



**FREE-STANDING MATHEMATICS QUALIFICATION
INTERMEDIATE LEVEL**

Foundations of Advanced Mathematics (MEI)

6989

Candidates answer on the answer sheet.

OCR supplied materials:

- Answer sheet (MS4)

Other materials required:

- Eraser
- Scientific calculator
- Soft pencil
- Ruler

**Thursday 20 January 2011
Morning**

Duration: 2 hours



INSTRUCTIONS TO CANDIDATES

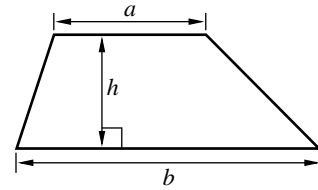
- Write your name clearly in capital letters, your centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar 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

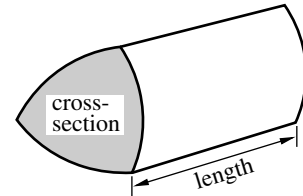
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- This document consists of **24** pages. Any blank pages are indicated.

Formulae Sheet: 6989 Foundations of Advanced Mathematics

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



Volume of prism $= (\text{area of cross-section}) \times \text{length}$

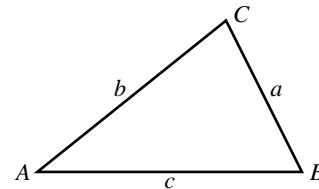


In any triangle ABC

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

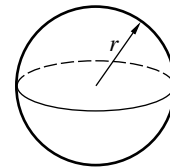
Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

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



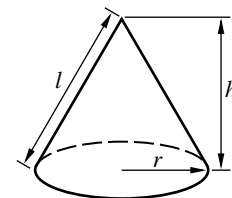
Volume of sphere $= \frac{4}{3}\pi r^3$

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

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

3

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

A $(-2)^4 = 16$

B $22 - 5 \times 3 = 7$

C $\frac{(+6) \times (-8)}{(-3) \times (-4)} = 4$

D $(3 - 7) - (2 - 5) = -1$

2 Look at this list of numbers.

12 18 64 144 216 360

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

A There are exactly 2 square numbers in the list.

B There are exactly 2 cube numbers in the list.

C There are exactly 2 factors of 36 in the list.

D There are exactly 2 multiples of 72 in the list.

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

A 70% is less than $\frac{5}{7}$.

B $0.33 < \frac{1}{3} < 0.34$

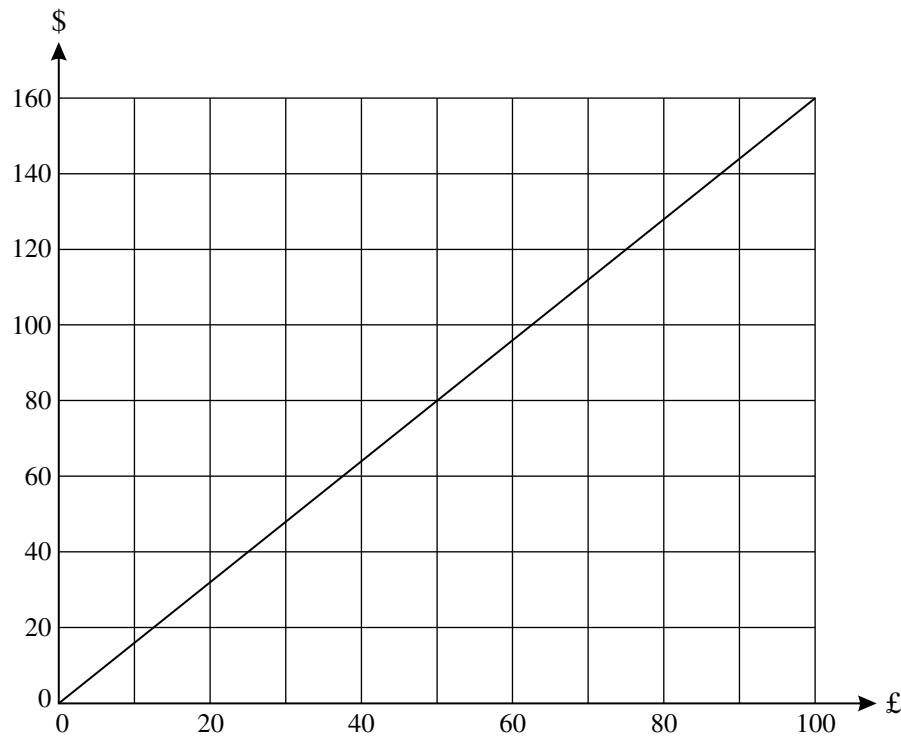
C When a quantity is divided in the ratio 2 : 3 the larger part is 60%.

D A quantity is divided into two parts. One part is three tenths of the whole so the parts are in the ratio 3 : 10.

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

- A $2.5 \text{ kg} = 2500 \text{ g}$
- B $100 \text{ mm}^2 = 10 \text{ cm}^2$
- C $750 \text{ millilitres} = 0.75 \text{ litres}$
- D $10 \text{ centimetres per second} = 360 \text{ metres per hour}$

5 The diagram below shows a conversion graph between pounds (£) and Canadian dollars (\$) on a particular day.



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

- A £40 is worth less than \$60.
- B \$140 is approximately £88.
- C £1 is worth more than \$1.
- D The gradient is the conversion factor from pounds to Canadian dollars.

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

- A $75.69 = 76$, correct to the nearest integer.
- B $\frac{1}{15} = 0.067$, correct to 2 decimal places.
- C $\sqrt{20} = 4.5$, correct to the nearest tenth.
- D $5^6 = 15\,600$, correct to 3 significant figures.

7 Jayon is collecting data about car colours. She records the colours of 20 cars passing her house as follows.

| | | | | |
|--------|--------|--------|--------|-------|
| Black | Silver | White | Blue | Black |
| Silver | Blue | Red | Silver | Blue |
| Green | Silver | Yellow | White | Blue |
| Red | Black | Silver | Black | Grey |

In order to complete this question you may find it helpful to summarise the data using the tally chart below.

| Car colour | Tally | Total |
|-------------------------------------|-------|-------|
| Black | | |
| Blue | | |
| Red | | |
| Silver | | |
| White | | |
| Other (eg Green, Grey, Yellow, ...) | | |

Three of the following statements about Jayon's data are true and **one** is false. Which one is **false**?

- A The modal class is Silver.
- B On a pie chart, the sector representing Red will have an angle of 36° .
- C Nearly two thirds of the cars are Black, Blue or Silver.
- D Based on the data the probability that the next car to pass Jayon's house will be Black is $\frac{1}{6}$.

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

Which **one** of the following expressions has the **greatest** value?

A $a + b + c$

B ab^2

C $\frac{a-b}{c}$

D $3abc$

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

A The solution of $19 - 2x = 11$ is a positive integer.

B The solution of $5x - 2(x - 4) = -1$ is a negative integer.

C The solution of $\frac{3x-7}{4} = 5$ is positive but not an integer.

D The solution of $5(x + 8) = -17$ is negative but not an integer.

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

A $\frac{9x^8}{3x^2} = 3x^6$

B $\frac{1}{4x} = 4x^{-1}$

C $2x^7 \times \frac{1}{2}x^4 = x^{11}$

D $\left(\frac{3x^2}{2}\right)^3 = \frac{27x^6}{8}$

11 Two groups of students do a test. The marks (out of 10) are as follows.

| | | | | | | | | |
|---------|---|---|---|---|---|---|---|----|
| Group A | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 |
| Group B | 2 | 3 | 5 | 7 | 8 | 8 | 9 | 10 |

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

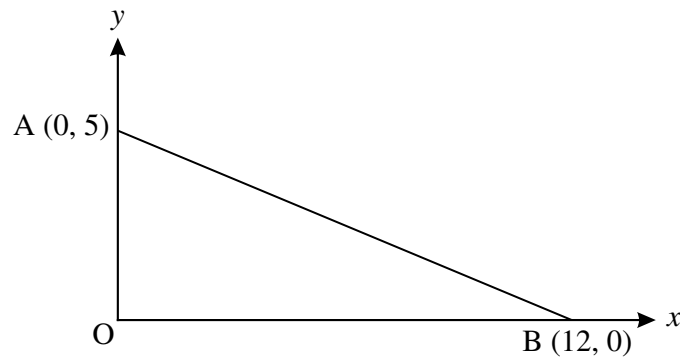
A The mean mark for Group B is 6.5.

B The range of marks for Group A is 3.

C The median mark is the same for each Group.

D The marks in Group A have a greater spread than the marks in Group B.

12



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

- A The gradient of the line AB is $\frac{5}{12}$.
- B The equation of the line AB may be written as $12y + 5x = 60$.
- C The point (3, 3.75) lies on the line AB.
- D The length of AB is 13 units.

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

- A The price of a bicycle has been reduced by 10% to £135. The original price was £150.
- B A salary of £26 000, when increased by 2.5%, becomes £26 650.
- C A 1 litre tin of paint covers an area of 2.5 m^2 , so a 5 litre tin will cover an area of 12.5 m^2 .
- D x and y are inversely proportional, so when x is doubled then y is doubled.

14 Which **one** of the following expressions has the **least** value?

A $2\frac{1}{4} + \frac{7}{8}$

B $4\frac{1}{8} - 1\frac{3}{8}$

C $1\frac{1}{2} \times 1\frac{3}{4}$

D $7\frac{2}{3} \div 2\frac{2}{3}$

15 Amber and Gemma are doing work on standard form.

- Amber claims that $(5 \times 10^6)^2 = 2.5 \times 10^{13}$.
- Gemma claims that $(4 \times 10^{-8}) \div (8 \times 10^{-4}) = 5 \times 10^{-5}$.

Which **one** of the following statements is **true**?

- A** Amber and Gemma are both correct.
- B** Amber is correct and Gemma is incorrect.
- C** Amber is incorrect and Gemma is correct.
- D** Amber and Gemma are both incorrect.

16 Three of the following statements are reasonable and **one** is unreasonable. Which one is **unreasonable**?

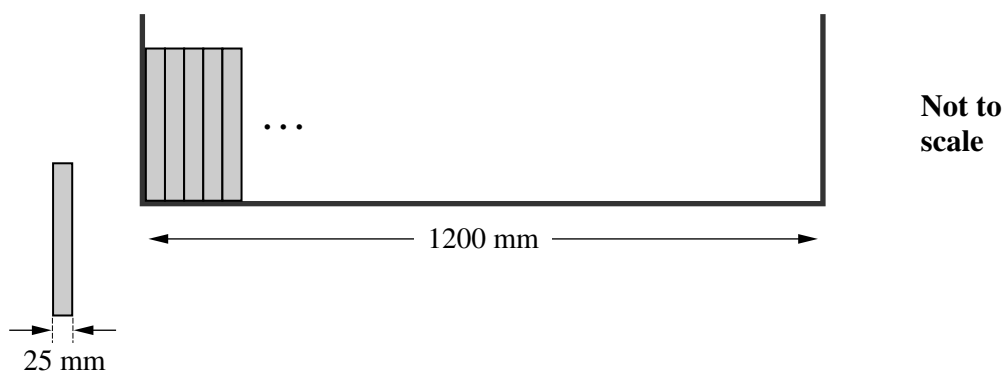
- A** The amount of water in a half full bath is measured in litres.
- B** The thickness of a piece of cardboard is measured in millimetres.
- C** The time in which a car can reach 50 mph from rest is measured in seconds.
- D** The weekly rainfall in London is measured in metres.

17 Three vectors are given by $\mathbf{a} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}$, $\mathbf{b} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$ and $\mathbf{c} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$.

Which **one** of the following is the **correct** value of $\mathbf{a} + 2\mathbf{b} - 3\mathbf{c}$?

- A** $\begin{pmatrix} -9 \\ 0 \end{pmatrix}$ **B** $\begin{pmatrix} -9 \\ 5 \end{pmatrix}$ **C** $\begin{pmatrix} 9 \\ 1 \end{pmatrix}$ **D** $\begin{pmatrix} 9 \\ 5 \end{pmatrix}$

18 The length of a shelf is 1200 mm, correct to the nearest 10 mm. Books which are each 25 mm thick, correct to the nearest millimetre, are placed on the shelf as shown.



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

- A** The length of the shelf is not greater than 1205 mm.
- B** The minimum thickness of a book is 24.5 mm.
- C** 47 books can definitely be placed on the shelf.
- D** It may be possible to place 49 books on the shelf.

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

A $4x(y - 2) - 3y(x - 1) = xy + 3y - 8x$

B $(5x + 4)(5x - 4) = 25x^2 - 16$

C $(x + 3)^2 = x^2 + 9$

D $2x^3y + 6x^2y^3 = 2x^2y(x + 3y^2)$

20 Charlie makes a scale drawing of the front of his house using a scale of 1 : 20.

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

A The scale can be written 5 cm : 1 m.

B The lounge window is 1.2 m high so it will be 6 cm high on the scale drawing.

C On the scale drawing the width of the garage door is 10 cm so the actual width of the garage door is 2 m.

D The front door has an area of 2.5 m^2 so it will have an area of 12.5 cm^2 on the scale drawing.

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

A The solution of $2x - 1 > 9$ is $x > 5$.

B The solution of $\frac{3x}{4} \leq 2$ is $x \leq \frac{8}{3}$.

C The solution of $5 - x \leq 1$ is $x \geq 4$.

D The solution of $2(3x - 4) - 5 > 0$ is $x < \frac{13}{6}$.

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

A $\cos 120^\circ = -\frac{1}{2}$

B There are exactly two values of θ in the interval $0^\circ \leq \theta \leq 360^\circ$ for which $\tan \theta = 1$.

C For any value of θ , $0 \leq \sin \theta \leq 1$.

D In the interval $0^\circ \leq \theta \leq 180^\circ$, $\cos \theta$ decreases as θ increases.

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

- A** Given $x^2 - 5x + 6 = 0$ then either $x - 2 = 0$ or $x - 3 = 0$.
- B** Given $x^2 + x - 6 = 0$ then either $x - 2 = 0$ or $x + 3 = 0$.
- C** Given $x^2 - 10x - 24 = 0$ then either $x - 6 = 0$ or $x + 4 = 0$.
- D** Given $x^2 + 2x - 24 = 0$ then either $x + 6 = 0$ or $x - 4 = 0$.

24 Next week Amy and Jack will each make exactly one visit to the skating arena. Their visits, which are independent, are equally likely to be on Monday, Tuesday, Wednesday, Thursday or Friday.

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

- A** The probability that Amy's visit is not on Monday is $\frac{4}{5}$.
- B** The probability that Jack's visit is on Tuesday or Wednesday is $\frac{2}{5}$.
- C** The probability that Amy and Jack both visit on Thursday is $\frac{1}{25}$.
- D** The probability that at least one of their visits is on Friday is $\frac{8}{25}$.

25 Which **one** of the following is the **correct** solution of the equation $7x^2 - 3 - 12x = 0$?

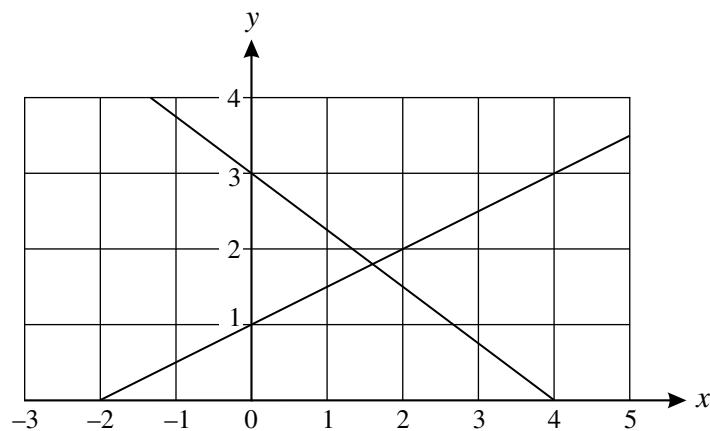
- A $\frac{12 \pm \sqrt{228}}{14}$ B $\frac{-12 \pm \sqrt{228}}{14}$ C $\frac{3 \pm \sqrt{345}}{14}$ D $\frac{-3 \pm \sqrt{345}}{14}$

26 The running cost of Avtar's car is n pence for every mile he drives. In a year he drives m miles.

Which **one** of the following expressions is the **correct** running cost (in pounds) for the year?

- A $\frac{mn}{100}$ B $100mn$ C $\frac{100m}{n}$ D $\frac{n}{100m}$

27 The graph below shows two straight lines.



Which **one** of the following pairs of simultaneous equations can be **solved** using this graph?

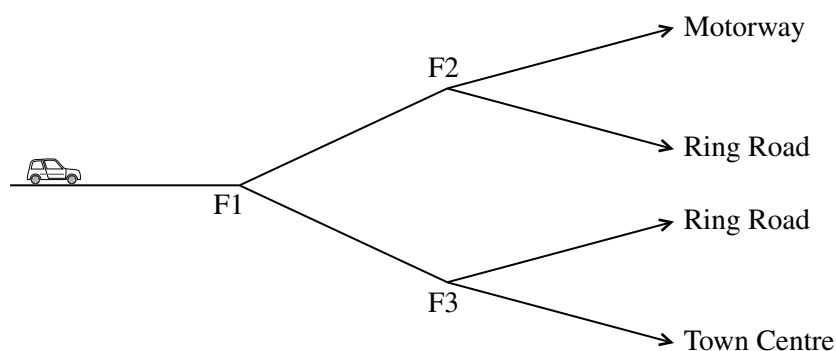
- A $y = x + 1$ and $4x + 3y = 9$
 B $2y = x + 2$ and $3x + 4y = 12$
 C $2y = x + 2$ and $4x + 3y = 9$
 D $y = x + 1$ and $3x + 4y = 12$

- 28 You are given the vectors $\mathbf{a} = 2\mathbf{i} - 3\mathbf{j}$, $\mathbf{b} = \mathbf{i} + 4\mathbf{j}$ and $\mathbf{c} = 4\mathbf{i} - 6\mathbf{j}$.

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

- A The modulus of vector \mathbf{a} is 13.
- B The angle between vectors \mathbf{b} and \mathbf{i} is 76° , correct to the nearest degree.
- C The vectors \mathbf{a} and \mathbf{c} have the same direction.
- D $2\mathbf{b} + \mathbf{c} = 2(3\mathbf{i} + \mathbf{j})$

- 29 Rachel is driving her car on the road network shown.



She has lost her way and at each fork (labelled F1, F2 and F3) she goes either left or right. The probability that she goes left at F1 is 0.8. If she goes left at F1 then the probability that she heads for the motorway at F2 is 0.7. If she goes right at F1 then the probability that she heads for the town centre at F3 is 0.4.

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

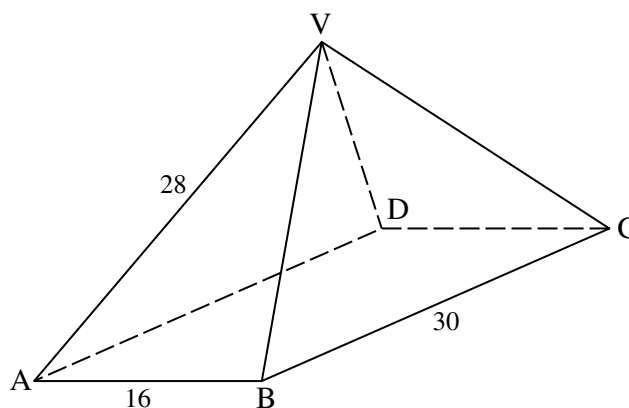
- A The probability that Rachel drives towards the motorway is 0.56.
- B The probability that Rachel drives towards the town centre is 0.08.
- C The probability that Rachel drives towards the ring road is 0.24.
- D The probability that Rachel took the same direction at both the forks she comes to is 0.64.

- 30 Which **one** of the following is the **correct** solution of this pair of simultaneous equations?

$$-2x + y = 4$$

$$2x + y = -8$$

- A $x = -3, y = -2$
- B $x = 3, y = 2$
- C $x = 1, y = 6$
- D $x = -1, y = -6$
- 31 The diagram shows a pyramid with vertex V and a rectangular base ABCD. $AB = 16$, $BC = 30$ and $VA = VB = VC = VD = 28$.



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

- A $AC = 34$
- B Angle $BCA = 28^\circ$, correct to the nearest degree.
- C The height of V above the base is 22.2, correct to 1 decimal place.
- D Angle $AVC = 105^\circ$, correct to the nearest degree.

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

A $3x + 4y = 8$ may be rearranged to give $y = -\frac{3x}{4} + 2$.

B $x = \sqrt{\frac{2E}{k}}$ may be rearranged to give $E = \frac{1}{2}kx^2$.

C $T = ar^{n-1}$ may be rearranged to give $r = \sqrt[n]{\frac{T}{a}} + 1$.

D $\frac{h}{H} = \frac{r}{R}$ may be rearranged to give $H = \frac{hR}{r}$.

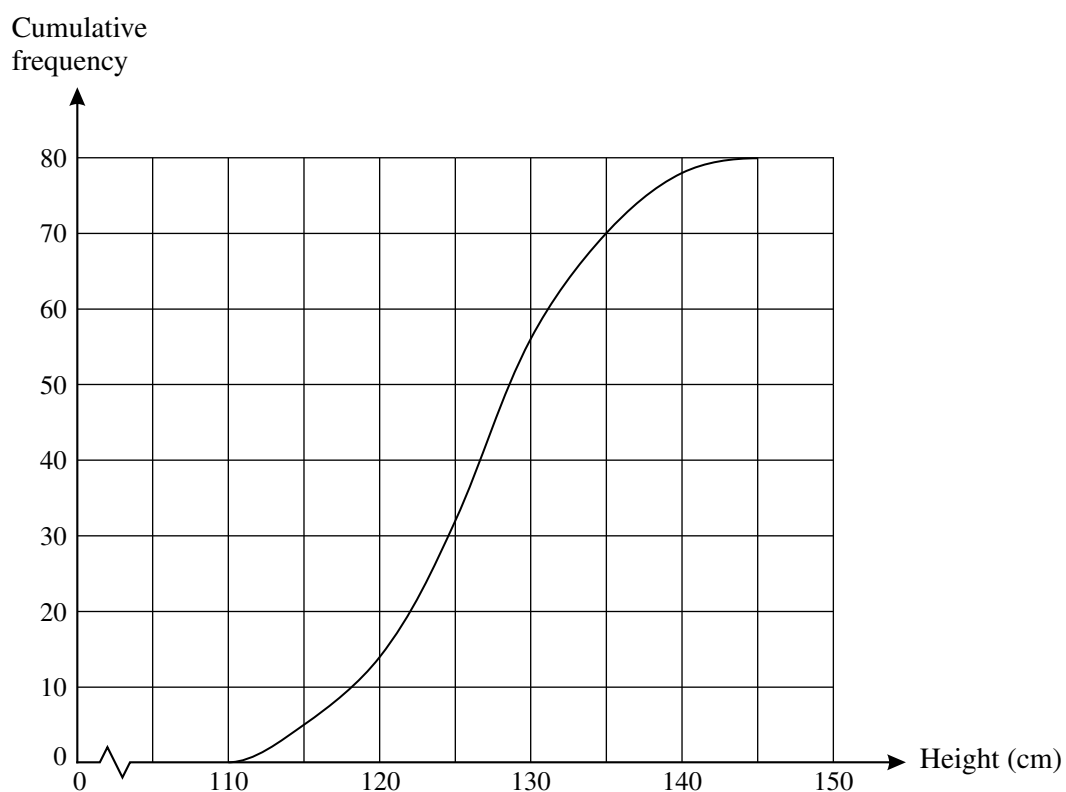
33 Three of the following statements are true and **one** is false. Which one is **false**?

- A If the perimeter of a square is 60 cm, then the area is 225 cm^2 .
- B If the diameter of a circle is 5 cm, then the circumference is $10\pi \text{ cm}$.
- C If the volume of a cube is 1000 cm^3 , then the area of a face is 100 cm^2 .
- D If the volume of a cylinder is 800 cm^3 and the area of its cross-section is 50 cm^2 , then the height is 16 cm.

34 Which **one** of the following is a **correct** simplification of $\frac{3x-4}{5} - \frac{4x-7}{2}$?

- A $\frac{-14x-15}{10}$
- B $\frac{-14x+27}{10}$
- C $\frac{-14x+31}{10}$
- D $\frac{-14x-43}{10}$

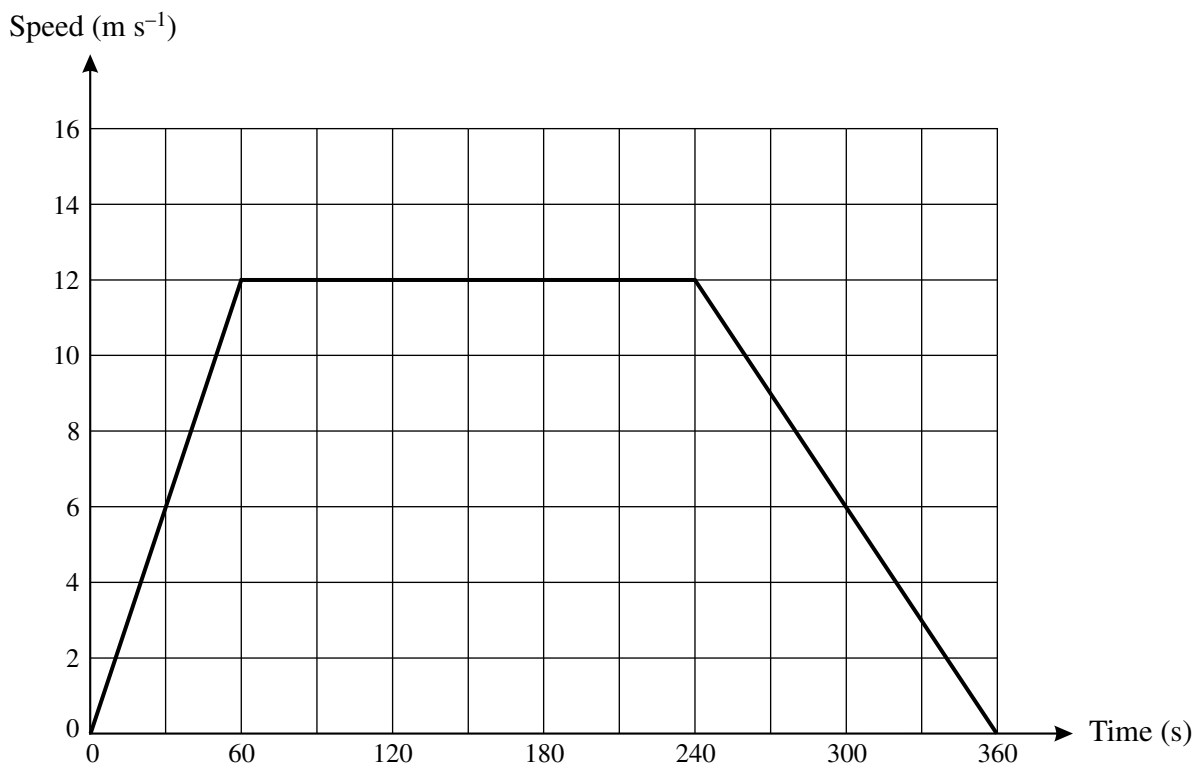
35 This cumulative frequency diagram summarises the heights of 80 boys.



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

- A Approximately 13 boys are less than 120 cm tall.
- B Approximately 55 boys are more than 130 cm tall.
- C The median height is approximately 127 cm.
- D The interquartile range is approximately 10 cm.

- 36 This graph shows the speed of a train when travelling from one station to the next.



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

- A The speed is constant for half the journey time.
- B The acceleration after 40 seconds is 8 m s^{-2} .
- C The distance covered is 3.24 km.
- D The speed after 15 seconds is the same as the speed after 330 seconds.

- 37 Here are three statements about sequences.

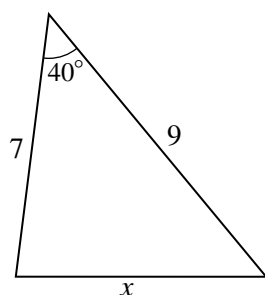
- The n th term of the sequence 8, 14, 20, 26, 32, ... is of the form $an + b$ where a and b are constants.
- The n th term of the sequence 2, 5, 10, 17, 26, ... is of the form $n^2 + 1$.
- 6, 18, 54, 162, 486, ... is an exponential sequence.

How **many** of these three statements are **true**?

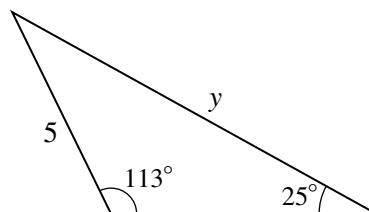
- A 0
- B 1
- C 2
- D 3

38 Liam and Tom are solving problems in trigonometry.

Liam's problem



Tom's problem



Not to
scale

- Liam claims that $x = 5.8$ correct to 1 decimal place.
- Tom claims that $y = 7.9$, correct to 1 decimal place.

Which **one** of the following statements is **true**?

- A Liam and Tom are both correct.
- B Liam is correct and Tom is incorrect.
- C Liam is incorrect and Tom is correct.
- D Liam and Tom are both incorrect.

39 Starting with a positive number, x , do the following.

- add 5 to it
- square the result
- subtract 9
- subtract twice the original number
- take the positive square root.

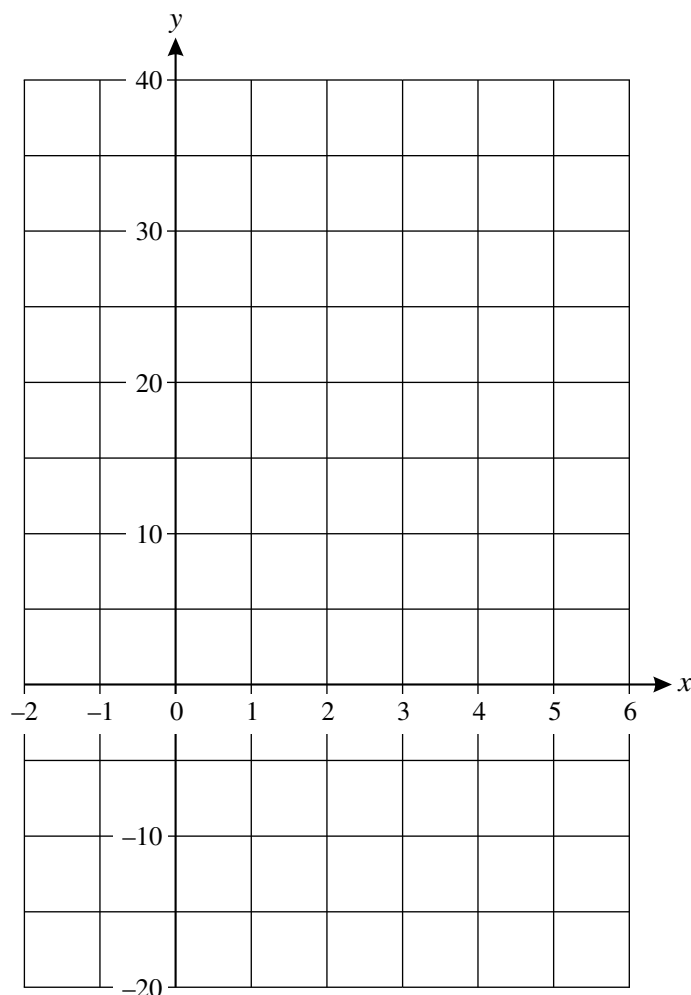
Which **one** of the following statements is **true**?

- A The answer will always be greater than x .
- B The answer will always be equal to x .
- C The answer will always be less than x .
- D The relationship between the answer and x varies depending on the value of x which is chosen to start with.

- 40 The table below shows points on the graph of $y = 2x^3 - 11x^2 + 12x + 5$.

| | | | | | | | |
|-----|-----|---|---|---|----|---|----|
| x | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
| y | -20 | 5 | 8 | 1 | -4 | 5 | 40 |

In order to answer this question you should draw the graph on the grid below.



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

- A The equation $2x^3 - 11x^2 + 12x + 5 = 0$ has two positive roots and one negative root.
- B The equation $2x^3 - 11x^2 + 12x + 5 = 22$ has only one root.
- C There are two points on the curve $y = 2x^3 - 11x^2 + 12x + 5$ at which the gradient is zero.
- D The curve $y = 2x^3 - 11x^2 + 12x + 5$ has negative gradient at $x = -0.5$.

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