

HU Collection

Engineering and Science Admissions Test

Mock Set E

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. Positive real numbers x , y and z satisfy the three equations

$$\log_2 x + \log_4 y + \log_8 z = 2, \quad \log_4 x + \log_8 y + \log_2 z = 2, \quad \log_8 x + \log_2 y + \log_4 z = 2.$$

What is the value of xyz ?

- A 2^6 B $2^{36/11}$ C $2^{12/11}$
 D $2^{11/6}$ E 2^2 F $2^{18/11}$

2. A monic quartic polynomial $p(x)$ (that is, a polynomial of degree 4 whose x^4 coefficient is 1) satisfies

$$p(1) = 2, \quad p(2) = 4, \quad p(3) = 6, \quad p(4) = 8.$$

What is the value of $p(6)$?

- A 126 B 144 C 132
 D 12 E 72 F 120

3. Two transformations are applied to a curve, one after the other. For some pairs of transformations the final curve is the same whichever of the two is applied first, whatever the starting curve; for other pairs the order can matter. In each pair below, translations are through a non-zero distance, and stretches have a positive scale factor other than 1 (a stretch parallel to the x -axis leaves the y -axis fixed, and a stretch parallel to the y -axis leaves the x -axis fixed).

- I. A translation parallel to the x -axis and a stretch parallel to the y -axis.
 II. A translation parallel to the x -axis and a stretch parallel to the x -axis.
 III. A reflection in the y -axis and a stretch parallel to the x -axis.

For which of these pairs does the order never matter, whatever the starting curve?

- A II and III only
 B I only
 C II only
 D I, II and III
 E III only
 F I and III only
 G none of them
 H I and II only

4. A monotonically decreasing geometric progression of positive terms has the property that every term is equal to three times the sum of all the terms that follow it. The sum to infinity of the progression is 12. What is its third term?

- A $\frac{8}{9}$ B $\frac{3}{4}$ C $\frac{9}{4}$
 D $\frac{27}{64}$ E $\frac{9}{16}$ F $\frac{1}{2}$

5. A triangular plot of land ABC has $AB = 8$ m and $BC = 7$ m, and the angle BAC is 60° . The length AC was not recorded, and more than one triangle fits this data. What is the sum of the areas, in m^2 , of all the non-congruent triangles that fit the data?

- A $15\sqrt{3}$ B $16\sqrt{3}$ C $6\sqrt{3}$
 D $10\sqrt{3}$ E $20\sqrt{3}$ F $8\sqrt{3}$

6. A particle moves along a straight line. At time t seconds its acceleration is $(6t - 12) \text{ m s}^{-2}$, and at time $t = 0$ it is at the point O moving with velocity 9 m s^{-1} . What is the total distance, in metres, that the particle travels during the first 4 seconds?

- A 12 B 8 C 36
 D 20 E 4 F 16

7. The edge of a circular stage is the circle

$$x^2 + y^2 - 2x - 2y - 7 = 0.$$

A spotlight stands at $P(7, 1)$, and the two tangents from P to the circle touch it at A and B . What is the area of the triangle PAB ?

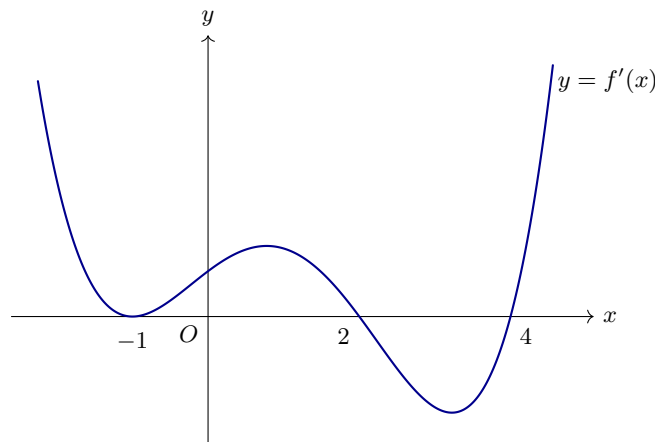
- A $\frac{27\sqrt{3}}{4}$ B $\frac{9\sqrt{3}}{4}$ C $\frac{27}{4}$
 D $9\sqrt{3}$ E $\frac{81\sqrt{3}}{8}$ F $\frac{27\sqrt{3}}{2}$

8. Find the complete set of real values of x for which

$$\log_{1/2}(x^2 - 3x) > -2.$$

- A $x < -1$ or $0 < x < 3$ or $x > 4$
 B $-1 < x < 4$
 C $0 < x < 3$
 D $x < -1$ or $x > 4$
 E $-1 < x < 0$ or $3 < x < 4$
 F $x < 0$ or $x > 3$

9. The figure shows the graph of $y = f'(x)$, the gradient function of a polynomial function f . The graph touches the x -axis at $x = -1$ and crosses it at $x = 2$ and at $x = 4$; it meets the x -axis nowhere else.

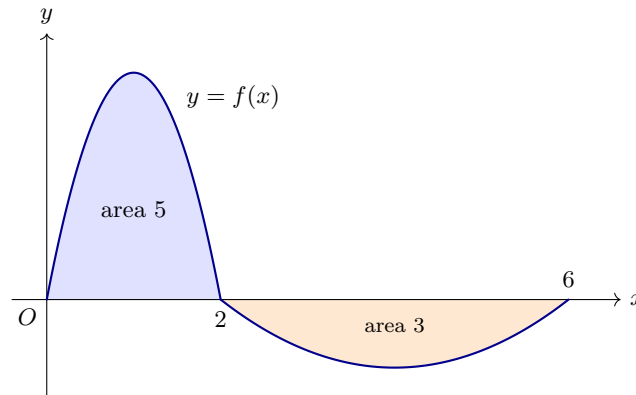


Which of the following statements must be true?

- I. f has exactly two stationary points.
- II. f has exactly one local minimum point.
- III. $f(-2) < f(0) < f(2)$.

- A I only
- B II and III only
- C I, II and III
- D none of them
- E I and III only
- F II only
- G III only
- H I and II only

10. The figure shows the graph of $y = f(x)$ for $0 \leq x \leq 6$. The curve meets the x -axis at $x = 0$, $x = 2$ and $x = 6$. The region between the curve and the x -axis for $0 \leq x \leq 2$ lies above the axis and has area 5, and the region between the curve and the x -axis for $2 \leq x \leq 6$ lies below the axis and has area 3.



What is the value of

$$\int_0^3 (f(6-2x) + 2) dx?$$

- | | | |
|-------------|------------|------------|
| A 10 | B 5 | C 3 |
| D 13 | E 8 | F 7 |

11. A new shop's monthly profits form an arithmetic progression: the profit in each month differs from the profit in the previous month by the same fixed amount. The total profit over the first 10 months is £100 000, and the total profit over the first 20 months is also £100 000. If this pattern continues, what is the greatest value that the total profit over the first n months reaches, for a positive integer n ?

- | | | |
|-------------------|-------------------|-------------------|
| A £100 000 | B £150 000 | C £125 000 |
| D £112 500 | E £112 000 | F £120 000 |

12. The curve $y = |x^2 - 2x|$ and the line $y = x$ enclose some finite regions. What is the total area of these regions?

- | | | |
|-------------------------|-------------------------|------------------------|
| A 2 | B $\frac{11}{6}$ | C $\frac{1}{6}$ |
| D $\frac{13}{6}$ | E $\frac{9}{2}$ | F $\frac{7}{3}$ |

13. How many real solutions does the equation

$$8 \sin x = x$$

have, where x is measured in radians?

- | | | |
|------------|------------|------------|
| A 6 | B 3 | C 7 |
| D 9 | E 5 | F 8 |

14. A graph-drawing program has two commands. Command A reflects the curve currently on the screen in the line $x = 1$. Command B reflects the curve currently on the screen in the line $x = 3$. The curve $y = 2^x$ is displayed, and then the seven commands

$$A, B, A, B, A, B, A$$

are carried out, in this order. At which point does the final curve meet the y -axis?

- A $(0, 2^{14})$
- B $(0, 2^{12})$
- C $(0, 2^{10})$
- D $(0, 2^{-10})$
- E $(0, 2^{-14})$
- F $(0, 2^{-12})$
- G $(0, 4)$

15. A function f is defined for all real x . It satisfies

$$f(x+2) = 2f(x) \quad \text{for every real } x, \quad \text{and} \quad f(x) = x(2-x) \quad \text{for } 0 \leq x \leq 2.$$

What is the value of

$$\int_{-4}^4 f(x) dx?$$

- A 5
- B 4
- C $\frac{20}{3}$
- D 6
- E 12
- F $\frac{16}{3}$

16. A cubic curve $y = x^3 + bx^2 + cx + d$, where b , c and d are real constants, has a local maximum point and a local minimum point, and their y -coordinates differ by 32. What is the gradient of the straight line through these two points?

- A -4
- B -8
- C -16
- D 8
- E -2
- F -12

17. The output y of a device is known to be given by a cubic polynomial in its input setting x . A technician records the output at six settings:

x	0	1	2	3	4	5
y	7	6	3	6	15	42

Exactly one of the six recorded outputs is wrong. Which is it, and what should it be?

- A the output at $x = 5$, which should be 40
- B the output at $x = 2$, which should be 5
- C the output at $x = 1$, which should be 4
- D the output at $x = 3$, which should be 4
- E the output at $x = 4$, which should be 13
- F the output at $x = 3$, which should be 8

18. In a city whose streets form a square grid, the *taxi distance* between points (x_1, y_1) and (x_2, y_2) is defined to be $|x_1 - x_2| + |y_1 - y_2|$. Two depots are at $A(0, 0)$ and $B(4, 2)$. A courier is licensed to work at every point P for which

$$(\text{taxi distance from } A \text{ to } P) + (\text{taxi distance from } P \text{ to } B) \leq 10.$$

What is the area of the region in which the courier is licensed to work?

- A** 40 **B** 50 **C** 88
D 48 **E** 36 **F** 32

19. The rim of a circular fountain is the circle $x^2 + y^2 = 25$, and a straight wall runs along the line $3x + 4y = 10$. How many points on the rim are at a whole-number distance from the line? (A distance of 0 counts as a whole number.)

- A** 14 **B** 24 **C** 16
D 22 **E** 20 **F** 18

20. The curves

$$y = x^3 + x \quad \text{and} \quad y = x^3 - 6x^2 + 13x - 10,$$

together with the lines $y = 1$ and $y = 7$, enclose a region R . What is the area of R ?

- A** 14 **B** 10 **C** 12
D 24 **E** 16 **F** 6

21. For each positive integer n , the curve C_n has equation

$$y = x + \frac{x^2}{2} + \frac{x^3}{3} + \cdots + \frac{x^n}{n}.$$

Which of the following statements are true?

- I. C_{20} has exactly one stationary point.
 II. C_{21} has at least one stationary point.
 III. On C_{10} , y is increasing for all $x > -1$.

- A** III only
B I, II and III
C I and III only
D I only
E I and II only
F none of them
G II only
H II and III only

22. The trapezium rule with n strips of equal width is used to estimate

$$\int_0^3 x^2 dx.$$

What is the smallest value of n for which the estimate exceeds the exact value of the integral by less than 0.01?

- | | | |
|-------------|-------------|-------------|
| A 16 | B 22 | C 11 |
| D 45 | E 30 | F 21 |

23. For each positive integer n , let $N(n)$ be the number of real solutions of the equation

$$2^x = x^n.$$

What is the value of $N(1) + N(2) + N(3) + \cdots + N(10)$?

- | | | |
|-------------|-------------|-------------|
| A 22 | B 20 | C 23 |
| D 28 | E 18 | F 27 |

24. For how many integers q does the equation

$$x^4 + 4x^3 + qx^2 + 4x + 1 = 0$$

have exactly two distinct real roots?

- A** 6
- B** 16
- C** 14
- D** 11
- E** infinitely many
- F** 15
- G** 17

25. A straight strut from the origin, along the line $y = mx$, is used to approximate a cable whose shape is the curve $y = x^2$ for $0 \leq x \leq 1$. The *misfit* is the total area of the region or regions lying between the line and the curve for $0 \leq x \leq 1$, every region counting positively. What is the least possible misfit, as m varies over all real numbers?

- | | | |
|-------------------------|---------------------------------|-------------------------|
| A $\frac{8}{81}$ | B $\frac{\sqrt{2}-1}{6}$ | C 0 |
| D $\frac{1}{8}$ | E $\frac{2-\sqrt{2}}{6}$ | F $\frac{1}{12}$ |

26. A straight rod is to be fixed beside a curved rail whose profile is the curve $y = \sqrt{x}$ for $0 \leq x \leq 4$. The rod lies along a line $y = mx + c$. For each choice of m and c , let E be the greatest value of the vertical gap $|\sqrt{x} - (mx + c)|$ for $0 \leq x \leq 4$. What is the least possible value of E ?

- | | | |
|------------------------|------------------------|------------------------|
| A $\frac{1}{4}$ | B $\frac{3}{8}$ | C $\frac{1}{6}$ |
| D $\frac{1}{8}$ | E $\frac{1}{3}$ | F $\frac{1}{2}$ |

27. How many of the 101 binomial coefficients

$$\binom{100}{0}, \binom{100}{1}, \binom{100}{2}, \dots, \binom{100}{100}$$

are odd?

A 32

B 16

C 12

D 4

E 6

F 8



End of paper