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**YISHUN SECONDARY SCHOOL  
PRELIMINARY EXAMINATION 2023  
SECONDARY 4 EXPRESS**

CANDIDATE  
NAME

CLASS

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**MATHEMATICS**

Paper 1

**4052/01**

**21 August 2023**

**2 hours 15 minutes**

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your class, index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For  $\pi$ , 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 of the marks for this paper is 90.

For examiner's use

**90**

[Turn over

---

This document consists of 21 printed pages and 1 blank page.

### *Mathematical Formulae*

#### *Compound Interest*

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

#### *Mensuration*

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

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

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

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

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

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

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

#### *Trigonometry*

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

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

#### *Statistics*

3

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

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

Answer **all** questions

- 1 Calculate  $121 - \sqrt{\frac{98}{0.61}} - 80$ .  
Write your answer correct to 4 significant figures.

$$\begin{aligned} & 121 - \sqrt{\frac{98}{0.61}} - 80 \\ & = 112.019 \\ & = 112.0(4\text{sf}) \quad \text{----- B1} \end{aligned}$$

Answer ..... [1]

- 2 The estimated population of Taiwan is 23.6 million.  
The estimated total land area is  $3.62 \times 10^4 \text{ km}^2$ .  
Calculate the average number of people per square kilometre of land area in Taiwan, giving your answers in standard form.

$$\begin{aligned} & \frac{23.6 \times 10^6}{3.62 \times 10^4} \quad \text{----- B1 convert million} \\ & = 651.933 \\ & = 6.52 \times 10^2 \quad \text{----- A1} \end{aligned}$$

Answer ..... [2]

- 3 When 540 is divided by  $m$ , a perfect square is formed.  
Find the smallest value of  $m$ , where  $m$  is an integer.

**[Turn over**

4

Answer  $m = \dots\dots\dots$  [2]

4 The scale of a map is 4 cm : 28 km.

(a) Find the length of a canal that is represented by 10 cm on the map.

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

(b) A lake is represented by an area of  $400 \text{ cm}^2$  on the map.  
Calculate the actual area of the lake in square kilometres.

Answer  $\dots\dots\dots \text{ km}^2$  [2]

5 (a) Express  $22 + 10x + x^2$  in the form of  $p + (q + x)^2$ .

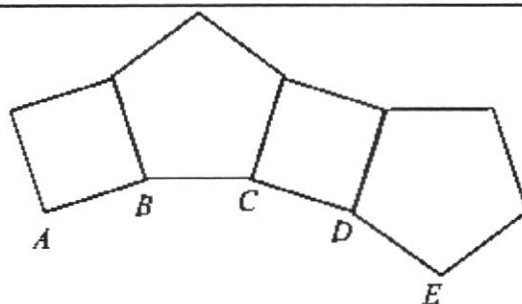
Answer ..... [2]

- (b) Write down the equation of line of symmetry for  $y = 22 + 10x + x^2$ .

Answer ..... [1]

---

6



A regular pentagon is joined to a square repeatedly until it forms a regular polygon.  
 $AB$ ,  $BC$ ,  $CD$  and  $DE$  are edges of the regular polygon.

Find the number of sides in this regular polygon.

[Turn over

6

Answer ..... [3]

- 7  $r$  is directly proportional to  $t^3$ .  
When  $t$  is decreased by 25%, find the percentage change in  $r$ .

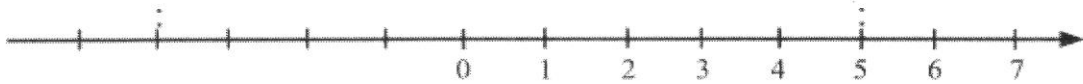
Answer ..... [2]

- 8 Sketch the graph of  $y = -(x+2)(x-3)$  on the axes below.  
Indicate clearly the values where the graph crosses the  $x$ - and  $y$ - axes and its turning point.

[2]

7

- 9 The solution of the inequality  $-2 \leq \frac{4-2x}{3} \leq 2k+5$ , where  $k$  is a constant, is represented on the number line below. Find the value of  $k$ .



Answer  $k = \dots\dots\dots$  [4]

- 10 Zac has written down five numbers.  
The mean of these numbers is 5.2, the median is 4 and the mode is 2.  
The largest number is five times the smallest number.

Find the five numbers.

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

[Turn over]

11 (a) Simplify  $\left(\frac{2x^3}{\sqrt{x^4}}\right)^{-3}$ .

Answer ..... [2]

(b) Solve  $\frac{3^{x+1}}{27^x} = 1$ .

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

---

12 Object  $A$  and object  $B$  are geometrically similar.

The ratio of the base area of object  $A$  to the base area of object  $B$  is  $4:9$ .

Find the ratio of the volume of object  $A$  to volume of object  $B$ .

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

13  $n$  is a positive integer.

Show that, for all  $n$ ,  $(2n+3)^2 - (2n-3)^2$  is not a prime number.

Answer

$$\begin{aligned}(2n+3)^2 - (2n-3)^2 &= 4n^2 + 12n + 9 - (4n^2 - 12n + 9) \\ &= 24n\end{aligned}$$

---- M1 quadratic expansion

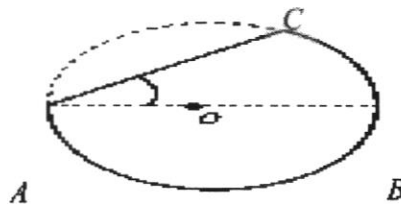
A prime number can only be divided by 1 or itself.

Since 24 is not prime,  $(2n+3)^2 - (2n-3)^2$  can be divided by all factors of 24, making it not prime.

A1 – Explanation based on definition of prime numbers.

[2]

14



The diagram shows a major segment  $ABC$  of a circle with centre  $O$  and radius 5 cm.

Angle  $OAC = \frac{\pi}{6}$ .

[Turn over]

10

Find the area of the major segment  $ABC$ .

Answer .....cm<sup>2</sup> [3]

---

15 (a) Factorise completely  $12pq - 3p + q - 4q^2$ .

Answer ..... [2]

(b) Simplify  $\frac{3x^2 + 15x - 42}{x^2 - 4}$ .

Answer ..... [3]

- 16** The volume of a cone with radius  $x$  and height  $y$  is twice the volume of a hemisphere with radius  $x$ .

$\frac{1}{27}$  of the cone is filled with water.

This water is poured into the hemisphere.

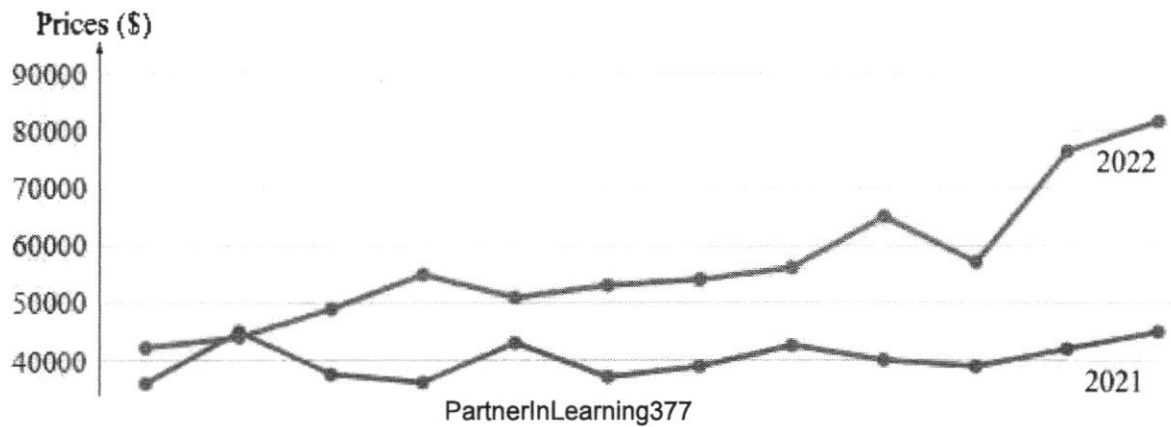
Find the fraction of the hemisphere that is filled with water.

[Turn over

Answer ..... [4]

- 17 The graph shows information about prices of the Certificate of Entitlement (COE) for buses for each month in year 2021 and 2022.

COE is a license for owning a vehicle in Singapore.



- (a) Estimate the price of COE in July 2022.

Answer \$..... [1]

- (b) A school bus company claims that the cost of buying new buses has increased and intends to increase the prices of the services they provide for the year 2023.

What feature of the graph can the company use to justify the company's claim?

Answer

[1]

- (c) Make one comparison between the mean COE prices in 2021 and 2022. Justify your answer with references to the graph.

Answer

[2]

- 
- 18 (a) The cash price of a TV is \$2100.  
Ben buys this TV on hire purchase.  
He pays a deposit of one fifth of the cash price.  
He then makes 12 monthly payments of \$160.

Find the total amount that Ben pays for the TV.

Answer \$..... [2]

[Turn over

14

- (b) Alicia invested a sum of money in an account paying compound interest at 3% per annum. After 5 years, she earned a total interest of \$3981.

Calculate the sum of money Alicia invested in the account.  
Give your answer to the nearest dollar.

Answer \$..... [3]

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

72       $p$        $q$       57       $r$

- (a) Find the values of  $p$ ,  $q$  and  $r$ .

Answer  $p =$  .....

$q =$  .....

$r =$  .....[2]

15

- (b) Write down an expression for the  $n$ th term of this sequence.

*Answer* ..... [2]

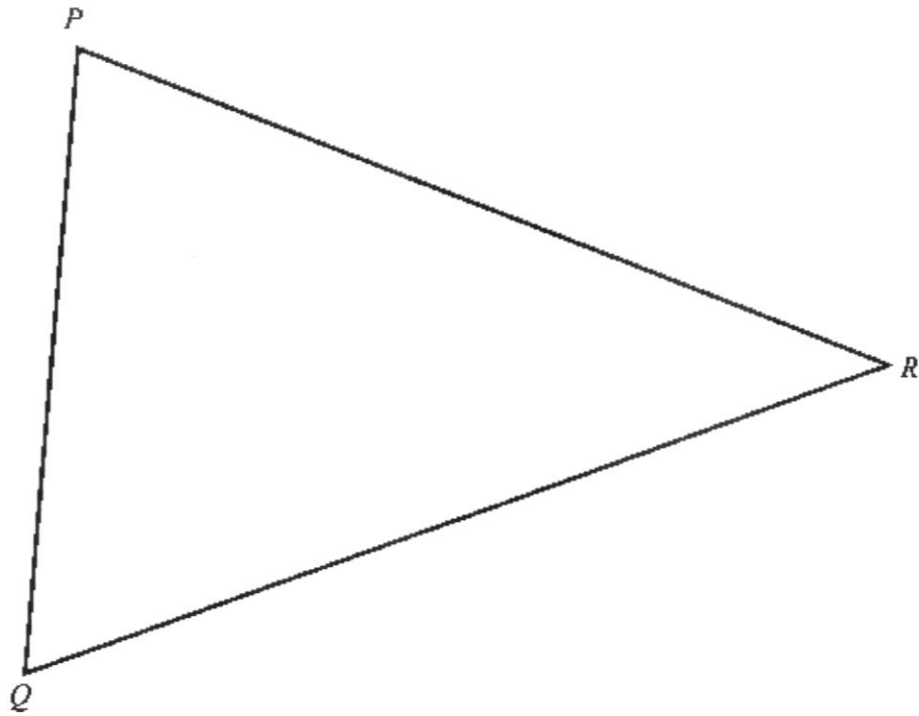
- (c) Explain why  $-100$  is not a term of this sequence.

[2]

---

[Turn over

- 20 The diagram shows a triangle  $PQR$ .



- (a) Construct the perpendicular bisector of  $QR$ . [1]
- (b) Construct the bisector of angle  $PRQ$ . [1]
- (c) Point  $B$  is equidistant from  $Q$  and  $R$  and equidistant from  $PR$  and  $RQ$ . Mark the point  $B$  on the diagram and measure the length  $BP$ .

Answer  $BP = \dots\dots\dots$  cm [1]

21  $\xi = \{\text{integers } x : 2 \leq x < 16\}$

$A = \{\text{multiples of 3}\}$

$B = \{\text{factors of 20}\}$

- (a) (i) List all the elements in  $A'$ .

Answer ..... [1]

- (ii) List all the elements in  $A \cap B$ .

Answer ..... [1]

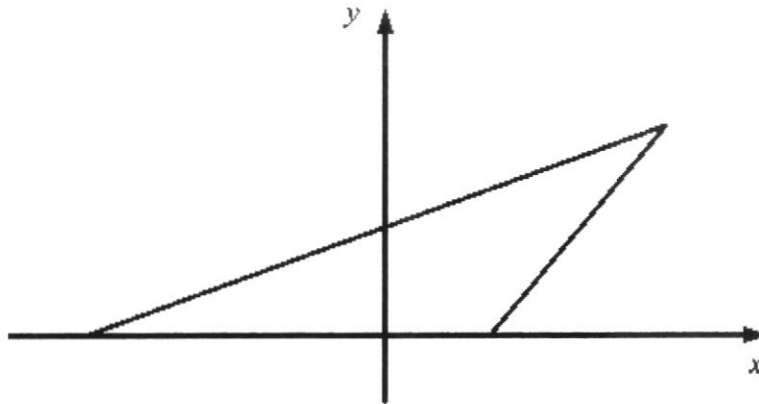
- (iii) Find the value of  $n(A \cup B)'$ .

Answer ..... [1]

- (b) On the Venn diagram, shade the region which represents  $(P' \cup Q) \cap Q'$ .

[Turn over

- 22 The diagram show triangle  $QRM$  with coordinates  $Q(-12, 0)$ ,  $R(4, 0)$  and  $M(8, 10)$ .  
 $P$  is a point on the  $y$ -axis.



- (a) Find length  $QM$ .

Answer .....units [2]

- (b) Find the coordinates of  $P$ .

Answer ( ..... , ..... ) [2]

- (c)  $S$  is a point such that it forms a parallelogram  $QRMS$ .  
 Find the area of  $QRMS$ .

Answer .....units<sup>2</sup> [1]

- 23 A shop sells two different flavours of waffles, coconut (C) and peanut (P).

In a morning, an average of 10 coconut and 8 peanut waffles were sold.

In an afternoon, an average of 21 coconut and 15 peanut waffles were sold.

In an evening, an average of 7 coconut and 14 peanut waffles were sold.

- (a) Represent this information in a  $3 \times 2$  matrix, **S**.

$$\text{Answer } \mathbf{S} = \begin{matrix} & \begin{matrix} \text{C} & \text{P} \end{matrix} \\ \begin{pmatrix} & & \end{pmatrix} & \begin{matrix} \text{morning} \\ \text{afternoon} \\ \text{evening} \end{matrix} \end{matrix} \quad [1]$$

The price of one coconut waffle and one peanut waffle is \$2.10 and \$2.70 respectively.

- (b) Find the matrix  $\mathbf{T} = 7\mathbf{S} \begin{pmatrix} 2.10 \\ 2.70 \end{pmatrix}$ .

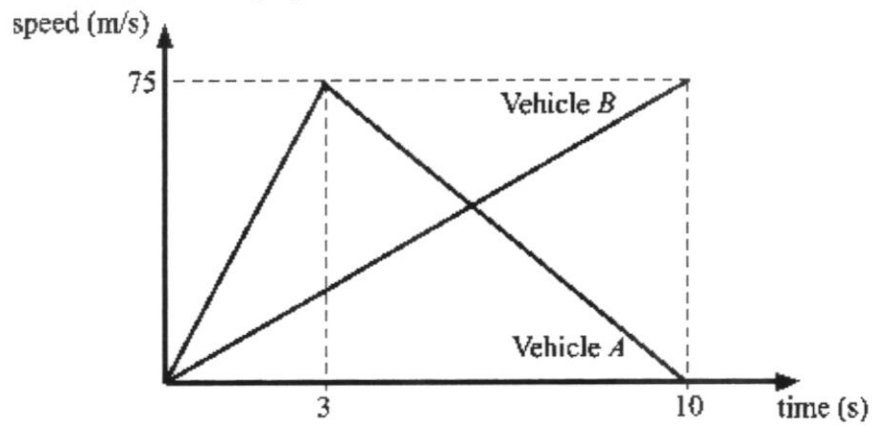
Answer  $\mathbf{T} =$  [2]

- (c) State what the elements of  $\mathbf{T}$  represents.

[Turn over

[1]

- 24 The diagram shows the speed-time graph of vehicle *A* and vehicle *B*.



- (a) Find the deceleration of vehicle *A*.

Answer .....m/s<sup>2</sup> [1]

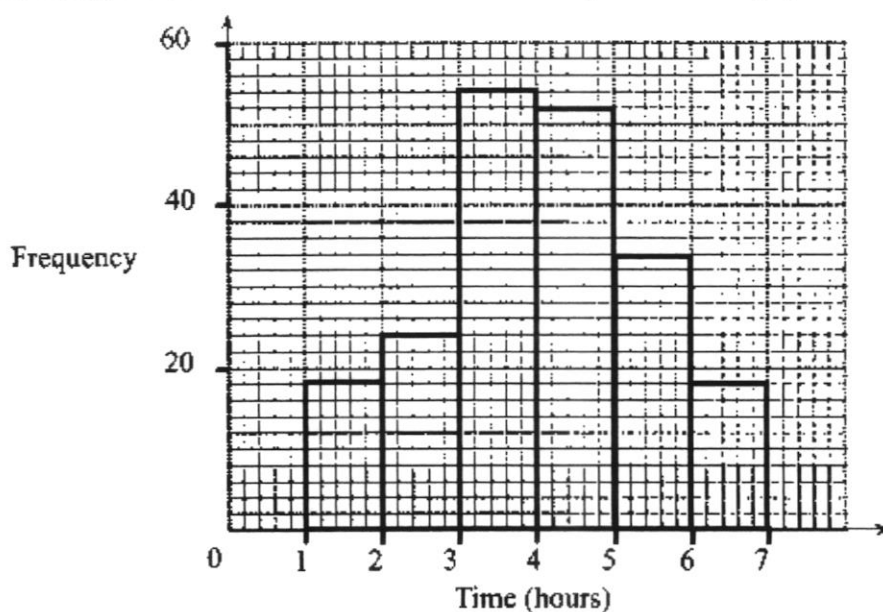
- (b) Both vehicles travel the same distance at the end of 10 seconds.  
Determine if this statement is true.

[2]

- (c) Draw the distance-time graph for vehicle *A* from 0 to 10 seconds.  
Distance (m)

[2]

- 25 (a) The histogram shows the distribution of the time spent exercising by 200 students from Jurong.



- (i) Which interval contains the median?

Answer ..... hours [1]

- (ii) Calculate an estimate of the mean.

Answer ..... hours [1]

- (iii) Calculate an estimate of the standard deviation.

Answer ..... hours [1]

- (iv) Explain why the mean and the standard deviation is just an estimate.

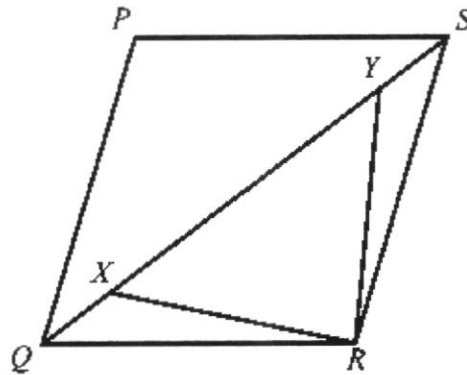
[1]

[Turn over

- (b) The standard deviation of the time spent exercising by a group of 200 students from Yishun is 2.21. Make a comparison between the distribution of the two groups of students.

[1]

26



$PQRS$  is a rhombus.

$X$  and  $Y$  are points on  $QS$  such that  $QX = SY$ .

Show that triangle  $RXY$  is an isosceles triangle.

[3]

- (b) Explain why it is not possible to draw a circle that passes through  $P$ ,  $Q$ ,  $R$  and  $S$ .

If a circle passes through all the points  $P$ ,  $Q$ ,  $R$  and  $S$ , by angles in the opposite segment,  
 $\text{angle } QPS + \text{angle } QRS = 180$ .

23

**BLANK PAGE**

[2]

**[Turn over**



# YISHUN SECONDARY SCHOOL

## PRELIMINARY EXAMINATION 2023

### SECONDARY 4 EXPRESS

CANDIDATE  
NAME

CLASS

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## MATHEMATICS

Paper 2

**4052/02**

**23 August 2023**

**2 hours 30 minutes**

Candidates answer on the Question Paper.

### READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.

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Omission of essential working will result in loss of marks.

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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 of the marks for this paper is 90.

For examiner's use

**90**

[Turn over

---

This document consists of **22** printed pages.

### ***Mathematical Formulae***

#### *Compound Interest*

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

#### *Mensuration*

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

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

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

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

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

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

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

#### *Trigonometry*

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

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

#### *Statistics*

3

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

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

- 1 (a) It is given that  $b = \frac{c+b}{3b-c}$ ,  
 (i) find the value of  $b$  when  $c = 2b$ ,

Answer ..... [3]

(b) Solve  $\frac{x+1}{(3-x)^2} - \frac{4}{x-3} = 1$ .

[Turn over]

*Answer* ..... [3]

- (c) A teacher wanted to give her 40 students a burger each. The cost of a chicken burger is \$2 and the cost of a fish burger is \$2.50. She spent a total of \$95 for  $x$  chicken burgers and  $y$  fish burgers. Use algebraic method to find the number of fish burgers that she ordered.

*Answer* ..... [3]

- 2 (a) John spends 1.5 hours at a sports centre. The ratio of the times he spends changing, warming up and running is 2 : 3 : 7. Calculate
- (i) the time he spends to change.

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

- (ii) the percentage of time he spends running at the sports centre.

(iii)

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

[Turn over

- (b) In 2021, John's fastest time for a 10 km run was 54 minutes 30 seconds.  
In 2022, he went to Thailand to take part in a 10 km competition.  
His time taken was 6% less than his fastest time in 2021.  
Calculate, in minutes and seconds, his best time in 2022.

*Answer* .....minutes.....seconds [2]

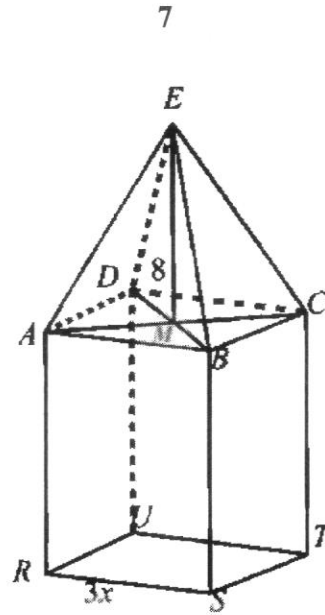
- (c) John saw a pair of branded running shoe which cost 17 430 Baht.  
The same pair costs 500 US Dollars (USD) in the United States.  
To buy these shoes, John will pay using his Singapore credit card and will be charged a fee of 1.7% fee for currency conversion.

The exchange rate between Singapore dollars (\$) and USD is  $\$1 = \text{USD } 0.74$  and  
between Thai Baht and Singapore Dollar is  $1 \text{ Baht} = 0.039 \text{ Singapore Dollars}$ .

Show, with clear working, if John should buy the pair of running shoes in Thailand  
or the United States.

[3]

3



The diagram shows a solid consisting of a cuboid attached to a pyramid.

The pyramid has a square base of length  $3x$  cm and a vertical height of 8 cm.

The height of the cuboid is twice the length of one side of its square base.

- (a) Form an equation, in terms of  $x$ , to represent this information and show that it simplifies to

$$9x^2 + 4x - 100 = 0$$

[3]

- (b) Solve the equation  $9x^2 + 4x - 100 = 0$ , giving your answers to 3 decimal places.

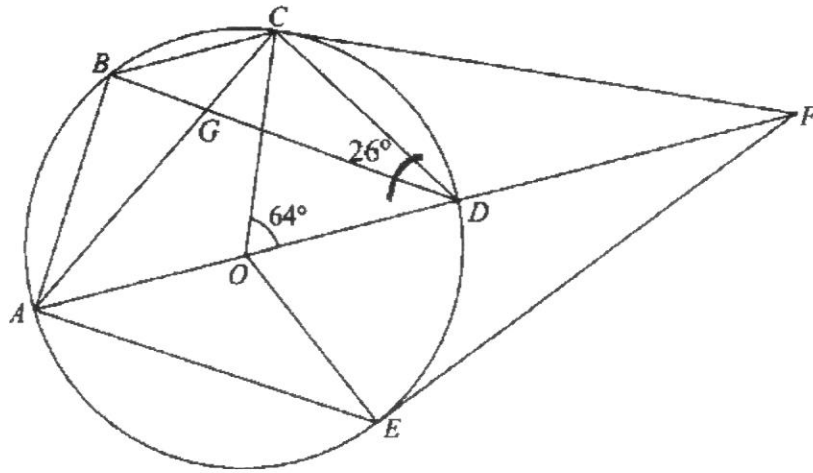
[Turn over]

*Answer*  $x = \dots\dots\dots$  or  $\dots\dots\dots$  [4]

- (c) Hence, calculate the slant length of the pyramid.

*Answer*  $\dots\dots\dots$  cm [3]

4



The diagram shows a circle  $ABCDE$  with centre at  $O$ .  
 $CF$  and  $EF$  are tangents to the circle at points  $C$  and  $E$  respectively.  
 Angle  $COD = 64^\circ$  and  $BDC = 26^\circ$ . [3]

- (a) Find  
 (i) angle  $CAD$ ,

- (ii) angle  $OFE$ ,

Answer ..... $^\circ$  [2]

- (iii) angle  $DCF$ .

[Turn over

Answer .....° [2]

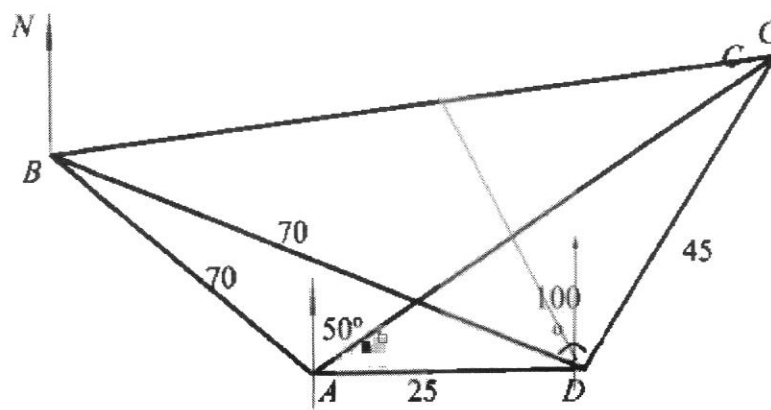
- (b) Show that triangle  $BGC$  is similar to triangle  $AGD$ .  
Give a reason for each statement you make.

- (c) Show with clear working and reasons, that  $ABCD$  is a trapezium.

[3]

[Turn over

- 5  $A, B, C$  and  $D$  are four points on level ground.  
 $A$  is due west of  $D$  and the bearing of  $C$  from  $A$  is  $050^\circ$ .  
 $AD = 25$  m,  $DC = 45$  m,  $DB = 70$  m and angle  $BDC = 100^\circ$ .



- (a) Show that  $BC = 89.5$  m, correct to 3 significant figures.

Answer ..... [2]

- (b) Calculate angle  $ACD$ .

Answer .....  $^\circ$  [2]

- (c) Calculate the bearing of  $D$  from  $C$ .

Answer ..... ° [2]

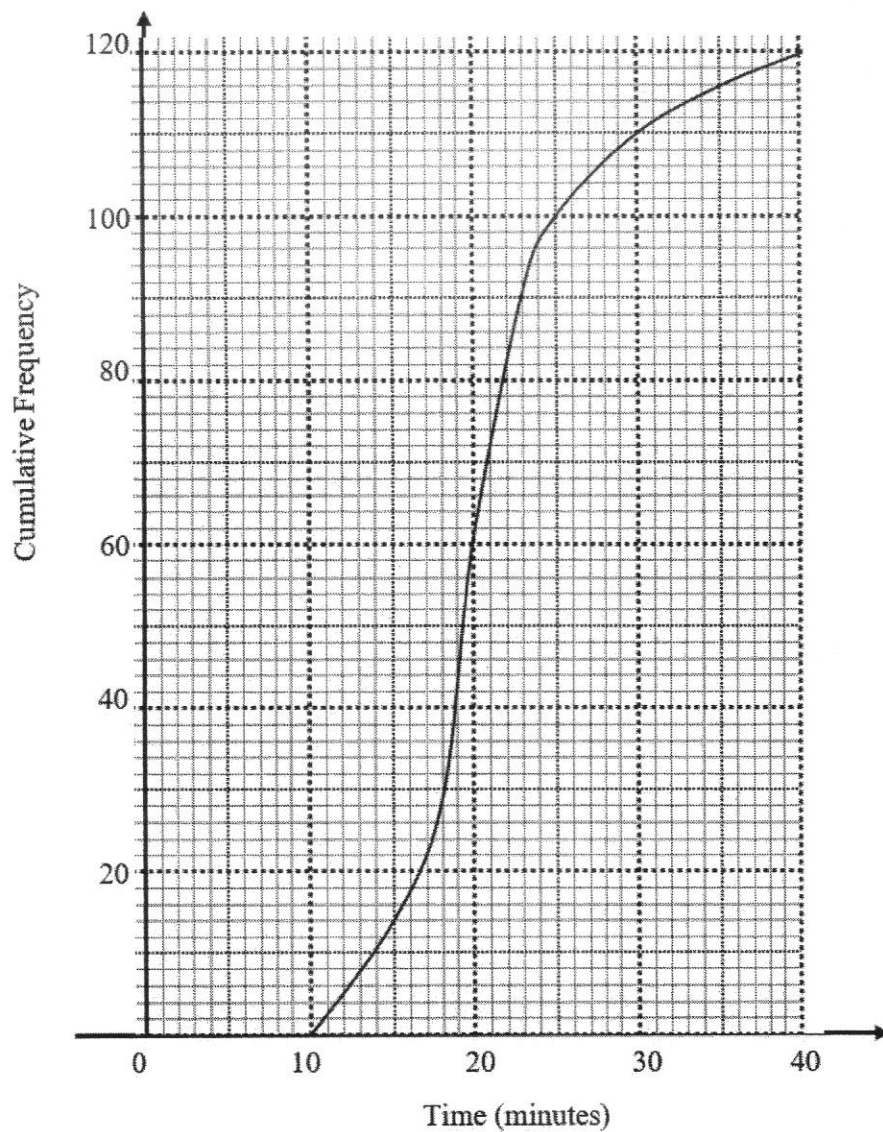
- (d)  $T$  is a point 53 m vertically above  $D$ .  
 A car travels along a straight path from  $B$  to  $C$  until it reaches a point  $E$  where the angle of elevation of  $T$  from  $E$  is the greatest.  
 Calculate this greatest angle of elevation.

|    |                                                                                                                                                                                                                                                                |                                                                                                                                                                                       |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 5c | $\frac{1}{2}(BC)(DE) = \frac{1}{2}(DC)(BD)\sin CDB$ $\frac{1}{2}(89.5487)(DE) = \frac{1}{2}(45)(70)\sin 100$ $DE = [(45)(70)\sin 100] \div 89.5487$ $DE = 34.64196$<br>$\tan x = \frac{53}{34.64196}$ $x = \tan^{-1}(1.52994)$ $= 56.830^\circ$ $= 56.8^\circ$ | <p>M1 find DE using area of triangle BDC or <math>\frac{1}{2} \times 89.5 \times \text{ht seen}</math></p> <p>A1</p> <p>M1 <b>correct angle</b> of elevation identified</p> <p>A1</p> |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

Answer ..... ° [4]

[Turn over

- 6 (a) The cumulative frequency graph shows the distribution of the time taken for 120 cars to travel a stretch of road from a research company.



- (i) Use the curve to estimate  
(a) the median time,

Answer ..... minutes [1]

- (b) the interquartile range of the time.

Answer ..... minutes [2]

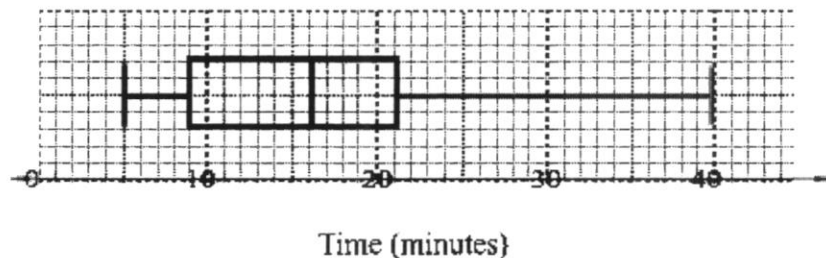
- (ii) A survey states that 10% of the cars took more than 31 minutes to travel this stretch of road. Comment whether the data from the research centre supports this statement.

Answer

[2]

- (v) Some candidates demonstrated their understanding of what was required by stating a relevant numerical value or values from which they could draw a conclusion. Most attempted to use the curve to find the cumulative frequency for babies weighing 2.8 kg, leading to a value that could be compared with the 90% quoted. The most common method was to read 9 babies from the graph and equate this to 82% of babies, leading to a correct conclusion. Some quoted 9 babies less than 2.8 kg or 41 more than 2.8 kg but did not compare their value with 9 or 41 resulting from the 90% given in the question. A common error was to misread the horizontal scale, for example reading at 2.65 or 2.9 instead of 2.8. Some candidates misinterpreted the curve and stated that 90% of babies had a mass of 3.9 kg or more.

- (iii) The box-and-whisker plot below represents the distribution of the time taken for 120 motorcycles to travel the same stretch of road.



Make two comparisons between these two modes of transport.  
Give a reason for your answer.

Answer

[2]

[Turn over

- 6 (b) This table shows information about a group of students in a playgroup.

|       | Boys | Girls |
|-------|------|-------|
| Korea | 4    | 3     |
| Japan | 2    | 7     |

- (i) A student of the group is selected at random.  
Find, as a fraction in its lowest terms, the probability that the student is a boy from Korea.

- (ii) Two students are selected at random.  
Find, as a fraction in its lowest terms, the probability that  
(a) they are both boys,

(b) they are both girls but only one is from Japan. [2]

- 7 (a) The point  $P$  has coordinates  $(-3, 8)$  and  $\overrightarrow{PQ} = \begin{pmatrix} -6 \\ 2 \end{pmatrix}$ .
- (i) Find the equation of the line  $PQ$ .

Answer ..... [2]

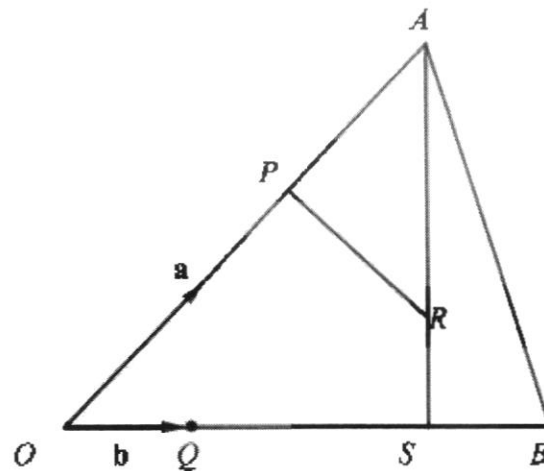
- (ii) The equation of the line  $ST$  is  $3y + x - 10 = 0$ .

Explain, with clear working, if line  $PQ$  intersects line  $ST$ .

[2]

[Turn over

(b)



$OAB$  is a triangle.

$Q$  and  $S$  are points on  $OB$  such that  $SB = OQ$  and  $OQ = \frac{1}{3} OS$ .

$P$  is a point on  $OA$  such that  $OP = \frac{2}{3} OA$ .

$R$  is a point on  $AS$  such that  $SR : RA = 1 : 2$ .

$\vec{OP} = \mathbf{p}$ ,  $\vec{OQ} = \mathbf{q}$ .

(i) Express, as simply as possible, in terms of  $\mathbf{p}$  and/or  $\mathbf{q}$ ,

Answer ..... [2]

(b)  $\vec{PB}$

Answer ..... [1]

- (ii) Show that  $P$ ,  $R$  and  $B$  lie on a straight line.

[3]

- (iii) Find the numerical value of  $\frac{\text{area of triangle } ASB}{\text{area of triangle } AOB}$ .

*Answer* ..... [1]

[Turn over]

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

(a) Complete the table of values for  $y = -\frac{1}{5}x^3 + 2x + 1$ .

|     |     |     |    |      |   |     |     |     |      |
|-----|-----|-----|----|------|---|-----|-----|-----|------|
| $x$ | -4  | -3  | -2 | -1   | 0 | 1   | 2   | 3   | 4    |
| $y$ | 5.8 | 0.4 |    | -0.8 | 1 | 2.8 | 3.4 | 1.6 | -3.8 |

[1]

- (b) On the grid opposite, draw the graph of  $y = -\frac{1}{5}x^3 + 2x + 1$  for  $-4 \leq x \leq 4$ .

[3]

- (c) By drawing a suitable tangent, find the gradient of the curve at  $x = -3$ .

Answer ..... [2]

- (d) (i) On the same grid, draw the graph of  $2y + x = 1$  for  $-4 \leq x \leq 4$ .

[1]

- (ii) Show that the points of intersection of the line and the curve gives the solution of  $-2x^3 + 25x + 5 = 0$ .

[2]

- (iii) Use your graph to solve the equation  $-2x^3 + 25x + 5 = 0$ .

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

[Turn over

- 9 To prevent vehicles from speeding, speed humps are built on the roads to regulate the speed of cars.

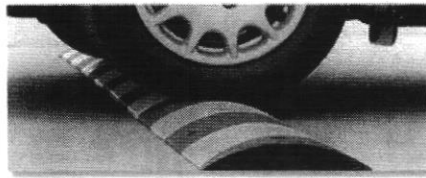


Diagram 1 shows the length, width and height of one speed hump. Each speed hump along a road has 4 identical speed humps joined together.

Diagram 1

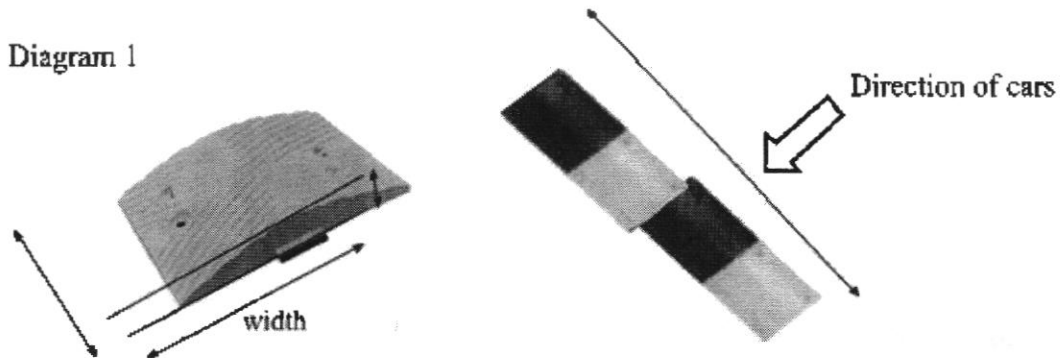
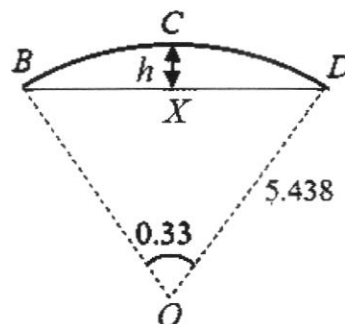


Diagram 2 shows the cross-section of one speed hump.  $BCD$  is part of sector  $OBCD$  with centre  $O$ , radius  $5.438$  m and angle  $BOD$  of  $0.33$  radians.

Diagram 2 : Cross-section of one speed hump



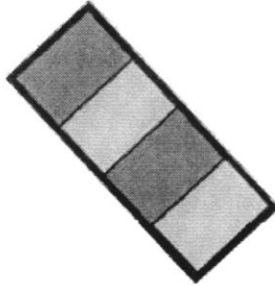
- (a) Find the length of the arc  $BCD$  of the speed hump as shown in Diagram 2.

Answer .....m [1]

- (b) Diagram 3 shows the top view of 4 identical speed humps joined together. The thickness of the rubber to cover the top of each speed hump is 0.5 cm and the total cost to cover four such speed humps is \$240.

Using the information given in the table, calculate the length of one speed hump.

Diagram 3 : Top view of four speed humps



| Information for material used and cost             |                        |
|----------------------------------------------------|------------------------|
| Density of rubber                                  | 1060 kg/m <sup>3</sup> |
| Cost of rubber per kg                              | \$20                   |
| Cost to cover the <b>top</b> part of 4 speed humps | \$240                  |

Answer .....m [3]

[Turn over

- (c) The engineers are to ensure that the height ( $h$ ), width ( $w$ ) and length ( $l$ ) of **each** speed hump meet the safety criteria as shown in the table.

|                                                                                                                                   |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Height of the hump ( $h$ )                                                                                                        | $0.0732 \text{ m} \leq h < 0.1016 \text{ m}$    |
| Width of the hump ( $w$ )                                                                                                         | $0.9144 \text{ m} \leq w < 1.8288 \text{ m}$    |
| Gradient of the hump ( $g$ ),<br>where $g$ is given as the ratio of the<br>height of the hump : horizontal length of $BX$ or $XD$ | $g < 0.1$                                       |
| Length of one speed hump ( $l$ )                                                                                                  | $0.3048 \text{ m} \leq l \leq 0.9144 \text{ m}$ |

Show with clear working if the engineers should approve this speed hump.







# YISHUN SECONDARY SCHOOL

## PRELIMINARY EXAMINATION 2023

### SECONDARY 4 EXPRESS

CANDIDATE  
NAME

CLASS

|  |  |  |
|--|--|--|
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INDEX  
NUMBER

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#### MATHEMATICS

Paper 1

**4052/01**

21 August 2023

2 hours 15 minutes

Candidates answer on the Question Paper.

#### READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For  $\pi$ , 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 of the marks for this paper is 90.

For examiner's use

**90**

[Turn over

---

This document consists of 21 printed pages and 1 blank page.

### *Mathematical Formulae*

#### *Compound Interest*

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

#### *Mensuration*

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

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

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

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

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

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

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

#### *Trigonometry*

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

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

#### *Statistics*

3

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

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

Answer all questions

- 1 Calculate  $121 - \sqrt{\frac{98}{0.61}} - 80$ .  
Write your answer correct to 4 significant figures.

$$\begin{aligned} & 121 - \sqrt{\frac{98}{0.61}} - 80 \\ & = 112.019 \\ & = 112.0(4\text{sf}) \quad \text{----- B1} \end{aligned}$$

Answer ..... [1]

- 2 The estimated population of Taiwan is 23.6 million.  
The estimated total land area is  $3.62 \times 10^4 \text{ km}^2$ .  
Calculate the average number of people per square kilometre of land area in Taiwan, giving your answers in standard form.

$$\begin{aligned} & \frac{23.6 \times 10^6}{3.62 \times 10^4} \quad \text{----- B1 convert million} \\ & = 651.933 \\ & = 6.52 \times 10^2 \quad \text{----- A1} \end{aligned}$$

Answer ..... [2]

- 3 When 540 is divided by  $m$ , a perfect square is formed.  
Find the smallest value of  $m$ , where  $m$  is an integer.

[Turn over]

4

$$540 = 2^2 \times 3^3 \times 5 \quad \text{----- M1 prime factorise 540}$$

$$m = 3 \times 5 = 15 \quad \text{----- A1}$$

*Answer m*----- [2]

4 The scale of a map is 4 cm : 28 km.

(a) Find the length of a canal that is represented by 10 cm on the map.

$$4 \text{ cm} : 28 \text{ km}$$

$$1 \text{ cm} : 7 \text{ km}$$

$$10 \text{ cm} : 70 \text{ km} \quad \text{----- B1}$$

*Answer*----- [1]

(b) A lake is represented by an area of 400 cm<sup>2</sup> on the map.  
Calculate the actual area of the lake in square kilometres.

$$1 \text{ cm} : 7 \text{ km}$$

$$1 \text{ cm}^2 : 49 \text{ km}^2 \quad \text{----- M1 find area scale}$$

$$400 \text{ cm}^2 : 49 \times 400 = 19600 \text{ km}^2 \quad \text{----- A1}$$

*Answer*----- km<sup>2</sup> [2]

5 (a) Express  $22 + 10x + x^2$  in the form of  $p + (q + x)^2$ .

5

$$\begin{aligned}
 22 + 10x + x^2 &= (x+5)^2 - 52 + 22 \\
 &= (x+5)^2 - 3 \\
 &= -3 + (5+x)^2 \text{----- B1, B1 or M1 complete square seen, A1}
 \end{aligned}$$

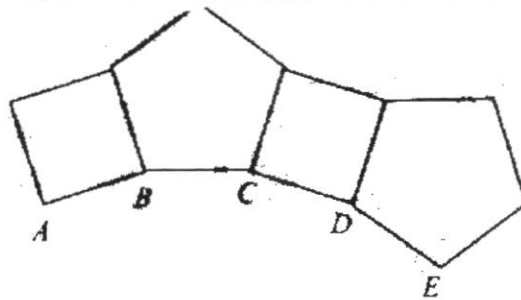
Answer ..... [2]

(b) Write down the equation of line of symmetry for  $-22 + 10x + x^2$

$$x = -5 \quad \text{B1}$$

Answer ..... [1]

6



A regular pentagon is joined to a square repeatedly until it forms a regular polygon  
 $AB$ ,  $BC$ ,  $CD$  and  $DE$  are edges of the regular polygon

Find the number of sides in this regular polygon

Interior angle of square = 90

$$\frac{(5-2) \times 180}{5} = 108$$

Interior angle of pentagon

Int. angle of reg. polygon =  $360 - 108 - 90 = 162$  ----- M1 new interior angle

### Method 1

Ext. angle of reg. polygon =  $180 - 162 = 18$  ----- M1 find one exterior angle

$$\frac{360}{18}$$

No. of sides of reg. polygon = 20 ----- A1

[Turn over

6

**Method 2**

$$(x-2) \times 180 = 162n \text{ ---- M1 use interior angle method to find } n$$

$$180n - 360 = 162n$$

$$18n = 360$$

$$n = 20 \text{ ---- A1}$$

Answer ..... [3]

7  $r$  is directly proportional to  $t^3$ .When  $t$  is decreased by 25%, find the percentage change in  $r$ .

$$r = kt^3$$

$$\text{new } r = k(0.75t)^3 \text{ ---- M1 cube } 0.75$$

iP

$$\% \text{ change} = \frac{k \left( \frac{27}{64} t^3 \right) - kt^3}{kt^3} \times 100$$

$$= \left( \frac{27}{64} - 1 \right) \times 100$$

$$= -57.8125\% \text{ or } -\frac{925}{16}\% \text{ or } -57\frac{13}{16}\% \text{ ---- A1}$$

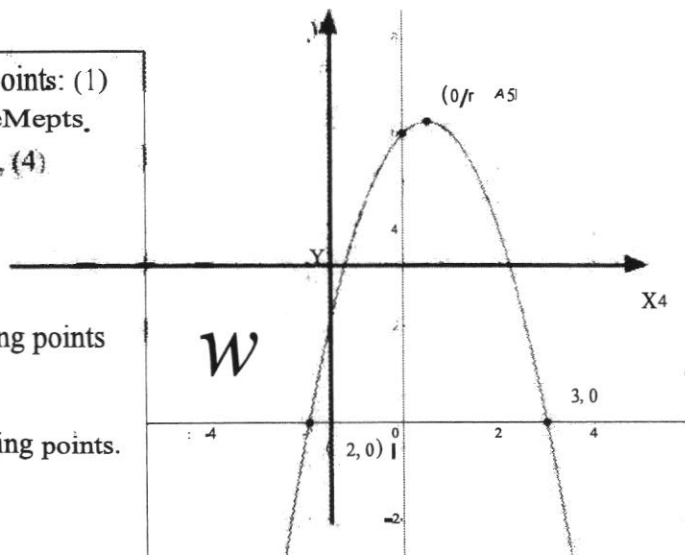
Answer ..... [2]

8 Sketch the graph of  $y = -(x+2)(x-3)$  on the axes below.Indicate clearly the lines where the graph crosses the  $x$ - and  $y$ -axes and its turning point.

Four marking points: (1)  
Shape, (2) intercepts,  
(3) y-intercept, (4)  
turning point

B2: all 4 marking points  
correct

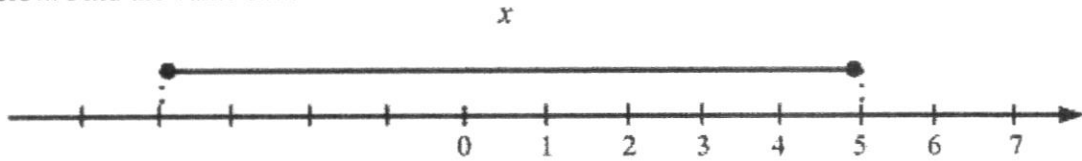
B1: 2–3 marking points.



[2]

7

- 9 The solution of the inequality  $-2 \leq \frac{4-2x}{3} \leq 2k+5$ , where  $k$  is a constant, is represented on the number line below. Find the value of  $k$ .



$$-2 \leq \frac{4-2x}{3} \leq 2k+5$$

$$-2 \leq \frac{4-2x}{3} \quad \text{and} \quad \frac{4-2x}{3} \leq 2k+5 \quad \text{---- M1 Split}$$

$$-6 \leq 4-2x \quad 4-2x \leq 6k+15$$

$$-10 \leq -2x \quad -2x \leq 6k+11 \quad \text{---- M1 divide by negative and flip sign}$$

$$x \leq 5 \quad x \geq \frac{6k+11}{-2}$$

$$\frac{6k+11}{-2} = -4 \quad \text{---- M1 equate}$$

$$6k+11=8$$

$$6k=-3$$

$$k = -\frac{1}{2} \quad \text{---- A1}$$

Answer  $k = \dots\dots\dots$  [4]

- 10 Zac has written down five numbers.  
The mean of these numbers is 5.2, the median is 4 and the mode is 2.  
The largest number is five times the smallest number.

Find the five numbers.

2, 2, 4, 8, 10

B2 – all 5 correct

B1 – 3 or 4 correct

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

[Turn over

11 (a) Simplify  $\left(\frac{2x^3}{\sqrt{x^4}}\right)^{-3}$ .

$$\left(\frac{2x^3}{\sqrt{x^4}}\right)^{-3} = \left(\frac{\sqrt{x^4}}{2x^3}\right)^3 \quad \text{---- M1 negative or distributive law applied correctly}$$

$$= \frac{x^6}{8x^9}$$

$$= \frac{1}{8x^3} \quad \text{---- A1}$$

Answer ..... [2]

(b) Solve  $\frac{3^{x+1}}{27^x} = 1$ .

$$\frac{3^{x+1}}{27^x} = 1$$

$$3^{x+1} = 27^x$$

$$3^{x+1} = 3^{3x} \quad \text{---- M1 make same base for all terms}$$

$$x+1 = 3x$$

$$x = \frac{1}{2} \quad \text{---- A1}$$

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

12 Object **A** and object **B** are geometrically similar.

The ratio of the base area of object **A** to the base area of object **B** is 4:9.

Find the ratio of the volume of object **A** to volume of object **B**.

$$\frac{A_A}{A_B} = \frac{4}{9}$$

$$\frac{l_A}{l_B} = \sqrt{\frac{4}{9}} = \frac{2}{3} \quad \text{---- M1 sq rt area ratio}$$

$$\frac{V_A}{V_B} = \left(\frac{2}{3}\right)^3 = \frac{8}{27}$$

Hence, ratio 8:27 ---- A1

Answer ..... [2]

13  $n$  is a positive integer.Show that, for all  $n$ ,  $(2n+3)^2 - (2n-3)^2$  is not a prime number.

Answer

$$\begin{aligned}
 (2n+3)^2 - (2n-3)^2 &= 4n^2 + 12n + 9 - (4n^2 - 12n + 9) \\
 &= 24n
 \end{aligned}$$

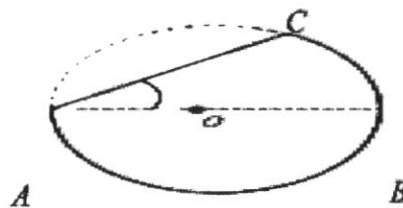
---- M1 quadratic expansion

A prime number can only be divided by 1 or itself

Since 24 is not prime,  $(2n+3)^2 - (2n-3)^2$  can be **divided** by all **factors** of 24, **making** it not prime.A1 – Explanation based on **definition** of **prime numbers**

[2]

14

The diagram shows a major segment  $ABC$  of a circle with centre  $O$  and radius 5 cm.

Angle  $OAC = \frac{\pi}{6}$

[Turn over]

10

Find the area of the major segment  $ABC$ .

$$\text{Reflex angle } AOC = 2\pi - \left(\pi - \frac{\pi}{6} - \frac{\pi}{6}\right) = \frac{4}{3}\pi \quad \text{----- B1 reflex angle}$$

Area of major segment = Area of major sector + Area of triangle

$$\begin{aligned} &= \frac{1}{2}(5^2)\left(\frac{4\pi}{3}\right) + \frac{1}{2}(5^2)\sin\left(\pi - \frac{\pi}{6} - \frac{\pi}{6}\right) \quad \text{----- M1} \\ &= 52.3598 + 10.8253 \\ &= 63.1851 \\ &= 63.2 \quad \text{----- A1} \end{aligned}$$

Answer .....  $\text{cm}^2$  [3]

15 (a) Factorise completely  $12pq - 3p + q - 4q^2$

$$\begin{aligned} 12pq - 3p + q - 4q^2 &= 3p(4q - 1) + q(1 - 4q) \\ &= 3p(4q - 1) - q(4q - 1) \\ &= (3p - q)(4q - 1) \quad \text{----- B2} \end{aligned}$$

Answer ..... [2]

(b) Simplify  $\frac{3x^2 + 15x - 42}{x^2 - 4}$ .

$$\begin{aligned} \frac{3x^2 + 15x - 42}{x^2 - 4} &= \frac{3(x^2 + 5x - 14)}{(x - 2)(x + 2)} && \text{----- M1 factorise denominator} \\ &= \frac{3(x - 2)(x + 7)}{(x - 2)(x + 2)} && \text{----- M1 quadratic factorisation} \\ &= \frac{3(x + 7)}{x + 2} && \text{----- A1} \end{aligned}$$

Answer ..... [3]

- 16 The volume of a cone with radius  $x$  and height  $y$  is twice the volume of a hemisphere with radius  $x$ .

$\frac{1}{27}$  of the cone is filled with water.

This water is poured into the hemisphere.

Find the fraction of the hemisphere that is filled with water.

Volume of cone = 2 volume of hemisphere

12

$$\frac{1}{3}\pi x^2 y = (2)\frac{1}{2}\left(\frac{4}{3}\pi x^3\right) \quad \text{----- B1}$$

$$\frac{1}{3}\pi x^2 y = \frac{4}{3}\pi x^3$$

$$y = 4x$$

----- M1 make y the subject

$$\text{Amt of water} = \frac{1}{27}\left(\frac{1}{3}\pi x^2 y\right)$$

$$= \frac{1}{81}\pi x^2(4x)$$

$$= \frac{4}{81}\pi x^3 \quad \text{----- M1 find volume of water in terms of x}$$

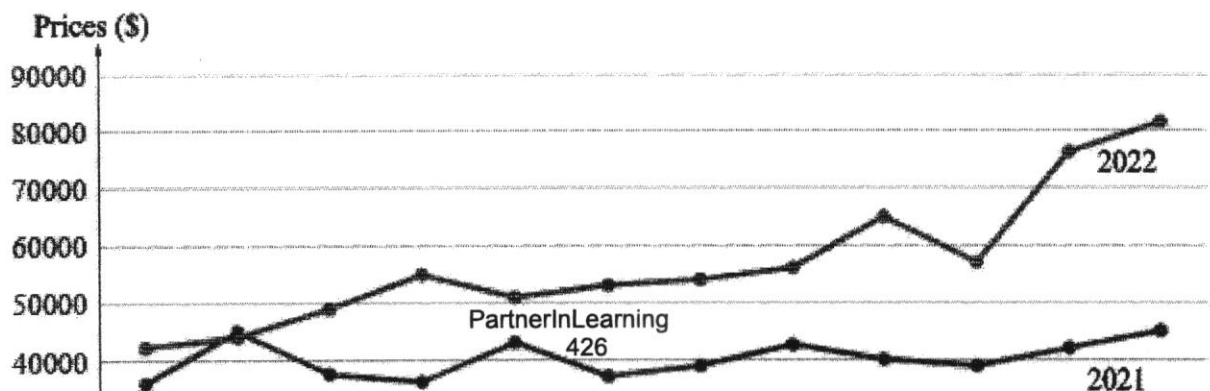
$$= \frac{2}{27}\left(\frac{2}{3}\pi x^3\right)$$

$$= \frac{2}{27}(\text{vol. of hemisphere}) \quad \text{--- A1}$$

Answer ..... [4]

- 17 The graph shows information about prices of the Certificate of Entitlement (COE) for buses for each month in year 2021 and 2022

COE is a license for owning a vehicle in Singapore.



- (a) Estimate the price of COE in July 2022.

\$54000/555000 — B1

Answer \$..... [1]

- (b) A school bus company claims that the cost of buying new buses has increased and intends to increase the prices of the services they provide for the year 2023!

What feature of the graph can the company use to justify the company's claim

**Answer** The line graph of 2022 shows an increasing trend for the COE prices from January 2022 to December 2022. Following the trend, there is a likelihood that it will continue to increase for 2023, hence, justifying the company's claim. [1]

- (c) Make one comparison between the mean COE prices in 2021 and 2022. Justify your answer with references to the graph.

**Answer** The mean COE price for 2022 is higher than 2021 [B1] as

the COE prices of every month except February in 2022 is higher than in 2021. This can be seen from the data points of 2022 lying above that of 2021.

[2]

- 18 (a) The cash price of a TV: \$2100.  
Ben buys this TV on hire purchase.  
He pays a deposit of one fifth of the cash price  
He then makes 12 monthly payments of \$160

**Find** >> total amount that Ben pays for the TV

$$\frac{1}{5} \times 2100 = 420 \quad \text{M1 one-fifth}$$

$$\text{Total} = 420 + 12 \times 160 = 2340 \quad \text{A1}$$

Answer \$..... [2]

[Turn over

- (b) Alicia invested a sum of money in an account paying compound interest at 3% per annum. After 5 years, she earned a total interest of \$3981.

Calculate the sum of money Alicia invested in the account.  
Give your answer to the nearest dollar.

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

$$P + 3981 = P \left( 1 + \frac{3}{100} \right)^5 \quad \text{----- M1 sub } r = 3, n = 5 \text{ with } P \text{ remaining as unknown}$$

$$P \left( 1 + \frac{3}{100} \right)^5 - P = 3981 \quad \text{----- M1 bring } P \text{ to one side}$$

$$0.15927P = 3981$$

$$P = \frac{3981}{0.15927} = 24994.65 = 24995 \quad \text{---- A1}$$

Answer \$..... [3]

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

$$72 \quad p \quad q \quad 57 \quad r$$

- (a) Find the values of  $p$ ,  $q$  and  $r$ .

$$\text{Common difference} = \frac{72 - 57}{3} = 5 \quad \text{---- B1}$$

$$p = 67$$

$$q = 62$$

$$r = 52 \quad \text{----- B1 All 3 correct}$$

Answer  $p =$  .....

$q =$  .....

$r =$  ..... [2]

15

- (b) Write down an expression for the  $n$ th term of this sequence.

$$77 - 5n$$

Answer ..... [2]

- (c) Explain why  $-100$  is not a term of this sequence

Answer

$$77 - 5n = -100$$

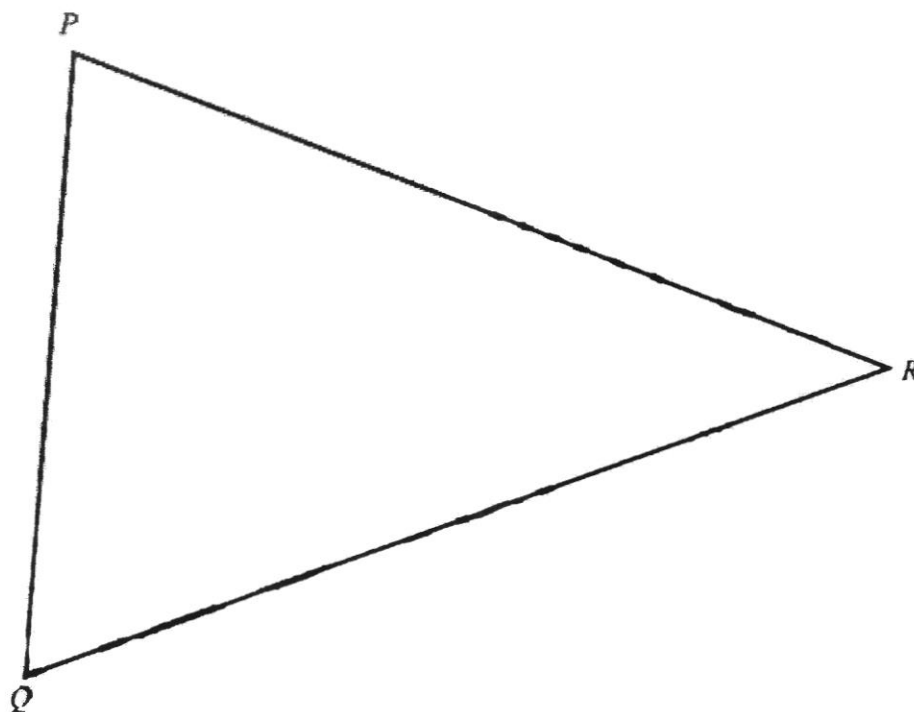
$$n = \frac{-100 - 77}{-5} = \frac{177}{5} \quad \text{---- M1 find } n$$

Since  $n$  is **not a positive integer**,  $-100$  **cannot** be a **term** in the sequence ---- A1 conclude

..... [2]

15

- 20 The diagram shows a triangle  $PQR$ .



- (a) Construct the perpendicular bisector of  $QR$ . [1]
- (b) Construct the bisector of angle  $PRQ$ . [1]
- (c) Point  $B$  is equidistant from  $Q$  and  $R$  and equidistant from  $PR$  and  $RQ$ . Mark the point  $B$  on the diagram and measure the length  $BP$ .

Answer  $BP = \dots\dots\dots$  cm [1]

21

$$\xi = \{\text{integers } x : 2 \leq x < 16\}$$

$$A = \{\text{multiples of 3}\}$$

$$B = \{\text{factors of 20}\}$$

- (a) (i) List all the elements in  $A'$ .

$$A' = \{2, 4, 5, 7, 8, 10, 11, 13, 14\} \quad \text{---- B1}$$

Answer ..... [1]

- (ii) List all the elements in  $A \cap B$ .

$$A = \{3, 6, 9, 12, 15\}$$

$$B = \{2, 4, 5, 10\}$$

$$A \cap B = \phi \text{ or } \{ \} \quad \text{---- B1}$$

Answer ..... [1]

- (iii) Find the value of  $n(A \cup B)'$

$$A = \{3, 6, 9, 12, 15\}$$

$$B = \{2, 4, 5, 10\}$$

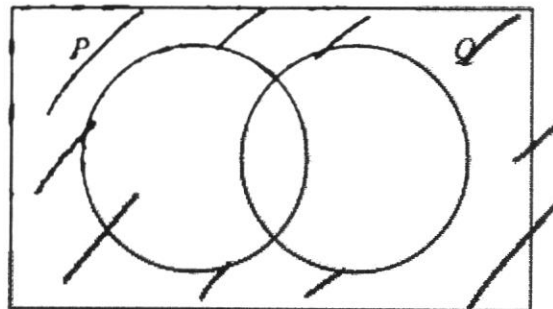
$$A \cup B = \{2, 3, 4, 5, 6, 9, 10, 12, 15\}$$

$$(A \cup B)' = \{7, 8, 11, 13, 14\}$$

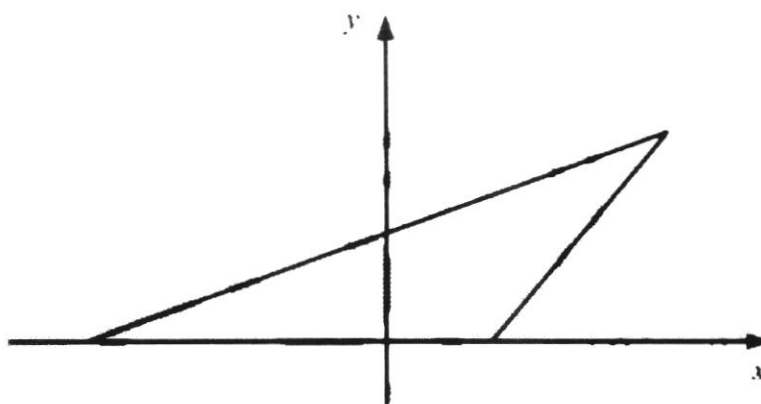
$$n(A \cup B)' = 5 \quad \text{----- B1}$$

Answer ..... [1]

- (b) On the Venn diagram, shade the region which represents  $(P' \cup Q) \cap Q'$ .



- 22 The diagram show triangle  $QRM$  with coordinates  $Q(-12,0)$ ,  $R(4,0)$  and  $M(8,10)$ .  
 $P$  is a point on the  $y$ -axis.



- (a) Find length  $QM$ .

$$\begin{aligned}
 QM &= \sqrt{(-12-8)^2 + (0-10)^2} \quad \text{----- M1 sub coords into formula} \\
 &= \sqrt{500} \\
 &= 22.3606 \\
 &= 22.4 \text{ units (3sf)} \quad \text{----- A1}
 \end{aligned}$$

Answer ..... units [2]

- (b) Find the coordinates of  $P$ .

|                                                                                                                                                                      |                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Method 1 – By similar triangles</p> $\frac{y}{10} = \frac{12}{20} \quad \text{----- M1 form eqn using ratio}$ $20y = 120$ $y = 6$ $P(0, 6) \quad \text{----- A1}$ | <p>Method 2 – By equation of straight line</p> $\text{gradient} = \frac{10}{8 - (-12)} = \frac{1}{2} \quad \text{----- M1 find gradient}$ $10 = \frac{1}{2}(8) + c$ $c = 6$ $P(0, 6) \quad \text{----- A1}$ |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Answer ( ..... , ..... ) [2]

- (c)  $S$  is a point such that it forms a parallelogram  $QRMS$ .  
 Find the area of  $QRMS$ .

19

Area of parallelogram = 2 Area of triangle QRM

$$= \frac{1}{2}(16)(10) \times 2 = 160 \quad \text{----- B1}$$

Answer .....units<sup>2</sup> [1]

- 23 A shop sells two different flavours of waffles, coconut (C) and peanut (P).

In a morning, an average of 10 coconut and 8 peanut waffles were sold.

In an afternoon, an average of 21 coconut and 15 peanut waffles were sold.

In an evening, an average of 7 coconut and 14 peanut waffles were sold.

- (a) Represent this information in a  $3 \times 2$  matrix, S.

----- B1

$$\text{Answer } S = \begin{pmatrix} & C & P \\ & & \\ & & \end{pmatrix} \begin{matrix} \text{morning} \\ \text{afternoon} \\ \text{evening} \end{matrix} \quad [1]$$

The price of one coconut waffle and one peanut waffle is \$2.10 and \$2.70 respectively.

- (b) Find the matrix  $T = 7S \begin{pmatrix} 2.10 \\ 2.70 \end{pmatrix}$ .

$$\begin{aligned} 7 \begin{pmatrix} 10 & 8 \\ 21 & 15 \\ 7 & 14 \end{pmatrix} \begin{pmatrix} 2.1 \\ 2.7 \end{pmatrix} &= \begin{pmatrix} 70 & 56 \\ 147 & 105 \\ 49 & 98 \end{pmatrix} \begin{pmatrix} 2.1 \\ 2.7 \end{pmatrix} \\ &= \begin{pmatrix} 298.2 \\ 592.2 \\ 367.5 \end{pmatrix} \quad \text{----- B2 all three terms correct, B1 two terms correct} \end{aligned}$$

Answer T = [2]

- (c) State what the elements of T represents.

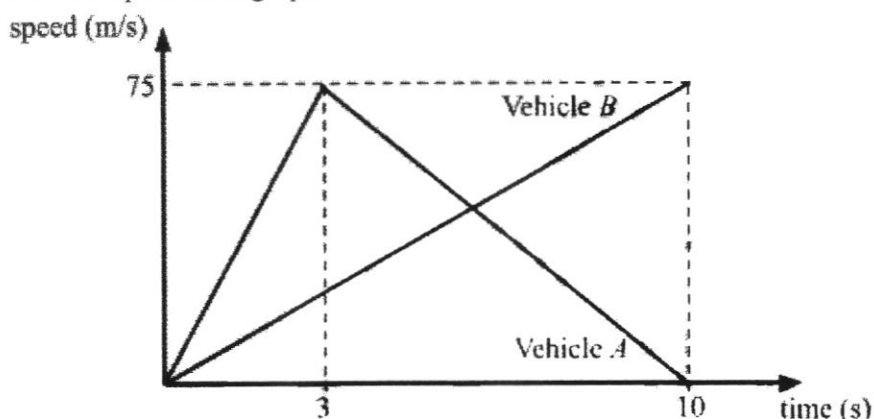
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*Answer*

It represents the total amount collected from the sales of the coconut and peanut waffles in morning, afternoon and evening respectively in 7 days.

[1]

- 24 The diagram shows the speed-time graph of vehicle A and vehicle B.



- (a) Find the deceleration of vehicle A.

$$\text{Deceleration} = \frac{75}{7} \text{ or } 10\frac{5}{7}$$

*Answer* .....m/s<sup>2</sup> [1]

- (b) Both vehicles travel the same distance at the end of 10 seconds.  
Determine if this statement is true.

*Answer*

$$\text{Distance travelled by vehicle B} = \frac{1}{2}(10)(75) = 375$$

$$\text{Distance travelled by vehicle A} = \frac{1}{2}(3)(75) + \frac{1}{2}(7)(75) = 375$$

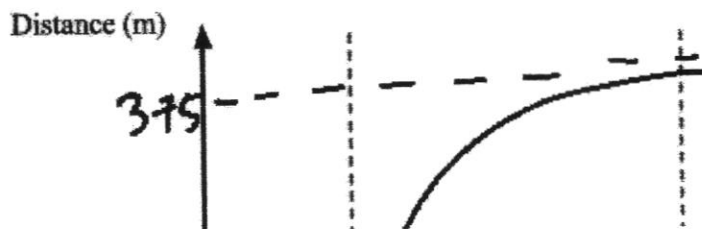
The statement is true. Both vehicle travels 375m.

M1 – find distance of either vehicle A or B.

A1 – conclude.

[2]

- (c) Draw the distance-time graph for vehicle A from 0 to 10 seconds.



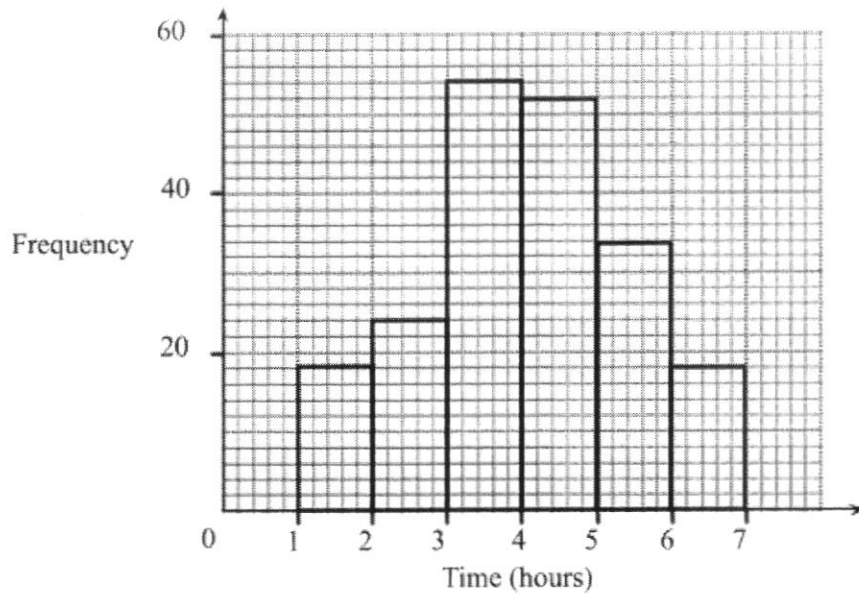
B1 – correct shape, B1 – correct axis labels or

B1 – first 3 seconds correct shape + distance labelled correctly, B1 for the next part of the journey (graph +

112.5 -----

[2]

- 25 (a) The histogram shows the distribution of the time spent exercising by 200 students from Jurong.



- (i) Which interval contains the median?  
 Median position = 100.5 (between 100 and 101)  
 4 to 5 hours ---- B1 or equivalent  
 Answer ..... hours [1]
- (ii) Calculate an estimate of the mean.  
 4.07 B1  
 Answer ..... hours [1]
- (iii) Calculate an estimate of the standard deviation.  
 1.3755 = 1.38 B1  
 Answer ..... hours [1]
- (iv) Explain why the mean and the standard deviation is just an estimate.  
 Answer  
 The exact values of the number of hours are not given. Mid-value of the interval are used in the calculation. .... [1]

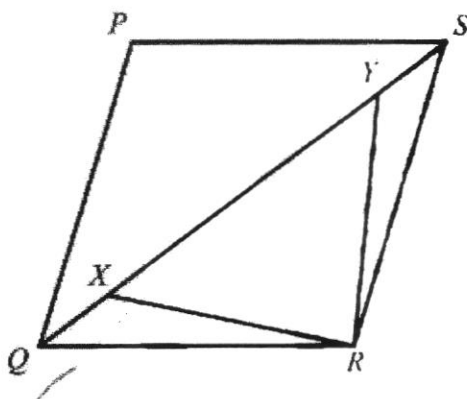
[Turn over]

- (b) The standard deviation of the time spent exercising by a group of 200 students from Yishun is 2.21. Make a comparison between the distribution of the two groups of students.

*Answer*

The number of hours spent exercising is more consistent among the students in Jurong than Yishun as the standard deviation of students in Jurong is smaller than that of students in Yishun,  $1.38 < 2.21$

[1]



$PQRS$  is a rhombus.

$X$  and  $Y$  are points on  $QS$  such that  $QX = SY$ .

Show that triangle  $RXY$  is an isosceles triangle.

*Answer*

$$QX = SY \text{ (given)}$$

$$QR = SR \text{ (sides of rhombus are equal in length)}$$

$$\angle XQR = \angle YSR \text{ (triangle } QRS \text{ is an isosceles triangle since } QR = RS)$$

M1 – two statements that are not given.

By SAS congruency test, triangle  $QXR$  is congruent to triangle  $SYR$ . ----- M1 congruency test.

Therefore,  $RX = RY$ , making  $RXY$  an isosceles triangle. ----- A1

[3]

- (b) Explain why it is not possible to draw a circle that passes through  $P$ ,  $Q$ ,  $R$  and  $S$ .

If a circle passes through all the points  $P$ ,  $Q$ ,  $R$  and  $S$ , by angles in the opposite segment, angle  $QPS + \text{angle } QRS = 180$ .

.....

.....

.....

.....

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[2]



**YISHUN SECONDARY SCHOOL  
PRELIMINARY EXAMINATION 2023  
SECONDARY 4 EXPRESS**

CANDIDATE  
NAME

CLASS

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INDEX  
NUMBER

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**MATHEMATICS**

Paper 2

**4052/02**

**23 August 2023**

**2 hours 30 minutes**

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your class, index number and name on **all** the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any **diagrams** or **graphs**.

Do not use staples, paper clips, glue or **correction** fluid.

Answer **all** the questions.

If working is needed for any **question** it must be shown **with** the answer.

Omission of essential working **will result in loss of marks**.

The use of an approved **scientific** calculator is **expected**, where appropriate.

If the degree of **accuracy** is not **specified** in **the** question, and if the **answer** is not exact, give the answer to three significant **figures**. Give **answers** in **degrees** to one decimal place.

For  $\pi$ , 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 of the **marks** for this **paper** is 90.

For examiner's use

**90**

[Turn over

3

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

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

- 1 (a) It is given that  $b = \frac{c-b}{3b-c}$ ,  
 (i) find the value of  $b$  when  $c = 2b$ ,

|         |                                                                            |    |  |
|---------|----------------------------------------------------------------------------|----|--|
| 1(a)(i) | $b = \frac{c-b}{3b-c}$ $b = \frac{2b+b}{3b-2b}$ $b = \frac{3b}{b}$ $b = 3$ | Al |  |
|---------|----------------------------------------------------------------------------|----|--|

Answer ..... [1]

- (ii) express  $c$  in terms of  $b$ .

|          |                                                                                                                                                                       |                                                                |  |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--|
| 1(a)(ii) | $b = \frac{c-b}{3b-c}$ $b(3b-c) = c+b$ $3b^2 - bc = c+b$ $3b^2 - b = c+bc$ $3b^2 - b = c(1+b)$ $c = \frac{3b^2 - b}{1+b} = \frac{b(3b-1)}{1+b} = \frac{b-3b^2}{-1-b}$ | M1 (cross multiply)<br><br>M1 (Take out c as factor)<br><br>Al |  |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--|

Answer ..... [3]

- (b) Solve  $\frac{x-1}{(3-x)^2} - \frac{4}{x-3} = 1$ .

[Turn over]

|    |                                                                                                                                                                                                            |                                                                                                  |  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--|
| 1b | $\frac{x+1}{(3-x)^2} - \frac{4}{x-3} = 1$ $\frac{x+1}{(x-3)^2} - \frac{4}{x-3} = 1$ $\frac{(x+1) - 4(x-3)}{(x-3)^2} = 1$ $x+1-4x+12 = x^2-6x+9$ $x^2-3x-4 = 0$ $(x-4)(x+1) = 0$ $x = 4 \text{ or } x = -1$ | M1<br>denominator/<br>single fraction<br><br>M1<br>simplified<br>quadratic<br>equation<br><br>A1 |  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--|

Answer ..... [3]

- (c) A teacher wanted to give her 40 students a burger each. The cost of a chicken burger is \$2 and the cost of a fish burger is \$2.50. She spent a total of \$95 for  $x$  chicken burgers and  $y$  fish burgers. Use algebraic method to find the number of fish burgers that she ordered.

|    |                                                                                                                                                                                                                                                                                                            |                                                                                                          |  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--|
| 1c | $x + y = 40 \quad \text{--- (1)}$ $2x + 2.5y = 95 \quad \text{--- (2)}$ <p>From 1 : <math>x = 40 - y</math><br/> Sub into eqn 2 :<br/> <math>2(40 - y) + 2.5y = 95</math><br/> <math>80 - 2y + 2.5y = 95</math><br/> <math>0.5y = 15</math><br/> <math>y = 30</math></p> <p>number of fish burger = 30</p> | B1 eqn of 1<br>or 2.<br><br>M1 : solve<br>sim equation<br>by<br>elimination or<br>substitution<br><br>A1 |  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--|

Answer ..... [3]

- 2 (a) John spends 1.5 hours at a sports centre. The ratio of the times he spends changing, warming up and running is 2 : 3 : 7. Calculate  
(ii) the time he spends to change.

|       |                                                                                   |    |              |
|-------|-----------------------------------------------------------------------------------|----|--------------|
| 2a(i) | 12 units rep 1.5h<br>warm-up: $\frac{1.5}{12} \times 2 = \frac{1}{4}$<br>= 15 min | A1 | 1u - 7.5 min |
|-------|-----------------------------------------------------------------------------------|----|--------------|

Answer ..... min [1]

- (ii) the percentage of time he spends running at the sports centre.

|        |                                                                    |    |  |
|--------|--------------------------------------------------------------------|----|--|
| 2a(ii) | $\frac{7}{12} \times 100\%$ $= 58\frac{1}{3}\% \text{ or } 58.3\%$ | A1 |  |
|--------|--------------------------------------------------------------------|----|--|

Answer .....% [1]

(iii)

- (b) In 2021, John's fastest time for a 10 km run was 54 minutes 30 seconds.  
 In 2022, he went to Thailand to take part in a 10 km competition.  
 His time taken was 6% less than his fastest time in 2021.  
 Calculate, in minutes and seconds, his best time in 2022.

|    |                                                                                                                                                                                                                      |                          |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--|
| 2b | $54 \text{ min } 30 \text{ sec} = 3270 \text{ sec}$<br>$100\% \text{ --- } 3270 \text{ sec}$<br><br>$94\% \text{ --- } \frac{3270}{100} \times 94$<br>$= 3073.8 \text{ sec}$<br>$= 51 \text{ min } 13.8 \text{ sec}$ | M1 for 94%<br><br><br>A1 |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--|

Answer .....minutes.....seconds [2]

- (c) John saw a pair of branded running shoe which cost 17 430 Baht.  
 The same pair costs 500 US Dollars (USD) in the United States.  
 To buy these shoes, John will pay using his Singapore credit card and will be charged a fee of 1.7% fee for currency conversion.

The exchange rate between Singapore dollars (\$) and USD is \$1 = USD 0.74 and  
 between Thai Baht and Singapore Dollar is 1 Baht = 0.039 Singapore Dollars.

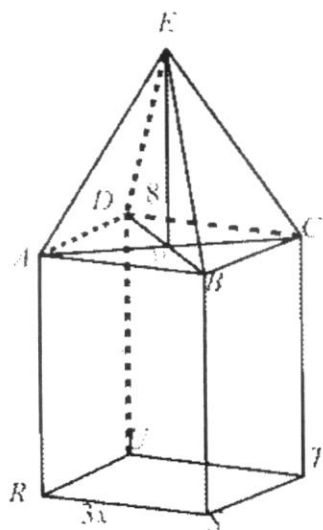
Show, with clear working, if John should buy the pair of running shoes in Thailand  
 or the United States.

Answer

[3]

|      |                                                                                                                                                                                                                                                                           |                                                                                                                                                     |  |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 2(c) | In Singapore, convert USD to SGD:<br>$\frac{500}{0.74} \times 1.017$<br>$= \$687.16$<br><br>In Thailand, convert Baht to SGD:<br>$17\,430 \times 0.039 \times 1.017$<br>$= 691.33$<br><br>John should buy the shoe from the US<br>since it is cheaper ( 687.16 < 691.16). | $\frac{500}{0.74}$<br>M1 for conversion<br>from USD to SGD<br>or conversion of Baht to<br>SGD<br><br>M1 for<br>their SGD x 1.017<br><br>A1 conclude |  |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|

3



The diagram shows a solid consisting of a cuboid attached to a pyramid.

The pyramid has a square base of length  $3x$  cm and a vertical height of 8 cm.

The height of the cuboid is twice the length of one side of its square base.

- (a) Form an equation, in terms of  $x$ , to represent this information and show that it simplifies to

$$9x^2 + 4x - 100 = 0$$

Answer

[3]

|      |                                                                                                         |                                                                                                                  |  |
|------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--|
| 3(a) | $6x(3x)(3x) + \frac{1}{3}(3x)(3x)8 = 600x$ $54x^3 - 24x^2 - 600x = 0$ $(\div 6x)$ $9x^2 + 4x - 100 = 0$ | <p>M2 for vol of cuboid and pyramid<br/><b>and equate to 600x</b><br/>M1 for 1 correct volume seen</p> <p>A1</p> |  |
|------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--|

- (b) Solve the equation  $9x^2 + 4x - 100 = 0$ , giving your answers to 3 decimal places.

|      |                                                                                                                                                                                 |                                                                                                                                                                                                                |  |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 3(b) | $9x^2 + 4x - 100 = 0$ $x = \frac{-4 \pm \sqrt{(4)^2 - 4(9)(-100)}}{2(9)}$ $x = \frac{-4 \pm \sqrt{3616}}{18}$ $x = 3.11850 \text{ or } -3.56295$ $x = 3.119 \text{ or } -3.563$ | <p>B1 or <math>\sqrt{3616}</math></p> $\frac{-3 \pm \sqrt{\text{their } 3616}}{18}$ <p>B1 for</p> <p>B2 (ans in 3 dp)<br/>B1<br/>for either 3.119 or -3.563 or both<br/>roots seen to more decimal places.</p> |  |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

[Turn over

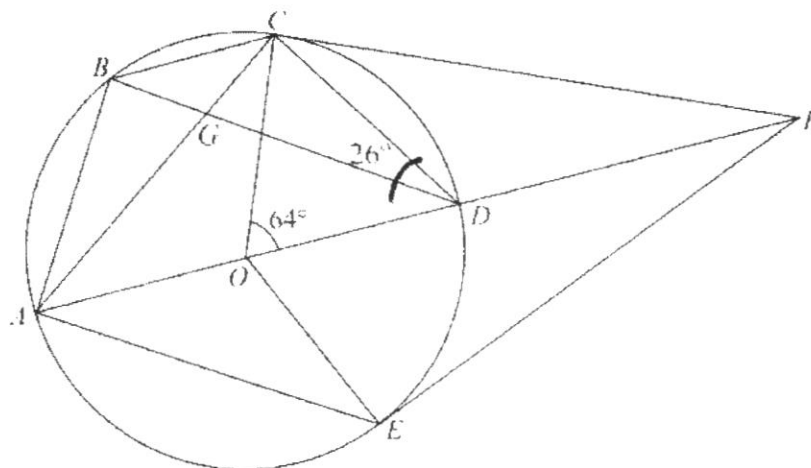
Answer  $x$  ..... or ..... [4]

(c) Hence, calculate the slant length of the pyramid.

|      |                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                 |  |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 3(c) | $AC^2 = AB^2 - BC^2$ $AC^2 = (3x)^2 + (3x)^2$ $AC^2 = 18x^2$ $AM = \frac{\sqrt{18x^2}}{2}$ $AE^2 = \left( \frac{\sqrt{18x^2}}{2} \right)^2 + 8^2$ $AE^2 = \frac{18(3.11850)^2}{4} + 8^2$ $AE = \sqrt{107.763}$ $= 10.3809$ $= 10.4$ | <p>M1 to find <math>AC^2</math> using their positive <math>x</math></p> <p>M1 to find <math>AE^2</math><br/>If <math>x=3.119</math> is used,<br/><math>AE = \sqrt{107.7767} = 10.3816</math></p> <p>A1 (ans is the same if they use <math>x = 3.119</math>)</p> |  |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

Answer ..... cm [3]

4



The diagram shows a circle  $ABCDE$  with centre at  $O$ .  
 $CF$  and  $EF$  are tangents to the circle at points  $C$  and  $E$  respectively.  
 Angle  $COD = 64^\circ$  and  $BDC = 26^\circ$ . [3]

- (a) Find  
 (i) angle  $CAD$ .

|       |                                                                                                                       |    |  |
|-------|-----------------------------------------------------------------------------------------------------------------------|----|--|
| 4a(i) | $\angle CAD = \frac{64}{2} \text{ (}\angle \text{ at centre} = \text{twice } \angle \text{ at circumference)}$ $= 32$ | A1 |  |
|-------|-----------------------------------------------------------------------------------------------------------------------|----|--|

- (ii) angle  $OFE$ .

|        |                                                                                                                                                                                                           |                                                                              |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--|
| 4a(ii) | $\angle OFE = \angle OFC \text{ (tangents from external point)}$ $\angle OCF = 90 \text{ (tangent perpendicular to radius)}$ $\angle OFC = 180 - 90 - 64 \text{ (}\angle \text{ sum of triangle)}$ $= 26$ | M1 for either<br>$\angle OFE = \angle OFC$<br>or $\angle OCF = 90$<br><br>A1 |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--|

Answer ..... [2]

- (iii) angle  $DCF$ .

|         |                                                                                                                                                                                        |                                                                              |  |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--|
| 4a(iii) | $\angle OCD = \frac{180 - 64}{2} \text{ (} OC = OD \text{ radius of circle)}$ $= 58$ $\angle OCF = 90 \text{ (tangent perpendicular to radius)}$ $\angle DCF = 90 - 58 = 32$ <p>OR</p> | B1 to find<br>angle $OC'D$<br><br>A1<br><br>B1 find<br>angle $CAD$<br><br>A1 |  |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--|

[Turn over]

|  |                                                                                                                                                   |  |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
|  | $\angle CAD = 64 \div 2$<br>( $\angle$ at centre is twice angle at circumference)<br>$= 32$<br>$\angle DCF = 32$ ( $\angle$ in alternate segment) |  |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------|--|--|

Answer ..... [2]

- (b) Show that triangle  $BGC$  is similar to triangle  $AGD$ .  
 Give a reason for each statement you make.

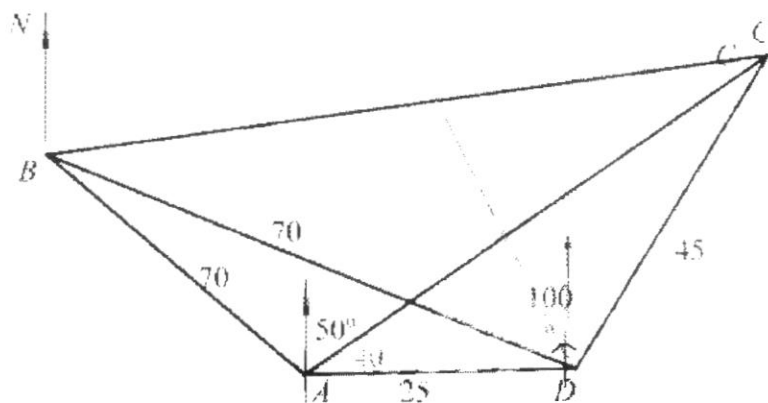
|         |                                                                                                                                                                                                                                                       |                                                            |  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|--|
| 4b<br>) | $\angle BGC = \angle AGD$ (vertically opposite angles)<br>$\angle GBC = \angle GAD$ (angle in the same segment are equal)<br>or $\angle BCG = \angle ADG$ (angle in the same segment are equal)<br>By AA, triangle $BGC$ is similar to triangle $AGD$ | B2, B1, B0 for 3, 2, 1 correct reasons with angle/ AA ppty |  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|--|

- (c) Show with clear working and reasons, that  $ABCD$  is a trapezium.  
 Answer

[3]

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 4c | $\angle ACD = 90$ ( $\angle$ in a semi-circle is $90$ )<br>$\angle BDA = 58 - 26 = 32$ ( $OCD$ is an isosceles triangle)<br>$\angle BDA = \angle BCA = 32$ ( $\angle$ in the same segment)<br>$\angle NCD + \angle CDA$<br>$= 32 + 90 + 58$<br>$= 180$<br>By interior angles of parallel sides,<br>line $BC$ is parallel to $AD$ ,<br>hence $ABCD$ is a trapezium.<br><br>OR<br>$\angle ACD = 90$ ( $\angle$ in a semi-circle is $90$ )<br>$\angle BDA = 58 - 26 = 32$ ( $OCD$ is an isosceles triangle)<br>$\angle BDA = \angle BCA = 32$ ( $\angle$ in the same segment)<br><br>$\angle CAD = 64 \div 2 = 32$<br>(from a(i) or $\angle$ at centre is twice angle at circumference)<br>$\angle CBD = \angle CAD = 32$ ( $\angle$ s in the same segment) OR<br>$\angle CBG = 32$ (corresponding $\angle$ s in similar triangles, shown in (b))<br>Hence, $\angle CBD = \angle BDA = 32$<br>By alternate angles, line $BC$ is parallel to $AD$ ,<br>hence $ABCD$ is a trapezium. | B1 or $\angle ABD = 90$ with reason<br><br>M1 to show<br>$\angle BCD + \angle CDA = 180$ or<br>$\angle ABC + \angle BAD = 180$<br><br>B1 to state int angles of parallel sides to conclude<br><br>B1 or $\angle ABD = 90$ with reason<br><br>M1 to show angle $CAD$ with reason and $=$ angle $BDA$ using a(i) and part b<br><br>B1 to state alternate angles used for parallel sides to conclude |  |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

- 5  $A, B, C$  and  $D$  are four points on level ground.  
 $A$  is due west of  $D$  and the bearing of  $C$  from  $A$  is  $050^\circ$ .  
 $AD = 25$  m,  $DC = 45$  m,  $DB = 70$  m and angle  $BDC = 100^\circ$ .



- (a) Show that  $BC = 89.5$  m, correct to 3 significant figures.

|     |                                                                                      |    |  |
|-----|--------------------------------------------------------------------------------------|----|--|
| 5a) | $BC^2 = 70^2 + 45^2 - 2(70)(45)\cos 100$ $BC = \sqrt{8018.9835}$ $= 89.549$ $= 89.5$ | M1 |  |
|     |                                                                                      | A1 |  |

Answer ..... [2]

- (b) Calculate angle  $ACD$ .

|     |                                                                                                                                           |                                                       |  |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|--|
| 5b) | $\frac{45}{\sin 40} = \frac{25}{\sin \angle ACD}$ $\sin \angle ACD = \frac{25 \sin 40}{45}$ $\angle ACD = 20.922$ $= 20.9 \text{ (1 dp)}$ | M1 use sin rule to find angle DCA with angle CAD = 40 |  |
|     |                                                                                                                                           | A1                                                    |  |

Answer ..... [2]

- (c) Calculate the bearing of  $D$  from  $C$ .

|     |                                                                                                                                                               |                                   |  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--|
| 5c) | $\text{Bearing of } D \text{ from } C$ $= 180^\circ + (50^\circ - \angle ACD)$ $= 180^\circ + 50^\circ - 20.922$ $= 180^\circ + 29.078^\circ$ $= 209.1^\circ$ | M1 to identifying correct bearing |  |
|     |                                                                                                                                                               | A1                                |  |

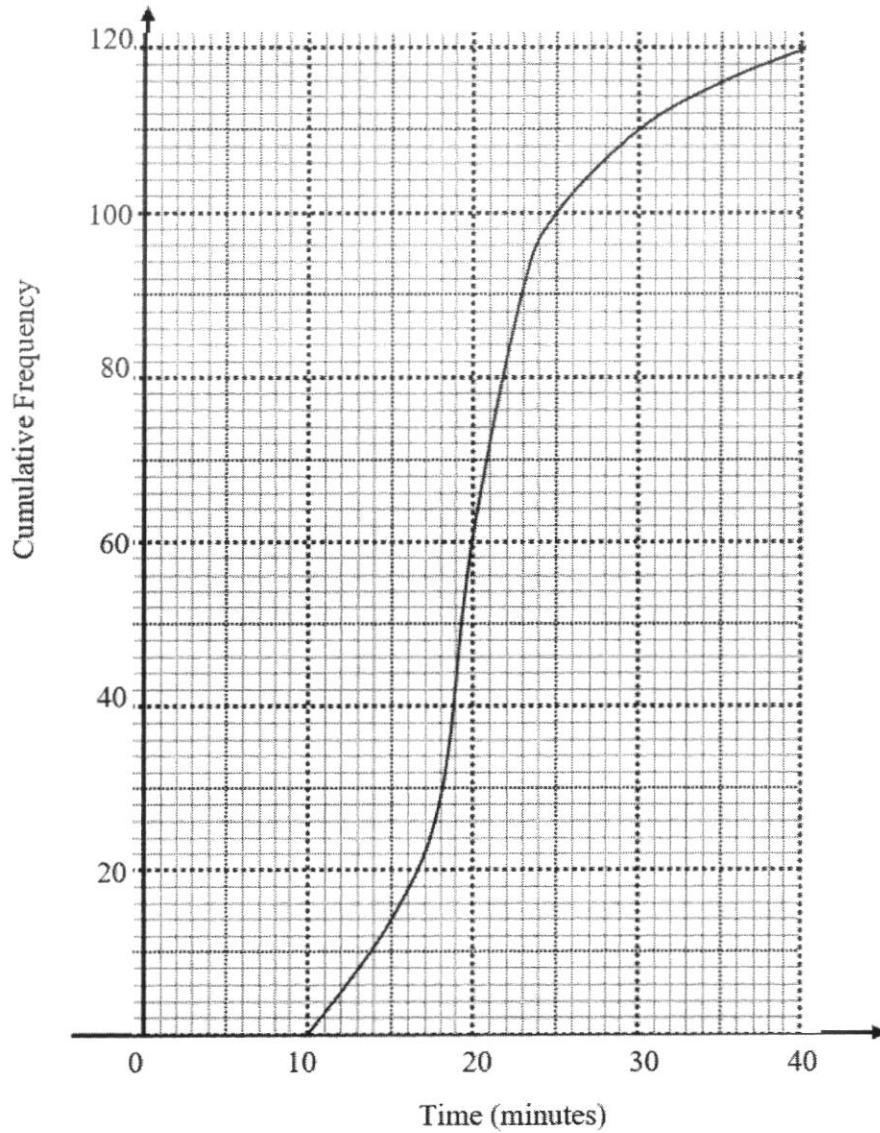
Answer ..... ° [2]

- (d)  $T$  is a point 53 m vertically above  $D$ .  
 A car travels along a straight path from  $B$  to  $C$  until it reaches a point  $E$  where the angle of elevation of  $T$  from  $E$  is the greatest.  
 Calculate this greatest angle of elevation.

|    |                                                                                                                                                                                                                                                                 |                                                                                                                                                                     |  |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 5c | $\frac{1}{2}(BC)(DE) = \frac{1}{2}(DC)(BD)\sin C'DB$ $\frac{1}{2}(89.5487)(DE) = \frac{1}{2}(45)(70)\sin 100$ $DE = [(45)(70)\sin 100] \div 89.5487$ $DE = 34.64196$<br>$\tan x = \frac{53}{34.64196}$ $x = \tan^{-1}(1.52994)$ $= 56.830^\circ$ $= 56.8^\circ$ | M1 find DE using area of triangle BDC or $\frac{1}{2} \times 89.5 \times \text{ht seen}$<br><br>A1<br><br>M1 <b>correct angle</b> of elevation identified<br><br>A1 |  |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

Answer ..... ° [4]

- 6 (a) The cumulative frequency graph shows the distribution of the time taken for 120 cars to travel a stretch of road from a research company.



(i) Use the curve to estimate

(a) the median time.

|            |        |    |  |
|------------|--------|----|--|
| 6(a)(i)(a) | 20 min | A1 |  |
|------------|--------|----|--|

Answer ..... minutes [1]

(b) the interquartile range of the time.

|            |                 |                  |  |
|------------|-----------------|------------------|--|
| 6(a)(i)(b) | 23 – 18 = 5 min | M1 UQ – LQ<br>A1 |  |
|------------|-----------------|------------------|--|

Answer ..... minutes [2]

- (ii) A survey states that 10% of the cars took more than 31 minutes to travel this stretch of road. Comment whether the data from the research centre supports this statement.

Answer

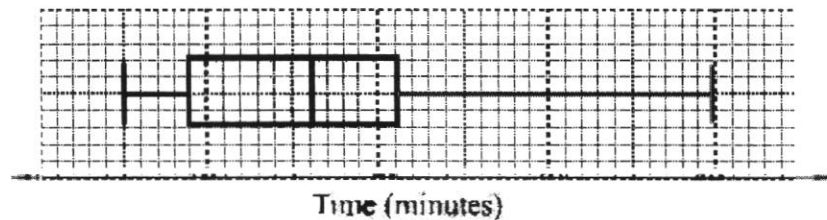
[2]

|       |                                                                                                                                                                                                                              |              |                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------|
| 6(ii) | $120 - 112 = 8$<br>$8/120 \times 100\% = 6.67\%$<br>Data does not support this statement $6.67\% < 10\%$<br>Accepted<br>10% of the car took more than 29min<br>8 cars took more than 31min<br>112 cars took less than 31 min | B1<br><br>A1 | State the number of 8 or 112 cars<br>Compare to number 12 cars or 108 cars resulting from 10% given in the qn) |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------|

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- (v) Some candidates demonstrated their understanding of what was required by stating a relevant numerical value or values from which they could draw a conclusion. Most attempted to use the curve to find the cumulative frequency for babies weighing 2.8 kg, leading to a value that could be compared with the 90% quoted. The most common method was to read 9 babies from the graph and equate this to 82% of babies, leading to a correct conclusion. Some quoted 9 babies less than 2.8 kg or 41 more than 2.8 kg but did not compare their value with 9 or 40 resulting from the 90% given in the question. A common error was to misread the horizontal scale, for example reading at 2.65 or 2.9 instead of 2.8. Some candidates misinterpreted the curve and stated that 90% of babies had a mass of 3.9 kg or more.

- (iii) The box-and-whisker plot below represents the distribution of the time taken for 120 motorcycles to travel the same stretch of road.



Make two comparisons between these two modes of transport.

Give a reason for your answer.

Answer

[2]

|        |                                                                                                                                                                                                                                               |              |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--|
| 6(iii) | Median time for motorcycle (16min) is lower than the cars (20min), motorcycles is a faster mode of transport.<br><br>IQR for cars (5 min) is lower than IQR of motorcycles (21- 9 = 12 min), hence the time taken by cars is more consistent. | B1<br><br>B1 |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--|

[Turn over]

- 6 (b) This table shows information about a group of students in a playgroup.

|       | Boys | Girls |
|-------|------|-------|
| Korea | 4    | 3     |
| Japan | 2    | 7     |

- (i) A student of the group is selected at random.  
Find, as a fraction in its lowest terms, the probability that the student is a boy from Korea

|       |                              |    |  |
|-------|------------------------------|----|--|
| 6b(i) | $\frac{4}{16} = \frac{1}{4}$ | B1 |  |
|-------|------------------------------|----|--|

- (ii) Two students are selected at random.  
Find, as a fraction in its lowest terms, the probability that  
(a) they are both boys,

(b) they are both girls but only one is from Japan. [2]

|            |                                                                       |              |  |
|------------|-----------------------------------------------------------------------|--------------|--|
| 6b(ii) (a) | $\frac{6}{16} \times \frac{5}{15}$                                    |              |  |
| 6b(ii) (b) | $\frac{7}{16} \times \frac{3}{15} + \frac{3}{16} \times \frac{7}{15}$ | M1 of either |  |
|            | $= \frac{7}{40}$                                                      | B1           |  |

- 7 (a) The point  $P$  has coordinates  $(-3, 8)$  and  $Q$  has coordinates  $(-6, 2)$ .  
 (i) Find the equation of the line  $PQ$ .

|       |                                                                                                                 |                                                                                                                         |  |
|-------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--|
| 7a(i) | $\text{grad} = \frac{-2}{6}$ $y = -\frac{1}{3}x + c$ $8 = -\frac{1}{3}(-3) + c$ $c = 7$ $y = -\frac{1}{3}x + 7$ | M1: grad of $-1/3$ seen and/ or attempt to find $c$ with their gradient found<br><br><br><br><br><br><br><br><br><br>A1 |  |
|-------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--|

Answer ..... [2]

- (ii) The equation of the line  $ST$  is  $3y + x - 10 = 0$ .

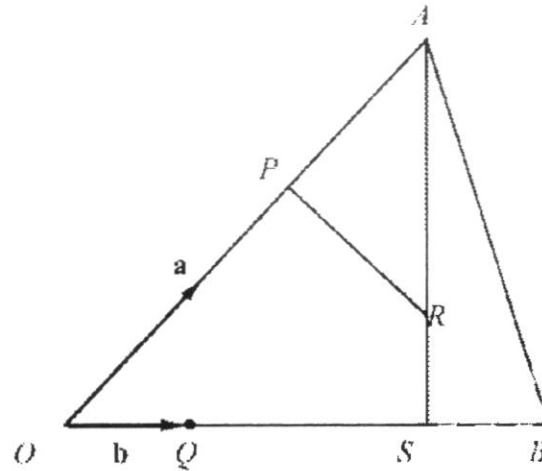
Explain, with clear working, if line  $PQ$  intersects line  $ST$ .

Answer

[2]

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                   |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 7a(ii) | $3y + x - 10 = 0$ $y = -\frac{1}{3}x + \frac{10}{3}$<br>$\text{Gradient of } ST = \text{gradient of } PQ = -\frac{1}{3}$<br>Lines are parallel, hence line $PQ$ does not intersect line $ST$ .<br><br>OR<br>$3y + x - 10 = 0 \quad \text{--- (1)}$ $y = -\frac{1}{3}x + 7 \quad \text{--- (2)}$ Sub (2) into (1)<br>$3(-\frac{1}{3}x + 7) - x - 10 = 0$ $-x + 21 - x - 10 = 0$ $-2x + 11 = 0$ $-2x = -11$ $x = \frac{11}{2}$ $y = -\frac{1}{3}(\frac{11}{2}) + 7 = \frac{-11 + 42}{6} = \frac{31}{6}$ Hence, line $PQ$ does not intersect line $ST$ | M1:<br>$\text{grad of } -\frac{1}{3}$ and compare with their grad found in (i)<br><br><br><br><br><br><br><br><br><br>B1: explain -parallel lines /same grad with different $y$ intercepts<br><br><br><br><br><br><br><br><br><br>M1 to solve sim eqn<br><br><br><br><br><br><br><br><br><br>B1: explain -no soln |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

(b)



$OAB$  is a triangle.

$Q$  and  $S$  are points on  $OB$  such that  $SB = OQ$  and  $OQ = \frac{1}{3} OS$ .

$P$  is a point on  $OA$  such that  $OP = \frac{2}{3} OA$ .

$R$  is a point on  $AS$  such that  $SR : RA = 1 : 2$ .

$\vec{OP} = \mathbf{p}$ ,  $\vec{OQ} = \mathbf{q}$ .

(i) Express, as simply as possible, in terms of  $\mathbf{p}$  and/or  $\mathbf{q}$ ,

(a)  $\vec{SA}$

|              |                                                                                    |                                       |  |
|--------------|------------------------------------------------------------------------------------|---------------------------------------|--|
| 7(b) (i) (a) | $\begin{aligned} OS &= 3b \\ SA &= SO + OA \\ &= -3b + \frac{3}{2}a \end{aligned}$ | B1: correct<br>$OS$ or $OA$<br><br>A1 |  |
|--------------|------------------------------------------------------------------------------------|---------------------------------------|--|

Answer ..... [2]

(b)  $\vec{PB}$

|              |                                                             |    |  |
|--------------|-------------------------------------------------------------|----|--|
| 7(b) (i) (a) | $\begin{aligned} PB &= PO + OB \\ &= -a + 4b \end{aligned}$ | A1 |  |
|--------------|-------------------------------------------------------------|----|--|

Answer ..... [1]

(ii) Show that  $P$ ,  $R$  and  $B$  lie on a straight line.

Answer

[3]

|        |                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                     |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 7b(ii) | $PR = PA + AR$ $= \frac{1}{2}a + \frac{2}{3}AS$ $= \frac{1}{2}a + \frac{2}{3}\left(3b - \frac{3}{2}a\right)$ $= -\frac{1}{2}a + 2b$ $= \frac{1}{2}(-a + 4b)$ $= \frac{1}{2}PB$ $\frac{PR}{PB} = \frac{1}{2}$ <p>Since <math>\frac{PR}{PB} = \frac{1}{2}</math> or <math>PR = \frac{1}{2}PB</math> and <math>P</math> is a common point <math>P, R, B</math> lie on a straight line.</p> | <p>M1: find <math>AR</math> or <math>PA</math> correctly</p> <p>M1: make <math>PR</math> as factor with <math>PB</math> seen</p> <p>A1 conclude with correct ratio and <u>P as common point</u></p> |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

(iii) Find the numerical value of  $\frac{\text{area of triangle } ASB}{\text{area of triangle } AOB}$ 

|          |                                                                                                                                       |    |  |
|----------|---------------------------------------------------------------------------------------------------------------------------------------|----|--|
| 7b (iii) | $\frac{\text{area of triangle } ASB}{\text{area of triangle } AOB}$ $= \frac{\frac{1}{2}(SB)(h)}{\frac{1}{2}(OB)(h)}$ $= \frac{1}{4}$ | A1 |  |
|----------|---------------------------------------------------------------------------------------------------------------------------------------|----|--|

Answer ..... [1]

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

(a) Complete the table of values for  $y = -\frac{1}{5}x^3 + 2x + 1$

|     |     |     |     |     |   |     |     |     |     |
|-----|-----|-----|-----|-----|---|-----|-----|-----|-----|
| $x$ | 4   | 3   | 2   | 1   | 0 | -1  | -2  | -3  | -4  |
| $y$ | 5.8 | 0.4 | 1.1 | 0.8 | 1 | 2.8 | 3.4 | 1.6 | 3.8 |

[1]

|    |     |    |  |
|----|-----|----|--|
| 8a | 1.4 | A1 |  |
|----|-----|----|--|

(b) On the grid opposite, draw the graph of  $y = -\frac{1}{5}x^3 + 2x + 1$  for  $-4 \leq x \leq 4$   
[3]

Marker's report:

Curve should be drawn with smooth curve using SHARP pencil

note curve has point (-3.5, 2.6) and (-2.5, 0.9)

|    |                                           |                                                                                                                                                                                   |  |
|----|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 8b | <b>Smooth curve</b> with correct 9 points | B3<br>Or B2FT for 9 points plotted correctly Or<br>B1FT for 7 or 8 points plotted correctly<br>Tolerance $\pm 1\text{mm}$ for plotting points and drawing<br>curve through points |  |
|----|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

- (c) By drawing a suitable tangent, find the gradient of the curve at  $x = -3$ .

|    |                                                  |                                           |  |
|----|--------------------------------------------------|-------------------------------------------|--|
| 8c | Draw tangent at<br>$x = -3$<br><br>$grad = -3.4$ | M1<br><br>A1 (accept<br>-2.1 to -4.1<br>) |  |
|----|--------------------------------------------------|-------------------------------------------|--|

Answer ..... [2]

- (d) (i) On the same grid, draw the graph of  $2y + x = 1$  for  $-4 \leq x \leq 4$

|    |              |                          |  |
|----|--------------|--------------------------|--|
| 8d | $2y + x = 1$ | L1 cuts at 0.5 at y-axis |  |
|----|--------------|--------------------------|--|

[1]

- (ii) Show that the points of intersection of the line and the curve gives the solution of  $-2x^3 + 25x + 5 = 0$ .

Answer

|        |                                                                                                                           |                                                  |  |
|--------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--|
| 8d(ii) | $-\frac{2}{5}x^3 - 5x + 1 = \frac{1}{2}x - \frac{1}{2}$ $-2x^3 + 20x + 10 = -5x + 5$ $2x^3 + 25x + 5 = 0 \text{ (shown)}$ | B1 Equate line and curve<br><br><b>B1 (x 10)</b> |  |
|--------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--|

[2]

- (iii) Use your graph to solve the equation  $-2x^3 + 25x + 5 = 0$ .

|         |                                  |                                                                                                                               |  |
|---------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--|
| 8d(iii) | $x = -3.4, -0.2 \text{ or } 3.7$ | A2<br>FT intersections of their line and their curve<br>Or A1FT for two correct solutions<br>Tolerance $\pm 0.1$ for readings |  |
|---------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--|

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

[Turn over

- 9 To prevent vehicles from speeding, speed humps are built on the roads to regulate the speed of cars.

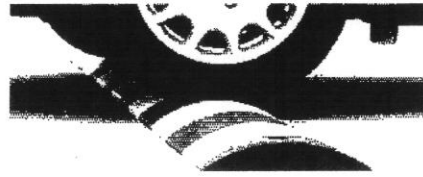


Diagram 1 shows the length, width and height of one speed hump. Each speed hump along a road has 4 identical speed humps joined together.

Diagram 1

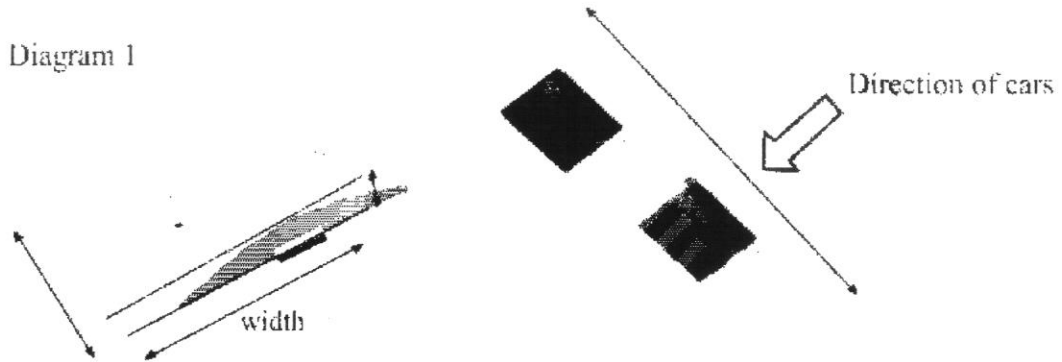
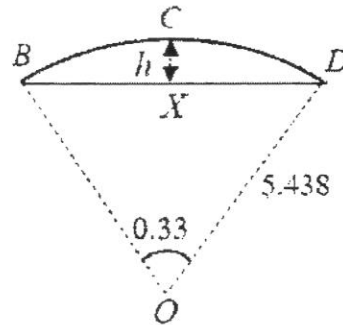


Diagram 2 shows the cross-section of one speed hump.  
 $BCD$  is part of sector  $OBCD$  with centre  $O$ , radius  $5.438$  m and angle  $BOD$  of  $0.33$  radians.

Diagram 2 : Cross-section of one speed hump



- (a) Find the length of the arc  $BCD$  of the speed hump as shown in Diagram 2.

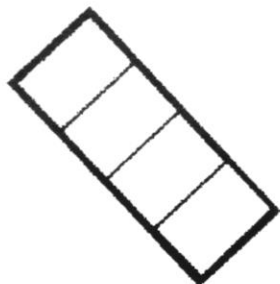
|     |                                                         |    |  |
|-----|---------------------------------------------------------|----|--|
| 9a) | $s = 5.438 (0.33)$<br>$= 1.79454$<br>$= 1.79 \text{ m}$ | A1 |  |
|-----|---------------------------------------------------------|----|--|

Answer .....m [1]

- (b) Diagram 3 shows the top view of 4 identical speed humps joined together. The thickness of the rubber to cover the top of each speed hump is 0.5 cm and the total cost to cover four such speed humps is \$240.

Using the information given in the table, calculate the length of one speed hump.

Diagram 3 : Top view of four speed humps



| Information for material used and cost             |                        |
|----------------------------------------------------|------------------------|
| Density of rubber                                  | 1060 kg/m <sup>3</sup> |
| Cost of rubber per kg                              | \$20                   |
| Cost to cover the <b>top</b> part of 4 speed humps | \$240                  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 9b | <p><u>Let the length of 1 bump be <math>x</math> m</u></p> <p>Using volume of rubber<br/> <math>0.005 \times 1.79\ 454 \times \text{length}</math><br/> <math>= 0.0089\ 727 \times m^3</math></p> <p>OR area of sector <math>\times</math> length<br/> <math>(\frac{1}{2} (5.438)^2 (0.33) - \frac{1}{2} (5.438 - 0.005)^2 (0.33))</math><br/> <math>= \frac{1}{2} (5.438)^2 (0.33) - \frac{1}{2} (5.433)^2 (0.33)</math><br/> <math>= 4.879\ 354 - 4.870\ 386</math><br/> <math>= 0.0089\ 68315\ m^3</math></p> <p>Mass of rubber<br/> <math>= 1060 \times 0.0089\ 727 \times</math> (mass = density <math>\times</math> vol)<br/> <math>= 9.511\ 062 \times\ kg</math></p> <p>Cost of rubber for 1 bump : <math>240 \div 4 = \\$60</math></p> <p><math>20 (9.511\ 062 \times) = 60</math></p> <p><math>x = \frac{60}{20(9.511062)} \quad \text{OR} \quad x = \frac{240}{4 \times 20(9.511062)}</math><br/> <math>x = 0.315\ 422\ m</math></p> <p>length of bump of 0.315 m.</p> | <p>M1 (find volume of 1 bump using <b>0.005</b> (in metre) <math>\times</math> their arc length BCD <math>\times</math> length or difference in area of sector <math>\times</math> length</p> <p>M1 find Mass of rubber <math>1060 \times</math> their vol<br/> OR<br/> M1 (find length using <math>\\$20 \times</math> mass of 1 rubber = 60 ) or <math>\\$20 \times</math> their mass <math>\times 4 = 240</math><br/> (M1 if find mass of 1 bump : <math>(240 \div 4) \div 20 = 3\text{kg}</math></p> <p>A1 (use of diff in sector, ans for 1 length will be 0.315568)</p> |  |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

|                                                           |  |  |
|-----------------------------------------------------------|--|--|
| Alternative                                               |  |  |
| Mass of 1 hump - $\frac{240}{4 \times 20} = 3 \text{ kg}$ |  |  |
| Vol = $3 \div 1060 = 0.0028301 \text{ m}^3$               |  |  |
| $x (1.79454 \times 0.005 = 0.0028301$                     |  |  |
| $x = 0.315 \text{ m}$                                     |  |  |

Answer .....m [3]

- (c) The engineers are to ensure that the height ( $h$ ), width ( $w$ ) and length ( $l$ ) of **each** speed hump meet the safety criteria as shown in the table.

|                                                                                                                                   |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Height of the hump ( $h$ )                                                                                                        | $0.0732 \text{ m} \leq h < 0.1016 \text{ m}$    |
| Width of the hump ( $w$ )                                                                                                         | $0.9144 \text{ m} \leq w < 1.8288 \text{ m}$    |
| Gradient of the hump ( $g$ ),<br>where $g$ is given as the ratio of the<br>height of the hump : horizontal length of $BX$ or $XD$ | $g < 0.1$                                       |
| Length of one speed hump ( $l$ )                                                                                                  | $0.3048 \text{ m} \leq l \leq 0.9144 \text{ m}$ |

Show with clear working if the engineers should approve this speed hump.

Answer

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                           |  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 9c | <p><u>Height of the hump:</u></p> $\cos 9.4538^\circ = \frac{OX}{5.438} \quad \text{or} \quad \cos 0.165 \text{ rad} = \frac{OX}{5.438}$ $OX = 5.438 \cos 9.538$ $OX = 5.36414$ $h = 5.438 - 5.36414$ $= 0.0738569$ $= 0.0739 \text{ m}$ <p><u>Chord BD</u></p> $\sin 9.4538^\circ = \frac{BX}{5.438} \quad \text{or} \quad \sin 0.165 \text{ rad} = \frac{BX}{5.438}$ $BX = 5.438 \sin 9.5288$ $BX = 0.893204$ $BD = 2 \times 0.893204$ $= 1.786408$ $= 1.79 \text{ m}$ | <p>M1 finding OX<br/>using trigo ratio or<br/>sine rule<br/>Pythagoras thm if<br/>they have found BD<br/>first</p> <p>A1 for correct <math>h</math> or<br/><math>BD</math> or <math>BX</math></p> <p>M1 finding BX<br/>using trigo ratio /<br/>sine rule or</p> <p>A1</p> |  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

|  |                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                    |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <p>OR</p> <p><u>Gradient of hump using ratio</u></p> $grad = \frac{0.073857}{0.893204}$ $= 0.0827$ <p>Gradient &lt; 0.1</p> <p>From 9b) length of bump of 0.316 m<br/>(0.3048m ≤ l ≤ 0.9144 m)</p> <p>All criteria are met, the engineers can approve the speed bump.</p> | <p>M1<br/>(their <math>h \div</math> their <math>BX</math><br/>or their <math>BD</math>)</p> <p>B1 for comparison<br/>of length from part b<br/>(to award only if<br/>length &lt; 1m)<br/>AND conclusion<br/>based for all safety<br/>criteria</p> |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

ORIGINAL

[6]

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                     |  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 9c | <p><u>Height of the hump:</u></p> $\cos 9.4538^\circ = \frac{OX}{5.438} \quad \text{or} \quad \cos 0.165 \text{ rad} = \frac{OX}{5.438}$ $OX = 5.438 \cos 9.538$ $OX = 5.36414$ $h = 5.438 - 5.36414$ $= 0.0738569$ $= 0.0739 \text{ m}$ <p><u>Chord BD</u></p> $\sin 9.4538^\circ = \frac{BX}{5.438} \quad \text{or} \quad \sin 0.165 \text{ rad} = \frac{BX}{5.438}$ $BX = 5.438 \sin 9.5288$ $BX = 0.893204$ $BD = 2 \times 0.893204$ $= 1.786408$ $= 1.79 \text{ m}$ <p><u>Gradient of hump using ratio</u></p> $\text{grad} = \frac{0.073857}{0.893204}$ $= 0.0827$ <p>Gradient &lt; 0.1</p> <p>From 9b) length of bump of 0.316 m<br/>(0.3048m ≤ l ≤ 0.9144 m)</p> <p>All criteria are met, the engineers can approve the speed bump.</p> | <p>M1 finding OX<br/>using trigo ratio or<br/>sine rule</p> <p>A1</p> <p>M1 finding BX<br/>using trigo ratio /<br/>sine rule</p> <p>A1</p> <p>M1<br/>(their h / their BX or<br/>their BD)</p> <p>B1 for comparison<br/>of length from part b<br/>(to award only if<br/>length &lt; 1m)<br/>AND conclusion<br/>based for all safety<br/>criteria</p> |  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|