quad \frac{3}{2}x + \frac{1}{2} \leq \frac{4}{5}x + \frac{2}{5}$ $\frac{1}{2}x < 4\frac{1}{2} \quad ; \quad \frac{7}{10}x \leq -\frac{1}{10}$ $x < 9 \quad ; \quad x \leq -\frac{1}{7}$ $x \leq -\frac{1}{7}$ | |
| 1f | $x = -\frac{1}{7}$ | |

| Solutions: | Marker's comments |
|--|-------------------|
| 2ai $QS = \sqrt{420^2 + 340^2} = \sqrt{292000}$ $= 540.37$ $\approx 540 \text{ m}$ | |
| 2aii $\angle RSQ = \tan^{-1} \frac{420}{340}$ $= 51.009^\circ$ $\angle QSP = 360^\circ - 21.009^\circ - 280^\circ \text{ (\angle s at a point)}$ $= 28.991^\circ$ $PQ = \sqrt{750^2 + (\sqrt{292000})^2 - 2(750)(\sqrt{292000}) \cos 28.991}$ $= 381.571$ $= 381 \text{ m}$ | |
| 2b $\frac{\sin \angle PQS}{750} = \frac{\sin 28.991^\circ}{381.46}$ $\angle PQS = 72.35^\circ \text{ (acute) } \boxed{72.33^\circ}$ $\text{obtuse } \angle PQS = 180^\circ - 72.35^\circ$ $= 107.65^\circ \text{ } \boxed{107.67^\circ}$ <p style="text-align: center;">} <i>or</i> } <i>Find using</i> } <i>Cosine rule</i></p> $\angle RQS = 180^\circ - 90^\circ - 51.009^\circ \text{ (\angle sum of } \Delta)$ $= 38.991^\circ$ $\text{Bearing required} = 128.991^\circ + 107.65^\circ$ $= 236.6^\circ \text{ } \boxed{236.7^\circ}$ | |
| 3a $\begin{pmatrix} 6 \\ 8 \\ 10 \end{pmatrix}$ | |
| 3bi $\begin{pmatrix} 64 \\ 190 \end{pmatrix}$ | |
| 3bii The elements represent the total amount collected from the sales of men's and womens' t-shirts respectively . | |
| 3ci (115 202.5 51.5) | |
| 3cii $(115 \ 202.5 \ 51.5) = (369)$ <p><i>or</i> $(10 \ 11.5) \begin{pmatrix} 7 \\ 26 \end{pmatrix} = (369)$</p> Total amount received = \$369 | |

| Solution: | | | |
|-----------|--|--|--|
| 4a | b = 4.75 | | |
| 4b | All points plotted correctly Correct Labelled Axis & Scale <i>Smooth</i> curve drawn with curve ruler passing through all points | | |
| 4c | Ruled straight line through (0,1) Must show gradient = $\frac{1}{3}$ | | |
| 4d | $-2.4 \leq x_1 \leq -2.2$, $x_2 = 0$, $2.2 \leq x_3 \leq 2.4$ | | |
| 4e | $A=3$, $B = 16$ $\frac{1}{3}x+1 = \frac{x^3}{4} - x+1$ $4x+12 = 3x^3 - 12x+12$ $3x^3 = 16x$ | | |
| 5ai | Vol of solid P = $\frac{2}{3} \times \pi \times 12^3$ = 1152π = 3619.114737 cm^3 Vol of solid Q = $3619.114737 \div 6$ $\approx 603 \text{ cm}^3$ | | |
| 5aii | Slant height of cone = $\sqrt{2}$ cm Total Curved surface area of solid R = $(\pi \times 1 \times \sqrt{2}) + (2 \times \pi \times 1 \times 2)$ = 17.0 cm^2 | | |
| 5bi | Vol of solid R = $(\frac{1}{3} \times \pi \times 1^2 \times 1) + (\pi \times 1^2 \times 2)$ = 7.33038 cm^3 = 7.33 cm^3 | | |
| 5bii | Number of complete solid R that can be obtained = 82 (nearest whole number) | | |
| 6ai | $\angle ADE = 90^\circ + \angle ADG$ $\angle CDG = 90^\circ + \angle ADG$ | | |

| Solution: | | | |
|--------------|--|--|--|
| | $\therefore \angle ADE = \angle CDG$ | | |
| 6aii | $AD = CD$ (sides of square $ABCD$) $\angle ADE = \angle CDG$ [from 6(a)(i)] $DE = DG$ (sides of square $DEFG$) $\therefore \triangle ADE \equiv \triangle CDG$ (SAS) | | |
| 6bi | $\angle ADE = 26^\circ$ (\angle s in same segment) | | |
| 6bii | $\angle AED = 180 - 78$ (adj. \angle s on a st. line) $= 102^\circ$ $\angle ACD = 180 - 102$ (\angle s in opp. segments) $= 78^\circ$ $\angle CDA = \frac{180^\circ - 78^\circ}{2}$ (base \angle of isos. triangle) $= 51^\circ$ | | |
| 6biii | $\angle CAE = 180 - 26 - 51$ (angles in opp. segments) $= 103^\circ$ | | |
| 7a | 48.1° | | |
| 7b | Arc length, $PR = 6(0.84)$ $= 5.04$ cm $OQ^2 = 6^2 + 6.7^2$ $OQ = \sqrt{6^2 + 6.7^2}$ $= 8.9939$ $RQ = 8.9939 - 6$ $= 2.9939$ Perimeter $= 5.04 + 2.9939 + 6.7$ $= 14.7$ cm | <div style="border: 1px solid black; padding: 5px; width: fit-content;"> Answers may vary slightly due to students using either Trigo Ratios, Pythagoras' Theorem or Cosine Rule to find OQ. </div> | |
| 8a | $\frac{2 \times 1.5 + a \times 2.5 + 8 \times 3.5 + 7 \times 4.5}{17 + a} = 3.5$ $2.5a + 62.5 = 59.5 + 3.5a$ $a = 3$ | | |
| 8bi | 0.949 kg | | |

| Solution: | | | |
|-------------|---|--|--|
| 8bii | The mid-values of the masses are used instead as the exact masses were not known. Masses were given in range. (adjusted answer key) | | |
| 8c | <p>The masses of durians from shop <i>B</i> are heavier (or have higher mass) than shop <i>A</i> because the mean mass of durians from shop <i>B</i> (4.4kg) is greater than shop <i>A</i> (3.5kg).</p> <p>The masses of durians from shop <i>B</i> have a greater spread than shop <i>A</i> because the standard deviation of the masses of durians from shop <i>B</i> (1.2kg) is greater than shop <i>A</i> (0.949kg).</p> <p>Or</p> <p>The masses of durians from shop <i>B</i> are less consistent than shop <i>A</i> because the standard deviation of the masses of durians from shop <i>B</i> (1.2kg) is greater than shop <i>A</i> (0.949kg).</p> | | |
| 9ai | $\begin{aligned} \overrightarrow{AD} &= \overrightarrow{OD} - \overrightarrow{OA} \\ &= \begin{pmatrix} -4 \\ 5 \end{pmatrix} - \begin{pmatrix} -7 \\ -5 \end{pmatrix} \\ &= \begin{pmatrix} 3 \\ 10 \end{pmatrix} \end{aligned}$ | | |
| 9aii | $\begin{aligned} \overrightarrow{AD} &= \sqrt{3^2 + 10^2} \\ &= 10.4 \text{ units} \end{aligned}$ | | |
| 9bi | $-2a$ | | |
| 9bii | $a - b$ | | |

| Solution: | | |
|-----------|---|--|
| 9c | $\begin{aligned}\overline{DE} &= \overline{DB} + \overline{BE} \\ &= 2\mathbf{b} + \frac{1}{3}(\mathbf{a} - \mathbf{b}) \\ &= 2\mathbf{b} + \frac{1}{3}\mathbf{a} - \frac{1}{3}\mathbf{b} \\ &= \frac{5}{3}\mathbf{b} + \frac{1}{3}\mathbf{a} \\ &= \frac{1}{3}(5\mathbf{b} + \mathbf{a}) \quad (\text{shown})\end{aligned}$ | <p>Also accepted:</p> $\begin{aligned}\overline{DE} &= \overline{DA} + \overline{AE} \\ &= \mathbf{b} + \mathbf{a} + \frac{2}{3}(\mathbf{b} - \mathbf{a}) \\ &= \frac{1}{3}(5\mathbf{b} + \mathbf{a}) \quad (\text{shown})\end{aligned}$ |
| 9d | $\begin{aligned}\overline{DF} &= \overline{DO} + \overline{OF} \\ &= \mathbf{b} + \frac{1}{5}\mathbf{a} \\ &= \frac{1}{5}(5\mathbf{b} + \mathbf{a})\end{aligned}$ <p>Must show same vector as 9c</p> $\overline{DE} = \frac{1}{3}(5\mathbf{b} + \mathbf{a})$ <p>Or</p> $\begin{aligned}&= \frac{5}{3}\left(\mathbf{b} + \frac{1}{5}\mathbf{a}\right) \\ &= \frac{5}{3}\overline{DF}\end{aligned}$ <p>Since $\overline{DF} = k\overline{DE}$, \overline{DF} is parallel to \overline{DE} and D is a common point, hence D, E, and F lie on the same straight line.</p> | |
| 9e | $\frac{4}{9}$ | |
| 10ai | $\frac{1}{2}$ | |
| 10aii | $\frac{\pi}{25}$ or 0.04π | |

| Solution: | | |
|---------------|---|---|
| 10aiii | $1 - \frac{1}{2} - \frac{1}{4} - \frac{\pi}{25}$ $= \frac{1}{4} - \frac{\pi}{25}$ $= \frac{25 - 4\pi}{100} \text{ (shown)}$ | $P(\text{Red}) = P(\text{Yellow-Blue})$ $\text{or } = \frac{1}{4} - \frac{\pi}{25}$ $= \frac{25 - 4\pi}{100} \text{ (shown)}$ |
| 10bi | $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ | |
| 10bii | $\left(\frac{1}{2} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{2}\right)$ $= \frac{1}{4}$ | |

| Solution: | | Marker's comments |
|---------------|---|-------------------|
| 10biii | $P(\text{at least 1 dart hit yellow area})$ $= 1 - P(\text{both darts not hitting yellow area})$ $= 1 - \left(\frac{3}{4}\right)^2$ $= \frac{7}{16}$ | |
| 11a | $1.6093 \text{ km} \rightarrow 1 \text{ mile}$ $1 \text{ km} \rightarrow \frac{1}{1.6093} \text{ miles}$ $584.6 \text{ km} \rightarrow 363 \text{ miles}$ | |
| 11b | $\text{Time taken for train journey}$ $= \frac{584.6}{94.8}$ $= \frac{37}{6} \text{ h}$ $= 6 \text{ hrs } 10 \text{ mins}$ | |

| Solution: | Marker's comments |
|--|-------------------|
| <p>11c <u>By Train</u></p> <p>Both Glen and Jane can depart only at 09 27 from Berlin in order to reach Munich latest by 4pm.</p> <p>Cost of train ride $= 68 \times 2$ $= \\$136$</p> <p><u>By Bus</u></p> <p>Both Glen and Jane have to take the bus via Bayreuth from Berlin in order to reach Munich latest by 4pm.</p> <p>Duration of bus ride = 7 hrs 40 mins</p> <p>Distance covered by bus in miles $= 7\frac{2}{3} \times 45$ $= 345 \text{ miles} \times 1.6093$ $= 555.2085 \text{ km}$</p> <p>Cost of bus ride $= [8 + (555.2085 \times 0.05)] \times 2$ $= \\$71.52$</p> <p><u>Recommend Bus</u> Advantage: Lower cost by bus (\$71.52) than train (\$136)</p> <p>Disadvantage: Longer travelling time by bus (7 hours 40 min) than train (6 hours 10 min)</p> <p>OR</p> <p><u>Recommend Train</u> Advantage: Shorter travelling time by train (6 hours 10 min) than bus (7 hours 40 min)</p> <p>Disadvantage: Higher cost by train (\$136) than bus (\$71.52)</p> | |