

HU Collection

Engineering and Science Admissions Test

Mock Set D

Mathematics 1

Time allowed: 40 minutes
Questions: 27 multiple choice
Calculators: not permitted
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Date written: 28 October 2026

Name: Date sat: Score: / 27

Instructions

Answer all 27 questions. Each question has exactly one correct option and is worth one mark. No marks are deducted for wrong answers, so answer every question. Calculators are not permitted. This paper is deliberately longer than the time allows: move on from any question that is costing you more than two minutes, and come back to it at the end.

Q	1	2	3	4	5	6	7	8	9	10
Ans										

Q	11	12	13	14	15	16	17	18	19	20
Ans										

Q	21	22	23	24	25	26	27			
Ans										

1. How many points with integer coordinates lie inside the finite region enclosed by the curve $y = x^2 - 6x + 5$ and the line $y = x - 1$? Points lying on the curve or on the line are not counted.

- | | | |
|-------------|-------------|-------------|
| A 14 | B 18 | C 26 |
| D 16 | E 20 | F 12 |

2. Car A has a fuel consumption of 6 litres per 100 km. Car B travels 45 miles per gallon of fuel. Take 1 mile = 1.6 km and 1 gallon = 4.5 litres. Each car makes the same journey of 480 km.

Which car uses less fuel on the journey, and by how much?

- A** Car A , by 1.2 litres
- B** Car B , by 4.8 litres
- C** They use the same amount of fuel.
- D** Car B , by 1.2 litres
- E** Car A , by 4.8 litres
- F** Car A , by 48 litres

3. $ABCDE$ is a convex cyclic pentagon: its five vertices lie on a circle, in that order. The interior angle $\angle ABC$ is 100° and the interior angle $\angle CDE$ is 120° .

What is the size of $\angle ACE$?

- | | | |
|---------------------|---------------------|---------------------|
| A 50° | B 20° | C 70° |
| D 40° | E 80° | F 60° |

4. Seven students sit a test. If the lowest of the seven marks is removed, the mean of the remaining six marks is 3 more than the mean of all seven marks. If instead the highest mark is removed, the mean of the remaining six marks is 4 less than the mean of all seven marks.

What is the range of the seven marks?

- | | | |
|-------------|-------------|-------------|
| A 49 | B 42 | C 21 |
| D 35 | E 7 | F 14 |

5. A clerk is asked to round a positive whole number N to the nearest 1000. Instead of doing this directly, she rounds N to the nearest 10, then rounds that answer to the nearest 100, and then rounds that answer to the nearest 1000. At every stage, a number exactly halfway between two candidates is rounded up.

For how many whole numbers N from 1 to 10 000 inclusive does her method give a different answer from rounding N directly to the nearest 1000?

- | | | |
|---------------|--------------|--------------|
| A 55 | B 50 | C 550 |
| D 1000 | E 450 | F 500 |

6. A spherical balloon is slowly leaking. It stays spherical, and during each hour its volume decreases by 27.1% of the volume it had at the start of that hour.

By what percentage has its surface area decreased after 2 hours?

- | | | |
|-----------------|--------------|-----------------|
| A 34.39% | B 38% | C 36.14% |
| D 46.86% | E 19% | F 18.07% |

7. The graph of $y = x^2 + bx + c$, where b and c are constants, passes through the point $(4, 10)$, and its turning point lies on the line $y = x$.

What is the sum of all the possible values of c ?

- | | | |
|-------------|-------------|--------------|
| A 44 | B 49 | C -14 |
| D 84 | E 42 | F 7 |

8. A hiker leaves her camp C and walks 3 km in a straight line on a bearing of 050° to a point P . She then walks 3 km in a straight line on a bearing of 170° to a point Q . The points C , P and Q are marked on a map of scale 1 : 25 000.

What is the length of the line segment QC on the map, and what is the bearing of C from Q ?

- | | | |
|--|---------------------------------|--------------------------------|
| A $12\sqrt{3}$ cm and 290° | B 12 cm and 230° | C 12 cm and 110° |
| D 1.2 cm and 290° | E 120 cm and 290° | F 12 cm and 290° |

9. A combination lock has four dials, each showing one of the digits 0 to 9, so that a code is an ordered list of four digits, such as 0 4 9 1.

How many codes have the property that the product of their four digits is 36?

- | | | |
|-------------|-------------|-------------|
| A 48 | B 72 | C 60 |
| D 36 | E 84 | F 66 |

10. Jug A contains 600 ml of a drink that is 20% fruit concentrate by volume, and jug B contains 400 ml of a drink that is 50% concentrate by volume. First, 200 ml is poured from A into B and mixed thoroughly. Then some of the mixture in B is poured back into A and mixed thoroughly, after which the drink in A is 30% concentrate. Assume that volumes simply add when liquids are mixed.

How much was poured back from B into A ?

- | | | |
|-----------------|-----------------|-----------------|
| A 500 ml | B 400 ml | C 600 ml |
| D 300 ml | E 250 ml | F 200 ml |

11. A cyclist rides at a constant speed along a long straight road. Buses run along the road in both directions. In each direction the buses leave their depot at the same regular time interval, and every bus travels at the same constant speed, which is greater than the cyclist's speed. The cyclist notices that she meets an oncoming bus every 6 minutes and is overtaken by a bus every 12 minutes.

At what time interval do the buses leave each depot?

- | | | |
|----------------------|----------------------|--------------------|
| A 7.5 minutes | B 4.5 minutes | C 9 minutes |
| D 10 minutes | E 6 minutes | F 8 minutes |

12. Two non-empty data sets X and Y , each consisting of real numbers, are combined into a single data set Z , which contains every value of X and every value of Y (repeated values are kept). Which of the following statements must be true?

- I. The mean of Z lies between the mean of X and the mean of Y , inclusive.
- II. The median of Z lies between the median of X and the median of Y , inclusive.
- III. The range of Z is at least as large as the range of X , and at least as large as the range of Y .
- IV. Every mode of Z is a mode of X or a mode of Y .

- A** I, III and IV only
- B** I only
- C** I, II and III only
- D** I, II, III and IV
- E** II and III only
- F** I and III only
- G** III only
- H** I and II only

13. A drone flies in a straight line from a base to a beacon and then straight back, at the same constant airspeed (its speed relative to the air) throughout; ignore the time taken to turn round. A steady wind of 10 km/h blows directly from the base towards the beacon, so the drone's speed over the ground is its airspeed plus 10 km/h on the way out and its airspeed minus 10 km/h on the way back. The round trip takes 25% longer than it would in still air.

What is the drone's airspeed, in km/h?

- | | | |
|-----------------------|-----------------------|-----------------------|
| A $20\sqrt{2}$ | B $10\sqrt{6}$ | C 20 |
| D $10\sqrt{5}$ | E 25 | F $10\sqrt{3}$ |

14. The times, t minutes, that a sample of customers spent in a shop are shown in a histogram with three bars. The bar for $0 \leq t < 10$ has frequency density 2 customers per minute, the bar for $10 \leq t < 15$ has frequency density 6 customers per minute, and the bar for $15 \leq t < b$ has frequency density 2.5 customers per minute, where the upper class boundary b has been smudged and cannot be read. Using linear interpolation within classes, the median time is estimated to be 20 minutes.

Using class midpoints, what is the estimated mean time, in minutes?

- | | | |
|----------------|---------------|---------------|
| A 22.5 | B 20 | C 19.4 |
| D 27.25 | E 23.6 | F 21.8 |

15. A robot starts at the origin of a coordinate grid. At each move it chooses one of the three displacement vectors

$$\mathbf{p} = \begin{pmatrix} 2 \\ 1 \end{pmatrix}, \quad \mathbf{q} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}, \quad \mathbf{r} = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

and moves through that displacement. Each vector may be used any number of times, in any order.

What is the smallest number of moves after which the robot can be at the point (11, 9)?

- | | | |
|-------------|-------------|-------------|
| A 8 | B 11 | C 23 |
| D 15 | E 7 | F 9 |

16. A security guard patrols the six corners of a hexagonal courtyard. She starts at one corner, and every minute she walks along a side to one of the two neighbouring corners, choosing each of the two with probability $\frac{1}{2}$, independently of all her previous choices.

What is the probability that she is back at her starting corner after exactly 6 minutes?

- | | | |
|-------------------------|--------------------------|--------------------------|
| A $\frac{3}{8}$ | B $\frac{1}{6}$ | C $\frac{11}{64}$ |
| D $\frac{1}{32}$ | E $\frac{11}{32}$ | F $\frac{5}{16}$ |

17. How many different straight lines pass through the point $(2, 3)$ and form, together with the x -axis and the y -axis, a triangle of area 12?

- | | | |
|------------|------------|------------|
| A 2 | B 3 | C 4 |
| D 5 | E 0 | F 1 |

18. At exactly 12 noon, two analogue clocks, each with a 12-hour dial, are both set to show the correct time. One clock runs fast, gaining 3 minutes every hour; the other runs slow, losing 2 minutes every hour. Each clock keeps running at its own constant rate.

When the two clocks next show exactly the same time as each other, what time do they show?

- | | | |
|---------------|----------------|---------------|
| A 2:24 | B 12:00 | C 6:00 |
| D 7:12 | E 4:48 | F 9:36 |

19. The transformation T consists of a reflection in the line $y = x$ followed by a rotation through 90° clockwise about the point $(2, 0)$. The point $P_0 = (1, 0)$ is mapped by T to P_1 , then P_1 is mapped by T to P_2 , and so on, so that P_{k+1} is the image of P_k under T for every $k \geq 0$.

What are the coordinates of P_{2026} ?

- | | | |
|--------------------|--------------------|--------------------|
| A (4051, 2) | B (1, 4052) | C (4053, 0) |
| D (4055, 0) | E (4053, 2) | F (2027, 0) |

20. In a city whose streets form a square grid, the *taxi distance* between the points (x_1, y_1) and (x_2, y_2) is defined to be $|x_1 - x_2| + |y_1 - y_2|$. Let $A = (0, 0)$ and $B = (4, 2)$.

How many points P with integer coordinates are at the same taxi distance from A as from B , with this common taxi distance at most 8?

- | | | |
|-------------|-------------|-------------|
| A 11 | B 7 | C 13 |
| D 15 | E 12 | F 17 |

21. Raffle tickets numbered $1, 2, 3, \dots, n$ were sold, each number appearing on exactly one ticket. One ticket was then lost. The mean of the numbers on the remaining $n - 1$ tickets is 31.25.

What number was on the lost ticket?

- | | | |
|-------------|-------------|-------------|
| A 61 | B 6 | C 46 |
| D 15 | E 16 | F 31 |

22. A sequence of positive numbers $u_1, u_2, u_3, \dots$ satisfies

$$u_{n+2} = \frac{u_{n+1} + 1}{u_n} \quad \text{for every } n \geq 1.$$

It is given that $u_{20} = 4$ and $u_{21} = 6$.

What is the value of u_{2028} ?

- | | | |
|------------------------|--------------------------|--------------------------|
| A $\frac{5}{6}$ | B 4 | C $\frac{11}{24}$ |
| D 6 | E $\frac{24}{11}$ | F $\frac{7}{4}$ |

23. A calculator displays the number 1. It has two special buttons. Button F replaces the displayed number x by $x + 1$, and button G replaces the displayed number x by $\frac{x}{x+1}$.

What is the smallest number of button presses after which the display can show $\frac{29}{12}$?

- A 9
- B 7
- C 8
- D 5
- E 6

F The display can never show $\frac{29}{12}$.

24. Ana and Ben watch a fair coin being tossed repeatedly. Ana wins as soon as two consecutive tosses are both heads. Ben wins as soon as a tail is immediately followed by a head. The tossing stops as soon as one of them has won.

What is the probability that Ana wins?

- | | | |
|-----------------|-----------------|-----------------|
| A $\frac{1}{3}$ | B $\frac{2}{3}$ | C $\frac{3}{4}$ |
| D $\frac{3}{8}$ | E $\frac{1}{4}$ | F $\frac{1}{2}$ |

25. Two squares, each of side length 1, have the same centre. One is obtained from the other by a rotation through 30° about this centre.

What is the area of the region that lies inside both squares?

- | | | |
|-----------------------------|----------------------------|-------------------|
| A $2 - \frac{2\sqrt{3}}{3}$ | B $\frac{3 + \sqrt{3}}{6}$ | C $\sqrt{3} - 1$ |
| D $\frac{5}{6}$ | E $\frac{\sqrt{3}}{2}$ | F $2\sqrt{2} - 2$ |

26. The numbers 1, 2, 3, 4, 5, 6, 7 are written in a row in some order. The row is called *connected* if every number after the first differs by exactly 1 from at least one of the numbers to its left. For example, 4356217 is connected, but 4365217 is not, because 6 differs by more than 1 from each of 4 and 3.

How many connected rows are there?

- | | | |
|-------|-------|------|
| A 64 | B 32 | C 42 |
| D 128 | E 720 | F 49 |

27. A square array of 25 dots is arranged in 5 rows and 5 columns, with neighbouring dots 1 cm apart horizontally and vertically.

How many squares, of any size and in any orientation, have all four of their vertices at dots of the array?

- | | | |
|------|------|------|
| A 40 | B 48 | C 54 |
| D 30 | E 60 | F 50 |

End of paper