Mathematics (041)

CBSE Class 12 Board Examination 2027 – Practice Paper No. 2

Practice Question Paper

Time: 3 hours **Max. Marks: 80**

(1) This question paper contains 38 questions. All questions are compulsory.
(2) This question paper is divided into five Sections – A, B, C, D and E.
(3) In Section A, Questions 1 to 18 are multiple choice questions (MCQs) and Questions 19 and 20 are Assertion–Reason based questions of 1 mark each.
(4) In Section B, Questions 21 to 25 are Very Short Answer (VSA) type questions, carrying 2 marks each.
(5) In Section C, Questions 26 to 31 are Short Answer (SA) type questions, carrying 3 marks each.
(6) In Section D, Questions 32 to 35 are Long Answer (LA) type questions, carrying 5 marks each.
(7) In Section E, Questions 36 to 38 are case study based questions, carrying 4 marks each.
(8) There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 3 questions in Section C, 2 questions in Section D and one sub-part each in 2 questions of Section E.
(9) Draw neat and clean figures wherever required. Take $\pi = 22/7$ wherever required, if not stated.
(10) Use of calculators is not allowed.

SECTION A This section comprises 18 multiple choice questions (Q1–Q18) of 1 mark each. Choose the correct option. **[18]**

1. The relation R on the set A = {1, 2, 3} given by R = {(1, 1), (2, 2), (3, 3), (1, 3), (3, 1), (2, 3)} is

(A) reflexive and symmetric but not transitive
(B) an equivalence relation
(C) reflexive but neither symmetric nor transitive
(D) reflexive and transitive but not symmetric

2. The range of the principal value branch of the function $y = \sec^{-1} x$ is

(A) $[0, \pi] - \{\pi/2\}$
(B) $[-\pi/2, \pi/2] - \{0\}$
(C) $(0, \pi)$
(D) $[-\pi/2, \pi/2]$

3. If $A = \begin{bmatrix} 1 & 0 \\ 3 & 1 \end{bmatrix}$ and $A^4 = \begin{bmatrix} 1 & 0 \\ k & 1 \end{bmatrix}$, then the value of k is

(A) 81
(B) 12
(C) 4
(D) 7

4. If the matrix $\begin{bmatrix} 0 & a & -3 \\ 2 & 0 & -1 \\ b & 1 & 0 \end{bmatrix}$ is skew-symmetric, then the value of a + b is

(A) 5
(B) −1
(C) −5
(D) 1

5. The cofactor of the element a_{23} of the determinant $\begin{vmatrix} 1 & 3 & -2 \\ 4 & -5 & 6 \\ 3 & 5 & 2 \end{vmatrix}$ is

(A) 4
(B) −4
(C) 14
(D) −14

6. The function $f(x) = |x - 3| + 2$, $x \in R$, is

(A) continuous and differentiable at $x = 3$

(B) continuous but not differentiable at $x = 3$

(C) differentiable but not continuous at $x = 3$

(D) neither continuous nor differentiable at $x = 3$

7. A cube-shaped block of ice is melting so that each edge decreases at the rate of 0.4 cm/min. The rate at which its total surface area decreases when the edge is 15 cm is

(A) 36 cm^2/min

(B) 180 cm^2/min

(C) 72 cm^2/min

(D) 144 cm^2/min

8. $\int e^x (\tan x + \sec^2 x)\, dx$ is equal to

(A) $e^x \tan x + C$

(B) $e^x \sec^2 x + C$

(C) $e^x \sec x + C$

(D) $e^x (\tan x + \sec x) + C$

9. If $\int_0^a (3x^2 + 2x + 1)\, dx = 14$, where a is real, then a is equal to

(A) 1

(B) 3

(C) −2

(D) 2

10. The area of the region bounded by the line $y = 2x - 4$, the x-axis and the lines $x = 0$ and $x = 4$ is

(A) 0 sq. units

(B) 4 sq. units

(C) 8 sq. units

(D) 16 sq. units

11. The solution of the differential equation $dy/dx = 2xy$ that satisfies $y(0) = 3$ is

(A) $y = 3e^{2x}$

(B) $y = 3e^{x^2}$

(C) $y = e^{x^2} + 2$

(D) $y = 3 + x^2$

12. If $|\vec{a}| = 3$, $|\vec{b}| = 4$ and $|\vec{a} + \vec{b}| = 5$, then $|\vec{a} - \vec{b}|$ is equal to

(A) 5

(B) 1

(C) 7

(D) $\sqrt{7}$

13. If $|\vec{a}| = 2$, $|\vec{b}| = 5$ and $|\vec{a} \times \vec{b}| = 8$, then $|\vec{a} \cdot \vec{b}|$ is equal to

(A) 10

(B) 3

(C) 2

(D) 6

14. The angle between the lines $(x + 1)/2 = (y - 3)/(-1) = (z - 2)/1$ and $x/1 = (y + 4)/1 = (z - 5)/2$ is

(A) $\pi/6$

(B) $\pi/4$

(C) $\pi/3$

(D) $\pi/2$

15. The corner points of the bounded feasible region of a linear programming problem are (0, 0), (5, 0), (4, 3) and (0, 6). The maximum value of the objective function $Z = 3x + 4y$ occurs at

(A) (4, 3) only

(B) (0, 6) only

(C) every point of the line segment joining (4, 3) and (0, 6)

(D) (5, 0)

16. Which of the following points does NOT lie in the feasible region determined by the constraints $2x + 3y \le 12$, $x + y \ge 2$, $x \ge 0$, $y \ge 0$?

(A) (1, 1)

(B) (0, 1)

(C) (3, 2)

(D) (6, 0)

17. If $P(A) = 2/5$, $P(B) = 1/2$ and $P(B|A) = 3/4$, then $P(A|B)$ is equal to

(A) 3/10

(B) 3/4

(C) 2/5

(D) 3/5

18. A bag contains 4 red and 6 black balls. Two balls are drawn at random one after the other without replacement. The probability that both balls are red is

(A) 4/25 (B) 2/15

(C) 4/15 (D) 1/5

SECTION A (contd.) Assertion–Reason based questions (Q19–Q20), 1 mark each. Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the options (A), (B), (C) and (D) given below each question. **[2]**

19. **Assertion (A):** $\tan^{-1}(\tan(4\pi/5)) = -\pi/5$.

Reason (R): The domain of the function $\tan^{-1}$ is the set R of all real numbers.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

20. **Assertion (A):** If A and B are independent events with P(A) = 0.4 and P(B) = 0.5, then $P(A \cup B) = 0.7$.

Reason (R): For any two events A and B, $P(A \cap B) = P(A) \cdot P(B)$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

SECTION B This section comprises 5 very short answer (VSA) type questions of 2 marks each. **[10]**

21. Find the domain of the function $f(x) = \sin^{-1}(x^2 - 3)$.

22. (A) If $x^2 + xy + y^3 = 7$, find dy/dx at the point (2, 1).

OR

(B) If $x = t^2 + 2t$ and $y = t^3 - 3t$, find dy/dx in terms of t and its value at t = 3.

23. The vectors $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + 2\hat{k}$ represent two adjacent sides of a parallelogram. Find the area of the parallelogram and show that its diagonals are perpendicular to each other.

24. (A) Find the vector and the cartesian equations of the line passing through the point (2, −1, 3) and parallel to the line $(x - 1)/3 = (y + 2)/(-2) = (4 - z)/6$.

OR

(B) Find the value of k for which the lines $(x + 2)/k = (y - 1)/3 = (z - 4)/(-2)$ and $(x - 3)/2 = y/(k + 1) = (z + 1)/4$ are perpendicular to each other.

25. If $y = (a + bx)\, e^{2x}$, where a and b are constants, show that $d^2y/dx^2 - 4\, dy/dx + 4y = 0$.

SECTION C This section comprises 6 short answer (SA) type questions of 3 marks each. **[18]**

26. Show that the function $f : R \to R$ defined by $f(x) = x^2 + 4x$ for $x \geq 0$ and $f(x) = 4x$ for $x < 0$ is both one-one and onto.

27. Express the matrix $A = \begin{bmatrix} 3 & 5 & -1 \\ 1 & -2 & 4 \\ 7 & 0 & 6 \end{bmatrix}$ as the sum of a symmetric matrix and a skew-symmetric matrix.

28. (A) Find: $\int (3x + 5)/\sqrt{(x^2 + 4x + 13)}\, dx$

OR

(B) Find: $\int \log(x^2 + 4)\, dx$

29. (A) Find the particular solution of the differential equation $2xy\,(dy/dx) = x^2 + 3y^2$, $x > 0$, given that $y = 2$ when $x = 1$.

OR

(B) Find the particular solution of the differential equation $x\,(dy/dx) + y = x \cos x$, $x > 0$, given that $y = 1$ when $x = \pi/2$.

30. Solve the following linear programming problem graphically:
Maximise and minimise $Z = 4x + 3y$
subject to the constraints $x + y \le 8$, $x + 3y \ge 6$, $x \le 6$, $x \ge 0$, $y \ge 0$.

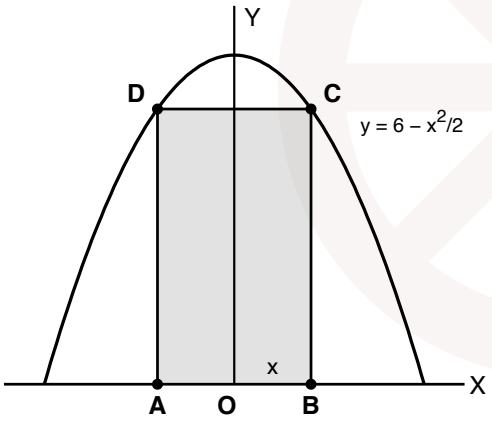
31. (A) Find the coordinates of the foot of the perpendicular drawn from the point P(5, 3, 4) to the line $(x - 1)/2 = y/(-1) = (z - 2)/2$. Hence find the perpendicular distance of P from the line.

OR

(B) Find the shortest distance between the lines $\vec{r} = (\hat{i} - 2\hat{j} + 3\hat{k}) + \lambda(\hat{i} + 2\hat{j} + 2\hat{k})$ and $\vec{r} = (4\hat{i} + \hat{j} + 3\hat{k}) + \mu(2\hat{i} + 4\hat{j} + 4\hat{k})$.

SECTION D This section comprises 4 long answer (LA) type questions of 5 marks each. **[20]**

32. The entrance of a school auditorium is a parabolic arch. Taking the mid-point O of the floor line of the arch as the origin, the x-axis along the floor and distances in metres, the arch is the curve $y = 6 - x^2/2$, $y \ge 0$ (see figure). A rectangular glass door ABCD is to be fitted in the arch with its lower edge AB on the floor and its upper corners C and D on the arch. Taking OB = x m, find the dimensions of the door of the largest area and this largest area. Also, using integration, find the area of the opening of the arch and show that the area of the largest door and the area of the opening are in the ratio $1 : \sqrt{3}$.



33. (A) Evaluate: $\int_0^{\pi/2} \sin^2 x/(2 + \sin 2x)\,dx$

OR

(B) Find: $\int (5x^2 - 4x + 7)/((x - 1)(x^2 + 3))\,dx$

34. (A) Using integration, find the area of the region bounded by the parabola $y^2 = 4x$ and the line $x - y = 3$.

OR

(B) Using integration, find the area of the triangle whose vertices are A(1, 2), B(3, 6) and C(5, 4).

35. During the monsoon in Mumbai, the probability that it rains on a given day is 0.6. On a rainy day, the probability that a particular suburban local train runs late is 0.5; on a day without rain this probability is 0.1. On a day chosen at random,
(i) find the probability that the train runs late; [2]
(ii) if the train runs late, find the probability that it rained that day; [2]
(iii) if the train is on time, find the probability that it did not rain that day. [1]

SECTION E This section comprises 3 case study based questions of 4 marks each. Questions 36 and 37 have three sub-parts of 1, 1 and 2 marks; Question 38 has two sub-parts of 2 marks each. **[12]**

36. **Case study:** In a 3-D design model of a cable-stayed footbridge over a river in Nagpur, three straight steel cables are represented by lines. Taking a fixed point on the bank as the origin and distances in metres, the first two cables lie along the lines
$l_1 : (x - 1)/2 = (y + 1)/3 = (z - 2)/6$ and $l_2 : (x + 3)/6 = y/2 = (z - 11)/(-3)$.
Based on the given information, answer the following questions:
(i) Find the direction cosines of the line l_1. [1]
(ii) Show that the lines l_1 and l_2 are perpendicular to each other. [1]
(iii) (a) Show that the lines l_1 and l_2 intersect and find their point of intersection. [2]
OR
(iii) (b) A third cable l_3 passes through the point Q(2, 3, 2) and is parallel to l_2. Find the shortest distance between the lines l_1 and l_3. [2]

37. **Case study:** At a computer centre, a student who has never typed before starts practising touch-typing. Her instructor models her typing speed y (in words per minute) after t weeks of practice as follows: the speed increases at a rate proportional to the difference between a limiting speed of 80 words per minute and her present speed, i.e. $dy/dt = k(80 - y)$, where k is a positive constant, and $y = 0$ when $t = 0$.
Based on the given information, answer the following questions:
(i) Write the order and the degree of the differential equation $dy/dt = k(80 - y)$. [1]
(ii) Solve the differential equation to show that $y = 80(1 - e^{-kt})$. [1]
(iii) (a) If her speed is 40 words per minute after 2 weeks, after how many weeks will her speed be 60 words per minute? [2]
OR
(iii) (b) If her speed is 20 words per minute after 3 weeks, find her speed after 6 weeks. [2]

38. **Case study:** Three farmers of a co-operative society in Satara buy bags of three fertilisers: urea, DAP and potash. Farmer 1 buys 2 bags of urea, 1 bag of DAP and 1 bag of potash for ₹3,650. Farmer 2 buys 1 bag of urea, 2 bags of DAP and 1 bag of potash for ₹4,700. Farmer 3 buys 3 bags of urea, 1 bag of DAP and 2 bags of potash for ₹5,650. Let the price of one bag of urea, DAP and potash be ₹x, ₹y and ₹z respectively.
Based on the given information, answer the following questions:
(i) Write the above information as a matrix equation AX = B, and find |A| and adj A. [2]
(ii) Find A^{-1} and hence find the price of one bag of each fertiliser. [2]

All the best for your exam!