

**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
- Rough Paper
- Scientific calculator
- Soft pencil
- Ruler

**Thursday 21 January 2010
Morning**

Duration: 2 hours



INSTRUCTIONS TO CANDIDATES

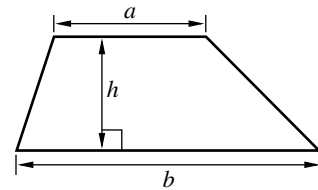
- Write your name clearly in capital letters, your Centre Number and Candidate Number on the Answer Sheet in the spaces provided unless this has already been done for you.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Do **not** write in 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

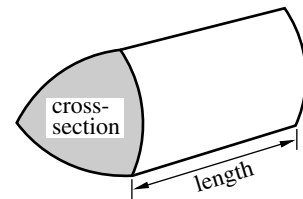
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Paper is provided for rough work; this should not be handed in.
- This document consists of **20** pages. Any blank pages are indicated.

Formulae Sheet: 6989 Foundations of Advanced Mathematics

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



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

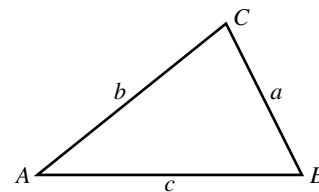


In any triangle ABC

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

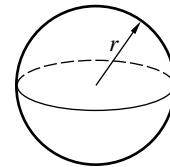
$$\text{Cosine rule} \quad a^2 = b^2 + c^2 - 2bc \cos A$$

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



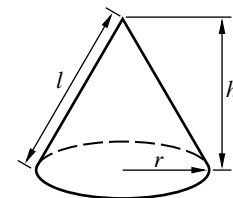
$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$

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



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

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



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 $4 - 8 + 2 = -6$

B $\frac{(-24)}{(+4) \times (-3)} = 2$

C $(-3)^3 = -27$

D $3 + 7 \times 2 = 17$

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

A The cube root of 125 is 5.

B 143 is a prime number.

C The lowest common multiple (LCM) of 15 and 25 is 75.

D There are nine different factors of 36.

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

A $4 \text{ mm} = 0.4 \text{ cm}$

B $2500 \text{ g} = 2.5 \text{ kg}$

C $5 \text{ m s}^{-1} = 18 \text{ km h}^{-1}$

D $70 \text{ centilitres} = 0.07 \text{ litres}$

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

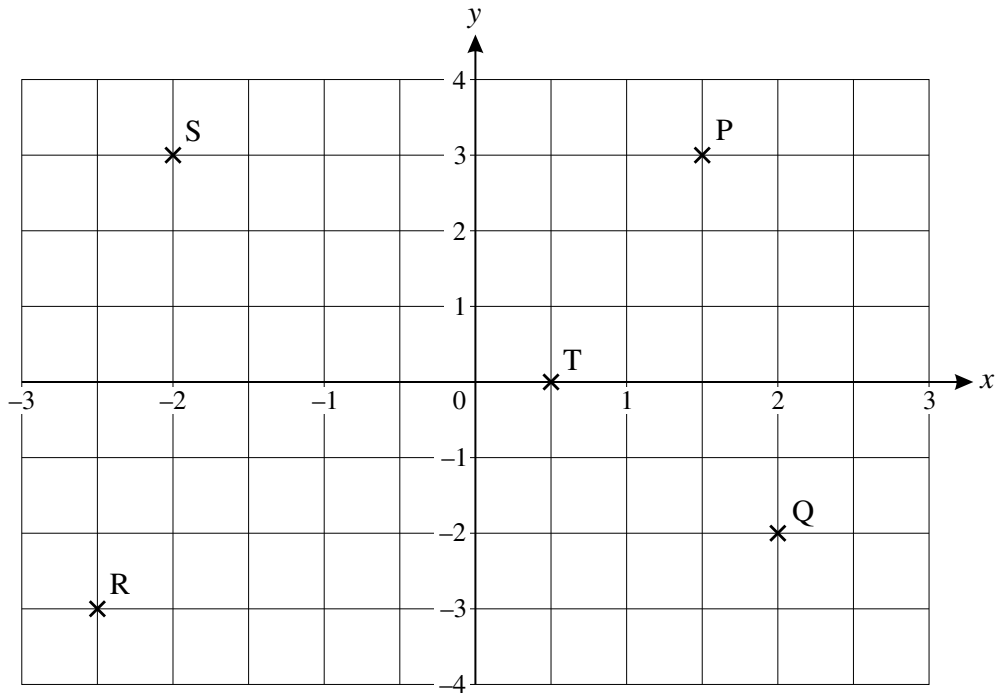
A $\frac{1}{7} = 0.143$, correct to 3 decimal places.

B $\sqrt{35} = 5.9$, correct to the nearest tenth.

C $7^6 = 117\,700$, correct to the nearest hundred.

D $234\,567 \div 89 = 2640$, correct to 3 significant figures.

- 5 Heena has tried to plot the points P (1.5, 3), Q (2, -2), R (-3, -2.5), S (-2, 3) and T (0, 0.5).



How **many** of these points are **correctly** plotted?

- A 2 or fewer B 3 C 4 D 5
- 6 Ria lists the number of goals scored by her team in ten football matches.

2 5 1 2 3 3 1 4 1 8

She makes the following statements.

- The mean is 3.
- The median is 2.5.
- The mode is 1.
- The range is 6.

How **many** of these statements are **correct**?

- A 1 B 2 C 3 D 4

- 7 Harry is attempting to solve the equation $5(x - 3) = x + 20$.

His working is shown in the four steps below, but his final answer is incorrect.

In which of the following steps **A**, **B**, **C**, **D** does his **first** error occur?

A $5x - 15 = x + 20$

B $5x - x = 20 - 15$

C $4x = 5$

D $x = \frac{4}{5}$

- 8 There are 1200 students in a mixed school. The Headteacher has proposed changes in the school rules. The School Council wants to obtain the views of a random sample of 100 students.

Which **one** of the following will produce a **random** sample?

A Give questionnaires to all the students and use the first 100 that are returned.

B Interview the first 50 boys and the first 50 girls arriving at the school one day.

C There are 100 students in Year 12. Interview all of them.

D Write the name of each student on a piece of paper, put the 1200 pieces of paper into a hat, mix them up and pick out 100 names.

- 9 You are given $a = 5$, $b = -3$ and $c = -2$.

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

A $a + b + c = 0$

B $ab^2 = 45$

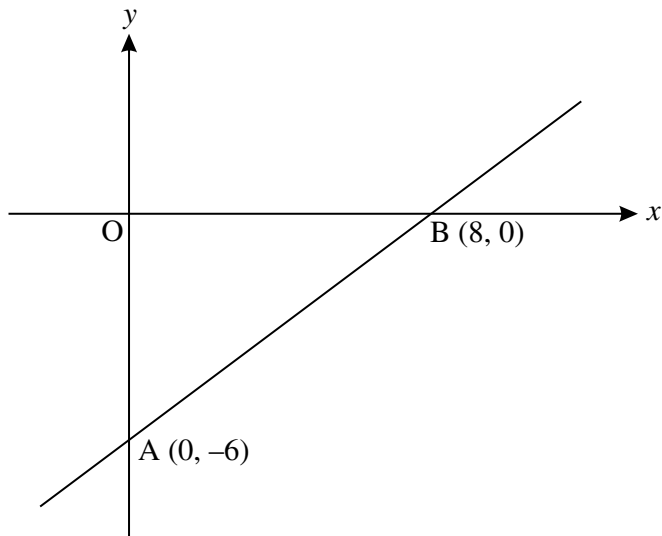
C $\frac{b^2 + c^2}{a^2} = 0.52$

D $\frac{b}{c} + \frac{c}{b} = 1$

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

- A In the expression $2x^3 - 8x^2 + x + 1$, the highest power of x is 3.
- B In the expression $5 + 6x - x^2$, the coefficient of x^2 is 1.
- C The expression $4x^3 - 5x^2 + 7x$ contains no constant term.
- D $4x(x - 3) + 9$ is equal to $(2x - 3)^2$ for all values of x .

11 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 0.75.
- B The equation of the line AB can be written $4y = 3x - 24$.
- C The area of triangle OAB is 24 units².
- D The line AB passes through the point (6, -4.5).

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

- A The distance from London to Birmingham is measured in kilometres.
- B The mass of a pencil is measured in kilograms.
- C The amount of petrol bought from a garage is measured in litres.
- D The length of a baby is measured in centimetres.

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

A $3x^2 \times 4x^5 = 12x^{10}$

B $\frac{6x^5}{12x} = \frac{1}{2}x^4$

C $(2x^3)^4 = 16x^{12}$

D $x^{\frac{1}{2}} = \sqrt{x}$

14 A card is drawn at random from an ordinary pack of 52 cards.

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

A The probability that the card is a club is 0.25.

B The probability that the card is not a King, Queen or Jack is 0.77, correct to 2 decimal places.

C The probability that the card is a diamond or an ace is 0.33, correct to 2 decimal places.

D The first card is replaced and again a card is drawn at random. The probability that the two cards drawn are the same is 0.02, correct to 2 decimal places.

15 A rectangular sandpit is 12.0 metres long and 5.0 metres wide, both correct to the nearest tenth of a metre.

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

A The length of the sandpit is not greater than 12.05 metres.

B The minimum possible width of the sandpit is 4.95 metres.

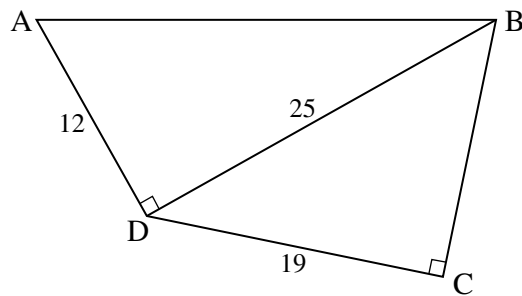
C The diagonal of the sandpit must be between 12.95 and 13.05 metres.

D The area of the sandpit is less than 60.8525 square metres.

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

- A A discount of 10% is the same as getting one tenth off the price.
- B A sign ' $\frac{1}{4}$ off marked price' means the customer pays 75% of the marked price.
- C An item priced at £80 excluding VAT costs £94 when VAT at 17.5% is added.
- D An item is priced at £400 including VAT at 17.5%. The VAT on the item is £70.

17 Rosie and Vicky are solving a problem involving right-angled triangles.



Not to scale

- Rosie claims that angle BDC is approximately 40.5° .
- Vicky claims that angle ABC is approximately 75.1° .

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

- A Rosie and Vicky are both correct.
- B Rosie is correct and Vicky is incorrect.
- C Rosie is incorrect and Vicky is correct.
- D Rosie and Vicky are both incorrect.

18 Which **one** of the following is the **correct** solution of the equation $4 - 9x + 3x^2 = 0$?

- A $\frac{9 \pm \sqrt{33}}{6}$
- B $\frac{-9 \pm \sqrt{33}}{6}$
- C $\frac{9 \pm \sqrt{33}}{8}$
- D $\frac{-9 \pm \sqrt{33}}{8}$

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

- A $250\,000\,000 = 2.5 \times 10^8$
- B $5 \times 10^{-2} - 5 \times 10^{-3} = 4.5 \times 10^{-3}$
- C $(3.6 \times 10^6)^2 = 1.296 \times 10^{13}$
- D $(6.8 \times 10^{20}) \div (3.4 \times 10^5) = 2 \times 10^{15}$

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

- A $3\frac{1}{8} - 2\frac{5}{8} = \frac{1}{2}$
- B $4\frac{1}{2} + 2\frac{2}{3} = 7\frac{1}{6}$
- C $(\frac{3}{4})^2 = \frac{3}{16}$
- D $\frac{3}{4} \div \frac{4}{5} = \frac{15}{16}$

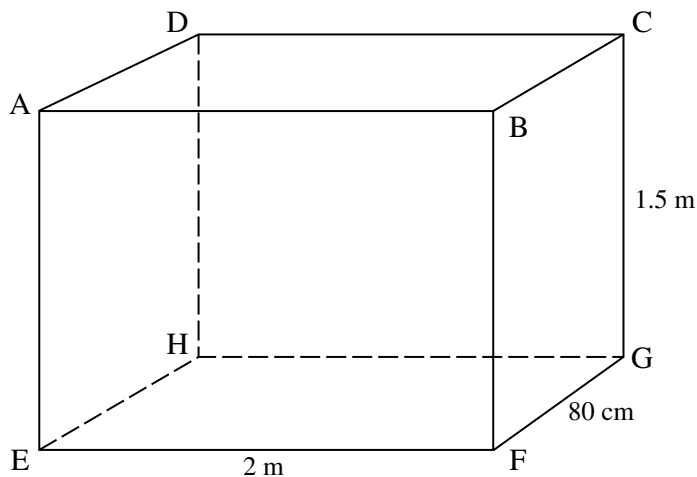
21 Three of the following statements are true and **one** is false. Which one is **false**?

- A The solution of $\frac{y}{3} > 4$ is $y > 12$.
- B The solution of $-5y \leq 15$ is $y \leq -3$.
- C The solution of $5(y - 7) \geq 12$ is $y \geq 9.4$.
- D The solution of $y < \frac{y}{4} + 6$ is $y < 8$.

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

- A One day Adam drove 120 miles in 2 hours. The following day he made the same journey at an average speed which was 10% slower so the time he took was 10% longer.
- B Given that 245 g of cheese costs £1.40 then 315 g of cheese will cost £1.80.
- C When £280 is shared in the ratio 3 : 2 the larger share is £168.
- D When a sum of money is shared in the ratio 2 : 3 : 4 then each share is less than half the original amount.

23 A water tank, ABCDEFGH, has length 2 m, width 80 cm and height 1.5 m.



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

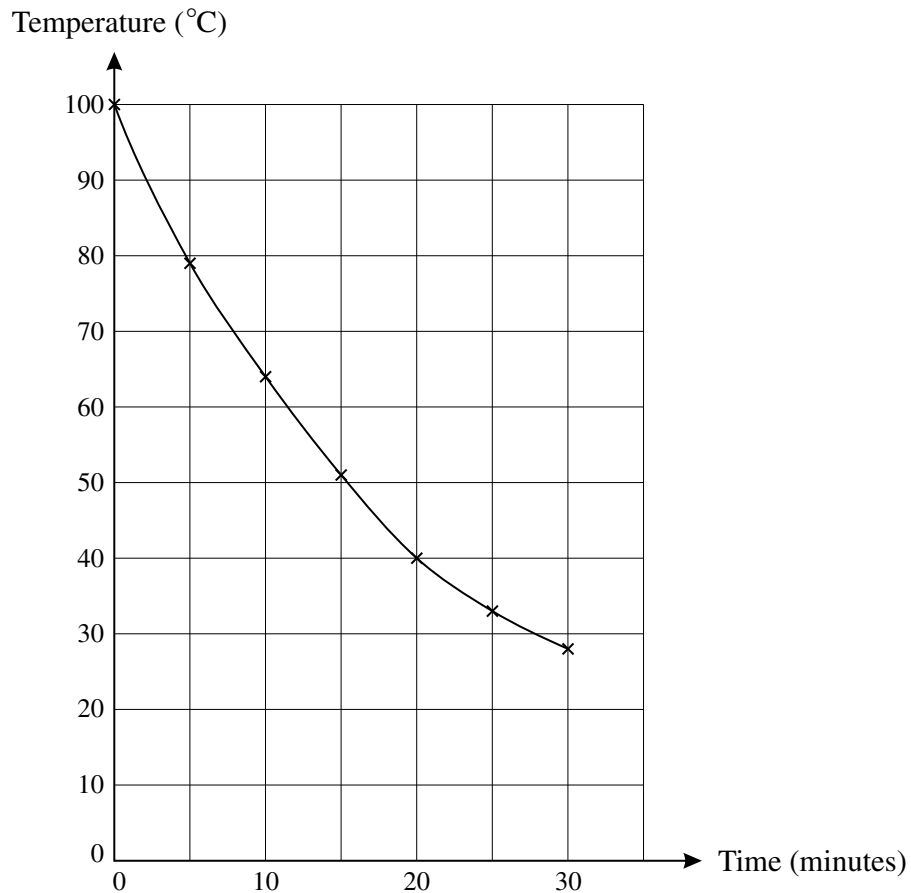
- A Each of the smallest faces has an area of 1.2 m^2 .
- B The length of AG is approximately 2.6 m.
- C When half full the tank contains 2400 litres.
- D The tank is lagged with insulating material covering all 6 outside faces. The area of insulating material required is 11.6 m^2 .

- 24 Three vectors are given by $\mathbf{x} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}$, $\mathbf{y} = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$ and $\mathbf{z} = \begin{pmatrix} -4 \\ 3 \end{pmatrix}$.

Which **one** of the following is the **correct** value of $4\mathbf{x} - \mathbf{y} - 2\mathbf{z}$?

- A $\begin{pmatrix} 26 \\ -5 \end{pmatrix}$ B $\begin{pmatrix} 26 \\ -2 \end{pmatrix}$ C $\begin{pmatrix} 10 \\ -5 \end{pmatrix}$ D $\begin{pmatrix} 10 \\ -2 \end{pmatrix}$

- 25 Wim boils some water and then records the temperature as it cools. His results are shown on the graph below.



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

- A When 5 minutes has elapsed the temperature has fallen by approximately 21°C .
 B When 17 minutes has elapsed the rate of cooling is approximately 2°C per minute.
 C It takes longer to cool from 40°C to 30°C than it does to cool from 90°C to 80°C .
 D As the temperature decreases the rate of cooling increases.

26 Here is a pair of simultaneous equations.

$$3x + 4y = 7$$

$$x - 6y = 17$$

Which **one** of the following describes their solution?

- A Both x and y are integers.
- B x is an integer but y is not.
- C y is an integer but x is not.
- D Neither x nor y is an integer.

27 Three of the following expressions can be factorised into the form $(x + p)(x + q)$ where p and q are integers (positive or negative) but one cannot.

Which **one** of the following **cannot** be factorised in this way?

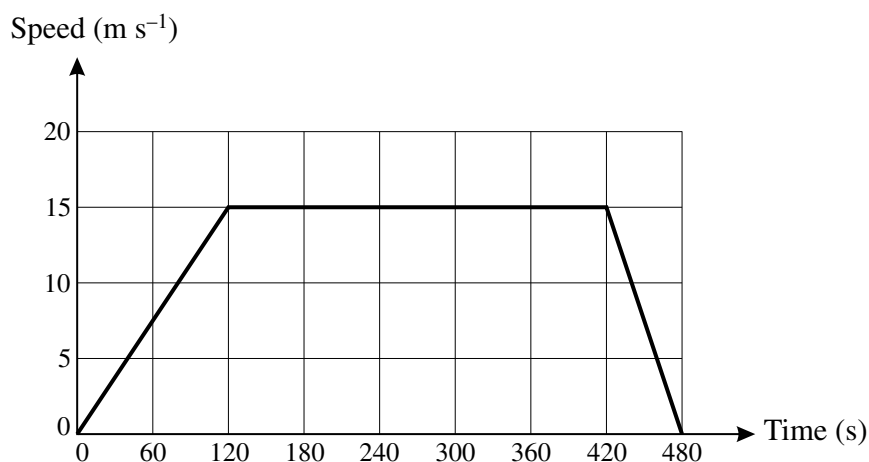
- A $x^2 + 16x + 15$
- B $x^2 + 5x - 6$
- C $x^2 - 4x - 12$
- D $x^2 - 9x - 20$

28 You are given the vectors $\mathbf{a} = 0.6\mathbf{i} + 0.8\mathbf{j}$, $\mathbf{b} = -3\mathbf{i} + 2\mathbf{j}$ and $\mathbf{c} = -6\mathbf{i} + 4\mathbf{j}$.

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

- A The vector \mathbf{a} is a unit vector.
- B The angle between vectors \mathbf{b} and \mathbf{i} is approximately 146.3° .
- C The vectors \mathbf{b} and \mathbf{c} have the same magnitude.
- D $5\mathbf{a} - \mathbf{c} = 9\mathbf{i}$

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



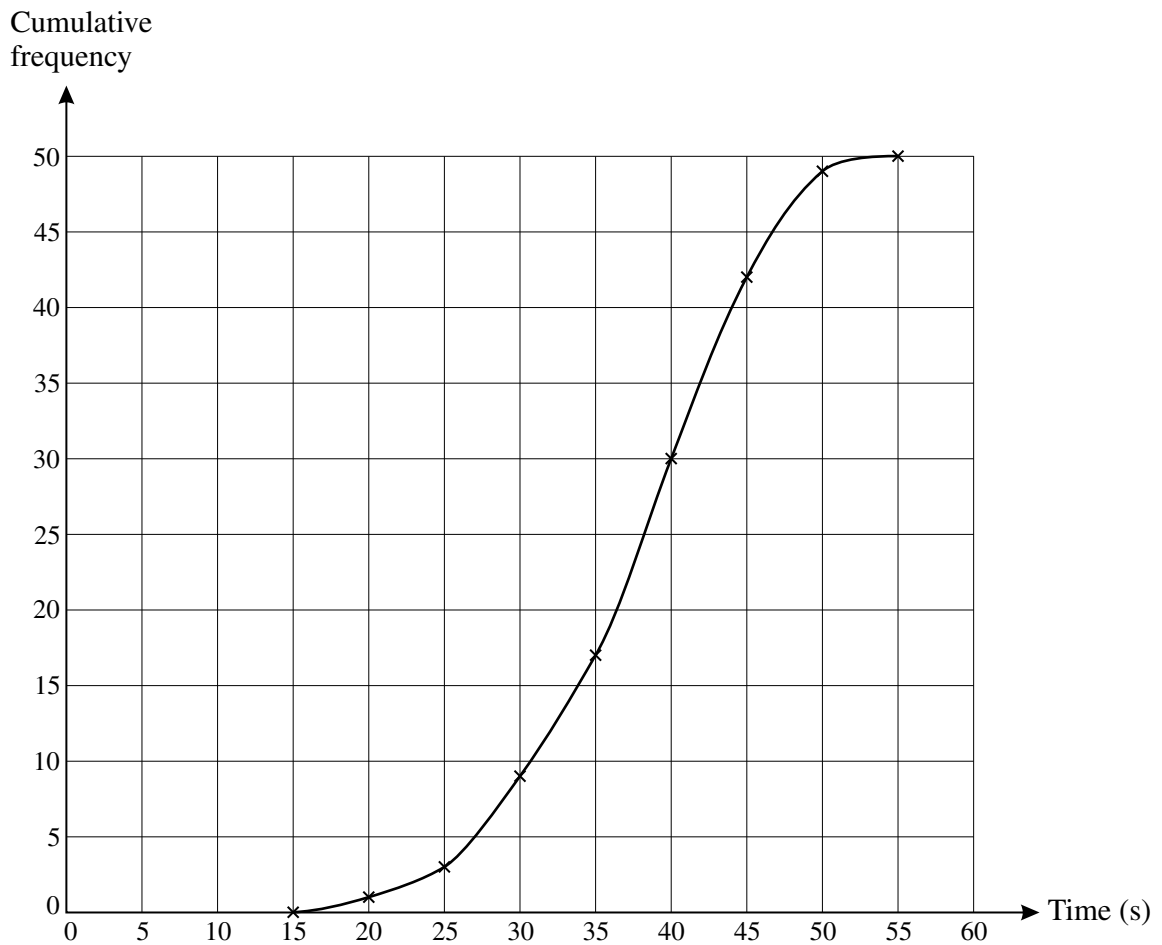
Three of the following statements are true and **one** is false. Which one is **false**?

- A During the first part of the journey the train is accelerating at $\frac{1}{8} \text{ m s}^{-2}$.
- B The distance between the two stations is 5.85 km.
- C When 240 seconds have elapsed the train has travelled half the distance between the two stations.
- D The train travels at constant speed for 5 minutes.

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

- A $(5x + 2y)(4x - 3y) = 20x^2 - 7xy - 6y^2$
- B $x + 3(x + 7) = x^2 + 10x + 21$
- C $xy^2(2x^3 + 9y) = 2x^4y^2 + 9xy^3$
- D $4x(x + 2) - 3(x^2 - 5) = x^2 + 8x + 15$

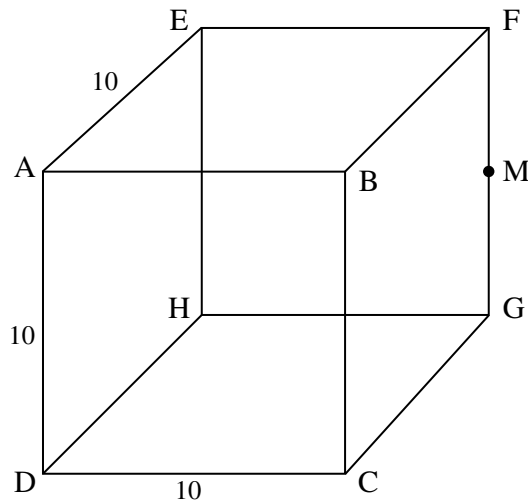
- 31 50 swimmers are timed when they swim one length of a pool. Their times, t seconds, are grouped in the classes $15 \leq t < 20$, $20 \leq t < 25$, $25 \leq t < 30$, ... , $50 \leq t < 55$ and are displayed below using a cumulative frequency graph.



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

- A The median is approximately 38 seconds.
- B The modal class is $35 \leq t < 40$.
- C About two-thirds of the swimmers take between 30 and 45 seconds.
- D Approximately 20% of the swimmers take 40 seconds or more.

- 32 ABCDEFGH is a cube of edge 10 cm. M is the midpoint of FG.



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

- A $DM = 15$ cm
- B Angle $FDG = 35.3^\circ$, correct to 1 decimal place.
- C Angle $FDM = 17.6^\circ$, correct to 1 decimal place.
- D Angle $HFC = 60^\circ$
- 33 A company makes two types of mugs, plain and patterned. It takes x seconds to paint a plain mug and y seconds to paint a patterned mug. The company produces m plain mugs and n patterned mugs. The total time required for painting is T hours.

Which **one** of the following is a **correct** formula?

- A $T = \frac{1}{3600}(mx + ny)$
- B $T = 3600(mx + ny)$
- C $T = \frac{1}{3600}\left(\frac{x}{m} + \frac{y}{n}\right)$
- D $T = 3600\left(\frac{x}{m} + \frac{y}{n}\right)$

- 34 Lucy and Emma play two sets of tennis. The probability that Lucy wins the first set is 0.7. If Lucy wins the first set the probability that she wins the second set is 0.8. If Lucy loses the first set then the probability that she wins the second set is 0.4. [Note: in tennis, a set must be won by one of the players. A set cannot end in a draw.]

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

- A The probability that Lucy wins both sets is 0.56.
- B The probability that Emma wins both sets is 0.18.
- C The probability that Lucy and Emma win one set each is 0.14.
- D The probability that Emma wins the second set is 0.32.

- 35 William has a map of his village which uses a scale of 1 cm to 5 m.

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

- A The scale of the map is 1 : 500.
- B A length of 16.4 cm on the map corresponds to 82 m on the ground.
- C A length of 0.2 km on the ground corresponds to 40 cm on the map.
- D An area of 5 cm² on the map corresponds to 25 m² on the ground.

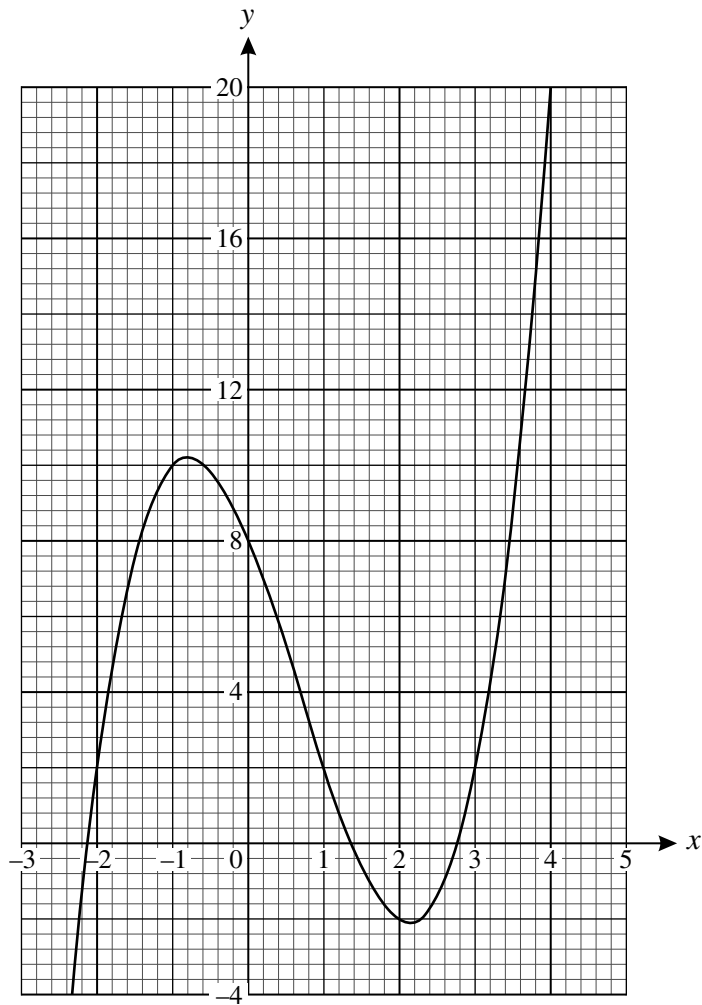
- 36 Oliver and Steve are practising rearranging formulae.

- Oliver claims that $s = ut + \frac{1}{2}at^2$ can be rearranged to give $a = \frac{2(s - ut)}{t^2}$.
- Steve claims that $T = 2\pi\sqrt{\frac{L}{g}}$ can be rearranged to give $g = \frac{T^2}{2\pi^2L}$.

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

- A Oliver and Steve are both correct.
- B Oliver is correct and Steve is incorrect.
- C Oliver is incorrect and Steve is correct.
- D Oliver and Steve are both incorrect.

37 The diagram shows part of the graph of $y = x^3 - 2x^2 - 5x + 8$.



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

- A There are two points on the curve $y = x^3 - 2x^2 - 5x + 8$ where the gradient is zero.
- B The gradient of the curve $y = x^3 - 2x^2 - 5x + 8$ is positive at $x = 1$.
- C The equation $x^3 - 2x^2 - 5x + 8 = 0$ has one negative root.
- D The equation $x^3 - 2x^2 - 5x + 8 = 12$ has exactly one real root.

38 Which **one** of the following is the **correct** simplification of $\frac{7a+b}{8} - \frac{(3a-b)}{4}$?

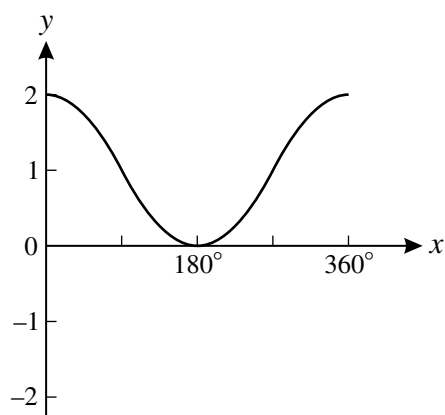
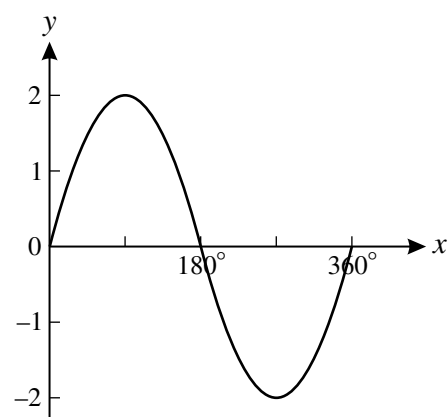
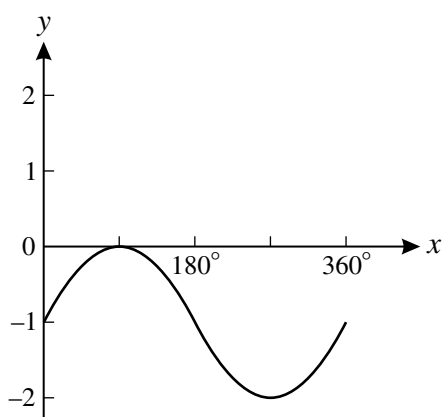
A $\frac{a+3b}{8}$

B $\frac{a-b}{8}$

C $\frac{a}{8}$

D $\frac{11a+3b}{8}$

39



Three of the following equations correspond to graphs above and **one** does not. Which one does **not**?

A $y = \cos x + 1$

B $y = -2 \cos x$

C $y = \sin x - 1$

D $y = 2 \sin x$

- 40 Merve has been given the first four terms of a quadratic sequence. She finds the first differences and the second differences as shown below.

| | | | | | | |
|-------------------|----|----|----|----|-----|-----|
| Sequence | 17 | 18 | 23 | 32 | ... | ... |
| First difference | | 1 | 5 | 9 | ... | ... |
| Second difference | | | 4 | 4 | ... | ... |

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

- A The next two numbers in the first difference row are 13 and 17.
- B The sixth term in the sequence is 62.
- C The n th term in the sequence is given by $n^2 - 2n + 18$.
- D The second difference is constant.

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