# Bukit View Secondary School

Secondary Four Express / Five Normal (Academic)
Mid-Year Examination 2021

CANDIDATE NAME

CLASS

INDEX NUMBER

**MATHEMATICS**
Paper 1

**4048 / 01**
4 May 2021
2 hours

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your candidate name, class and number in the spaces at the top of this page.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For $\pi$, use either your calculator value or 3.142, unless the question requires the answer in terms of $\pi$.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total marks for this paper is 80.

| For Examiner's use |
| --- |
| Marks |
| 80 |

**Setter: Mrs Irni Prasad**

**Parent's Signature:** _____

This paper consists of **18** printed pages



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## *Mathematical Formulae*

*Compound interest*

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

*Mensuration*

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

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

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

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

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

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

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

*Trigonometry*

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

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

*Statistics*

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

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


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Answer **all** the questions.

**1.** Factorise fully $2x^2 + y^2 - 2x - xy^2$.

*Answer* : ..... [2]

---

**2.** It takes $p$ workers $q$ days to build $r$ houses.
If the number of days is halved and $5r$ houses are to be built, how many workers must be hired for the job?

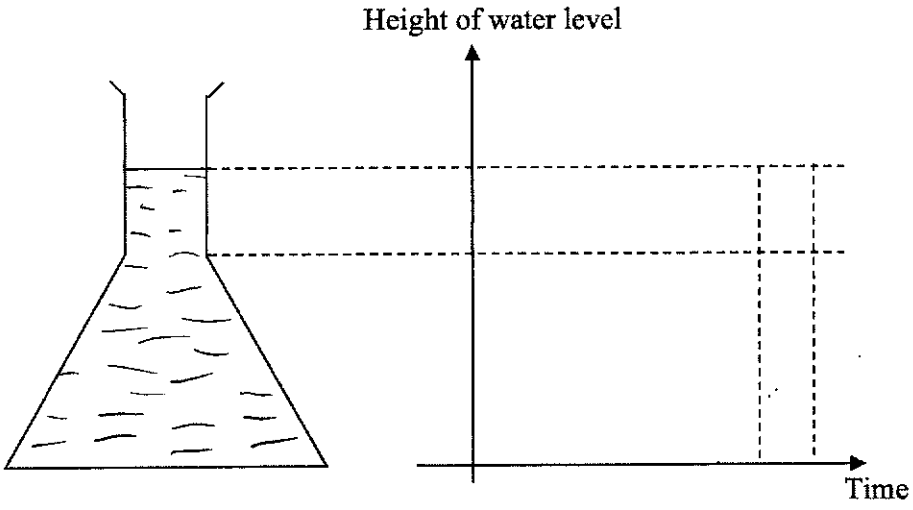
Express your answer in terms of $p$.

*Answer* : ..... [2]

---

**3.** Water is poured at a constant rate into the conical flask as shown below.
Draw on the axes provided, the change in the water level of the conical flask over time.

*Answer*




[2]

---



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**4.** Solve the equation $(1-x)^2 = \frac{9}{4}$.

*Answer* : $x =$ ..... or ..... [2]

---

**5.** A group of 15 students recorded their timings (to the nearest minute), for a 5-km run. The results are represented in the stem and leaf diagram below.

| Stem | Leaf |
|---|---|
| 2 | 6 8 8 9 |
| 3 | 0 0 1 3 4 4 4 5 7 9 |
| 4 | |
| 5 | |
| 6 | 1 |

Key: 2|6 means 26 minutes

**(a)** Find the percentage of students who took at least 35 minutes to complete the run.

*Answer* : ..... % [1]

**(b)** Explain why the mean may not be an appropriate measure of average time taken by these students to complete the 5-km run.

*Answer* :.....

..... [1]

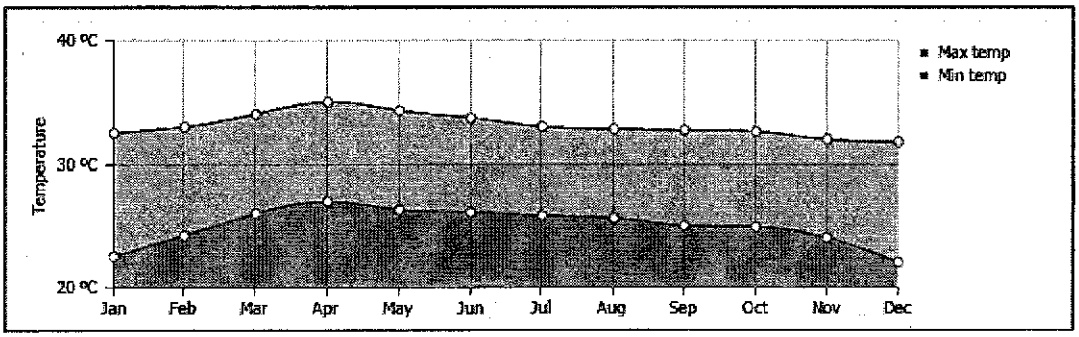
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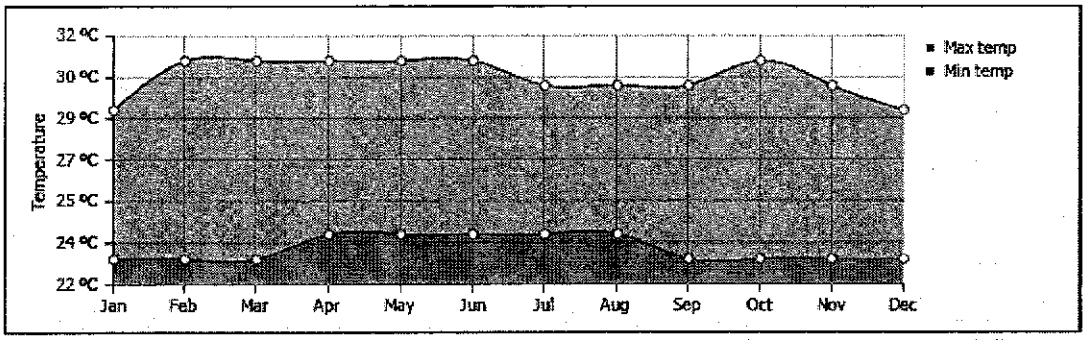
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**6.** The line graphs below show the monthly average minimum and maximum temperatures of Bangkok (Thailand) and Singapore, for the year 2020.




Average min and max temperature, Bangkok Thailand Copyright 2020 www.weather-and-climate.com




Average min and max temperature, Singapore Copyright 2020 www.weather-and-climate.com

**(a)** Huda claims that Singapore experienced wider differences between the maximum and minimum temperatures.

Explain why the data presented above may have been misleading for Huda.

*Answer* : .....

.....

..... [1]

**(b)** Give a suggestion on how the data above can be presented in a clearer way.

*Answer* : .....

..... [1]

---



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7. A polygon with $n$ sides has two exterior angles 100° and 50°.
The remaining $(n-2)$ exterior angles are 14° each.

Find $n$.

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

---

8. Written as the product of its prime factors, $504 = 2^x \times 3^y \times 7$.

**(a)** Find the values of $x$ and $y$.

*Answer* : $x$ = ..... , $y$ = ..... [1]

**(b)** The highest common factor and the lowest common multiple of 18 and $z$ are 6 and 504 respectively.

Find the smallest possible value of $z$.

*Answer* : smallest $z$ = ..... [2]

---


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**9.** Simplify $\left(\frac{x^6}{64}\right)^{-\frac{2}{3}} \div \frac{y^3}{x^6}$.

Leave your answer in positive index.

*Answer* : ..... [3]

---

**10.** Mr Png bought a massage chair with a down payment of 15% of the cash price and a monthly instalment of $195.60 for 18 months.

If he paid a total of $3970.80, find the cash price of the massage chair.

*Answer* : $ ..... [3]

---

**11.** Given that $m = \sqrt{\frac{2m+1+k}{4k}}$, express $k$ in terms $m$, in its simplest form.

*Answer* : $k$ =..... [3]

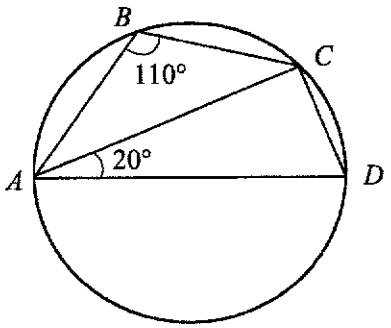
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**12.** The diagram shows a circle with points $A$, $B$, $C$ and $D$ on its circumference.
Angle $ABC = 110°$ and angle $CAD = 20°$.

Explain why $AD$ is a diameter of the circle.




*Answer* :

[3]

---

**13.** $n$ is a positive integer.

**(a)** Show that $(3n-2)^2 - n^2$ is a multiple of 4.

[2]

**(b)** Hence or otherwise, factorise $(3n-2)^2 - n^2$ fully.

*Answer* : ..... [1]

---



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**14.** A bean bag is filled with small polystyrene balls of radius 3 millimetres.

**(a)** Write the radius of the ball in metres, leaving your answer in standard form.

*Answer* : ..... m [1]

**(b)** A bean bag of volume 2.88 $m^3$ is to be 80% filled with the spherical polystyrene balls.

Find the number of polystyrene balls required, giving your answer to the nearest million.

*Answer* ..... million [3]

---

**15.** The scores for a Mathematics Test sat by six students are as follows:

$$a\ ,\ b\ ,\ 59\ ,\ c\ ,\ 65\ ,\ 90$$

The range of the scores is 48.
The median score is 62.
The mean score is 61.

Find the values of $a$, $b$ and of $c$.

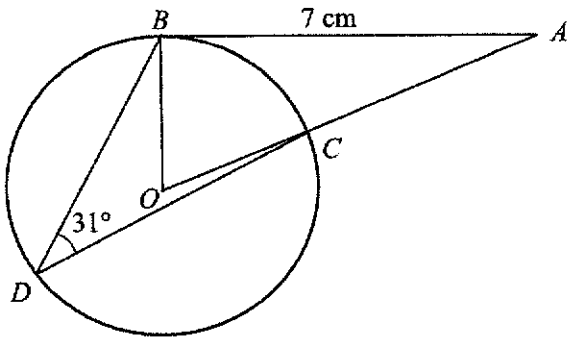
*Answer* : $a$ = ..... , $b$ = ..... , $c$ = ..... [4]

---


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**16.**




In the diagram, $B$, $C$ and $D$ are points on a circle.

$O$ is the centre, $OCA$ is a straight line and $BA$ is tangent to the circle at $B$.
Angle $BDC = 31°$ and $AB = 7$ cm.

**(a)** State the reason why angle $OBA = 90°$.

*Reason* : ..... [1]

**(b)** Find the length of the radius of the circle.

*Answer* : ..... cm [3]

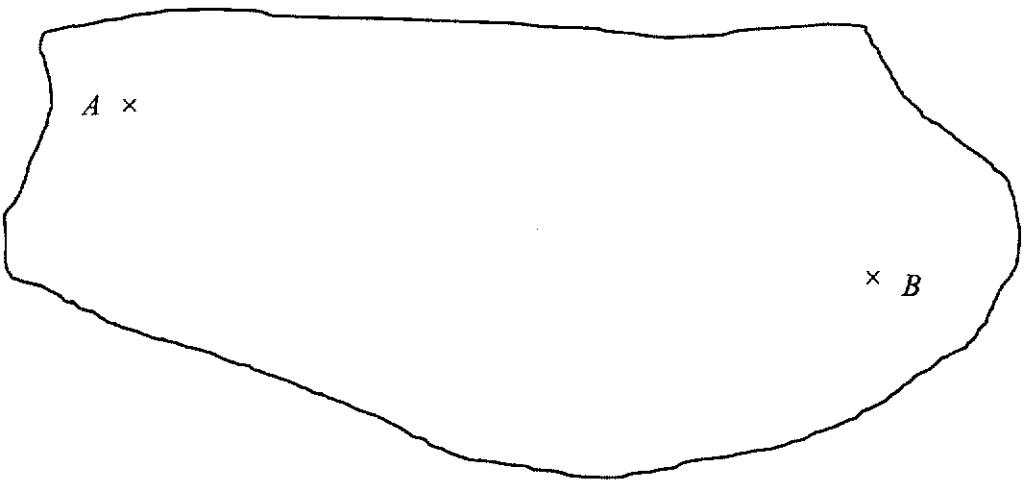
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**17. (Diagram is drawn to scale)**

The scale of the map below is 1 : 50 000.




Asher cycles from Point *A* to Point *B* at an average speed of 13 km/h.

If Asher has to reach point *B* by 4.30 pm, suggest the latest time he should set off from point *A*.

Show your working clearly.

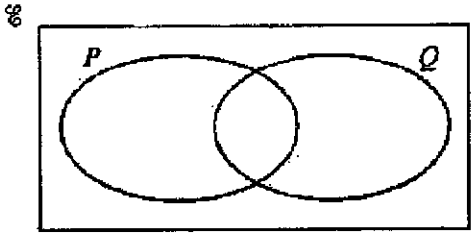
*Answer* : He should leave point *A* latest by ..... pm [4]

---


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**18. (a)** On the Venn diagram, shade the region which represents $P' \cup Q'$.




[1]

**(b)** $\varepsilon = \{ x : x \text{ is an integer such that } 5 \leq x \leq 9 \}$

$A = \{ x : 5 - \frac{x}{2} \geq 1 \}$

$B = \{ x : 4x - 1 > 19 \}$

List the element(s) contained in the set $(A \cap B)'$.

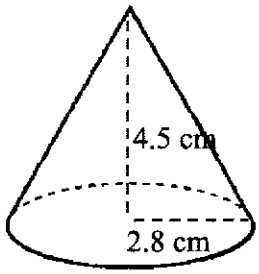
*Answer* : $(A \cap B)' = \{$ $\}$ [3]

---


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**19.** The diagram shows a paper cup in a shape of a cone with radius 2.8 cm and vertical height 4.5 cm.



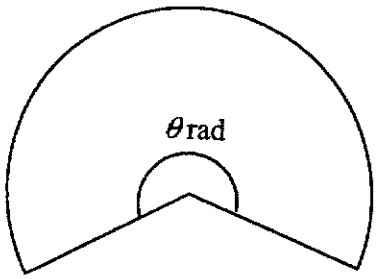

**(a)** Show that the curved surface area is $14.84\ \pi\ \text{cm}^2$.

*Answer* :

[2]

**(b)** The paper cup is cut open to form a sector of a circle with angle $\theta$ radians.

Find angle $\theta$.

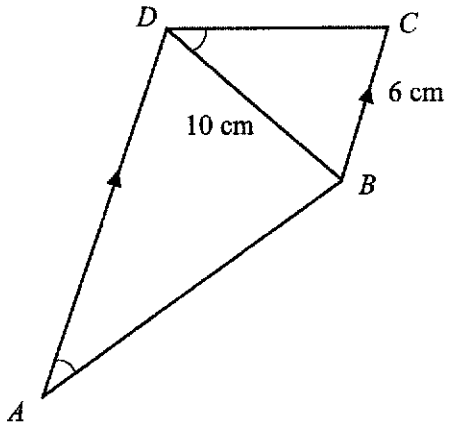



*Answer* : $\theta$ = ..... rad [2]



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**20.** In the diagram, the line $AD$ is parallel to $BC$ and $\angle BAD$ is equal to $\angle CDB$.
$BC = 6$ cm and $BD = 10$ cm.




**(a)** Explain why $\Delta ABD$ is similar to $\Delta DCB$.

*Answer* .....

.....

.....

..... [2]

**(b)** Find the length of $AD$.

*Answer* : ..... cm [2]

---


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**21.** The equation of a curve is given by $y = x(10 - x)$.

**(a)** Explain why the maximum value of $y$ is 25.

*Answer* .....

.....

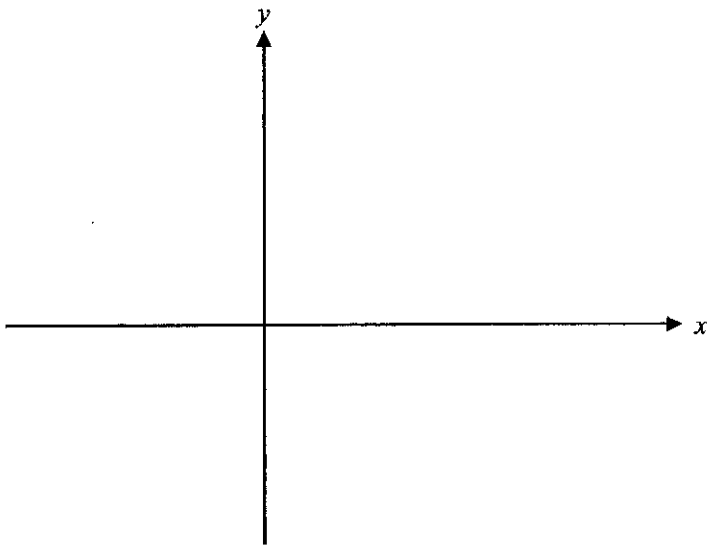
.....

.....

.....

..... [3]

**(b)** Sketch the curve $y = x(10 - x)$, showing clearly the intercepts and the maximum point.

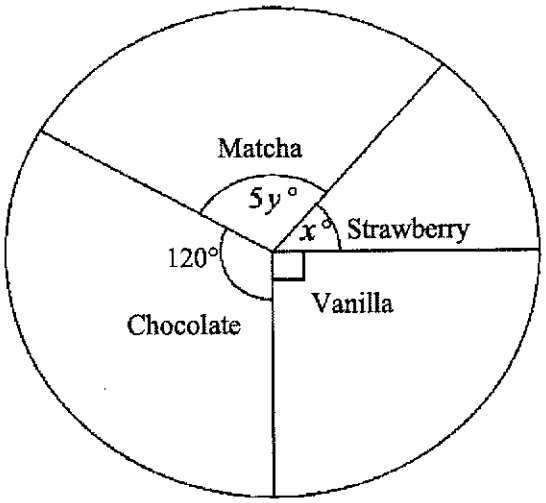



[2]



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**22.** The pie chart represented the number of people who chose their favourite milkshake flavour.




**(a)** Form an equation in terms of $x$ and $y$.

*Answer* ..... [1]

**(b)** The ratio of people who chose Strawberry to Matcha flavour was 4 : 11.
Show that $11x - 20y = 0$.

[1]

**(c)** Using your equations from **(a)** and **(b)**, solve them simultaneously to find the values of $x$ and of $y$.

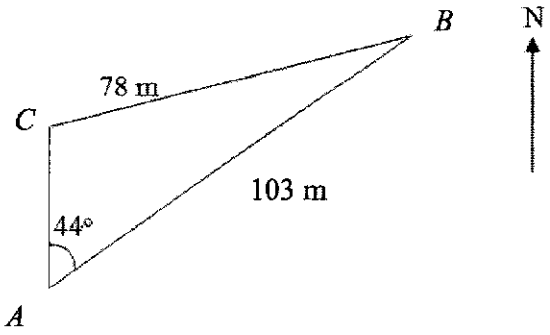
*Answer* $x =$ ..... , $y =$ ..... [3]

---


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**23.**




$A$, $B$ and $C$ are 3 points on level ground.
$BC = 78$ m, $AB = 103$ m and angle $BAC = 44°$.
$C$ is due north of $A$.

**(a)** Calculate the bearing of $A$ from $B$.

*Answer* : .....° [1]

**(b)** Find the area of triangle $ABC$.

*Answer* : ..... $m^2$ [4]

---



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**24.** A line passes through the points $A$ and $B$ whose coordinates are $(5, -13)$ and $(-2, 8)$ respectively.

**(a)** Find the equation of the line $AB$.

*Answer* : ..... [2]

**(b)** A point $P$ lies on the $y$-axis, such that it is the same distance from $A$ as it is from $B$.

Find the coordinates of point $P$.

*Answer* : $P$ = (..... , .....) [3]

---

End of Paper



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# Bukit View Secondary School

Secondary Four Express/Five Normal (Academic)
Mid-Year Examination 2021

| | | | |
|---|---|---|---|
| CANDIDATE NAME | | | |
| CLASS | | INDEX NUMBER | |

**MATHEMATICS** **4048/02**
Paper 2 **10 May 2021**
Candidates answer on the Question Paper. **2 hour 30 minutes**

**READ THESE INSTRUCTIONS FIRST**

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The number of marks is given in brackets [ ] at the end of each question or part question.
The total marks for this paper is 100.

| For Examiner's use |
|---|
| Marks |
| 100 |

**Setter: Ms Patricia Lye** **Parent's Signature:**_____

This question paper consists of **27** printed pages and **1** blank page.



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## *Mathematical Formulae*

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


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**[Turn over for Question 1]**


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**1** **(a)** Write as a single fraction in its simplest form

**(i)** $\frac{9a^3}{b} \div \frac{81a}{b^7}$,

*Answer* ..... [1]

**(ii)** $\frac{5}{(y-3)^2} - \frac{7}{3-y}$.

*Answer* ..... [2]

**(b)** Simplify $\frac{8x^2-18}{2x^2-x-6}$.

*Answer* ..... [3]



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**(c)** Solve the equation $\frac{32}{x-5} = 3x - 5$.

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

**2** **(a)** From 2019 to 2020 the total number of international visitors in Singapore decreased by 85.9%.
In 2020, the total number was $2.7 \times 10^6$.
Calculate the number of international visitors in 2019, giving your answer in standard form.

*Answer* ..... [2]


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**(b)** Siti invested some money in a saving accounts for 4 years.
The rate of interest was fixed at 1.08% per annum compounded annually.
At the end of 4 years, there was $8351.24 in her account.

How much did Siti invest in the account?
Give your answer correct to the nearest cent.

*Answer* $..... [2]


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**(c)** The exchange rate between Singapore dollars ($) and Euros (€) is $1=€0.63.

Andy is shopping online for a pair of boots.
He finds these prices online for the same model of boots.

| **Website** | **Price** |
|---|---|
| Zalora | $195 (before 7% GST) |
| Footshopping | €130 Nett |

**(i)** Both websites offer free shipping to Singapore.
GST needs to be paid if he buys from Zalora.
It is also known that Andy's credit card charges a foreign currency transaction fee of 3.25%.

Which website offers a better deal?
Show your working clearly.

*Answer* ..... [3]

**(ii)** A certain debit card offers $x$% foreign currency transaction fee.
$x$ must be less than a certain value so that buying from Footshopping will be a better deal.

Find that value.

*Answer* ..... [2]


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3 Gardens by the Bay Flower Dome operates for 340 days a year.
The matrix, **M**, shows the number of different types of tickets (**in thousands**) sold per day in 2019.

$$\begin{matrix} & \text{Child} & \text{Adult} & \text{Senior} & \\ \mathbf{M} = & \begin{pmatrix} 1.2 & 2 & 5 \\ 2.1 & 4.5 & 9 \end{pmatrix} & & \begin{matrix} \text{Residents} \\ \text{Non-residents} \end{matrix} \end{matrix}$$

**(a)** Evaluate the matrix $\mathbf{P} = 340\mathbf{M}$.

*Answer* ..... [1]

**(b)** The tickets cost \$10, \$16 and \$14 for child, adult and senior respectively.

Represent these amounts in a $3 \times 1$ matrix **N**.

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

**(c)** Evaluate the matrix $\mathbf{T} = \mathbf{PN}$.

*Answer* $\mathbf{T} =$ [2]


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**(d)** State what each of the elements of **T** represents.

*Answer* .....

.....

..... [1]

**(e)** Calculate the total amount of ticket sales in 2019.
Give your answer correct to the nearest million.

*Answer* $..... million [1]

**(f)** In 2020, the number of tickets sold for residents increased by 60% across the different types of tickets.
In the same year, the number of tickets sold for non-residents dropped to 20% across the different types of tickets.

Calculate the percentage change in the amount of ticket sales from 2019 to 2020.
State whether this change is an increase or a decrease.

*Answer* .....%

increase / decrease
(circle the appropriate answer) [3]


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**4** **(a)** The first three terms in a sequence of numbers, $T_1$ , $T_2$ , $T_3$ , ... are given below.

$$T_1 = 1^2 + 1 = 2$$
$$T_2 = 2^2 + 3 = 7$$
$$T_3 = 3^2 + 5 = 14$$

**(i)** Find $T_4$.

*Answer* ..... [1]

**(ii)** Find an expression, in terms of $n$, for $T_n$.

*Answer* ..... [2]

**(b)** The first four terms in a different sequence are –55, –51, –47, –43.

**(i)** Find an expression, in terms of $n$, for the $n$th term, $P_n$, of this sequence.

*Answer* ..... [2]



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**(ii)** Explain why 222 is not a term of this sequence.

*Answer* .....

.....

.....

.....

..... [1]

**(iii)** Find the least value of $n$ for which $P_n > 1$.

*Answer* ..... [2]



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

Some corresponding values of $x$ and $y$ are given in the table below.

| $x$ | –4 | –3 | –2 | –1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| $y$ | $p$ | 0.1 | 2.4 | 2.3 | 1 | –0.3 | –0.4 | 1.9 | 7.8 |

**(a)** Find the value of $p$.

*Answer* $p$ = ..... [1]

**(b)** Draw the graph of $y = \frac{x^3}{5} - \frac{3x}{2} + 1$ for $-4 \le x \le 4$ in the given grid. [3]

**(c)** **(i)** On the same grid, draw the graph of $2y - 3x = 2$ for $-4 \le x \le 4$. [2]

**(ii)** Show that the points of intersection of the line and the curve give the solutions of the equation $x^3 - 15x = 0$.

*Answer*

[2]

**(iii)** Hence, solve the equation $x^3 - 15x = 0$.

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

**(d)** By drawing a tangent, find the gradient of the curve at (3, 1.9).

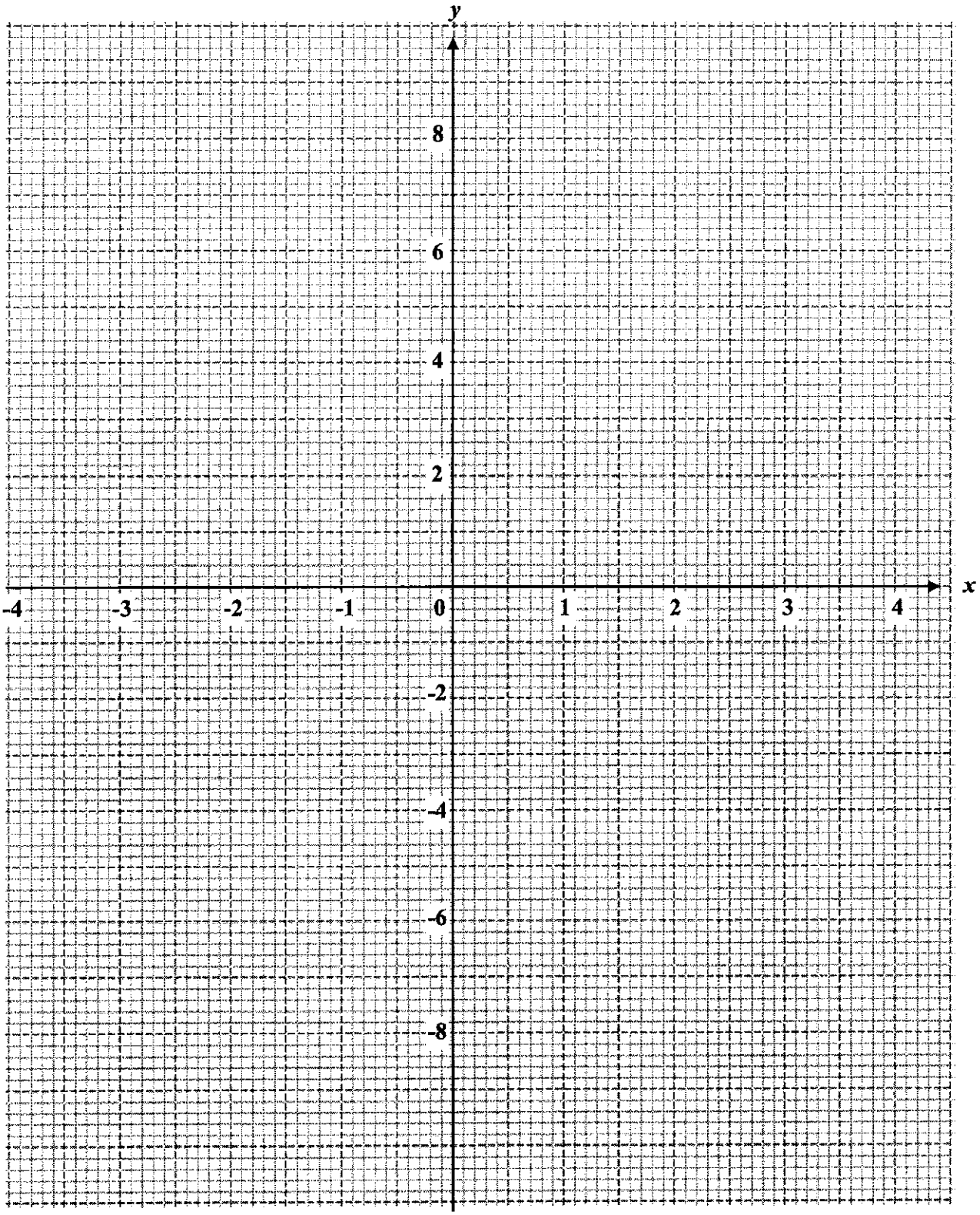
*Answer* ..... [2]

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6 Jacelyn and Patrine went for a 21 km hike.

**(a)** Jacelyn walked at a constant speed of $x$ kilometres per hour.
Write down an expression, in terms of $x$, for the number of hours she took.

*Answer* .....h [1]

**(b)** Patrine walked at a constant speed which was $\frac{1}{3}$ km/h more than Jacelyn's speed.
Write down an expression, in terms of $x$, for the number of hours she took.

*Answer* .....h [1]

**(c)** The difference between their times was 15 **minutes**.
Write down an equation in $x$ to represent this information, and show that it reduces to $3x^2 + x - 84 = 0$.

[3]


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**(d)** Solve the equation $3x^2 + x - 84 = 0$, giving the answers correct to **three** decimal places.

*Answer* $x =$ ..... or ..... [4]

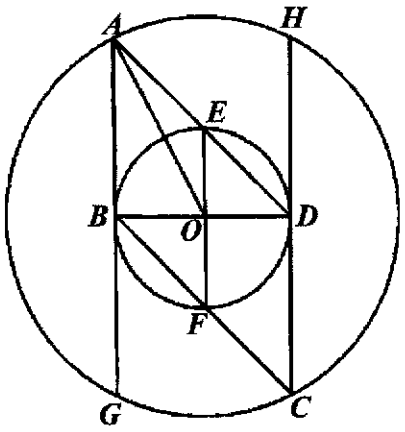
**(e)** Calculate the time that Jacelyn took to complete the hike, giving your answer in hours, minutes and seconds.

*Answer* ..... h ..... min .....sec [2]

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The centers of the two circles are at $O$.
$BD$ is a diameter of the smaller circle.
$AB$ and $CD$ are tangents to the smaller circle.

**(a)** Show that triangle $ABD$ is congruent to triangle $CDB$.
Give a reason for each statement you make.

*Answer*

[3]

**(b)** Suppose the diameter of the smaller circle is 8 cm, angle $BAD = 45°$ and $BD$ is perpendicular to $EF$.

**(i)** Calculate the length of $OA$.

*Answer* .....cm [2]


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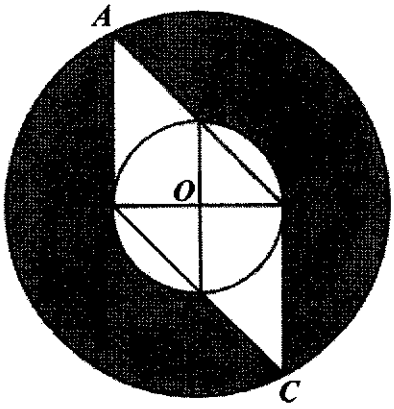
**(ii)** Calculate the area of triangle $ABD$.

*Answer* .....cm$^2$ [1]

**(iii)** Calculate the area of sector $OBE$, giving your answer in terms of $\pi$.

*Answer* .....cm$^2$ [1]

**(iv)** Calculate the shaded area.

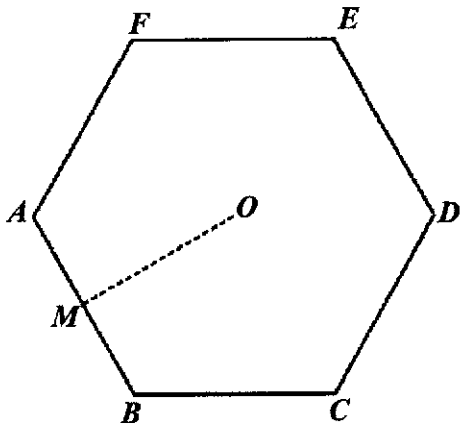



*Answer* .....cm$^2$ [3]



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**8**




A regular hexagon, *ABCDEF*, has sides of 5 cm.
*M* is the midpoint of *AB* and *O* is the centre of the hexagon.

**(a)** Show that the area of the hexagon *ABCDEF* is 64.95 $cm^2$, correct to 4 significant figures.

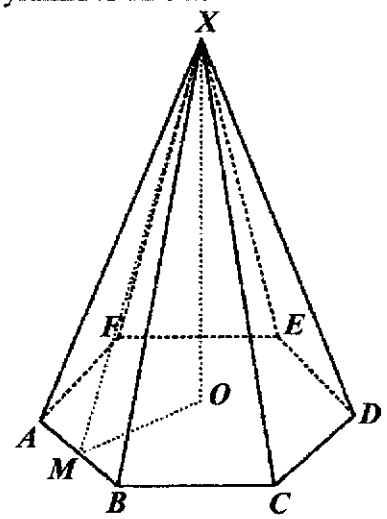
*Answer*

[3]


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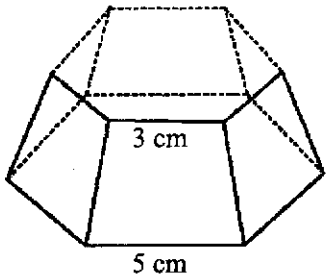
Hexagon *ABCDEF* forms the base of a pyramid.
The vertex, *X*, is directly above *O*.
The height, *OX*, of the pyramid is 12 cm.




**(b)** Calculate the volume of the pyramid.

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

**(c)** The top part of the pyramid is cut off leaving the bottom portion as shown.
The smaller hexagon has sides of 3 cm.
Find the volume of the remaining bottom portion.




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



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**(d)** Calculate the slant height, $MX$, of the pyramid.

*Answer* .....cm [2]

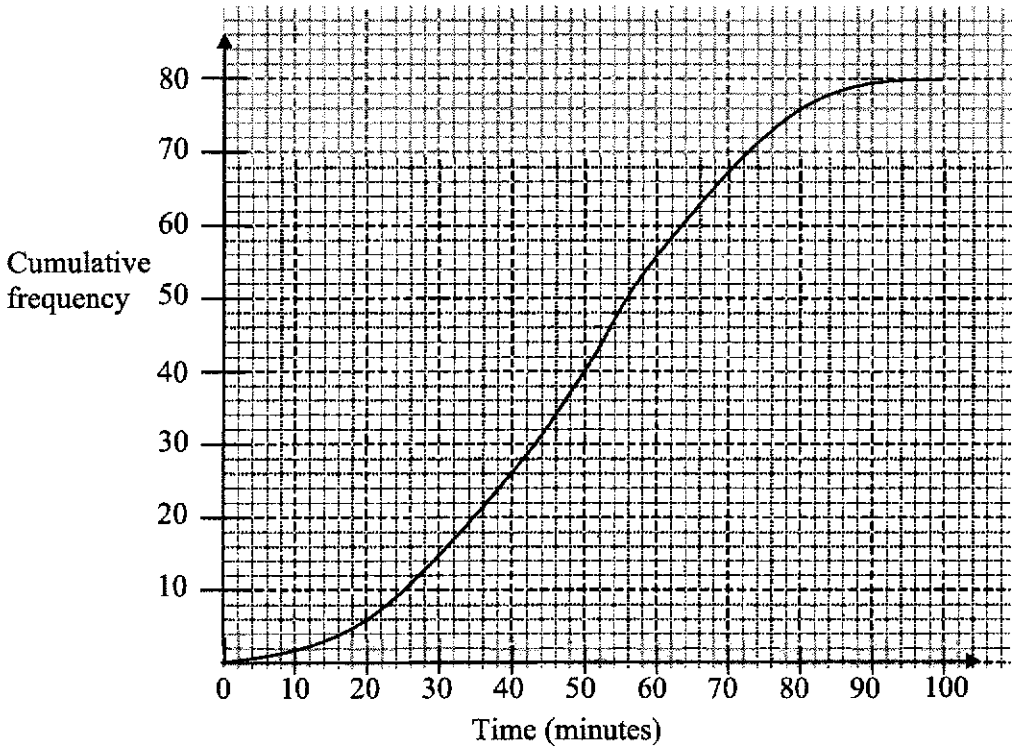
**(e)** Calculate the **total** surface area of the pyramid.

*Answer* .....$cm^2$ [2]


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**9** The amount of time 80 secondary school students spent on social media in a day are recorded.
The cumulative frequency curve below shows the distribution of their times.




**(a)** Use the curve to estimate

**(i)** the median,

*Answer* ..... min [1]

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

*Answer* ..... min [2]



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**(b)** Estimate the percentage of secondary students who spent more than 70 min on social media per day.

*Answer* .....% [2]

**(c)** Complete the grouped frequency table for the time spent on social media.

| Time (min) | $0 \le x < 20$ | $20 \le x < 40$ | $40 \le x < 60$ | $60 \le x < 80$ | $80 \le x < 100$ |
|---|---|---|---|---|---|
| Frequency | 6 | 20 | | | |

[1]

**(d)** Calculate an estimate of the mean time spent on social media.

*Answer* ..... min [1]

**(e)** Calculate an estimate of the standard deviation.

*Answer* ..... min [1]

**(f)** Explain why the mean and standard deviation are estimates.

*Answer* .....

.....

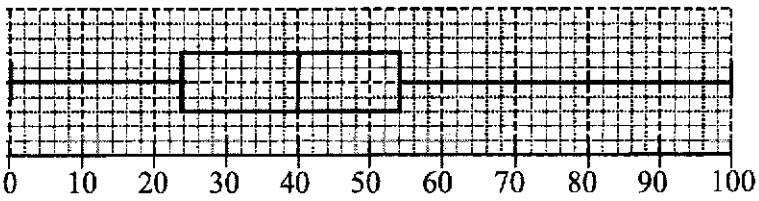
..... [1]



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**(g)** The amount of time 80 **primary** school students spent on social media in a day are also recorded.
The box-and-whisker plot shows the distribution of the times (in minutes).




Make two comments comparing the amount of time primary school students and secondary school students spent on social media.

*Answer* .....

.....

.....

.....

.....

.....

.....

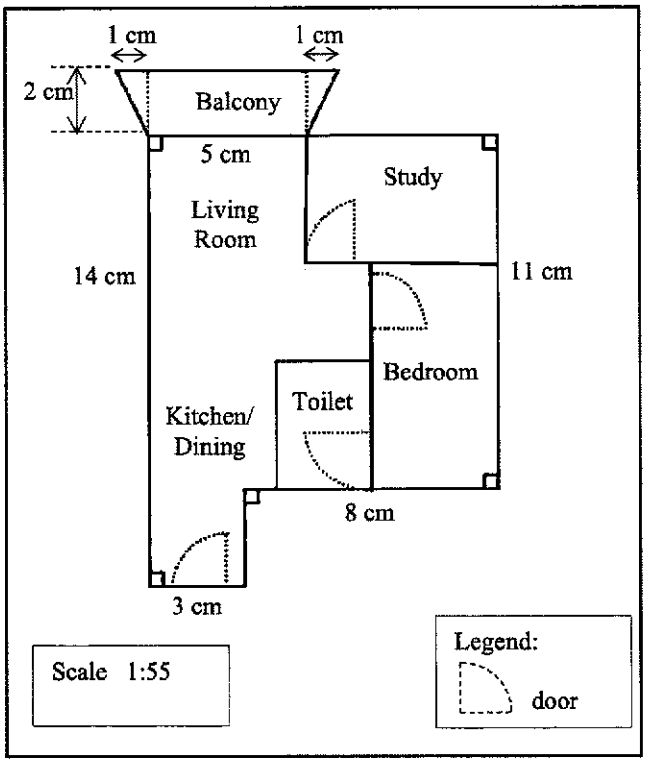
.....

..... [2]



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**10** Xavier and his wife are planning to buy an apartment.
The brochure below shows the layout of the apartment they are interested in.

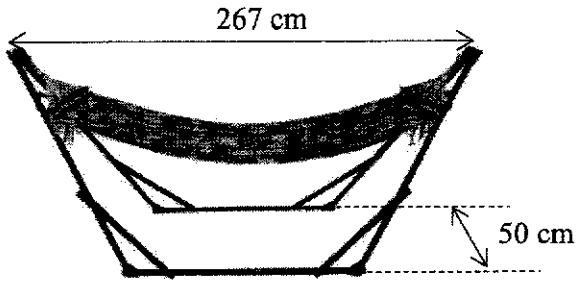



**(a)** Find the **ratio of area** of the floor plan to the actual area of the apartment in $1 : n$.

*Answer* 1 : ..... [1]


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**(b)** Xavier wanted to buy the following hammock to be placed at the trapezium-shaped balcony.
He wanted a walking space of at least 30 cm to be all around when the hammock is placed at the balcony.




Show, with appropriate working, if he should buy this hammock.

*Answer*

He *should / should not* buy the hammock.
(circle the appropriate answer) [3]


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(c) Xavier and his wife wanted to change the flooring for the whole apartment. They wanted the whole apartment to have the same flooring.
The cost of different types of flooring materials and the cost of installation are found in the tables below.

**Cost of different types of flooring materials**

| Type of flooring | Cost per square foot |
|---|---|
| Vinyl flooring | $4 - $7 |
| Porcelain tiles | $3 - $5 |

https://www.homerenoguru.sg/articles/renovation-essentials/flooring-singapore/

**Cost of flooring installation by material**

| Type of flooring | Cost per square foot |
|---|---|
| Vinyl flooring | $4 - $8 |
| Porcelain tiles | $7 - $11 |

https://www.homeadvisor.com/cost/flooring/install-flooring/

Which type of flooring should they go for if they have limited budget?
Suggest a suitable budget Xavier and his wife should set aside for changing the flooring.
Show your working clearly stating your assumption(s).
1 $m^2$ = 10.7639 $ft^2$


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*Type of Flooring* .....

*Budget* $.....

*Assumption(s)* .....

.....

[6]

**----------End of Paper ----------**


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MARKING SCHEME

**1.** Factorise fully $2x^2 + y^2 - 2x - xy^2$.

| | |
|---|---|
| $2x^2 + y^2 - 2x - xy^2$<br>$= 2x(x-1) + y^2(1-x)$<br>$= 2x(x-1) - y^2(x-1)$<br>$= (2x - y^2)(x-1)$ | M1 (first level factorization)<br><br>A1 |

*Answer* : $(2x - y^2)(x-1)$ [2]

---

**2.** It takes $p$ workers $q$ days to build $r$ houses.
If the number of days is halved and $5r$ houses are to be built, how many workers must be hired for the job?

Express your answer in terms of $p$.

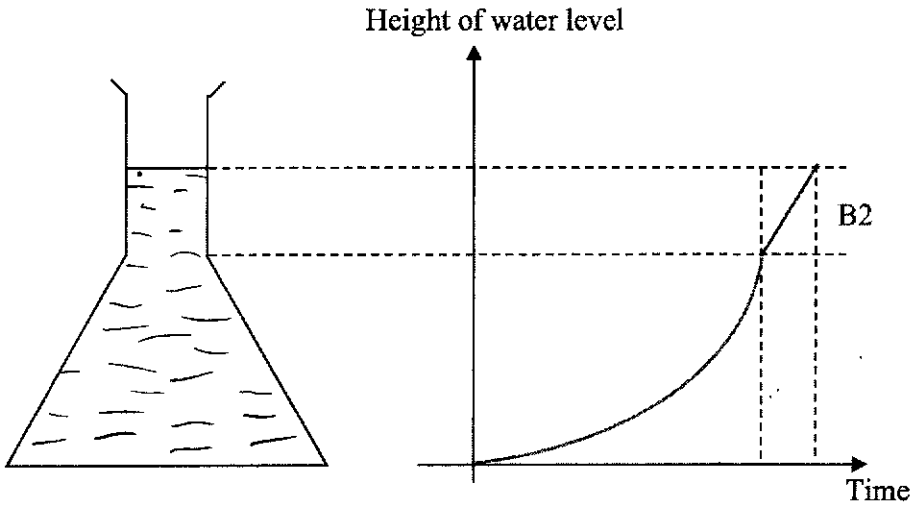
| | | |
|---|---|---|
| Workers : Days : Houses<br>$p$ : $q$ : $r$<br>$5p$ : $q$ : $5r$<br>**10p** : $\frac{q}{2}$ : $5r$ | *OR*<br>Workers : Days : Houses<br>$p$ : $q$ : $r$<br>$2p$ : $\frac{q}{2}$ : $r$<br>**10p** : $\frac{q}{2}$ : $5r$ | M1 (direct proportion W and H or Inverse proportion W and D)<br><br>A1 ( $10p$ ) |

*Answer* : ..... **10*p*** ..... [2]

---

**3.** Water is poured at a constant rate into the conical flask as shown below.
Draw on the axes provided, the change in the water level of the conical flask over time.

*Answer*




[2]

---



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MARKING SCHEME

**4.** Solve the equation $(1-x)^2 = \frac{9}{4}$.

| | |
|---|---|
| $(1-x)^2 = \frac{9}{4}$<br>$1-x = \pm\sqrt{\frac{9}{4}}$<br><br>$1-x = \frac{3}{2}$ or $1-x = -\frac{3}{2}$<br>$x = 1-\frac{3}{2}$ $\quad$ $x = 1+\frac{3}{2}$<br>$x = -\frac{1}{2}$ $\quad$ $x = 2\frac{1}{2}$ | M1<br>(or if alternative M1 Quadratic Formula Step)<br><br>A1 |

*Answer* : $x = -\frac{1}{2}$ , $x = 2\frac{1}{2}$ [2]

---

**5.** A group of 15 students recorded their timings (to the nearest minute), for a 5-km run. The results are represented in the stem and leaf diagram below.

| Stem | Leaf |
|---|---|
| 2 | 6 8 8 9 |
| 3 | 0 0 1 3 4 4 4 5 7 9 |
| 4 | |
| 5 | |
| 6 | 1 |

Key: 2|6 means 26 minutes

**(a)** Find the percentage of students who took at least 35 minutes to complete the run.

| | |
|---|---|
| $\frac{4}{15} \times 100 = 26\frac{2}{3}\%$ | B1<br>(accept 26.7%) |

*Answer* : ..... $26\frac{2}{3}\%$ ..... [1]

**(b)** Explain why the mean may not be an appropriate measure of average time taken by these students to complete the 5 km run.

There is an outlier / extreme value of 61. B1

*Answer* :.....

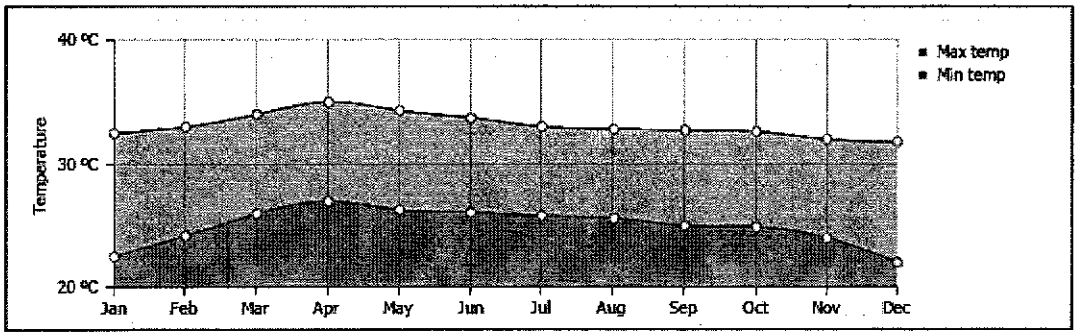
..... Accept : Range is too wide because of 61/ anomaly ..... [1]
Any equivalent description of outlier



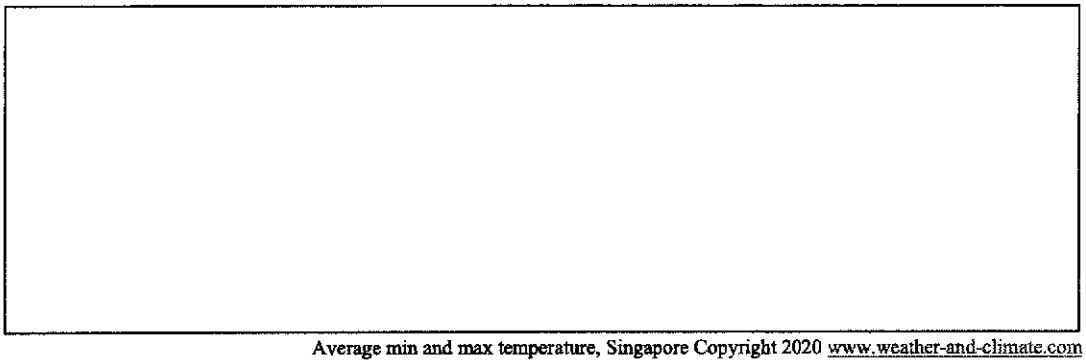
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MARKING SCHEME

**6.** The line graphs below show the monthly average minimum and maximum temperatures of Bangkok (Thailand) and Singapore, for the year 2020.




Average min and max temperature, Bangkok Thailand Copyright 2020 www.weather-and-climate.com



Average min and max temperature, Singapore Copyright 2020 www.weather-and-climate.com

**(a)** Huda claims that Singapore experienced wider differences between the maximum and minimum temperatures.

Explain why the data presented above may have been misleading for Huda.

*Answer* : The gap between lowest(min) and highest (max) temperatures appear greater for Singapore. This is due to the **different scale** used for the vertical axis. B1

The range on y-axis for Bangkok is 20-40 whereas for spore is 22-32 hence difficult to compare. [1]

**(b)** Give a suggestion on how the data above can be presented in a clearer way.

*Answer* : 1. Use the same scale for vertical axis or

2. Draw both on the sames grid/same graph/same axes B1 [1]

3. use Comparative Bar Graph/ Comparative line graph

---

Accept any equivalent to SCALE (unit per degree etc)

Do not accept if "did not start from zero" without mentioning scale



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MARKING SCHEME

7. A polygon with $n$ sides has two exterior angles 100° and 50°.
The remaining $(n-2)$ exterior angles are 14° each.

Find $n$.

| | |
|---|---|
| $100+50+14(n-2)=360$<br>$14(n-2)=210$<br>$n-2=15$<br>$n=17$ | M1 (application sum of ext angles)<br><br><br>A1 |

*Answer* : $n$ = … 17 ..... [2]

---

8. Written as the product of its prime factors, $504=2^x\times3^y\times7$.

**(a)** Find the values of $x$ and $y$.

| | |
|---|---|
| 2 \| 504<br>2 \| 252<br>2 \| 126<br>3 \| 63<br>3 \| 21<br>7 \| 7<br>1<br><br>$504=2^3\times3^2\times7$<br>$x=3, y=2$ | B1 |

*Answer* : $x$ = ..... 3 ..... , $y$ = ..... 2 ..... [1]

**(b)** The highest common factor and the lowest common multiple of 18 and $z$ are 6 and 504 respectively. Find the smallest possible value of $z$.

| | |
|---|---|
| HCF = 6 $=2\times3$<br>LCM = 504 $=2^3\times3^2\times7$<br><br>18 $=2\times3^2$<br>$z$ $=2^3\times3\times7=168$ | <br><br><br>M1 (prime factorization of 18)<br>A1 |

*Answer* : smallest $z$ = ..... 168 ..... [2]

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MARKING SCHEME

**9.** Simplify $\left(\frac{x^6}{64}\right)^{-\frac{2}{3}} \div \frac{y^3}{x^6}$. Leave your answer in positive index.

| | |
|---|---|
| $\left(\frac{x^6}{64}\right)^{-\frac{2}{3}} \div \frac{y^3}{x^6} = \left(\frac{64}{x^6}\right)^{\frac{2}{3}} \div \frac{y^3}{x^6}$<br>$= \frac{16}{x^4} \times \frac{x^6}{y^3}$<br>$= \frac{16x^6}{x^4y^3}$<br>$= \frac{16x^2}{y^3}$ | M1 (negative index to positive with reciprocal O.E)<br><br>A1 ($16/y^3$)<br>A1 ($x^2$)<br>[allow A1 if only '16' is not seen] |

*Answer* : ..... $\frac{16x^2}{y^3}$ ..... [3]

---

**10.** Mr Png bought a massage chair with a down payment of 15% of the cash price and a monthly instalment of $195.60 for 18 months.
If he paid a total of $3970.80, find the cash price of the massage chair.

| | |
|---|---|
| Total monthly installment = $195.60 × 18<br>= $3520.80<br>Downpayment = $3970.8 – 3520.80 = $450<br><br>∴ Cash price = $\frac{450}{15} \times 100$<br>= $3000 | M1 (mthly x 18)<br><br>M1 (√ 'their' downpayment /15 x 100)<br>A1 |

*Answer* : $ ... 3000 ... [3]

---

**11.** Given that $m = \sqrt{\frac{2m+1+k}{4k}}$, express $k$ in terms $m$, in its simplest form.

| | |
|---|---|
| $m = \sqrt{\frac{2m+1+k}{4k}}$<br>$m^2 = \frac{2m+1+k}{4k}$<br>$4km^2 = 2m+1+k$<br>$4km^2 - k = 2m+1$<br>$k(4m^2-1) = 2m+1$<br>$k = \frac{2m+1}{4m^2-1}$<br>$k = \frac{2m+1}{(2m+1)(2m-1)}$<br>$k = \frac{1}{2m-1}$ | <br>M1 (square both sides)<br><br>M1 (isolating $k$)<br><br><br><br>A1 |

*Answer* : $k = \frac{1}{2m-1}$ [3]



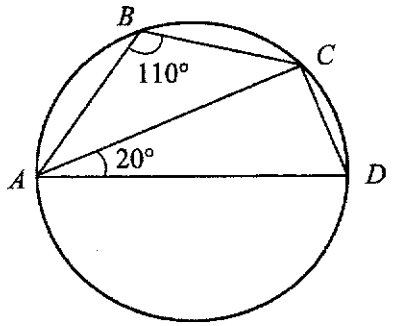
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MARKING SCHEME

**12.** The diagram shows a circle with points $A$, $B$, $C$ and $D$ on its circumference. $AB = BC$, angle $ABC = 110°$, and angle $CAD = 20°$.

Explain why $AD$ is a diameter of the circle.




*Answer* :

| | |
|---|---|
| $\angle ADC = 180° - 110°$ (angles in opp. segment)<br>$= 70°$<br><br>$\angle ACD = 180° - 70° - 20°$ (angle sum of $\Delta$)<br>$= 90°$<br><br>Since $\angle ACD = 90°$, using **right-angle in a semicircle property**, $AD$ is a diameter of the circle. | M1 (with reason)<br><br>M1 (accept if no reason provided above have)<br><br>A1 |

[3]

---

**13.** $n$ is a positive integer.

**(a)** Show that $(3n-2)^2 - n^2$ is a multiple of 4.

| | |
|---|---|
| $(3n-2)^2 - n^2 = 9n^2 - 12n + 4 - n^2$<br>$= 8n^2 - 12n + 4$<br>$= 4(2n^2 - 3n + 1)$ | M1 (expansion)<br><br>A1 (accept if student able to explain that 4 is a factor of each term)<br><br>Give B1 if $8n^2 - 12n + 4$ is evident in (b) but not in (a) |

[2]

**(b)** Hence or otherwise, factorise $(3n-2)^2 - n^2$ fully.

| | |
|---|---|
| $(3n-2)^2 - n^2 = 4(2n^2 - 3n + 1)$<br>$= 4(2n-1)(n-1)$ | B1 |

*Answer* : $4(2n-1)(n-1)$ [1]

---



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MARKING SCHEME

**14.** A bean bag is filled with small polystyrene balls of radius 3 millimetres.

**(a)** Write the radius of the ball in metres, leaving your answer in standard form.

| | |
|---|---|
| 3 mm = $3 \div 1000$ m<br>$= 3\times10^{-3}$ m | B1 (do not accept 3.0) |

*Answer* : ..... $3\times10^{-3}$ ..... m [1]

**(b)** A bean bag of volume 2.88 $m^3$ is to be 80% filled with the spherical polystyrene balls.
Find the number of polystyrene balls required, giving your answer to the nearest million.

| | |
|---|---|
| $\frac{80}{100}\times 2.88 = 2.304$ $m^3$ | M1 |
| No. of polystyrene balls (vol. sphere)<br>$= \frac{2.304}{\frac{4}{3}\pi(3\times10^{-3})^3}$ m | M1 (√ 'their' volume divide by vol sphere) |
| $= 20371832.72$<br>**= 20 million** | A1 |

*Answer* ... 20... million [3]

---

**15.** The scores for a Mathematics Test sat by six students are as follows:

$$a\ ,\ b\ ,\ 59\ ,\ c\ ,\ 65\ ,\ 90$$

The range of the scores is 48.
The median score is 62.
The mean score is 61.

Find the values of $a$, $b$ and of $c$.

***a*** ***b*** **59** c **65** **90**

Median : $\frac{59+c}{2} = 62$

$59 + c = 124$

$\boldsymbol{c = 65}$ -------- B1

Using range :
$\boldsymbol{a} = 90 - 48 = \mathbf{42}$ --------B1

Mean : $\frac{42+b+59+65+65+90}{6} = 61$ -------- M1 (using 'their' 6 values)

$321 + b = 366$

$\boldsymbol{b = 45}$ -------- A1

*Answer* : $a$ = ... 42 ... , $b$ = ..... 45..... , $c$ = ... 65..... [4]

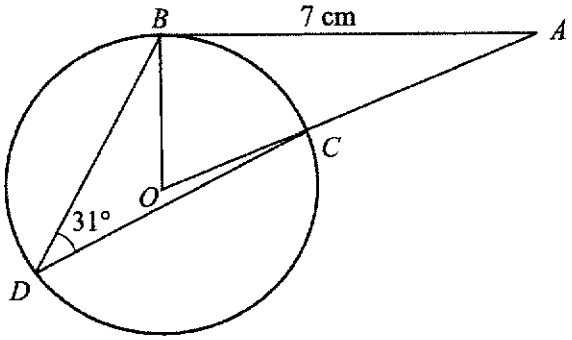


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MARKING SCHEME

**16.**




In the diagram, $B$, $C$ and $D$ are points on a circle.

$O$ is the centre , $OCA$ is a straight line and $BA$ is tangent to the circle at $B$.
Angle $BDC = 31°$ and $AB = 7$ cm.

*Accept any full explanation describing Tangent and radius, hence 90°*

**(a)** State the reason why angle $OBA = 90°$.

*Reason* : Tangent is perpendicular to radius. B1 (write in full) ..... [1]

**(b)** Find the length of the radius of the circle.

| | |
|---|---|
| $\angle BOC = 31° \times 2$ (angle at centre = 2 angle circumference)<br>$= 62°$ | M1 |
| $\tan 62° = \frac{7}{OB}$<br>$OB = \frac{7}{\tan 62°}$ | M1 (correct trig ratio) |
| $OB = 3.72$ cm | A1 |

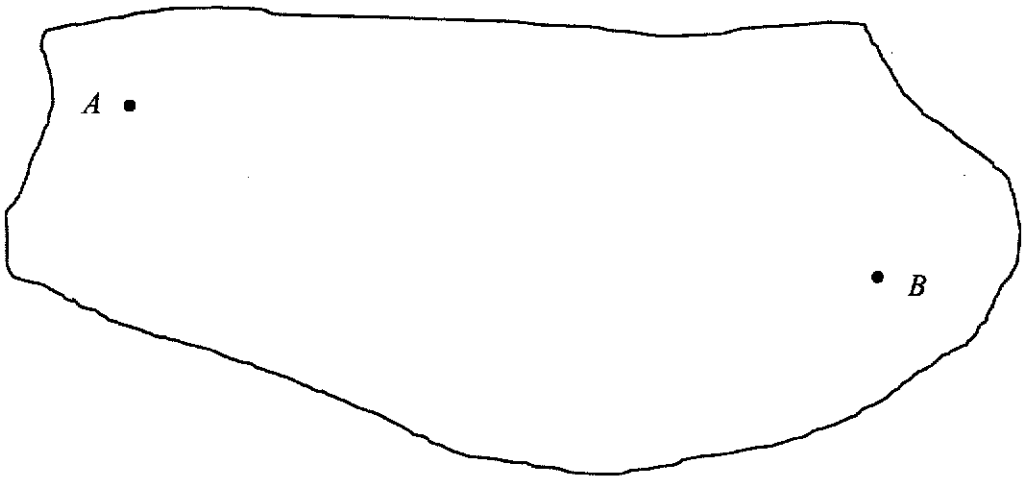
*Answer* : ..... 3.72 ..... cm [3]



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**17. (Diagram is drawn to scale)**

The scale of the map below is 1 : 50 000.




Asher cycles from Point *A* to Point *B* at an average speed of 13 km/h.

If Asher has to reach point *B* by 4.30 pm, suggest the latest time he should set off from point *A*.

Show your working clearly.

| | |
|---|---|
| 1 cm : 50 000 cm<br>1 cm : 0.5 km<br><br>10.6 cm (measured) → 0.5 × 10.6<br>= 5.3 km<br><br>Time = $\frac{5.3}{13}$ h<br>= 0.407 h<br>= 24 min 27 sec<br><br>He should leave house at **by 4.05pm** latest. | M1 (using scale with or w/o conversion)<br>(0.5 x 10.6 or 10.6 x 50000)<br><br>M1 (dist in km over speed)<br>M1 [Correct conversion to min]<br>A1 |

*Answer* : He should leave point *A* latest by … **4.05** ... pm [4]

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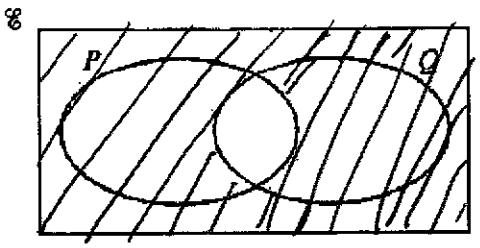


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**18. (a)** On the Venn diagram, shade the region which represents $P' \cup Q'$.




B1 [1]

**(b)** $\varepsilon = \{ x : x \text{ is an integer such that } 5 \leq x \leq 9 \}$

$A = \{ x : 5 - \frac{x}{2} \geq 1 \}$

$B = \{ x : 4x - 1 > 19 \}$

List the element(s) contained in the set $(A \cap B)'$.

| | |
|---|---|
| $5 - \frac{x}{2} \geq 1$ $\quad 4x - 1 > 19$<br>$5 - 1 \geq \frac{x}{2} \quad 4x > 20$<br>$4 \geq \frac{x}{2} \quad x > 5$ ---- M1 (or B = { 6, 7, 8, 9} B1)<br>$8 \geq x$<br>$x \leq 8$ ------ M1 (or A = {5, 6, 7, 8}--- B1)<br><br>$(A \cap B) = \{6, 7, 8\}$<br><br>$(A \cap B)' = \{5, 9\}$ | A1 (ecf that is appropriate) |

*Answer* : $(A \cap B)' = \{ \quad 5 \quad , \quad 9 \quad \}$ [3]

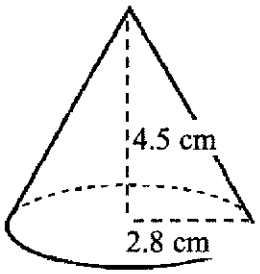
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**19.** The diagram shows a paper cup in a shape of a cone with radius 2.8 cm and vertical height 4.5 cm.




**(a)** Show that the curved surface area is $14.84\ \pi\ \text{cm}^2$.

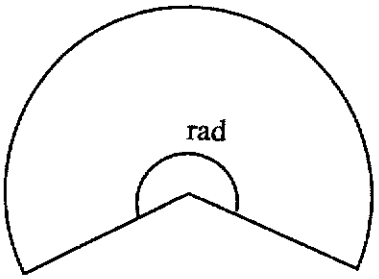
*Answer* :

| | |
|---|---|
| To find slant height (using Pythagoras' Theorem)<br>$l^2 = 2.8^2 + 4.5^2$<br>$l = 5.3$<br><br>Curved Surface Area = $\pi rl$<br>$= \pi \times 2.8 \times 5.3$<br>$= 14.84\ \pi\ \text{cm}^2$. (shown) | M1/<br>B1<br><br><br><br>B1 |

[2]

**(b)** The paper cup is cut open to form a sector of a circle with angle $\theta$ radians.

Find angle $\theta$.




| | |
|---|---|
| Area Sector = Area Curved Surface Cone<br>$\frac{1}{2}r^2\theta = 14.84\pi$<br><br>$\frac{1}{2}(5.3)^2\theta = 14.84\pi$<br>$\theta = \frac{14.84\pi}{\frac{1}{2}(5.3)^2}$<br>$\theta = 3.32$ rad | M1 (form equation connecting area sector and cone S.A)<br>Accept equation connecting arc length + 2r = conebase circumference.<br><br><br>A1 |

*Answer* : $\theta$ = ..... 3.32 ..... rad [2]

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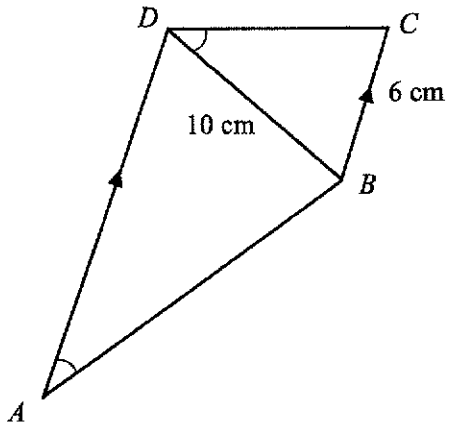


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**20.** In the diagram, the line $AD$ is parallel to $BC$ and $\angle BAD$ is equal to $\angle CDB$. $\angle ABD = 81°$, $BC = 6$ cm and $BD = 10$ cm.




**(a)** Explain why $\Delta ABD$ is similar to $\Delta DCB$.

*Answer* $\angle ADB = \angle CBD$ (alt angles) ------- B1(both correct)

$\angle BAD = \angle CDB$ (given)

$\therefore \Delta ABD$ *is similar to* $\Delta DCB$ (AA Similarity Test) ---------- B1

..... [2]

**(b)** Find the length of $AD$.

| | |
|---|---|
| $\frac{AD}{10} = \frac{10}{6}$<br>$6\,AD = 100$<br>$AD = 16\frac{2}{3}$ cm | M1 (correct ratio)<br><br>A1 (accept 16.7) |

*Answer* : ..... $16\frac{2}{3}$ ..... cm [2]

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**21.** The equation of a curve is given by $y = x(10-x)$.

**(a)** Explain why the maximum value of $y$ is 25.

*Answer* The $x$-intercepts are 0 and 10. [B1]

The line of symmetry is $x = \frac{0+10}{2}$ $x = 5$ [B1]

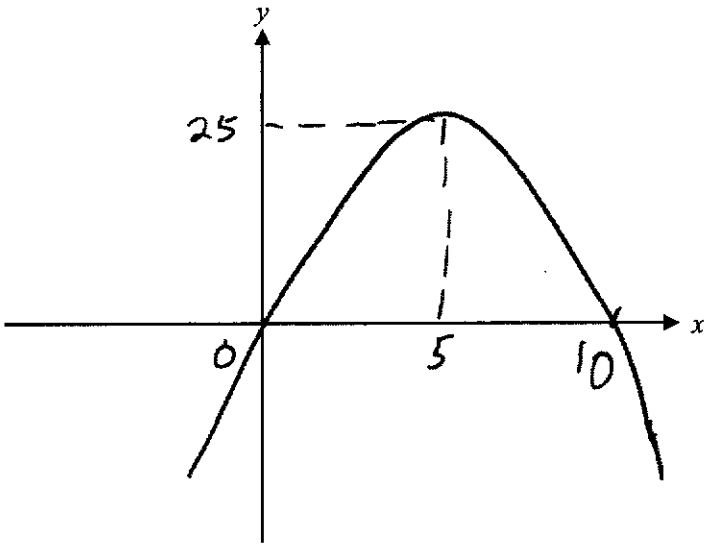
Maximum occur at line of symmetry.

When $x = 5$, $y = 5\,(10-5) = 25$ [B1 (sub x=5)]

..... [3]

**(b)** Sketch the curve $y = x(10-x)$, showing clearly the intercepts and the maximum point.

B1 open downwards, cutting at 0 and 10
B1 max point (5,25)




[2]

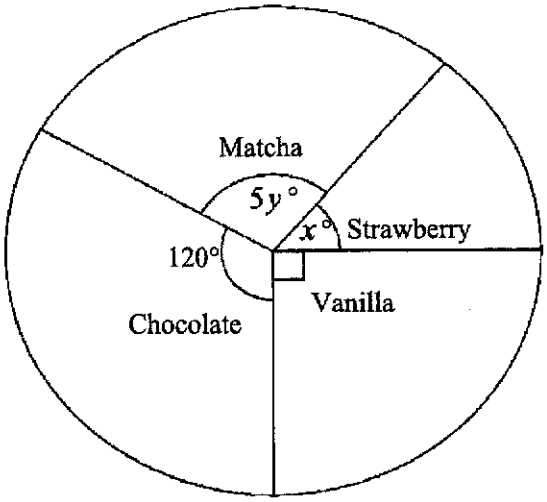


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**22.** The pie chart represented the number of people who chose their favourite milkshake flavour.




**(a)** Form an equation in terms of $x$ and $y$.

| | |
|---|---|
| $5y+x+120+90=360$<br>$5y+x=150$ | B1 (accept non-simplified) |

*Answer* ..... $5y+x=150$ ..... [1]

**(b)** The ratio of people who chose Strawberry to Matcha flavour was 4 : 11. Show that $11x-20y=0$.

| | |
|---|---|
| $\frac{x}{5y}=\frac{4}{11}$<br>$11x=20y$<br>$11x-20y=0$ | B1 (starting with ratio form) |

[1]

**(c)** Using your equations from **(a)** and **(b)**, solve them simultaneously to find the values of $x$ and of $y$.

| | |
|---|---|
| $5y+x=150$<br>$x=150-5y$ --------- [1]<br>$11x-20y=0$ --------- [2]<br>Sub [1] into [2]<br>$11(150-5y)-20y=0$<br>$1650-55y-20y=0$<br>$1650-75y=0$<br>$75y=1650$<br>$y=22$<br><br>And $x=150-5(22)=40$ | M1 [elimination or substitution step]<br><br><br><br><br><br>A1<br><br>A1 |



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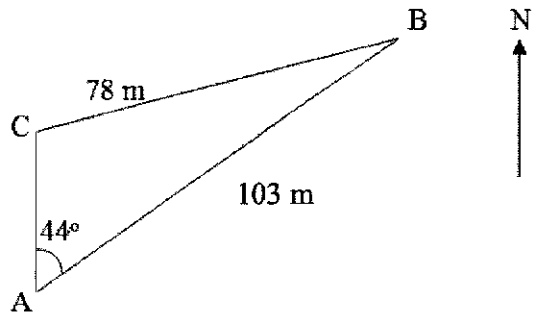


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*Answer* $x$ = .....40... , $y$ = .....22.... [3]

---

**23.**




$A$, $B$ and $C$ are 3 points on level ground.
$BC$ = 78 m, $AB$ = 103 m and angle $BAC$ = 44°. $C$ is due north of $A$.

**(a)** Calculate the bearing of $A$ from $B$.

| | |
|---|---|
| 180° + 44° = 224° | B1 |

*Answer* : .....224.....° [1]

**(b)** Find the area of triangle $ABC$.

| | |
|---|---|
| To find ∠ACB, using sine rule"<br>$\frac{\sin A\hat{C}B}{10[redacted]} = \frac{\sin 44°}{[redacted]}$ | M1 (correct application of sine rule) |
| $A\hat{C}B = 66.5352°$<br>Taking Obtuse angle = 180° – 66.5352°<br>= 113.5° | A1 |
| ∠CBA = 180° – 113.5° – 44°<br>= 22.535° | |
| Area of $\Delta = \frac{1}{2} \times 78 \times 103 \times \sin 22.535°$<br>= 1539.5228<br>= 1540 m$^2$ | M1 (using 'their' angle $CBA$)<br>A1 |

*Answer* : ..... 1540 ..... m$^2$ [4]

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**24.** A line passes through the points $A$ and $B$ whose coordinates are (5, –13) and (–2, 8) respectively.

**(a)** Find the equation of the line $AB$.

| | |
|---|---|
| Gradient $= \frac{8-(-13)}{-2-5} = -3$ | M1 (gradient) |
| $y = -3x + C$<br>Using (–2, 8),<br>$8 = -3(-2) + C$<br>$8 = 6 + C$<br>$C = 2$ | |
| Equation : $y = -3x + 2$ | A1 |

*Answer* : ..... $y = -3x + 2$ ..... [2]

**(b)** A point $P$ lies on the $y$-axis , such that it is the same distance from $A$ as it is from $B$.

Find the coordinates of point $P$.

| | |
|---|---|
| Let $P = (0 , a)$ | |
| distance $AP$ = distance $PB$ | |
| $\sqrt{(0-5)^2 + [a-(-13)]^2} = \sqrt{[0-(-2)]^2 + (a-8)^2}$ | M1 (correct application) |
| $25 + a^2 + 26a + 169 = 4 + a^2 - 16a + 64$ | M1 (Expansion) |
| $42a = -126$ | |
| $a = -3$ | |
| therefore , $P = (0 , -3)$ | A1 |

*Answer* : $P = ( 0 , -3 )$ [3]

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End of Paper



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| | | | | |
|---|---|---|---|---|
| 1 | (a) | Write as a single fraction in its simplest form | | |
| | | (i) | $\frac{9a^3}{b} \div \frac{81a}{b^7}$, | |
| | | | $\frac{a^2b^6}{9}$ [B1] | |
| | | | | |
| | | (ii) | $\frac{5}{(y-3)^2} - \frac{7}{3-y}$. | |
| | | | $\frac{5}{(y-3)^2} + \frac{7}{y-3}$ [M1 – changing denominator to $y-3$]<br><br>$= \frac{5+7(y-3)}{(y-3)^2}$<br><br>$= \frac{7y-16}{(y-3)^2}$ [A1] | |
| | | | | |
| | (b) | Simplify $\frac{8x^2-18}{2x^2-x-6}$. | | |
| | | $\frac{2(4x^2-9)}{(2x+3)(x-2)}$ [M1 for factorising **denominator**]<br><br>$= \frac{2(2x+3)(2x-3)}{(2x+3)(x-2)}$ [M1 for factorising **numerator** - at least twice]<br><br>$= \frac{2(2x-3)}{(x-2)}$ or $= \frac{4x-6}{(x-2)}$ [A1] | | |
| | | | | |
| | (c) | Solve the equation $\frac{32}{x-5} = 3x-5$. | | |
| | | $32 = 3x^2 - 20x + 25$ [M1 for multiplying $x-5$ on both sides and expanding RHS]<br>$(3x+1)(x-7) = 0$ [M1 for all terms on one side and factorising/quadratic formula]<br><br>$x = -\frac{1}{3}$ or $x = 7$ [A1 for both answers] | | |



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**2 (a)** From 2019 to 2020 the total number of international visitors in Singapore decreased by 85.9%.
In 2020, the total number was $2.7\times10^6$.
Calculate the number of international visitors in 2019, giving your answer in standard form.

$\frac{2.7\times10^6}{14.1}\times100$ [M1 for finding 1%]

$=1.91\times10^7$ [A1]

**(b)** Siti invested some money in a saving accounts for 4 years.
The rate of interest was fixed at 1.08% per annum compounded annually.
At the end of 4 years, there was \$8351.24 in her account.

How much did Siti invest in the account?
Give your answer correct to the nearest cent.

$8351.24 = P(1+\frac{1.08}{100})^4$ [M1]

$P =$ \$8000.00 [A1 – to nearest cent]

**(c)** The exchange rate between Singapore dollars (\$) and euros is \$1 = €0.63.

Andy is shopping online for a pair of boots.
He finds these prices online for the same model of boots.

| Website | Price |
|---|---|
| Zalora | \$195 (before 7% GST) |
| Footshopping | €130 Nett |

**(i)** Both websites offer free shipping to Singapore.
GST needs to be paid if he buys from Zalora.
It is also known that Andy's credit card charges a foreign currency transaction fee of 3.25%.

Which website offers a better deal?
Show your working clearly.

Zalora
$1.07\times195 =$ \$208.65 [M1 for calculating cost including GST]

Footshopping
$€130\times1.0325 = €134.225 =$ \$213.06
[M1 for calculating cost inclusive of transaction fee and converting to \$]

[accept if students convert Zalora to euros instead]

Zalora offers a better deal. [A1]



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| | | | | |
|---|---|---|---|---|
| | | (ii) | A certain debit card offers $x$% foreign currency transaction fee.<br>$x$ must be less than a certain value so that buying from Footshopping will be a better deal.<br><br>Find that value. | |
| | | | €130 = $206.35 [M1 for converting €130 to $]<br><br>$\frac{\$208.65-\$206.35}{206.35}\times 100\% = 1.11\%$ [A1 for 1.11 without %<br>accept 1.12] | |
| | | | | |
| 3 | Gardens by the Bay Flower Dome operates for 340 days a year.<br>The matrix, **M**, shows the number of different types of tickets **(in thousands)** sold per day in 2019.<br><br>$\mathbf{M} = \begin{pmatrix} 1.2 & 2 & 5 \\ 2.1 & 4.5 & 9 \end{pmatrix}$ Child Adult Senior; Residents; Non-residents | | | |
| | | | | |
| | **(a)** | Evaluate the matrix **P = 340M.** | | |
| | | $\mathbf{P} = \begin{pmatrix} 408 & 680 & 1700 \\ 714 & 1530 & 3060 \end{pmatrix}$ [B1] | | |
| | | | | |
| | **(b)** | The tickets cost $10, $16 and $14 for child, adult and senior respectively.<br><br>Represent these amounts in a 3×1 matrix **N.** | | |
| | | $\mathbf{N} = \begin{pmatrix} 10 \\ 16 \\ 14 \end{pmatrix}$ [B1] | | |
| | | | | |
| | **(c)** | Evaluate the matrix **T = PN.** | | |
| | | $\mathbf{T} = \begin{pmatrix} 38760 \\ 74460 \end{pmatrix}$ [B2]<br>or<br>[M1 for either 38760 or 74460. Allow ecf] | | |
| | | | | |
| | **(d)** | State what each of the elements of **T** represents. | | |
| | | Total amount of money in thousands collected from ticket sales from residents and non-residents respectively. [B1] | | |



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| | | | | |
|---|---|---|---|---|
| | (e) | Calculate the total amount of ticket sales in 2019.<br>Give your answer correct to the nearest million. | | |
| | | $113220\times10^3$<br>$=113.22\times10^6$<br>113 [B1] | | |
| | | | | |
| | (f) | In 2020, the number of tickets sold for residents increased by 60% across the different types of tickets.<br>In the same year, the number of tickets sold for non-residents dropped to 20% across the different types of tickets.<br><br>Calculate the percentage change in the amount of ticket sales from 2019 to 2020.<br>State whether this change is an increase or a decrease. | | |
| | | <u>Amount taken in tickets sales for 2020</u><br>$38760\times1.6+74460\times0.2$<br>$=76908$ [M1] accept other methds e.g. $\begin{pmatrix}652.8 & 1088 & 2720\\142.8 & 306 & 612\end{pmatrix}\begin{pmatrix}10\\16\\14\end{pmatrix}$<br><br><u>Percentage change</u><br>$\frac{113220-76908}{113220}\times100\%$<br><br>$=32.1\%$ [A1]<br><br>decrease [A1] | | |
| | | | | |
| 4 | (a) | The first three terms in a sequence of numbers, $T_1$ , $T_2$ , $T_3$ , ... are given below.<br>$T_1=1^2+1=2$<br>$T_2=2^2+3=7$<br>$T_3=3^2+5=14$ | | |
| | | | | |
| | | (i) | Find $T_4$. | |
| | | | $T_4=23$ [B1] | |
| | | | | |
| | | (ii) | Find an expression, in terms of $n$, for $T_n$. | |
| | | | $T_n=n^2+2n-1$<br>[B1 for $n^2$; B1 for $2n-1$]<br>[M1 for correct expression without simplification] | |



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| | | | | |
|---|---|---|---|---|
| | **(b)** | The first four terms in a **different sequence** are –55, –51, –47, –43. | | |
| | | **(i)** | Find an expression, in terms of $n$, for the $n$th term, $P_n$, of this sequence. | |
| | | | $P_n = 4n - 59$<br>[B1 for $4n$; B1 for –59] | |
| | | | | |
| | | **(ii)** | Explain why 222 is not a term of this sequence. | |
| | | | $222 = 4n - 59$<br>$n = 70.25$<br>Since n is not an integer, 222 is not a term of this sequence. [B1] | |
| | | | | |
| | | **(iii)** | Find the least value of $n$ for which $P_n > 1$. | |
| | | | $4n - 59 > 1$<br>$n > 15$ [M1]<br>Least value of $n$ is <u>16</u>. [A1] or [B2] | |



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

Some corresponding values of $x$ and $y$ are given in the table below.

| $x$ | –4 | –3 | –2 | –1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| $y$ | $p$ | 0.1 | 2.4 | 2.3 | 1 | –0.3 | –0.4 | 1.9 | 7.8 |

**(a)** Find the value of $p$.

$p=-5.8$ [B1]

**(b)** Draw the graph of $y=\frac{x^3}{5}-\frac{3x}{2}+1$ for $-4\le x\le 4$ in the given grid. [3]

Points – [B2 for all points correctly plotted; B1 for 1 mistake]
Curve – [B1 for smooth curve]

**(c)** **(i)** On the same grid, draw the graph of $2y-3x=2$ for $-4\le x\le 4$. [2]

Points – [B1 for at least 2 points]
Curve – [B1 for line]

**(ii)** Show that the points of intersection of the line and the curve give the solutions of the equation $x^3-15x=0$.

$\frac{x^3}{5}-\frac{3x}{2}+1=\frac{3}{2}x+1$ [M1 or equivalent e.g. substitution]

$\frac{x^3}{5}-3x=0$

$x^3-15x=0$ [A1] [2]

**(iii)** Hence, solve the equation $x^3-15x=0$.

$x=-3.9\pm0.1$ or $x=0$ or $x=3.9\pm0.1$ [B2]
[B1 for any one correct answer]
Do not accept $x=-3.87$ or $x=3.87$

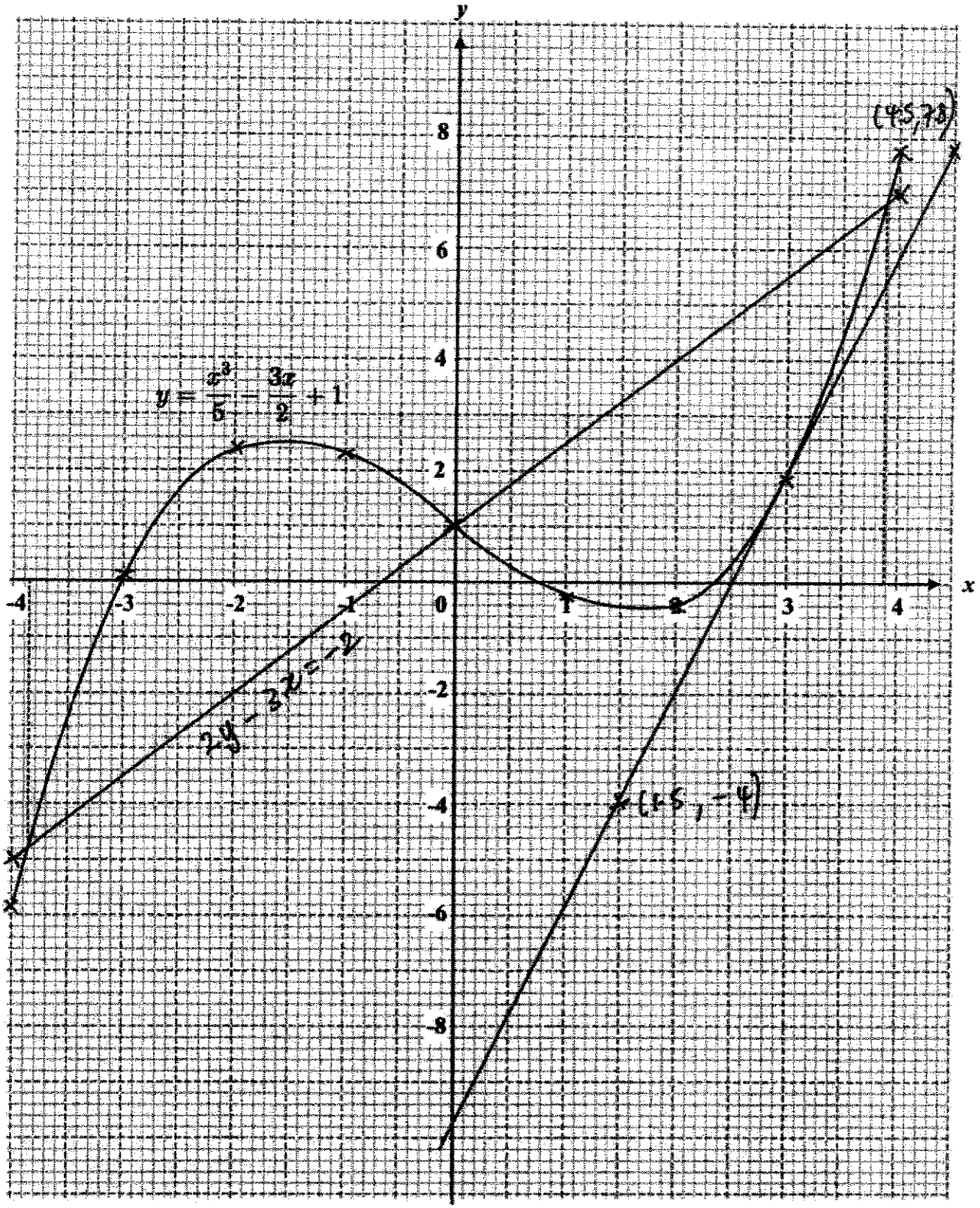
**(d)** By drawing a tangent, find the gradient of the curve at (3, 1.9).

[M1 for tangent line drawn]
$m=3.93\pm0.5$ [A1]



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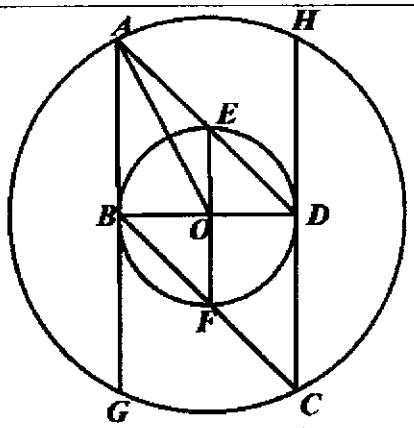
| | | | |
|---|---|---|---|
| 6 | Jacelyn and Patrine went for a 21 km hike. | | |
| | (a) | Jacelyn walked at a constant speed of $x$ kilometres per hour.<br>Write down an expression, in terms of $x$, for the number of hours she took. | |
| | | $\frac{21}{x}$ [B1] | |
| | | | |
| | (b) | Patrine walked at a constant speed which was $\frac{1}{3}$ km/h more than Jacelyn's speed.<br>Write down an expression, in terms of $x$, for the number of hours she took. | |
| | | $\frac{21}{x+\frac{1}{3}}$ [B1] accept $\frac{63}{3x+1}$ | |
| | | | |
| | (c) | The difference between their times was 15 **minutes**.<br>Write down an equation in $x$ to represent this information, and show that it reduces to $3x^2+x-84=0$. | |
| | | $\frac{21}{x}-\frac{21}{x+\frac{1}{3}}=\frac{15}{60}$ [M1]<br>$\frac{21(x+\frac{1}{3})-21x}{x(x+\frac{1}{3})}=\frac{1}{4}$ [M1 for putting as common denominator]<br>$3x^2+x-84=0$ [A1] | |
| | | | |
| | (d) | Solve the equation $3x^2+x-84=0$, giving the answers correct to **three** decimal places. | |
| | | $x=\frac{-1\pm\sqrt{1^2-4(3)(-84)}}{2(3)}$ [M1]<br>$x=\frac{-1\pm\sqrt{1009}}{6}$<br>$x=5.127$ [A1]<br>or<br>$x=-5.461$ [A1]<br>[M1 for 3 decimal places] | |



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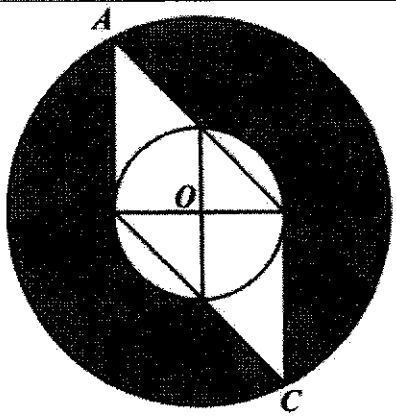
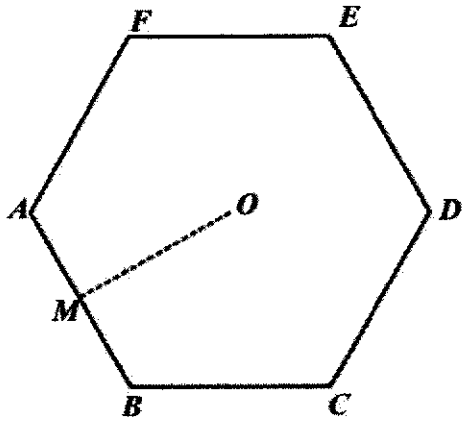
| | | | | |
|---|---|---|---|---|
| | (e) | Calculate the time that Jacelyn took to complete the hike, giving your answer in hours, minutes and seconds. | | |
| | | $Time = \frac{21}{5.127}$ [M1]<br><br>= 4h 5min 44sec/ 45 sec [A1] | | |
| | | | | |
| 7 | | <br><br>The centers of the two circles are at $O$.<br>$BD$ is a diameter of the smaller circle.<br>$AB$ and $CD$ are tangents to the smaller circle. | | |
| | (a) | Show that triangle $ABD$ is congruent to triangle $CDB$.<br>Give a reason for each statement you make. | | |
| | | $BD = DB$ (common side)<br>$\angle ABD = \angle CDB$ (tangent $\perp$ radius) | | B2/ B1/ 0 |
| | | Since $BO = OD$ and $\angle ABO = \angle CDO = 90^o$<br>Therefore $AG = CH$ (Equal chords)<br>$AB = BG$ and $CD = DH$ ($\perp$ bisectors of chord)<br>Therefore $AB = CD$ | | |
| | | Triangle $ABD$ is congruent to triangle $CDB$ (SAS property) | | [B1] |
| | | | | |
| | (b) | Suppose the diameter of the smaller circle is 8 cm, angle $BAD = 45^o$ and $BD$ is perpendicular to $EF$. | | |
| | | (i) Calculate the length of $OA$. | | |
| | | $OA = \sqrt{8^2 + 4^2}$ [M1 – accepts other correct method]<br><br>$OA = 8.94$ [A1] | | |
| | | | | |
| | | (ii) Calculate the area of triangle $ABD$. | | |
| | | 32/ 32.0 [B1] | | |
| | | | | |
| | | (iii) Calculate the area of sector $OBE$, giving your answer in terms of $\pi$. | | |
| | | $4\pi$ [B1] | | |



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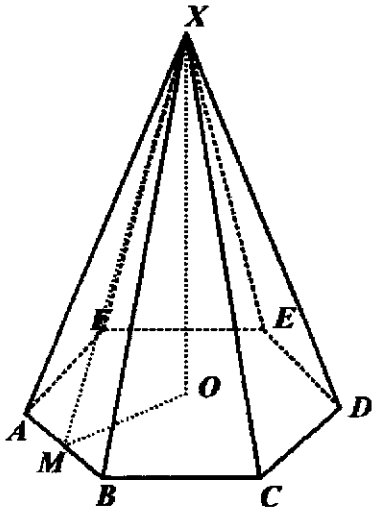
| | | | |
|---|---|---|---|
| | | **(iv)** Calculate the shaded area. | |
| | |  | |
| | | Area of $ABE = 32 - 4\pi - \frac{1}{2} \times 4 \times 4$<br>$= 24 - 4\pi$ [M1]<br>Area of bigger circle $= \pi\sqrt{80}^2$ [M1 for finding area of bigger circle]<br>Shaded area $= \pi\sqrt{80}^2 - \pi \times 4^2 - 2(24 - 4\pi)$<br>$= 178 \text{ cm}^2$ [A1] | |
| | | | |
| **8** | |  | |
| | A regular hexagon, *ABCDEF*, has sides of 5 cm.<br>*M* is the midpoint of *AB* and *O* is the centre of the hexagon. | | |
| | **(a)** | Show that the area of the hexagon *ABCDEF* is 64.95 cm$^2$, correct to 4 significant figures. | |
| | | Area of triangle $OAB = \frac{1}{2} \times 5 \times 5 \times \sin 60°$ [M1 for finding area of 1 $\Delta$ ]<br>Area of hexagon $= 6 \times \frac{1}{2} \times 5 \times 5 \times \sin 60°$ [M1 for multiplying by 6]<br>Area of hexagon = 64.95 cm$^2$ [A1] | |



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Hexagon *ABCDEF* forms the base of a pyramid.
The vertex, *X*, is directly above *O*.
The height, *OX*, of the pyramid is 12 cm.

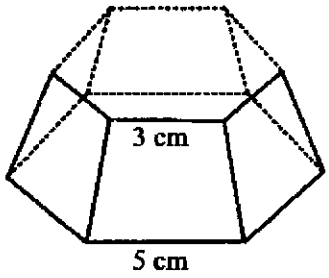



**(b)** Calculate the volume of the pyramid.

$\text{Vol} = \frac{1}{3} \times 64.95 \times 12$ [M1]

$\text{Vol} = 260 \text{ cm}^3$ [A1]

**(c)** The top part of the pyramid is cut off leaving the bottom portion as shown.
The smaller hexagon has sides of 3 cm.
Find the volume of the remaining bottom portion.




Ratio of vol = 27: 125 [M1 for finding ratio of volume. Accept other method]
Remaining units = 125 – 27 = 98
125 units – 259.8 $\text{cm}^3$
98 units – 204 $\text{cm}^3$ [A1]

**(d)** Calculate the slant height, *MX*, of the pyramid

$\tan 30^\circ = \frac{2.5}{OM}$

$OM = \frac{2.5}{\tan 30^\circ}$ [M1 for finding lengh of *OM*]

MX = 12.8 cm [A1]



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**(e)** Calculate the **total** surface area of the pyramid.

Area of 6 lateral triangles = $6\times\frac{1}{2}\times5\times12.7573...$ [M1]

TSA = 256 $cm^2$ [A1]

**9** The amount of time 80 secondary school students spent on social media in a day are recorded.
The cumulative frequency curve below shows the distribution of their times.

**(a)** Use the curve to estimate

**(i)** the median,

50 min [B1]

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

IQR = 63 – 35 [M1 accept 64– 35]
IQR = 28 [A1 accept 29]

**(b)** Estimate the percentage of secondary students who spent more than 70 min on social media per day.

Number of students who spent more than 70min = 80 – 68
[M1 accept 80 – 67]
Percentage = 15% [A1 accept 16.25%]

**(c)** Complete the grouped frequency table for the time spent on social media.

| Time (min) | $0 \le x < 20$ | $20 \le x < 40$ | $40 \le x < 60$ | $60 \le x < 80$ | $80 \le x < 100$ |
|---|---|---|---|---|---|
| Frequency | 6 | 20 | **30** | **20** | **4** |

[B1 for all 3 correct values]

**(d)** Calculate an estimate of the mean time spent on social media.

$\text{Mean} = \frac{10\times6+30\times20+50\times30+70\times20+90\times4}{80}$

Mean = 49 [B1/ ecf]

**(e)** Calculate an estimate of the standard deviation.

SD = 20.0 [B1/ ecf]

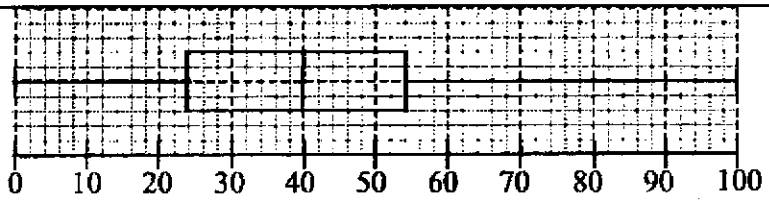
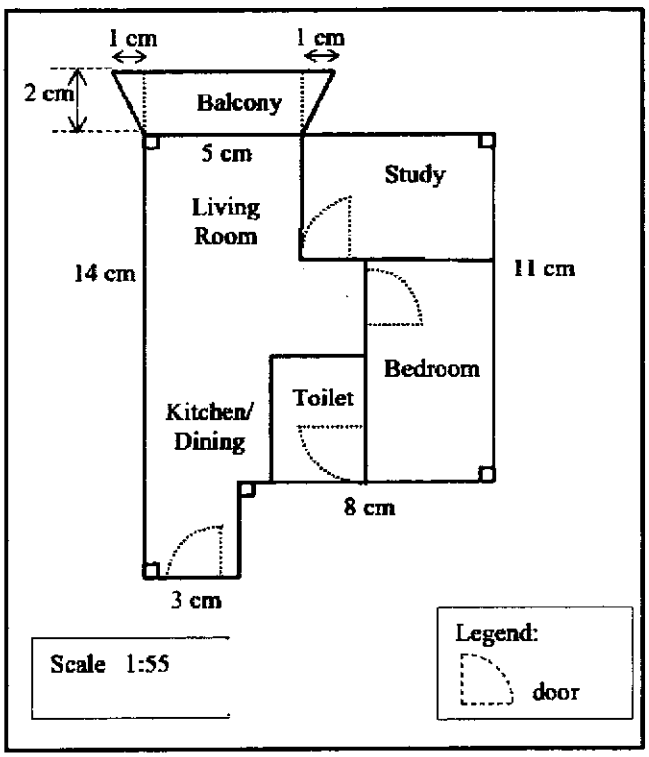
**(f)** Explain why the mean and standard deviation are estimates.

We do not know the exact time each student spent on social media. [B1]
or
Mid-values are used in the calculation. [B1]



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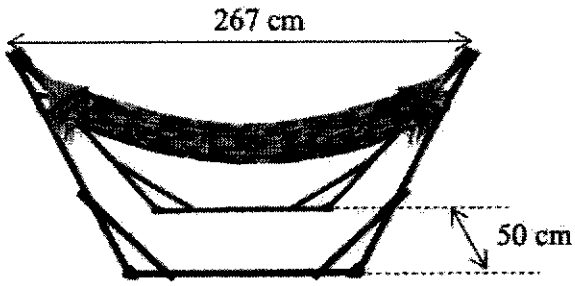
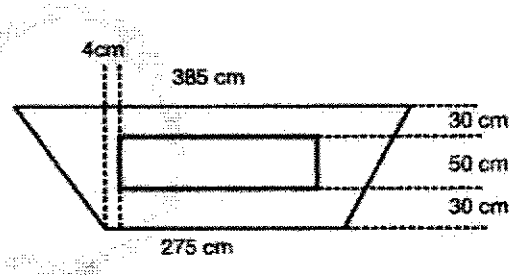
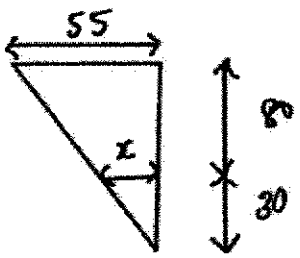
| | | | |
|---|---|---|---|
| | **(g)** | The amount of time 80 **primary** school students spent on social media in a day are also recorded.<br>The box-and-whisker plot shows the distribution of the times (in minutes). | |
| | |  | |
| | | Make two comments comparing the amount of time primary school students and secondary school students spent on social media. | |
| | | The median time for primary school students is 10 min lower than secondary school students => On average, secondary school students spend more time on social media. | [B1] |
| | | The interquartile range of the primary school students is higher than secondary school students => higher spread among the primary school students. | [B1] |
| **10** | Xavier and his wife are planning to buy an apartment.<br>The brochure below shows the layout of the apartment they are interested in. | | |
| | |  | |
| | **(a)** | Find the **ratio of area** of the floor plan to the actual area of the apartment in $1 : n$. | |
| | | 1: 3025 **[B1]** | |



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| | | | |
|---|---|---|---|
| | **(b)** | Javier wanted to buy the following hammock to be placed at the trapezium-shaped balcony.<br>He wanted a walking space of at least 30 cm to be all around when the hammock is placed at the balcony. | |
| | |  | |
| | | Show, with appropriate working, if he should buy this hammock. | |
| | | <br><br>[M1 for evidence of 30 cm, 50 cm, 30 cm or 110 cm]<br>$\frac{x}{55} = \frac{30}{110}$<br>$x = 15$ cm [M1 for applying similar triangles]<br>narrowest distance = 15 + 4 = 19 cm<br>He should not buy the hammock. [A1 - ecf] | |



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(c) Xavier and his wife wanted to change the flooring for the whole apartment. They wanted the whole apartment to have the same flooring.
The cost of different types of flooring materials and the cost of installation are found in the tables below.

**Cost of different types of flooring materials**

| Type of flooring | Cost per square foot |
|---|---|
| Vinyl flooring | $4 - $7 |
| Porcelain tiles | $3 - $5 |

https://www.homerenoguru.sg/articles/renovation-essentials/flooring-singapore/

**Cost of flooring installation by material**

| Type of flooring | Cost per square foot |
|---|---|
| Vinyl flooring | $4 - $8 |
| Porcelain tiles | $7 - $11 |

https://www.homeadvisor.com/cost/flooring/install-flooring/

Which type of flooring should they go for if they have limited budget?
Suggest a suitable budget for Xavier and his wife.
Show your working clearly stating your assumption(s).
$1\ m^2 = 10.7639\ ft^2$

Area of floor plan $= 11 \times 11 + \frac{1}{2}(5+7) \times 2 + 3 \times 3$

Area of floor plan = $142\ cm^2$ [M1]

$142\ cm^2 : 42.955\ m^2$ [M1 for finding actual area in either $m^2$ or $cm^2$]
$42.955\ m^2 = 463\ ft^2$ (rounded up)
[M1 for converting to square feet and rounding up]

Vinyl
Cost = $\$7 \times 463 + \$8 \times 463 = \$6945$ [assume highest in range]
Cost = $\$5.5 \times 463 + \$6 \times 463 = \$5324.50$ [assume mid-point]
Cost = $\$4 \times 463 + \$4 \times 463 = \$3704$ [assume lowest in range]
Procelain
Cost = $\$5 \times 463 + \$11 \times 463 = \$7408$ [assume highest in range]
Cost = $\$4 \times 463 + \$9 \times 463 = \$6019$ [assume highest in range]
Cost = $\$3 \times 463 + \$7 \times 463 = \$4630$ [assume lowest in range]
[M1 for calculating total cost for Vinyl and Procelain]

Type of flooring: Vinyl

Budget: $6945 [Highest value in range.]
Or $5324.50 [Mid-point] or $3704 [lowest range]
Accept other reasonable budget provided working is clear
[A1 – for correct type of flooring and corresponding budget]
Assumtpion: Assume the highest value in the range for materials and installation. [B1 - ok to assume mid-point or lowest]



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