



Oxford Cambridge and RSA

**Tuesday 21 June 2016 – Morning**

**FSMQ INTERMEDIATE LEVEL**

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



Candidates answer on the Answer Sheet.

**OCR supplied materials:**

- Answer Sheet (MS4)

**Duration: 2 hours**

**Other materials required:**

- Eraser
- Scientific calculator
- Soft pencil
- Ruler



**INSTRUCTIONS TO CANDIDATES**

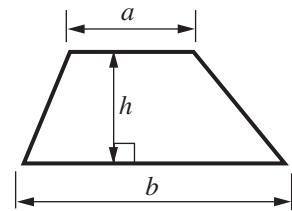
- Write your name clearly in capital letters, your centre number and candidate number on the Answer Sheet in the spaces provided unless this has already been done for you.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- There are **forty** questions 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**

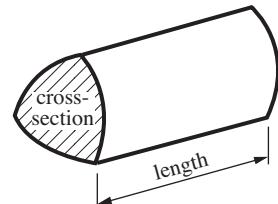
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- This document consists of **24** pages. Any blank pages are indicated.

## Formulae Sheet: 6989 Foundations of Advanced Mathematics

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



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

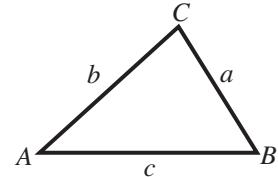


In any triangle  $ABC$

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

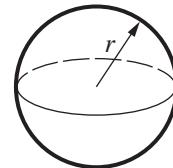
$$\text{Cosine rule} \quad a^2 = b^2 + c^2 - 2bc \cos A$$

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



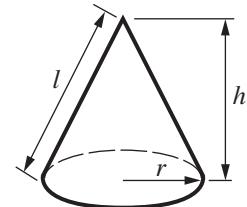
$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$

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



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

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



### 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  $2016 = 2^5 \times 3^2 \times 7$

B 187 is a prime number.

C 627 is a multiple of 11.

D The highest common factor (HCF) of 36 and 90 is 18.

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

A  $(-2)^3 = -8$

B  $4 + 3 \times 2 = 14$

C  $(-2) - (-3) = 1$

D  $\frac{2+7}{3} = 3$

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

A  $\left(\frac{3}{4}\right)^2 = \frac{9}{16}$

B  $3\frac{1}{2} + 1\frac{2}{3} = 5\frac{1}{6}$

C  $4\frac{5}{8} - 2\frac{1}{2} = 2\frac{1}{8}$

D  $\frac{3}{4} \div \frac{4}{7} = \frac{3}{7}$

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

A When a sum of money is shared in the ratio  $4:5:6$  the smallest share is 0.4 of the sum.

B If the scale of a map is  $1:50\,000$  then 2 cm on the map represents a distance of 1 km on the ground.

C If cheese is priced at £3.50 per kilogram, then 140 g will cost 49p.

D When a line of length 300 cm is split into two parts in the ratio  $5:1$  the length of the longer part is 250 cm.

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

A A discount of 20% is the same as getting one twentieth off the original price.

B In a sale, “ $\frac{1}{5}$  off” means that the customer pays 80% of the original price.

C An item priced at £30 excluding VAT costs £36 when VAT at 20% is added.

D The VAT on an item costing £150 including VAT at 20% is £25.

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

A  $300\,000 = 3 \times 10^5$

B  $3 \times 10^3 + 4 \times 10^4 = 3.4 \times 10^4$

C  $(4.3 \times 10^4) \times (2.0 \times 10^{-2}) = 8.6 \times 10^2$

D  $(2 \times 10^7) \div (4 \times 10^{-3}) = 5 \times 10^9$

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

A The mass of an apple is measured in milligrams.

B Petrol bought at a garage is measured in litres.

C The distance from London to Edinburgh is measured in kilometres.

D The area of a postage stamp is measured in  $\text{mm}^2$ .

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

A  $3500 \text{ g} = 3.5 \text{ kg}$

B  $220 \text{ mm} = 22 \text{ cm}$

C A speed limit of  $90 \text{ km hr}^{-1}$  on some French roads is about 56 mph.

D 8 litres is approximately 5 pints.

9 A water barrel at the side of a house to collect rainwater is a cylinder. Its height is 1.5 m and its diameter is 1 m.

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

A The area of the top of the barrel is approximately  $0.79 \text{ m}^2$ .

B The volume of the barrel is approximately  $1.2 \text{ m}^3$ .

C The curved surface area of the barrel is approximately  $4.7 \text{ m}^2$ .

D When full the barrel holds more than 5000 litres.

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

- A  $4.3 \times 5.6 = 24.1$ , correct to 3 significant figures.
- B  $\frac{1}{13} = 0.077$ , correct to 3 decimal places.
- C  $\sqrt{5257} = 72$ , correct to the nearest integer.
- D  $4^6 = 4100$ , correct to the nearest hundred.

11 A piece of card is 17 cm long and 11 cm wide, both correct to the nearest centimetre.

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

- A The minimum possible width of the card is 105 mm.
- B The length of the card cannot be greater than 17.05 cm.
- C The area of the card is not less than  $173.25 \text{ cm}^2$ .
- D The diagonal of the card could be 19.6 cm.

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

- A  $4.9 \times 5.1$  is approximately 25.
- B  $\frac{101 \times 97}{9.94}$  is approximately  $10^3$ .
- C  $\sqrt{8.1 \times 2.1}$  is greater than 4.
- D  $(11.1 \times 0.094)^2$  is approximately 11.

13 You are given the formula  $s = ut + \frac{1}{2}at^2$ .

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

A  $a = 2$  when  $s = 27$ ,  $u = 6$  and  $t = 3$ .

B  $u = 0$  when  $s = 8$ ,  $a = 1$  and  $t = 4$ .

C  $s = 66$  when  $u = 8$ ,  $a = -1$  and  $t = 6$ .

D When  $u = 4$ ,  $a = 2$  and  $s = 30$  then  $t$  satisfies the quadratic equation  $t^2 + 4t - 30 = 0$ .

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

A The solution of  $7 - 2x = 13$  is  $x = -3$ .

B The solution of  $3x - 5 = 9 - 4x$  is  $x = 2$ .

C The solution of  $\frac{x}{4} > x - 3$  is  $x < 3$ .

D The solution of  $4 + 2(x - 3) < 1 - x$  is  $x < 1$ .

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

A  $x = 2$  or  $x = \frac{1}{3}$

B  $x = 3$  or  $x = \frac{1}{2}$

C  $x = -3$  or  $x = -\frac{1}{2}$

D  $x = 6$  or  $x = 1$

16 Here is a pair of simultaneous equations.

$$\begin{aligned}x + 3y &= 3 \\7x - 6y &= 12\end{aligned}$$

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

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

17 A company makes sweaters. It takes  $x$  minutes to make a round neck sweater and  $y$  minutes to make a V neck sweater.

In one day the company makes  $m$  round neck sweaters and  $n$  V neck sweaters. The total time taken is  $T$  hours.

Which **one** of the following is a **correct** formula for  $T$ ?

- A  $T = 60(xm + yn)$
- B  $T = \frac{1}{60}(xm + yn)$
- C  $T = \frac{1}{60}(x+y)(m+n)$
- D  $T = 60\left(\frac{x}{m} + \frac{y}{n}\right)$

18 Lidka and Jason have to rearrange some formulae to solve problems in physics.

Lidka says that  $L = \frac{gT^2}{4\pi^2}$  can be rearranged to give  $T = 2\pi\sqrt{\frac{L}{g}}$ .

Jason says that  $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$  can be rearranged to give  $f = u + v$ .

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

- A Lidka and Jason are both correct.
- B Lidka and Jason are both incorrect.
- C Lidka is correct and Jason is incorrect.
- D Lidka is incorrect and Jason is correct.

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

- A The  $n$ th term of the sequence 1, 3, 5, 7, ... is  $2n - 1$ .
- B The  $n$ th term of the sequence 3, 6, 12, 24, ... is  $3 \times 2^{n-1}$ .
- C The  $n$ th term of the sequence 14, 8, 2, -4, ... is  $14 - 6n$ .
- D The sequence 2, 5, 10, 17, ... is quadratic.

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

A  $x^{\frac{1}{3}} = \sqrt[3]{x}$

B  $3x^3 \times 4x^4 = 12x^7$

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

D  $\frac{6x^4}{2x} = 3x^3$

21 Which **one** of the following is a **correct** simplification of  $\frac{2x+3}{5} - \frac{1-2x}{3}$ ?

A  $\frac{16x+4}{15}$

B  $\frac{4-4x}{15}$

C  $\frac{4x+4}{15}$

D  $2x+1$

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

A  $x^3(2x^2 - y^2) = 2x^6 - x^3y^2$

B  $x+2(x+3) = 3x+6$

C  $(x-3)(x-4) = x^2 - 7x + 12$

D  $3(x-4) - 4(4-3x) = 15x - 28$

23 Three of the following expressions can be factorised into the form  $(x-2)(x+a)$ , where  $a$  is an integer (positive or negative), and one cannot.

Which **one** of the following **cannot** be factorised into this form?

A  $x^2 + x - 6$

B  $x^2 - 4$

C  $x^2 - 5x + 6$

D  $x^2 - x + 6$

24 You are given that, correct to 2 decimal places,  $a = 5.56$  and  $b = 2.43$ .

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

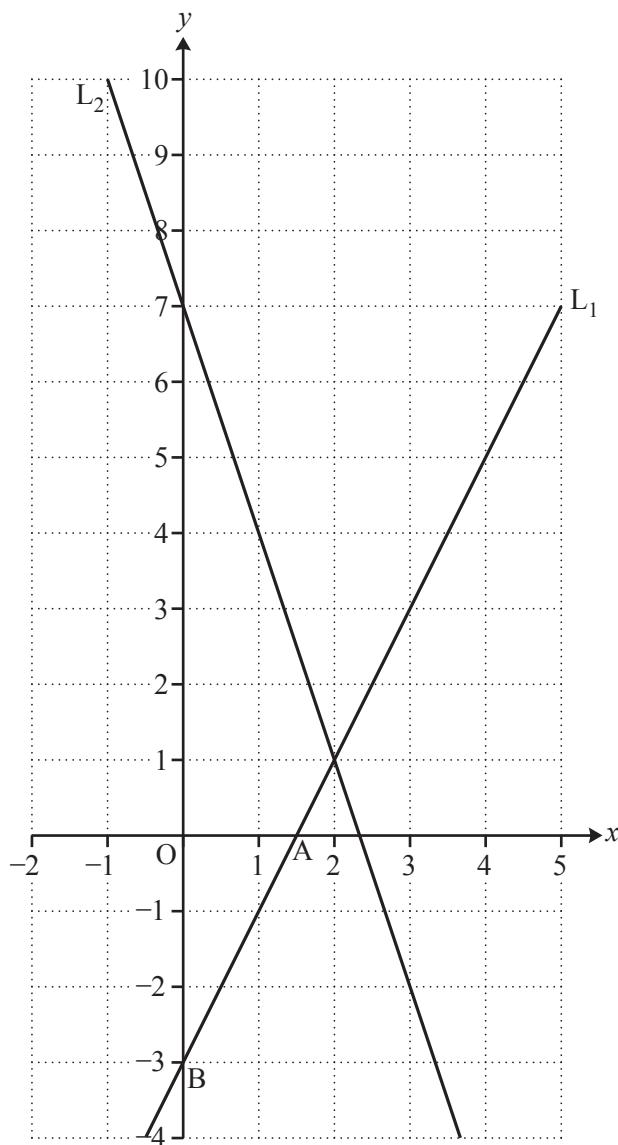
A  $a + b = 8.0$ , correct to 1 decimal place.

B  $a - b = 3.1$ , correct to 1 decimal place.

C  $10a + 5b = 67$ , to the nearest whole number.

D  $\frac{a}{b} = 2.3$ , correct to 1 decimal place.

25 Two lines,  $L_1$  and  $L_2$ , are shown on the graph.  $L_1$  crosses the  $x$ -axis at the point A and the  $y$ -axis at the point B.

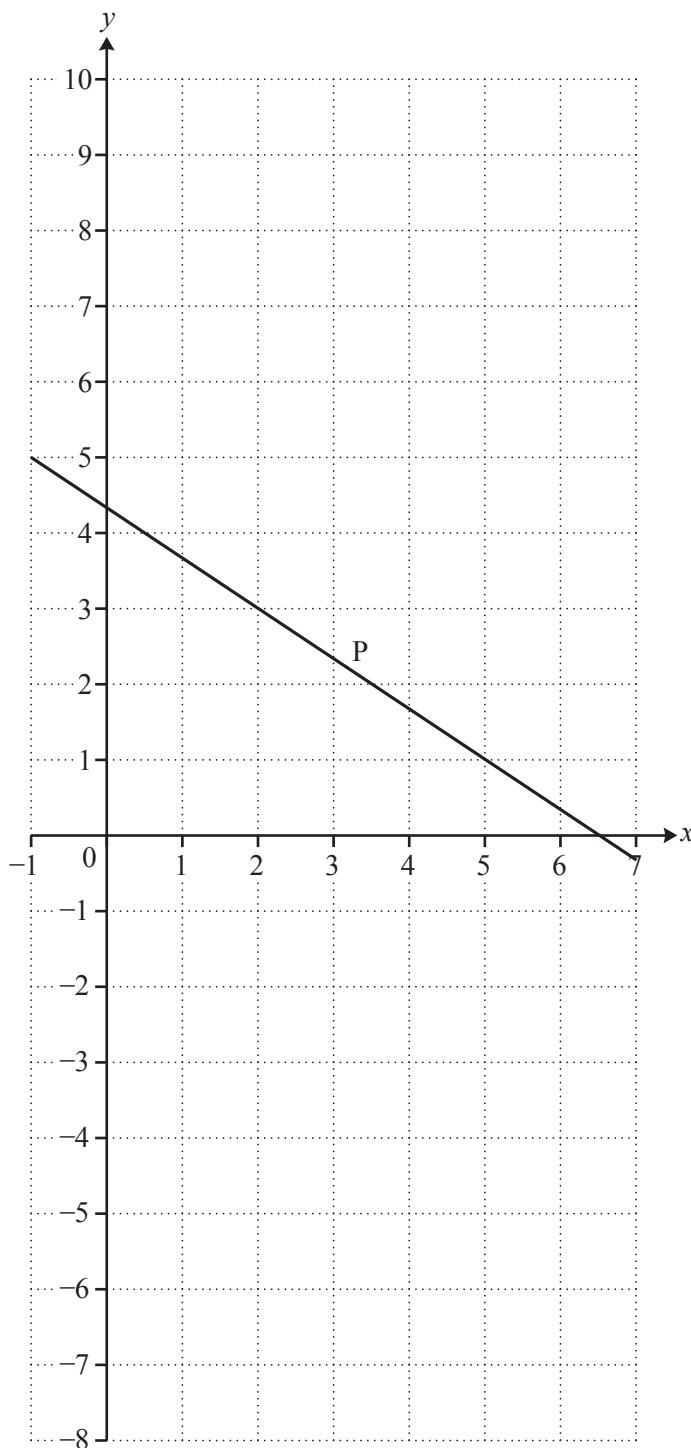


Three of the following statements are true and **one** is false. Which one is **false**?

- A The coordinates of A are  $(1\frac{1}{2}, 0)$ .
- B The gradient of  $L_2$  is  $-2$ .
- C The equation of  $L_1$  is  $y = 2x - 3$ .
- D The area of triangle OAB is  $2.25$  square units.

26 The line P is shown on the graph.

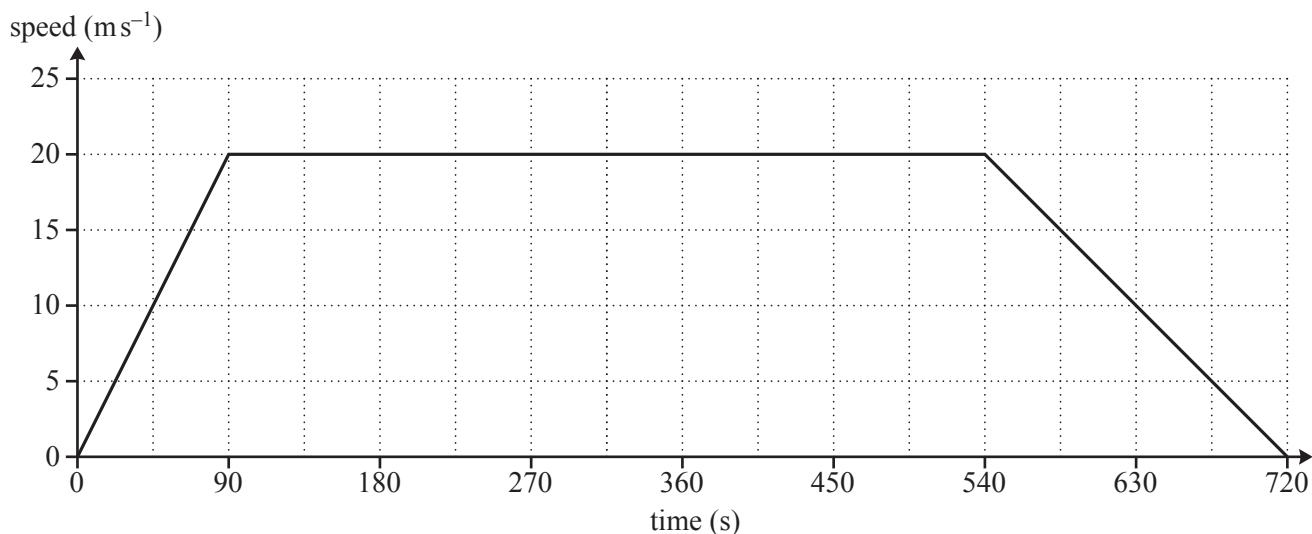
*In order to answer this question you are advised to draw the line Q with equation  $y = 5x - 7$  on the same graph.*



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

- A The solution of the equation  $5x - 7 = 0$  can be found where the line Q intersects the  $x$ -axis.
- B The solution of the simultaneous equations corresponding to the lines P and Q is represented by the point  $(2, 3)$ .
- C The line Q passes through the point  $(-1, -2)$ .
- D The  $y$ -intercept of Q is  $-7$ .

27 This graph models the speed of a train when travelling from station A to station B.



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

- A The train travels at a constant speed for  $7\frac{1}{2}$  minutes.
- B The distance between the two stations is 11.7 km.
- C When 360 seconds have elapsed, the train is halfway between the stations.
- D The acceleration for the first part of the journey is  $\frac{2}{9} \text{ m s}^{-2}$ .

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

Which **one** of the following is the **correct** value of  $\mathbf{x} - 2\mathbf{y} + 3\mathbf{z}$ ?

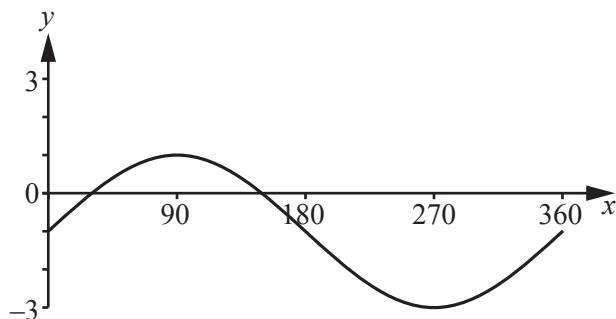
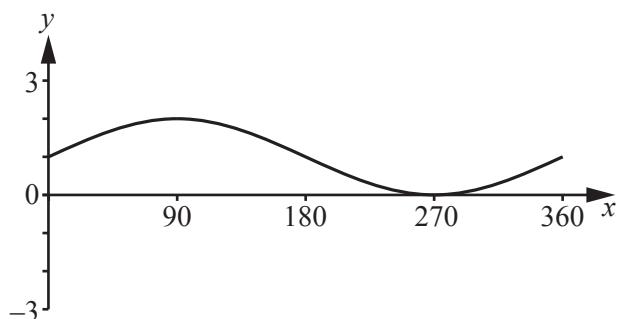
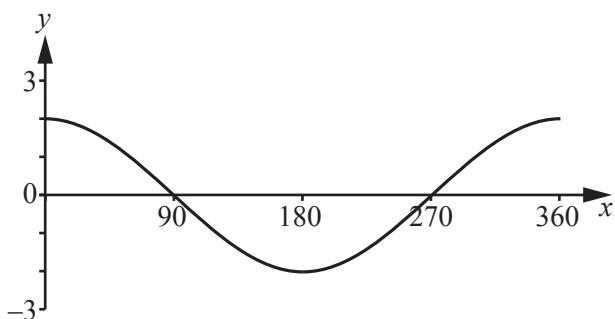
A  $\begin{pmatrix} 11 \\ -18 \end{pmatrix}$

B  $\begin{pmatrix} 7 \\ -6 \end{pmatrix}$

C  $\begin{pmatrix} -1 \\ 6 \end{pmatrix}$

D  $\begin{pmatrix} -1 \\ -18 \end{pmatrix}$

29



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

A  $y = 2\cos x$

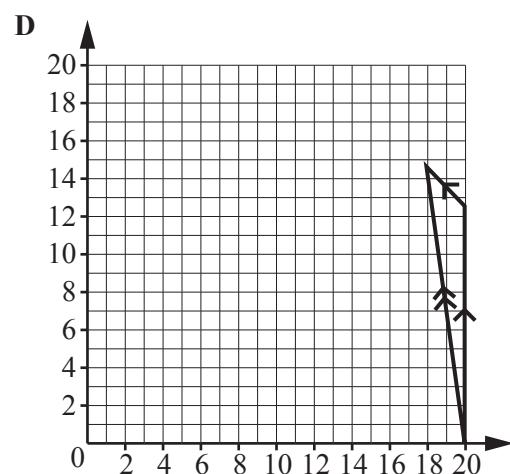
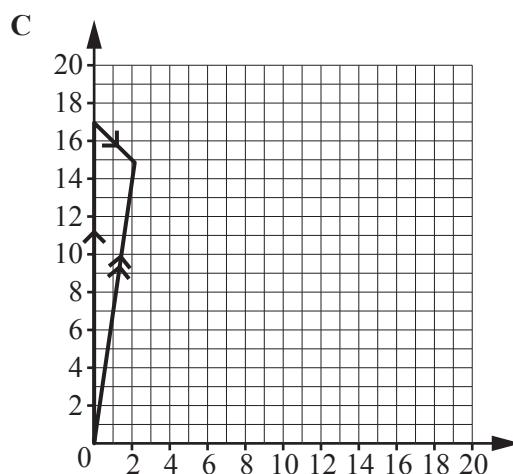
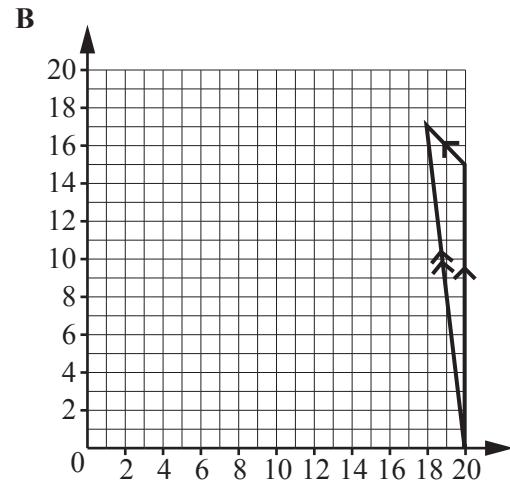
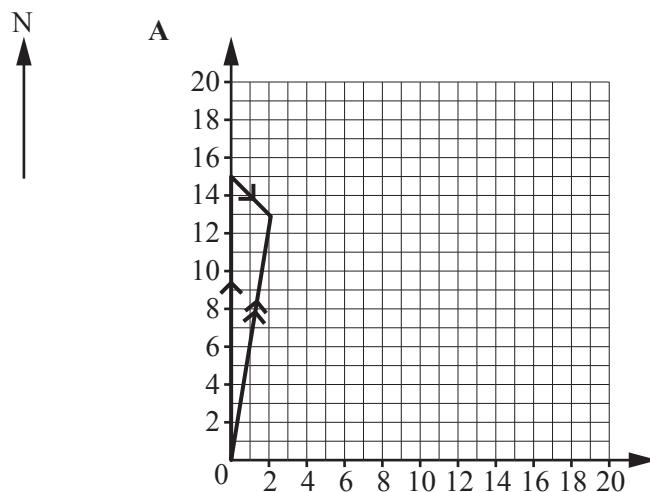
B  $y = 1 - \cos x$

C  $y = \sin x + 1$

D  $y = 2\sin x - 1$

30 A ship can travel in still water at 15 knots. (1 knot is 1 nautical mile per hour.) One day it is steering due north but experiences a current from the north-west of about 3 knots.

Which **one** of the following diagrams represents the **correct** direction and speed of the ship?



31 John and Fred play a game in which one of them wins. (So the game cannot end in a draw.) The probability that John wins the first game is 0.6. If he wins the first game, then the probability that he wins the second game is 0.7. If Fred wins the first game, then the probability that he wins the second game is 0.5.

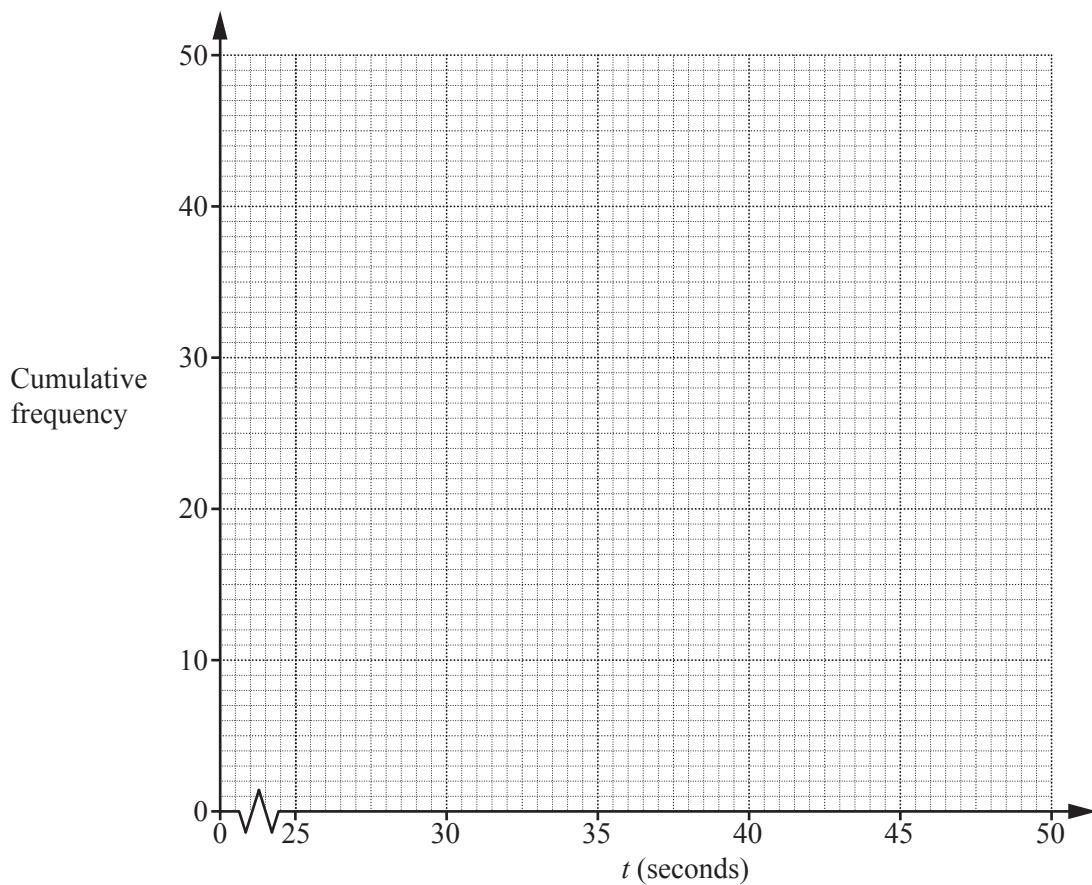
Three of the following statements are true and **one** is false. Which one is **false**?

- A The probability that John wins both games is 0.42.
- B The probability that Fred wins both games is 0.2.
- C The probability that Fred wins the second game is 0.38.
- D The probability that they win one game each is 0.62.

32 50 students are timed when they run 200 metres. Their times,  $t$  seconds, are grouped in the classes shown in the table.

*In order to answer this question you are advised to complete the cumulative frequency table and the cumulative frequency curve on the grid below.*

Time	$t < 25$	$25 \leq t < 30$	$30 \leq t < 35$	$35 \leq t < 40$	$40 \leq t < 45$	$45 \leq t < 50$
Frequency	0	5	11	23	7	4
Cumulative frequency	0	5				50



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

- A The median is approximately 37 seconds.
- B The modal class is  $35 \leq t < 40$ .
- C About 60% of the students take more than 38 seconds.
- D The interquartile range is approximately 5.5 seconds.

33 There are 2000 employees in a factory. The managing director wants to consider changing the hours of the working day and so decides to take a random sample of 100 employees to find out their views.

Which **one** of the following procedures will produce a **random** sample of employees' views?

- A A questionnaire is given to all employees and the first 100 that are returned are used.
- B In a spreadsheet, the employees are listed alphabetically and numbered from 1 to 2000. Those numbered 1, 21, 41, ... are interviewed.
- C There are 100 employees in the Paint Department. All of them are interviewed.
- D The names of each of the 2000 employees are put on pieces of paper, put in a hat, mixed up and then 100 are selected.

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

- A  $2xy^2 - 10x^3y = 2xy(y - 5x^2)$
- B  $9 - x^2 = (3 - x)(3 + x)$
- C  $x^2 + x - 12 = (x + 4)(x - 3)$
- D  $2x^2 - x - 1 = (x - 1)(2x - 1)$

35 An ordinary die is thrown three times and the number that comes up each time is noted.

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

- A The probability of obtaining 3 sixes is  $\frac{1}{216}$ .
- B The probability of obtaining exactly 1 four is  $\frac{25}{216}$ .
- C The probability that all 3 numbers are even is  $\frac{1}{8}$ .
- D The probability that there is at least 1 two is  $\frac{91}{216}$ .

36 Starting with a positive integer,  $n$ , do the following steps in order to find the answer.

- Step 1: Square it
- Step 2: Add 5
- Step 3: Double it
- Step 4: Subtract twelve times the starting integer

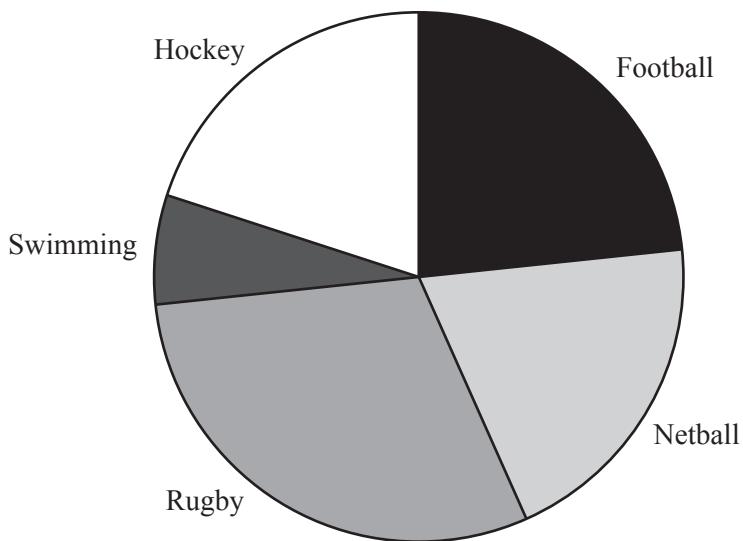
Three of the following statements are true and **one** is false. Which one is **false**?

- A The answer is always even.
- B The answer is sometimes negative.
- C For two values of  $n$  the answer is zero.
- D The answer is always a square number.

37 In a sports club, 150 junior members opt for one sport. The sports offered and the numbers opting for each are shown in the table below.

Sport	Number of junior members
Football	35
Hockey	30
Rugby	45
Netball	30
Swimming	10

A pie chart to illustrate these data is shown below.



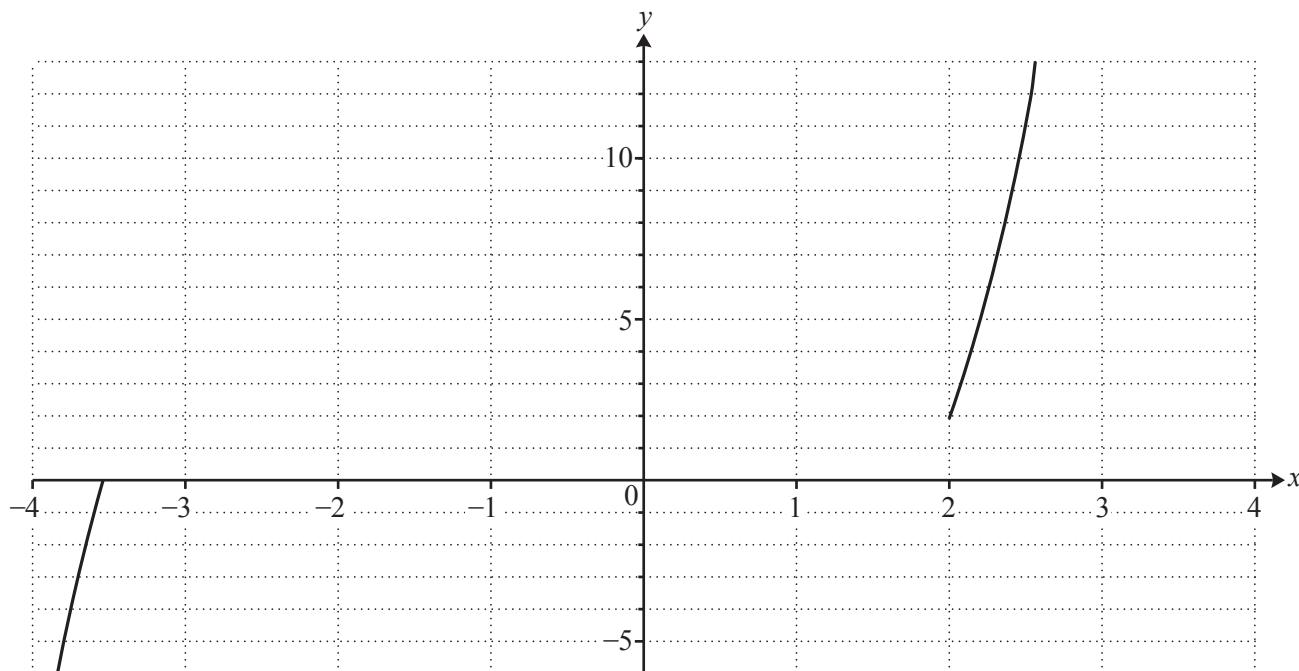
Three of the following statements are true and **one** is false. Which one is **false**?

- A Exactly half of the junior members chose rugby or hockey.
- B The angle of the sector representing swimming is  $24^\circ$ .
- C The angle of the sector representing rugby is  $108^\circ$ .
- D 50 new junior members join the club and 10 opt for each sport. The angles in the pie chart will remain the same.

38 This question concerns the graph of  $y = x^3 + 2x^2 - 6x - 2$ .  
 The table below gives some values of  $y$  for given values of  $x$ .  
 The graph below is of part of the graph of this equation.

*In order to answer this question you are advised to fill in the table and complete the graph.*

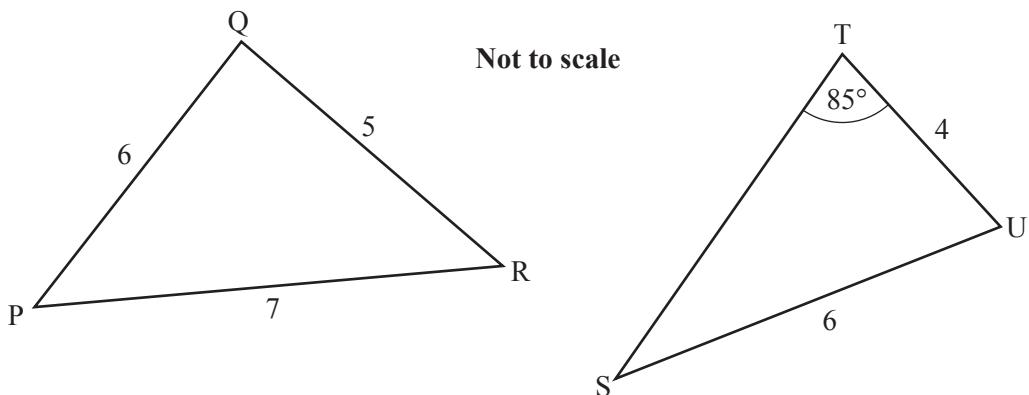
$x$	-3	-2	-1	0	1	2
$y$	7			-2		



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

- A The positive root of the equation  $x^3 + 2x^2 - 6x - 2 = 0$  is approximately  $x = 1.8$ .
- B The equation  $x^3 + 2x^2 - 6x - 2 = 12$  has three roots.
- C When  $x = 0$  the gradient of the curve is negative.
- D There are two points on the curve where the gradient is zero.

39 Barbara and Valerie are trying to find angles in two triangles.



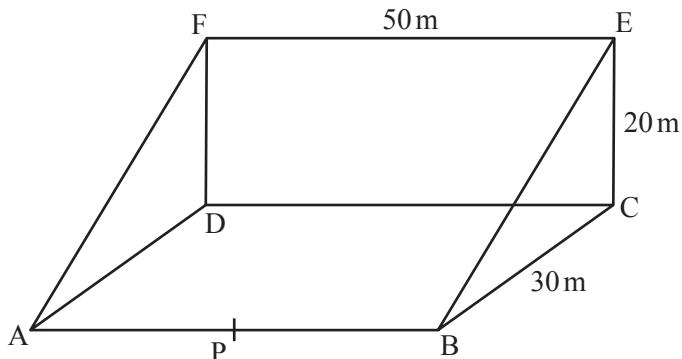
Barbara claims that angle  $P = 44^\circ$ , correct to the nearest degree.

Valerie claims that angle  $S = 42^\circ$ , correct to the nearest degree.

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

- A Barbara and Valerie are both correct.
- B Barbara and Valerie are both incorrect.
- C Barbara is correct and Valerie is incorrect.
- D Barbara is incorrect and Valerie is correct.

40 An artificial ski slope is in the form of a wedge as shown in the diagram.  
 The base ABCD is a horizontal rectangle with  $AB = DC = 50\text{ m}$  and  $BC = AD = 30\text{ m}$ .  
 The rectangle DCEF is vertical with  $CE = DF = 20\text{ m}$  and  $DC = FE = 50\text{ m}$ .  
 P is a point on the line AB.



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

- A The angle EPC is smaller than the angle EBC but greater than the angle EAC.
- B The angle EBC =  $33.7^\circ$ , correct to 1 decimal place.
- C The angle EAC =  $18.9^\circ$ , correct to 1 decimal place.
- D The direct path from A to E is 54.8 m long, correct to 1 decimal place.

**END OF QUESTION PAPER**