



**ZHONGHUA SECONDARY SCHOOL**  
**PRELIMINARY EXAMINATION 2018**  
**SECONDARY 4E/4N/5N**

Candidate's Name	Class	Register Number

**MATHEMATICS**

**4048/01**

PAPER 1

27 Aug 2018  
2 hours

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and register number 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 paper clips, glue or correction fluid.

Answer **all** questions.  
The number of marks is given in brackets [ ] at the end of each question or part question.

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 total of the marks for this paper is **80**.

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  $\pi$ .

For Examiner's Use
<b>80</b>

**Mathematical Formulae****Compound Interest**

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

**Mensuration**

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

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

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

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

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

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

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

**Trigonometry**

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

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

**Statistics**

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

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

Answer **all** the questions.

1 (a) Calculate  $\frac{3 + \sqrt{-4^2 + 2 \times 11}}{5}$ .

Write down the first 6 digits on your calculator display.

*Answer* ..... [1]

(b) Write your answer to part (a) correct to 3 decimal places.

*Answer* ..... [1]

2 These are the first five terms of a sequence.

2018      2011      2004      1997      1990

(a) Write down the tenth term in the sequence

*Answer* ..... [1]

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

*Answer* ..... [1]

(c) Explain why the number 3 does not appear in the sequence.

Show your working clearly.

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

3 (a) Factorise completely  $48xy - 8y$ .

*Answer* ..... [1]

(b) Factorise completely  $x^4 + 3x^3 - 4x^2$ .

*Answer* ..... [2]

---

4 Solve the equation  $x(x-3) = 5(x^2 - 9)$ .

*Answer* ..... [3]

---

5 Calculate the interior angle of a regular 10-sided polygon.  
Show your working clearly.

*Answer* .....<sup>°</sup> [2]

---

- 6 (a) Given that  $6^m \div 6^{-3} = 6^2$ , find the value of  $m$ .

*Answer*  $m = \dots\dots\dots$  [1]

- (b) Arrange the following numbers in increasing value.

Show your working clearly.

$$0.0037 \times 10^6 \qquad 3.7 \times 10^5 \qquad 370 \times 10^{-3} \qquad 37$$

*Answer*  $\dots\dots\dots, \dots\dots\dots, \dots\dots\dots, \dots\dots\dots$  [2]  
smallest smallest largest largest

- (c) Simplify  $\sqrt[3]{8x^6} \times \frac{1}{3y^{-5}}$ . Leave your answer in positive index form.

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

- 7 Ken invested \$12 000 into a fund which pays compound interest of 4% per annum compounded half-yearly.

Calculate the total interest earned in 5 years.

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

- 8 (a) Express  $x^2 - 8x + 11$  in the form  $(x - a)^2 + b$ .

*Answer* ..... [2]

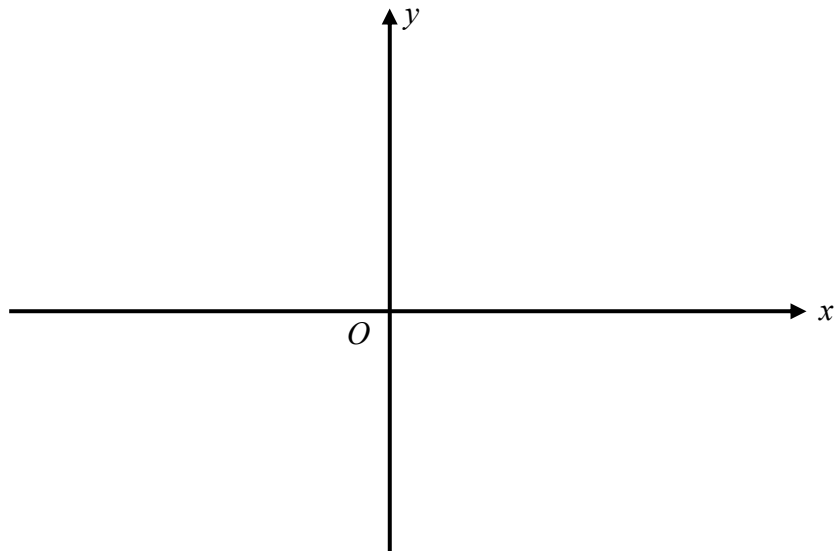
- (b) Hence solve the equation  $x^2 - 8x + 11 = 0$ , giving your answers correct to two decimal places.

*Answer*  $x = \dots\dots\dots$  or  $x = \dots\dots\dots$  [2]

- (c) Sketch the graph of  $y = x^2 - 8x + 11$ .

Indicate the  $y$ -intercept and the turning point of the graph clearly.

*Answer*

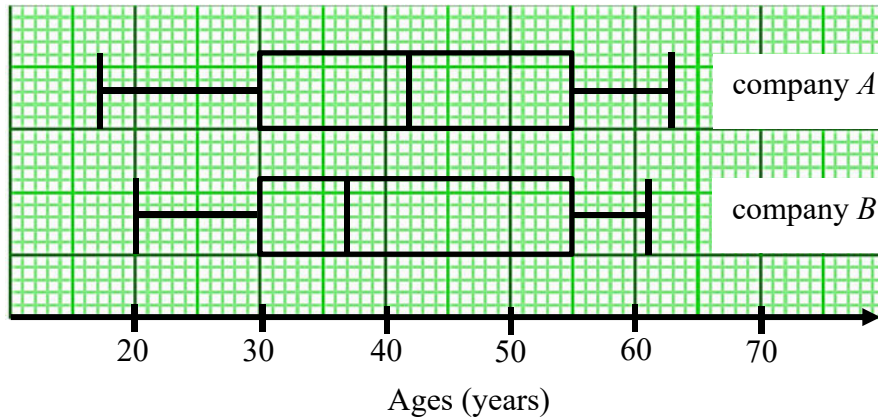


[2]

- (d) Write down the equation of line of symmetry of the graph of  $y = x^2 - 8x + 11$ .

*Answer* ..... [1]

- 9 These box plots show the age distributions of the 200 employees in each of company *A* and company *B*.



- (a) Find the range of the employee's age of company *A*.

*Answer* ..... [1]

- (b) For each the following statements, write whether you agree or disagree.  
Give a statistical reason which you use to support your decision.

- (i) On average, company *A* has older employees than company *B*.

*Answer* ..... because .....  
.....  
..... [1]

- (ii) There are more employees who are below 30 years old in company *A* than in company *B*.

*Answer* ..... because .....  
.....  
..... [1]

- (c) An employee is randomly selected from company *B*.

Find the probability that the employee ages between 30 and 55 years old.

*Answer* ..... [1]

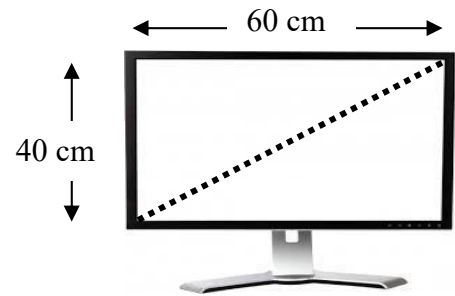
**10** The size of television (TV) screens are measured diagonally in inches.

(1 inch = 2.54 cm)

**(a)** A TV screen has dimension 40 cm by 60 cm.

Find the size of the TV.

Give your answer correct to the nearest inch.



*Answer* .....inches [2]

**(b)** An electronic store offers 20% discount storewide.

Ali wishes to buy a new 45-inch TV which costs \$2298.

All TV sets have an additional  $y\%$  off after a storewide discount.

He received a receipt with poor print quality and some numbers missing.

45-inch TV		\$ 2298
After 20% off		\$ x
After $y\%$ off		\$ 1562.64
Amount Paid		\$

Find the value of  $x$  and  $y$ .

*Answer*  $x =$  .....

$y =$  ..... [2]



11 (a)  $\xi = \{\text{integers } x : 2 \leq x \leq 10\}$

$F = \{\text{factors of } 18\}$

$G = \{\text{prime numbers}\}$

(i) List the elements in  $F'$ .

Answer ..... [1]

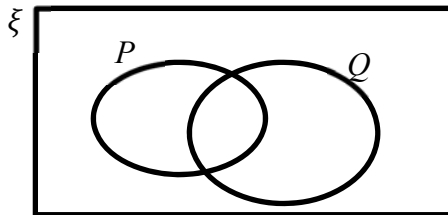
(ii) State the number of elements in  $F \cup G$ .

Answer ..... [1]

(iii) Explain why  $2 \in (F \cap G)$ .

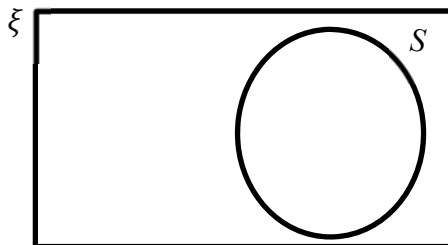
Answer .....  
 ..... [1]

(b) On the Venn diagram shown below, shade the set  $P \cap Q'$ .



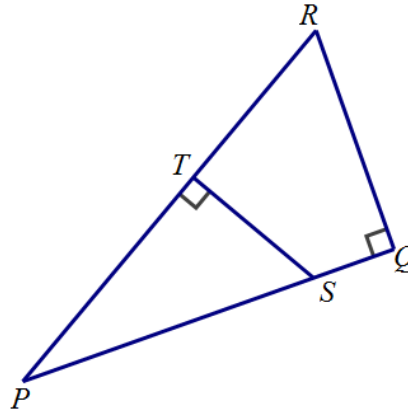
Answer On the diagram [1]

(c) On the diagram below, draw the set  $R$  such that  $R \cap S = \emptyset$ .



Answer On the diagram [1]

- 12 (i)  $PQR$  forms a right-angled triangle such that angle  $PQR = 90^\circ$ .  
 $ST$  is perpendicular to  $PR$ .



Name a triangle which is similar to triangle  $PQR$ .

*Answer* Triangle..... [1]

- (ii) Given further that  $PQ = 8$  cm ,  $QR = 6$  cm and  $PR = 10$  cm, find the length of  $ST$  where  $T$  is the midpoint of  $PR$ .

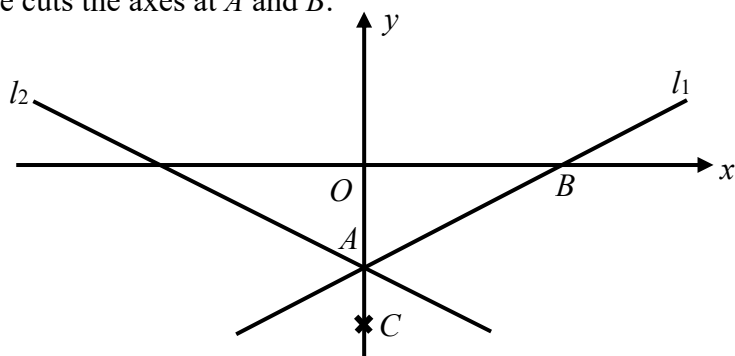
*Answer*  $ST =$  ..... cm [2]

- 13 The radius of a cylinder is increased by 25% and its height is decreased by 50%.  
 Calculate the percentage decrease in the volume of the cylinder.  
 Give your answer correct to 1 decimal place.

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

14 The following diagram shows a sketch of the line  $l_1 : y = \frac{3}{4}x - 3$ .

The line cuts the axes at  $A$  and  $B$ .



(a) Find the coordinates of  $A$  and  $B$ .

Answer  $A$  (....., .....)  
 $B$  (....., .....) [2]

(b) The line  $l_2$  is a reflection of the line  $l_1$  along the  $y$ -axis.  
 Write down the equation of the line  $l_2$ .

Answer ..... [1]

(c)  $C$  is a point on  $y$ -axis, as shown on the diagram.  
 Calculate the exact value of  $\cos \angle BAC$ .

Answer ..... [1]

(d) Another line  $l_3 : y = \frac{3}{4}x + 2$  can be drawn on the same axes.

Explain why the lines  $l_1$  and  $l_3$  do not meet.

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

- 15 Two geometrically similar containers have the following specifications.

	<b>Container A</b>	<b>Container B</b>
Height (m)	$p$	50
Cost of painting the base (\$)	120	480
Time taken to completely fill the container with water (to the nearest minute)	123 minutes	$q$ hours $r$ minutes

Find the values of  $p$ ,  $q$  and  $r$ .

*Answer*  $p = \dots\dots\dots$   
 $q = \dots\dots\dots$   
 $r = \dots\dots\dots$  [5]

- 16 Given that  $y$  varies as  $x^n$ , write down the value of  $n$  in each of the following cases:

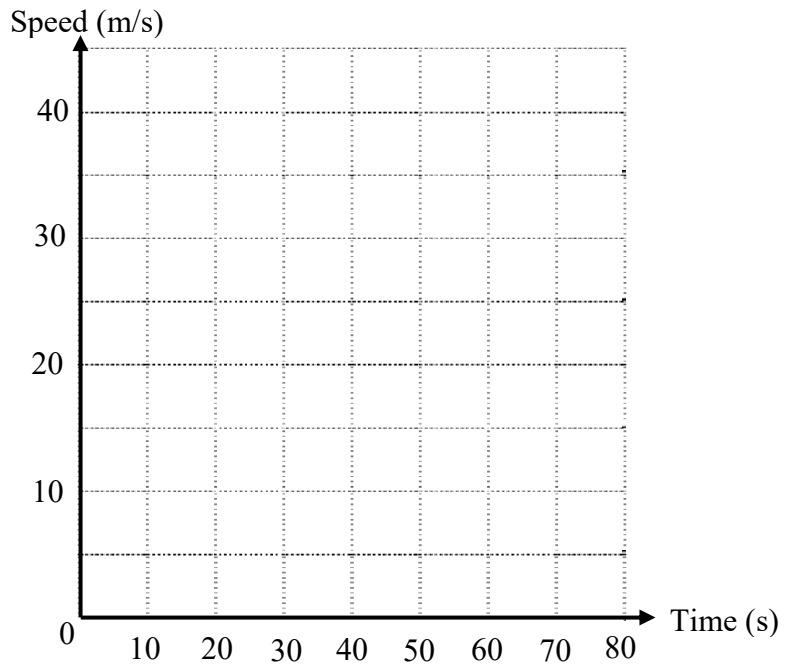
(a)  $y$  is the volume of a sphere of radius  $x$ ,

*Answer*  $n = \dots\dots\dots$  [1]

(b)  $y$  and  $x$  are the sides of a rectangle of given area.

*Answer*  $n = \dots\dots\dots$  [1]

- 17 A train travels at a constant speed of 40 m/s for 50 seconds.  
 It then slows down at a constant rate until it comes at rest in 20 seconds.  
 (a) On the axes, draw the speed-time graph for the journey.



*Answer* On the diagram [1]

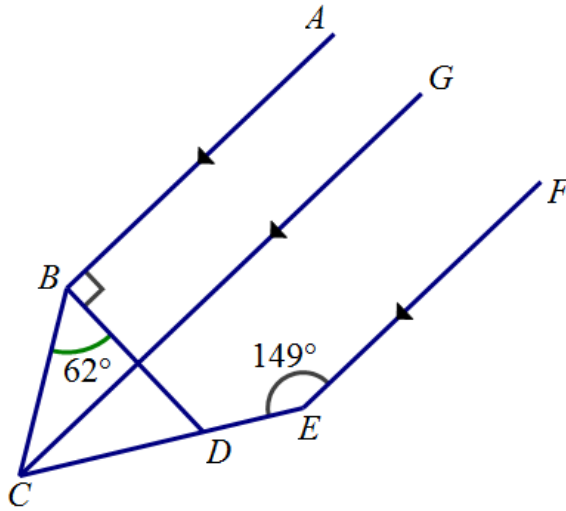
- (b) Calculate the distance travelled by the train during the first 60 seconds.

*Answer* .....m [2]

18 In the figure,  $AB$  is parallel to  $GC$  and  $FE$ .

Angle  $CEF = 149^\circ$  and angle  $CBD = 62^\circ$ .

$D$  is a point on  $CE$  such that angle  $ABD = 90^\circ$ .



Find, stating the reasons clearly,

(a) angle  $BCD$ ,

Answer ..... $^\circ$  [3]

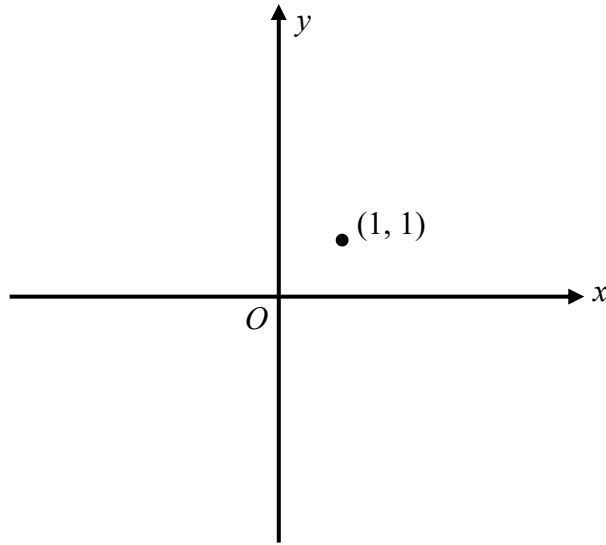
(b) angle  $BDE$ .

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

19 Sketch the graph of each of the following equations.

The point (1, 1) is plotted on each diagram.

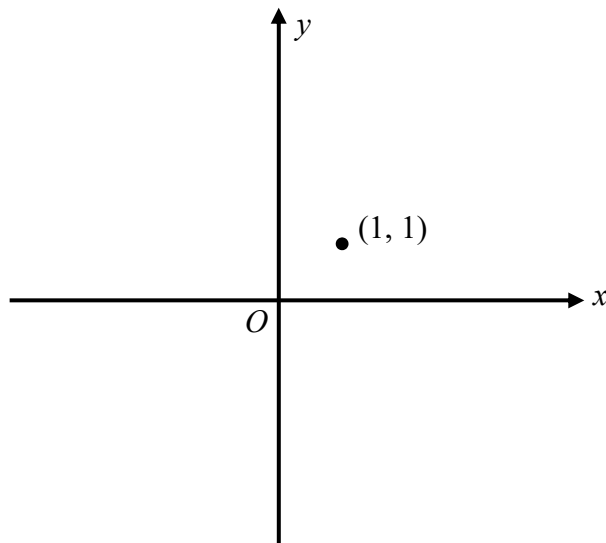
(a)  $y = 2^x$



Answer On the diagram

[1]

(b)  $y = \frac{1}{x^2}$



Answer On the diagram

[1]

20 The line  $AB$  is drawn below.



- (a) Construct triangle  $ABC$  where angle  $ABC = 60^\circ$  and  $BC = 8$  cm. [2]
- (b) Construct the perpendicular bisector of  $BC$ . [1]
- (c) From  $C$ , construct a line that is equidistant from the lines  $CA$  and  $CB$ . [1]
- (d) Find the reflex angle  $ACB$ .

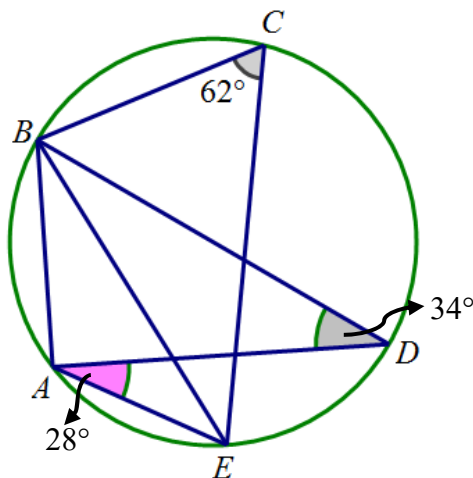
Answer ..... $^\circ$  [1]

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21 A circle passes through  $A, B, C, D$  and  $E$ .

It is given that angle  $ADB = 34^\circ$ , angle  $DAE = 28^\circ$  and angle  $BCE = 62^\circ$ .



By stating the reasons clearly,

(a) show that  $BD$  is a diameter of the circle,

*Answer*

[3]

(b) show that  $BE$  bisects angle  $ABD$ .

*Answer*

[2]

~~~ End of Paper ~~~

**Answers**

- 1a) 1.08989  
 1b) 1.090
- 2a) 1955  
 2b)  $2025 - 7n$
- 3a)  $8y(6x - 1)$   
 3b)  $x^2(x + 4)(x - 1)$
- 4)  $x = 3$  or  $x = \frac{15}{4}$
- 5)  $144^\circ$
- 6a)  $m = -1$   
 6b)  $370 \times 10^{-3}, 37, 0.0037 \times 10^6, 3.7 \times 10^5$   
 6c)  $\frac{2}{5}x^2y^3$
- 7) \$2627.93
- 8a)  $(x - 4)^2 - 5$   
 8b)  $x = 6.24$  or  $x = 1.76$   
 8d)  $x = 4$
- 9a) 46 years  
 9b) agree, due to Company A has higher median age than Company B  
 9c) disagree, both companies have equal lower quartile and therefore they have equal number of employees whose age is below 30.
- 10a) 28  
 10b)  $x = 1838.40, y = 15$
- 11ai) {4, 5, 7, 8, 10}  
 11aii) 6  
 11aiii) Because 2 is a factor of 18 AND it is also a prime number
- 12i) triangle PTS  
 12ii) 3.75 cm
- 13 21.9%
- 14a)  $A(0, -3), B(4, 0)$   
 14b)  $y = -\frac{3}{4}x - 3$   
 14c)  $-\frac{3}{5}$   
 14d) Both lines have equal gradient, therefore they are parallel. As both lines are parallel and have different y-intercept, both lines do not meet.
- 15  $p = 25, q = 16, r = 24$
- 16a)  $n = 3$   
 16b)  $n = -1$
- 17b) 2300
- 18a)  $59^\circ$   
 18b)  $121^\circ$



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Candidate's Name

Class

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**MARKING SCHEME**

**MATHEMATICS**

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|--------------------|
| <b>80</b>          |

**Mathematical Formulae****Compound Interest**

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

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

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**Trigonometry**

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

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

**Statistics**

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

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

Answer **all** the questions.

1 (a) Calculate  $\frac{3 + \sqrt{-4^2 + 2 \times 11}}{5}$ .

Write down the first 6 digits on your calculator display.

*Answer* 1.08989 [B1] [1]

(b) Write your answer to part (a) correct to 3 decimal places.

*Answer* 1.090 [B1] [1]

2 These are the first five terms of a sequence.

2018      2011      2004      1997      1990

(a) Write down the tenth term in the sequence.

*Answer* 1955 [B1] [1]

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

*Answer* 2025 – 7*n* or  
2018 – 7(*n* – 1) [B1] [1]

(c) Explain why the number 3 does not appear in the sequence.

Show your working clearly.

$$2025 - 7n = 3$$

$$2022 = 7n$$

$$n = \frac{2022}{7} \text{ [B1]}$$

*Answer* Since  $n = \frac{2022}{7}$  is not a positive integer or whole number [A1], the

number 3 does not appear in the sequence.[2]

- 3 (a) Factorise completely  $48xy - 8y$ .

*Answer*  $8y(6x - 1)$  [B1] [1]

- (b) Factorise completely  $x^4 + 3x^3 - 4x^2$ .

$$\begin{aligned} x^4 + 3x^3 - 4x^2 &= x^2(x^2 + 3x - 4) \text{[M1 - factorise } x^2\text{]} \\ &= x^2(x + 4)(x - 1) \end{aligned}$$

*Answer*  $x^2(x + 4)(x - 1)$  [A1] [2]

---

- 4 Solve the equation  $x(x - 3) = 5(x^2 - 9)$ .

**Method 1:**

$$x(x - 3) = 5(x - 3)(x + 3) \text{[M1]}$$

$$(x - 3)(x - 5(x + 3)) = 0 \text{[M1]}$$

$$(x - 3)(-4x - 15) = 0$$

**Method 2:**

$$x^2 - 3x = 5x^2 - 45 \text{[M1]}$$

$$-4x^2 - 3x + 45 = 0$$

$$(-4x - 15)(x - 3) = 0 \text{[M1]}$$

*Answer*  $x = 3$  or  $x = -\frac{15}{4}$  [A1] [3]

---

- 5 Calculate the interior angle of a regular 10-sided polygon.

Show your working clearly.

$$\begin{aligned} \text{int. angle} &= \frac{10 - 2}{10} \times 180^\circ \text{[M1]} \\ &= 144^\circ \end{aligned}$$

*Answer*  $144^\circ$  [A1] [2]

---

- 6 (a) Given that  $6^m \div 6^{-3} = 6^2$ , find the value of  $m$ .

$$\text{Answer } m = -1 \text{ [B1]} \quad [1]$$

- (b) Arrange the following numbers in increasing value.

Show your working clearly.

$$\begin{array}{cccc} 0.0037 \times 10^6 & 3.7 \times 10^5 & 370 \times 10^{-3} & 37 \\ = 3.7 \times 10^3 & & = 3.7 \times 10^{-1} & = 3.7 \times 10^1 \end{array}$$

[M1 – conversion to multiplication of 3.7]

[A1 – correct order]

$$\text{Answer } 370 \times 10^{-3}, \quad 37, \quad 0.0037 \times 10^6, \quad 3.7 \times 10^5 \quad [2]$$

smallest  largest

- (c) Simplify  $\sqrt[3]{8x^6} \times \frac{1}{3y^{-5}}$ . Leave your answer in positive index form.

$$\begin{aligned} \sqrt[3]{8x^6} \times \frac{1}{3y^{-5}} &= 2x^2 \times \frac{1}{3}y^5 \text{ [B1 – } 2x^2 \text{ seen]} \\ &= \frac{2}{3}x^2y^5 \end{aligned}$$

$$\text{Answer } \frac{2}{3}x^2y^5 \text{ [A1]} \quad [2]$$

- 7 Ken invested \$12 000 into a fund which pays compound interest of 4% per annum compounded half-yearly.

Calculate the total interest earned in 5 years.

$$\begin{aligned} \text{Total interest} &= 12000 \left(1 + \frac{4\%}{2}\right)^{10} - 12000 && \text{[B1 – } \frac{4\%}{2} \text{ or } 2\% \text{ seen]} \\ &= 2627.93 && \text{[B1 – to the power of 10]} \end{aligned}$$

$$\text{Answer } \$ 2627.93 \text{ [A1]} \quad [3]$$

- 8 (a) Express  $x^2 - 8x + 11$  in the form  $(x - a)^2 + b$ .

[B1 – for value of  $a$ ] [B1 – for value of  $b$ ]

*Answer*  $(x - 4)^2 - 5$  [2]

- (b) Hence solve the equation  $x^2 - 8x + 11 = 0$ , giving your answers correct to two decimal places.

$$x^2 - 8x + 11 = 0$$

$$(x - 4)^2 - 5 = 0$$

$$x - 4 = \pm\sqrt{5} \text{ [M1]}$$

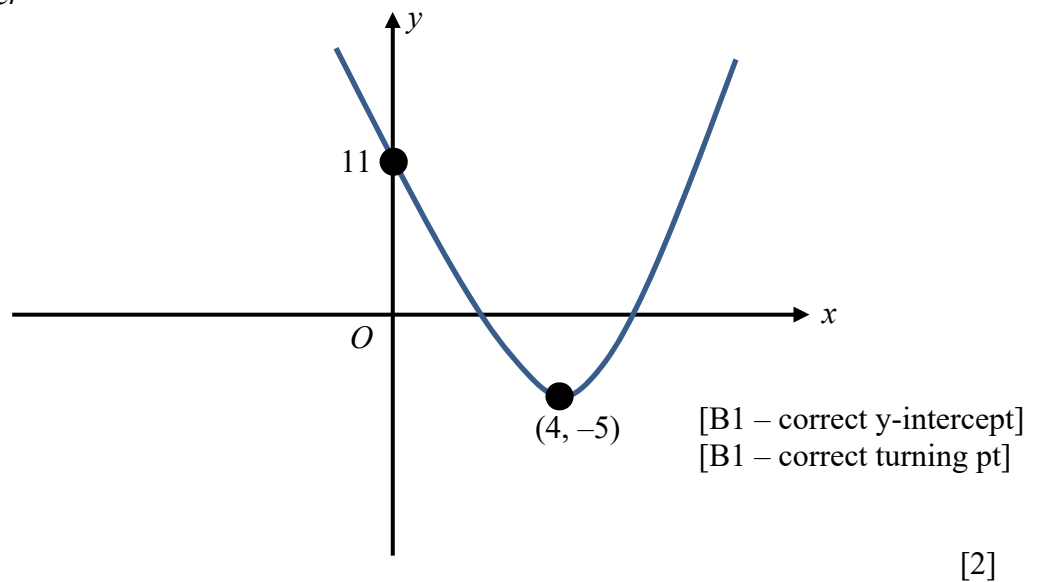
[A1 – for both values of  $x$ ]

*Answer*  $x = 6.24$  or  $x = 1.76$  [2]

- (c) Sketch the graph of  $y = x^2 - 8x + 11$ .

Indicate the  $y$ -intercept and the turning point of the graph clearly.

*Answer*

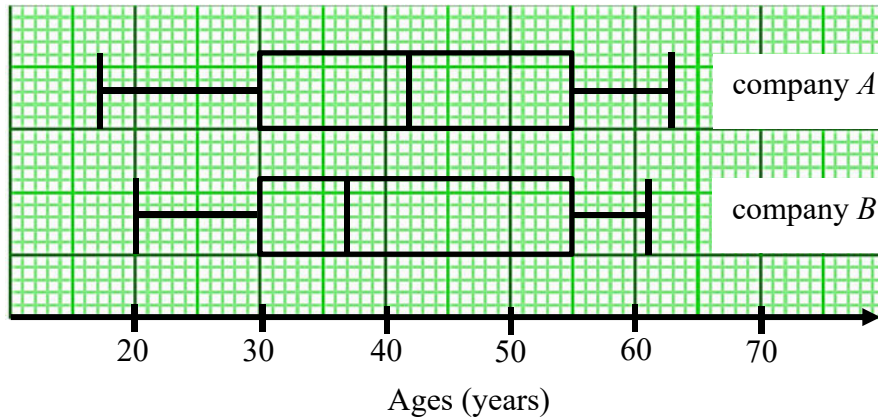


- (d) Write down the equation of line of symmetry of the graph of  $y = x^2 - 8x + 11$ .

*Answer*  $x = 4$  [B1] [1]



- 9 These box plots show the age distributions of the 200 employees in each of company *A* and company *B*.



- (a) Find the range of the employee's age of company *A*.

*Answer*                      46 years [B1]                      [1]

- (b) For each the following statements, write whether you agree or disagree.  
Give a statistical reason which you use to support your decision.

- (i) On average, company *A* has older employees than company *B*.

*Answer*      Agree because the median age of employees in company *A* is higher than the median age of employees in company *B*.                      [1]

- (ii) There are more employees who are below 30 years old in company *A* than in company *B*.

*Answer*      Disagree because employees in both companies have equal lower quartile, therefore there are equal number of employees who are below 30 years old in both companies.                      [1]

- (c) An employee is randomly selected from company *B*.

Find the probability that the employee ages between 30 and 55 years old.

*Answer*                      0.5 [B1]                      [1]

10 The size of television (TV) screens are measured diagonally in inches.

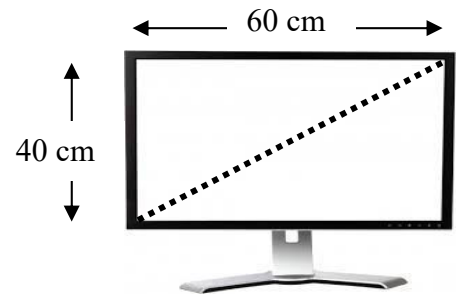
(1 inch = 2.54 cm)

(a) A TV screen has dimension 40 cm by 60 cm.

Find the size of the TV.

Give your answer correct to the nearest inch.

$$\begin{aligned} \text{size} &= \sqrt{\left(\frac{40}{2.54}\right)^2 + \left(\frac{60}{2.54}\right)^2} \text{ [M1]} \\ &= 28.390 \end{aligned}$$



*Answer*                      28 [A1] inches                      [2]

(b) An electronic store offers 20% discount storewide.

Ali wishes to buy a new 45-inch TV which costs \$2298.

All TV sets have an additional  $y\%$  off after a storewide discount.

He received a receipt with poor print quality and some numbers missing.

|                 |  |            |
|-----------------|--|------------|
| 45-inch TV      |  | \$ 2298    |
| After 20% off   |  | \$ x       |
| After $y\%$ off |  | \$ 1562.64 |
| Amount Paid     |  | \$         |

Find the value of  $x$  and  $y$ .

*Answer*     $x = 1838.40$  [B1]

$y = 15$  [B1]                      [2]

11 (a)  $\xi = \{\text{integers } x : 2 \leq x \leq 10\}$

$F = \{\text{factors of } 18\}$

$G = \{\text{prime numbers}\}$

(i) List the elements in  $F'$ .

*Answer*       $\{4, 5, 7, 8, 10\}$  [B1]      [1]

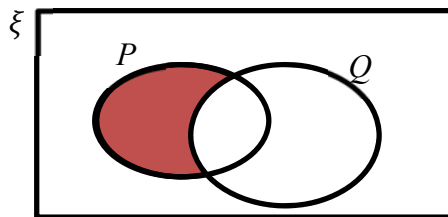
(ii) State the number of elements in  $F \cup G$ .

*Answer*      6 [B1]      [1]

(iii) Explain why  $2 \in (F \cap G)$ .

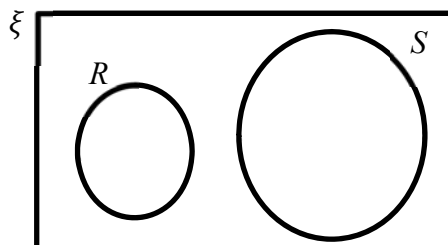
*Answer*      Because 2 is a factor of 18 **AND** also a prime number. [B1]

(b) On the Venn diagram shown below, shade the set  $P \cap Q'$ .



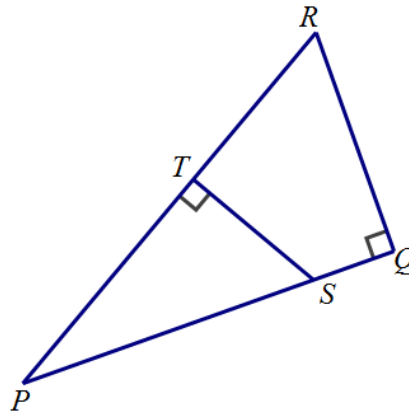
*Answer*      On the diagram [1]

(c) On the diagram below, draw the set  $R$  such that  $R \cap S = \emptyset$ .



*Answer*      On the diagram [1]

- 12 (i)  $PQR$  forms a right-angled triangle such that angle  $PQR = 90^\circ$ .  
 $ST$  is perpendicular to  $PR$ .



Name a triangle which is similar to triangle  $PQR$ .

*Answer* Triangle  $PTS$  [B1] [1]

- (ii) Given further that  $PQ = 8$  cm,  $QR = 6$  cm and  $PR = 10$  cm, find the length of  $ST$  where  $T$  is the midpoint of  $PR$ .

$$\frac{PQ}{PT} = \frac{QR}{TS} \text{ [M1]}$$

$$\frac{8}{5} = \frac{6}{TS}$$

$$TS = 3.75$$

*Answer*  $ST = 3.75$  [A1] cm [2]

- 13 The radius of a cylinder is increased by 25% and its height is decreased by 50%.

Calculate the percentage decrease in the volume of the cylinder.

Give your answer correct to 1 decimal place.

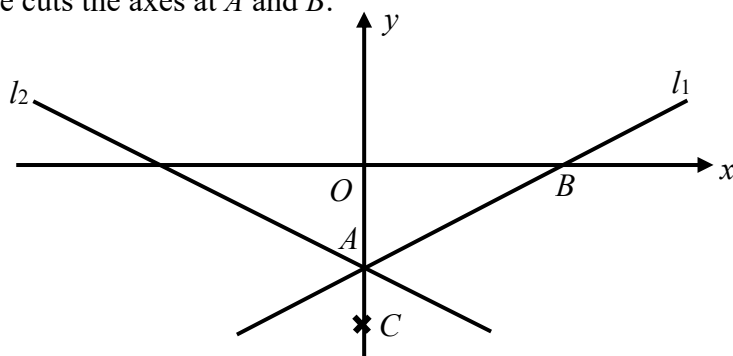
Let the radius and the height of the cylinder be  $r$  and  $h$  respectively.

$$\begin{aligned} \text{\% change in volume} &= \frac{\pi(1.25r)^2(0.5h) - \pi r^2 h}{\pi r^2 h} \times 100\% \text{ [B1 - } 1.25r \text{ or } 0.5h \text{ seen]} \\ &= -21.875\% \end{aligned}$$

*Answer* 21.9 [A1] % [2]

- 14 The following diagram shows a sketch of the line  $l_1 : y = \frac{3}{4}x - 3$ .

The line cuts the axes at  $A$  and  $B$ .



- (a) Find the coordinates of  $A$  and  $B$ .

*Answer*  $A(0, -3)$  [B1]  
 $B(4, 0)$  [B1] [2]

- (b) The line  $l_2$  is a reflection of the line  $l_1$  along the  $y$ -axis.

Write down the equation of the line  $l_2$ .

*Answer*  $y = -\frac{3}{4}x - 3$  [B1] [1]

- (c)  $C$  is a point on  $y$ -axis, as shown on the diagram.

Calculate the exact value of  $\cos \angle BAC$ .

*Answer*  $-\frac{3}{5}$  [B1] [1]

- (d) Another line  $l_3 : y = \frac{3}{4}x + 2$  can be drawn on the same axes.

Explain why the lines  $l_1$  and  $l_3$  do not meet.

*Answer* The line  $l_1$  and  $l_3$  have **equal gradient**. Therefore, they are **parallel**. [B1]

As both lines are parallel and have **different  $y$ -intercepts**, both lines do not meet.

[B1]

..... [2]

- 15 Two geometrically similar containers have the following specifications.

|                                                                                | Container A | Container B           |
|--------------------------------------------------------------------------------|-------------|-----------------------|
| Height (m)                                                                     | $p$         | 50                    |
| Cost of painting the base (\$)                                                 | 120         | 480                   |
| Time taken to completely fill the container with water (to the nearest minute) | 123 minutes | $q$ hours $r$ minutes |

Find the values of  $p$ ,  $q$  and  $r$ .

$$\left(\frac{p}{50}\right)^2 = \frac{120}{480} \text{ [M1]}$$

$$p = 25$$

Let the time taken to completely fill container  $B$  be  $T$  minutes.

$$\left(\frac{25}{50}\right)^3 = \frac{123}{T} \text{ [M1]}$$

$$T = 984$$

$$T = 16 \text{ hours } 24 \text{ minutes}$$

$$\text{Answer } p = 25 \text{ [A1]}$$

$$q = 16 \text{ [A1]}$$

$$r = 24 \text{ [A1]}$$

[5]

- 16 Given that  $y$  varies as  $x^n$ , write down the value of  $n$  in each of the following cases:

- (a)  $y$  is the volume of a sphere of radius  $x$ ,

$$\text{Answer } n = 3 \text{ [B1]}$$

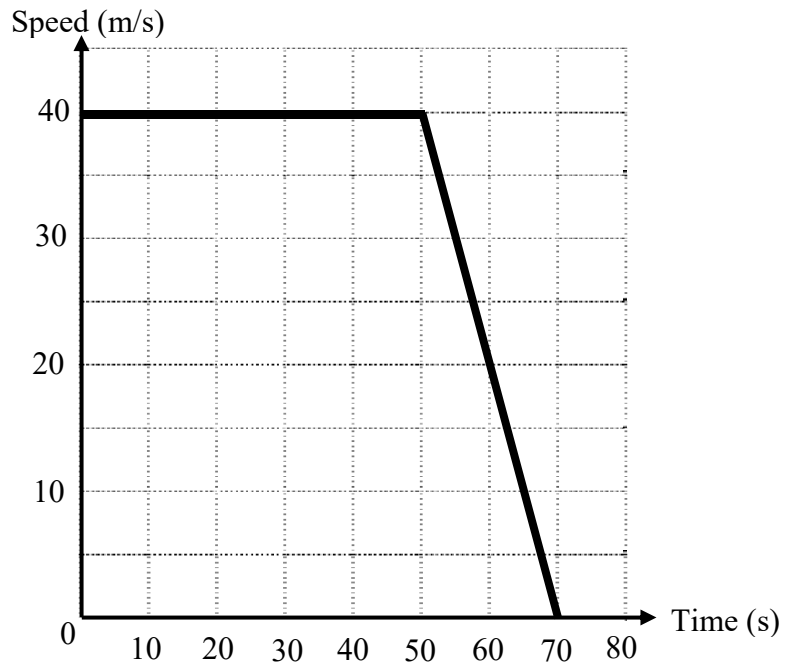
[1]

- (b)  $y$  and  $x$  are the sides of a rectangle of given area.

$$\text{Answer } n = -1 \text{ [B1]}$$

[1]

- 17 A train travels at a constant speed of 40 m/s for 50 seconds.  
It then slows down at a constant rate until it comes at rest in 20 seconds.
- (a) On the axes, draw the speed-time graph for the journey.



*Answer* On the diagram [1]

- (b) Calculate the distance travelled by the train during the first 60 seconds.

distance travelled = area under graph

$$= (60 \times 40) - \frac{1}{2} \times 10 \times 20 \text{ [M1]}$$

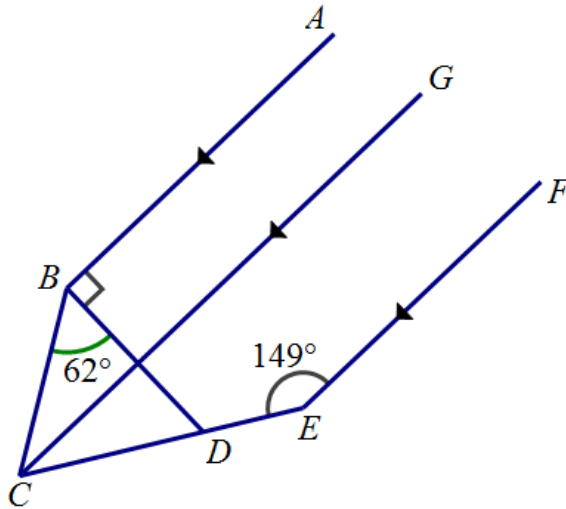
$$= 2300 \text{ m}$$

*Answer* 2300 [A1] m [2]

18 In the figure,  $AB$  is parallel to  $GC$  and  $FE$ .

Angle  $CEF = 149^\circ$  and angle  $CBD = 62^\circ$ .

$D$  is a point on  $CE$  such that angle  $ABD = 90^\circ$ .



Find, stating the reasons clearly,

(a) angle  $BCD$ ,

$$\angle GCE + \angle CEF = 180^\circ \quad (\text{sum of int. } \angle\text{s} = 180^\circ, GC \parallel FE) \text{ [B1 - reason]}$$

$$\angle GCE + 149^\circ = 180^\circ$$

$$\angle GCE = 31^\circ$$

Let  $T$  be the intersection of  $GC$  and  $BD$ .

$$\angle BTC = \angle ABT = 90^\circ (\text{alt. } \angle\text{s}, GC \parallel AB)$$

$$\angle BCG + \angle TBC = 90 \quad (\text{complementary angles}) \text{ [M1]}$$

$$\angle BCG + 62^\circ = 90^\circ$$

$$\angle BCG = 28^\circ$$

Therefore,  $\angle BCD = 59^\circ$

Answer 59 [A1] ° [3]

(b) angle  $BDE$ .

$$\angle BDE = \angle CBD + \angle BCD (\text{sum of 2 int. } \angle\text{s} = \text{exterior } \angle \text{ of a triangle}) \text{ [B1]}$$

$$= 62^\circ + 59^\circ$$

$$= 121^\circ$$

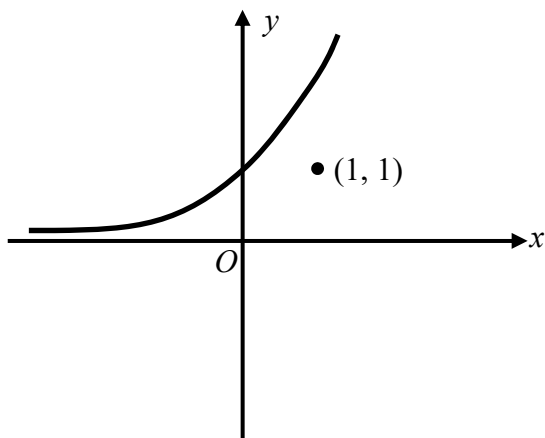
Answer 121 [A1] ° [2]



19 Sketch the graph of each of the following equations.

The point (1, 1) is plotted on each diagram.

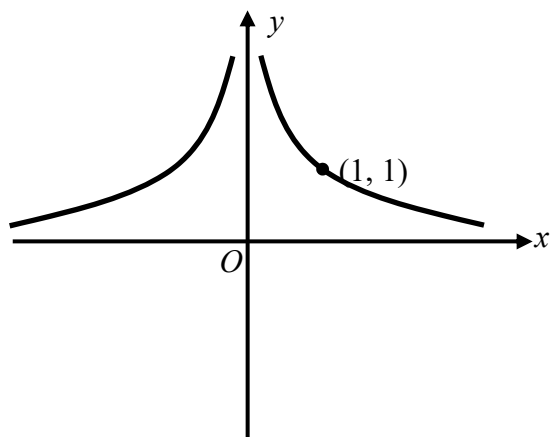
(a)  $y = 2^x$



Answer On the diagram

[1]

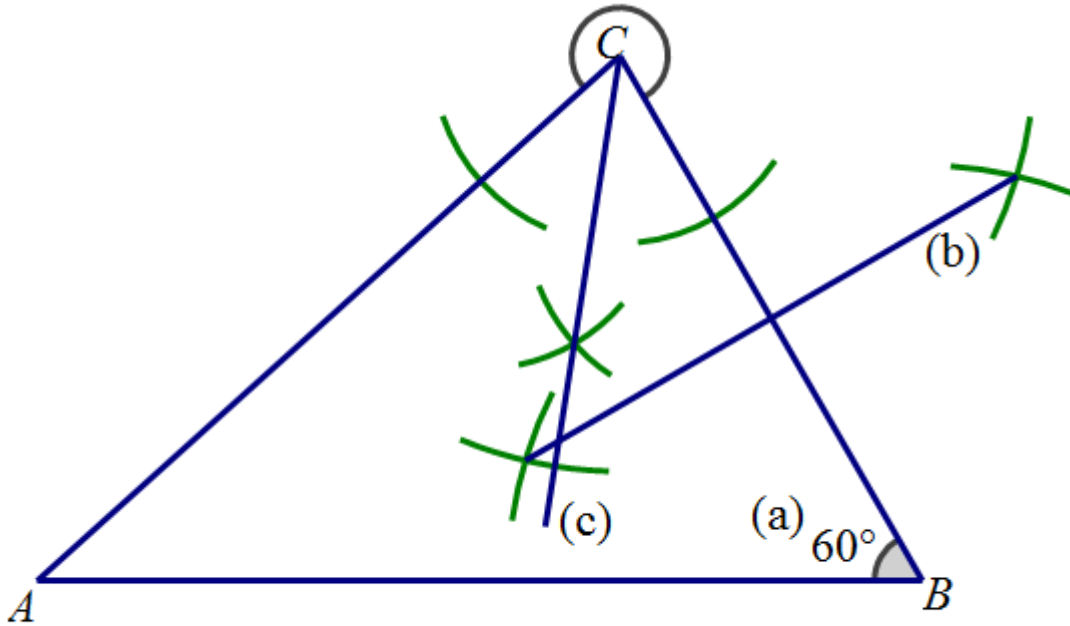
(b)  $y = \frac{1}{x^2}$



Answer On the diagram

[1]

20 The line  $AB$  is drawn below.



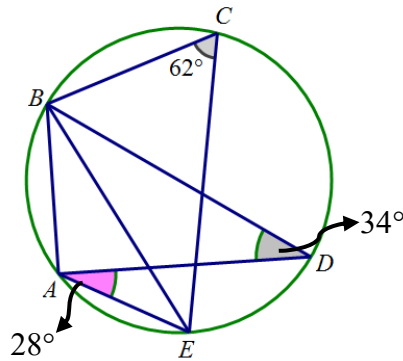
$$\text{reflex } \angle ACB = 281.98^\circ \pm 2$$

- (a) Construct triangle  $ABC$  where angle  $ABC = 60^\circ$  and  $BC = 8$  cm. [2]
- (b) Construct the perpendicular bisector of  $BC$ . [1]
- (c) From  $C$ , construct a line that is equidistant from the lines  $CA$  and  $CB$ . [1]
- (d) Find the reflex angle  $ACB$ .

Answer ..... $^\circ$  [1]

21 A circle passes through  $A, B, C, D$  and  $E$ .

It is given that angle  $ADB = 34^\circ$ , angle  $DAE = 28^\circ$  and angle  $BCE = 62^\circ$ .



By stating the reasons clearly,

(a) show that  $BD$  is a diameter of the circle,

*Answer*

$$\angle BCE + \angle BAE = 180^\circ (\angle s \text{ in opp. segments are supplementary}) \text{ [B1]}$$

$$62^\circ + \angle BAD + 28^\circ = 180^\circ$$

$$\angle BAD = 90^\circ \text{ [A1]}$$

Since  $BD$  is a chord and  $\angle BAD = 90^\circ$ ,  $BD$  is a diameter of a circle. [AG]

(angle in a semicircle) [B1]

[3]

(b) show that  $BE$  bisects angle  $ABD$ .

*Answer*

$$\angle DBE = \angle DAE (\angle s \text{ in the same segment are equal}) \text{ [B1- reason]}$$

$$= 28^\circ$$

$$\angle BEA = \angle BDA (\angle s \text{ in the same segment are equal})$$

$$= 34^\circ$$

$$\angle ABE = 180^\circ - \angle BAE - \angle BEA (\angle \text{ sum of a triangle} = 180^\circ)$$

$$= 180^\circ - (90^\circ + 28^\circ) - 34^\circ$$

$$= 28^\circ \text{ [A1]}$$

Since  $\angle ABE = \angle DBE = 28^\circ$ ,  $BE$  bisects angle  $ABD$ . [AG]

[2]

---

~~~ End of Paper ~~~



**ZHONGHUA SECONDARY SCHOOL**  
**PRELIMINARY EXAMINATION 2018**  
**SECONDARY 4E/4N/5N**

Candidate's Name

Class

Register Number

|  |  |  |
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|  |  |  |
|--|--|--|

**MATHEMATICS**

PAPER 2

**4048/02**

29 Aug 2018

2 hours and 30 minutes

Additional Materials: Writing paper, Graph paper (1 sheet)

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and register number on all the work you hand in.  
Write in dark blue or black pen on both sides of the paper.  
You may use an HB pencil for any diagrams or graphs.  
Do not use paper clips, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

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 total of the marks for this paper is **100**.

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  $\pi$ .

|                           |
|---------------------------|
| <b>For Examiner's Use</b> |
| <b>100</b>                |

**Mathematical Formulae****Compound Interest**

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

**Mensuration**

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

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

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

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

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

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

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

**Trigonometry**

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

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

**Statistics**

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

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

Answer **all** the questions.

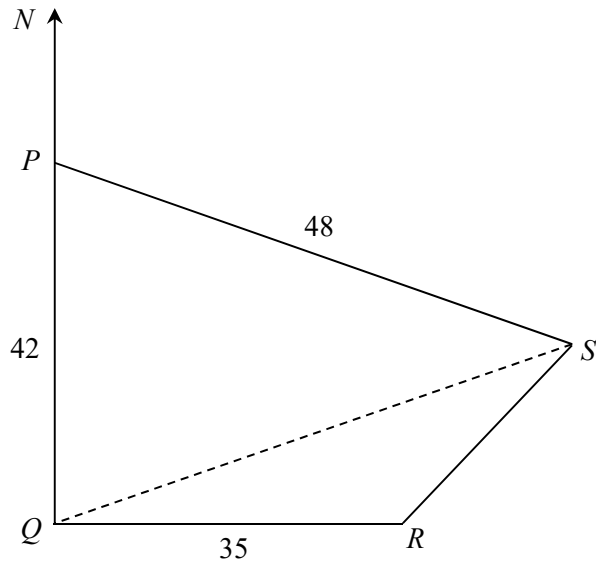
- 1 (a) Simplify  $\frac{5x^3}{7y^3} \div \frac{25x}{49y^4}$  [2]
- (b) Simplify  $\frac{9x^2-1}{6x^2+x-1}$  [3]
- (c) Solve the inequality  $2x - 1 < 3x \leq \frac{2+3x}{3}$  [3]
- (d) (i) Express as a single fraction in its simplest form  

$$\frac{5}{x-7} - \frac{1}{x+1}$$
 [2]
- (ii) Solve the equation  

$$\frac{5}{x-7} - \frac{1}{x+1} = \frac{4}{5}$$
 [4]
- 

- 2 (a) Carol and Pei are at a flower shop.  
 Carol buys three pots of mint and two pots of rosemary for \$17.85.  
 Pei buys five pots of mint and four pots of rosemary.  
 She pays with a \$50 note and receives change of \$17.25.
- (i) Write down a pair of simultaneous equations to represent this information.  
 Use  $m$  to represent the cost, in dollars, of a pot of mint  
 and  $r$  to represent the cost, in dollars, of a pot of rosemary. [2]
- (ii) Solve your simultaneous equations to find  $m$  and  $r$ . [2]
- (iii) Work out the cost of two pots of mint and three pots of rosemary. [1]
- (b) Factorise  $4x^2 + 4xy - x - y$ . [2]
- (c) (i) Express 3850 as the product of its prime factors. [1]
- (ii) Given that  $\frac{3850}{k}$  is a perfect square, find the smallest possible integer value of  $k$ . [1]
- (iii) The product of two 2-digit numbers is 3850.  
 The highest common factor of these two numbers is 5.  
 Find the two numbers. [2]
-

3



The diagram shows a field,  $PQRS$ .

$P$ ,  $Q$ ,  $R$  and  $S$  are on level ground such that  $R$  is due east of  $Q$ .

The bearing of  $S$  from  $P$  is  $105^\circ$ .

$QS$  is a straight path across the field.

$PQ = 42$  m,  $PS = 48$  m,  $QR = 35$  m.

- (a) Calculate  $QS$ . [3]
- (b) Find the bearing of  $S$  from  $Q$ . [3]
- (c) Calculate the area of the field  $PQRS$ . [3]
- (d) A drone flies in a straight line from  $Q$  to  $S$  at a height of 20 m above ground.

A man standing at  $R$  looks up at the drone.

Calculate the largest angle of elevation of the drone from the man. [3]

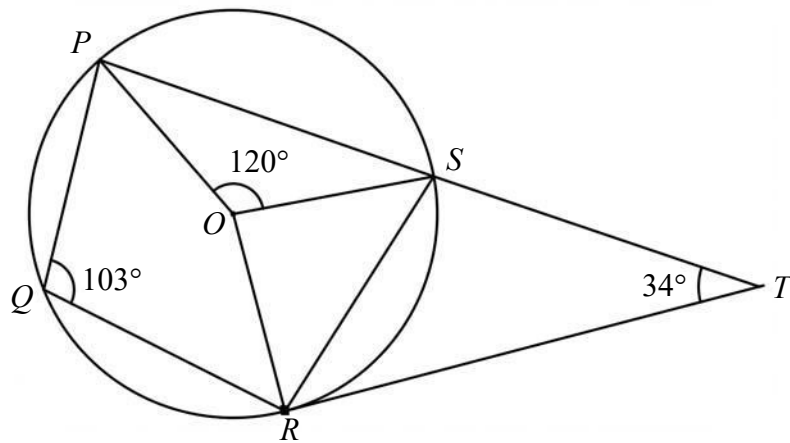
- 4 (a) The daily dietary requirements differ slightly for school-going children and adolescents, based on their age-range. The table summarises their respective daily dietary requirements of fruit and vegetables by number of servings.

| Age             | Fruit | Vegetables |
|-----------------|-------|------------|
| 3-6 years old   | 1     | 1          |
| 7-12 years old  | 2     | 2          |
| 13-18 years old | 2     | 2          |

- (i) Represent the above information in a  $3 \times 2$  matrix **M**. [1]
- (ii) One serving of fruit weighs 145g and one serving of vegetables weighs 150g. Represent the weight for one serving in a  $2 \times 1$  column matrix **N**. [1]
- (iii) Evaluate the matrix **T** = **MN**. [1]
- (iv) State what the elements of **T** represent. [1]
- (b) The recommended period of time spent on physical activities for adolescents is one hour daily. 17-year-old Janet plots a route for her daily walk.
- (i) The length of her route on a map is 8.2 cm. The scale of the map is 1 : 50 000. Work out the number of kilometres Janet walks each day. [1]
- (ii) If Janet walks at a speed of 1.2 metres per second, will she be able to complete her route in an hour? Justify your answer with figures. [2]
-



5 (a)



$O$  is the centre of the circle  $PQRS$ .

$RT$  is a tangent to the circle, and when produced, the line  $PS$  meets the tangent at  $T$ .

Angle  $PQR = 103^\circ$ , angle  $SOP = 120^\circ$  and angle  $STR = 34^\circ$ .

(i) Stating your reasons clearly, find

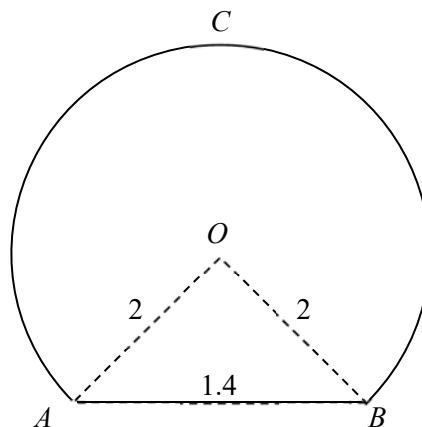
(a) angle  $POR$ , [2]

(b) angle  $OST$ , [2]

(ii) Show that angle  $OPQ + \text{angle } ORQ = 103^\circ$ . [2]

(iii) Determine if quadrilateral  $OSTR$  is a trapezium. Justify your answer with appropriate reason(s). [1]

(b)



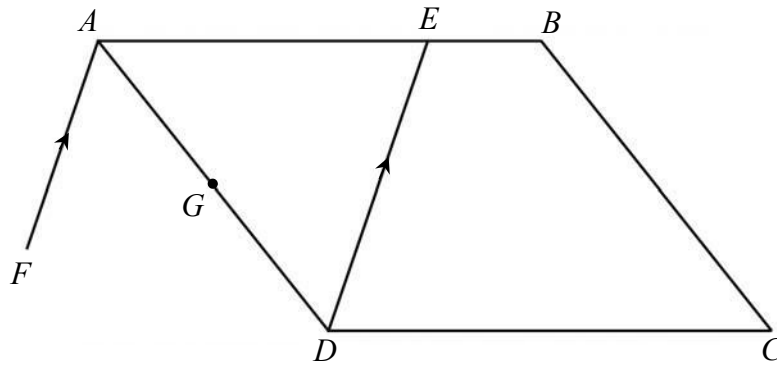
The diagram shows a major segment,  $ACB$ , of radius 2 m with  $AB = 1.4$  m.

(i) Calculate angle  $AOB$  in radians. [2]

(ii) Calculate the perimeter of the major segment  $ACB$ . [2]

- 6 (a)  $P$  is the point  $(5, 12)$ .  $Q$  is the point  $(-5, 0)$ .
- (i) Write down the column vector  $\overrightarrow{PQ}$ . [1]
- (ii) Find  $|\overrightarrow{PQ}|$ . [2]
- (iii)  $R$  is the point such that  $\overrightarrow{PQ} = 2\overrightarrow{QR}$ .  
Find the coordinates of  $R$ . [2]

(b)



$ABCD$  is a parallelogram.

$\overrightarrow{AB} = \mathbf{a}$  and  $\overrightarrow{BC} = \mathbf{b}$ .

$E$  is a point on  $AB$  such that  $AE = 3EB$ .

$G$  is the midpoint of  $AD$ .

$FA$  is parallel to  $DE$  such that  $FA : DE = 4 : 5$ .

- (i) Express each of the following, as simply as possible, in terms of  $\mathbf{a}$  and/or  $\mathbf{b}$ .
- (a)  $\overrightarrow{AE}$ , [1]
- (b)  $\overrightarrow{DE}$ , [1]
- (c)  $\overrightarrow{FA}$ . [1]
- (ii) Write down the value of  $\frac{\text{area of } \triangle AFD}{\text{area of } \triangle ADE}$ . [1]
- (iii) Determine if points  $F$ ,  $G$ , and  $B$  lie on a straight line.  
Justify your answer using vectors. [3]

- 7 (a) The number of goals scored by France in the 2018 World Cup is shown in the table below.

|                 |   |   |   |   |   |
|-----------------|---|---|---|---|---|
| Number of goals | 0 | 1 | 2 | 3 | 4 |
| Frequency       | 1 | 2 | 2 | 0 | 2 |

- (i) Is mode an appropriate measure of average for this set of data?  
Justify your answer. [1]
- (ii) Calculate
- (a) the mean number of goals scored per game, [1]
- (b) the standard deviation. [1]
- (iii) France played 7 games at the 2006 World Cup.  
The results are summarised below.

|                    |                     |
|--------------------|---------------------|
| Mean               | 1.29 goals per game |
| Standard Deviation | 0.88 goals per game |

Make two comparisons between the number of goals scored per game by France in the two World Cups. [2]

- (b) A packet of mixed nuts contains three different kinds of nuts: macadamia, almond, peanut.  
There are a total of 10 macadamia nuts, 12 almond nuts, and 21 peanuts.  
Mary picks two nuts at random without replacement.
- (i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]
- (ii) Find, as a fraction in its simplest form, the probability that
- (a) the first nut taken is a macadamia nut, [1]
- (b) both nuts are peanuts, [1]
- (c) one almond nut and one macadamia nut was picked, [2]
- (d) both nuts are different. [2]
-

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

The variables  $x$  and  $y$  are connected by the equation

$$y = 4x + \frac{25}{x^2}.$$

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

|     |     |      |      |      |      |      |      |      |
|-----|-----|------|------|------|------|------|------|------|
| $x$ | 1   | 1.25 | 1.5  | 2.0  | 2.5  | 3.0  | 3.5  | 4.0  |
| $y$ | $p$ | 21.0 | 17.1 | 14.3 | 14.0 | 14.8 | 16.0 | 17.6 |

- (a) Calculate the value of  $p$ , to 1 decimal place. [1]
- (b) Using a scale of 2 cm to represent 0.5 unit, draw a horizontal  $x$ -axis for  $0 \leq x \leq 4$ .  
Using a scale of 2 cm to represent 5 units, draw a vertical  $y$ -axis for  $0 \leq y \leq 30$ .  
On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Use your graph to find the solution(s) of the equation  $4x + \frac{25}{x^2} = 25$  for  $0 \leq x \leq 4$  [2]
- (d) By drawing a tangent, find the gradient of the curve at  $x = 1.5$ . [2]
- (e) By drawing a suitable straight line graph, solve  $3x^3 + 10x^2 - 25 = 0$ . [3]
-

- 9 Ivy runs an online business delivering goods by post. The local postage rates are shown below.

| Weight-Step Up to | Standard Regular (C5, C6 & DL size envelope) | Standard Large (Up to C4 size envelope) | Non-Standard |
|-------------------|--|---|--------------|
| 20g               | \$0.30                                       | \$0.60                                  | \$0.60       |
| 40g               | \$0.37                                       |   |              |
| 100g              |  |   | \$0.90       |
| 250g              |  | \$0.90                                  | \$1.15       |
| 500g              |  | \$1.15                                  | \$1.70       |
| 1kg               |  | \$2.55                                  |              |
| 2kg               |  | \$3.55                                  |              |

[Extracted from <https://www.singpost.com/sites/default/files/PostageRates-MailingGuidelines.pdf>]

- (a) (i) For a particular delivery, Ivy used a C4 size envelope for her paper-based goods which weighed 150g. Write down the cost of posting this package. [1]
- (ii) However, when Ivy attempted to deliver the package, she was informed that her package is considered a non-standard mail as it contained merchandise.

Calculate the additional amount she has to pay to deliver the package. [2]

Ivy would like to expand her business to delivering to overseas customers. The airmail rates for packages are shown below.

| Destination  | Small Packages*                     |              |
|--|-------------------------------------|--------------|
|  | Weight-Step Up To (max weight: 2kg) | Postage Rate |
| <b>Zone 1</b><br>Malaysia and Brunei   | 100g                                | \$2.50       |
|  | 250g                                | \$3.90       |
|  | 500g                                | \$5.20       |
|  | per additional 100g                 | \$1.10       |
| <b>Zone 2</b><br>Countries in the Asia & The Pacific (except Australia, Japan & New Zealand)   | 100g                                | \$3.20       |
|  | 250g                                | \$6.80       |
|  | 500g                                | \$12.00      |
|  | per additional 100g                 | \$2.50       |
| <b>Zone 3</b><br>Countries in the rest of the world, including Australia, Japan, New Zealand, Africa, The Americas, Europe & The Middle East | 100g                                | \$4.70       |
|  | 250g                                | \$9.85       |
|  | 500g                                | \$17.00      |
|  | per additional 100g                 | \$3.50       |

\*Small Packages are mail containing goods or merchandise that are up to 2kg in weight. The largest dimensions should not exceed 60 cm, with length, width and height combined not exceeding 90 cm.

[Extracted from <https://www.singpost.com/sites/default/files/PostageRates-MailingGuidelines.pdf>]

- (b) (i) Calculate the cost of sending a package weighing 562g to Australia. [1]
- (ii) Write down a possible set of dimensions of a small package, giving your answer in cm. [1]
- (iii) Ivy observed that the packages usually weigh from 210g to 270g. For ease of charging, Ivy would like to implement a fixed delivery charge, regardless of destination.

Assume that an equal amount of packages is delivered to each zone, and considering the range of weights of packages, determine a reasonable fixed delivery charge that Ivy should implement. Justify your answer with appropriate working.

[4]

**ZHONGHUA SECONDARY SCHOOL  
PRELIMINARY EXAMINATIONS  
MATHEMATICS PAPER 2 (4048/2)  
ANSWER KEY**

|       |  |       |   |
|-------|--|-------|---|
| 1a    | $\frac{7}{5}x^2y$  | 5aiii | Since $\angle ROS + \angle TRO = 86^\circ + 90^\circ \neq 180^\circ$ , $OR$ is not parallel to $RT$ .<br>Therefore, $OSTR$ is not a trapezium as it does not have a pair of parallel sides.   |
| 1b    | $\frac{(3x+1)}{(2x+1)}$  |       |   |
| 1c    | $-1 < x \leq \frac{1}{3}$  | 5bi   | 0.715 radians   |
| 1di   | $\frac{4x+12}{(x-7)(x+1)}$   | 5bii  | 12.5m   |
| 1dii  | $x = 12.7$ or $-1.73$ (3 sig fig)  | 6ai   | $\begin{pmatrix} -10 \\ -12 \end{pmatrix}$  |
| 2ai   | $3m + 2r = 17.85$<br>$5m + 4r = 32.75$   | 6aai  | 15.6 units  |
|       |  | 6aiii | $(-10, -6)$   |
| 2aai  | $m = 2.95, r = 4.5$  | 6bia  | $\vec{AE} = \frac{3}{4}\mathbf{a}$  |
| 2aiii | \$19.40  |       |   |
| 2b    | $(4x-1)(x+y)$  | 6bib  | $\vec{DE} = -\mathbf{b} + \frac{3}{4}\mathbf{a}$  |
| 2ci   | $2 \times 5^2 \times 7 \times 11$  |       |   |
| 2cii  | 154  | 6bic  | $\vec{FA} = -\frac{4}{5}\mathbf{b} + \frac{3}{5}\mathbf{a}$   |
| 2ciii | 55 and 70  |       |   |
| 3a    | 55.0 m   | 6bii  | $\frac{4}{5}$   |
| 3b    | $057.5^\circ$  |       |   |
| 3c    | $1490\text{m}^2$   | 7ai   | No, because the highest frequency occurs 3 times.   |
| 3d    | $46.7^\circ$   |       |   |
| 4ai   | $\begin{pmatrix} 1 & 1 \\ 2 & 2 \\ 2 & 2 \end{pmatrix}$  | 7aiia | 2 goals   |
|       |  | 7aiib | 1.41 goals (3 sig. fig.)  |
|       |  | 7aiii | As the mean number of goals was smaller in 2006 than in 2018, France scored better at the 2018 World Cup.<br>As the standard deviation of goals was smaller in 2006 than in 2018, France scored more consistently at the 2006 World Cup.      |
| 4aai  | $\begin{pmatrix} 145 \\ 150 \end{pmatrix}$   |       |   |
| 4aiii | $\begin{pmatrix} 295 \\ 590 \\ 590 \end{pmatrix}$  |       |   |
| 4aiv  | The elements of $\mathbf{T}$ represent the total weight of fruits and vegetables consumed by school-going children and adolescents, based on their age-range.                            | 7bi   | 1 <sup>st</sup> selection: $\frac{10}{43}, \frac{12}{43}, \frac{21}{43}$<br>2 <sup>nd</sup> selection: $\frac{9}{42}, \frac{12}{42}, \frac{21}{42}, \frac{10}{42}, \frac{11}{42}, \frac{21}{42}, \frac{10}{42}, \frac{12}{42}, \frac{20}{42}$ |
|       |  | 7biia | $\frac{10}{43}$   |
| 4bi   | 4.1 km   | 7biib | $\frac{10}{43}$   |
| 4bii  | Yes.   |       |   |
| 5aia  | $154^\circ$  | 7biic | $\frac{40}{301}$  |
| 5aib  | $150^\circ$  |       |   |
| 5aai  | $\angle POR = 154^\circ$ (from (a)(i)(a))<br>$\angle OPQ + \angle ORQ + 154^\circ + 103^\circ = 360^\circ$ (angle sum of quadrilateral)<br>$\angle OPQ + \angle ORQ = 103^\circ$ (shown) | 7biid | $\frac{194}{301}$   |

|       |                              |
|-------|------------------------------|
| 8a    | 29.0                         |
| 8b    | Graph                        |
| 8c    | $x = 1.1$                    |
| 8d    | Gradient = $-10.814$ (exact) |
| 8e    | $x = 1.325$                  |
| 9ai   | \$0.90                       |
| 9aia  | \$0.25                       |
| 9bi   | \$20.50                      |
| 9bii  | e.g. 20cm by 30cm by 40cm    |
| 9biii | \$9.20                       |





**ZHONGHUA SECONDARY SCHOOL**  
**4E/4N/5N**  
**PRELIMINARY EXAMINATIONS (2018)**

**Marking Scheme**

| Qn [14m] | Answer  | Mark Allocated   |
|----------|---|--|
| <b>1</b> | <b>(a)</b><br>$\frac{5x^3}{7y^3} \div \frac{25x}{49y^4}$ $= \frac{5x^3}{7y^3} \times \frac{49y^4}{25x}$ $= \frac{7}{5}x^2y$   | M1<br><br>A1   |
|          | <b>(b)</b><br>$\frac{9x^2 - 1}{6x^2 + x - 1}$ $= \frac{(3x - 1)(3x + 1)}{(3x - 1)(2x + 1)}$ $= \frac{(3x + 1)}{(2x + 1)}$   | B1 – factorisation of $9x^2 - 1$<br>B1 – factorisation of $6x^2 + x - 1$<br>A1 |
|          | <b>(c)</b><br>$2x - 1 < 3x \leq \frac{2 + 3x}{3}$ $2x - 1 < 3x \quad \text{and} \quad 3x \leq \frac{2 + 3x}{3}$ $2x - 1 < 3x \quad \text{and} \quad 9x \leq 2 + 3x$ $x > -1 \quad \text{and} \quad x \leq \frac{1}{3}$ $\therefore -1 < x \leq \frac{1}{3}$ | B1, B1 – each correct inequality<br>B1   |
|          | <b>(d)(i)</b><br>$\frac{5}{x - 7} - \frac{1}{x + 1}$ $= \frac{5(x + 1) - (x - 7)}{(x - 7)(x + 1)}$ $= \frac{5x + 5 - x + 7}{(x - 7)(x + 1)}$ $= \frac{4x + 12}{(x - 7)(x + 1)}$   | M1 – taking common denominator<br><br>A1                                       |
|          | <b>(d)(ii)</b><br>$\frac{5}{x - 7} - \frac{1}{x + 1} = \frac{4}{5}$ $\frac{4x + 12}{(x - 7)(x + 1)} = \frac{4}{5}$ $\frac{x + 3}{(x - 7)(x + 1)} = \frac{1}{5}$ $5x + 15 = x^2 - 6x - 7$  | M1 – ft from their (d)(i)  |

|  |  |   |
|--|--|---|
|  | $x^2 - 11x - 22 = 0$ $x = \frac{-(-11) \pm \sqrt{(-11)^2 - 4(1)(-22)}}{2(1)}$ $x = 12.7 \text{ or } -1.73 \text{ (3 sig fig)}$ | M1 – reduce to quadratic<br>M1 – substitution of values seen<br>A1 – both roots |
|--|--|---|

| Qn [11m] | Answer   | Mark Allocated   |                                  |
|----------|----------|--|----------------------------------|
| 2        | (a)(i)   | $3m + 2r = 17.85$<br>$5m + 4r = 32.75$   | B1<br>B1                         |
|          | (a)(ii)  | $3m + 2r = 17.85$ ---①<br>$5m + 4r = 32.75$ ---②<br><br>① × 2: $6m + 4r = 35.7$ ---③<br>③ – ②: $m = 2.95$<br>$r = 4.5$ | B1<br>B1                         |
|          | (a)(iii) | \$19.40  | B1 – B0 if not written to 2 d.p. |
|          | (b)      | $4x^2 + 4xy - x - y$<br>$= 4x(x + y) - (x + y)$<br>$= (4x - 1)(x + y)$   | M1<br>A1                         |
|          | (c)(i)   | $2 \times 5^2 \times 7 \times 11$  | B1                               |
|          | (c)(ii)  | 154  | B1                               |
|          | (c)(iii) | 55 and 70  | B1, B1                           |

| Qn [12m] | Answer | Mark Allocated   |  |
|----------|--------|--|--|
| 3        | (a)    | $\angle QPS = 180^\circ - 105^\circ = 75^\circ$ (adj. $\angle$ s on a st. line)<br><br>By cosine rule,<br>$QS^2 = 42^2 + 48^2 - 2(42)(48)\cos 75^\circ$<br>$QS^2 = 3024.44161$<br>$QS = 54.9949 = 55.0 \text{ m (3 sig. fig.)}$  | M1 – seen or implied<br><br>M1 – applying Cosine rule<br><br>A1                                    |
|          | (b)    | By sine rule,<br>$\frac{\sin \angle PQS}{48} = \frac{\sin 75^\circ}{54.9949}$<br>$\sin \angle PQS = 0.84306$<br>$\angle PQS = 57.4655$<br><br>Bearing of S from Q<br>$= 057.5^\circ$ (1 dec.pl.)   | M1 – applying Sine rule<br><br>A1 – finding $\angle PQS$<br><br>A1 – answer statement must be seen |
|          | (c)    | Area of $\triangle PQS = \frac{1}{2} \times 42 \times 48 \times \sin 75^\circ = 973.653 \text{ m}^2$<br>Area of $\triangle QRS$<br>$= \frac{1}{2} \times 54.9949 \times 35 \times \sin(90 - 57.4655)^\circ$<br>$= 517.591 \text{ m}^2$<br><br>Area of field PQRS = 1491.24 = 1490 $\text{m}^2$ (3 sig. fig.) | M1<br><br>M1 – for (90 – their $\angle PQS$ )<br><br>A1  |

|     |  |  |
|-----|--|--|
| (d) | <p>Let <math>h</math> be the shortest distance from <math>R</math> to <math>QS</math>.</p> $\frac{1}{2} \times QS \times h = 517.59 \quad \text{or} \quad \sin \angle SQR = \frac{h}{35}$ $h = 18.823 = 18.8 \text{ m (3 sig. fig.)}$ <p>Let angle of elevation be <math>\theta</math>.</p> $\tan \theta = \frac{20}{18.823}$ $\theta = 46.736 = 46.7^\circ \text{ (1 dec. pl.)}$ <p>Largest angle of elevation = <math>46.7^\circ</math> (1 dec. pl.)</p> | <p>M1 (or trigo ratio)</p> <p>M1 – calculating angle of elevation</p> <p>A1 – answer statement</p> |
|-----|--|--|

| Qn [7 m] | Answer   | Mark Allocated  |
|----------|----------|---|
| 4        | (a)(i)   | B1  |
|          | (a)(ii)  | B1  |
|          | (a)(iii) | B1  |
|          | (a)(iv)  | B1  |
|          | (b)(i)   | B1  |
|          | (b)(ii)  | M1 – conversion to km/h<br><br>A1 – concluding statement seen<br><br><br><br><br><br><br><br><br><br>M1 – conversion to min<br>A1 – concluding statement seen |

| Qn [11m] | Answer  | Mark Allocated  |   |
|----------|---|---|---|
| 5        | (a)(i)(a)   | <p>Reflex <math>\angle POR = 103^\circ \times 2 = 206^\circ</math><br/>(angle at centre = twice of angle at circumference)</p> <p><math>\angle POR = 360^\circ - 206^\circ = 154^\circ</math><br/>(angles at a point)</p>   | M1<br><br>A1  |
|          | (a)(i)(b)   | <p><math>\angle ORT = 90^\circ</math> (tangent perpendicular to radius)<br/> <math>\angle ROS = 206^\circ - 120^\circ = 86^\circ</math><br/> <math>\angle OST = 360^\circ - 86^\circ - 90^\circ - 34^\circ = 150^\circ</math></p> <p><b>OR</b><br/> <math>\angle OSP = (180^\circ - 120^\circ) \div 2 = 30^\circ</math> (<math>\angle</math> sum of triangle, base angles of isosceles triangle)<br/> <math>\angle OST = 180^\circ - 30^\circ = 150^\circ</math></p>  | M1 – reason stated<br><br>A1<br><br>M1 – reason stated<br><br>A1  |
|          | (a)(ii)   | <p><math>\angle OPS = (180^\circ - 120^\circ) \div 2 = 30^\circ</math><br/> <math>\angle ORS = (180^\circ - 86^\circ) \div 2 = 47^\circ</math></p> <p><math>\angle QPS + \angle QRS = 180^\circ</math> (angles in opposite segment)<br/> <math>\angle OPQ + \angle OPS + \angle ORQ + \angle ORS = 180^\circ</math><br/> <math>\angle OPQ + 30^\circ + \angle ORQ + 47^\circ = 180^\circ</math><br/> <math>\angle OPQ + \angle ORQ = 103^\circ</math> (shown)</p> <p><b>OR</b><br/> <math>\angle POR = 154^\circ</math> (from (a)(i)(a))<br/> <math>\angle OPQ + \angle ORQ + 154^\circ + 103^\circ = 360^\circ</math> (angle sum of quadrilateral)<br/> <math>\angle OPQ + \angle ORQ = 103^\circ</math> (shown)</p> | B1 – for both angles<br><br>B1 – reason stated, leading to conclusion<br><br>B1 – reason stated<br><br>B1 |
| (a)(iii) | <p>Since <math>\angle ROS + \angle TRO = 86^\circ + 90^\circ \neq 180^\circ</math>, <math>OR</math> is not parallel to <math>RT</math>.<br/>Therefore, <math>OSTR</math> is not a trapezium as it does not have a pair of parallel sides.</p> | B1  |   |
| (b)(i)   | <p>By cosine rule,<br/> <math display="block">\cos \angle AOB = \frac{2^2 + 2^2 - 1.4^2}{2(2)(2)} = \frac{151}{200}</math> <math>\angle AOB = 0.71514 = 0.715</math> radians (3 sig. fig.)</p>  | M1 – correct application of cosine rule<br>A1   |   |
| (b)(ii)  | <p>Reflex <math>\angle POQ = 2\pi - 0.71514 = 5.5680</math></p> <p>Perimeter of major segment = <math>2(5.5680) + 1.4 = 12.5</math>m (3 sig. fig.)</p>  | M1 – seen or implied, their (bi)<br><br>A1  |   |

| Qn [12m] | Answer    | Mark Allocated   |   |
|----------|-----------|--|---|
| 6        | (a)(i)    | $\overrightarrow{PQ} = \begin{pmatrix} -10 \\ -12 \end{pmatrix}$   | B1  |
|          | (a)(ii)   | $ \overrightarrow{PQ}  = \sqrt{(-12)^2 + (-10)^2}$<br>$= 15.6 \text{ units (3 sig. fig.)}$   | M1 – ft from their (i)<br>A1 – correct answer only            |
|          | (a)(iii)  | $\overrightarrow{QR} = \frac{1}{2}\overrightarrow{PQ} = \begin{pmatrix} -5 \\ -6 \end{pmatrix}$<br>$\overrightarrow{OR} = \overrightarrow{OQ} + \overrightarrow{QR}$<br>$\overrightarrow{OR} = \begin{pmatrix} -5 \\ 0 \end{pmatrix} + \begin{pmatrix} -5 \\ -6 \end{pmatrix} = \begin{pmatrix} -10 \\ -6 \end{pmatrix}$<br><br>Coordinates of $R = (-10, -6)$   | M1 – ft from their (i)<br><br>A1 – coordinates must be stated |
|          | (b)(i)(a) | $\overrightarrow{AE} = \frac{3}{4}\mathbf{a}$  | B1  |
|          | (b)(i)(b) | $\overrightarrow{DE} = \overrightarrow{DA} + \overrightarrow{AE} = -\mathbf{b} + \frac{3}{4}\mathbf{a}$  | B1  |
|          | (b)(i)(c) | $\overrightarrow{FA} = \frac{4}{5}\left(-\mathbf{b} + \frac{3}{4}\mathbf{a}\right) = -\frac{4}{5}\mathbf{b} + \frac{3}{5}\mathbf{a}$   | B1  |
|          | (b)(ii)   | $\frac{\text{area of } \triangle AFD}{\text{area of } \triangle ADE} = \frac{4}{5}$  | B1  |
|          | (b)(iii)  | $\overrightarrow{FB} = \overrightarrow{FA} + \overrightarrow{AB} = -\frac{4}{5}\mathbf{b} + \frac{3}{5}\mathbf{a} + \mathbf{a}$<br>$= \frac{8}{5}\mathbf{a} - \frac{4}{5}\mathbf{b}$<br>$= \frac{8}{5}\left(\mathbf{a} - \frac{1}{2}\mathbf{b}\right)$<br>$\overrightarrow{GB} = \overrightarrow{GA} + \overrightarrow{AB} = -\frac{1}{2}\mathbf{b} + \mathbf{a}$<br>$\overrightarrow{FG} = -\frac{3}{10}\mathbf{b} + \frac{3}{5}\mathbf{a}$<br><br>Since $\overrightarrow{FB} = \frac{8}{5}\overrightarrow{GB}$ , $\overrightarrow{FB}$ is parallel to $\overrightarrow{GB}$ , $B$ is a common point, therefore $F$ , $G$ , and $B$ lie on a straight line. | M2 – find any two vectors<br><br>A1 – concluding statement    |

| Qn [13m] | Answer     | Mark Allocated   |              |
|----------|------------|--|--------------|
| 7        | (a)(i)     | No, because the highest frequency occurs 3 times.  | B1           |
|          | (a)(ii)(a) | 2 goals  | B1           |
|          | (a)(ii)(b) | 1.41 goals (3 sig. fig.)   | B1           |
|          | (a)(iii)   | As the mean number of goals was smaller in 2006 than in 2018, France scored better at the 2018 World Cup.<br><br>As the standard deviation of goals was smaller in 2006 than in 2018, France scored more consistently at the 2006 World Cup. | B1<br><br>B1 |

|            |  |  |
|------------|--|--|
| (b)(i)     | <p style="text-align: center;">-1 mark if legend/key is missing</p>  | <p>B2 – Correct tree diagram with all probabilities correct</p> <p>B1 – for branches for first selection correct</p> <p>1<sup>st</sup> selection:<br/> <math>\frac{10}{43}, \frac{12}{43}, \frac{21}{43}</math></p> <p>2<sup>nd</sup> selection:<br/> <math>\frac{9}{42}, \frac{12}{42}, \frac{21}{42}, \frac{10}{42}, \frac{11}{42}, \frac{21}{42}</math><br/> <math>\frac{10}{42}, \frac{12}{42}, \frac{20}{42}</math></p> |
| (b)(ii)(a) | $\frac{10}{43}$  | B1   |
| (b)(ii)(b) | $\frac{21}{43} \times \frac{20}{42} = \frac{10}{43}$   | B1   |
| (b)(ii)(c) | $\frac{12}{43} \times \frac{10}{42} \times 2$<br>$= \frac{40}{301}$  | M1 – ft from tree diagram<br>A1  |
| (b)(ii)(d) | $1 - \left(\frac{10}{43} \times \frac{19}{42}\right) - \left(\frac{12}{43} \times \frac{11}{42}\right) - \left(\frac{21}{43} \times \frac{20}{42}\right)$<br>$= \frac{194}{301}$ | M1<br>A1   |

| Qn [11m] | Answer  |
|----------|---|
| 8 (a)    | $p = 29.0$  |
| (b)      | P2 – All 8 points plotted<br>(P1 – at least 6 points plotted correctly)<br>C1 – Smooth curve drawn through plotted points, dependent on P1<br>Minus 1 mark if scale is not adhered to   |
| (c)      | $x = 1.1$   |
| (d)      | Gradient = $-10.814$ (exact)<br><br>M1 – tangent line drawn at $x = 1.5$<br>A1 – gradient estimated and calculated between $-9$ to $-11$  |
| (e)      | $3x^3 + 10x^2 - 25 = 0$<br>$7x + 10 = 4x + \frac{25}{x^2}$<br>Draw $y = 7x + 10$<br>M2 for straight line $y = 7x + 10$ drawn.<br>(M1 if only $y = 7x + 10$ is seen)<br>$x = 1.325$ [A1] |

