Name: **Register Number:** **Class:**

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NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION (2) 2018

SECONDARY FOUR EXPRESS

MATHEMATICS **4048/01**

Paper 1 **6 August 2018, Monday**

2 hours

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, 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 calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

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.

Setter: Ms Ting Shi Yun

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Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

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Trigonometry

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

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

Statistics

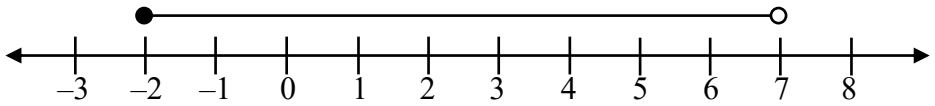
$$\text{Mean} = \frac{\Sigma fx}{\Sigma f}$$

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

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Answer all the questions.

1 A range of values of x is represented on the number line below.



Write down inequalities that represent this range of values of x.

Answer …… [1]

---

2 The stem-and-leaf diagram shows the masses, in grams, of some oranges.

19	1	2	2	*m*	5	6	6	8
20	0	0	3	4	6			
21	1	4	7					

Key: 19 | 2 represents 192 grams

(a) Find the median of these masses.

Answer median = …… g [1]

(b) Given that the interquartile range is 10, find the value of m.

Answer m = …… [2]

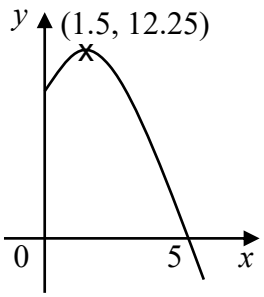
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3 Given that $2^{x+1} + 2^x = 24$, find the value of x.

Answer x = …… [2]

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4 The diagram shows part of the curve $y = ax^2 + bx + 10$. It cuts the x-axis at 5 and the coordinates of the maximum point is (1.5, 12.25). Find the value of a and of b.



Answer a = ……

b = …… [3]

---

5 The first four terms in a sequence of numbers T_1, T_2, T_3, T_4, …, are given below.

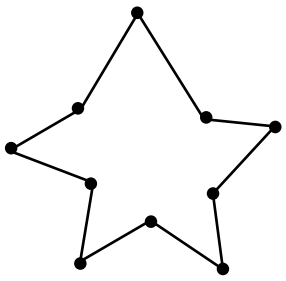
$$\frac{1}{3} \quad , \quad \frac{7}{15} \quad , \quad \frac{13}{35} \quad , \quad \frac{19}{63} \quad , \quad \ldots$$

Find an expression, in terms of n, for T_n.

Answer T_n = …… [2]

---

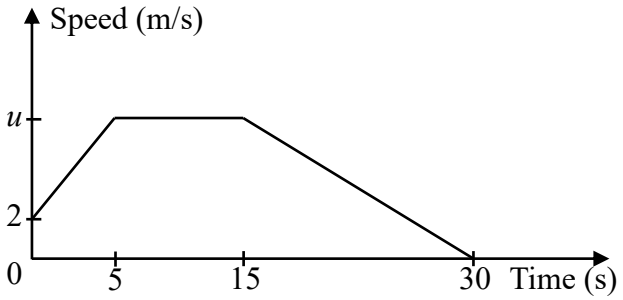
6 The diagram shows an irregular polygon.
Find the sum of all interior angles of this polygon.



Answer ……° [2]

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7 The diagram shows the speed-time graph of a remote controlled toy car for the first 30 seconds of the journey.



(a) Given that the deceleration of the car is 0.5 m/s^2, find the greatest speed, u m/s.

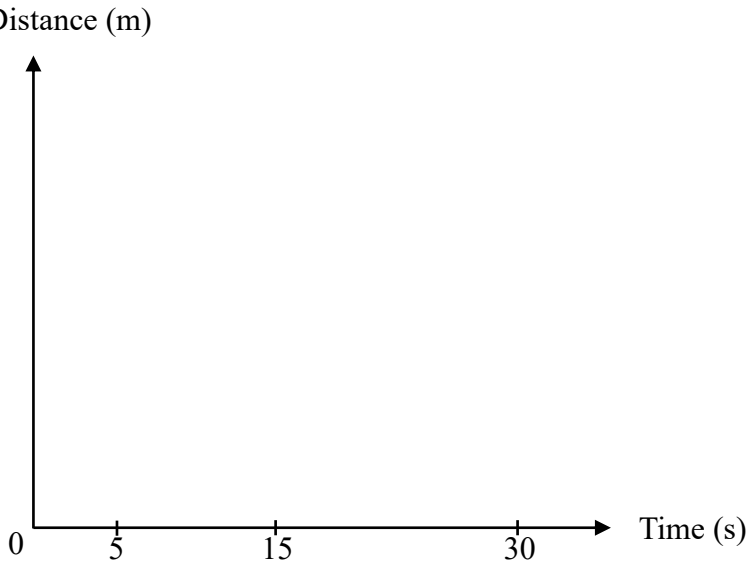
Answer u = ……..…… [1]

(b) Calculate the average speed of the car for the first 30 seconds of the journey.

Answer ……..…… m/s [2]

(c) Sketch the distance-time graph below for the car's journey.

Answer



[3]

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8 $\varepsilon = \{\text{natural number less than } 10\}$
$A = \{\text{factors of } 6\}$
$B = \{\text{prime numbers}\}$
$C = \{\text{perfect squares}\}$

Use one of the symbols below to complete each statement.

$$\emptyset \quad \in \quad \subseteq \quad \subset \quad \notin$$

(a) $B \cap C =$ …… [1]

(b) $\{2, 3\}$ …… A [1]

(c) 8 …… $(A \cup B)' \cap C'$ [1]

---

9 **(a)** Factorise $9x^2 - 3x - 16y^2 + 4y$ completely.

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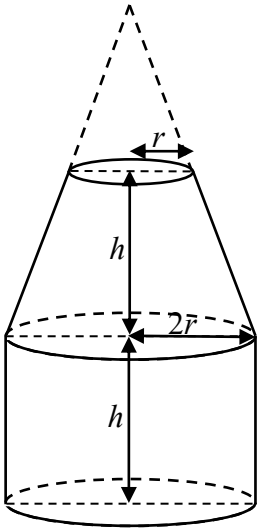
Answer …… [2]

(b) Given that $(2x - 1)^4 + (y + 2)^4 = 0$, find the value of $x - y$.

Answer $x - y =$ …… [3]

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10 The diagram shows a milk container which is made up of a frustum and a cylinder. The height, h cm, of the cylinder is the same as the height of the frustum. The radius of the cylinder base is twice the radius of the top circular surface of the frustum, r cm. Given that the **curved** surface areas of the frustum and cylinder are equal, find an expression for h, in terms of r.



Answer $h =$ …… [3]

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11 Solve $\frac{2}{1-x^2} - \frac{3}{x-1} = 5$.

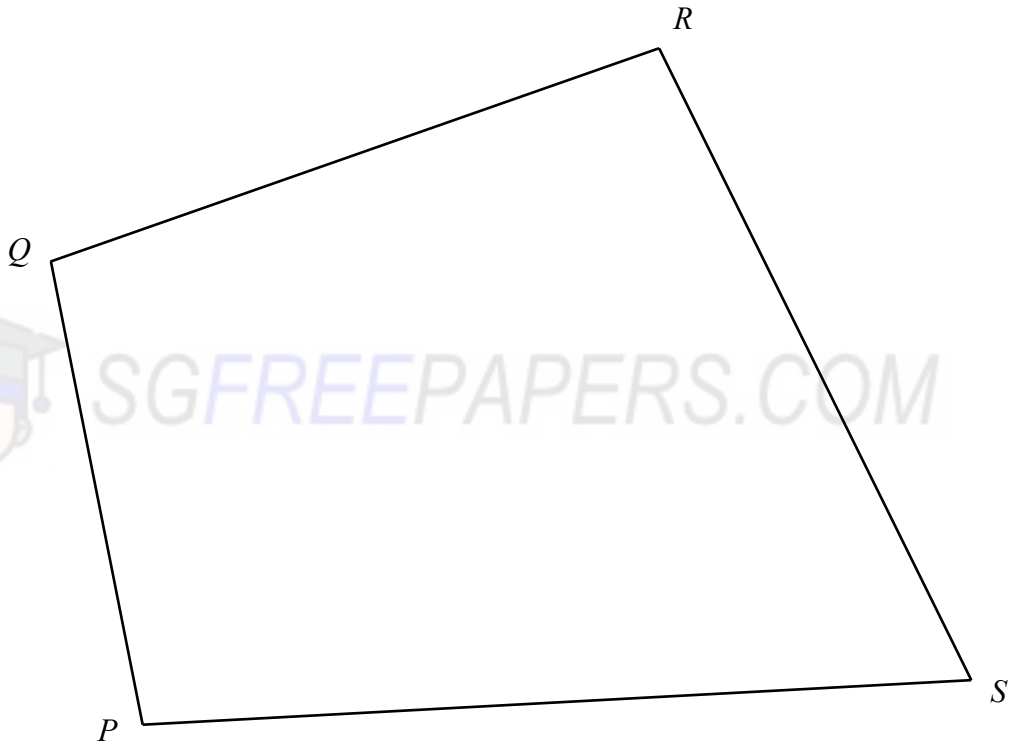
Answer $x =$ …… [3]

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12 In the diagram *PQRS* represents a plot of land. A multi-storey carpark is to be built within *PQRS* with the following conditions:

- nearer to *PS* than *PQ*,
- nearer to *P* than *S* and
- nearer to *Q* than *P*.

Shade the region where the carpark is to be built. [3]



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13 Given ABC is a triangle where $\overrightarrow{AB} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$ and $\overrightarrow{AC} = \begin{pmatrix} -1 \\ 8 \end{pmatrix}$.

(a) Find $\overrightarrow{BC}$.

Answer ……. [2]

(b) Hence, or otherwise, show that $\angle BAC = 108.4°$.

Answer

[2]

(c) Hence, calculate the area of ΔABC.

Answer …….…….…… units^2 [3]

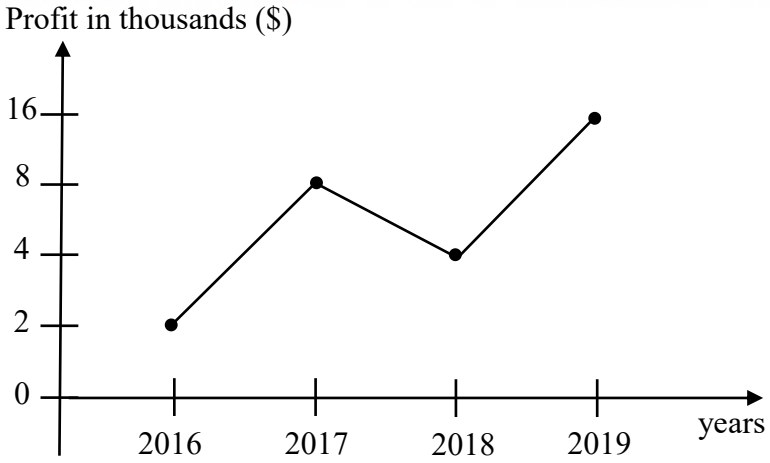
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14 Four numbers a, b, c, d are such that $a + b + c + d = 14$ and $a^2 + b^2 + c^2 + d^2 = 54$.
When the fifth number, e, is added, the standard deviation of the five numbers became 1.
Find the value of e.

Answer $e =$ …… [3]

---

15 The line graph below shows the profit made by Company *X* over the 4 years.



State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph.

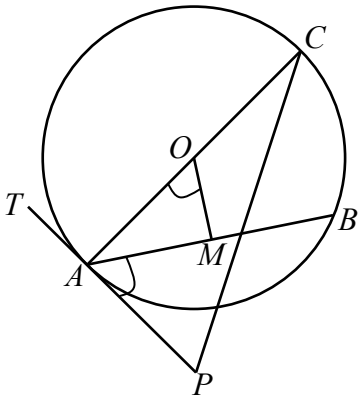
Answer ……..

……

……..... [2]

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16 The diagram shows a circle *ABC*, with centre *O*. *AC* is the diameter of the circle. *M* is the midpoint of chord *AB* and *TAP* is tangent to the circle at point *A*.



Show, with reasons, that $\angle BAP = \angle AOM$.

Answer

[3]

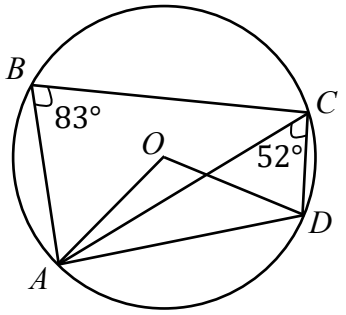
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17 Mrs Teo wishes to open an account with a bank by investing \$5000 for 5 years.
Bank A offers 3% per annum, compounded half-yearly.
Bank B offers *r*% per annum simple interest.
Given that both banks offer the same amount of interest at the end of 5 years, find the value of *r*.

Answer $r =$ …… [3]

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18



In the diagram, *A*, *B*, *C* and *D* are points on a circle, centre *O*.
Angle *ABC* = 83° and angle *ACD* = 52°.
Find angle *ODC*.

Answer $\angle ODC$ = …..……° [3]

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19 **(a)** The volume of cube *A* is $1176x$ cm^3, where the length of the sides is an integer.
Find the smallest possible positive integer *x*.

Answer x = …… [2]

(b) What is the maximum number of cube *A* that a container of dimensions 5 m by 1m by 3 m can hold?

Answer ….…… [3]

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20 Singapore Chinese Dance Theatre put up a production in July.
The tickets pricing for senior citizens, students and adults were \$28, \$38 and \$48 respectively.

This information can be represented by the matrix $\mathbf{Q} = \begin{pmatrix} 28 \\ 38 \\ 48 \end{pmatrix}$

(a) 2 senior citizens, 15 students and 10 adults order tickets through NC School.
21 students and x adults order tickets through RV School.
Represent this information in a 2×3 matrix **P**.

Answer **P** = $\begin{pmatrix} & & \end{pmatrix} \begin{matrix} NC \\ RV \end{matrix}$ [1]

(b) Find the matrix **R**, in terms of x, such that **R** = **PQ**.

Answer **R** = $\begin{pmatrix} & \\ & \end{pmatrix}$ [1]

(c) Explain what each element in matrix **R** represents.

…….

……. [1]

(d) The total amount of money collected from NC School is less than RV School.
Work out the least value of x.

Answer x = …… [2]

(e) All tickets ordered through school will be entitled to a 25% discount for senior citizens, 20% discount for students and 15% discount for adults. Write down matrix **D** such that the elements in matrix multiplication of **PDQ** gives the total amount of money collected from each school after discount.

Answer **D** = $\begin{pmatrix} & & \\ & & \end{pmatrix}$ [1]

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21 Anna and Betty have been given a task to complete 24 stamps in 15 days.
If Anna fall sick after 12 days, Betty will take additional 2 days to complete the task.
If Betty fall sick after 12 days, Anna will take additional n days to complete the task.

(a) Find the value of n.

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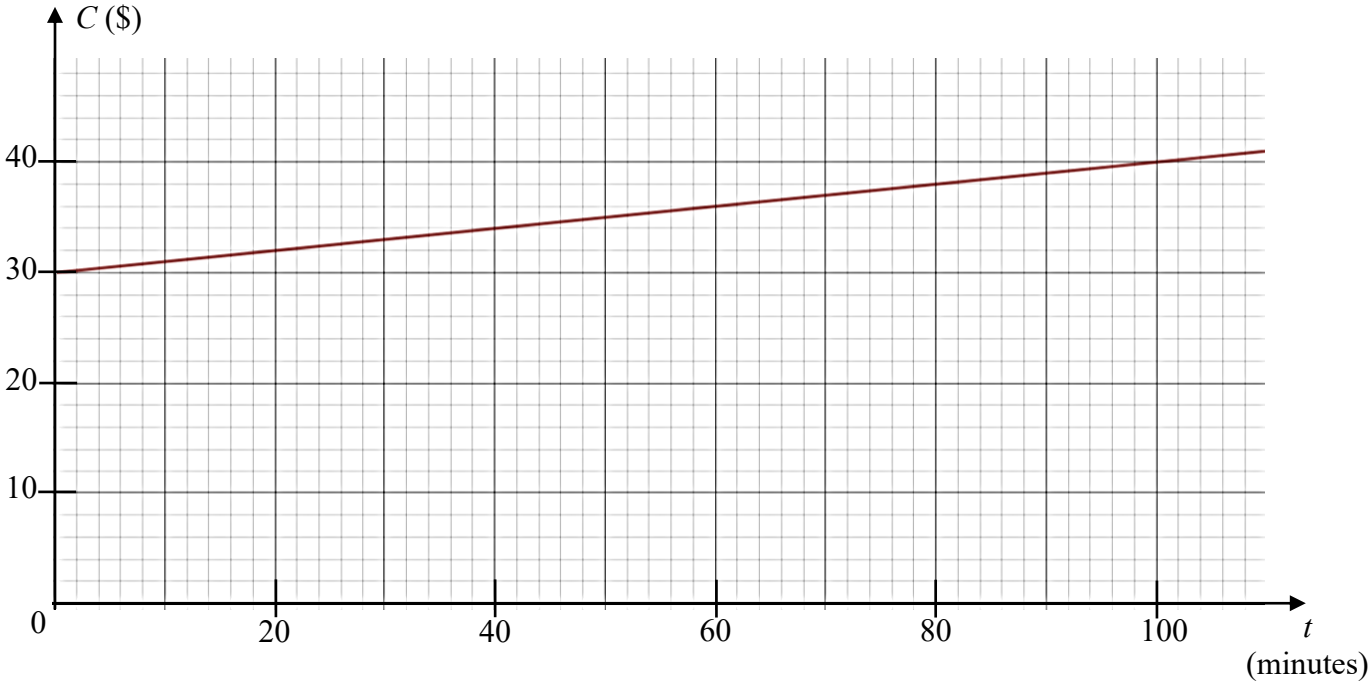
Answer $n =$ …… [4]

(b) State an assumption you have made for part **(a)**.

Answer …….. [1]

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22 The cost of a mobile phone plan, $\$C$, with respect to the amount of additional talktime, t minutes, by the user can be represented by the graph below.



(a) State the equation of this line.

Answer ……. [1]

(b) Explain what the vertical C-intercept value represents.

Answer ……..

…… [1]

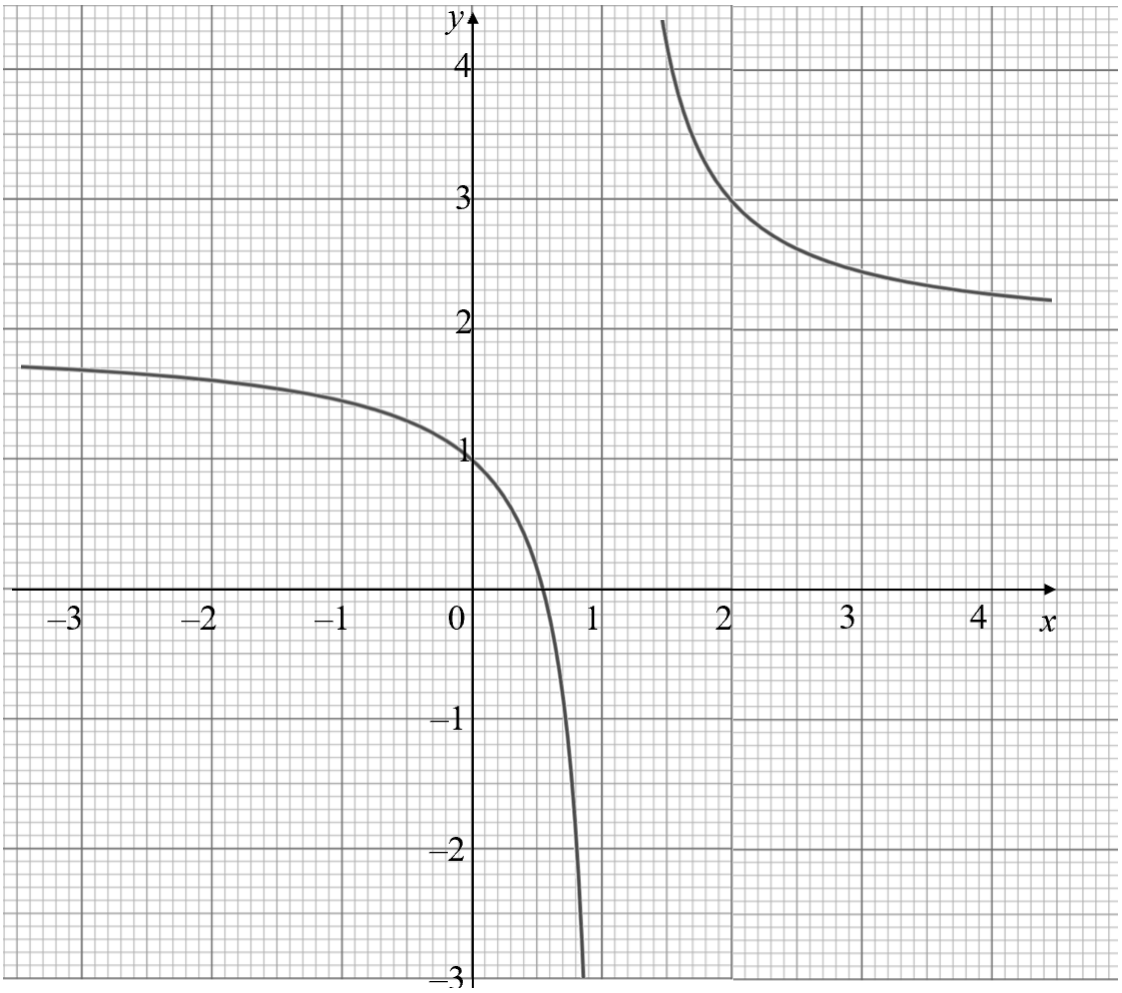
(c) Give a reason why the cost is **not** directly proportional to the additional talktime.

Answer ...……..……..……..

…… [1]

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23 The graph of $y = \frac{1}{x-1} + 2$ is drawn on the grid.



(a) The equation $x^2 - x = 1$ can be solved by drawing a suitable straight line on the grid. Find the equation of this straight line.

Answer …… [2]

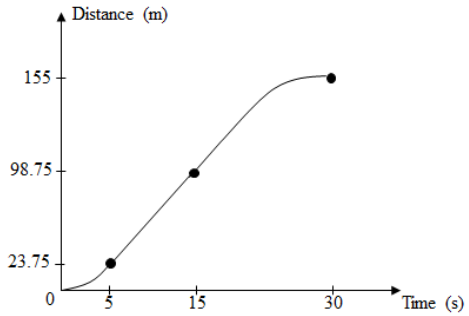
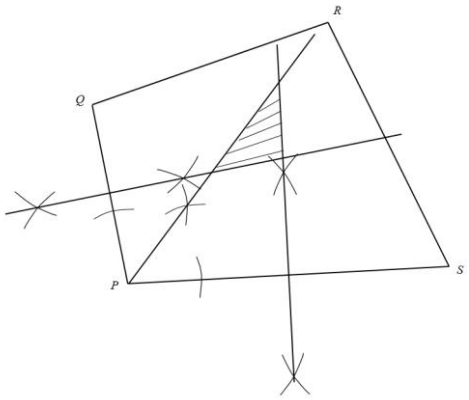
(b) By drawing the straight line from part **(a)**, solve the equation $x^2 - x = 1$.

Answer x = …… or …… [2]

~ End of paper ~

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Answers

1	$-2 \leq x < 7$
2a	199
2b	5
3	3
4	$a = -1 \ , \ \ b = 3$
5	$\dfrac{6n-5}{4n^2-1}$
6	1440
7a	7.5
7b	$5\frac{1}{6}$
7c	
8a	$\varnothing$
8b	$\subset$
8c	$\in$
9a	$(3x-4y)(3x+4y-1)$
9b	2.5
10	$1.13r$
11	0 or 0.6
12	
13a	$\begin{pmatrix}-6\\9\end{pmatrix}$
13b	Shown
13c	19.5

14	3.5
15	The vertical axis is inconsistent, hence making the increase from 2016 to 2017 looks the same as the increase from 2018 to 2019, but the actual is lesser. Or The data for 2019 is invalid. There can be a decrease instead of increase.
16	Shown
17	3.21
18	59
19a	63
19b	154
20a	$\mathbf{P} = \begin{pmatrix}2 & 15 & 10\\0 & 21 & x\end{pmatrix}$
20b	$\mathbf{R} = \begin{pmatrix}1106\\798+48x\end{pmatrix}$
20c	It represents the total amount collected/ to be paid by NC and RV respectively.
20d	$x = 7$
20e	$\mathbf{D} = \begin{pmatrix}0.75 & 0 & 0\\0 & 0.8 & 0\\0 & 0 & 0.85\end{pmatrix}$
21a	3.5
21b	Both Anna and Betty worked at a constant rate.
22a	$C = 30 + 0.1t$
22b	It represents the basic cost without any additional talktime.
22c	The graph does not start from origin. Or $\frac{C}{t} \neq$ constant.
23a	$y = x + 2$
23b	Accept -0.6 ± 0.05 and 1.6 ± 0.05

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Name: **ANSWERS** **Register Number:** **Class:**

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MATHEMATICS **4048/01**

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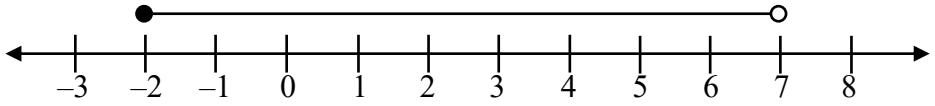
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$$\text{Standard deviation} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$

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Answer all the questions.

1 A range of values of x is represented on the number line below.



Write down inequalities that represent this range of values of x.

Answer $-2 \leq x < 7$ **B1** [1]

---

2 The stem-and-leaf diagram shows the masses, in grams, of some oranges.

19	1	2	2	m	5	6	6	8
20	0	0	3	4	6			
21	1	4	7					

Key: 19 | 2 represents 192 grams

(a) Find the median of these masses.

Answer median = 199 **B1** g [1]

(b) Given that the interquartile range is 10, find the value of m.

$205 - Q_1 = 10$

$Q_1 = 195$ **M1**

$\therefore m = 5$ **A1**

Answer m = 5 [2]

---

3 Given that $2^{x+1} + 2^x = 24$, find the value of x.

$2^x(2 + 1) = 24$

$2^x = 8$ **M1**

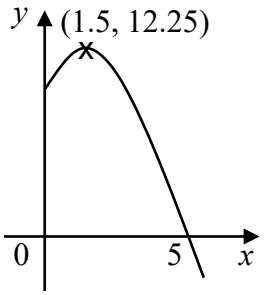
$2^x = 2^3$

$\therefore x = 3$ **A1**

Answer x = 3 [2]

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4 The diagram shows part of the curve $y = ax^2 + bx + 10$. It cuts the x-axis at 5 and the coordinates of the maximum point is (1.5, 12.25). Find the value of a and of b.



$y = a(x - 1.5)^2 + 12.25$

$y = a(x^2 - 3x + 2.25) + 12.25$

$\therefore a(2.25) + 12.25 = 10$ **M1**

$a = -1$ **A1**

$\therefore b = 3$ **B1**

Answer $a =$ -1

$b =$ 3 [3]

---

5 The first four terms in a sequence of numbers T_1, T_2, T_3, T_4, …, are given below.

$$\frac{1}{3} \ , \ \frac{7}{15} \ , \ \frac{13}{35} \ , \ \frac{19}{63} \ , \ \ldots$$

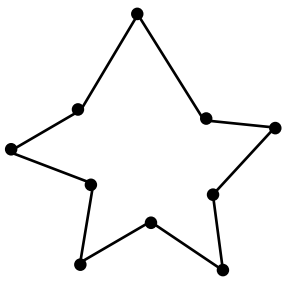
Find an expression, in terms of n, for T_n.

Note: If students only find numerator or denominator, award **B1**

Answer $T_n =$ $\dfrac{6n-5}{4n^2-1}$ **B2** [2]

---

6 The diagram shows an irregular polygon.
Find the sum of all interior angles of this polygon.



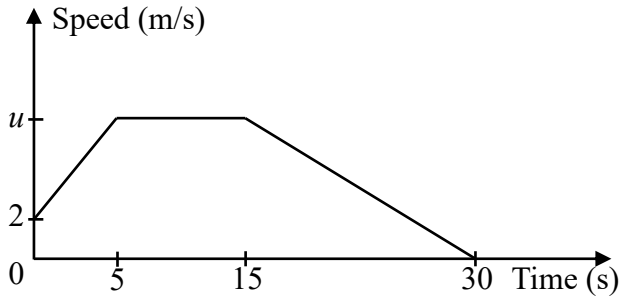
8×180 **M1**

$= 1440°$ **A1**

Answer 1440° [2]

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7 The diagram shows the speed-time graph of a remote controlled toy car for the first 30 seconds of the journey.



(a) Given that the deceleration of the car is 0.5 m/s^2, find the greatest speed, u m/s.

Answer $u =$ ……7.5…… **B1** [1]

(b) Calculate the average speed of the car for the first 30 seconds of the journey.

$$\text{Total distance} = \frac{1}{2}(2 + 7.5)(5) + (7.5)(10) + \frac{1}{2}(7.5)(15)$$
$$= 23.75 + 75 + 56.25$$
$$= 155 \quad \textbf{M1}$$

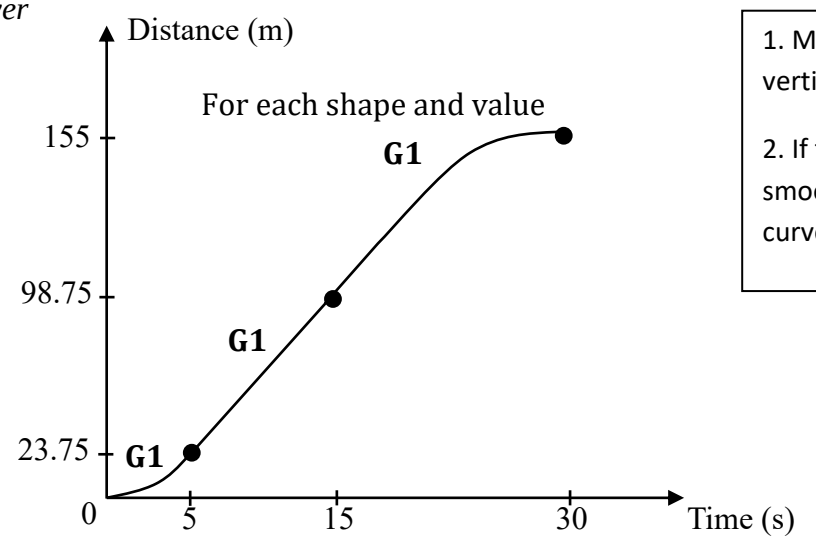
Only accept exact proper fraction

$$\textbf{Average speed} = \frac{155}{30} = 5\frac{1}{6} \quad \textbf{A1}$$

Answer ……$5\frac{1}{6}$…… m/s [2]

(c) Sketch the distance-time graph below for the car's journey.

Answer



1. Missing markings on vertical axis: –1 mark

2. If the sketch is not smooth (a.k.a. pimple curve), –1 mark

[3]

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8 ε = {natural number less than 10}= {1, 2, 3, 4, 5, 6, 7, 8, 9}
A = {factors of 6} = {1, 2, 3, 6}
B = {prime numbers} = {2, 3, 5, 7}
C = {perfect squares} = {1, 4 , 9}

Use one of the symbols below to complete each statement.

$\emptyset$ $\in$ $\subseteq$ $\subset$ $\notin$

(a) $B \cap C =$ ..... $\emptyset$ **B1** [1]

(b) {2, 3} ..... $\subset$ ..... A **B1** [1]

(c) 8 ..... $\in$ ..... $(A \cup B)' \cap C'$ **B1** [1]

---

9 **(a)** Factorise $9x^2 - 3x - 16y^2 + 4y$ completely.

$9x^2 - 16y^2 - 3x + 4y$

$= (3x - 4y)(3x + 4y) - (3x - 4y)$ **M1**

$= (3x - 4y)(3x + 4y - 1)$ **A1**

Answer $(3x - 4y)(3x + 4y - 1)$ [2]

(b) Given that $(2x - 1)^4 + (y + 2)^4 = 0$, find the value of $x - y$.

Since $(2x - 1)^4 \geq 0$ and $(y + 2)^4 \geq 0$, **B1** reason

$2x - 1 = 0$ and $y + 2 = 0$

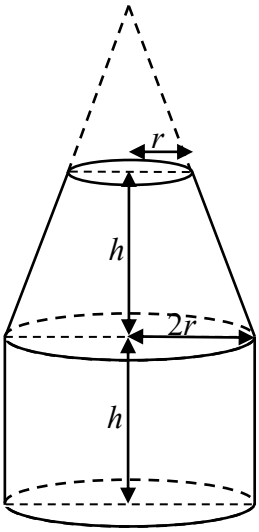
$x = \frac{1}{2}$ and $y = -2$ **M1**

$\therefore x - y = 2.5$ **A1**

Answer $x - y =$ 2.5 [3]

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10 The diagram shows a milk container which is made up of a frustum and a cylinder. The height, h cm, of the cylinder is the same as the height of the frustum. The radius of the cylinder base is twice the radius of the top circular surface of the frustum, r cm. Given that the **curved** surface areas of the frustum and cylinder are equal, find an expression for h, in terms of r.



$$\frac{\text{Area}_{\text{small cone}}}{\text{Area}_{\text{big cone}}} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

Surface area of frustum $= 3\pi r\sqrt{h^2 + r^2}$ **M1**

$$3\pi r\sqrt{h^2 + r^2} = 2\pi(2r)h \quad \textbf{M1}$$

$$3\sqrt{h^2 + r^2} = 4h$$

$$9(h^2 + r^2) = 16h^2$$

$$9r^2 = 7h^2$$

$$h^2 = \frac{9r^2}{7}$$

$$h = \frac{3}{\sqrt{7}}r \quad \text{or} \quad \frac{3\sqrt{7}}{7}r \quad \text{or} \quad 1.13r \quad \textbf{A1}$$

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Answer $h =$ ..... 1.13r [3]

---

11 Solve $\frac{2}{1-x^2} - \frac{3}{x-1} = 5$.

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

$$\frac{2 + 3(1+x)}{(1-x)(1+x)} = 5 \quad \textbf{M1}$$

$$2 + 3(1+x) = 5(1-x)(1+x)$$

$$5x^2 + 3x = 0$$

$$x(5x+3) = 0 \quad \textbf{M1}$$

$$x = 0 \quad \text{or} \quad x = -\frac{3}{5} \quad \textbf{A1}$$

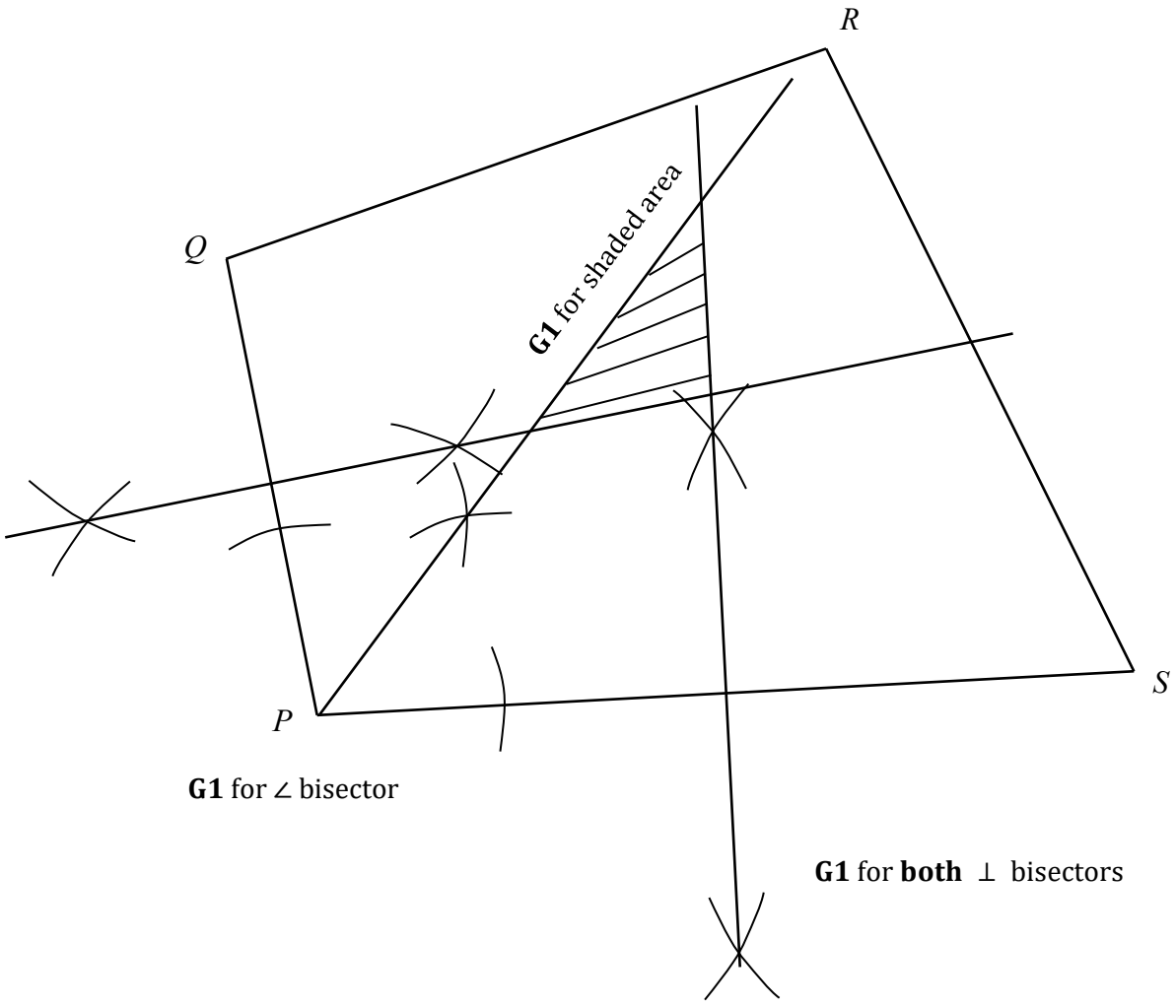
Answer $x =$ ..... 0 or $-\frac{3}{5}$ [3]

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12 In the diagram *PQRS* represents a plot of land. A multi-storey carpark is to be built within *PQRS* with the following conditions:

- nearer to *PS* than *PQ*,
- nearer to *P* than *S* and
- nearer to *Q* than *P*.

Shade the region where the carpark is to be built. [3]



G1 for ∠ bisector

G1 for **both** ⊥ bisectors

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13 Given ABC is a triangle where $\overrightarrow{AB} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$ and $\overrightarrow{AC} = \begin{pmatrix} -1 \\ 8 \end{pmatrix}$.

(a) Find $\overrightarrow{BC}$.

$$\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AC}$$
$$= -\begin{pmatrix} 5 \\ -1 \end{pmatrix} + \begin{pmatrix} -1 \\ 8 \end{pmatrix} \quad \textbf{M1}$$
$$= \begin{pmatrix} -6 \\ 9 \end{pmatrix} \quad \textbf{A1}$$

Answer $\begin{pmatrix} -6 \\ 9 \end{pmatrix}$ [2]

(b) Hence, or otherwise, show that $\angle BAC = 108.4°$.

Answer

[2]

"Hence" method

$|\overrightarrow{BC}| = \sqrt{117}$

$|\overrightarrow{AB}| = \sqrt{26}$

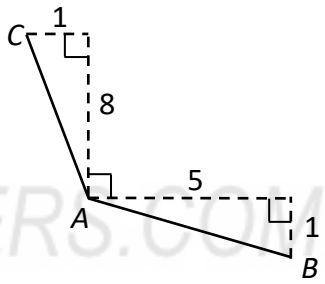
$|\overrightarrow{AC}| = \sqrt{65}$

$117 = 26 + 65 - (\sqrt{26})(\sqrt{65})cos\angle BAC$ **M1**

$cos\angle BAC = -0.3162277$

$\angle BAC = 108.4°$ **A1**

"Otherwise" method



$\angle BAC = 90 + tan^{-1}\frac{1}{5} + tan^{-1}\frac{1}{8}$ **M1**

$= 108.4°$ **A1**

(c) Hence, calculate the area of ΔABC.

Area = $\frac{1}{2}(\sqrt{26})(\sqrt{65})\sin 108.4$

= 19.5 units^2

M1 length of AB and AC
M1 formula
A1

If students calculate the length in part (b), award them the M1 too.

Answer 19.5 units^2

[3]

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14 Four numbers a, b, c, d are such that $a + b + c + d = 14$ and $a^2 + b^2 + c^2 + d^2 = 54$. When the fifth number, e, is added, the standard deviation of the five numbers became 1. Find the value of e.

$$\sqrt{\frac{54 + e^2}{5} - \left(\frac{14 + e}{5}\right)^2} = 1 \qquad \textbf{M1}$$

$$\frac{5(54 + e^2) - (14 + e)^2}{25} = 1$$

$$270 + 5e^2 - 196 - 28e - e^2 = 25$$

$$4e^2 - 28e + 49 = 0 \qquad \textbf{M1}$$

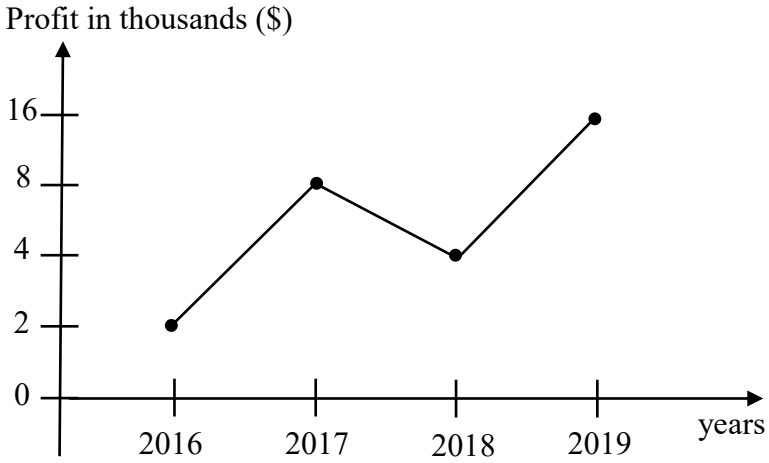
$$(2e - 7)^2 = 0$$

$$e = 3.5 \qquad \textbf{A1}$$

Answer $e =$ 3.5 [3]

---

15 The line graph below shows the profit made by Company *X* over the 4 years.



State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph.

B1

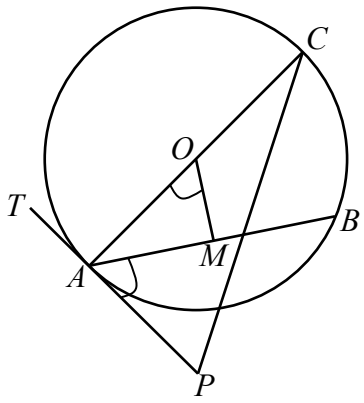
Answer The vertical axis is inconsistent, hence making the increase from 2016 to 2017 looks the same as the increase from 2018 to 2019, but the actual is lesser. **B1**

OR The data for 2019 is invalid. There can be a decrease instead of increase. [2]

B1 **B1**

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16 The diagram shows a circle *ABC*, with centre *O*. *AC* is the diameter of the circle. *M* is the midpoint of chord *AB* and *TAP* is tangent to the circle at point *A*.



Show, with reasons, that $\angle BAP = \angle AOM$.

Answer

[3]

$\angle OAP = 90°$ (Tangent perpendicular to radius) **M1**

$\angle AM0 = 90°$ (Perpendicular bisector of chord) **M1**

$\angle AOM = 180 - 90 - \angle OAM$ ($\angle$ sum of Δ)

$= 90 - (90 - \angle BAP)$ **A1**

$= \angle BAP$

Any missing reasons: **overall** –1 mark.

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---

17 Mrs Teo wishes to open an account with a bank by investing \$5000 for 5 years.
Bank A offers 3% per annum, compounded half-yearly.
Bank B offers *r*% per annum simple interest.
Given that both banks offer the same amount of interest at the end of 5 years, find the value of *r*.

$$\text{Interest} = 5000\left(1 + \frac{3}{200}\right)^{10} - 5000$$ **M1**

$$\frac{5000 \times r \times 5}{100} = 802.7041$$ **M1**

$$250r = 802.7041$$

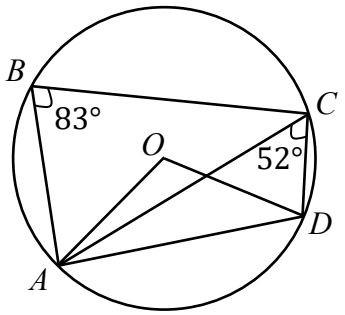
$$r = 3.21$$ **A1**

If student write 3.21% on answer blank, –1 mark.

Answer $r =$ 3.21 [3]

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18



In the diagram, *A*, *B*, *C* and *D* are points on a circle, centre *O*.
Angle *ABC* = 83° and angle *ACD* = 52°.
Find angle *ODC*.

Any missing reasons:
overall –1 mark.

$\angle AOD = 52 \times 2 = 104°$ (∠ at centre = 2∠ at circumference) **M1**

$\angle ODA = (180 - 104) \div 2 = 38°$ (base of isosceles Δ) **M1**

$\angle ODC = 180 - 83 - 38$ (∠ in opposite segment)
$= 59°$ **A1**

Answer ∠*ODC* = ……59……° [3]

---

19 **(a)** The volume of cube *A* is 1176*x* cm^3, where the length of the sides is an integer.
Find the smallest possible positive integer *x*.

$1176 = 2^3 \times 3 \times 7^2$ **M1**

$\therefore x = 3^2 \times 7 = 63$ **A1**

Answer *x* = ……63…… [2]

(b) What is the maximum number of cube *A* that a container of dimensions 5 m by 1m by 3 m can hold?

Length of cube = $2 \times 3 \times 7 = 42$ **M1**

$\frac{500}{42} = 11\frac{19}{21}$
$\frac{100}{42} = 2\frac{8}{21}$ **M1**
$\frac{300}{42} = 7\frac{1}{7}$

No. of cubes = $11 \times 2 \times 7 = 154$ **A1**

Answer ……154…… [3]

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20 Singapore Chinese Dance Theatre put up a production in July.
The tickets pricing for senior citizens, students and adults were \$28, \$38 and \$48 respectively.

This information can be represented by the matrix $\mathbf{Q} = \begin{pmatrix} 28 \\ 38 \\ 48 \end{pmatrix}$

(a) 2 senior citizens, 15 students and 10 adults order tickets through NC School.
21 students and x adults order tickets through RV School.
Represent this information in a 2×3 matrix **P**.

B1

Answer $\mathbf{P} = \begin{pmatrix} 2 & 15 & 10 \\ 0 & 21 & x \end{pmatrix} \begin{matrix} NC \\ RV \end{matrix}$ [1]

(b) Find the matrix **R**, in terms of x, such that $\mathbf{R} = \mathbf{PQ}$.

Answer $\mathbf{R} = \begin{pmatrix} 1106 \\ 798 + 48x \end{pmatrix}$ **B1**
[1]

(c) Explain what each element in matrix **R** represents.

It represents the total amount collected/ to be paid by NC and RV respectively **B1**
.....
.....
[1]

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(d) The total amount of money collected from NC School is less than RV School.
Work out the least value of x.

$798 + 48x > 1106$ **M1**

$x > 6\frac{5}{12}$

$\therefore x = 7$ **A1**

Answer $x =$ 7 [2]

(e) All tickets ordered through school will be entitled to a 25% discount for senior citizens, 20% discount for students and 15% discount for adults. Write down matrix **D** such that the elements in matrix multiplication of **PDQ** gives the total amount of money collected from each school after discount.

Answer $\mathbf{D} = \begin{pmatrix} 0.75 & 0 & 0 \\ 0 & 0.8 & 0 \\ 0 & 0 & 0.85 \end{pmatrix}$ **B1**
[1]

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21 Anna and Betty have been given a task to complete 24 stamps in 15 days.
If Anna fall sick after 12 days, Betty will take additional 2 days to complete the task.
If Betty fall sick after 12 days, Anna will take additional *n* days to complete the task.

(a) Find the value of *n*.

A+B: 15 days, 24 stamps
1 day, 1.6 stamps
3 days, 4.8 stamps left **M1** no. of stamps left

B: 5 days, 4.8 stamps
1 day, 0.96 stamp **M1** rate of B

A: (3+*n*) days, 4.8 stamps
1 day , $\frac{4.8}{3+n}$

$$\frac{4.8}{3+n} + 0.96 = 1.6 \quad \textbf{M1}$$

$$\frac{4.8}{3+n} = 0.64$$

$$3 + n = 7.5$$

$$n = 3.5 \quad \textbf{A1}$$

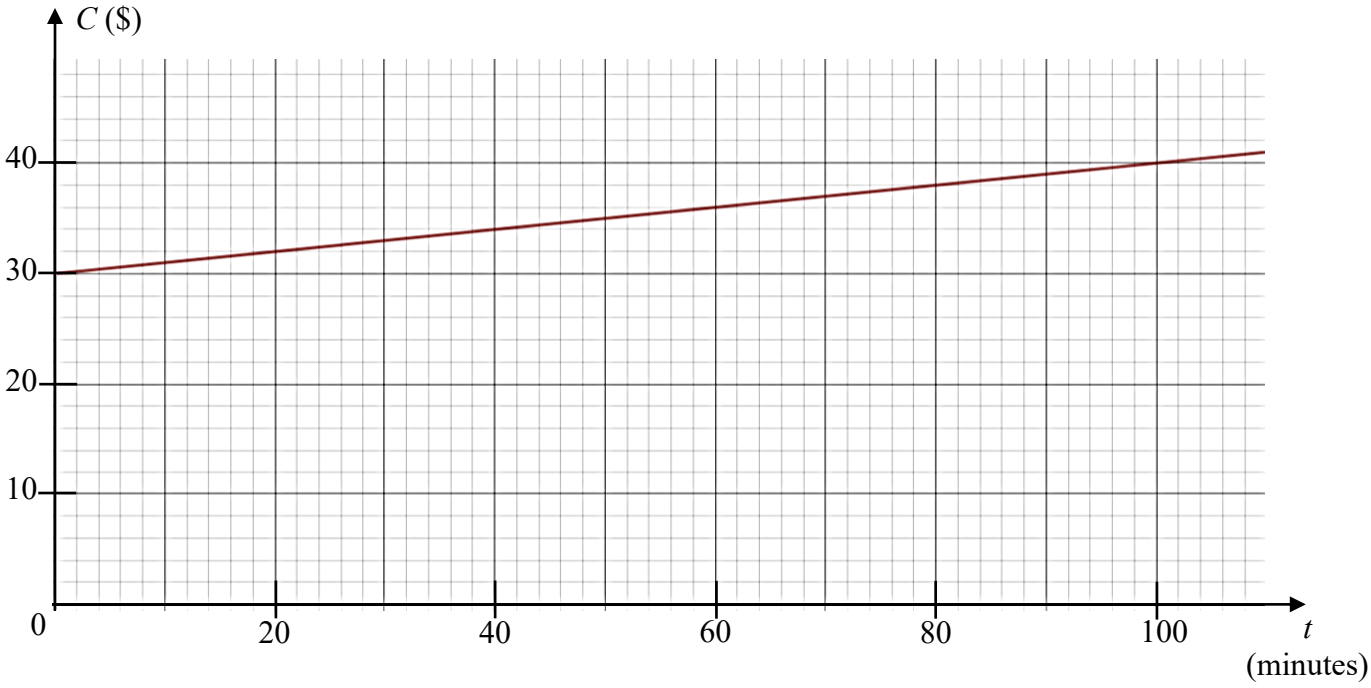
Answer $n =$ 3.5 [4]

(b) State an assumption you have made for part **(a)**.

Answer Both Anna and Betty worked at a constant rate. **B1** [1]

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22 The cost of a mobile phone plan, $\$C$, with respect to the amount of additional talktime, t minutes, by the user can be represented by the graph below.



(a) State the equation of this line.

Answer $C = 30 + 0.1t$ **B1** [1]

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(b) Explain what the vertical C-intercept value represents.

Answer It represents the basic cost without any additional talktime. **B1**

[1]

(c) Give a reason why the cost is **not** directly proportional to the additional talktime.

Answer The graph does not start from origin. **B1**

OR $\frac{C}{t} \neq constant$ **B1**

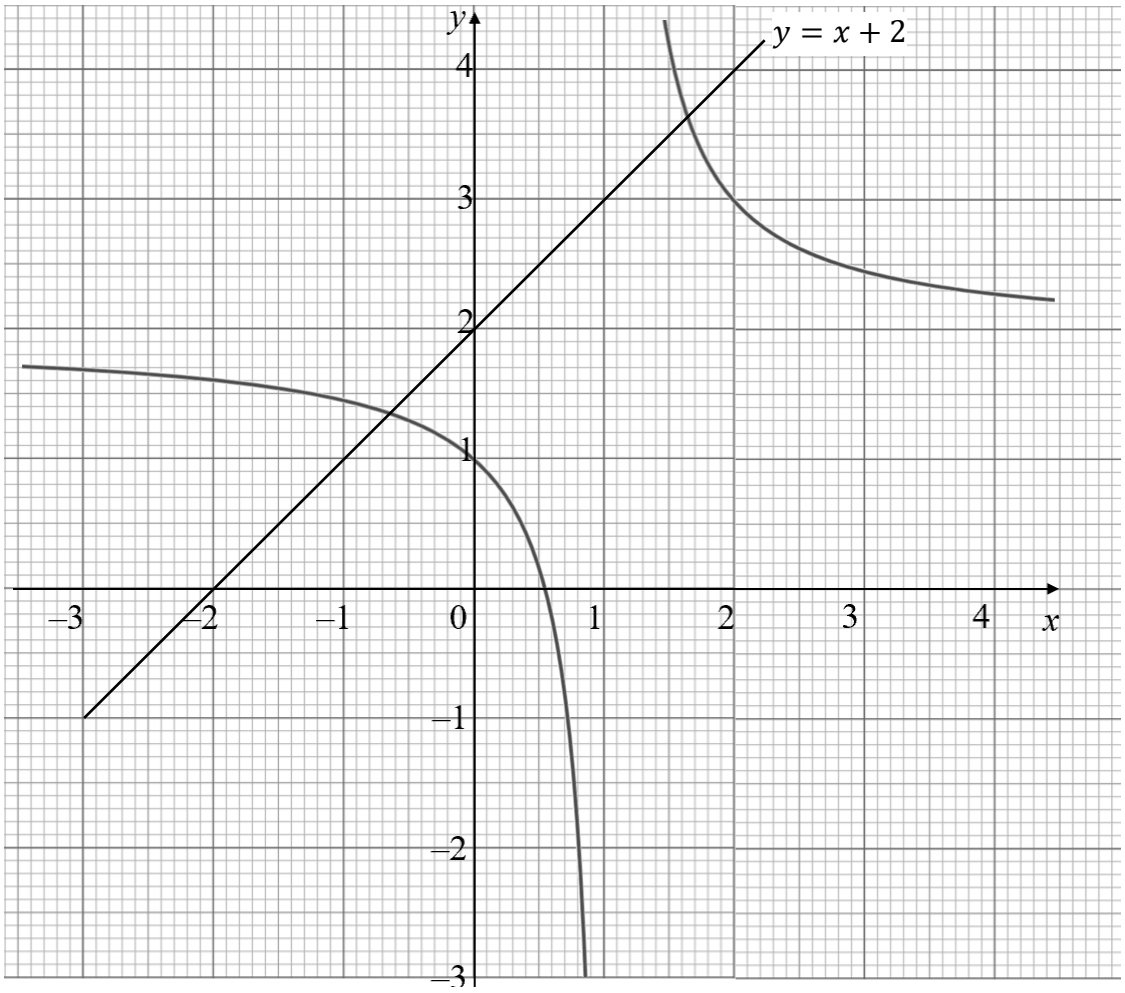
Students cannot write $\frac{C}{t} \neq k$ and not defining what k is.

[1]

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23 The graph of $y = \frac{1}{x-1} + 2$ is drawn on the grid.

G1



(a) The equation $x^2 - x = 1$ can be solved by drawing a suitable straight line on the grid. Find the equation of this straight line.

$x(x-1) = 1$ **M1**

$x = \frac{1}{x-1}$

$x + 2 = \frac{1}{x-1} + 2$

$y = x + 2$ **A1**

Answer $y = x + 2$ [2]

(b) By drawing the straight line from part **(a)**, solve the equation $x^2 - x = 1$.

B1 for both ans

Answer $x =$ -0.65 or 1.65 [2]

Accept **–0.6 ± 0.05** and **1.6 ± 0.05**

~ End of paper ~

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Name: **Register Number:** **Class:**

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION (2) 2018
SECONDARY FOUR EXPRESS

MATHEMATICS **4048/02**

PAPER 2 **10 September 2018, Monday**

2 hours 30 minutes

Additional materials: Writing Papers (8 sheets)
Graph Paper (1 sheet)

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READ THESE INSTRUCTIONS FIRST

Write your name, class and index number at the top of the cover page.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, 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.
Calculators should be used where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
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**.

Setter: Mrs Sim Hwee Mung

This document consists of **12** printed pages including the cover page.

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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

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

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

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Answer **all** questions.

1 **(a)** Simplify $\frac{(2xy)^2}{35xy^7} \div \left(\frac{x^{-1}y^{-2}}{4}\right)^{-2}$, leaving your answer in positive index form. [2]

(b) Solve the inequality $\frac{1}{4}x - \frac{3}{5}\left(x + \frac{1}{3}\right) \geq \frac{1}{2}(x - 9)$. [2]

(c) **(i)** Express $\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2}$ as a single fraction in its simplest form. [4]

(ii) Hence solve the equation $\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2} = \frac{3}{x-2}$. [2]

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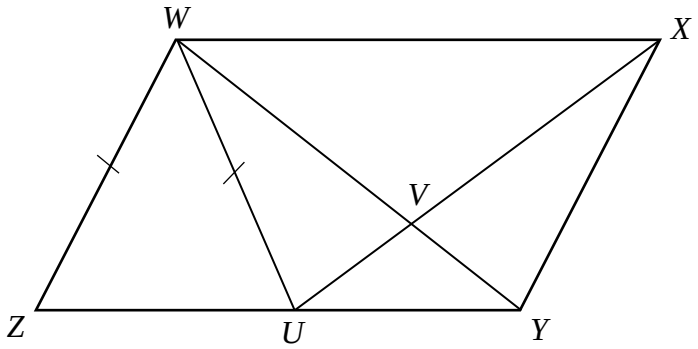
2 **(a)** *PQRS* is a parallelogram in which the coordinates of *P* and *Q* are $(p\,, 4)$ and $(7\,, 11)$ respectively. The line $9y + 27 - 7x = 0$ cuts the *y*-axis at *R* and is parallel to the line *PQ*.
Find

(i) the value of *p*, [3]

(ii) the coordinates of *S* by **vector method**. [3]

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(b) In the diagram, *WXYZ* is a parallelogram and *U* is a point on *ZY* such that *WZ* = *WU*. The lines *WY* and *UX* intersect at *V*.



Prove that ΔWUY is congruent to ΔXYU. [3]

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3 **(a)** The radius of a particular spherical cell is approximately 6.2×10^{-11} metre.

(i) 88 of these spherical cells are arranged to form a straight line such that each cell touches one another without overlapping. Calculate the length, in metre, of the straight line formed. Give your answer in standard form. [1]

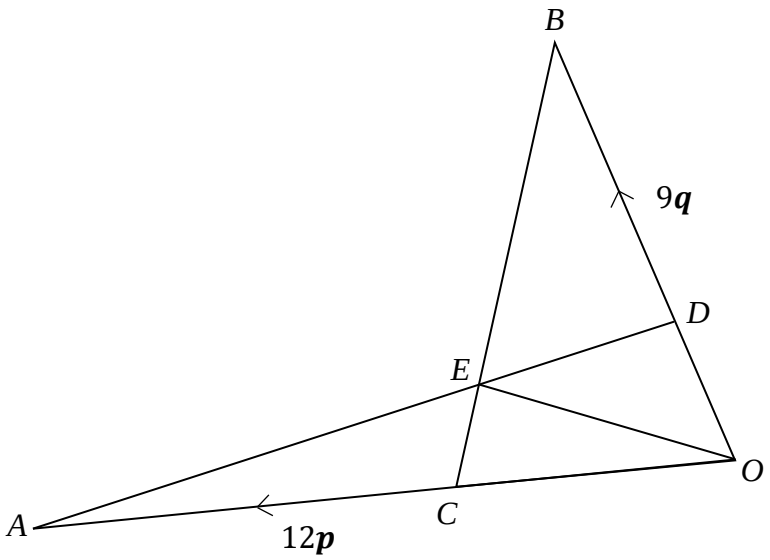
(ii) Calculate the volume of a spherical cell, in cubic centimetre. Give your answer in standard form correct to 2 decimal places. [1]

(b) The planet Mercury is approximately 77 billion metre from the Earth. Given that radio waves travel at a speed of 3×10^{8} m/s, find the time taken for radio waves to travel from the Earth to Mercury, giving your answer to the nearest minutes. [2]

(c) The word 'Googol' is defined as 1×10^{100}. If a man has ten 'Googol' cents and a Boeing 737 aircraft costs $72 million, how many such aircrafts can he buy? Give your answer in standard form correct to 5 significant figures. [3]

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4 In the diagram, $\overrightarrow{OA} = 12\boldsymbol{p}$ and $\overrightarrow{OB} = 9\boldsymbol{q}$.
It is given that $3DB = 2OB$ and $OA = 3OC$.



(a) Express, as simply as possible, in terms of $\boldsymbol{p}$ and $\boldsymbol{q}$,

(i) $\overrightarrow{BC}$, [2]

(ii) $\overrightarrow{DA}$. [2]

(b) Given that $\dfrac{\text{area of triangle } ODE}{\text{area of triangle } ODA} = \dfrac{1}{4}$, find $\overrightarrow{OE}$ in terms of $\boldsymbol{p}$ and $\boldsymbol{q}$. [2]

(c) Find the value of $\dfrac{\text{area of triangle } BDE}{\text{area of quadrailateral } EDOC}$. [2]

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5 Answer the whole of this question on a sheet of graph paper.

A radioactive substance decays such that its mass, m grams, after d days is given by the equation $m = 43(3)^{-d}$.

The table below shows record of the mass, m grams of the substance, corrected to 1 decimal place, after d days.

d (days)	0	1	2	3	4	5	6
m (grams)	43	14.3	4.8	p	0.5	0.2	0.1

(a) Find the value of p. [1]

(b) Using a horizontal scale of 2 cm to represent 1 day and a vertical scale of 2 cm to represent 5 grams, draw the graph of $m = 43(3)^{-d}$ for $0 \le d \le 6$. [3]

(c) Use your graph to estimate the value of d when the mass of substance is reduced to 65% of its original mass. [1]

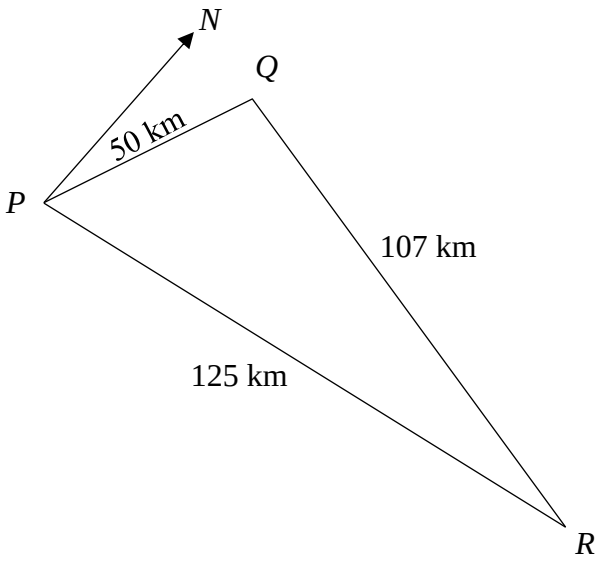
(d) By drawing a tangent, find the gradient of the curve at the point when $d = 2.5$.

State briefly what this gradient represents. [3]

(e) Using your graph, find the range of d for $86(3)^{-d} + 12d < 60$. [2]

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6 PQR represents a triangular plot of land on horizontal ground.
PQ = 50 km, QR = 107 km and PR = 125 km.
R is due east of P.



(a) Calculate

(i) the bearing of Q from P, [3]

(ii) the bearing of P from Q, [2]

(iii) the obtuse angle PQR, [2]

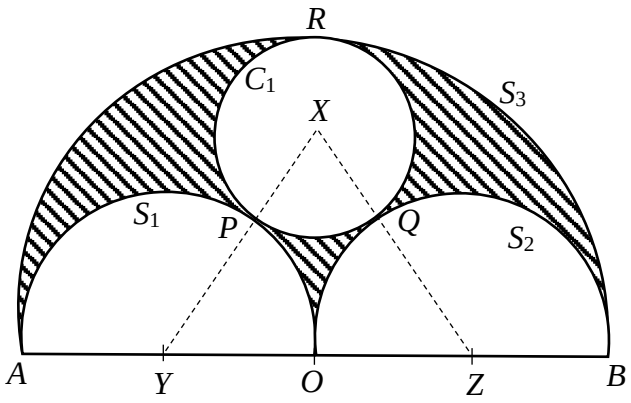
(iv) the area of the triangular plot of land PQR. [2]

(b) A vertical pole of height 9 km is erected at Q. Calculate the greatest angle of elevation of the top of the pole from a point S along PR. [3]

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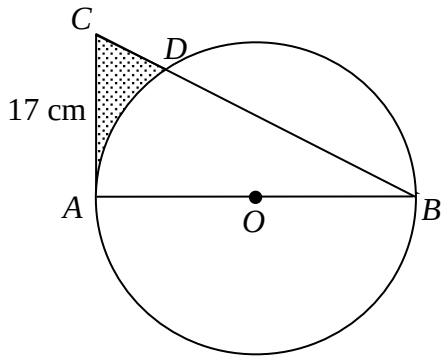
7 In the diagram, the circle C_1 with centre X has a radius $(3r + 1)$ cm, where r is a constant. Two identical semicircles, S_1 and S_2 with centre at Y and Z respectively, have a radius $(13 - 6r)$ cm.
Another semicircle, S_3 with centre O has a diameter AB.
C_1 touches S_1 and S_2 at P and Q respectively while S_1 and S_2 touches one another at O.
S_3 touches C_1, S_1 and S_2 at R, A and B respectively.
$AYOZB$ is a straight line.



(a) Write down an expression, in its simplest form and in terms of r, for
(i) XZ, [1]
(ii) XO. [2]
(b) Hence, form an equation in terms of r and show that it reduces to $126r^2 - 411r + 299 = 0$. [3]
(c) Solve the equation $126r^2 - 411r + 299 = 0$. [2]
(d) Hence, find the area of the shaded region. [3]

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8 **(a)** The diagram shows a circle with centre O and radius of 12 cm. AB is the diameter of the circle and AC is a tangent to the circle at A with AC = 17 cm. The circle intersects the line BC at D.



(i) Show that angle $DOA = 1.23$ radians. [2]

Calculate

(ii) the length of minor arc AD, [1]

(iii) the area of the shaded region. [3]

(b) Diagram I shows an open container which is made up of a cylinder and a cone. The cylinder has radius r cm and height 30 cm.
The cone has base radius r cm and slant height l cm.
The container is fully filled with water.

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Diagram II shows a spherical object in which half of it is immersed into the container and some water is displaced. The radius of the sphere is the same as the radius of the cylinder. Assume the thickness of the container and the spherical object are negligible.

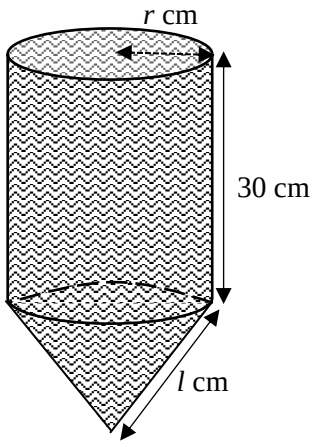


Diagram I

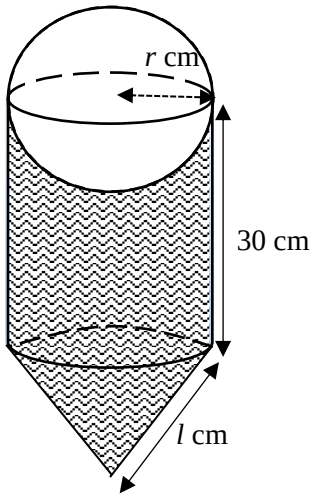


Diagram II

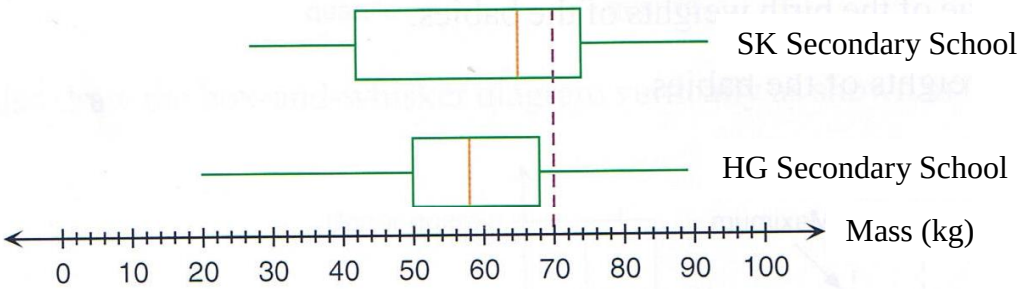
Given that the volume of the water displaced is 1152π cm^3 and the volume of the water left in the container is 3600π cm^3, find

(i) the value of r and of l, [4]

(ii) the total internal area of the container and the sphere that is in contact with water, leaving your answer in terms of π. [2]

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9 **(a)** The following box-and-whisker diagrams show the distribution of the mass of 300 students from each school, SK Secondary School and HG Secondary School respectively.

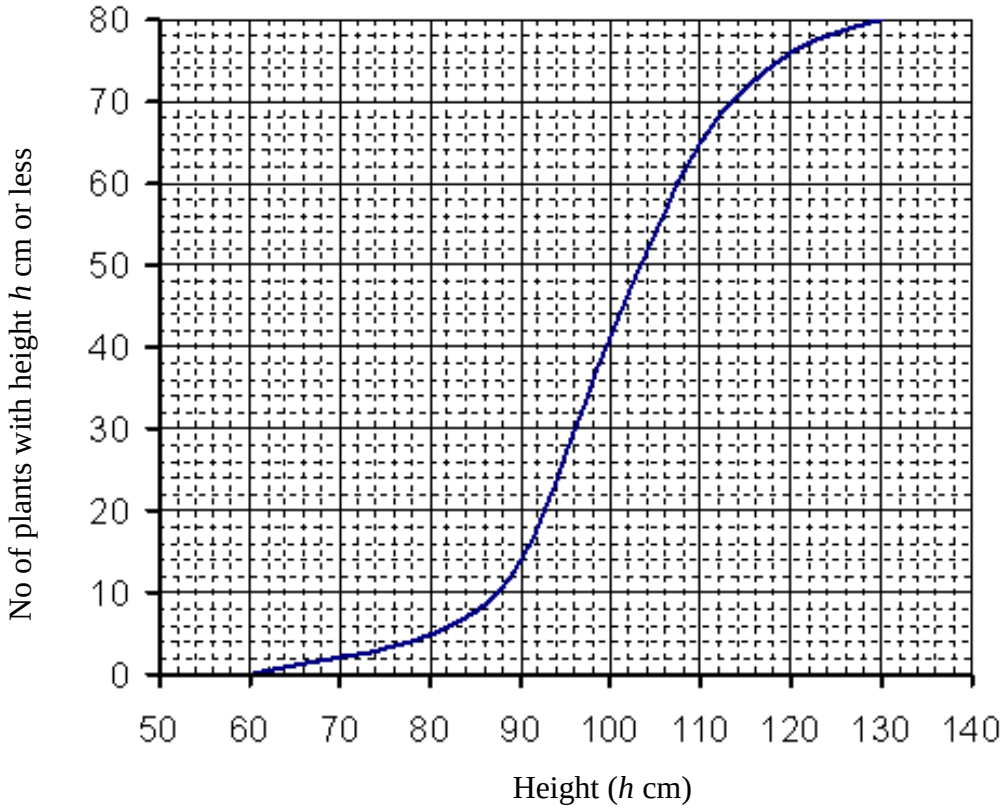


(i) What is the median mass for each school? [1]

(ii) Compare the mass of the students from SK Secondary School and HG Secondary School in two ways. [2]

(iii) Mary commented that there are more students in HG Secondary School than SK Secondary School who weigh more than or equal to 70 kg.
Do you agree with Mary? Support with a reason. [1]

(b) The cumulative frequency curve shows the height distribution of 80 plants.



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(i) Use the graph to find

(a) the value of m, if 32.5% of the plants have heights more than m cm, [2]

(b) the probability that two plants chosen will each has a height of more than 118 cm. [2]

(ii) **(a)** The height distribution of the 80 plants was also recorded in the following frequency table. Find the value of a and of b.

Height (h cm)	**Number of plants**
$60 < h \leq 70$	2
$70 < h \leq 80$	a
$80 < h \leq 90$	9
$90 < h \leq 100$	27
$100 < h \leq 110$	23
$110 < h \leq 120$	b
$120 < h \leq 130$	4

[1]

(b) Hence find the mean and the standard deviation of the height of the 80 plants. [2]

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10 Mr and Mrs Tan bought a 3-bedroom unit at a newly launched condominium project at Serangoon. The unit has a floor area of 1152 square foot (sqft). The selling price for the unit is at $1494 per sqft. The developer gives a 5% early bird discount to all buyers.

(a) Calculate the price that they paid for the unit. [1]

Mr and Mrs Tan are both Singapore citizens and they also owned a HDB 5-room flat and they do not have any intention of selling their flat. As such, they will have to pay Additional Buyer's Stamp Duty (ABSD) to the government on top of the Buyer's Stamp Duty (BSD). Table 1 shows the BSD rate and Table 2 shows the ABSD rate.

Table 1. BSD

Based on purchase price	**Rate**
First $180 000	1%
Next $180 000	2%
Next $640 000	3%
Remaining amount	4%

Table 2. ABSD

Based on purchase price	**Rate**
SC^1 buying first residential property	NA
SC^1 buying second residential property	12%
SC^1 buying third and subsequent residential property	15%

SC^1 denotes Singapore Citizens

(b) Calculate the **total** Buyer's Stamp Duty paid by Mr and Mrs Tan. [4]

Mr and Mrs Tan made a 20% down-payment based on the amount paid for the unit obtained in **(a)**. For the remaining amount, which exclude the total Buyer's Stamp Duty, they had decided to sign up either for a 20-years Home Loan plan from CBCO Bank or a 30-years Home Loan plan from BSOP Bank.

(c) Determine which bank they should sign up if they can only afford a monthly instalment of not more than $6000.
Support you answer with appropriate workings. [5]

Simple Interest Rate for CBCO Bank

Loan period: 20 years

1st year:	2nd Year:
2.18% p.a.	2.18% p.a.
Thereafter: 2.68% p.a.	

Simple Interest Rate for BSOP Bank

Loan period: 30 years

1st year:	2nd Year:
1.95% p.a.	1.95% p.a.
Thereafter: 2.15% p.a.	

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

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Answer keys for 2018 NCHS Prelim Exam 2_E.Maths Paper 2

1a	$\frac{1}{140xy^9}$	7ai	14 – 3r
1b	$x \leq 5\frac{1}{17}$	7aii	25 – 15r
1ci	$\frac{3x}{(x-2)(2x-1)}$	7b	$(14-3r)^2 = (25-15r)^2 + (13-6r)^2$
1cii	$x = 1$	7c	$2\frac{1}{6}$ or $1\frac{2}{21}$
2ai	$p = -2$	7d	72.1 cm^2
2aii	S = (-9, -10)	8ai	In triangle CAB, $\tan C\hat{B}A = \frac{17}{24}$ $C\hat{B}A = 0.61630\ rad$ $D\hat{O}A = 2 \times 0.61630$ (angle at centre = 2× angle at circumference) = 1.23 rad (shown)
2b	WZ = WU (given) = XY (opp sides of *ll*gram) UY (common length) $W\hat{U}Y = 180 - W\hat{U}Z$ (adj angles on a str. line) $X\hat{Y}U = 180 - W\hat{Z}U$ (int. angles) Since WZ = WU $\Rightarrow W\hat{Z}U = W\hat{U}Z$ Hence $W\hat{U}Y = X\hat{Y}U$ ΔWUY is congruent to ΔXYU (SAS)	8aii	14.8 cm
3ai	1.09×10^{-8} m	8aiii	47.3 cm^3
3aii	9.98×10^{-25} cm^3	8bi	h = 9 cm , $l = 15\ cm$
3b	4 min	8bii	1188π cm^2
3c	1.3889×10^{91}	9ai	For SK Sec, median = 65 kg For HG Sec, median = 58 kg
4ai	$-9\boldsymbol{q} + 4\boldsymbol{p}$	9aii	Generally, the students for SK Sec Sch are heavier compared to the students in HG Sec Sch because of the higher median. The mass of the students in HG Sec Sch is more consistent than that of SK Sec Sch.
4aii	$-3\boldsymbol{q} + 12\boldsymbol{p}$	9aiii	Disagree as there are more than 25% of the students from SK Sec Sch weigh more than 70 kg while there are less than 25% of the students fron HG Sec Sch weigh more than 70 kg. Accept: There are more students in SK Sec Sch weigh more than 70 kg because it has a higher upper quartile than HG Sec Sch.
4b	$3\boldsymbol{p} + \frac{9}{4}\boldsymbol{q}$	9bia	m = 105
4c	1	9bib	$\frac{3}{632}$
5a	1.6	9biia	a = 3, b = 12
5c	Accept 0.2 to 0.4	9biib	99.75 cm ; SD = 12.6 cm
5d	Accept -3.06 to -2.46 It represents the rate of change of mass with respect to day when d = 2.5.	10a	$1 635 033.60
5e	0.3 < d < 4.95	10b	$246 205.38
6ai	032.3°	10c	**CBCO Bank** Monthly instalment = $8316.87 > $6000 **BSOP Bank** Monthly instalment = $5962.42 < $6000Mr and Mrs Tan should sign up with BSOP Bank as the monthly instalment is less than $6000.
6aii	212.3°		
6aiii	99.0°		
6aiv	2640 km^2		
6b	12.0°		

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Name: **Register Number:** **Class:**

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION (2) 2018
SECONDARY FOUR EXPRESS

MATHEMATICS **4048/02**

PAPER 2 **10 September 2018, Monday**

2 hours 30 minutes

SUGGESTED SOLUTIONS

Setter: Mrs Sim Hwee Mung

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1 **(a)** Simplify $\frac{(2xy)^2}{35xy^7} \div \left(\frac{x^{-1}y^{-2}}{4}\right)^{-2}$, leaving your answer in positive index form. [2]

(b) Solve the inequality $\frac{1}{4}x - \frac{3}{5}\left(x + \frac{1}{3}\right) \geq \frac{1}{2}(x - 9)$. [2]

(c) **(i)** Express $\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2}$ as a single fraction in its simplest form. [4]

(ii) Hence solve the equation $\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2} = \frac{3}{x-2}$. [2]

1	**(a)**	$\frac{(2xy)^2}{35xy^7} \div \left(\frac{x^{-1}y^{-2}}{4}\right)^{-2}$ $= \frac{4x^2y^2}{35xy^7} \div \left(\frac{4}{x^{-1}y^{-2}}\right)^2$ $= \frac{4x^2y^2}{35xy^7}$ x $\frac{x^{-2}y^{-4}}{16}$ [Able to remove both brackets][M1] $= \frac{1}{140xy^9}$ [A1]	
	(b)	$\frac{1}{4}x - \frac{3}{5}\left(x + \frac{1}{3}\right) \geq \frac{1}{2}(x - 9)$ $\frac{1}{4}x - \frac{3}{5}x - \frac{1}{5} \geq \frac{1}{2}x - \frac{9}{2}$ [Able to expand all terms correctly][M1] $-\frac{17}{20}x \geq -\frac{43}{10}$ $x \leq 5\frac{1}{17}$ [A1]	
	(c)(i)	$\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2}$ $= \frac{-2}{2x-1} + \frac{3x-3}{(x-2)(2x-1)} + \frac{1}{x-2}$ [Able to factorise $2x^2 - 5x + 2$][M1] $= \frac{-2(x-2)+3(x-1)+2x-1}{(x-2)(2x-1)}$ [Able to combine into common denominator][M1] $= \frac{-2x+4+3x-3+2x-1}{(x-2)(2x-1)}$ [Able to expand correctly][M1] $= \frac{3x}{(x-2)(2x-1)}$ [A1]	
	(c)(ii)	$\frac{2}{1-2x} + \frac{3(x-1)}{2x^2-5x+2} + \frac{1}{x-2} = \frac{3}{x-2}$ $\frac{3x}{(x-2)(2x-1)} = \frac{3}{x-2}, x \neq 2$ [M1] $\frac{3x}{2x-1} = 3$ $6x - 3 = 3x$ $3x = 3$ $x = 1$ [A1]	**[10]**

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2 (a) *PQRS* is a parallelogram in which the coordinates of *P* and *Q* are $(p\,,4)$ and $(7\,,11)$ respectively. The line $9y + 27 - 7x = 0$ cuts the *y*-axis at *R* and is parallel to the line *PQ*.

Find

(i) the value of *p*, [3]

(ii) the coordinates of *S* by **vector method**. [3]

(a)(i)

$9y = 7x - 27$

$y = \frac{7}{9}x - 3$

Gradient of the line = $\frac{7}{9}$

Gradient of $PQ = \frac{7}{9}$ (parallel lines) [M1]

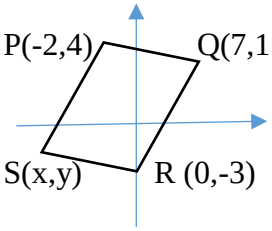
$m_{PQ} = \frac{11-4}{7-p}$

$\frac{11-4}{7-p} = \frac{7}{9}$ [M1]

$7 - p = 9$

$p = -2$ [A1] **[9]**

(a)(ii)



$\overrightarrow{OP} = \begin{pmatrix}-2\\4\end{pmatrix}, \overrightarrow{OQ} = \begin{pmatrix}7\\11\end{pmatrix},$

$\overrightarrow{OS} = \begin{pmatrix}x\\y\end{pmatrix}, \overrightarrow{OR} = \begin{pmatrix}0\\-3\end{pmatrix}$

Accept $\overrightarrow{SR} = \overrightarrow{PQ}$

By vector method, $\overrightarrow{PS} = \overrightarrow{QR}$ [Concept of equal vectors][M1]

$-\begin{pmatrix}-2\\4\end{pmatrix} + \begin{pmatrix}x\\y\end{pmatrix} = -\begin{pmatrix}7\\11\end{pmatrix} + \begin{pmatrix}0\\-3\end{pmatrix}$ [M1]

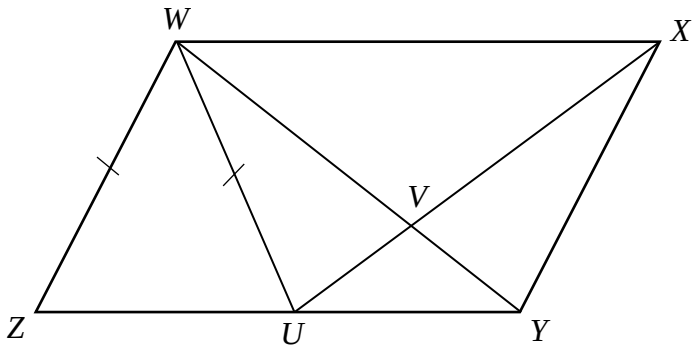
$\begin{pmatrix}x\\y\end{pmatrix} = \begin{pmatrix}-7\\-14\end{pmatrix} + \begin{pmatrix}-2\\4\end{pmatrix}$

$= \begin{pmatrix}-9\\-10\end{pmatrix}$

S = (-9, -10) [A1]

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(b) In the diagram, *WXYZ* is a parallelogram and *U* is a point on *ZY* such that *WZ* = *WU*. The lines *WY* and *UX* intersect at *V*.



Prove that ΔWUY is congruent to ΔXYU. [3]

	(b)	WZ = WU (given) = XY (opp sides of *ll*gram) UY (common length) $W\hat{U}Y = 180 - W\hat{U}Z$ (adj angles on a str. line) $X\hat{Y}U = 180 - W\hat{Z}U$ (int. angles) Since WZ = WU $\Rightarrow W\hat{Z}U = W\hat{U}Z$ Hence $W\hat{U}Y = X\hat{Y}U$ ΔWUY is congruent to ΔXYU (SAS) [A1]	Prove 2 pairs of equal sides [M1] Prove included angle [M1]	

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3 **(a)** The radius of a particular spherical cell is approximately 6.2×10^{-11} metre.

(i) 88 of these spherical cells are arranged to form a straight line such that each cell touches one another without overlapping. Calculate the length, in metre, of the straight line formed. Give your answer in standard form. [1]

(ii) Calculate the volume of a spherical cell, in cubic centimetre. Give your answer in standard form correct to 2 decimal places. [1]

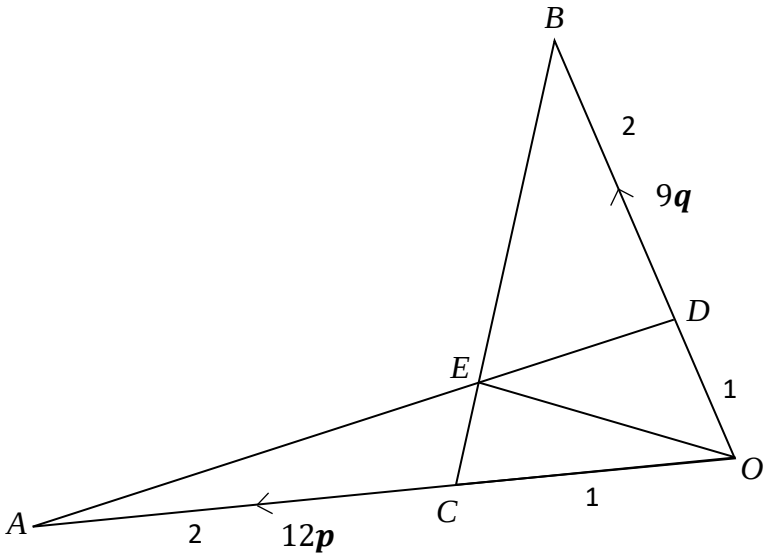
(b) The planet Mercury is approximately 77 billion metre from the Earth. Given that radio waves travel at a speed of 3×10^{8} m/s, find the time taken for radio waves to travel from the Earth to Mercury, giving your answer to the nearest minutes. [2]

(c) The word 'Googol' is defined as 1×10^{100}. If a man has ten 'Googol' cents and a Boeing 737 aircraft costs \$72 million, how many such aircrafts can he buy? Give your answer in standard form correct to 5 significant figures. [3]

	(a)(i)	Diameter = 2 x 6.2×10^{-11} Length = 88 x 2 x 6.2×10^{-11} = 1.09×10^{-8} m [B1]	
	(a)(ii)	Volume = $\frac{4}{3}\pi$ x $(6.2\times10^{-9})^3$ Note: r = 6.2×10^{-11} m = 6.2×10^{-9} cm = 9.98×10^{-25} cm^3 (2dp) [B1]	
	(b)	$t = \frac{77\times10^{9}}{3\times10^{8}}$ [M1] = $256\frac{2}{3}$ s = 4 min (nearest min) [A1]	
	(c)	ten 'Googol' cents = \$ $\frac{10 \text{ x } 1\times10^{100}}{100}$ = \$$10^{99}$ [Change to \$][M1] No of aircrafts = $\frac{10^{99}}{72\text{x}10^{6}}$ [M1] = $1.3889\,\text{x}\,10^{91}$ [A1]	**[7]**

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4 In the diagram, $\overrightarrow{OA} = 12\boldsymbol{p}$ and $\overrightarrow{OB} = 9\boldsymbol{q}$.
It is given that $3DB = 2OB$ and $OA = 3OC$.



(a) Express, as simply as possible, in terms of $\boldsymbol{p}$ and $\boldsymbol{q}$,

(i) $\overrightarrow{BC}$, [2]

(ii) $\overrightarrow{DA}$. [2]

(b) Given that $\dfrac{\text{area of triangle } ODE}{\text{area of triangle } ODA} = \dfrac{1}{4}$, find $\overrightarrow{OE}$ in terms of $\boldsymbol{p}$ and $\boldsymbol{q}$. [2]

(c) Find the value of $\dfrac{\text{area of triangle } BDE}{\text{area of quadrailateral } EDOC}$. [2]

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	(a)(i)	$\overrightarrow{BC} = \overrightarrow{BO} + \overrightarrow{OC}$ $= -9\boldsymbol{q} + \frac{1}{3}\overrightarrow{OA}$ $= -9\boldsymbol{q} + 4\boldsymbol{p}$ [B1]	
	(a)(ii)	$\overrightarrow{DA} = \overrightarrow{DO} + \overrightarrow{OA}$ $= \frac{1}{3}\overrightarrow{BO} + 12\boldsymbol{p}$ [M1] $= -3\boldsymbol{q} + 12\boldsymbol{p}$ [A1]	
	(b)	$\dfrac{\text{area of triangle } ODE}{\text{area of triangle } ODA} = \dfrac{1}{4}$ $\dfrac{0.5 \text{ x ED x h}}{0.5 \text{ x AD x h}} = \dfrac{1}{4}$ [Shared same perpendicular height][M1] $\dfrac{\text{ED}}{\text{AD}} = \dfrac{1}{4}$ $\overrightarrow{OE} = \overrightarrow{OA} + \overrightarrow{AE}$ $= 12\boldsymbol{p} + \frac{3}{4}\overrightarrow{AD}$ $= 12\boldsymbol{p} + \frac{3}{4}(3\boldsymbol{q} - 12\boldsymbol{p})$ [M1] $= 3\boldsymbol{p} + \frac{9}{4}\boldsymbol{q}$ [A1]	**[8]**

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	(c)	$\frac{\text{area of triangle } ODE}{\text{area of triangle } DEB} = \frac{OD}{DB} = \frac{1}{2}$ $\frac{\text{area of triangle } AEC}{\text{area of triangle } OEC} = \frac{AC}{OC} = \frac{2}{1}$ M1 Triangle ODE: Triangle DEB: Triangle AEC : Triangle OEC = 1 : 2 : 2 : 1 $\frac{\text{area of triangle } BDE}{\text{area of quadrailateral } EDOC}$ $= \frac{2}{2}$ = 1 [A1]	

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5 Answer the whole of this question on a sheet of graph paper.

A radioactive substance decays such that its mass, m grams, after d days is given by the equation $m = 43(3)^{-d}$.

The table below shows record of the mass, m grams of the substance, corrected to 1 decimal place, after d days.

d (days)	0	1	2	3	4	5	6
m (grams)	43	14.3	4.8	p	0.5	0.2	0.1

(a) Find the value of p. [1]

(b) Using a horizontal scale of 2 cm to represent 1 day and a vertical scale of 2 cm to represent 5 grams, draw the graph of $m = 43(3)^{-d}$ for $0 \le d \le 6$. [3]

(c) Use your graph to estimate the value of d when the mass of substance is reduced to 65% of its original mass. [1]

(d) By drawing a tangent, find the gradient of the curve at the point when $d = 2.5$.

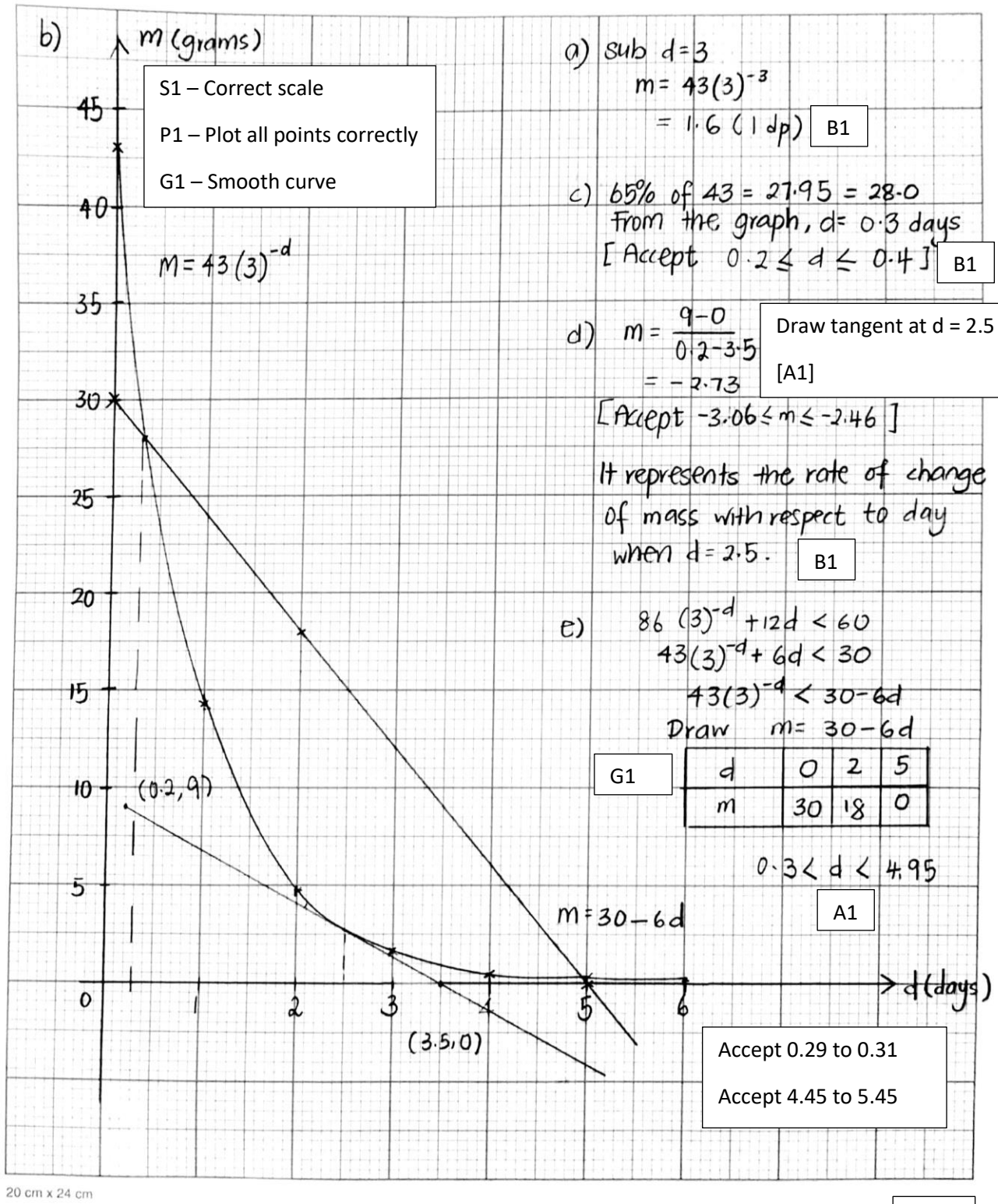
State briefly what this gradient represents. [3]

(e) Using your graph, find the range of d for $86(3)^{-d} + 12d < 60$. [2]

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Subject Question 5 Class Date



S1 – Correct scale

P1 – Plot all points correctly

G1 – Smooth curve

a) sub $d = 3$

$m = 43(3)^{-3}$

$= 1.6$ (1 dp) B1

c) 65% of 43 = 27.95 = 28.0

From the graph, $d = 0.3$ days

[Accept $0.2 \leq d \leq 0.4$] B1

d) $m = \frac{9-0}{0.2-3.5}$

$= -2.73$

[Accept $-3.06 \leq m \leq -2.46$]

Draw tangent at d = 2.5 [G1]

[A1]

It represents the rate of change of mass with respect to day when $d = 2.5$. B1

e) $86(3)^{-d} + 12d < 60$

$43(3)^{-d} + 6d < 30$

$43(3)^{-d} < 30 - 6d$

Draw $m = 30 - 6d$

G1

d	0	2	5
m	30	18	0

$0.3 < d < 4.95$ A1

Accept 0.29 to 0.31

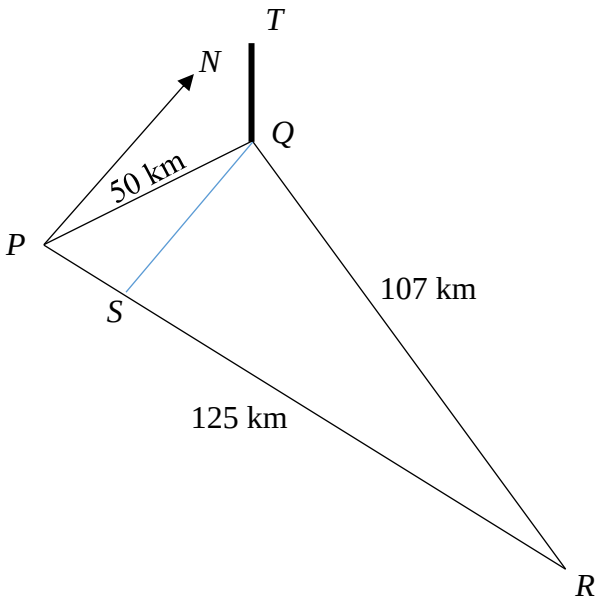
Accept 4.45 to 5.45

20 cm x 24 cm

[10]

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6 *PQR* represents a triangular plot of land on horizontal ground.
PQ = 50 km, *QR* = 107 km and *PR* = 125 km.
R is due east of *P*.



(a) Calculate

(i) the bearing of *Q* from *P*, [3]

(ii) the bearing of *P* from *Q*, [2]

(iii) the obtuse angle *PQR*, [2]

(iv) the area of the triangular plot of land *PQR*. [2]

(b) A vertical pole of height 9 km is erected at *Q*. Calculate the greatest angle of elevation of the top of the pole from a point *S* along *PR*. [3]

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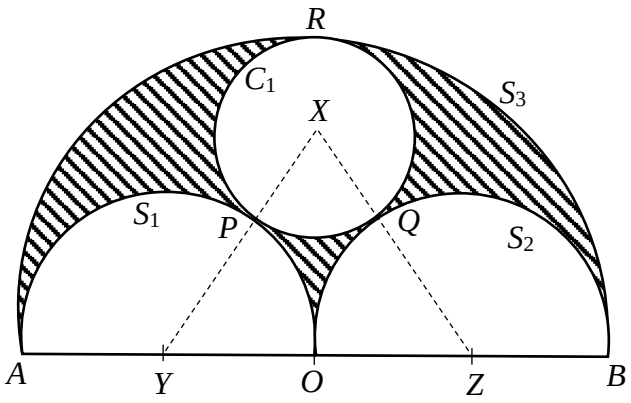
(a)(i)	$\cos \mathrm{Q}\hat{P}R = \frac{125^2+50^2-107^2}{(2)(125)(50)}$ [M1] $\mathrm{Q}\hat{P}R = 57.718$ Bearing of Q from P $= 90 - 57.718$ [M1] $=032.3°$ (1dp) [A1]	
(a)(ii)	Bearing of P from Q $=360 - (180 - 32.282)$ [M1] $=212.3°$(1dp) [A1]	
(a)(iii)	$\frac{\sin P\hat{Q}R}{125} = \frac{\sin 57.718}{107}$ [M1] $\mathrm{P}\hat{Q}R = 80.987° \ (rejected)$ *or* $\mathrm{P}\hat{Q}R = 99.013°$ obtuse $\mathrm{P}\hat{Q}R = 99.0°$ [A1] or $\cos \mathrm{P}\hat{Q}R = \frac{107^2+50^2-125^2}{(2)(107)(50)}$ [M1] obtuse $\mathrm{P}\hat{Q}R = 99.0°$ [A1]	**[12]**

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(a)(iv)	Area of the triangular plot of land *PQR* $=\frac{1}{2}(125)(50)\sin 57.718$ [M1] = 2640 km^2 [A1]	
(b)	In triangle PQS, $\sin 57.718 = \frac{d}{50}$ [M1] d = 42.271 In triangle PQT, $\tan e = \frac{9}{42.271}$ [M1] $e = 12.0°$ [A1]	

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7 In the diagram, the circle C_1 with centre X has a radius $(3r + 1)$ cm, where r is a constant. Two identical semicircles, S_1 and S_2 with centre at Y and Z respectively, have a radius $(13 - 6r)$ cm.
Another semicircle, S_3 with centre O has a diameter AB.
C_1 touches S_1 and S_2 at P and Q respectively while S_1 and S_2 touches one another at O.
S_3 touches C_1, S_1 and S_2 at R, A and B respectively.
$AYOZB$ is a straight line.



(a) Write down an expression, in its simplest form and in terms of r, for
(i) XZ, [1]
(ii) XO. [2]

(b) Hence, form an equation in terms of r and show that it reduces to $126r^2 - 411r + 299 = 0$. [3]

(c) Solve the equation $126r^2 - 411r + 299 = 0$. [2]

(d) Hence, find the area of the shaded region. [3]

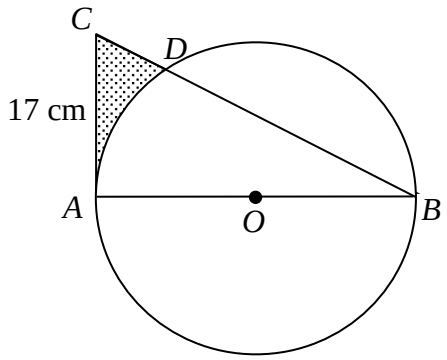
(a)(i)	XZ = XQ + QZ = 3r + 1 + 13 – 6r = 14 – 3r [B1]	
(a)(ii)	XO = 2 (13 – 6r) – (3r + 1) [M1] = 25 – 15r [A1]	
(b)	$XZ^2 = XO^2 + OZ^2$ $(14 - 3r)^2 = (25 - 15r)^2 + (13 - 6r)^2$ [M1] $196 - 84r + 9r^2 = 625 - 750r + 225r^2 + 169 - 156r + 36r^2$ [M1] $252r^2 - 822r + 598 = 0$ [A1] $126r^2 - 411r + 299 = 0$ (shown)	
(c)	$r = \frac{411 \pm \sqrt{(-411)^2 - 4(126)(299)}}{2(126)}$ [M1] $= 2\frac{1}{6}$ or $1\frac{2}{21}$ [A1]	
(d)	If r = $2\frac{1}{6}$, then XO < 0. Hence r = $1\frac{2}{21}$	**[11]**

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	Area of the shaded region $=\frac{1}{2}\pi(26-12\left(1\frac{2}{21}\right))^2-\pi\left(3\left(1\frac{2}{21}\right)+1\right)^2-\pi(13-6\left(1\frac{2}{21}\right))^2$ [M1- Area of S3][M1 – correct unshaded area] $=72.1\ cm^2$ [A1]	

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8 **(a)** The diagram shows a circle with centre O and radius of 12 cm. AB is the diameter of the circle and AC is a tangent to the circle at A with AC = 17 cm. The circle intersects the line BC at D.



(i) Show that angle $DOA = 1.23$ radians. [2]

Calculate

(ii) the length of minor arc AD, [1]

(iii) the area of the shaded region. [3]

(b) Diagram I shows an open container which is made up of a cylinder and a cone. The cylinder has radius r cm and height 30 cm.
The cone has base radius r cm and slant height l cm.
The container is fully filled with water.

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Diagram II shows a spherical object in which half of it is immersed into the container and some water is displaced. The radius of the sphere is the same as the radius of the cylinder. Assume the thickness of the container and the spherical object are negligible.

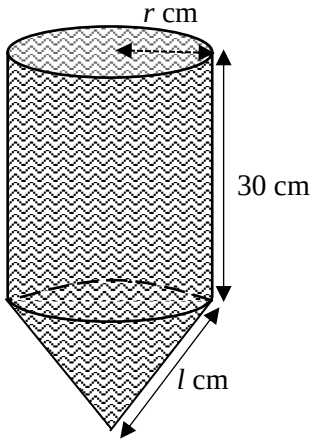


Diagram I

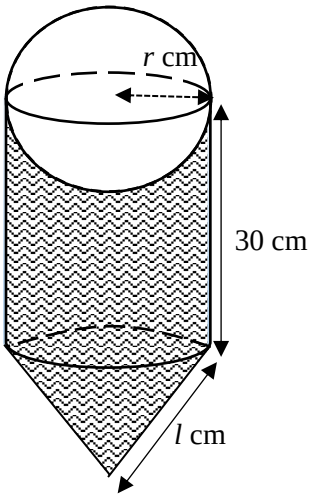


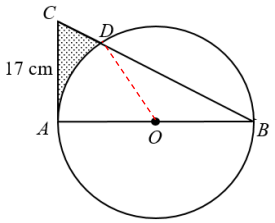
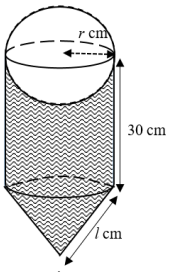
Diagram II

Given that the volume of the water displaced is 1152π cm^3 and the volume of the water left in the container is 3600π cm^3, find

(i) the value of r and of l, [4]

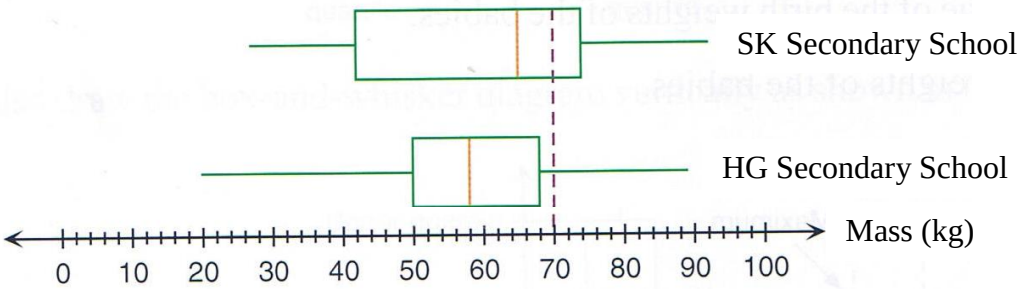
(ii) the total internal area of the container and the sphere that is in contact with water, leaving your answer in terms of π. [2]

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	(a)(i)	 In triangle CAB, $\tan C\hat{B}A = \frac{17}{24}$ [M1] $C\hat{B}A = 0.61630\ rad$ $D\hat{O}A = 2 \times 0.61630$ (angle at centre = 2× angle at circumference) = 1.2326 = 1.23 rad (shown) [A1]	
	(a)(ii)	length of minor arc *AD* = 12 (1.2326) = 14.8 cm [B1]	
	(a)(iii)	Area of the shaded region (Join OD) $=\frac{1}{2}(17)(24) - \frac{1}{2}(12)^2(1.2326) - \frac{1}{2}(12)^2\sin(\pi - 1.2326)$ [M1-Sector area][M1-area of triangle] = 204 – 88.747 – 67.922 = 47.3 cm^3 [A1]	
	(b)(i)	Vol of water displaced = 1152π $\frac{1}{2} \times \frac{4}{3}\pi(r)^3 = 1152\pi$ [M1] $r^3 = 1728$ r = 12 cm [A1] Total volume $=1152\pi + 3600\pi$ $=4752\pi$ $\pi(12)^2(30) + \frac{1}{3}\pi(12)^2 h = 4752\pi$ [M1] 48 h = 432 h = 9 cm By Pythagoras' Theorem, $l^2 = 9^2 + 12^2$ $l = 15\ cm$ [A1]	
	(b)(ii)	Internal area $=\pi(12)(15) + 2\pi(12)(30) + 2\pi(12^2)$ [M1] = 1188π cm^2 [A1]	**[12]**

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9 **(a)** The following box-and-whisker diagrams show the distribution of the mass of 300 students from each school, SK Secondary School and HG Secondary School respectively.



(i) What is the median mass for each school? [1]

(ii) Compare the mass of the students from SK Secondary School and HG Secondary School in two ways. [2]

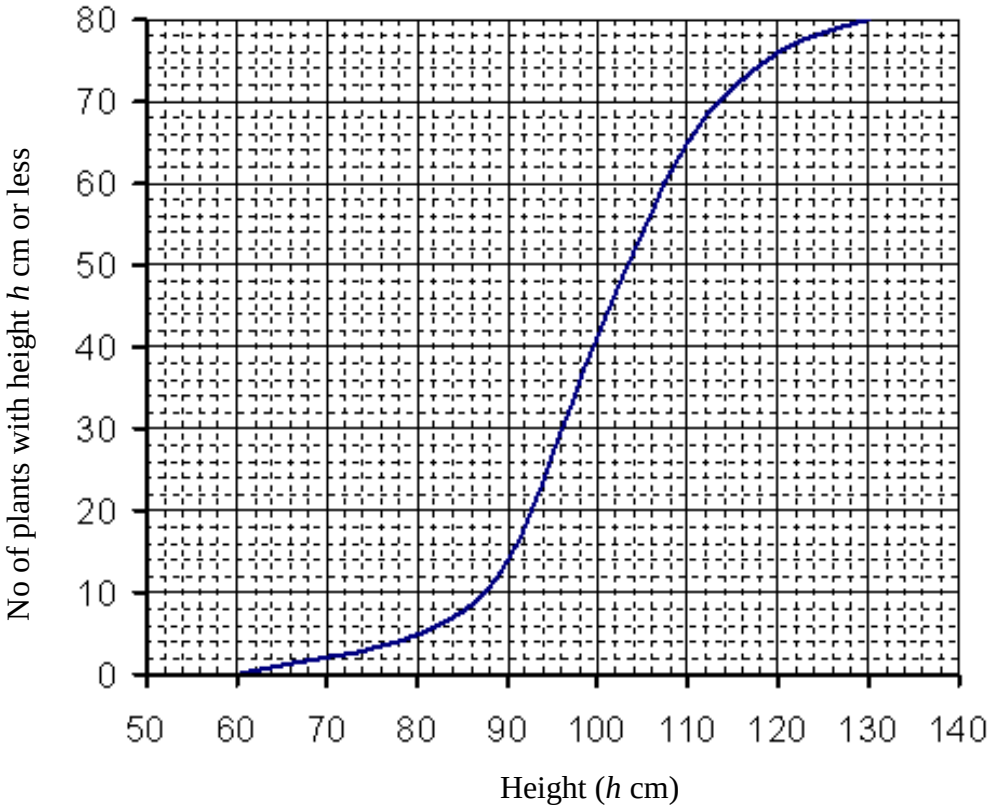
(iii) Mary commented that there are more students in HG Secondary School than SK Secondary School who weigh more than or equal to 70 kg.
Do you agree with Mary? Support with a reason. [1]

	(i)	For SK Sec, median = 65 kg For HG Sec, median = 58 kg Both correct [B1]	
	(ii)	Generally, the students for SK Sec Sch are heavier compared to the students in HG Sec Sch because of the higher median. [B1] For SK, IQR= 32 kg; For HG, IQR = 18 kg The mass of the students in HG Sec Sch is more consistent than that of SK Sec Sch because of smaller interquartile range. [B1]	
	(iii)	Disagree as there are more than 25% of the students from SK Sec Sch weigh more than 70 kg while there are less than 25% of the students fron HG Sec Sch weigh more than 70 kg. [B1] Accept: There are more students in SK Sec Sch weigh more than 70 kg because it has a higher upper quartile than HG Sec Sch.	**[4]**

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(b) The cumulative frequency curve shows the height distribution of 80 plants.



(i) Use the graph to find

(a) the value of m, if 32.5% of the plants have heights more than m cm, [2]

(b) the probability that two plants chosen will each has a height of more than 118 cm. [2]

(ii) **(a)** The height distribution of the 80 plants was also recorded in the following frequency table. Find the value of a and of b.

Height (h cm)	**Number of plants**
$60 < h \leq 70$	2
$70 < h \leq 80$	a
$80 < h \leq 90$	9
$90 < h \leq 100$	27
$100 < h \leq 110$	23
$110 < h \leq 120$	b
$120 < h \leq 130$	4

[1]

(b) Hence find the mean and the standard deviation of the height of the 80 plants. [2]

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		(bi)	**(a)**	No of plants less than or equal to m cm = 67.5% of 80 = 54 plants [B1] m = 105 [A1]	
		(bi)	**(b)**	$\frac{6}{80} \times \frac{5}{79}$ [M1] $= \frac{3}{632}$ [A1]	
		(bii)	**(a)**	a = 3, b = 12 Both correct [B1]	
		(bii)	**(b)**	Mean = 99.75 cm [B1] Standard deviation = 12.6 cm [B1]	**[7]**

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10 Mr and Mrs Tan bought a 3-bedroom unit at a newly launched condominium project at Serangoon. The unit has a floor area of 1152 square foot (sqft). The selling price for the unit is at $1494 per sqft. The developer gives a 5% early bird discount to all buyers.

(a) Calculate the price that they paid for the unit. [1]

Mr and Mrs Tan are both Singapore citizens and they also owned a HDB 5-room flat and they do not have any intention of selling their flat. As such, they will have to pay Additional Buyer's Stamp Duty (ABSD) to the government on top of the Buyer's Stamp Duty (BSD). Table 1 shows the BSD rate and Table 2 shows the ABSD rate.

Table 1. BSD

Based on purchase price	**Rate**
First $180 000	1%
Next $180 000	2%
Next $640 000	3%
Remaining amount	4%

Table 2. ABSD

Based on purchase price	**Rate**
SC^1 buying first residential property	NA
SC^1 buying second residential property	12%
SC^1 buying third and subsequent residential property	15%

SC^1 denotes Singapore Citizens

(b) Calculate the **total** Buyer's Stamp Duty paid by Mr and Mrs Tan. [4]

Mr and Mrs Tan made a 20% down-payment based on the amount paid for the unit obtained in **(a)**. For the remaining amount, which exclude the total Buyer's Stamp Duty, they had decided to sign up either for a 20-years Home Loan plan from CBCO Bank or a 30-years Home Loan plan from BSOP Bank.

(c) Determine which bank they should sign up if they can only afford a monthly instalment of not more than $6000.
Support you answer with appropriate workings. [5]

Simple Interest Rate for CBCO Bank

Loan period: 20 years

1st year:	2nd Year:
2.18% p.a.	2.18% p.a.
Thereafter: 2.68% p.a.	

Simple Interest Rate for BSOP Bank

Loan period: 30 years

1st year:	2nd Year:
1.95% p.a.	1.95% p.a.
Thereafter: 2.15% p.a.	

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	(a)	Amount paid =1152 x 1494 x 0.95 = $1 635 033.60 [B1]	
	(b)	BSD paid = 0.01 x 180 000 + 0.02 x 180 000 + 0.03 x 640 000 + 0.04 x 635 033.60 [M1 – First 1 mil][M1 – remaining amount] = 50 001.344 ABSD paid = 0.12 x 1 635 033.60 [M1] = 196 204.032 Total stamp duty = 50 001.344 + 196 204.032 = $246 205.38 [A1]	
	(c)	Loan amount = 0.8 x 1 635 033.60 [M1] = $1 308 026.88 **<u>CBCO Bank</u>** Interest = 2.18% x 2 x 1308026.88 + 2.68% x 18 x 1308026.88 [M1] = 688 022.1389 Monthly instalment = (688 022.1389 + 1 308 026.88)÷(20 x 12) [M1 for either of the monthly instalments] = $8316.87 > $6000 **<u>BSOP Bank</u>** Interest = 1.95% x 2 x 1308026.88 + 2.15% x 28 x 1308026.88 [M1] = 838 445.2301 Monthly instalment = (838 445.2301+ 1 308 026.88)÷(30 x 12) = $5962.42 < $6000 Mr and Mrs Tan should sign up with BSOP Bank as the monthly instalment is less than $6000. [A1]	[10]

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