

HU Collection

Engineering and Science Admissions Test

Mock Set C

Mathematics 2

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. An ornamental pond has a circular boundary which passes through the points $A(1, 1)$ and $B(7, 1)$, and the centre of the circle lies on the line $y = 2x - 3$. Coordinates are in metres. A straight path starts at the origin O , which lies outside the pond, and crosses the pond, meeting the boundary first at P and then at Q . Which of the following is true of the product $OP \times OQ$, in m^2 ?

- A** It depends on the direction of the path, and its greatest possible value is 41.
- B** It equals 25 for every such path.
- C** It equals 9 for every such path.
- D** It equals 41 for every such path.
- E** It equals 16 for every such path.
- F** It depends on the direction of the path, and its least possible value is 16.

2. The reading on a sensor t hours after it is switched on is modelled by

$$f(t) = p + q r^t,$$

where p , q and r are constants with $r > 0$ and $r \neq 1$. The readings at $t = 1, 2$ and 3 are 10, 4 and 1 respectively. As t increases without limit, the readings approach a limiting value. What is it?

- | | | |
|---------------|------------------------|-------------------------|
| A -1 | B $\frac{1}{4}$ | C $-\frac{1}{2}$ |
| D -4 | E 0 | F -2 |

3. Find the term independent of x in the expansion of

$$(1 + x^3) \left(2x^2 - \frac{1}{x} \right)^9.$$

- | | | |
|-----------------|----------------|-----------------|
| A -528 | B 528 | C 672 |
| D 816 | E 384 | F -144 |

4. The line $y = x$ divides the circle

$$x^2 + y^2 - 6x - 2y + 6 = 0$$

into two segments. What is the area of the minor segment?

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

5. Find the sum of all real solutions of the equation

$$\log_2 x \cdot \log_3 x = \log_2 x + \log_3 x.$$

- | | | |
|--------------|--------------|--------------|
| A 8 | B 6 | C 1 |
| D 5 | E 9 | F 7 |

6. The equation

$$x^4 - 10x^2 + k = 0,$$

where k is a constant, has four distinct real roots, and these roots, in a suitable order, form an arithmetic progression. Find k .

- | | | |
|--------------------------|-------------|-------------|
| A 21 | B 24 | C 9 |
| D $\frac{100}{9}$ | E 25 | F 16 |

7. A geometric series has a positive first term. Its sum to infinity is 16, and the sum of its first four terms is 15. Let T be the sum of the terms in the odd positions (the 1st, 3rd, 5th, ... terms). What is the sum of all possible values of T ?

- | | | | | | |
|----------|-----------------|----------|----|----------|----------------|
| A | $\frac{128}{3}$ | B | 40 | C | 32 |
| D | $\frac{32}{3}$ | E | 16 | F | $\frac{64}{3}$ |

8. Which of the following sequences of two transformations map the curve $y = \sqrt{x}$ onto the curve $y = \sqrt{9x + 18}$?

- I. A translation by 2 units in the negative x -direction, followed by a stretch parallel to the y -axis with scale factor 3.
- II. A stretch parallel to the x -axis with scale factor $\frac{1}{9}$, followed by a translation by 2 units in the negative x -direction.
- III. A translation by 18 units in the negative x -direction, followed by a stretch parallel to the x -axis with scale factor $\frac{1}{9}$.
- IV. A translation by 2 units in the negative x -direction, followed by a stretch parallel to the x -axis with scale factor $\frac{1}{9}$.

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

9. A thin circular wheel of radius 2 cm rolls without slipping around the outside of a fixed flat plate in the shape of a regular hexagon of side 3 cm, lying in the same plane. The wheel stays in contact with the boundary of the plate at all times, and it makes one complete circuit, returning to its starting position for the first time. Through what total angle, in radians, has the wheel turned about its own centre?

- A** $18 + 4\pi$
B $9 + \pi$
C $18 + 2\pi$
D $9 + 2\pi$
E 9
F $9 + 4\pi$

G $9 + \frac{\pi}{3}$

10. A flower bed is an annular sector: the region between two concentric circular arcs, of radii r and R with $0 < r < R$, and two radii which meet at the common centre at an angle of θ radians, where $0 < \theta < 2\pi$. Edging for the two curved edges costs 2 pounds per metre and edging for the two straight edges costs 5 pounds per metre. The total edging budget is 200 pounds, and all of it is spent. What is the greatest possible area of the bed, in m^2 ?

A 500

B 250

C 125

D 200

E $\frac{625}{2}$

F $\frac{1250}{\pi}$

11. Find the complete set of values of the constant k for which the equation

$$\sin\left(2x + \frac{\pi}{6}\right) = k$$

has exactly two solutions in the interval $0 \leq x \leq \pi$.

A $-1 < k < 1$

B $\frac{1}{2} < k < 1$ only

C $-1 < k < \frac{1}{2}$ only

D $-1 < k < 1$ and $k \neq \frac{1}{2}$

E $-1 < k \leq \frac{1}{2}$

F $-1 \leq k \leq 1$ and $k \neq \frac{1}{2}$

12. Three trees stand at the points $A(0, 0)$, $B(8, 0)$ and $C(3, 2)$ in a park, with distances in metres. A circular fence is to be built so that all three trees lie inside the fence or on it. What is the smallest possible radius of the fence, in metres?

A $\frac{13}{3}$

B 4

C $\sqrt{29}$

D 5

E $\frac{\sqrt{377}}{4}$

F $4\sqrt{2}$

13. A cyclic quadrilateral $ABCD$ has sides $AB = 5$, $BC = 3$, $CD = 3$ and $DA = 8$. What is the radius of the circle through A , B , C and D ?

A $\frac{7}{2}$

B 4

C $\frac{7\sqrt{3}}{6}$

D $\frac{14\sqrt{3}}{3}$

E $\frac{7\sqrt{3}}{3}$

F $\frac{\sqrt{57}}{3}$

14. For each positive integer n , let A_n be the area of the region between the curve $y = x^n(1 - x)^2$ and the x -axis for $0 \leq x \leq 1$. Find the value of

$$A_1 + A_2 + A_3 + \dots$$

A $\frac{2}{3}$

B $\frac{1}{2}$

C $\frac{1}{12}$

D $\frac{1}{3}$

E $\frac{1}{6}$

F $\frac{1}{4}$

15. Ana thinks of a polynomial $p(x)$ whose coefficients are all non-negative integers. She tells Ben that $p(1) = 7$ and $p(10) = 2041$, and claims that this is enough for him to work out $p(3)$. What is $p(3)$?

- | | | |
|-------------|-------------|-------------|
| A 73 | B 61 | C 67 |
| D 55 | E 85 | F 91 |

16. Numbers are arranged in a triangle. Row 1 contains the single number 1. Each later row contains one more number than the row above it. Each number is equal to the number diagonally above it to the left plus twice the number diagonally above it to the right, where a missing number counts as 0. So row 2 is 2, 1 and row 3 is 4, 4, 1. What is the largest number in row 9?

- | | | |
|---------------|---------------|---------------|
| A 5376 | B 1792 | C 3584 |
| D 896 | E 1120 | F 1024 |

17. A park ranger starts at the point $A(1, 1)$. She must walk to some point of the x -axis and to some point of the y -axis, in either order, and then on to the edge of a circular pond whose centre is $(2, 3)$ and whose radius is 1, where she stops. She walks in straight lines between these points. Distances are in kilometres. What is the shortest possible total length of her walk?

- | | | |
|------------|--------------------------|-------------------------------------|
| A 4 | B 3 | C $2\sqrt{5} - 1$ |
| D 5 | E $3\sqrt{2} - 1$ | F $\sqrt{2} + \sqrt{13} - 1$ |

18. The circles

$$x^2 + y^2 = 9 \quad \text{and} \quad x^2 + y^2 - 6x + 4y - 3 = 0$$

meet at two points A and B . What is the radius of the circle that passes through A , B and the origin?

- | | | |
|----------------------|------------------------|---------------------------------|
| A $\sqrt{13}$ | B $\frac{9}{2}$ | C $\frac{13}{2}$ |
| D $3\sqrt{5}$ | E $2\sqrt{13}$ | F $\frac{3\sqrt{13}}{2}$ |

19. The sides of a triangle have lengths a , b and c , and C is the angle opposite the side of length c . It is given that $a^2 + b^2 = 2c^2$. Which of the following is the set of all possible values of C ?

- | | | |
|--------------------------------------|--|--|
| A $0^\circ < C \leq 60^\circ$ | B $0^\circ < C \leq 90^\circ$ | C $C = 60^\circ$ only |
| D $0^\circ < C < 60^\circ$ | E $45^\circ \leq C \leq 60^\circ$ | F $60^\circ \leq C < 180^\circ$ |

20. The circle C has equation $x^2 + y^2 - 2x - 4y - 4 = 0$. For a constant c , consider the points P on the line $x + y = c$ with the property that the two tangents from P to C are perpendicular to each other. For how many integer values of c are there exactly two such points P ?

- | | | |
|-------------|-------------|-------------|
| A 9 | B 11 | C 12 |
| D 13 | E 5 | F 7 |

21. How many values of x in the interval $0 \leq x < 2\pi$ satisfy

$$\sin^6 x + \cos^6 x = \frac{5}{8}?$$

- | | | |
|-------------|------------|------------|
| A 2 | B 6 | C 8 |
| D 16 | E 4 | F 0 |

22. An equilateral triangle has one vertex on each of the three parallel lines $y = 0$, $y = 1$ and $y = 3$. What is the area of the triangle?

A $\frac{7\sqrt{3}}{4}$

B $3\sqrt{3}$

C $\frac{7\sqrt{3}}{6}$

D $\frac{13\sqrt{3}}{4}$

E $\frac{7\sqrt{3}}{3}$

F $\frac{9\sqrt{3}}{4}$

23. Find the coefficient of x^{50} in the expansion of

$$(1+x) + (1+x)^2 + (1+x)^3 + \cdots + (1+x)^{100}.$$

A $\binom{101}{51}$

B $\binom{100}{51}$

C $\binom{100}{50}$

D $\binom{102}{50}$

E $\binom{101}{52}$

F $\binom{102}{51}$

24. The parabola $y = x^2$ divides the disc $x^2 + y^2 \leq 12$ into two regions. What is the area of the smaller region?

A $4\pi + \sqrt{3}$

B $2\pi + 3\sqrt{3}$

C $4\pi - \sqrt{3}$

D $2\pi + \sqrt{3}$

E $2\pi - \sqrt{3}$

F $10\pi - \sqrt{3}$

25. Twelve points are equally spaced around a circle of radius 1. Any three of them are the vertices of a triangle, and there are 220 such triangles. How many of these triangles have an area that is a rational number?

A 48

B 24

C 36

D 12

E 60

F 40

G 72

26. The circle $x^2 + y^2 = 5$ and the line $x + 2y = 10$ are given. For each point P on the line, the two tangents from P to the circle touch it at A and B , and M is the midpoint of AB . As P moves along the whole line, the point M moves along a curve. What is the length of this curve?

A $\frac{\sqrt{5}\pi}{2}$

B $\frac{5\pi}{4}$

C $2\sqrt{5}\pi$

D $\sqrt{5}\pi$

E $\frac{\sqrt{15}\pi}{2}$

F $\frac{\sqrt{5}\pi}{4}$

27. How many values of x in the interval $0 \leq x < 2\pi$ satisfy

$$\cos(\pi \sin x) = \sin(\pi \cos x)?$$

A 8

B 3

C 6

D 4

E 0

F 2

End of paper