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Your JEE Guide

CBSE Class XII · Mathematics (041)

Sample Question Paper 3 · Session 2026-27

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

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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 = {(a, b): a ≤ b²} on the set of real numbers is: (A) symmetric only (B) neither reflexive nor symmetric nor transitive (C) reflexive only (D) an equivalence relation	1
2.	The number of one-one functions from {1, 2, 3} to itself is: (A) 6 (B) 27 (C) 9 (D) 3	1
3.	The value of $\sin\left(\frac{\pi}{3} - \sin^{-1}\left(-\frac{1}{2}\right)\right)$ is: (A) –1 (B) 0 (C) $\frac{1}{2}$ (D) 1	1
4.	The range of the principal value branch of $\tan^{-1} x$ is: (A) $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ (B) $[0, \pi]$ (C) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ (D) $(0, \pi)$	1

5.	If $A = \begin{bmatrix} 0 & 2 \\ 3 & -4 \end{bmatrix}$ and $kA = \begin{bmatrix} 0 & 3a \\ 2b & 24 \end{bmatrix}$, then: (A) k = 6, a = –4, b = 9 (B) k = –6, a = –4, b = –9 (C) k = 6, a = 4, b = 9 (D) k = –6, a = 4, b = –9	1
6.	If A is a skew-symmetric matrix of order 3, then |A| is: (A) –1 (B) 3 (C) 1 (D) 0	1
7.	If A is of order 2 × 3 and B is of order 3 × 2, the order of AB is: (A) 2 × 2 (B) 3 × 3 (C) 3 × 2 (D) 2 × 3	1
8.	$\frac{d}{dx}\left(e^x \log x\right)$ is: (A) $e^x \log x$ (B) $\frac{e^x}{x}$ (C) $e^x\left(\log x + \frac{1}{x}\right)$ (D) $e^x\left(\log x - \frac{1}{x}\right)$	1
9.	If $x = at^2$ and $y = 2at$, then $\frac{dy}{dx}$ is: (A) t (B) 2t (C) $\frac{1}{t}$ (D) $\frac{1}{2t}$	1
10.	The maximum value of $\sin x \cos x$ is: (A) $\frac{1}{2}$ (B) 1 (C) $\sqrt{2}$ (D) 2	1
11.	$\int \frac{\log x}{x}\, dx$ equals: (A) $\log(\log x) + C$ (B) $(\log x)^2 + C$ (C) $\frac{\log x}{x^2} + C$ (D) $\frac{(\log x)^2}{2} + C$	1
12.	$\int_0^{\pi/2} \cos^2 x\, dx$ equals: (A) $\frac{\pi}{2}$ (B) $\frac{\pi}{4}$ (C) $\frac{1}{2}$ (D) π	1
13.	The solution of $\frac{dy}{dx} = y$ with y(0) = 2 is: (A) $y = 2e^x$ (B) $y = e^x + 1$ (C) $y = e^{2x}$ (D) $y = 2e^{-x}$	1
14.	Which of the following is a homogeneous function of degree 2? (A) $x^2 + y$ (B) $x + y^2$ (C) $x^2 + xy$ (D) $x^3 + y^2$	1

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15.	If $\lvert\vec{a}\rvert = 2$, $\lvert\vec{b}\rvert = 5$ and $\vec{a}\cdot\vec{b} = 8$, then $\lvert\vec{a}\times\vec{b}\rvert$ is: (A) 10 (B) 6 (C) 8 (D) 4	1
16.	The angle between two lines with direction ratios 1, 1, 2 and $\sqrt{3}-1, -\sqrt{3}-1, 4$ is: (A) $\frac{\pi}{2}$ (B) $\frac{\pi}{4}$ (C) $\frac{\pi}{6}$ (D) $\frac{\pi}{3}$	1
17.	If A and B are independent events with P(A) = ½ and P(B) = ⅓, then P(A′ ∩ B′) is: (A) $\frac{1}{3}$ (B) $\frac{5}{6}$ (C) $\frac{1}{6}$ (D) $\frac{2}{3}$	1
18.	In a linear programming problem, the objective function is: (A) any of the constraints (B) a quadratic function (C) always a constant (D) a linear function to be maximised or minimised	1
19.	**Assertion (A):** The matrix $\begin{bmatrix}1 & 2\\ 2 & 4\end{bmatrix}$ is singular. **Reason (R):** A square matrix is singular if its determinant is zero. (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):** The function $f(x) = x^3$ has a local extremum at x = 0. **Reason (R):** $f'(0) = 0$. (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.	Find the value of $\tan^{-1}1 + \cos^{-1}\left(-\frac{1}{2}\right) + \sin^{-1}\left(-\frac{1}{2}\right)$. **OR** Write $\cot^{-1}\frac{1}{\sqrt{x^2-1}}$, |x| > 1, in the simplest form.	2
22.	If $y = \sin^{-1}x$, show that $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} = 0$.	2

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23.	Find two positive numbers whose sum is 15 and the sum of whose squares is the least. **OR** Find the absolute maximum and minimum values of $f(x) = 2x^3 - 15x^2 + 36x + 1$ on [1, 5].	2
24.	If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors with $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, find $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$.	2
25.	A coin is tossed three times. E: a head on the third toss; F: heads on the first two tosses. Find P(E|F).	2

Section C

26.	Find $\int \frac{dx}{\sqrt{x^2 + 2x + 2}}$. **OR** Find $\int \frac{3x + 1}{x^2 - 3x + 2}\, dx$.	3
27.	Evaluate $\int_0^{\pi/2} \frac{\sqrt{\sin x}}{\sqrt{\sin x} + \sqrt{\cos x}}\, dx$.	3
28.	Find the particular solution of $\frac{dy}{dx} + y \cot x = 2x + x^2 \cot x$, x ≠ 0, given y = 0 when $x = \frac{\pi}{2}$. **OR** Solve $(x^2 - 1)\frac{dy}{dx} + 2xy = \frac{2}{x^2 - 1}$, |x| > 1.	3
29.	Find the shortest distance between the lines $\frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{1}$ and $\frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1}$. **OR** Show that the lines $\frac{x-5}{7} = \frac{y+2}{-5} = \frac{z}{1}$ and $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ are perpendicular to each other.	3
30.	Solve graphically: maximise Z = 5x + 3y subject to 3x + 5y ≤ 15, 5x + 2y ≤ 10, x ≥ 0, y ≥ 0.	3
31.	An urn has 5 red and 5 black balls. A ball is drawn at random, its colour noted, and it is returned with 2 more balls of the same colour. A second ball is then drawn. Find the probability that it is red.	3

Section D

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32.	Let f: N → N be defined by $f(n) = \frac{n+1}{2}$ if n is odd and $f(n) = \frac{n}{2}$ if n is even. Show that f is onto but not one-one. **OR** Show that the relation R on the set of all triangles, with $T_1 R T_2$ if T_1 is similar to T_2, is an equivalence relation. Which of the right triangles with sides (3, 4, 5), (5, 12, 13) and (6, 8, 10) are related?	5
33.	If $A = \begin{bmatrix} 1 & 2 & -3 \\ 2 & 3 & 2 \\ 3 & -3 & -4 \end{bmatrix}$, find A^{-1} and hence solve x + 2y − 3z = −4, 2x + 3y + 2z = 2, 3x − 3y − 4z = 11.	5
34.	Find the area of the region in the first quadrant enclosed by the x-axis, the line y = x and the circle $x^2 + y^2 = 32$. **OR** Find the area of the smaller part of the circle $x^2 + y^2 = a^2$ cut off by the line $x = \frac{a}{\sqrt{2}}$.	5
35.	Find $\int \frac{x^3 + x + 1}{x^2 - 1}\, dx$.	5

Section E

36.	**Case study 1.** An open box is made from a square sheet of tin of side 18 cm by cutting equal squares of side x cm from each corner and folding up the flaps. (i) Write the volume V of the box in terms of x. *[1]* (ii) Find $\frac{dV}{dx}$. *[1]* (iii) Find the side of the square to be cut off for the largest volume, and the largest volume. *[2]* **OR** (iii) If the sheet had side 24 cm, what would the largest volume be? *[2]*	4
37.	**Case study 2.** Two archers A and B shoot at a target independently. The probability that A hits it is 3/5 and that B hits it is 2/5. (i) Find the probability that both hit the target. *[1]* (ii) Find the probability that neither hits the target. *[1]* (iii) Find the probability that the target is hit. *[2]* **OR** (iii) Find the probability that exactly one of them hits the target. *[2]*	4

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38.	**Case study 3.** A courier company charges according to the function $f(x) = \begin{cases} x^2, & x \leq 1 \\ 2x - 1, & x > 1 \end{cases}$, where x is the weight in kg. (i) Is f continuous at x = 1? Justify. *[2]* (ii) Is f differentiable at x = 1? Justify. *[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. **(B)** neither reflexive nor symmetric nor transitive. *Working:* (½, ½) ∉ R; (1, 2) ∈ R but (2, 1) ∉ R; (3, 2), (2, 1.5) ∈ R but (3, 1.5) ∉ R.

2. **(A)** 6. *Working:* 3! = 6.

3. **(D)** 1. *Working:* $\sin\left(\frac{\pi}{3}+\frac{\pi}{6}\right)=\sin\frac{\pi}{2}$.

4. **(C)** $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$. *Working:* tan is not defined at $\pm\frac{\pi}{2}$.

5. **(B)** k = –6, a = –4, b = –9. *Working:* –4k = 24 gives k = –6; then 3a = 2k and 2b = 3k.

6. **(D)** 0. *Working:* $|A|=|A^T|=|-A|=(-1)^3|A|$, so |A| = 0.

7. **(A)** 2 × 2. *Working:* (2 × 3)(3 × 2) gives 2 × 2.

8. **(C)** $e^x\left(\log x+\frac{1}{x}\right)$. *Working:* Product rule.

9. **(C)** $\frac{1}{t}$. *Working:* $\frac{2a}{2at}$.

10. **(A)** $\frac{1}{2}$. *Working:* $\frac{1}{2}\sin 2x$ has maximum $\frac{1}{2}$.

11. **(D)** $\frac{(\log x)^2}{2}+C$. *Working:* Put log x = t.

12. **(B)** $\frac{\pi}{4}$. *Working:* $\int_0^{\pi/2}\frac{1+\cos 2x}{2}dx=\frac{\pi}{4}$.

13. **(A)** $y=2e^x$. *Working:* $y=Ce^x$, C = 2.

14. **(C)** x^2+xy. *Working:* Each term has degree 2: $f(\lambda x,\lambda y)=\lambda^2 f(x,y)$.

15. **(B)** 6. *Working:* $\cos\theta=\frac{4}{5}$, $\sin\theta=\frac{3}{5}$, so $10\times\frac{3}{5}=6$.

16. **(D)** $\frac{\pi}{3}$. *Working:* $\cos\theta=\frac{6}{\sqrt{6}\cdot\sqrt{24}}=\frac{1}{2}$.

17. **(A)** $\frac{1}{3}$. *Working:* A′ and B′ are also independent: $\frac{1}{2}\times\frac{2}{3}$.

18. **(D)** a linear function to be maximised or minimised. *Working:* It is the linear function Z = ax + by that is optimised.

19. **(A)** Both Assertion (A) and Reason (R) are true and R is the correct explanation of A. *Working:* 4 – 4 = 0.

20. **(D)** A is false but R is true. *Working:* A is false: $f'(x)=3x^2$ does not change sign at 0, so x = 0 is a point of inflection. R is true.

Section B

21. $\frac{\pi}{4}+\frac{2\pi}{3}-\frac{\pi}{6}$ (1½) $=\frac{3\pi}{4}$ (½).

OR Put x = sec θ, so $\sqrt{x^2-1}=\tan\theta$ (1). The expression is $\cot^{-1}(\cot\theta)=\theta=\sec^{-1}x$ (1).

22. $y'=\frac{1}{\sqrt{1-x^2}}$, so $\sqrt{1-x^2}\,y'=1$ (½). Differentiating: $\sqrt{1-x^2}\,y''-\frac{x}{\sqrt{1-x^2}}y'=0$ (1). Multiplying by $\sqrt{1-x^2}$ gives the result (½).

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23. $S = x^2 + (15 - x)^2$, $S' = 4x - 30 = 0$ gives x = 7.5 (1). $S'' = 4 > 0$: minimum; the numbers are 7.5 and 7.5 (1).

OR $f'(x) = 6(x - 2)(x - 3)$; f(1) = 24, f(2) = 29, f(3) = 28, f(5) = 56 (1). Absolute maximum 56 at x = 5; absolute minimum 24 at x = 1 (1).

24. $|\vec{a} + \vec{b} + \vec{c}|^2 = 0 = 3 + 2(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a})$ (1). Value $= -\frac{3}{2}$ (1).

25. F = {HHH, HHT}, E ∩ F = {HHH} (1). P(E|F) = (1/8)/(2/8) = ½ (1).

Section C

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

OR $\frac{3x+1}{(x-1)(x-2)} = \frac{-4}{x-1} + \frac{7}{x-2}$ (1½). Integral $= -4\log|x - 1| + 7\log|x - 2| + C$ (1½).

27. Using $x \to \frac{\pi}{2} - x$, the integral equals the same with $\sqrt{\cos x}$ in the numerator (1). Adding, $2I = \int_0^{\pi/2} 1\,dx = \frac{\pi}{2}$ (1½). $I = \frac{\pi}{4}$ (½).

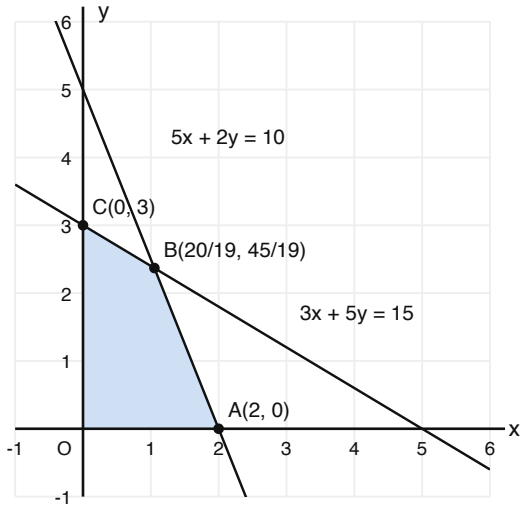
28. IF $= e^{\int \cot x\,dx} = \sin x$ (½). $y \sin x = \int (2x \sin x + x^2 \cos x)\,dx = x^2 \sin x + C$ (1½). y(π/2) = 0 gives $C = -\frac{\pi^2}{4}$; $y = x^2 - \frac{\pi^2}{4}\operatorname{cosec} x$ (1).

OR The left side is $\frac{d}{dx}\left[y(x^2 - 1)\right]$ (1). $y(x^2 - 1) = \int \frac{2\,dx}{x^2 - 1}$ (1) $= \log\left|\frac{x-1}{x+1}\right| + C$ (1).

29. $\vec{b}_1 \times \vec{b}_2 = -4\hat{i} - 6\hat{j} - 8\hat{k}$, magnitude $\sqrt{116}$ (1). $\vec{a}_2 - \vec{a}_1 = 4\hat{i} + 6\hat{j} + 8\hat{k}$; dot product = –116 (1). SD $= \frac{116}{\sqrt{116}} = 2\sqrt{29}$ units (1).

OR Direction ratios 7, –5, 1 and 1, 2, 3 (1). $7(1) + (-5)(2) + 1(3) = 0$ (1½), so the lines are perpendicular (½).

30. Corners O(0, 0), A(2, 0), B(20/19, 45/19), C(0, 3) (1½):



Z = 0, 10, 235/19, 9 (1). Maximum $Z = \frac{235}{19}$ at $\left(\frac{20}{19}, \frac{45}{19}\right)$ (½).

31. P(R_1) = P(B_1) = ½ (½). P(R_2|R_1) = 7/12, P(R_2|B_1) = 5/12 (1). P(R_2) = ½ · 7/12 + ½ · 5/12 (1) = ½ (½).

Section D

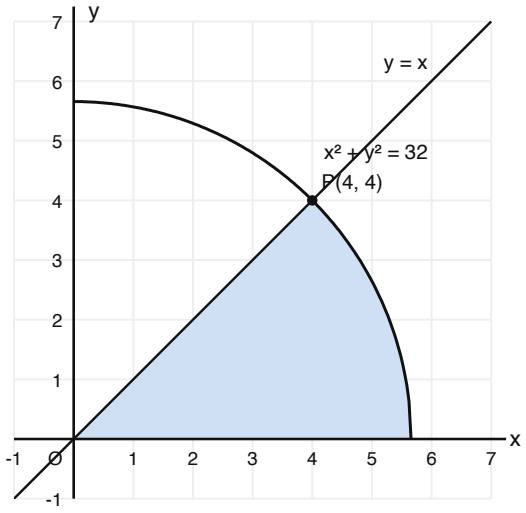
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32. f(1) = 1 and f(2) = 1, so f is not one-one (2). For any n ∈ N, 2n – 1 (odd) maps to n, so every element has a pre-image and f is onto (3).

OR Every triangle is similar to itself; similarity is symmetric; and if $T_1 \sim T_2$ and $T_2 \sim T_3$ then $T_1 \sim T_3$ (3). Sides 3, 4, 5 and 6, 8, 10 are proportional, so these two are related (2).

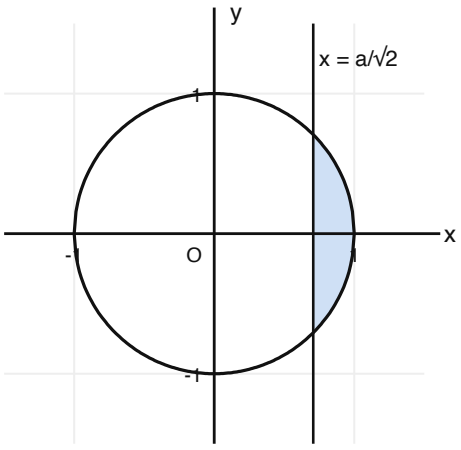
33. |A| = 67 (1). $\operatorname{adj} A = \begin{bmatrix} -6 & 17 & 13 \\ 14 & 5 & -8 \\ -15 & 9 & -1 \end{bmatrix}$, $A^{-1} = \frac{1}{67} \operatorname{adj} A$ (2). $X = A^{-1} \begin{bmatrix} -4 \\ 2 \\ 11 \end{bmatrix} = \begin{bmatrix} 3 \\ -2 \\ 1 \end{bmatrix}$: x = 3, y = –2, z = 1 (2).

34. The line and circle meet at (4, 4) (1). Figure (1):



Area $= \int_0^4 x\,dx + \int_4^{4\sqrt{2}} \sqrt{32 - x^2}\,dx$ (1) $= 8 + \left[\frac{x}{2}\sqrt{32 - x^2} + 16 \sin^{-1} \frac{x}{4\sqrt{2}}\right]_4^{4\sqrt{2}} = 8 + (8\pi - 8 - 4\pi) = 4\pi$ sq. units (2).

OR Figure (1):



Area $= 2\int_{a/\sqrt{2}}^{a} \sqrt{a^2 - x^2}\,dx$ (1) $= 2\left[\frac{x}{2}\sqrt{a^2 - x^2} + \frac{a^2}{2} \sin^{-1} \frac{x}{a}\right]_{a/\sqrt{2}}^{a}$ (1) $= \frac{a^2}{4}(\pi - 2)$ sq. units (2).

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35. Dividing: $x + \frac{2x+1}{x^2-1}$ (1½). $\frac{2x+1}{(x-1)(x+1)} = \frac{3/2}{x-1} + \frac{1/2}{x+1}$ (1½). Integral $= \frac{x^2}{2} + \frac{3}{2}\log|x-1| + \frac{1}{2}\log|x+1| + C$ (2).

Section E

36. (i) $V = x(18-2x)^2$.
(ii) $(18-2x)^2 - 4x(18-2x) = (18-2x)(18-6x)$.
(iii) x = 3 (x = 9 gives no box); $V''(3) < 0$. Largest volume $= 3 \times 12^2 = 432$ cm³. **OR** V = x(24 – 2x)², maximum at x = 4: $4 \times 16^2 = 1024$ cm³.

37. (i) $\frac{3}{5} \times \frac{2}{5} = \frac{6}{25}$.
(ii) $\frac{2}{5} \times \frac{3}{5} = \frac{6}{25}$.
(iii) $1 - \frac{6}{25} = \frac{19}{25}$. **OR** $\frac{3}{5}\cdot\frac{3}{5} + \frac{2}{5}\cdot\frac{2}{5} = \frac{13}{25}$.

38. (i) LHL = 1, RHL = 2 – 1 = 1 and f(1) = 1, so f is continuous at x = 1.
(ii) LHD = $\lim_{h\to 0}\frac{(1-h)^2-1}{-h} = 2$; RHD = $\lim_{h\to 0}\frac{2(1+h)-1-1}{h} = 2$. They are equal, so f is differentiable at x = 1.

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