Please check the examination details below before entering your candidate information

Candidate Name	Class	Section

BLOOM Mathematics Olympiad (BMO)

Question Paper 2024-25

Class 11

Total Questions: **50 + 5** (Tie-Breaking Section)

Total Time Allotted : 60 minutes

Total Marks 60

Instructions

1. There are **50 Multiple Choice Questions** in this booklet having 4 options out of which **ONLY ONE** is correct.
2. There are two sections in the Question Paper; **Section A** having 40 Questions carrying 1 Mark each & **Section B** having 10 Higher Difficulty Order Questions carrying 2 Marks each.
3. All questions are compulsory. There is **NO negative** marking for incorrect answers.
4. Total time allotted to complete the paper is 60 minutes.
5. Please fill in your details in the space provided on this page before attempting the paper.

OMR Sheet Instructions

1. Before starting the paper, fill in all the details in the OMR sheet.
2. Additional 10 minutes will be provided to fill up the OMR sheet, before the start of the exam.
3. Use HB Pencil to darken the circle of the correct Option in OMR sheet. The correct way to darken the circle in OMR sheet is shown below

   ● ○ ○ ○
4. Use black or blue ball point pen/HB pencil to fill the information in the OMR sheet. Partially filled OMR sheet will not be checked.
5. Return the OMR sheet to the invigilator after the exam.

CODE #120

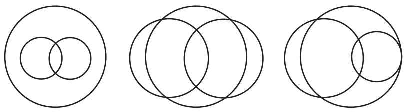
M11

BLOOM CAP
Founded by arihant

Bloom Mathematics Olympiad Class 11

Section A (1 Mark)

1. In a school, there are three types of games to be played. Some of the students play two types of games but none plays all the three games. Which venn diagram can justify the above statement?



(P) (Q) (R)

(a) P and Q (b) P and R
(c) Q and R (d) None of these

2. Let $A = \{1, 2, 3, 4, 5, 6, 7\}$ and $B = \{3, 6, 7, 9\}$. Then, the number of elements in the set $\{C \subseteq A : C \cap B \neq \phi\}$ is

(a) 111 (b) 112 (c) 113 (d) 114

3. If $X = (4^n - 3n - 1 : n \in N)$ and $Y = \{9(n-1) : n \in N\}$, where N is the set of natural numbers, then $X \cup Y$ is equal to

(a) N (b) $Y - X$ (c) X (d) Y

4. Consider the two sets, $A = \{m \in R$: both the roots of $x^2 - (m+1)x + m + 4 = 0$ are real$\}$ and $B = [-3, 5)$. Which of the following is not true?

(a) $A - B = (-\infty, -3) \cup [5, \infty)$
(b) $A \cap B = \{-3\}$
(c) $B - A = (-3, 5]$
(d) $A \cup B = R$

5. If $A = \{(x, y) : x^2 + y^2 = 16\}$, $\forall\, x, y \in R$ and $B = \{(x, y) : 3x = 2y\}$, $\forall\, x, y \in R$, then set A and set B intersect at

(a) one points (b) two points
(c) three points (d) infinite points

6. Domain of the function

$$f(x) = \frac{3}{4 - x^2} + \log_{10}(x^3 - x), \text{ is}$$

(a) $(1, 2)$ (b) $(-1, 0) \cup (1, 2)$
(c) $(1, 2) \cup (2, \infty)$ (d) $(-1, 0) \cup (1, 2) \cup (2, \infty)$

7. Let $f : R - \{2, 6\} \to R$ be real valued function defined as $f(x) = \dfrac{x^2 + 2x + 1}{x^2 - 8x + 12}$. Then, range of f is

(a) $\left(-\infty, -\dfrac{21}{4}\right] \cup [1, \infty)$

(b) $\left(-\infty, -\dfrac{21}{4}\right] \cup [0, \infty)$

(c) $\left(-\infty, -\dfrac{21}{4}\right] \cup \left[\dfrac{21}{4}, \infty\right)$

(d) $\left(-\infty, -\dfrac{21}{4}\right) \cup (0, \infty)$

8. If $a + \alpha = 1$, $b + \beta = 2$ and $af(x) + \alpha f\left(\dfrac{1}{x}\right) = bx + \dfrac{\beta}{x}$, $x \neq 0$, then the value of expression $\dfrac{f(x) + f\left(\dfrac{1}{x}\right)}{x + \dfrac{1}{x}}$ is

(a) -2 (b) 2
(c) 1 (d) -1

9. For $\alpha, \beta \in \left(0, \dfrac{\pi}{2}\right)$, let $3\sin(\alpha + \beta) = 2\sin(\alpha - \beta)$ and a real number k be such that $\tan\alpha = k\tan\beta$. Then, the value of k is equal to

(a) $\dfrac{-2}{3}$ (b) -5 (c) $\dfrac{2}{3}$ (d) 5

10. If $\cot\alpha = 1$ and $\sec\beta = -\dfrac{5}{3}$, where $\pi < \alpha < \dfrac{3\pi}{2}$ and $\dfrac{\pi}{2} < \beta < \pi$, then the value of $\tan(\alpha + \beta)$ and the quadrant in which $\alpha + \beta$ lies, respectively are

(a) $-\dfrac{1}{7}$ and IV quadrant
(b) 7 and I quadrant
(c) -7 and IV quadrant
(d) $\dfrac{1}{7}$ and I quadrant

11. If $\frac{\sqrt{2}\sin\alpha}{\sqrt{1+\cos 2\alpha}} = \frac{1}{7}$ and $\sqrt{\frac{1-\cos 2\beta}{2}} = \frac{1}{\sqrt{10}}$, $\alpha, \beta \in \left(0, \frac{\pi}{2}\right)$, then $\tan(\alpha + 2\beta)$ is equal to

(a) 0 (b) 1
(c) 2 (d) 3

12. If $\sin(\alpha + \beta) = 1$ and $\sin(\alpha - \beta) = \frac{1}{2}$, then $\tan(\alpha + 2\beta)\tan(2\alpha + \beta)$ is equal to

(a) 1 (b) –1
(c) zero (d) None of these

13. Let z be a complex number such that $|z+2| = 1$ and $\text{Im}\left(\frac{z+1}{z+2}\right) = \frac{1}{5}$. Then, the value of $|\text{Re}\,(\overline{z+2})|$ is

(a) $\frac{24}{5}$ (b) $\frac{2\sqrt{6}}{5}$
(c) $\frac{1+\sqrt{6}}{5}$ (d) $\frac{\sqrt{6}}{5}$

14. For $z = \alpha + i\beta$, $|z+2| = z + 4(1+i)$, then $\alpha + \beta$ and $\alpha\beta$ are the roots of the equation

(a) $x^2 + 2x - 3 = 0$ (b) $x^2 + 7x + 12 = 0$
(c) $x^2 + 3x - 4 = 0$ (d) $x^2 + x - 12 = 0$

15. If z and w are two complex numbers such that $|zw| = 1$ and $\arg(z) - \arg(w) = \pi/2$, then

(a) $\bar{z}w = -i$ (b) $z\bar{w} = \frac{1-i}{\sqrt{2}}$
(c) $\bar{z}w = i$ (d) $z\bar{w} = \frac{-1+i}{\sqrt{2}}$

16. Let $z = \left(\frac{\sqrt{3}}{2} + \frac{i}{2}\right)^5 + \left(\frac{\sqrt{3}}{2} - \frac{i}{2}\right)^5$. If $\text{Re}(z)$ and $\text{Im}(z)$, respectively denote the real and imaginary parts of z, then

(a) $\text{Re}(z) > 0$ and $\text{Im}(z) > 0$
(b) $\text{Im}(z) = 0$
(c) $\text{Re}(z) < 0$ and $\text{Im}(z) > 0$
(d) $\text{Re}(z) = -3$

17. If z_1 and z_2 both satisfy the relation $z + \bar{z} = 2|z-1|$ and $\arg(z_1 - z_2) = \frac{\pi}{4}$, then the imaginary part of $(z_1 + z_2)$ is

(a) 1 (b) 2 (c) 3 (d) 4

18. If z_1 and z_2 are two complex numbers satisfying the equation $\left|\frac{z_1 + z_2}{z_1 - z_2}\right| = 1$, then $\frac{z_1}{z_2}$ is a number which is

(a) zero or purely imaginary
(b) purely real
(c) of unit modulus
(d) None of the above

19. The solution set for x of the inequality $\frac{2P + x}{3} \le \frac{4Px - 1}{2}$ is $x \ge \frac{3}{4}$, then the value of the parameter P is

(a) $\frac{7}{10}$ (b) $\frac{9}{10}$
(c) $\frac{9}{11}$ (d) None of these

20. The length of a rectangle is three times the breadth. If the minimum perimeter of the rectangle is 160 cm, then

(a) breadth > 20 cm (b) length < 20 cm
(c) breadth ≥ 20 cm (d) length ≤ 20 cm

21. If $\frac{|x+3| + x}{x+2} > 1$, then interval for x is (consider the only case, when $x + 3 \ge 0$).

(a) $x \in (-3, -2) \cup (-1, \infty)$
(b) $x \in (-5, -2) \cup (-1, \infty)$
(c) $x \in (-5, -2)$
(d) $x \in (-1, \infty)$

22. The cost and revenue functions of a product are given by $C(x) = 20x + 4000$ and $R(x) = 60x + 2000$, respectively, where x is the number of items, produced and sold. How many items must be sold to realise some profit?

(a) $x \ge 50$ (b) $x > 50$
(c) $x < 50$ (d) $x \le 50$

23. For what value of $x, \frac{1}{8!} + \frac{1}{9!} = \frac{x}{10!}$?

(a) 10 (b) 90
(c) 100 (d) 200

24. If ${}^nP_r = {}^nP_{r+1}$ and ${}^nC_r = {}^nC_{r-1}$, then the value of r is equal to

(a) 1 (b) 4
(c) 2 (d) 3

25. 5-digit numbers are to be formed using 2, 3, 5, 7, 9 without repeating the digits. If p is the number of such numbers that exceed 20000 and q is the number of those that lie between 30000 and 90000, then $p : q$ is

(a) 6 : 5 (b) 3 : 2
(c) 4 : 3 (d) 5 : 3

26. If ${}^{2n}C_3 : {}^nC_3 = 10 : 1$, then the ratio $(n^2 + 3n) : (n^2 - 3n + 4)$ is

(a) 27:11 (b) 2:1
(c) 65:37 (d) 35:16

27. The total number of positive integral solutions (x, y, z) such that $xyz = 24$ is

(a) 36 (b) 24
(c) 45 (d) 30

28. A class contains b boys and g girls. If the number of ways of selecting 3 boys and 2 girls from the class is 168, then $b + 3g$ is equal to

(a) 16 (b) 15
(c) 12 (d) 17

29. If the coefficients of x^7 in $\left(x^2 + \frac{1}{bx}\right)^{11}$ and x^{-7} in $\left(x - \frac{1}{bx^2}\right)^{11}$, $b \neq 0$, are equal, then the value of b is equal to

(a) 2 (b) –1
(c) 1 (d) –2

30. Let $n \geq 5$ be an integer. If $9^n - 8n - 1 = 64\alpha$ and $6^n - 5n - 1 = 25\beta$, then $\alpha - \beta$ is equal to

(a) $1 + {}^nC_2(8-5) + {}^nC_3(8^2 - 5^2) + \ldots + {}^nC_n(8^{n-1} - 5^{n-1})$

(b) $1 + {}^nC_3(8-5) + {}^nC_4(8^2 - 5^2) + \ldots + {}^nC_n(8^{n-2} - 5^{n-2})$

(c) ${}^nC_3(8-5) + {}^nC_4(8^2 - 5^2) + \ldots + {}^nC_n(8^{n-2} - 5^{n-2})$

(d) ${}^nC_4(8-5) + {}^nC_5(8^2 - 5^2) + \ldots + {}^nC_n(8^{n-3} - 5^{n-3})$

31. If the number of terms in $\left(x + \frac{1}{x} + 1\right)^n, \forall n \in I^+$ is 401, then n is greater than

(a) 201 (b) 200
(c) 199 (d) None of these

32. If $(1 + x - 2x^2)^6 = 1 + a_1x + a_2x^2 + \ldots + a_{12}x^{12}$, then $a_2 + a_4 + a_6 + \ldots + a_{12}$ is equal to

(a) 29 (b) 31 (c) 27 (d) 33

33. The value of

$$\frac{1}{(1!)(n-1)!} + \frac{1}{(3!)(n-3)!} + \frac{1}{(5!)(n-5)!} + \ldots \text{ is}$$

(a) $\frac{2^n}{n!}$ (b) $\frac{2^n}{(n+1)!}$

(c) $\frac{2^{n-1}}{n!}$ (d) $\frac{2^{n+1}}{n!}$

34. If in the expansion of $(a - 2b)^n$, the sum of the 5th and 6th terms is zero, then the value of $\frac{a}{b}$ is

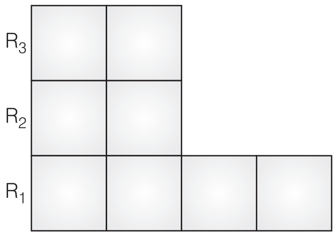
(a) $\frac{n-4}{5}$

(b) $\frac{2(n-4)}{5}$

(c) $\frac{5}{n-4}$

(d) $\frac{5}{2(n-4)}$

35. In how many ways that the letters of the word 'PEARSON' can be placed in the squares of the adjoining figure so that no row remains empty?



(a) $24 \times 6!$ (b) $26 \times 6!$
(c) $26 \times 7!$ (d) $20 \times 5!$

36. The number of ways in which the number 27720 can be split into two factors which are co-prime is

(a) 16 (b) 25
(c) 15 (d) 49

37. For $x \geq 0$, the least value of k, for which $4^{1+x} + 4^{1-x}, \frac{k}{2}, 16^x + 16^{-x}$ are three consecutive terms of an AP, is equal to

(a) 10 (b) 16
(c) 4 (d) 8

38. If $\log_e a, \log_e b, \log_e c$ are in an AP and $\log_e a - \log_e 2b, \log_e 2b - \log_e 3c, \log_e 3c - \log_e a$ are also in an AP, then $a : b : c$ is equal to

(a) 16 : 4 : 1 (b) 9 : 6 : 4
(c) 25 : 10 : 4 (d) 6 : 3 : 2

39. If n arithmetic means are inserted between a and 100 such that the ratio of the first mean to the last mean is 1 : 7 and $a + n = 33$, then the value of n is

(a) 21 (b) 22
(c) 23 (d) 24

40. If a, b and c are three distinct real numbers in GP and $a + b + c = xb$, then x cannot be equal to

(a) 4 (b) 2
(c) –2 (d) –3

Section B (2 Marks)

41. If the two lines $x + (a-1)y = 1$ and $2x + a^2y = 1$, $(a \in R - \{0, 1\})$ are perpendicular, then the distance of their point of intersection from the origin is

(a) $\frac{2}{5}$ (b) $\frac{\sqrt{2}}{5}$
(c) $\frac{2}{\sqrt{5}}$ (d) $\sqrt{\frac{2}{5}}$

42. If the straight line, $2x - 3y + 17 = 0$ is perpendicular to the line passing through the points (7, 17) and (15, β), then β equals

(a) $\frac{35}{3}$ (b) – 5
(c) $-\frac{35}{3}$ (d) 5

43. The lines $L_1 : y - x = 0$ and $L_2 : 2x + y = 0$ intersect the line $L_3 : y + 2 = 0$ at P and Q, respectively. The bisector of the acute angle between L_1 and L_2 intersects L_3 at R.

Statement I The ratio $PR : RQ$ equals $2\sqrt{2} : \sqrt{5}$.
Statement II In any triangle, bisector of an angle divides the triangle into two similar triangles.

(a) Statement I is true, Statement II is true; Statement II is not a correct explanation of Statement I.
(b) Statement I is true, Statement II is false.
(c) Statement I is false, Statement II is true.
(d) Statement I is true, Statement II is true; Statement II is a correct explanation of Statement I.

44. The equation of the straight line which passes through the point (–5, 4) and is such that the portion of it between the axes is divided by the given point in the ratio 1 : 2 is

(a) $\frac{x}{12} + \frac{y}{\frac{-15}{2}} = 1$ (b) $\frac{x}{\frac{-15}{2}} + \frac{y}{12} = 1$
(c) $\frac{x}{12} + \frac{y}{\frac{15}{2}} = 1$ (d) None of these

45. The line $\frac{x}{a}+\frac{y}{b}=1$ meets the X-axis at point A and the Y-axis at point B, and the line $y = x$ at point C such that the area of ΔAOC is twice the area of ΔBOC. Then, the coordinates of C are

(a) $C\left(\frac{2b}{3},\frac{2b}{3}\right)$ (b) $C\left(\frac{b}{3},\frac{b}{3}\right)$

(c) $C\left(\frac{2a}{3},\frac{2a}{3}\right)$ (d) $C(a, a)$

46. If the straight line $\alpha x+\beta y+\gamma=0$ ($\forall\ \alpha, \beta, \gamma \neq 0$) passes through the first quadrant and cut the positive X-axis is, then

(a) $\alpha\gamma>0, \beta\gamma>0$ (b) $\alpha\ \gamma>0, \beta\ \gamma<0$

(c) $\alpha\ \gamma>0$ or $\beta\gamma>0$ (d) $\alpha\gamma<0$ or $\beta\gamma<0$

47. If a variable line drawn through the intersection of the lines $\frac{x}{3}+\frac{y}{4}=1$ and $\frac{x}{4}+\frac{y}{3}=1$ meets the coordinate axes at P and Q, where $P \neq Q$. Then, the locus of the mid-point of PQ is

(a) $6xy = 7(x+y)$

(b) $7xy = 6(x+y)$

(c) $4(x+y)^2 - 28(x+y) + 49 = 0$

(d) $14(x+y)^2 - 97(x+y) + 168 = 0$

48. Let a variable line passing through the centre of the circle $x^2+y^2-16x-4y=0$, meet the positive coordinate axes at the points A and B. Then, the minimum value of $OA+OB$, where O is the origin is equal to

(a) 18 (b) 24

(c) 20 (d) 12

49. If $\lim\limits_{x\to 1}\frac{x+x^2+x^3+....+x^n-n}{x-1}=820, (n\in N)$, then the value of n is equal to

(a) 60 (b) 50

(c) 40 (d) 30

50. If two different numbers are taken from the set {0, 1, 2, 3……… 10}, then the probability that their sum as well as absolute difference are both multiple of 4, is

(a) $\frac{6}{55}$

(b) $\frac{12}{55}$

(c) $\frac{14}{45}$

(d) $\frac{7}{55}$

Tie-Breaking Section

Instructions

1. This section consists of 5 questions.
2. The score achieved in this section will not be included in the total marks.
3. If overall marks of two or more students are same, winner will be decided based on the score in this section.
4. Participation in this section is optional, and students may choose to attempt it or not.

1. If $\frac{(1+3P)}{3}, \left(\frac{1-P}{4}\right), \left(\frac{1-2P}{2}\right)$ are the possibilities of three mutually exclusive events, then the set of the values of P is.

(a) $P \in \left[0, \frac{1}{2}\right]$

(b) $P \in \left[\frac{1}{3}, 1\right]$

(c) $P \in \left[\frac{1}{3}, \frac{1}{2}\right]$

(d) $P \in \left[\frac{1}{2}, 1\right]$

2. Five real numbers x_1, x_2, x_3, x_4, and x_5 are such that $\sqrt{x_1 - 1} + 2\sqrt{x_2 - 4} + 3\sqrt{x_3 - 9} + 4\sqrt{x_4 - 16} + 5\sqrt{x_5 - 25} = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{2}$.

The value of $\frac{x_1 + x_2 + x_3 + x_4 + x_5}{2}$ is

(a) 210 (b) 54

(c) 60 (d) 55

3. A parallelepiped is formed by planes drawn through the points (2, 3, 5) and (5, 9, 7) parallel to the coordinate planes. The length of a diagonal of the parallelepiped is

(a) 7 units (b) $\sqrt{38}$ units

(c) $\sqrt{155}$ units (d) None of these

4. If $\bar{x}_1$ and $\bar{x}_2$ are the means of two distributions such that $\bar{x}_1 < \bar{x}_2$ and $\bar{x}$ is the mean of combined distribution, then

(a) $\bar{x} < \bar{x}_1$

(b) $\bar{x} > \bar{x}_2$

(c) $\bar{x} = \frac{\bar{x}_1 - \bar{x}_2}{2}$

(d) $\bar{x}_1 < \bar{x} < \bar{x}_2$

5. For observations $x_1, x_2, x_3, \ldots x_n$, if $\sum_{i=1}^{n} (x_i + 1)^2 = 9n$ and $\sum_{i=1}^{n} (x_i - 1)^2 = 5n$, then standard deviation of the data is

(a) $\sqrt{3}$ (b) $\sqrt{5}$

(c) $\sqrt{2}$ (d) $\sqrt{10}$