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Your JEE Guide

CBSE Class XII · Mathematics (041)

Sample Question Paper 5 · Session 2026-27

Time allowed: 3 hours **Maximum marks: 80**

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This is an original practice paper written to the official CBSE 2026-27 design; it is not issued by CBSE.

General instructions:

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 π = 22/7 wherever required, if not stated.
10. Use of calculators is not allowed.

Section A

1.	The relation R on N given by "a R b if a divides b" is: (A) reflexive and transitive but not symmetric (B) an equivalence relation (C) reflexive and symmetric but not transitive (D) symmetric only	1
2.	The number of onto functions from {1, 2, 3} to {a, b} is: (A) 2 (B) 9 (C) 6 (D) 8	1
3.	The value of $\cos\left(\tan^{-1}\frac{3}{4}\right)$ is: (A) $\frac{3}{4}$ (B) $\frac{4}{5}$ (C) $\frac{5}{4}$ (D) $\frac{3}{5}$	1
4.	The value of $\sec^2(\tan^{-1}2) + \operatorname{cosec}^2(\cot^{-1}3)$ is: (A) 13 (B) 5 (C) 10 (D) 15	1

5.	If A is a square matrix of order 3 with |A| = –2, then |3A| is: (A) –18 (B) 54 (C) –6 (D) –54	1
6.	Which of the following is a scalar matrix? (A) $\begin{bmatrix}0 & 3\\3 & 0\end{bmatrix}$ (B) $\begin{bmatrix}3 & 0\\0 & 3\end{bmatrix}$ (C) $\begin{bmatrix}3 & 1\\0 & 3\end{bmatrix}$ (D) $\begin{bmatrix}3 & 0\\0 & 2\end{bmatrix}$	1
7.	If $\begin{bmatrix}x+y & 2\\5 & xy\end{bmatrix} = \begin{bmatrix}6 & 2\\5 & 8\end{bmatrix}$, then: (A) {x, y} = {2, 4} (B) x = 3, y = 3 (C) x = 6, y = 8 (D) x = 1, y = 5	1
8.	The function f(x) = x|x| is: (A) not continuous at x = 0 (B) continuous but not differentiable at x = 0 (C) differentiable everywhere (D) differentiable only for x > 0	1
9.	For |x| < 1, $\frac{d}{dx}\tan^{-1}\left(\frac{2x}{1-x^2}\right)$ is: (A) $\frac{1}{1+x^2}$ (B) $\frac{-2}{1+x^2}$ (C) $\frac{2}{1-x^2}$ (D) $\frac{2}{1+x^2}$	1
10.	The minimum value of $x^2 + \frac{16}{x^2}$, x ≠ 0, is: (A) 16 (B) 8 (C) 4 (D) 2	1
11.	$\int \tan^2 x\,dx$ equals: (A) $\sec x - x + C$ (B) $\frac{\tan^3 x}{3} + C$ (C) $\tan x - x + C$ (D) $\tan x + x + C$	1
12.	$\int_0^{\pi} \lvert\cos x\rvert\,dx$ equals: (A) 2 (B) 0 (C) π (D) 1	1
13.	The integrating factor of $\frac{dy}{dx} - y = \cos x$ is: (A) e^x (B) $-x$ (C) $\cos x$ (D) e^{-x}	1
14.	The function $y = Ae^{3x} + Be^{-3x}$ satisfies: (A) $y'' - 9y = 0$ (B) $y'' = 3y$ (C) $y' - 3y = 0$ (D) $y'' + 9y = 0$	1

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15.	The value of $\hat{i} \cdot (\hat{j} \times \hat{k}) + \hat{j} \cdot (\hat{i} \times \hat{k}) + \hat{k} \cdot (\hat{i} \times \hat{j})$ is: (A) –1 (B) 1 (C) 0 (D) 3	1
16.	The cartesian equation of the line through (1, 2, 3) parallel to $3\hat{i} + 2\hat{j} - 2\hat{k}$ is: (A) $\frac{x-1}{3} = \frac{y-2}{2} = \frac{z-3}{2}$ (B) $\frac{x-3}{1} = \frac{y-2}{2} = \frac{z+2}{3}$ (C) $\frac{x-1}{3} = \frac{y-2}{2} = \frac{z-3}{-2}$ (D) $\frac{x+1}{3} = \frac{y+2}{2} = \frac{z+3}{-2}$	1
17.	Two dice are thrown and the sum is 9. The probability that one of the dice shows 4 is: (A) $\frac{1}{9}$ (B) $\frac{1}{4}$ (C) $\frac{1}{2}$ (D) $\frac{1}{3}$	1
18.	If the feasible region of an LPP is unbounded, then: (A) there is never an optimal solution (B) the optimum is always at the origin (C) every point is optimal (D) a maximum or minimum of the objective function may not exist	1
19.	**Assertion (A):** The determinant of an identity matrix of any order is 1. **Reason (R):** The determinant of a diagonal matrix is the product of its diagonal elements. (A) Both Assertion (A) and Reason (R) are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.	1
20.	**Assertion (A):** $\tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}$ for all real x. **Reason (R):** $\sin^{-1} x + \cos^{-1} x = \pi$ for all x in [–1, 1]. (A) Both Assertion (A) and Reason (R) are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.	1

Section B

21.	Prove that $\sin^{-1}\left(2x\sqrt{1-x^2}\right) = 2\sin^{-1} x$, $-\frac{1}{\sqrt{2}} \le x \le \frac{1}{\sqrt{2}}$. **OR** Find the value of $\tan\left(\cos^{-1}\frac{3}{5} + \tan^{-1}\frac{1}{4}\right)$.	2
22.	If x = a(θ – sin θ) and y = a(1 – cos θ), find $\frac{dy}{dx}$.	2

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23.	The profit (in ₹) of a company from selling x units is $P(x) = 41 + 24x - 18x^2$. Find the maximum profit. **OR** Find the intervals in which $f(x) = \sin x + \cos x$, $0 \le x \le 2\pi$, is increasing or decreasing.	2
24.	If $\lvert\vec{a} + \vec{b}\rvert = \lvert\vec{a} - \vec{b}\rvert$, show that $\vec{a}$ and $\vec{b}$ are perpendicular.	2
25.	A speaks the truth in 60% of cases and B in 90% of cases. In what percentage of cases are they likely to contradict each other when stating the same fact?	2

Section C

26.	Find $\int \frac{x+2}{\sqrt{x^2+2x+3}}\,dx$. **OR** Find $\int \frac{dx}{x(x^4-1)}$.	3
27.	Evaluate $\int_0^{\pi} \frac{x}{1+\sin x}\,dx$.	3
28.	Solve $\frac{dy}{dx} + y = e^{-x}$. **OR** Find the particular solution of $\frac{dy}{dx} = y\tan x$, given y = 1 when x = 0.	3
29.	Find the distance between the parallel lines $\vec{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda(2\hat{i} + 3\hat{j} + 6\hat{k})$ and $\vec{r} = 3\hat{i} + 3\hat{j} - 5\hat{k} + \mu(2\hat{i} + 3\hat{j} + 6\hat{k})$. **OR** Find p so that the lines $\frac{1-x}{3} = \frac{7y-14}{2p} = \frac{z-3}{2}$ and $\frac{7-7x}{3p} = \frac{y-5}{1} = \frac{6-z}{5}$ are at right angles.	3
30.	Solve graphically: maximise Z = x + 2y subject to x + 2y ≥ 100, 2x − y ≤ 0, 2x + y ≤ 200, x ≥ 0, y ≥ 0.	3
31.	Two dice are thrown. Given that the numbers on them are different, find the probability that their sum is 4.	3

Section D

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32.	Show that f: N → N, f(x) = x², is one-one but not onto. Also show that g: Z → Z, g(x) = x², is neither one-one nor onto. **OR** Let A be the set of all points in a plane and R = {(P, Q): the distance of P from the origin equals the distance of Q from the origin}. Show that R is an equivalence relation, and that the set of points related to P ≠ O is the circle through P with centre O.	5
33.	If $A = \begin{bmatrix} 3 & -2 & 3 \\ 2 & 1 & -1 \\ 4 & -3 & 2 \end{bmatrix}$, find A^{-1} and hence solve 3x – 2y + 3z = 8, 2x + y – z = 1, 4x – 3y + 2z = 4.	5
34.	Using integration, find the area of the region bounded by $x^2 = 4y$, the lines y = 2 and y = 4, and the y-axis, in the first quadrant. **OR** Using integration, find the area bounded by the curve y = cos x and the x-axis between x = 0 and x = 2π.	5
35.	Evaluate $\int_0^{\pi/2} \sin 2x \, \tan^{-1}(\sin x)\, dx.$	5

Section E

36.	**Case study 1.** A window is in the shape of a rectangle surmounted by a semicircle whose diameter is the width of the rectangle. Its total perimeter is 10 m. Let the width be x m and the height of the rectangular part y m. (i) Express y in terms of x. *[1]* (ii) Write the area A of the window in terms of x. *[1]* (iii) Find the width that admits the most light (largest area). *[2]* **OR** (iii) Find the height y of the rectangular part for the largest area. *[2]*	4
37.	**Case study 2.** A box contains two coins: one fair coin and one coin with heads on both sides. A coin is picked at random and tossed. (i) Find the probability of getting a head. *[1]* (ii) Find the probability that the fair coin is picked and shows a head. *[1]* (iii) A head appears. Find the probability that it was the two-headed coin. *[2]* **OR** (iii) A head appears. Find the probability that it was the fair coin. *[2]*	4

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38.	**Case study 3.** The number of bacteria in a culture grows at a rate proportional to the number present: $\frac{dP}{dt} = kP$. Initially there are 1 00 000 bacteria, and the number increases by 10% in 2 hours. (i) Solve the differential equation to express P in terms of t. *[2]* (ii) Find k. *[2]*	4

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Section A

1. **(A)** reflexive and transitive but not symmetric. *Working:* a | a; a | b and b | c give a | c; but 2 | 4 while 4 ∤ 2.

2. **(C)** 6. *Working:* All $2^3 = 8$ functions except the 2 constant ones.

3. **(B)** $\frac{4}{5}$. *Working:* A right triangle with sides 3, 4, 5.

4. **(D)** 15. *Working:* (1 + 4) + (1 + 9).

5. **(D)** –54. *Working:* $3^3 \times (-2)$.

6. **(B)** $\begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$. *Working:* A diagonal matrix with all diagonal elements equal.

7. **(A)** {x, y} = {2, 4}. *Working:* x + y = 6 and xy = 8.

8. **(C)** differentiable everywhere. *Working:* f(x) = x² for x ≥ 0 and –x² for x < 0; both one-sided derivatives at 0 are 0.

9. **(D)** $\frac{2}{1+x^2}$. *Working:* For |x| < 1 the function is $2\tan^{-1} x$.

10. **(B)** 8. *Working:* $2x - \frac{32}{x^3} = 0$ gives $x^2 = 4$; the value is 4 + 4.

11. **(C)** $\tan x - x + C$. *Working:* $\tan^2 x = \sec^2 x - 1$.

12. **(A)** 2. *Working:* $\int_0^{\pi/2} \cos x\, dx - \int_{\pi/2}^{\pi} \cos x\, dx = 1 + 1$.

13. **(D)** e^{-x}. *Working:* $e^{\int -1\, dx}$.

14. **(A)** $y'' - 9y = 0$. *Working:* $y'' = 9Ae^{3x} + 9Be^{-3x} = 9y$.

15. **(B)** 1. *Working:* 1 + (–1) + 1.

16. **(C)** $\frac{x-1}{3} = \frac{y-2}{2} = \frac{z-3}{-2}$. *Working:* Point (1, 2, 3), direction ratios 3, 2, –2.

17. **(C)** $\frac{1}{2}$. *Working:* Sum 9: (3, 6), (4, 5), (5, 4), (6, 3); two contain a 4.

18. **(D)** a maximum or minimum of the objective function may not exist. *Working:* An unbounded region may or may not have an optimal value; it must be checked.

19. **(A)** Both Assertion (A) and Reason (R) are true and R is the correct explanation of A. *Working:* The identity matrix is diagonal with all diagonal elements 1.

20. **(C)** A is true but R is false. *Working:* A is true. R is false: the sum is $\frac{\pi}{2}$.

Section B

21. Put x = sin θ with $\theta \in \left[-\frac{\pi}{4}, \frac{\pi}{4}\right]$ (½). $2x\sqrt{1-x^2} = \sin 2\theta$ and $2\theta \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ (1). So LHS = 2θ = 2 $\sin^{-1}$x (½).

OR $\cos^{-1}\frac{3}{5} = \tan^{-1}\frac{4}{3}$ (½). $\tan(A+B) = \frac{\frac{4}{3}+\frac{1}{4}}{1-\frac{4}{3}\cdot\frac{1}{4}}$ (1) $= \frac{19/12}{2/3} = \frac{19}{8}$ (½).

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22. $\frac{dx}{d\theta} = a(1-\cos\theta)$, $\frac{dy}{d\theta} = a\sin\theta$ (1). $\frac{dy}{dx} = \frac{\sin\theta}{1-\cos\theta} = \cot\frac{\theta}{2}$ (1).

23. $P'(x) = 24 - 36x = 0$ gives $x = \frac{2}{3}$; $P'' = -36 < 0$ (1). Maximum profit $= 41 + 16 - 8 = ₹49$ (1).

OR $f'(x) = \cos x - \sin x = 0$ at $x = \frac{\pi}{4}, \frac{5\pi}{4}$ (½). Increasing on $[0, \frac{\pi}{4})$ and $(\frac{5\pi}{4}, 2\pi]$; decreasing on $(\frac{\pi}{4}, \frac{5\pi}{4})$ (1½).

24. Squaring: $|\vec{a}|^2 + 2\vec{a}\cdot\vec{b} + |\vec{b}|^2 = |\vec{a}|^2 - 2\vec{a}\cdot\vec{b} + |\vec{b}|^2$ (1). So $\vec{a}\cdot\vec{b} = 0$ and the vectors are perpendicular (1).

25. They contradict when exactly one speaks the truth (½). 0.6 × 0.1 + 0.4 × 0.9 (1) = 0.42, i.e. 42% (½).

Section C

26. $x + 2 = \frac{1}{2}(2x+2) + 1$ (1). Integral $= \sqrt{x^2+2x+3} + \int \frac{dx}{\sqrt{(x+1)^2+2}}$ (1) $= \sqrt{x^2+2x+3} + \log\left|x+1+\sqrt{x^2+2x+3}\right| + C$ (1).

OR Multiply and divide by x^3 and put $x^4 = t$: $\frac{1}{4}\int \frac{dt}{t(t-1)}$ (1½) $= \frac{1}{4}\log\left|\frac{x^4-1}{x^4}\right| + C$ (1½).

27. Using $x \to \pi - x$: $2I = \pi\int_0^\pi \frac{dx}{1+\sin x}$ (1). $\frac{1}{1+\sin x} = \frac{1-\sin x}{\cos^2 x}$, so $\int_0^\pi (\sec^2 x - \sec x\tan x)\,dx = [\tan x - \sec x]_0^\pi = 2$ (1½). $I = \pi$ (½).

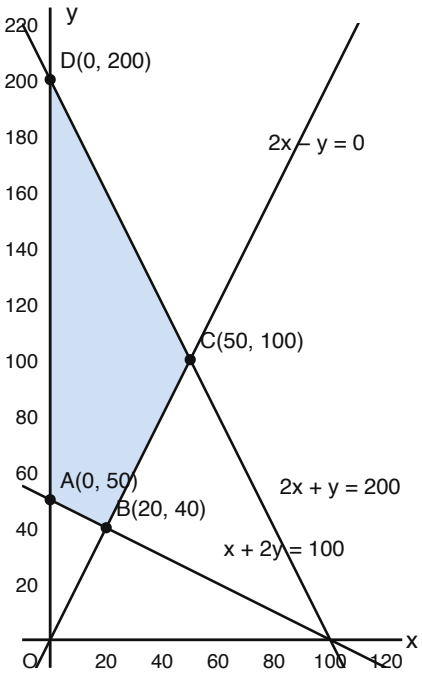
28. IF $= e^x$ (1). $ye^x = \int e^{-x}e^x\,dx = x + C$ (1½). $y = (x+C)e^{-x}$ (½).

OR $\int \frac{dy}{y} = \int \tan x\,dx$: log|y| = log|sec x| + C (1½). x = 0, y = 1 gives C = 0 (½). y = sec x (1).

29. $\vec{a}_2 - \vec{a}_1 = 2\hat{i} + \hat{j} - \hat{k}$; $\vec{b}\times(\vec{a}_2 - \vec{a}_1) = -9\hat{i} + 14\hat{j} - 4\hat{k}$ (1½). Distance $= \frac{\sqrt{293}}{7}$ units (1½).

OR Direction ratios $-3, \frac{2p}{7}, 2$ and $-\frac{3p}{7}, 1, -5$ (1½). $\frac{9p}{7} + \frac{2p}{7} - 10 = 0$ gives $p = \frac{70}{11}$ (1½).

30. Corners A(0, 50), B(20, 40), C(50, 100), D(0, 200) (1½):



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Z = 100, 100, 250, 400 (1). Maximum Z = 400 at (0, 200) (½).

31. Outcomes with different numbers: 36 − 6 = 30 (1). Among these, sum 4: (1, 3), (3, 1) (1). Probability = 2/30 = 1/15 (1).

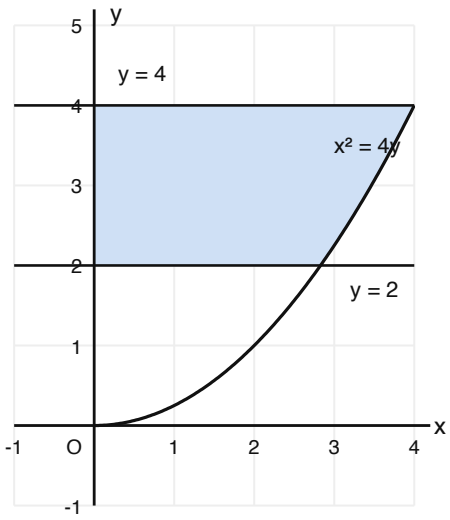
Section D

32. On N, $x_1^2 = x_2^2 \Rightarrow x_1 = x_2$, so f is one-one (1½); 2 is not a square, so f is not onto (1). g(−1) = g(1), so g is not one-one (1½); −1 has no pre-image, so g is not onto (1).

OR OP = OP; OP = OQ ⇒ OQ = OP; OP = OQ and OQ = OS ⇒ OP = OS (3). Points Q related to P satisfy OQ = OP, i.e. they lie on the circle with centre O through P (2).

33. |A| = −17 (1). $\operatorname{adj} A = \begin{bmatrix} -1 & -5 & -1 \\ -8 & -6 & 9 \\ -10 & 1 & 7 \end{bmatrix}$, $A^{-1} = -\frac{1}{17}\operatorname{adj} A$ (2). $X = A^{-1}\begin{bmatrix} 8 \\ 1 \\ 4 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$: x = 1, y = 2, z = 3 (2).

34. Here $x = 2\sqrt{y}$ (½). Figure (1):



Area $= \int_2^4 2\sqrt{y}\,dy$ (1½) $= \frac{4}{3}\left[y^{3/2}\right]_2^4 = \frac{32-8\sqrt{2}}{3}$ sq. units (2).

OR Area $= \int_0^{\pi/2} \cos x\,dx + \left|\int_{\pi/2}^{3\pi/2} \cos x\,dx\right| + \int_{3\pi/2}^{2\pi} \cos x\,dx$ (2) $= 1 + 2 + 1 = 4$ sq. units (3).

35. Put sin x = t: $I = \int_0^1 2t\tan^{-1} t\,dt$ (1). By parts: $\left[t^2\tan^{-1} t\right]_0^1 - \int_0^1 \frac{t^2}{1+t^2}dt$ (2) $= \frac{\pi}{4} - \left(1 - \frac{\pi}{4}\right) = \frac{\pi}{2} - 1$ (2).

Section E

36. (i) $x + 2y + \frac{\pi x}{2} = 10$, so $y = \frac{1}{2}\left(10 - x - \frac{\pi x}{2}\right)$.
(ii) $A = xy + \frac{\pi x^2}{8} = 5x - \frac{x^2}{2} - \frac{\pi x^2}{8}$.
(iii) $A' = 5 - x - \frac{\pi x}{4} = 0$ gives $x = \frac{20}{\pi+4}$ m; $A'' < 0$, so maximum. **OR** $y = \frac{10}{\pi+4}$ m.

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37. (i) $\frac{1}{2}\cdot\frac{1}{2}+\frac{1}{2}\cdot 1=\frac{3}{4}$.
(ii) $\frac{1}{2}\cdot\frac{1}{2}=\frac{1}{4}$.
(iii) $\frac{1/2}{3/4}=\frac{2}{3}$. **OR** $\frac{1/4}{3/4}=\frac{1}{3}$.

38. (i) $\int \frac{dP}{P}=\int k\,dt$ gives $P=P_0e^{kt}$, with $P_0=100000$.
(ii) $110000=100000e^{2k}$, so $k=\frac{1}{2}\log_e 1.1$ per hour.

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