



**Thursday 16 January 2014 – Afternoon**

**FSMQ INTERMEDIATE LEVEL**

**6989/01** Foundations of Advanced Mathematics (MEI)

Candidates answer on the Answer Sheet.

**OCR supplied materials:**

- Answer Sheet (MS4)

**Other materials required:**

- Eraser
- Scientific calculator
- Soft pencil
- Ruler

**Duration:** 2 hours



**INSTRUCTIONS TO CANDIDATES**

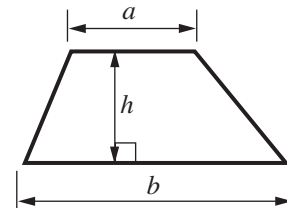
- Write your name clearly in capital letters, your centre number and candidate number on the Answer Sheet in the spaces provided unless this has already been done for you.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- There are **forty** questions in this paper. Attempt as many questions as possible. For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.
- **Read very carefully the instructions on the Answer Sheet.**

**INFORMATION FOR CANDIDATES**

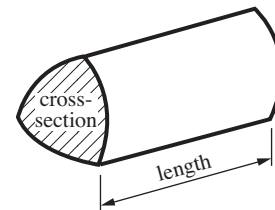
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- This document consists of **28** pages. Any blank pages are indicated.

## Formulae Sheet: 6989 Foundations of Advanced Mathematics

**Area of trapezium** =  $\frac{1}{2}(a + b)h$



**Volume of prism** = (area of cross-section)  $\times$  length

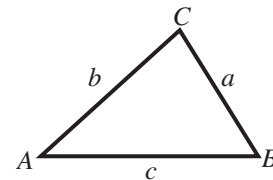


**In any triangle  $ABC$**

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

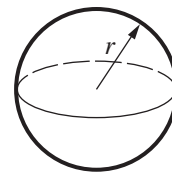
**Cosine rule**  $a^2 = b^2 + c^2 - 2bc \cos A$

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



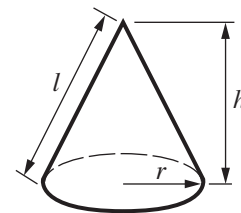
**Volume of sphere** =  $\frac{4}{3}\pi r^3$

**Surface area of sphere** =  $4\pi r^2$



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

**Curved surface area of cone** =  $\pi r l$



**The Quadratic Equation**

The solutions of  $ax^2 + bx + c = 0$ ,  
where  $a \neq 0$ , are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1 Three of the following statements are true and **one** is false. Which one is **false**?

A  $8 + 2 \times 3 - 1 = 29$

B  $(3 + 2) \times (4 - 5) = -5$

C  $6 + 9 \div 3 = 9$

D  $(2 \times 3)^2 = 36$

2 Here is a list of numbers.

3   4   12   17   24   25

Three of the following statements are true and **one** is false. Which one is **false**?

A There are two prime numbers in the list.

B Exactly two of the numbers in the list are square numbers.

C The lowest common multiple of 3 and 4 is in the list.

D There are exactly two factors of 24 in the list.

3 Three of the following statements are true and **one** is false. Which one is **false**?

A The solution of  $2x - 3 = 10$  is  $x = 6.5$ .

B The solution of  $4 < 2x + 1 \leq 6$  is  $1.5 < x \leq 2.5$ .

C The solution of  $7 - 3a < 1$  is  $a < 2$ .

D The solution of  $4x = 5x - 5$  is  $x = 5$ .

- 4 You are given that  $a = -2$ ,  $b = 3$  and  $c = \frac{1}{2}$ .

Three of the following statements are true and **one** is false. Which one is **false**?

A  $a^2c^2 = 1$

B  $(a+b)c = \frac{1}{2}$

C  $\frac{a}{c} = -4$

D  $a^b = 8$

- 5 A group of students take a test. The marks are as follows.

2      3      6      6      2      5      2      9

Three of the following statements about these marks are true and **one** is false. Which one is **false**?

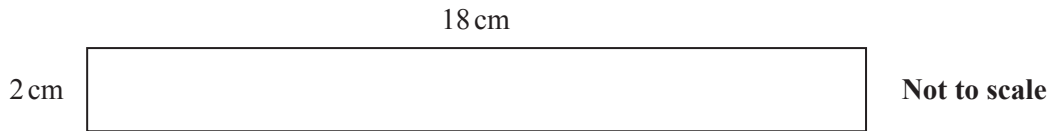
A Mode < Median

B Mean > Mode

C Median = Mean

D The range is 7.

- 6 Rectangle R has sides 18 cm and 2 cm, as shown in the diagram.



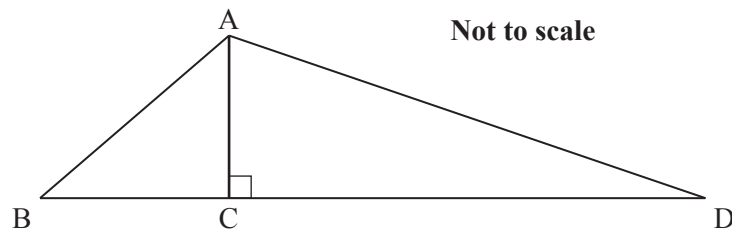
Three of the following statements are true and **one** is false. Which one is **false**?

- A Another rectangle whose sides are half of those of rectangle R has an area of  $9 \text{ cm}^2$ .
- B The square with the same perimeter as rectangle R has side 10 cm.
- C When the sides of rectangle R are increased by scale factor 2, the area is doubled.
- D A rectangle with sides 16 cm and 4 cm has an area greater than the area of rectangle R.

- 7 Three of the following statements are true and **one** is false. Which one is **false**?

- A  $\frac{2}{3} \div \frac{4}{5} = \frac{5}{6}$
- B  $\frac{8}{9} = 0.\dot{8}$
- C  $\left(\frac{2}{3}\right)^{-2} = 2.25$
- D  $\sqrt[4]{64} = 2$

- 8 The triangle ABD is shown in the diagram. C is on BD such that AC is perpendicular to BD.



The length of AB is 8 cm, the length of BD is 20 cm and the ratio of BC : CD is 1 : 3.

Three of the following statements are true and **one** is false. Which one is **false**?

- A The length of CD is 15 cm.
- B The length of AC is  $\sqrt{39}$  cm.
- C The length of AD is 16.2 cm, correct to 3 significant figures.
- D The area of triangle ABD is  $80 \text{ cm}^2$ .

- 9 The grandmother of Annie, Beth and Charlene made a gift of £1500 to be divided amongst them in the ratio of their ages which are 6, 8 and 16 respectively.

Three of the following statements are true and **one** is false. Which one is **false**?

- A The ratios of their ages are 0.375 : 0.5 : 1.
- B Annie receives £300 less than Charlene.
- C The size of Beth's share is 50% of the size of Charlene's share.
- D Beth receives  $\frac{4}{15}$  of the total amount.

**10** Three of the following statements are true and **one** is false. Which one is **false**?

- A** The formula  $v^2 = u^2 + 2as$  can be rearranged to give  $s = \frac{v^2 + u^2}{2a}$ .
- B** The formula  $v^2 = u^2 + 2as$  can be rearranged to give  $u = \pm \sqrt{v^2 - 2as}$ .
- C** The formula  $A = \frac{h(a+b)}{2}$  can be rearranged to give  $h = \frac{2A}{a+b}$ .
- D** The formula  $A = \frac{h(a+b)}{2}$  can be rearranged to give  $a = \frac{2A}{h} - b$ .

**11** An electrician charges a call out fee of £45 and then £30 for each hour he works. The number of hours he works is  $h$  and the extra charge for materials used is £ $m$ .

Three of the following statements are true and **one** is false. Which one is **false**?

- A** The electrician charges £214 for a job taking 2 hours using materials costing £109.
- B** A job taking 5 hours without using any materials will cost £195.
- C** The formula to calculate the cost, £ $C$ , of a job is  $C = 45 + 30h + m$ .
- D** The formula to calculate the number of hours the electrician works given that his charge is £ $C$  is  $h = \frac{C + 45 - m}{30}$ .

- 12 The equation of a curve is  $y = (x - 3)^2 - 16$ .

Three of the following statements are true and **one** is false. Which one is **false**?

- A The equation of the curve can be written  $y = x^2 - 6x - 7$ .
- B The solution of the equation  $0 = (x - 3)^2 - 16$  is  $x = 1$  or  $x = -7$ .
- C The curve crosses the  $y$ -axis at  $y = -7$ .
- D The point with coordinates  $(4, -15)$  lies on the curve.

- 13 A gardener weighs 24 tomatoes she has grown. The masses in grams are shown below.

60.5 64.0 64.5 59.0 67.0 61.5 67.8 66.5 58.0 59.3 57.2 67.0  
67.5 59.3 63.0 64.2 69.0 57.0 57.8 62.4 65.5 57.0 61.5 71.0

*In order to answer this question you are advised to complete the following table.*

Mass ( $m$ grams)	Tally	Frequency
$56.0 \leq m < 60.0$		
$60.0 \leq m < 64.0$		
$64.0 \leq m < 68.0$		
$68.0 \leq m < 72.0$		

Three of the following statements are true and **one** is false. Which one is **false**?

- A The estimated total mass of all 24 tomatoes is 1500 grams, correct to 2 significant figures.
- B There are 9 items of data in the interval  $64.0 \leq m < 68.0$ .
- C The estimated mean mass of the tomatoes is less than 63 grams.
- D There are exactly 5 tomatoes with a mass less than 64.0 grams.



14 On a map, 1 cm represents 10 km.

Three of the following statements are true and **one** is false. Which one is **false**?

- A An actual distance of 135 km is represented on the map by a distance of 13.5 cm.
- B The scale of the map is 1 : 100 000.
- C A distance of 31.2 cm on the map represents an actual distance of 312 km.
- D An actual area of  $910 \text{ km}^2$  is represented on the map by an area of  $9.1 \text{ cm}^2$ .

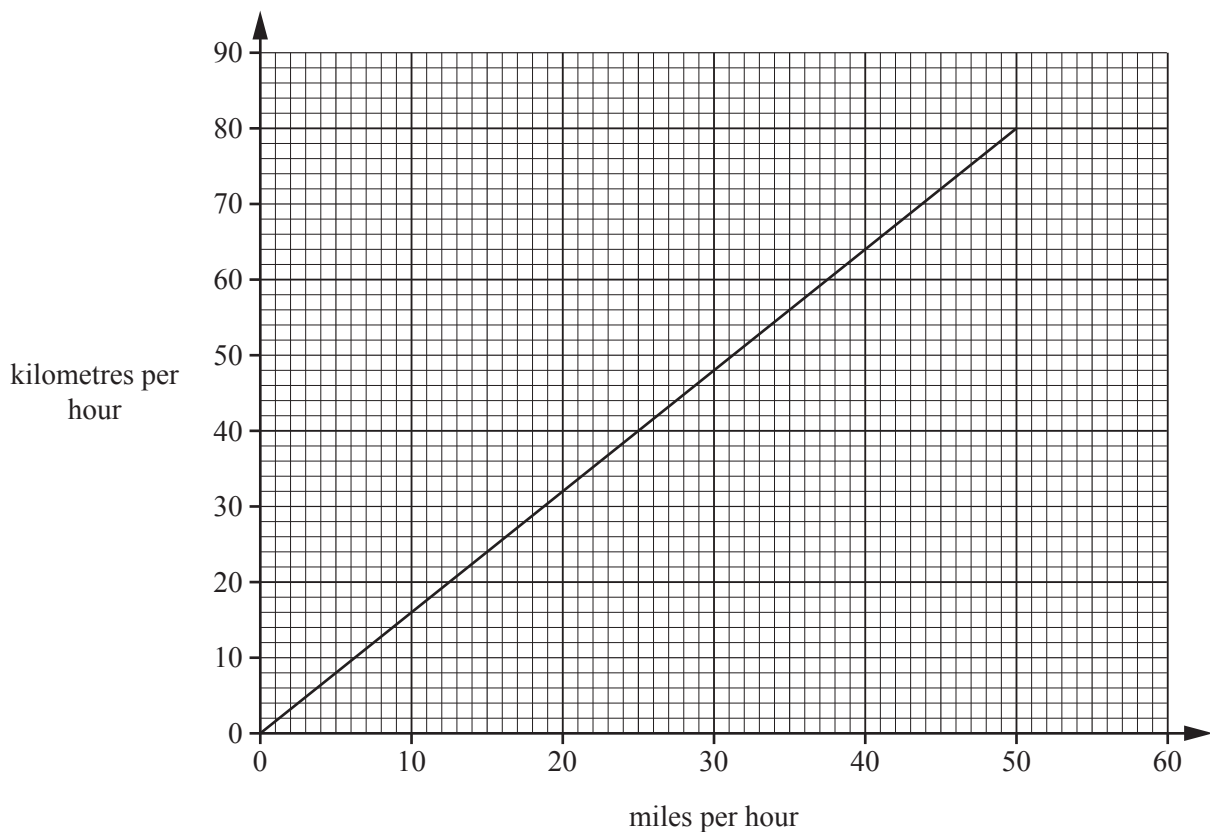
15 Three of the following statements are true and **one** is false. Which one is **false**?

- A The 5th term of the sequence with  $n$ th term  $100 - 10n$  is 40.
- B 5 is a term in the sequence with  $n$ th term  $4n - 7$ .
- C The 7th terms of the sequences with  $n$ th terms  $2n + 1$  and  $3n - 6$  have the same value.
- D The  $n$ th term of the sequence 22, 19, 16, 13, ... is  $25 - 3n$ .

16 Three of the following involve sensible units and **one** does not. Which one does **not**?

- A The distance from London to Barcelona is approximately 1140 km.
- B The length of a pencil is approximately 7 inches.
- C The mass of an adult elephant is approximately 5 tonnes.
- D The volume of the petrol tank in a medium-sized car is  $600 \text{ cm}^3$ .

17 The graph below is used to convert between miles per hour and kilometres per hour.



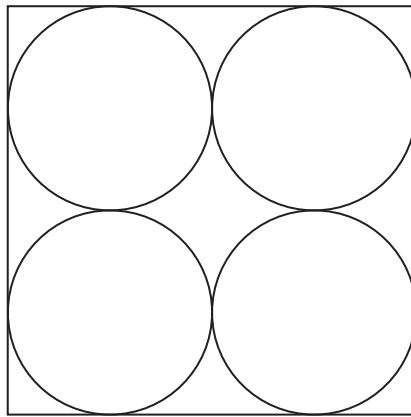
Three of the following statements are true and **one** is false. Which one is **false**?

- A A speed of 80 kilometres per hour is the same as a speed of 50 miles per hour.
- B In order to travel a distance of 160 kilometres in 2 hours, the average speed of the whole journey must be 50 miles per hour.
- C The speed of 50 kilometres per hour is the same as 30 miles per hour.
- D An aeroplane flying at an average speed of 540 kilometres per hour will fly a distance of 450 miles in a time of 1 hour 20 minutes.

18 Three of the following statements are true and **one** is false. Which one is **false**?

- A 56% is equivalent to  $\frac{23}{50}$ .
- B The numbers 0.5%, 0.02,  $\frac{1}{20}$  have been written in order, from smallest to largest.
- C The cube of 0.5 is 0.125.
- D The highest common factor (HCF) of 18 and 6 is 6.

19 A square contains 4 circles as shown. Each circle has a radius of 2.3 cm.



Three of the following statements are true and **one** is false. Which one is **false**?

- A The area of the square is  $84.64 \text{ cm}^2$ .
- B The perimeter of the square is 18.4 cm.
- C The area of one of the circles is  $16.6 \text{ cm}^2$ , correct to 1 decimal place.
- D The four circles occupy nearly 79% of the area of the square.

- 20 The equation of a straight line is  $2x + 3y - 5 = 0$ .

Three of the following statements are true and **one** is false. Which one is **false**?

- A The line crosses the  $x$ -axis at  $(2.5, 0)$ .
- B The intercept on the  $y$ -axis is  $1\frac{2}{3}$ .
- C The gradient of the line is  $-2$ .
- D The point  $(1, 1)$  lies on the line.

- 21 Five strawberry, three orange and seven blackcurrant flavoured sweets are placed in a box.

Three of the following statements are true and **one** is false. Which one is **false**?

- A A sweet is chosen at random. The probability of selecting a strawberry flavoured sweet is  $\frac{1}{3}$ .
- B Two sweets are chosen at random and the first sweet is not replaced. The probability that they will be both orange flavoured is  $\frac{1}{25}$ .
- C A sweet is chosen at random. The probability that the sweet will not be blackcurrant flavoured is  $\frac{8}{15}$ .
- D Two sweets are chosen at random and the first sweet is replaced. The probability that one is orange flavoured and the other is not is  $\frac{8}{25}$ .

22 Three of the following statements are true and **one** is false. Which one is **false**?

A  $(x-4)(2x+6) = 2x^2 - 2x - 24$

B  $9a^2 - 4b^2 = (3a-2b)(3a+2b)$

C  $3(2x+4y) - (x-y) = 5x + 11y$

D The roots of the equation  $5x^2 + 20x = 0$  are  $x = 0$  and  $x = -4$ .

23 You are given that  $a = 3.24 \times 10^6$ ,  $b = 3.6 \times 10^4$ ,  $c = 8 \times 10^{-7}$ .

Three of the following statements are true and **one** is false. Which one is **false**?

A  $ab = 1.1664 \times 10^{10}$

B  $a+b = 3.276 \times 10^6$

C  $c = 0.0000008$

D  $\frac{b}{c} = 4.5 \times 10^{10}$

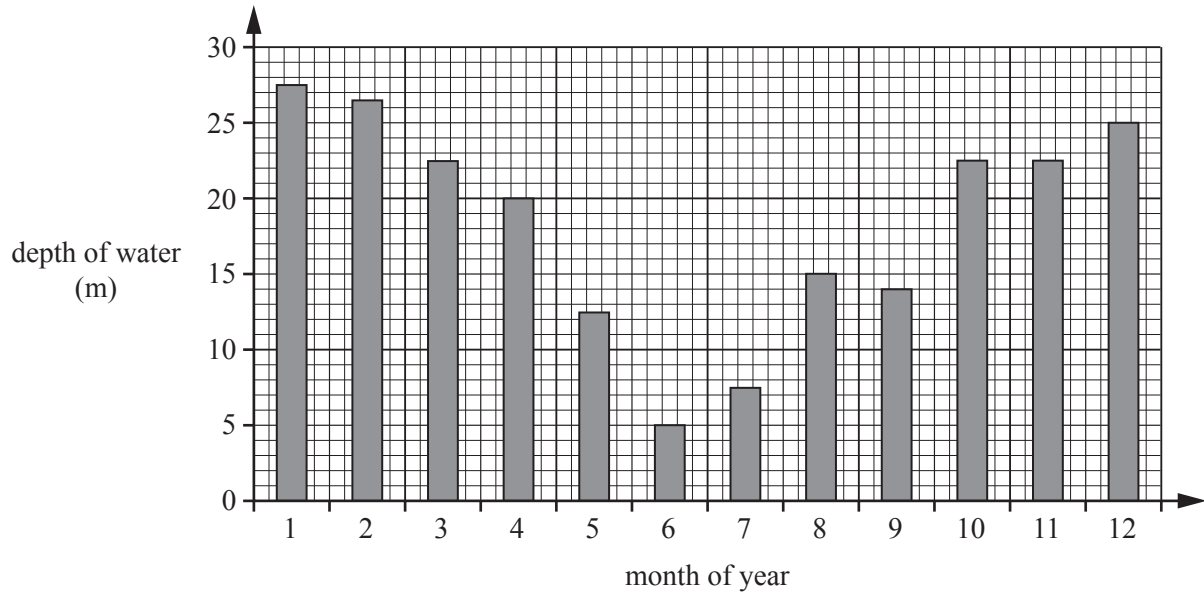
- 24 A small island in the Caribbean Sea exports only four commodities: bananas, cocoa, fish and rum. The value of these exports in 2013 is shown in the table below.

Export	Value (millions of \$)
Bananas	24
Cocoa	51
Fish	42
Rum	15

Three of the following statements are true and **one** is false. Which one is **false**?

- A In a pie chart, the angle representing cocoa is  $139^\circ$ , correct to the nearest degree.
- B Rum represents 11.4% of the total exports of the island in 2013, correct to 1 decimal place.
- C The total exports in 2013 showed an increase of 13% above the total exports in 2012. The value of the total exports in 2012 was \$115 million, correct to the nearest million.
- D Bananas represented  $\frac{2}{11}$  of the total exports.

- 25 The chart shows the depth, in metres, of water in a reservoir each month for one year.



Three of the following statements are true and **one** is false. Which one is **false**?

- A The depth of water in the fifth month was 12.5 metres.
- B The depth of water in the reservoir fell by 15 metres per month between the fourth and sixth months.
- C The depth of water was greatest in the first month.
- D The largest monthly increase in the depth of the water occurred between the ninth and tenth months.

- 26 A farmer can buy 6 goats and 5 sheep for £206, or 4 goats and 7 sheep for £196.

Which **one** of the following gives the **correct** costs of a goat and a sheep?

- A A goat costs £26 and a sheep costs £16.
- B A goat costs £16 and a sheep costs £21.
- C A goat costs £21 and a sheep costs £16.
- D A goat costs £26 and a sheep costs £21.

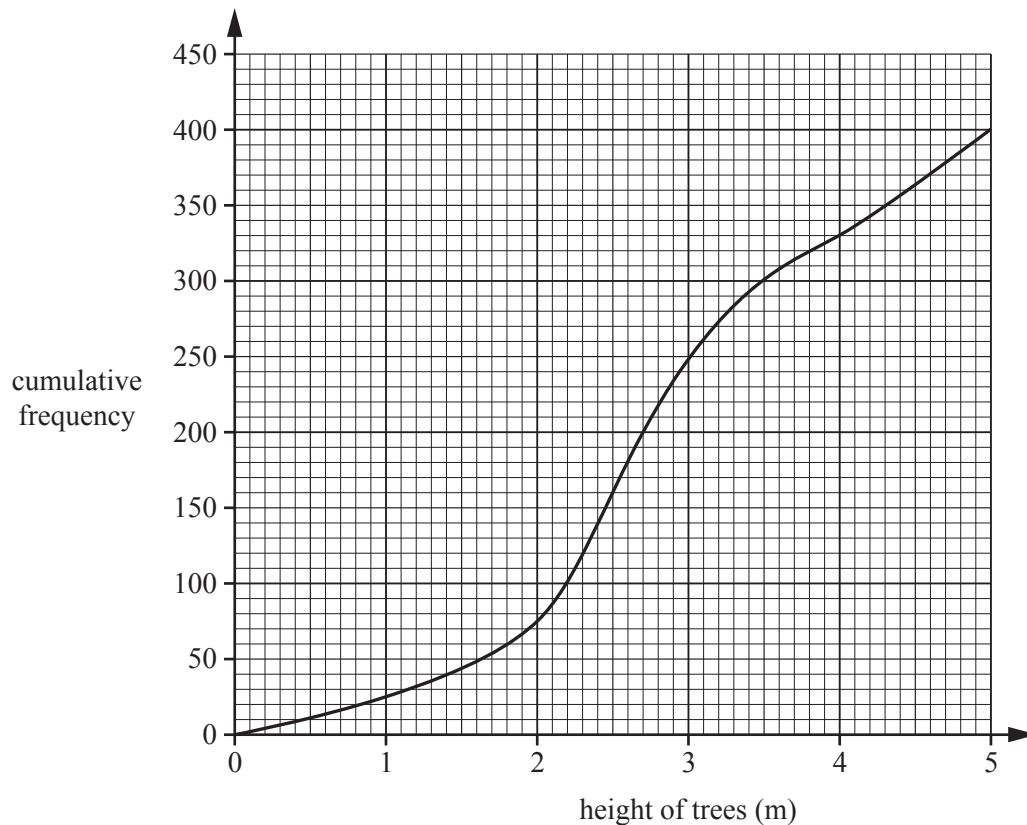
- 27 The dimensions of a door are 90 cm wide and 195 cm high, correct to the nearest centimetre.

Three of the following statements are true and **one** is false. Which one is **false**?

- A The upper bound of the height of the door is 196 cm.
- B The height of the door is more than twice the width of the door.
- C The lower bound of the width of the door is 89.5 cm.
- D The lower bound of the area of the door is  $17407.75 \text{ cm}^2$ .



- 28 The cumulative frequency graph below shows the data collected for the heights of trees in a wood.



Three of the following statements are true and **one** is false. Which one is **false**?

- A The median height of the trees is approximately 2.7 metres.
- B There are approximately 240 trees between 2 and 3 metres in height.
- C The range of the heights of the trees is at most 5 metres.
- D Approximately 75% of the trees are less than 3.5 metres in height.

29 You are given the equation  $y = 3x^2 - 7x - 25$ .

Three of the following statements are true and **one** is false. Which one is **false**?

A When  $y = 0$ ,  $x = 4.280$  or  $x = -1.947$ , correct to 4 significant figures.

B When  $y = 15$ ,  $x = 5$  or  $x = -\frac{3}{8}$ .

C When  $x = 0$ ,  $y = -25$ .

D When  $x = 1.1$ ,  $y = -29.07$ .

30 You are given the vectors  $\mathbf{a} = 2\mathbf{i} - \mathbf{j}$ ,  $\mathbf{b} = 3\mathbf{i} + 4\mathbf{j}$  and  $\mathbf{c} = 5\mathbf{j}$ .

Three of the following statements are true and **one** is false. Which one is **false**?

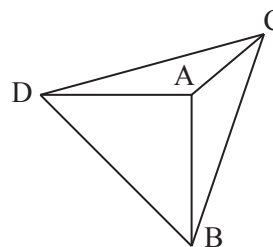
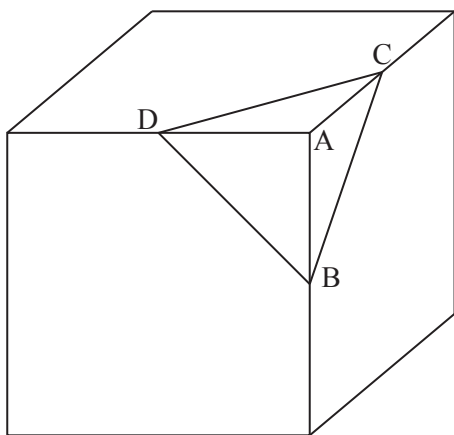
A  $\mathbf{a} + 2\mathbf{c} = 2\mathbf{i} + 9\mathbf{j}$

B The magnitude of the vector  $\mathbf{b}$  is 5 units.

C The vector  $2\mathbf{i} + 10\mathbf{j}$  is in the same direction as the vector  $\mathbf{a} - \mathbf{b}$ .

D The vector  $-5\mathbf{i}$  is at an angle of  $90^\circ$  to the vector  $\mathbf{c}$ .

- 31 The diagram shows an 8 cm cube. Cutting through the midpoints B, D and C of three edges forms a pyramid ABCD which has a triangular base DAB. Triangles ADC, ACB and DAB are all right-angled triangles.



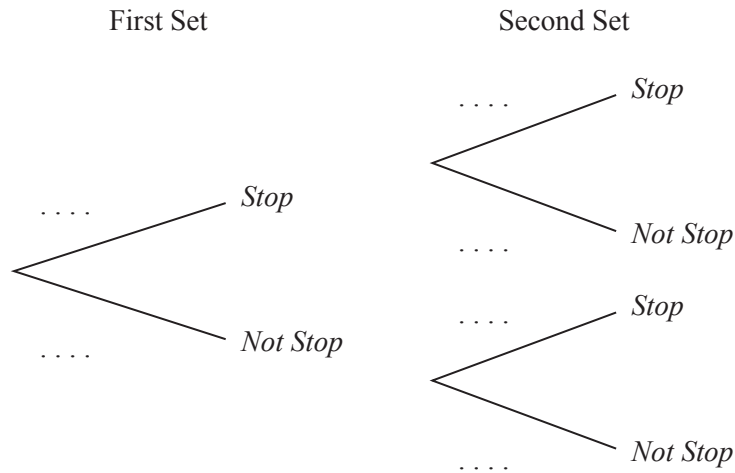
Three of the following statements are true and **one** is false. Which one is **false**?

- A The area of the triangle DAB is  $8\text{ cm}^2$ .
- B The length of CB is  $4\sqrt{2}\text{ cm}$ .
- C Triangle DCB is an equilateral triangle.
- D The volume of the pyramid ABCD is  $\frac{32\sqrt{2}}{3}\text{ cm}^3$ .

[The volume of a pyramid is  $\frac{1}{3} \times \text{base area} \times \text{height}$ ]

- 32 In Sasha's journey to work, she must pass through two sets of traffic lights. The probability that she stops at the first set of traffic lights is 0.3. If she stops at the first set of traffic lights, the probability she will need to stop at the second set is 0.5. If, however, she does not stop at the first set of traffic lights, the probability of stopping at the second set of traffic lights is 0.4.

*In order to complete this question you are advised to complete the tree diagram.*



Three of the following statements are true and **one** is false. Which one is **false**?

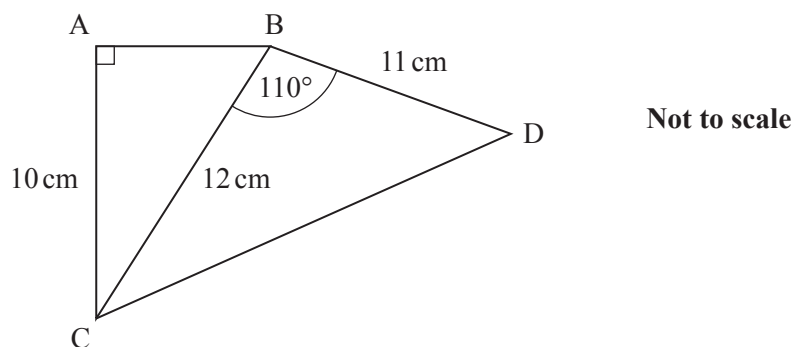
- A The probability of Sasha stopping at the second set of traffic lights depends on whether she stops at the first set of traffic lights.
- B The probability of Sasha stopping only at the second set of traffic lights is 0.43.
- C The probability of Sasha not stopping at either set of traffic lights is 0.42.
- D The probability of Sasha stopping at one or both sets of traffic lights is 0.58.

- 33 A tank travels 5 km due west from base O and then 12 km due north to point P.

Three of the following statements are true and **one** is false. Which one is **false**?

- A The direct distance from O to P is 13 km.
- B If the tank drives at an average speed of  $51 \text{ km h}^{-1}$  it completes the journey in 20 minutes.
- C Point P is on a bearing of  $337^\circ$ , correct to the nearest degree, from base O.
- D In order to return from point P directly back to base in a straight line, the tank should travel on a bearing of  $023^\circ$ , correct to the nearest degree.

34



Three of the following statements are true and **one** is false. Which one is **false**?

- A The length of CD is 18.8 cm, correct to 3 significant figures.
- B  $\sin BCA = \frac{5}{6}$
- C The length of side AB is  $2\sqrt{11}$  cm.
- D Angle BCD is  $33^\circ$ , correct to the nearest whole number.

35 Which **one** of the following is the **correct** simplification of  $\frac{3x+1}{6} - \frac{2x-3}{4}$ ?

A  $\frac{x-2}{2}$

B  $\frac{x-2}{12}$

C  $\frac{x+4}{2}$

D  $\frac{11}{12}$

36 The  $n$ th term of a quadratic sequence is  $2n^2 - 3n + 4$ .

Three of the following statements are true and **one** is false. Which one is **false**?

A The 5th term of the sequence is 39.

B 71 is a term in the sequence.

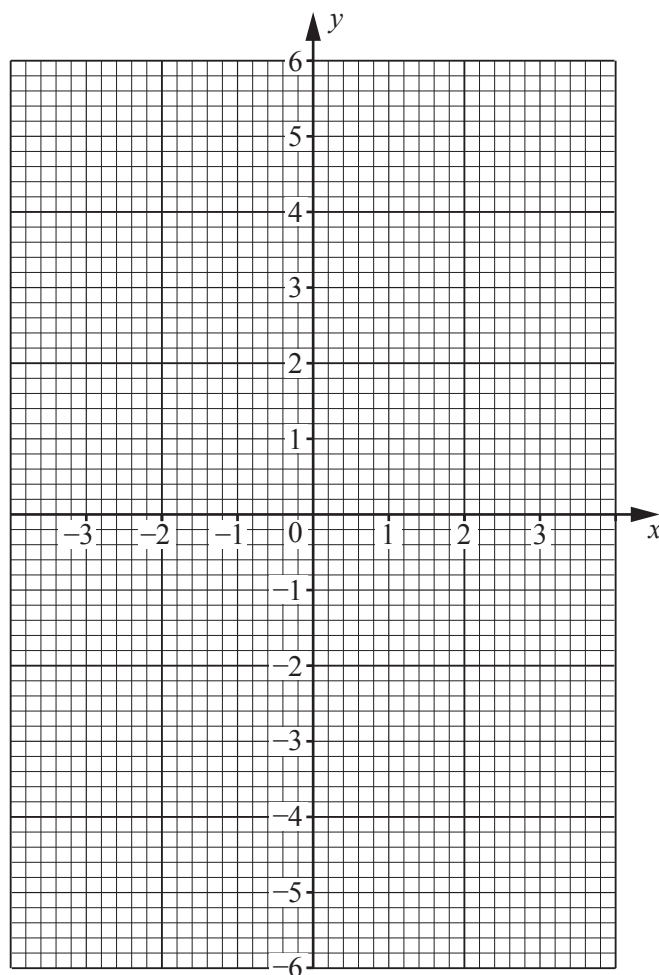
C The difference between the 1st and 2nd terms is 3.

D There are no negative terms in the sequence.

- 37 You are given the equation of the curve  $y = 1 + 3x - \frac{x^3}{2}$ .

The following table of values should be completed, and the curve of the equation drawn on the coordinate grid in order to answer this question.

$x$	-3	-2	-1	0	1	2	3
$y$	5.5	-1				3	-3.5



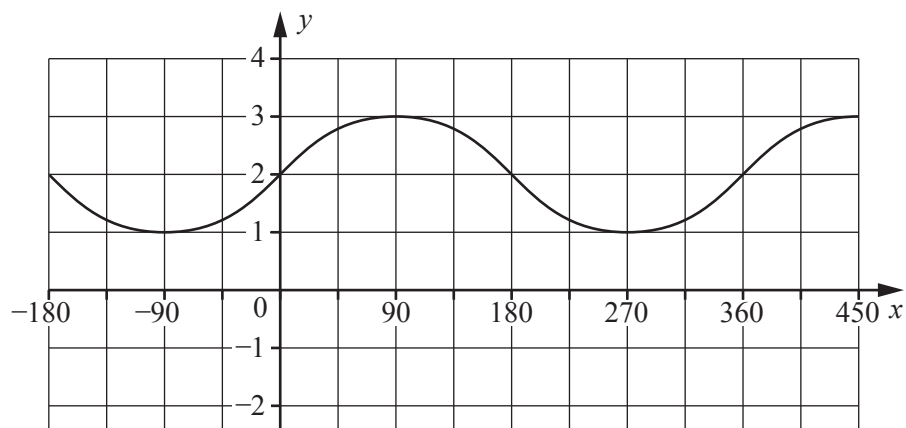
Three of the following statements are true and **one** is false. Which one is **false**?

- A** The equation  $1 + 3x - \frac{x^3}{2} = 0$  has a root between  $x = -3$  and  $x = -2$ .
- B** The value for the total area enclosed between the curve  $y = 1 + 3x - \frac{x^3}{2}$ , the  $x$ -axis, the  $y$ -axis and the line  $x = 2$  is between 5 and 7 square units.
- C** The equation  $1 + 3x - \frac{x^3}{2} = 0$  has three real roots.
- D** The gradient of the tangent to the curve where it crosses the  $y$ -axis is approximately  $-3$ .



38 Three of the following statements are true and **one** is false. Which one is **false**?

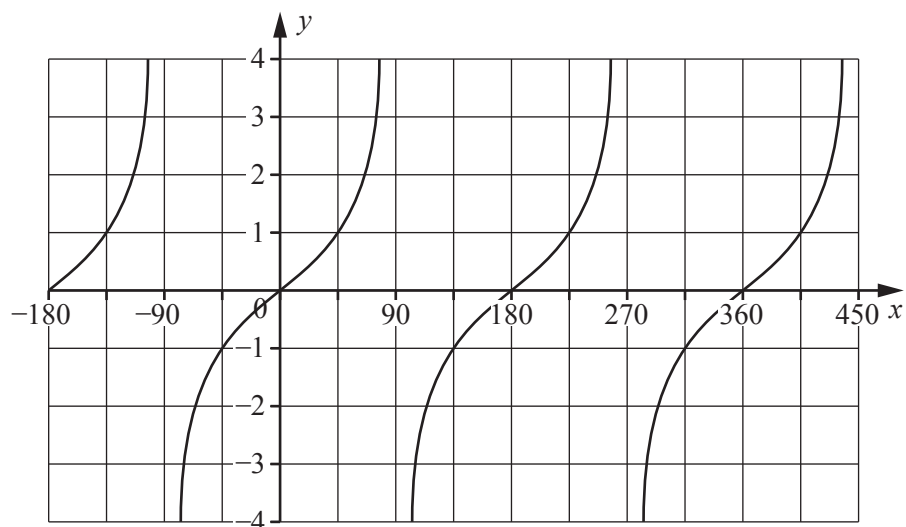
A The equation of the graph shown below is  $y = \sin 2x$ .



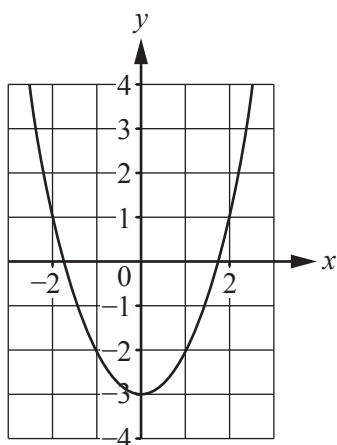
B The graph of  $y = \cos x$  crosses the  $x$ -axis at  $x = 450^\circ$ .

C The graph of  $y = \cos x - 1$  has no positive  $y$  values.

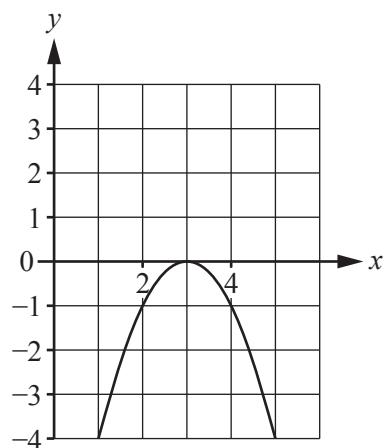
D The equation of the graph shown below is  $y = \tan x$ .



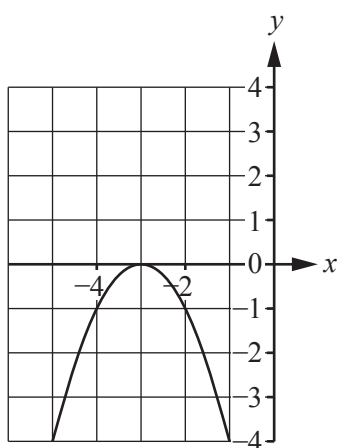
- 39 One of the following equations corresponds correctly to the graph drawn above it. Which equation is correct for its graph?



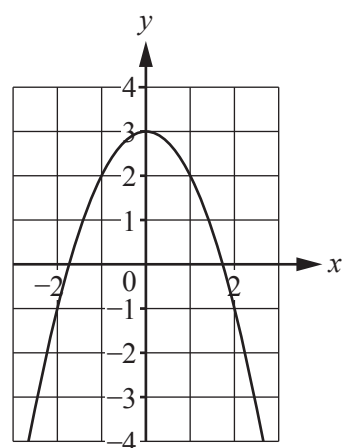
**A**  $y = x^2 - 3$



**B**  $y = 3 - x^2$

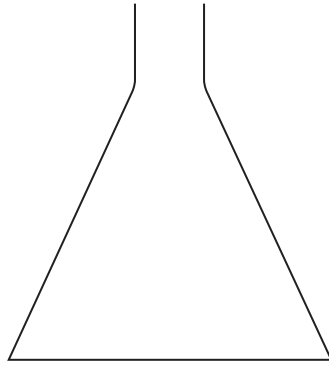


**C**  $y = (x - 3)^2$

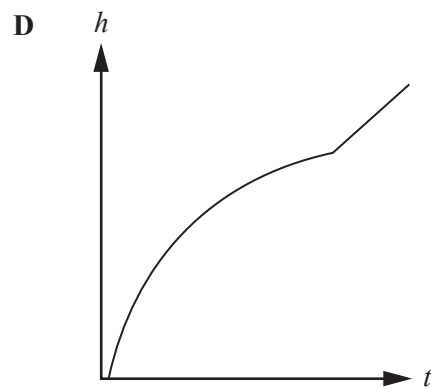
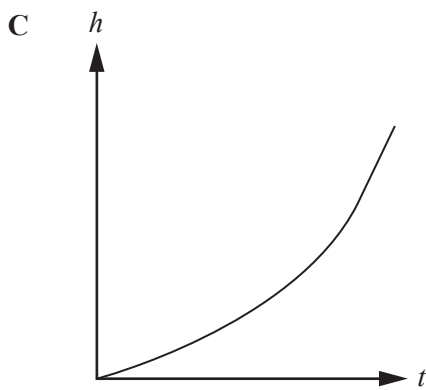
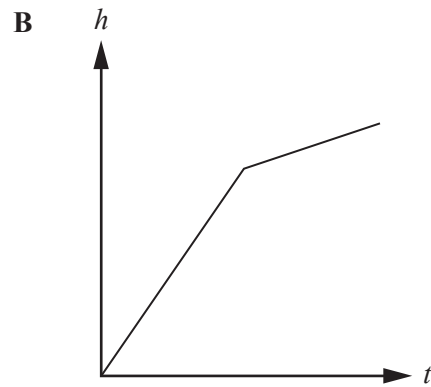
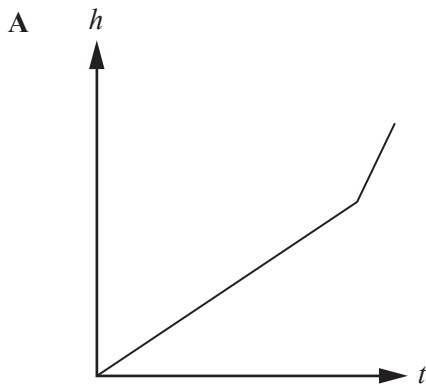


**D**  $y = (3 - x)^2$

- 40 The cross-section of a container is shown below. The container is filled with water at a constant rate.



Which **one** of the following graphs shows the **correct** relationship between the height,  $h$ , of water in the container and time  $t$ ?



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