

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

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



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 $=\pi rl$

The Quadratic Equation

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

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



length



crosssection





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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
$$3 + 7 \times 2 = 17$$

- 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 mm = 0.4 cm
 - **B** 2500 g = 2.5 kg
 - C $5 \text{ m s}^{-1} = 18 \text{ km h}^{-1}$
 - **D** 70 centilitres = 0.07 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.
 - $C = 7^6 = 117700$, correct to the nearest hundred.
 - **D** $234567 \div 89 = 2640$, correct to 3 significant figures.



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?

 $\mathbf{A} \quad 5x - 15 = x + 20$

B
$$5x - x = 20 - 15$$

- \mathbb{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?

$$\mathbf{A} \quad a+b+c=0$$

B $ab^2 = 45$

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

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

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

- In the expression $2x^3 8x^2 + x + 1$, the highest power of x is 3. A
- In the expression $5 + 6x x^2$, the coefficient of x^2 is 1. B
- The expression $4x^3 5x^2 + 7x$ contains no constant term. C
- 4x(x-3) + 9 is equal to $(2x-3)^2$ for all values of x. D
- Three of the following statements about the diagram are true and one is false. Which one is false? 11

6



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

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

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

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

- A $3x^2 \times 4x^5 = 12x^{10}$
- $\mathbf{B} \qquad \frac{6x^5}{12x} = \frac{1}{2}x^4$
- \mathbb{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.

- 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.

- Three of the following statements are true and one is false. Which one is false? 16
 - A discount of 10% is the same as getting one tenth off the price. A
- StudentBounty.com A sign $\frac{1}{4}$ off marked price' means the customer pays 75% of the marked price. B

8

- An item priced at £80 excluding VAT costs £94 when VAT at 17.5% is added. C
- An item is priced at £400 including VAT at 17.5%. The VAT on the item is £70. D
- Rosie and Vicky are solving a problem involving right-angled triangles. 17



- 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?

- Rosie and Vicky are both correct. A
- Rosie is correct and Vicky is incorrect. B
- Rosie is incorrect and Vicky is correct. С
- Rosie and Vicky are both incorrect. D
- Which one of the following is the correct solution of the equation $4 9x + 3x^2 = 0$? 18



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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 $4\frac{1}{2} + 2\frac{2}{3} = 7\frac{1}{6}$
- $\mathbf{C} \qquad \left(\frac{3}{4}\right)^2 = \frac{3}{16}$
- **D** $\frac{3}{4} \div \frac{4}{5} = \frac{15}{16}$

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

- Three of the following statements are true and one is false. Which one is false? 22
- StudentBounty.com One day Adam drove 120 miles in 2 hours. The following day he made the same journ A average speed which was 10% slower so the time he took was 10% longer.
 - Given that 245 g of cheese costs ± 1.40 then 315 g of cheese will cost ± 1.80 . B
 - When £280 is shared in the ratio 3:2 the larger share is £168. C
 - When a sum of money is shared in the ratio 2:3:4 then each share is less than half the original D amount.
- A water tank, ABCDEFGH, has length 2 m, width 80 cm and height 1.5 m. 23



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

- Each of the smallest faces has an area of 1.2 m^2 . A
- The length of AG is approximately 2.6 m. B
- When half full the tank contains 2400 litres. C
- The tank is lagged with insulating material covering all 6 outside faces. The area of insulating D material required is 11.6 m².

10

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.

11

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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.

3x + 4y = 7x - 6y = 17

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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 **a** is a unit vector.

B The angle between vectors **b** and **i** is approximately 146.3° .

C The vectors **b** and **c** have the same magnitude.

 $D \quad 5a - c = 9i$

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



- During the first part of the journey the train is accelerating at $\frac{1}{8}$ m s⁻². A
- The distance between the two stations is 5.85 km. B
- When 240 seconds have elapsed the train has travelled half the distance between the two stations. C
- The train travels at constant speed for 5 minutes. D
- Three of the following statements are true and one is false. Which one is false? 30
 - $(5x+2y)(4x-3y) = 20x^2 7xy 6y^2$ A
 - $x + 3(x + 7) = x^{2} + 10x + 21$ B
 - C $xy^2(2x^3+9y) = 2x^4y^2 + 9xy^3$
 - $4x(x+2) 3(x^2 5) = x^2 + 8x + 15$ D

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



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

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

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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° , correct to 1 decimal place.
- C Angle FDM = 17.6° , correct to 1 decimal place.
- **D** Angle HFC = 60°
- 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?

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

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

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

- The probability that Lucy wins both sets is 0.56. A
- The probability that Emma wins both sets is 0.18. B
- The probability that Lucy and Emma win one set each is 0.14. С
- The probability that Emma wins the second set is 0.32. D
- William has a map of his village which uses a scale of 1 cm to 5 m. 35

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

- The scale of the map is 1 : 500. A
- A length of 16.4 cm on the map corresponds to 82 m on the ground. B
- A length of 0.2 km on the ground corresponds to 40 cm on the map. C
- An area of 5 cm^2 on the map corresponds to 25 m^2 on the ground. D

Oliver and Steve are practising rearranging formulae. 36

- 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 $g = \frac{T^2}{2\pi^2 L}$.

Which one of the following statements is true?

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

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



17

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- 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.



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

 $y = -2\cos x$

B

 $\mathbf{C} \quad y = \sin x - 1 \qquad \mathbf{D} \quad y = 2\sin x$

A $y = \cos x + 1$

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

						27				S			
				19						.9	der		
e has been given the cond differences as	first fo shown l	ur teri pelow	ns of a	quad	ratic se	quenc	e. Sh	e finds	the fi	rst diff		Bount	
Sequence	17		18		23		32					2.0	
First difference		1		5		9						1	>
Second difference			4		4	9			•••				

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



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Foundations of Advanced Mathematics (MEI)

INTERMEDIATE FSMQ 6989

Report on the Unit

January 2010

6989/MS/R/10J

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This report on the Examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the Examination.

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Foundations of Advanced Mathematics FSMQ (6989)

REPORT ON THE UNIT

Unit	Page	
Foundations of Advanced Mathematics – 6989	1	
Grade Thresholds	3	

Foundations of Advanced Mathematics – 6989

StudentBounts.com There were nearly 800 entries for this session, an increase on the previous January series. The mean mark was 24.5. The lowest mark on this paper was 12. One candidate achieved full marks, one 39 and a further seven candidates scored 38 marks.

In many papers in recent series there have been no candidate omitting a question. In this paper there were thirty questions in which at least one candidate offered no response and there were two questions where eight candidates did not give an answer. Given that there is no penalty for an incorrect response this is surprising.

In all questions each of the distracting answers was selected by at least one candidate.

In four questions the correct response was chosen by a minority of candidates and in four further questions an incorrect response was chosen by a majority of candidates.

Q 21 (Algebra – solution of inequalities)

The correct response required a division by a negative number with the inequality sign not changing. This was missed by a significant proportion of candidates who chose instead the most complicated looking inequality.

Q 28 (Vectors)

A third of candidates selected the response that the angle between **b** and **i** was more than 90[°] which was, in fact correct, Rather fewer decided that two vectors had the same magnitude in a situation where the coefficients of one were double the other; these two vectors are parallel with one double the length.

Q 33 (Algebra – formulation of a formula from a statement in words) Just a few more candidates chose to turn seconds into hours by multiplying by 3600 rather than dividing by 3600.

Q 38 (Algebra – subtraction of algebraic terms)

This question was a standard one which has appeared many times before. It was necessary to deal with an LCM but more significantly, the subtraction of a negative term - many candidates subtracted the positive equivalent.

91 - 100%	Question 7 8 12	Topic Solution of equation Statistics – selection of a random sample Arithmetic – choice of sensible units
81 - 90%	1	Arithmetic
	4	Rounding of numbers
	9	Evaluation of expressions
	13	Algebra – simplification of algebraic terms
	19	Arithmetic – standard form
	20	Arithmetic – fractions
	40	Algebra – quadratic sequence
71 - 80%	6	Statistics – average and spread of a set of data
61 - 70%	5	Coordinate geometry – plotting of points.
	11	Coordinate geometry – the straight line

		- SE
Report on the Unit t	aken in Janı	uary 2010
	15 16 22 23	Arithmetic – range of rounded values Arithmetic – percentages Arithmetic – ratios Arithmetic – volume and capacity of cuboid
	24 25 27 31	Vectors Graphs – interpretation of exponential graph Algebra – quadratic factorisation Statistics – cumulative frequency graph
51 - 60%	3 10 26 30 34 36 37 39	Arithmetic – conversion of units Algebra – expressions Algebra – solution of linear simultaneous equations Algebra – expansion of brackets Probability Algebra – rearranging formulae Graphs – graph of cubic function Trigonometry – identification of graphs of trigonometrical functions
41 - 50%	2 14 18 29 35	Arithmetic Probability Algebra – solution of quadratic equation Algebra – interpretation of speed/time graph Arithmetic – scales of maps
31 - 40%	17 32 33 38	Trigonometry – right-angled triangles Trigonometry – diagonals and angles in a cuboid Algebra – formula for a statement in words Algebra – subtraction of 2 algebraic terms
21 - 30%	21 28	Algebra – solution of inequalities Vectors
11 - 20%		

Grade Thresholds

Foundations of Advanced Mathematics FSMQ (6989) January 2010 Assessment Series

Unit Threshold Marks

Unit	Maximum Mark	Α	В	С	D	Е	U
6989	40	31	27	23	19	16	0

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The cumulative percentage of candidates awarded each grade was as follows:

	Α	В	С	D	E	U	Total Number of Candidates
6989	19.2	36.1	61.6	84.5	93.8	100	792



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