

HU Collection

Engineering and Science Admissions Test

Mock Set E

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. The intensity of light that a plant receives from a small lamp is directly proportional to the power of the lamp and inversely proportional to the square of the distance between the plant and the lamp. The plant is moved so that its distance from the lamp increases by 25%, and at the same time the lamp is replaced by one whose power is 20% greater. By what percentage does the intensity received by the plant decrease?

- A** 23.2% **B** 4% **C** 44.8%
D 16% **E** 36% **F** 5%

2. Paper is sold by its *grammage*, the mass in grams of one square metre of the sheet. An A0 sheet has area 1 m^2 , and each size A1, A2, A3, ... is obtained by cutting the previous size in half, so an A4 sheet has area $\frac{1}{16} \text{ m}^2$.

A ream of 500 sheets of A4 paper with grammage 80 g/m^2 forms a stack 5.0 cm high. What is the density of the paper, in kg/m^3 ?

- A** 1600 **B** 400 **C** 8000
D 80 **E** 800 **F** 0.8

3. A patient of mass 60 kg is prescribed a drug at a rate of 0.5 mg per kilogram of body mass per hour. The drug is supplied as a 0.25% solution, which means that every 100 ml of solution contains 0.25 g of the drug. It is given through a drip that delivers 20 drops per millilitre.

How many drops per minute should the drip deliver?

- A** 0.4 **B** 240 **C** 40
D 8 **E** 12 **F** 4

4. The curve $y = 2x^2 - 12x + 23$ is translated so that its turning point moves to the origin. The resulting curve is reflected in the x -axis, and then translated by the vector $\begin{pmatrix} 1 \\ 5 \end{pmatrix}$.

At which values of x does the final curve cross the x -axis?

- A** $x = 1 \pm \frac{\sqrt{10}}{2}$
B $x = 3 \pm \frac{\sqrt{10}}{2}$
C The final curve does not cross the x -axis.
D $x = -1 \pm \frac{\sqrt{10}}{2}$
E $x = 1 \pm \sqrt{10}$
F $x = 1 \pm \frac{\sqrt{5}}{2}$

5. The depth of water at the entrance to a harbour, d metres, at time t hours after midnight is modelled by

$$d = 5 + 3 \sin \theta, \quad \text{where } \theta = 30t \text{ degrees,}$$

for $0 \leq t \leq 24$. A ship can pass through the entrance only when the depth is at least 6.5 metres.

According to the model, for how many hours in total during the 24 hours can the ship pass through?

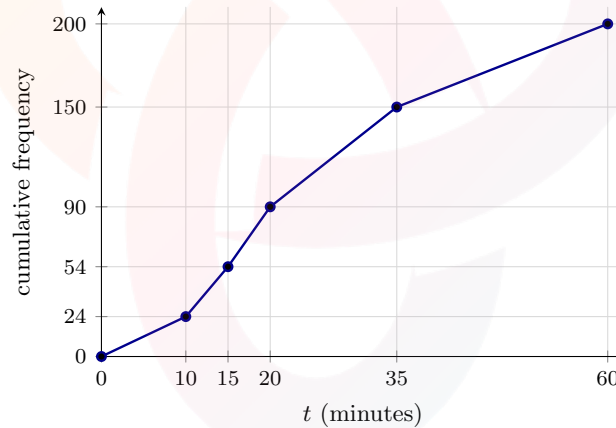
- A** 16 **B** 10 **C** 6
D 12 **E** 8 **F** 4

6. A sculptor makes a solid scale model of a statue at a scale of 1 : 20. The model is cast in bronze, of density 8.8 g/cm^3 , and has mass 2.2 kg. The statue itself will be carved from solid marble, of density 2.7 g/cm^3 .

What will be the mass of the statue, in tonnes? (1 tonne = 1000 kg.)

- A** 0.27 **B** 0.0135 **C** 1.35
D 17.6 **E** 5.4 **F** 54

7. The cumulative frequency graph shows the journey times, t minutes, of 200 commuters. The plotted points are joined by straight line segments.



The same data are to be shown in a histogram with the classes $0 \leq t < 10$, $10 \leq t < 15$, $15 \leq t < 20$, $20 \leq t < 35$ and $35 \leq t < 60$. Which class has the tallest bar, and what is the frequency density of that bar, in commuters per minute?

- A** $20 \leq t < 35$, with frequency density 4
B $20 \leq t < 35$, with frequency density 60
C $15 \leq t < 20$, with frequency density 7.2
D $15 \leq t < 20$, with frequency density 36
E $35 \leq t < 60$, with frequency density 2
F $10 \leq t < 15$, with frequency density 6

8. Seven points $A_1, A_2, \dots, A_7$ lie on a circle, in that order, but are not necessarily equally spaced. Each point is joined by a straight line segment to the two points that are three places away from it around the circle, so A_1 is joined to A_4 and to A_5 , A_2 is joined to A_5 and to A_6 , and so on. This draws a seven-pointed star.

What is the sum of the seven angles at the tips of the star, namely $\angle A_4A_1A_5$, $\angle A_5A_2A_6$, $\dots$, $\angle A_3A_7A_4$?

- A 360°
- B 180°
- C It depends on the positions of the points.
- D 720°
- E 540°
- F 900°

9. Dana has sat five tests. Her five marks have median 70 and mean 72. She then sits a sixth test, and afterwards her six marks have mean 74 and median 72.

What was the second highest of her first five marks?

- | | | |
|------|------|------|
| A 84 | B 72 | C 76 |
| D 78 | E 70 | F 74 |

10. A car starts from rest and its speed v , in m/s, is recorded every 10 seconds.

t (s)	0	10	20	30	40	50	60
v (m/s)	0	12	20	25	28	30	31

The graph of v against t is a smooth curve which bends downwards everywhere, so that every chord joining two points of the curve lies below the curve between them. The distance travelled in the first minute is estimated from the area under the graph, using six trapezia of width 10 seconds. What is the estimate, and how does it compare with the true distance?

- A 1305 m, an underestimate
- B 1305 m, an overestimate
- C 1460 m, an overestimate
- D 1150 m, an underestimate
- E 2610 m, an underestimate
- F 1305 m, equal to the true distance

11. $ABCD$ is a rectangular field, labelled in order around its edge. A post P stands inside the field, 50 m from corner A , 70 m from corner B and 90 m from corner C .

How far is the post from corner D ?

- | | | |
|-------------------|--------------------|--------------------|
| A $10\sqrt{65}$ m | B $10\sqrt{57}$ m | C 110 m |
| D 70 m | E $10\sqrt{155}$ m | F $10\sqrt{105}$ m |

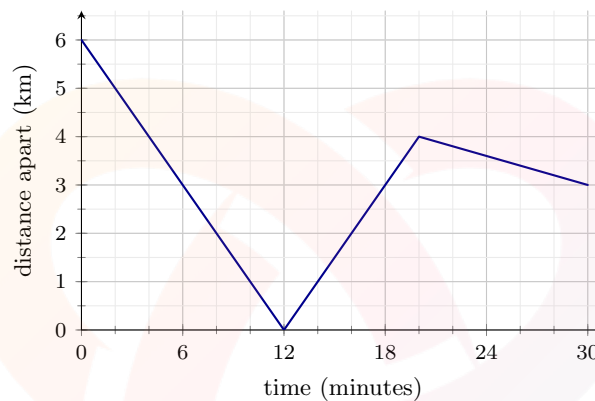
12. Two fair six-sided dice, each numbered 1 to 6, and one fair four-sided die, numbered 1 to 4, are rolled together.

What is the probability that the median of the three scores is equal to their mean?

- | | | |
|--------------------------|------------------------|-------------------------|
| A $\frac{13}{72}$ | B $\frac{1}{4}$ | C $\frac{5}{24}$ |
| D $\frac{7}{36}$ | E $\frac{1}{6}$ | F $\frac{7}{48}$ |

13. A jogger and a cyclist move along a long straight path, each at a constant speed. At time 0 the jogger leaves point A , running along the path towards the cyclist, who is 6 km away and riding towards A . After they pass each other the cyclist carries on to A , turns round instantly, and chases the jogger. The jogger never turns round.

The graph shows the distance between the jogger and the cyclist during the first 30 minutes.



How far from A is the jogger when the cyclist catches up with her?

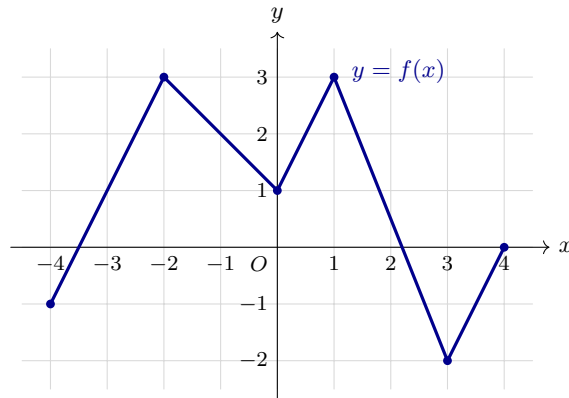
- | | | |
|----------------|---------------|----------------|
| A 6 km | B 9 km | C 15 km |
| D 10 km | E 8 km | F 12 km |

14. A stained-glass panel is made from a square $ABCD$ of side 6 cm, labelled in order, together with an equilateral triangle ABE drawn on the side AB , outside the square. A circular lead line is to pass through the three points C , D and E .

What is the radius of this circle, in cm?

- | | | |
|-------------------------|----------------------|----------------------|
| A 6 | B $3\sqrt{3}$ | C $4\sqrt{3}$ |
| D $3 + \sqrt{3}$ | E $2\sqrt{3}$ | F $3\sqrt{2}$ |

15. The function f is defined only for $-4 \leq x \leq 4$, and its graph $y = f(x)$ consists of the five line segments shown.



In each statement below, a point where two graphs meet must lie on both graphs, so each function involved must be defined there.

- I. The graphs of $y = f(x)$ and $y = f(-x)$ meet at exactly 5 points.
- II. The graphs of $y = f(x) + 1$ and $y = -f(x)$ meet at exactly 2 points.
- III. The graphs of $y = f(x)$ and $y = f(x - 2) - 1$ meet at exactly 4 points.

Which of the statements are true?

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

16. Ana and Ben agree to meet at a cafe. Each arrives at a random time between 1 pm and 2 pm, with all arrival times in that hour equally likely, independently of each other. If Ana arrives first, she waits 10 minutes for Ben and then leaves. If Ben arrives first, he waits 20 minutes for Ana and then leaves. Neither waits beyond 2 pm.

What is the probability that they meet?

- | | | |
|--------------------------|--------------------------|--------------------------|
| A $\frac{7}{16}$ | B $\frac{5}{12}$ | C $\frac{1}{2}$ |
| D $\frac{31}{72}$ | E $\frac{11}{36}$ | F $\frac{41}{72}$ |

17. How many of the integers $1, 2, 3, \dots, 999$ can be written in the form $a^2 - b^2$, where a and b are positive integers?

- A 749 B 666 C 747
D 750 E 748 F 499

18. A hexagonal tile has all six interior angles equal to 120° . Going round the tile, four consecutive sides have lengths 4 cm, 2 cm, 3 cm and 3 cm. The lengths of the remaining two sides are not given. What is the area of the tile, in cm^2 ?

- A $12\sqrt{3}$ B $\frac{47\sqrt{3}}{4}$ C $\frac{43\sqrt{3}}{4}$
D $\frac{45\sqrt{3}}{4}$ E $16\sqrt{3}$ F $\frac{51\sqrt{3}}{4}$

19. What is the sum of all the real numbers x that satisfy

$$(x^2 - 5x + 5)^{x^2 - 4x - 5} = 1?$$

- A 14 B 12 C 13
D 16 E 5 F 9

20. Consider the following four equations, where in IV the angle x is measured in degrees and x may be any real number.

- I. $2^x = x + 2$
II. $\frac{1}{x} = x^2 - 3$
III. $2^{-x} = x^2$
IV. $\sin x^\circ = \frac{x}{500}$

Which of these equations have exactly three real solutions?

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

21. A rectangular sheet of paper $ABCD$ has $AB = 8$ cm and $BC = 4$ cm, and lies flat on a table. It is folded along a straight crease so that corner C lands exactly on corner A , and then pressed flat. The area of the table covered by the folded sheet is what fraction of the area of the original sheet?

- | | | |
|--------------------------|--------------------------|-------------------------|
| A $\frac{3}{4}$ | B $\frac{13}{16}$ | C $\frac{9}{16}$ |
| D $\frac{11}{16}$ | E $\frac{1}{2}$ | F $\frac{5}{8}$ |

22. Let $A = (0, 1)$ and $B = (3, 8)$, and let Γ be the part of the curve $y = 2^x$ from A to B . The curve Γ is translated by the vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ to give a curve Γ' , joining A' to B' , the images of A and B .

What is the area of the region enclosed by Γ , the line segment BB' , the curve Γ' and the line segment $A'A$?

- | | | |
|-------------|-------------|-------------|
| A 15 | B 21 | C 27 |
| D 24 | E 54 | F 33 |

23. The seven digits 1, 2, 3, 4, 5, 6, 7 are arranged in a random order, with all orders equally likely, to form a seven-digit number. You may use the fact that a whole number is divisible by 11 exactly when the sum of its digits in the 1st, 3rd, 5th, ... places minus the sum of its digits in the 2nd, 4th, 6th, ... places is a multiple of 11 (where 0 counts as a multiple of 11).

What is the probability that the number is divisible by 11?

- | | | |
|-------------------------|-------------------------|-------------------------|
| A $\frac{1}{11}$ | B $\frac{1}{7}$ | C $\frac{3}{35}$ |
| D $\frac{2}{35}$ | E $\frac{4}{35}$ | F $\frac{8}{35}$ |

24. For positive integers a and b , define

$$a \star b = \frac{\text{LCM}(a, b)}{\text{HCF}(a, b)},$$

where LCM and HCF denote the lowest common multiple and the highest common factor. For example, $4 \star 6 = \frac{12}{2} = 6$.

How many ordered pairs (a, b) of positive integers, with $a \leq 100$ and $b \leq 100$, satisfy $a \star b = 36$?

- | | | |
|-------------|-------------|-------------|
| A 25 | B 13 | C 26 |
| D 24 | E 4 | F 30 |

25. A delivery robot works in a town whose streets form a square grid. It starts at the junction $(0, 0)$ and must reach the junction $(4, 4)$, moving only east (increasing the first coordinate by 1) or north (increasing the second by 1) along the streets. It never leaves the region $0 \leq x \leq 4$, $0 \leq y \leq 4$. At each junction where both directions are possible it chooses east or north with probability $\frac{1}{2}$ each, independently of earlier choices; where only one direction is possible, it takes that one.

What is the probability that the robot passes through the junction $(4, 2)$?

- | | | |
|--------------------------|--------------------------|-------------------------|
| A $\frac{7}{32}$ | B $\frac{3}{8}$ | C $\frac{3}{14}$ |
| D $\frac{11}{32}$ | E $\frac{15}{64}$ | F $\frac{1}{4}$ |

26. A function f is defined on the positive integers by the rules

$$f(1) = 1, \quad f(2n) = f(n), \quad f(2n+1) = f(n) + 1 \quad \text{for every positive integer } n.$$

For example, $f(6) = f(3) = f(1) + 1 = 2$.

For how many integers n with $1 \leq n \leq 100$ is $f(n) = 3$?

- | | | |
|-------------|-------------|-------------|
| A 30 | B 34 | C 35 |
| D 33 | E 27 | F 32 |

27. A function f is defined for all real numbers x by the two rules

$$f(x) = x^2 \quad \text{for } -1 \leq x \leq 1, \quad \text{and} \quad f(x+2) = f(x) \quad \text{for every real } x.$$

How many real solutions does the equation $f(x) = \frac{x}{5}$ have?

- | | | |
|------------|------------|------------|
| A 7 | B 6 | C 4 |
| D 5 | E 8 | F 3 |

End of paper