**OCR**
RECOGNISING ACHIEVEMENT

# Thursday 31 May 2012 – Morning

## FSMQ INTERMEDIATE LEVEL

**6989**    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.**
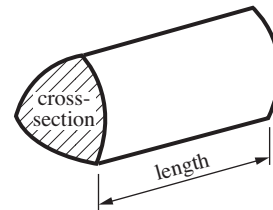
**INFORMATION FOR CANDIDATES**

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

**Turn over**

**Formulae Sheet: 6989 Foundations of Advanced Mathematics**

**Area of trapezium** $= \frac{1}{2}(a+b)h$
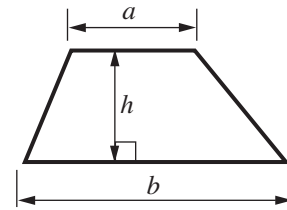
**Volume of prism** = (area of cross-section) × length

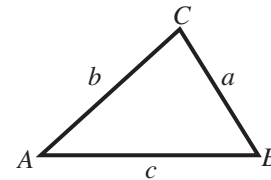**In any triangle *ABC***

**Sine rule** $\quad \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$
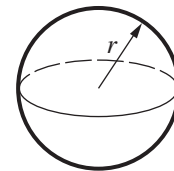
**Cosine rule** $\quad a^2 = b^2 + c^2 - 2bc\cos A$
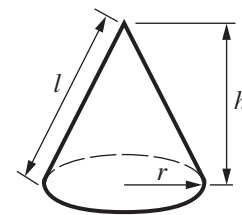
**Area of triangle** $= \frac{1}{2}ab\sin C$

**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**   503 is a factor of 2012.

    **B**   The square root of 361 is 19.

    **C**   73 is a prime number.

    **D**   The reciprocal of 0.25 is $\frac{1}{4}$.

**2**   Which **one** of the following has the **smallest** value?

    **A**   12.5% of 50

    **B**   4 divided by $\frac{3}{5}$

    **C**   $\frac{2}{5}$ of 16

    **D**   $\sqrt{40}$

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

    **A**   $(-3) \times (+2) = (-6)$

    **B**   $(-4) - (-3) = -1$

    **C**   $7 \times 9 - 5 = 28$

    **D**   $\dfrac{4 + 3 \times 2}{10 - 3 \times 2} = 2.5$

**4** The number 8765.449 is written below in four different ways.

Three of the ways are correct and **one** is incorrect. Which one is **incorrect**?

**A** 8765, correct to the nearest integer.

**B** 8765.4, correct to 1 decimal place.

**C** 8700, correct to 2 significant figures.

**D** 9000, correct to the nearest thousand.

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

**A** $2\frac{1}{4} - 1\frac{3}{4} = \frac{1}{2}$

**B** $2\frac{1}{3} + 1\frac{1}{2} = 3\frac{2}{5}$

**C** $\frac{2}{3} \times \frac{9}{16} = \frac{3}{8}$

**D** $\frac{2}{5} \div \frac{18}{25} = \frac{5}{9}$

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

**A** 64 miles is about 40 kilometres.

**B** 30 inches is about 76 centimetres.

**C** 1 pint is about 0.57 litres.

**D** 1 lb is about 450 g.

**7**  Josie makes a spinner with 5 sides, numbered from 1 to 5. To investigate whether it is biased or not she spins her spinner 100 times and records the results in a table.

| Score | Frequency |
|:-----:|:---------:|
| 1 | 35 |
| 2 | 17 |
| 3 | 15 |
| 4 | 16 |
| 5 | 17 |

Josie wishes to estimate the probabilities of outcomes when she spins it again.

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

**A**  The spinner is biased towards 1 with the other numbers about equally likely to occur.

**B**  The probability that the score will be a 1 is approximately twice the probability that the score will be a 2.

**C**  The probability that the score will be 3 is approximately $\frac{1}{6}$.

**D**  In 300 spins a reasonable estimate for the number of times that Josie gets a score of 2 or more is 100.

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

**A**  $x^2 + 5x - 24 = (x - 3)(x + 8)$

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

**C**  $(2x + 3)(3x + 2) = 6x^2 + 13x + 6$

**D**  $2x^2y + 8xy^3 = 2xy(x + 4y^2)$

**9** Which **one** of the following is the **correct** solution of the equation $x^2 - 3x - 5 = 0$?

**A** $\dfrac{-3 \pm \sqrt{29}}{2}$ **B** $\dfrac{3 \pm \sqrt{29}}{2}$ **C** $\dfrac{-3 \pm \sqrt{11}}{2}$ **D** $\dfrac{3 \pm \sqrt{11}}{2}$

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

**A** $(4xy^2)^2 = 16x^2y^4$

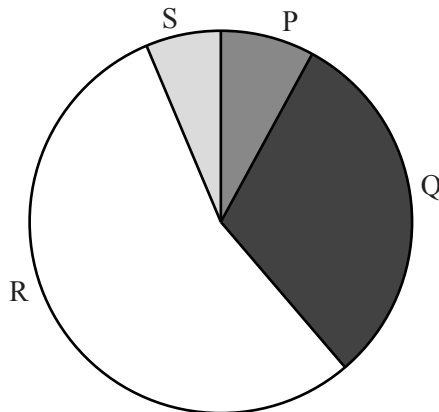**B** $(3xy^2) \times 3 = 27xy^2$

**C** $\dfrac{x^2 \times x^4}{x^5} = x$

**D** $2(x - 1) - 3(2 - x) = 5x - 8$

**11** A survey was carried out on the heights of 400 students. As a result, each student was placed in one of 4 categories. The table shows the results of the survey.

| Category | Number |
|----------|--------|
| P | 32 |
| Q | |
| R | 220 |
| S | 24 |

This pie chart displays these data.



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

**A**   There are 124 students in Category Q.

**B**   8% of students are in Category P.

**C**   In the pie chart the angle for Category R is 198°.

**D**   The angles for Category P and Category S differ by 18°, correct to the nearest degree.

**12** You are given that $a = 2$, $b = 4$, $c = -3$.

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

**A**   $c^2 = 9$

**B**   $ab + bc + ca = -10$

**C**   $\dfrac{ac + 3b}{2} = 9$

**D**   $ac - b^2 = -22$

**13** Paul and Quentin are rearranging equations.

Paul has rearranged $s = ut + \frac{1}{2}at^2$ to give $a = \dfrac{2s - ut}{t^2}$ .

Quentin has rearranged $v^2 = u^2 + 2as$ to give $a = \dfrac{v^2 - u^2}{2s}$ .

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

**A**   Both Paul and Quentin are correct.

**B**   Both Paul and Quentin are incorrect.

**C**   Paul is correct and Quentin is incorrect.

**D**   Paul is incorrect and Quentin is correct.

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

**A**   $1\,230\,000 = 1.23 \times 10^6$

**B**   $(1.23 \times 10^3) + (2.34 \times 10^4) = 3.57 \times 10^7$

**C**   $(2 \times 10^6) \times (7 \times 10^7) = 1.4 \times 10^{14}$

**D**   $(1.15 \times 10^6) \div (4.6 \times 10^2) = 2.5 \times 10^3$

**15** The office staff of a company are offered a pay rise of either 2% or £350 per year.

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

**A** For John, who currently earns £19 000 per year, the 2% rise is £380.

**B** For Afra, who currently earns £17 500 per year, it makes no difference which option she chooses.

**C** For Philippa, who currently earns £16 000 per year, the 2% rise is less than £350.

**D** When Joe is given the 2% rise his new salary will be £20 400. This means that his current salary is £19 992 per year.

**16** A sum of £2400 is to be split between two people in the ratio 11:14.

Which **one** of the following is the **correct** value for the smaller sum?

**A** £218.18, correct to the nearest penny.

**B** £1056

**C** £1344

**D** £1885.71, correct to the nearest penny.

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

    **A**    The distance from Calais to Paris is measured in kilometres.

    **B**    The capacity of a fridge is measured in litres.

    **C**    The mass of a bag of coal is measured in kilograms.

    **D**    The length of a fly is measured in metres.

18 Sally has 4 pieces of wood. Each piece is 25 cm, correct to the nearest cm. She lays them in a straight line end to end.

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

    **A**    The length of one piece of wood could be 254 mm.

    **B**    The length of the line does not exceed 102 cm.

    **C**    The length of the line must be at least 98 cm.

    **D**    The length of each piece of wood must be at least 249.5 mm.

**19** The scale of a map is 1 cm to 250 m.

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

**A** The scale of the map is 1:25 000.

**B** A distance of 4 cm on the map represents 1 kilometre on the ground.

**C** A distance of 3500 m on the ground is a length of 14 cm on the map.

**D** An area of $4\,\text{cm}^2$ on the map corresponds to $25\,\text{km}^2$ on the ground.

**20** A group of students is asked to work out the value of $n(n-1)^2$ for a particular value of $n$.

Akosua says that you subtract 1 from $n$, square the result and multiply by $n$.
Bob says that you subtract 1 from $n$, multiply by $n$ and square the result.
Christa says that you cube $n$ and subtract 1.
Danielle says that you cube $n$ and add $n$.

Which **one** of the students has given a **correct** way to evaluate this expresson?

**A** Akosua

**B** Bob

**C** Christa

**D** Danielle

**21** Alisha is attempting to solve these simultaneous equations.

$$2x - 3y = 9 \qquad \text{(i)}$$
$$y = 3x - 4 \quad \text{(ii)}$$

Her working is shown in the four steps below, but her final answer is incorrect.

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

**A**  Substitute (ii) into (i):  $2x - 3(3x - 4) = 9$

**B**  Expand the bracket:  $2x - 9x - 12 = 9$

**C**  Solve the equation:  $x = -3$

**D**  Substitute into (ii):  $y = -9 - 4 = -13$

**22** 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 $4 - 3x < 1 + x$ is $x > \frac{3}{4}$ .

**C**  The solution of $2(x - 1) = 3 - 2x$ is $x = \frac{4}{5}$ .

**D**  The solution of $\dfrac{2x}{5} = 1 - x$ is $x = \frac{5}{7}$ .

**23**  Peter takes $h$ hours, $m$ minutes and $s$ seconds to complete a race.

Which **one** of the following is a **correct** expression for his total time in minutes?

**A**   $60h + m + \dfrac{s}{60}$

**B**   $3600h + 60m + s$

**C**   $\dfrac{h}{60} + m + 60s$

**D**   $h + 60m + 3600s$

**24**  Which **one** of the following is the number of integers which satisfy the inequality

$$-1 \leqslant 2x - 7 < 12 \ ?$$

**A**  5          **B**  7          **C**  11          **D**  13

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

   **A**   For any value of $\theta$, $0 \leqslant \sin\theta \leqslant 1$.

   **B**   If $\theta = 150°$ then $\tan\theta = -0.577$, correct to 3 decimal places.

   **C**   If $\cos\theta = -0.3$ then one value of $\theta$ is $253°$, correct to the nearest degree.

   **D**   If $\sin\theta = -\frac{3}{5}$ and $\cos\theta = \frac{4}{5}$ then one value of $\theta$ is $323°$, correct to the nearest degree.

**26**   Ava and Bethany are working out the angles DAB and DCB in the diagram below.
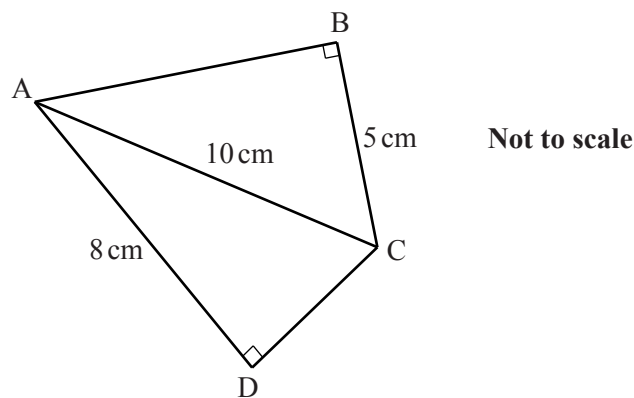


Ava says that angle DAB is $67°$, correct to the nearest degree.
Bethany says that angle DCB is $113°$, correct to the nearest degree.

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

   **A**   Ava and Bethany are both correct.

   **B**   Ava is correct, but Bethany is incorrect.

   **C**   Ava is incorrect but Bethany is correct.

   **D**   Both Ava and Bethany are incorrect.

**27** Dylan went for a run on a straight road from his house. The distance-time graph below shows the distance he is from home $t$ minutes after starting out on his run.
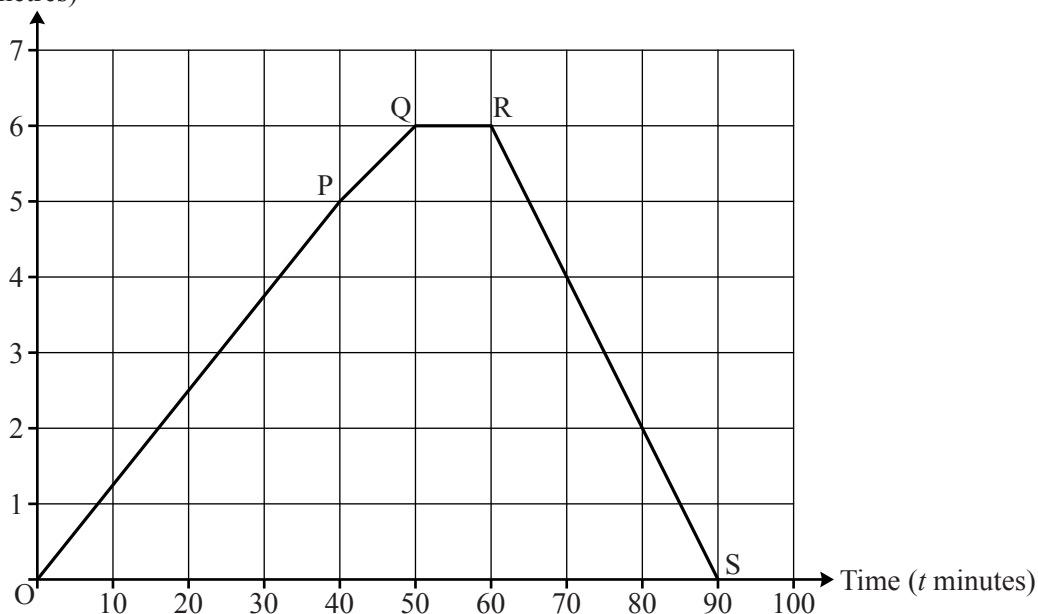


Three of the following statements are true and **one** is false. Which one is **false**?

**A**    The line QR indicates that he was stationary between the times $t = 50$ and $t = 60$.

**B**    The distance run was 12 kilometres.

**C**    The fastest speed is indicated by the line OP.

**D**    The average speed was 8 kilometres per hour.

**28** The first four terms of a quadratic sequence are 2, 3, 5 and 8.

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

**A**    The next two terms of the sequence are 12 and 17.

**B**    39 is a term of the sequence.

**C**    The first differences form a linear sequence.

**D**    The $n$th term of the sequence is given by $\dfrac{n^2}{2} - \dfrac{n}{2} + 2$.

**29** The diagram shows rectangular box ABCDEFGH.
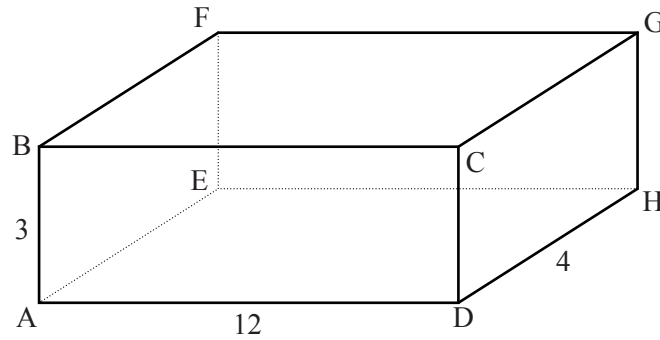


Three of the following triangles are right-angled and **one** is not. Which one is **not**?

**A**  BGH

**B**  BEH

**C**  EDG

**D**  FBD

**30** In the triangle ABC, angle A = 80°, AB = 8 cm and AC = 5 cm, as shown in the diagram.



**Not to scale**
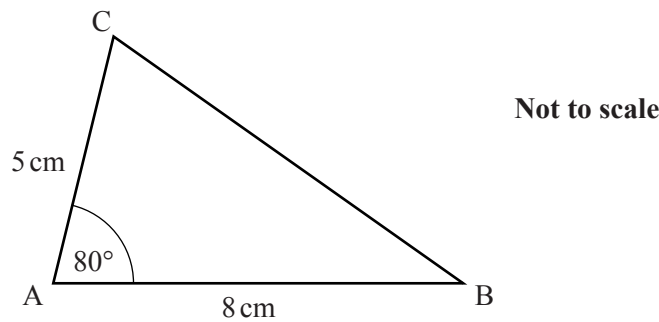
Which **one** of the following is the **correct** length for BC?

**A**  8.12 cm, correct to 2 decimal places.

**B**  8.67 cm, correct to 2 decimal places.

**C**  9.43 cm, correct to 2 decimal places.

**D**  10.14 cm, correct to 2 decimal places.

**31** Mr and Mrs Smith monitored the length of 50 telephone calls that Mrs Smith made and 50 telephone calls that Mr Smith made.

The results for Mr Smith's calls are shown in the table below.

| Time ($t$ minutes) | $0 < t \leqslant 4$ | $4 < t \leqslant 8$ | $8 < t \leqslant 12$ | $12 < t \leqslant 16$ | $16 < t \leqslant 20$ |
|---|---|---|---|---|---|
| Frequency | 14 | 23 | 7 | 4 | 2 |

The results for Mrs Smith's calls are shown on the cumulative frequency graph below.

*In order to answer this question you are advised to draw the cumulative frequency graph for Mr Smith's calls on the same graph below as those for Mrs Smith.*
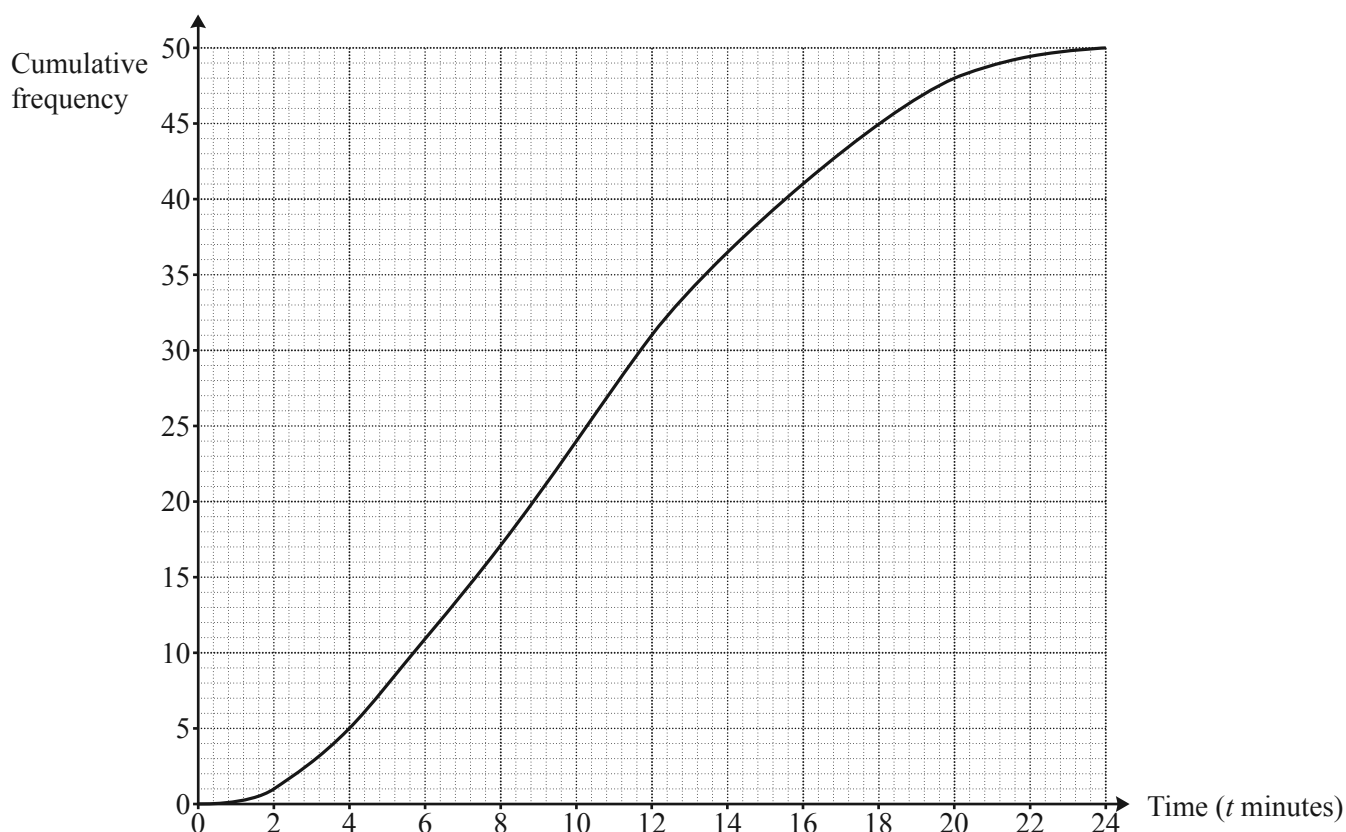


Three of the following statements are true and **one** is false. Which one is **false**?

**A** The longest call was made by Mrs Smith.

**B** Approximately 60% of Mr Smith's calls took more than 7 minutes.

**C** The median length for Mrs Smith's calls was more than the median length for Mr Smith's calls.

**D** The interquartile range for Mr Smith's calls was approximately 5 minutes.

**32** The graph below represents the speed of a car as it accelerates from rest to a speed of $30\,\text{m}\,\text{s}^{-1}$ in 20 seconds.
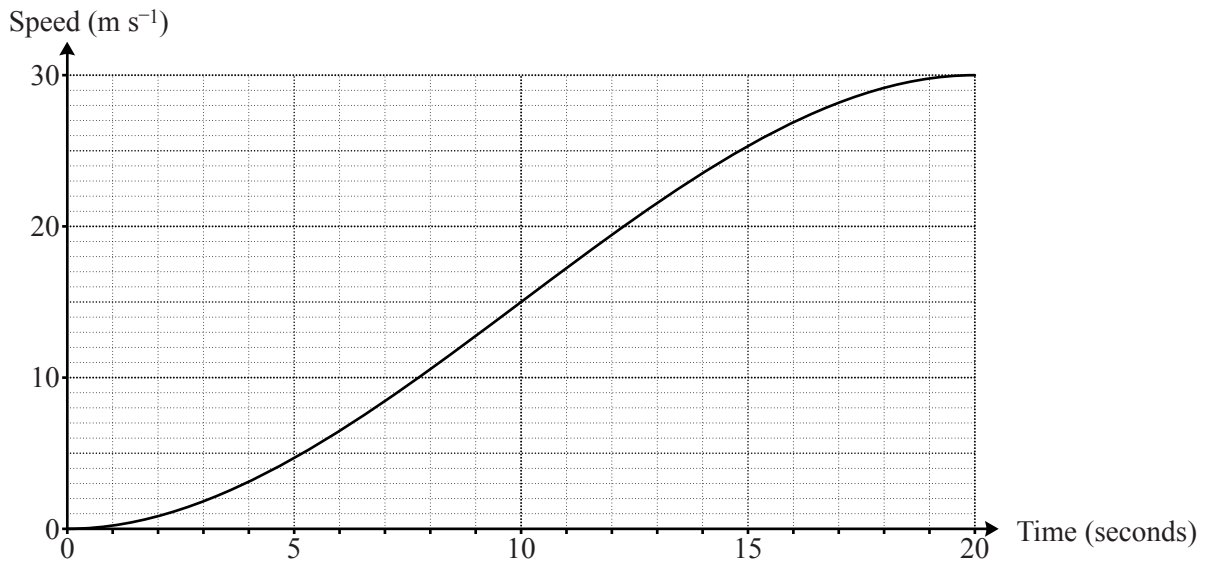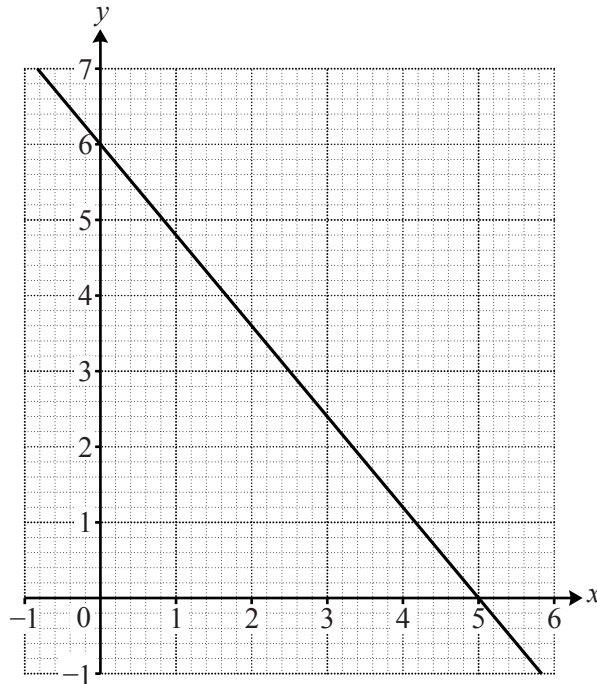


Three of the following statements are true and **one** is false. Which one is **false**?

**A** $30\,\text{m}\,\text{s}^{-1}$ is $108\,\text{km}\,\text{h}^{-1}$.

**B** The greatest acceleration occurs approximately 10 seconds after the start.

**C** The acceleration 5 seconds after the start is approximately $0.6\,\text{m}\,\text{s}^{-2}$.

**D** The distance travelled is approximately 300 metres.

**33** Three vectors are given by $\mathbf{a} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$, $\mathbf{b} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$ and $\mathbf{c} = \begin{pmatrix} -1 \\ 7 \end{pmatrix}$.

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

**A** $\mathbf{c} - \mathbf{a} = \mathbf{b}$

**B** $4\mathbf{a} + 3\mathbf{b} = \mathbf{c}$

**C** $\mathbf{a} + 5\mathbf{c} = \mathbf{b}$

**D** $\mathbf{a} + \mathbf{b} + \mathbf{c} = \mathbf{0}$

**34** The graph of a line is given on the grid below.



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

**A** The gradient of the line is $-\frac{5}{6}$.

**B** The equation of the line can be written $6x + 5y = 30$.

**C** The line passes through the point (4, 1.2).

**D** The line is parallel to the line $y = 4 - \frac{6}{5}x$.

**35** Aaron has two packs of ordinary playing cards. The Jacks, Queens and Kings are called picture cards. He draws one card at random from each pack.

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

**A** P(the card from the first pack is a picture card) $= \dfrac{3}{13}$

**B** P(both cards drawn are picture cards) $= \dfrac{9}{169}$

**C** P(just one card is a picture card) $= \dfrac{30}{169}$

**D** P(at least one card is a picture card) $= \dfrac{69}{169}$

36  The diagram shows two vectors, **P** and **Q**, which are at right angles. The magnitudes of **P** and **Q** are 4.4 and 3.3 respectively. **R** is the resultant of **P** and **Q**. The angle between **P** and **R** is $\theta$.



**Not to scale**
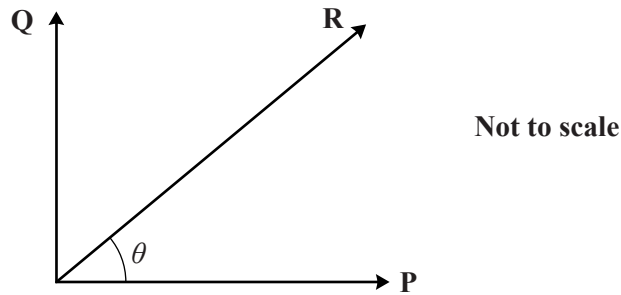
Which **one** of the following statements is the **correct** description of the resultant **R** where the angle $\theta$ is correct to the nearest degree?

A    The magnitude of **R** is 7.7 and $\theta$ is 37°.

B    The magnitude of **R** is 7.7 and $\theta$ is 53°.

C    The magnitude of **R** is 5.5 and $\theta$ is 37°.

D    The magnitude of **R** is 5.5 and $\theta$ is 53°.

37  Which **one** of the following is a **correct** simplification of $\dfrac{5x - 2y}{4} - \dfrac{3x - 4y}{5}$ ?

A    $\dfrac{13x - 6y}{20}$

B    $\dfrac{13x + 6y}{20}$

C    $\dfrac{37x - 26y}{20}$

D    $\dfrac{x - y}{10}$

**38** The chart shows the number of people getting off a bus at the end of its journey on each of 5 days.
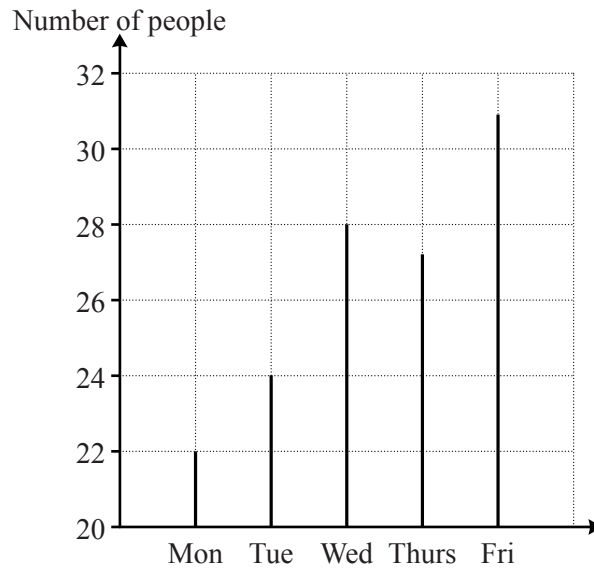
Number of people



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

**A** The chart is misleading.

**B** The number of people getting off the bus on Friday was over 40% more than the number getting off on Monday.

**C** The median was 28.

**D** The mean was 26.4.

**39** In a school, 40 students were chosen from Year 11. The choice was made by taking the first 5 students on the alphabetical list from each of the 8 mathematics sets.
The time taken to complete a mathematical puzzle was recorded to the nearest minute for these students.

| Recorded time (minutes) | Frequency |
|:---:|:---:|
| 2 | 2 |
| 3 | 5 |
| 4 | 7 |
| 5 | 9 |
| 6 | 8 |
| 7 | 7 |
| 8 | 0 |
| 9 | 2 |

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

**A**   The modal recorded time is 5 minutes.

**B**   The mean recorded time is 5.175 minutes.

**C**   The greatest possible range of the actual times is 8 minutes.

**D**   The selection from the year group forms a random sample.

**40** The graph of the function $y = x^3 - 3x + 7$ is to be drawn. Part of a table of values is shown below.

| $x$ | $-3$ | $-2$ | $-1$ | $0$ | $1$ | $2$ |
|---|---|---|---|---|---|---|
| $x^3$ | | | $-1$ | | | $8$ |
| $-3x$ | | | $3$ | | | $-6$ |
| $+7$ | | | $7$ | | | $7$ |
| $y$ | | | $9$ | | | $9$ |

*In order to answer this question you are advised to complete the table and then draw the graph on the grid below.*
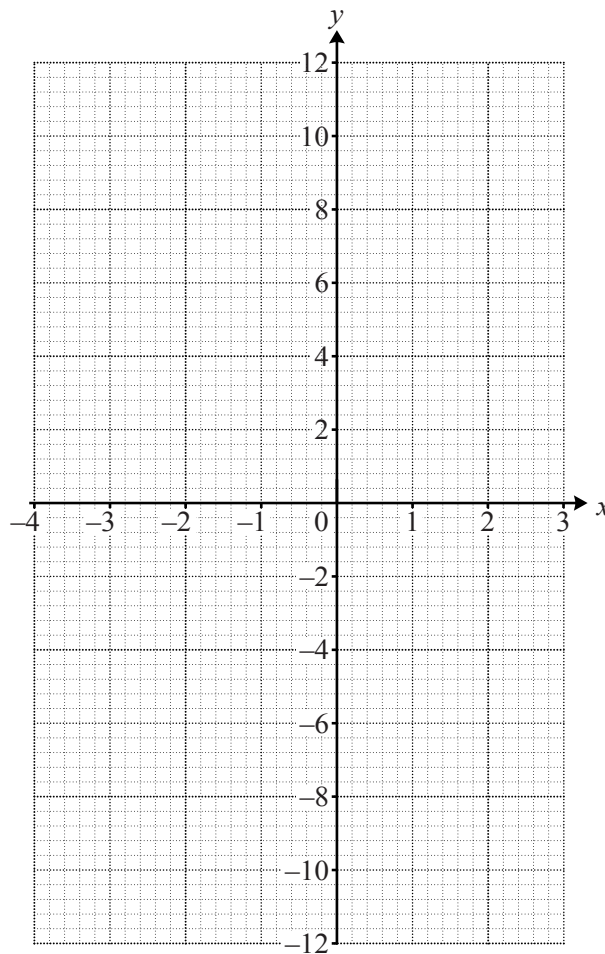


Three of the following statements are true and **one** is false. Which one is **false**?

**A** At the point where the curve crosses the $y$-axis the gradient is positive.

**B** The equation $x^3 - 3x + 7 = 0$ has only one root.

**C** The equation $x^3 - 3x + 7 = 6$ has only one negative root.

**D** For all possible values of $k$, the equation $x^3 - 3x + 7 = k$ has at least one root.