Imperial College London Mathematics School Admissions Test

2025 Sample paper 2

Mark Scheme

Marking instructions

- Each question in sections A and B scores 2 marks for the correct answer or zero for no answer, the wrong answer or more than one answer.

- Questions in section C may be worth 1 or 2 marks for the correct answer (as indicated) or zero for no answer, the wrong answer or more than one answer.

Section A

Number	Solution	Mark	Guidance
1	**A** 1.6×10^{21}	**2**	Either 2 or zero for each question on Section A. **Example reasoning** $(2 \times 10^5)^4 = 2^4 \times (10^5)^4 = 16 \times 10^{20}$ but this is not in standard form. $16 \times 10^{20} = 1.6 \times 10 \times 10^{20} = 1.6 \times 10^{21}$
2	**D** $\frac{13}{27}$	**2**	**Example reasoning** For an even total, the three numbers in order could be Even, even, even with prob $\frac{1}{27}$ Even, odd, odd with prob $\frac{4}{27}$ Odd, even odd with prob $\frac{4}{27}$ Odd, odd, even with prob $\frac{4}{27}$ $\frac{1}{27} + \frac{4}{27} + \frac{4}{27} + \frac{4}{27} = \frac{13}{27}$
3	**E** 3.5	**2**	**Example reasoning** $\frac{3}{2} \times \frac{4}{3} \times \frac{5}{4} \times \frac{6}{5} \times \frac{7}{6}$. Most numbers cancel, leaving $\frac{7}{2}$
4	**B** All the numbers in the sequence are even.	**2**	**Example reasoning** $n^2 + n = n(n+1)$. This is a product of two consecutive numbers so one will be odd and one will be even with the product being even.
5	**A** All 4 sides have the same length.	**2**	**Example reasoning** The diagonals of FRGP cross at right angles so it is a kite or rhombus. FR is parallel to PG so FRGP is a rhombus.

Number	Solution	Mark	Guidance
6	**D**	**2**	**NOTE:** Students might indicate their answer on the diagram **Example reasoning** AO is 5 units. BO $= \sqrt{3^2 + 4^2} = 5$ CO $= \sqrt{3^2 + 4^2} = 5$ DO $= \sqrt{1^2 + 5^2} \neq 5$
7	**B** -3	**2**	**Example reasoning** $x = -1$ is a root so $(-1)^2 - a + 3 = 0$ $a = 4$ so the equation is $x^2 + 4x + 3 = 0$ $(x + 1)(x + 3) = 0$ Roots are -1 and -3
8	**D** 3	**2**	**Example reasoning** Three of the answers can be shown to be equal by e.g. $\frac{1}{2022} + \frac{1}{2023} = \frac{2023+2022}{2022\times2023}$ $\frac{2023}{2022} - \frac{2022}{2023} = \frac{2023^2-2022^2}{2022\times2023}$ $\frac{2023^2-2022^2}{2022\times2023} = \frac{(2023-2022)(2023+2022)}{2022\times2023}$ $\frac{(2023-2022)^2}{2022\times2023}$ is the only one that can't be shown to give the same value

Number	Solution	Mark	Guidance
9	**B** $\frac{9}{4}$	**2**	**Example reasoning** $\frac{10x-9y}{2x} = 3$ so $5 - \frac{9y}{2x} = 3$ $2 = \frac{9y}{2x}$ $\frac{4}{9} = \frac{y}{x}$ so $\frac{x}{y} = \frac{9}{4}$
10	**C** $\frac{\pi}{2} - 1$	**2**	**Example reasoning** A quarter of the circle has area $\frac{\pi}{4}$. The square minus a quarter circle has area $1 - \frac{\pi}{4}$. The shaded area is the square minus two of these so $1 - 2\left(1 - \frac{\pi}{4}\right) = 1 - 2 + \frac{\pi}{2}$

Section B

Number	Solution	Mark	Guidance
11	**D** In the busiest months, over 10 million people travelled abroad from the UK.	**2**	Either 2 or zero for each question on Section B. **Example reasoning** The busiest month in each year is August. Adding the figures for North America, Europe and other countries in August gives over 10 million.
12	**E** In general, London boroughs with lower median house prices recycle a higher proportion of their household waste.	**2**	**Example reasoning** There is a general downward trend in the points.
13	**E** 20%	**2**	**Example reasoning** For each £1 of the original price, the cost becomes £1.25 after the reduction. The reduction of 25p to get back to the original price is $\frac{1}{5}$ of the new price. This is 20% as a percentage.
14	**A** 47% is a reasonable estimate for the proportion of all voters who think that the prime minister is doing a good job.	**2**	**Example reasoning** An opinion poll using a fair sample is more likely to give a good estimate than one person asking their friends but you can't assume that the sample is completely representative of all voters.
15	**C** £92	**2**	**Example reasoning** Sunday nights tend to be cheap and Saturdays expensive. The cheapest pair of nights is 7 and 8 Nov. The cost is about £30 + £60 = £90 but the Monday is a bit more than £60 so £92 is the total cost.

<table>
<tr><th>Number</th><th>Solution</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>16</td><td>B £26.25</td><td>2</td><td>Example reasoning
The two child tickets add up to a full price ticket.
Each railcard ticket is $\frac{2}{3}$ of the price of a full price ticket
Let x be the price of a full price ticket
$\left(4+\frac{4}{3}\right)x = 140$
$\left(1+\frac{1}{3}\right)x = 35$
$\frac{4}{3}x = 35$
$4x = 105$
$x = 26.25$</td></tr>
<tr><td>17</td><td>A 696 m in 2 minutes.</td><td>2</td><td>Example reasoning
696 m in 2 minutes is 348 m in 1 minute
903 m in 3 minutes is 301 m in 1 minute
A is faster than B or D so just need to compare A and C.
348 m in 1 minute is 58 m in 10 seconds
In 1 minute 50 seconds, A would travel 696 – 58 = 638 m
A is fastest</td></tr>
<tr><td>18</td><td>C 4</td><td>2</td><td>Example reasoning
Possibilities are shown in the table below.
<table>
<tr><th>Right</th><th>Wrong</th><th>Missed</th></tr>
<tr><td>2</td><td>1</td><td>17</td></tr>
<tr><td>3</td><td>5</td><td>12</td></tr>
<tr><td>4</td><td>9</td><td>7</td></tr>
<tr><td>5</td><td>13</td><td>2</td></tr>
</table></td></tr>
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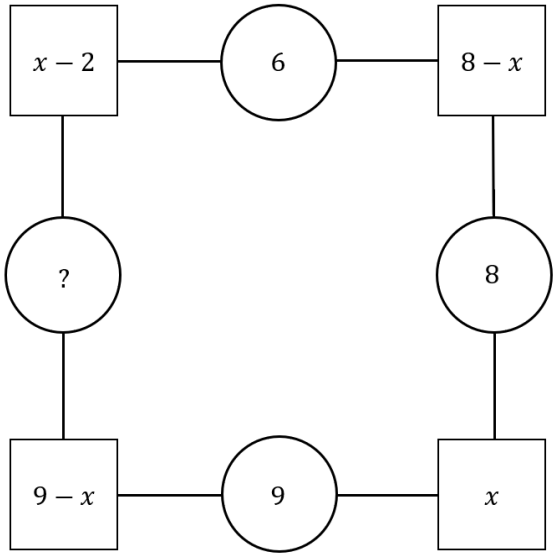
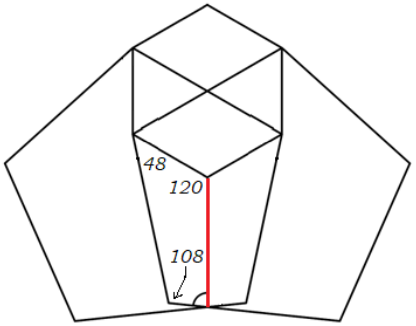
<table>
<tr><th>Number</th><th>Solution</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>19</td><td>A The most likely event is that the difference between the two numbers is 0.</td><td>2</td><td>Example reasoning
The 36 outcomes are shown in the following table.
<table><tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr><tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>
6 outcomes have a difference of 0
5 outcomes have a sum of 6
4 outcomes have an answer of 6 when the numbers are multiplied so A.</td></tr>
</table>

Number	Solution	Mark	Guidance
20	**C** 1	**2**	**Example reasoning** Let the number in the bottom right square be x The other numbers in the squares are shown in terms of x in the diagram below.  $x-2+9-x=7$ The ? must be 7 if there are solutions to the puzzle. $x=3$ gives one solution with all positive whole numbers so there is at least one solution. There is only one possibility for ?.

Section C

Number	Solution	Mark	Guidance
21a	**D** $120°$	**1**	**Example reasoning** $\frac{360}{6} = 60, 180 - 60 = 120°$
21b	**C** $108°$	**1**	$\frac{360}{5} = 72, 180 - 72 = 108°$
21c	**D** $48°$	**2**	$120 \div 2 = 60$ $108 - 60 = 48°$
21d	**B** $168°$	**2**	Drawing a vertical line that bisects d gives  Using the quadrilateral, the sum $\frac{d}{2} + 108 + 120 + 48 = 360$ $\frac{d}{2} = 360 - 276 = 84$ so $a = 168°$
		[6]	

Number	Solution	Mark	Guidance
22a	E $(0, -4)$	**1**	**Example reasoning** $5y = (x + 2)(x - 10)$ $x = 0$ $5y = -20$ $y = -4$
22b	E $x = 5$	**2**	For the equation to yield an integer value, the left-hand side must be a multiple of 5. The only value for which one of $(x + 2)$ or $(x - 10)$ gives a multiple of 5 is $x = 5$.
22c	A 6	**2**	$x = -1, 1, 2, 4, 6, 7, 9$ don't $x = -2$ gives 0×-12, $x = 0$ gives 2×-10, $x = 3$ gives 5×-7, $x = 5$ gives 7×-5 (the reflection of $(3, -35)$ in the line of symmetry), $x = 8$ does (10×-2) (reflection of $(0, -20)$ in the line of symmetry) $x = 10$ does (12×0) (reflection of $(-2, 0)$ in the line of symmetry) Six pairs of integer coordinates in total
22d	C Neil and Oliver	**2**	For Neil, the points where $x = 4$, $x = 5$, $x = 6$ and $x = 7$ on the line do not have whole number y values e.g. for $x = 4$, $(3 \times 4) - 5y = 44$ gives $5y = 12 - 44$ i.e. $5y = -32$ so $y = -6.4$ For Oliver, the inequalities $3x - 5y > 44$ and $5y > (x + 2)(x - 10)$ do not include the boundaries of the region (where some points exist by part c)
		[7]	

Number	Solution	Mark	Guidance
23a	B $\frac{3}{20}$	**1**	**Example reasoning** $\mathrm{P}(\textbf{not } 1) = 1 - \frac{1}{4} = \frac{3}{4}$ This will be shared equally amongst the other possible outcomes so $\mathrm{P}(6) = \frac{3}{4} \div 5 = \frac{3}{20}$
23b	C $\frac{31}{40}$	**2**	$\mathrm{P}(\textbf{not } 2) = 1 - \frac{5}{8} = \frac{3}{8}$ This will be shared equally amongst the other possible outcomes so the probability of each of the other outcomes is $\frac{3}{8} \div 5 = \frac{3}{40}$ Either $\mathrm{P}(\text{even number}) = \frac{5}{8} + \frac{3}{40} + \frac{3}{40} = \frac{25+6}{40} = \frac{31}{40}$ or $\mathrm{P}(\text{even number}) = 1 - \left(3 \times \frac{3}{40}\right) = 1 - \frac{9}{40} = \frac{31}{40}$
23c	D $\frac{2}{9}$	**2**	$3p + 3 \times 2p = 1$ so $p = \frac{1}{9}$ $\mathrm{P}(6) = 2p = \frac{2}{9}$

23d	D Bernard and David only	**2**	

	1	2	3	4	5	6
R	$\frac{1}{4}$	$\frac{3}{20}$	$\frac{3}{20}$	$\frac{3}{20}$	$\frac{3}{20}$	$\frac{3}{20}$
Y	$\frac{3}{40}$	$\frac{5}{8}$	$\frac{3}{40}$	$\frac{3}{40}$	$\frac{3}{40}$	$\frac{3}{40}$
B	$\frac{1}{9}$	$\frac{2}{9}$	$\frac{1}{9}$	$\frac{2}{9}$	$\frac{1}{9}$	$\frac{2}{9}$

Blue: $\mathrm{P}(\text{even}) = \frac{6}{9} = \frac{2}{3}$ Yellow: $\mathrm{P}(\text{even}) = \frac{5}{8} + \frac{6}{40} = \frac{31}{40}$

Since $\frac{3}{2} \times \frac{31}{40} > 1$ Amita is not correct

Red: $\mathrm{P}(\text{prime}) = \frac{3}{20} + \frac{3}{20} + \frac{3}{20} = \frac{9}{20}$

Blue: $\mathrm{P}(\text{prime}) = \frac{2}{9} + \frac{1}{9} + \frac{1}{9} = \frac{4}{9}$

$\frac{9}{20} = \frac{81}{180}$ and $\frac{4}{9} = \frac{80}{180}$ so Bernard is correct

Yellow and Blue: $(1,2)$ or $(2,1)$

$\mathrm{P}(\text{tot } 3) = \frac{3}{40} \times \frac{2}{9} + \frac{5}{8} \times \frac{1}{9} = \frac{1}{60} + \frac{5}{72}$

Red and Blue: $(1,2)$ or $(2,1)$

$\mathrm{P}(\text{tot } 3) = \frac{1}{4} \times \frac{2}{9} + \frac{3}{20} \times \frac{1}{9} = \frac{1}{18} + \frac{1}{60} = \frac{4}{72} + \frac{1}{60}$

Yellow & Blue > Red and Blue so Carol is not correct

Red and Blue: $(6,5)$ or $(6,6)$ or $(5,6)$

$\mathrm{P}(\text{tot} > 10) = \frac{3}{20} \times \frac{1}{9} + \frac{3}{20} \times \frac{2}{9} + \frac{3}{20} \times \frac{2}{9} = \frac{1}{60} + \frac{2}{60} + \frac{2}{60}$

$= \frac{5}{60} = \frac{1}{12}$

Yellow and Blue: $(6,5)$ or $(6,6)$ or $(5,6)$

$\mathrm{P}(\text{tot} > 10) = \frac{3}{40} \times \frac{1}{9} + \frac{3}{40} \times \frac{2}{9} + \frac{3}{40} \times \frac{2}{9}$

$= \frac{1}{120} + \frac{2}{120} + \frac{2}{120} = \frac{5}{120} = \frac{1}{24}$

Number	Solution	Mark	Guidance
			$2 \times \frac{1}{24} - \frac{1}{12}$ so David is correct
		[7]	

Number	Solution	Mark	Guidance
23	• B is $(6, 0)$ OR D is $(-6, 0)$ OR C is $(0, -6)$ OR gradient of AB is -1 OR gradient of CD is -1 • AB has equation $x + y = 6$ Or equivalent OR CD has equation $x + y = -6$ • Distance of E from y-axis is one third of distance of B from y-axis. May be seen on diagram. OR similar for x-axis. Implied by correct coordinates for E or F	**M2**	M1 for each bullet point up to a maximum of 2
	E has coordinates $(2, 4)$	**A1**	OR F has coordinates $(4, 2)$
	$2 \times 4 = k$	**M1**	Using *their* point on the curve to find k
	$k = 8$	**A1**	
		[5]	