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Your JEE Guide

MP Board Class XII · Higher Mathematics

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 MPBSE 2027 sample question paper pattern; it is not issued by MPBSE.

General instructions:

1. All questions are compulsory.
2. Sub-questions of question numbers 1 to 5 carry 1 mark each.
3. Question numbers 6 to 15 carry 2 marks each.
4. Question numbers 16 to 19 carry 3 marks each.
5. Question numbers 20 to 23 carry 4 marks each.
6. Internal choices are provided for question numbers 16 to 23.
7. Draw neat and clean labelled diagrams wherever required.

1.	**(i)** *Choose and write the correct option:* The number of equivalence relations on the set {1, 2} is: (a) 3 (b) 2 (c) 4 (d) 1	1
	(ii) The value of $\sin^{-1}(-1) + \cos^{-1}(-1)$ is: (a) 0 (b) π (c) $\frac{\pi}{2}$ (d) $\frac{3\pi}{2}$	1
	(iii) If A is a symmetric matrix, then A – A′ is: (a) the zero matrix (b) A (c) 2A (d) I	1
	(iv) $\frac{d}{dx}\tan^{-1}(x^2)$ equals: (a) $\frac{x^2}{1+x^4}$ (b) $\frac{2x}{1+x^2}$ (c) $\frac{1}{1+x^4}$ (d) $\frac{2x}{1+x^4}$	1
	(v) $\int_{-\pi/4}^{\pi/4} \tan x \, dx$ equals: (a) 1 (b) 0 (c) log 2 (d) $\frac{\pi}{2}$	1
	(vi) The angle between $\hat{i}$ and $\hat{i} + \hat{j}$ is: (a) 0 (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}$	1

2.	**(i)** *Fill in the blanks:* If $f(x) = x^2$ and $g(x) = \sqrt{x}$ for x ≥ 0, then (f ∘ g)(x) = _____.	1
	(ii) The principal value of $\tan^{-1}\frac{1}{\sqrt{3}}$ is _____.	1
	(iii) For any square matrix A, the matrix A + A′ is _____.	1
	(iv) $\frac{d}{dx}(\cos 2x)$ = _____.	1
	(v) $\int_0^{\pi} \cos x \, dx$ = _____.	1
	(vi) For any event A with P(A) > 0, P(A | A) = _____.	1
3.	**(i)** *Write True or False:* The empty relation on a non-empty set is reflexive.	1
	(ii) $\cos^{-1}(-x) = \pi - \cos^{-1} x$ for x in [–1, 1].	1
	(iii) If A is a 2 × 2 matrix with |A| = 0, then A^{-1} exists.	1
	(iv) $f(x) = x^2$ is strictly decreasing on (–∞, 0).	1
	(v) The differential equation $\frac{dy}{dx} = \frac{y}{x}$ is homogeneous.	1
	(vi) $\hat{i} \times \hat{i}$ is the zero vector.	1
4.	Match column A with column B:	7

Column A	Column B
(i) $\frac{d}{dx}\log\lvert\cos x\rvert$	(a) 1
(ii) $\frac{d}{dx}\frac{1}{x}$	(b) $e^x \sin x + C$
(iii) $\int 2x \, dx$	(c) $\sqrt{3}$
(iv) $\int e^x(\sin x + \cos x)\, dx$	(d) –tan x
(v) $\lvert\hat{i} + \hat{j} + \hat{k}\rvert$	(e) $x^2 + C$
(vi) P(S), S the sample space	(f) 4|A|
(vii) |2A| for a 2 × 2 matrix A	(g) $-\frac{1}{x^2}$

5.	**(i)** *Write the answer in one word or one sentence:* R = {(x, y): x + 2y = 8} is a relation on ℕ. Write the domain of R.	1
	(ii) Write the value of $\sin\left(\sin^{-1}\frac{1}{3}\right)$.	1
	(iii) If $\begin{vmatrix} x & 2 \\ 3 & 4 \end{vmatrix} = 2$, write the value of x.	1
	(iv) Write $\frac{d^2}{dx^2}(x^3)$.	1

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	(v) Write $\int 0\,dx$.	1
	(vi) Write the vector component of $2\hat{i} - 3\hat{j}$ along the y-axis.	1
	(vii) A fair die is thrown. Write the probability of getting a prime number.	1
6.	If $f(x) = x^2 + 1$ and g(x) = 2x – 1, find f ∘ g and g ∘ f.	2
7.	Write $\tan^{-1}\frac{1-\cos x}{\sin x}$, 0 < x < π, in the simplest form.	2
8.	Find the matrix X such that 2A + X = B, where $A = \begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$ and $B = \begin{bmatrix}5 & 6\\ 7 & 8\end{bmatrix}$.	2
9.	For $A = \begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$, find adj A and verify that A(adj A) = |A| I.	2
10.	Find $\frac{dy}{dx}$ if $y = \cos\sqrt{x}$.	2
11.	Show that f(x) = log x is strictly increasing on (0, ∞).	2
12.	Find $\int \frac{dx}{x^2 - 25}$.	2
13.	Evaluate $\int_0^{\pi/2} \sin x \cos x\,dx$.	2
14.	Find the area of the parallelogram whose adjacent sides are $2\hat{i} + 3\hat{j}$ and $\hat{i} - \hat{j} + 2\hat{k}$.	2
15.	Two cards are drawn one after the other, with replacement, from a pack of 52. Find the probability that both are hearts.	2
16.	Prove that $\cos^{-1}\frac{4}{5} + \cos^{-1}\frac{12}{13} = \cos^{-1}\frac{33}{65}$. **OR** Show that the function f: $\mathbb{R} \to \mathbb{R}$, f(x) = 5x + 7 is a bijection, and find f^{-1}.	3
17.	Find k if $f(x) = \begin{cases}\frac{x^2-9}{x-3}, & x \neq 3\\ k, & x = 3\end{cases}$ is continuous at x = 3. **OR** If $y = e^{a\cos^{-1}x}$, show that $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - a^2y = 0$.	3
18.	Find $\int \frac{x+1}{\sqrt{x^2+6x+10}}\,dx$. **OR** Evaluate $\int_0^1 \frac{x}{1+x^4}\,dx$.	3

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19.	A test detects a disease in 99% of the people who have it, but also gives a positive result for 2% of healthy people. 1% of a population has the disease. A person chosen at random tests positive. Find the probability that the person has the disease. **OR** Three coins are tossed. Find the probability distribution of the number of heads and its mean.	3
20.	Solve by the matrix method: x + y − z = 2, 2x − y + z = 7, x − 2y + 3z = 7. **OR** Find the inverse of $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$ and verify that $AA^{-1} = I$.	4
21.	An open tank with a square base and vertical sides is to hold 32 m³ of water. Find its dimensions so that the area of sheet used is the least. **OR** Find the absolute maximum and minimum values of $f(x) = 2x^3 - 24x + 107$ on [1, 3].	4
22.	Using integration, find the area of the region bounded by the curve $y = 6x - x^2$ and the x-axis. **OR** Find $\displaystyle\int \frac{3x+1}{(x-1)(x+2)(x-3)}\,dx$.	4
23.	Solve $\frac{dy}{dx} = \frac{2x+1}{3y^2}$, given y = 1 when x = 0. **OR** Solve graphically: Maximise Z = 4x + 5y subject to 2x + y ≤ 14, x + 3y ≤ 12, x ≥ 0, y ≥ 0.	4

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Answers and Marking Scheme

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

Question 1

(i) **(b)** 2. *Working:* Only the identity relation and the universal relation.

(ii) **(c)** $\frac{\pi}{2}$. *Working:* $-\frac{\pi}{2} + \pi$.

(iii) **(a)** the zero matrix. *Working:* A′ = A, so A − A′ = O.

(iv) **(d)** $\frac{2x}{1+x^4}$. *Working:* Chain rule.

(v) **(b)** 0. *Working:* tan x is an odd function.

(vi) **(d)** $\frac{\pi}{4}$. *Working:* $\cos\theta = \frac{1}{\sqrt{2}}$.

Question 2

(i) x.

(ii) $\frac{\pi}{6}$.

(iii) symmetric.

(iv) −2 sin 2x.

(v) 0.

(vi) 1.

Question 3

(i) False.

(ii) True.

(iii) False: A is singular.

(iv) True: f′(x) = 2x < 0 there.

(v) True.

(vi) True.

4. (i) – (d) −tan x; (ii) – (g) $-\frac{1}{x^2}$; (iii) – (e) $x^2 + C$; (iv) – (b) $e^x \sin x + C$; (v) – (c) $\sqrt{3}$; (vi) – (a) 1; (vii) – (f) 4|A|

Question 5

(i) {2, 4, 6}.

(ii) $\frac{1}{3}$.

(iii) 4x − 6 = 2, so x = 2.

(iv) 6x.

(v) C, a constant.

(vi) $-3\hat{j}$.

(vii) $\frac{1}{2}$ (2, 3 or 5).

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6. (f ∘ g)(x) = (2x − 1)² + 1 = 4x² − 4x + 2 (1). (g ∘ f)(x) = 2(x² + 1) − 1 = 2x² + 1 (1).

7. $\frac{1-\cos x}{\sin x} = \frac{2\sin^2\frac{x}{2}}{2\sin\frac{x}{2}\cos\frac{x}{2}} = \tan\frac{x}{2}$ (1). So the expression is $\frac{x}{2}$ (1).

8. X = B − 2A (1) $= \begin{bmatrix} 3 & 2 \\ 1 & 0 \end{bmatrix}$ (1).

9. $\operatorname{adj} A = \begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$ (1). $A(\operatorname{adj} A) = \begin{bmatrix} -2 & 0 \\ 0 & -2 \end{bmatrix} = -2I$, and |A| = −2 (1).

10. $\frac{dy}{dx} = -\sin\sqrt{x}\cdot\frac{d}{dx}\sqrt{x}$ (1) $= -\frac{\sin\sqrt{x}}{2\sqrt{x}}$ (1).

11. $f'(x) = \frac{1}{x}$ (1), which is positive for every x > 0 (1).

12. Using $\int \frac{dx}{x^2-a^2} = \frac{1}{2a}\log\left|\frac{x-a}{x+a}\right|$ (1), the integral is $\frac{1}{10}\log\left|\frac{x-5}{x+5}\right| + C$ (1).

13. $\sin x\cos x = \frac{1}{2}\sin 2x$ (1). Value $= \left[-\frac{1}{4}\cos 2x\right]_0^{\pi/2} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$ (1).

14. Cross product $= 6\hat{i} - 4\hat{j} - 5\hat{k}$ (1). Area $= \sqrt{36 + 16 + 25} = \sqrt{77}$ square units (1).

15. P(heart) = 13/52 = 1/4 on each draw, and the draws are independent (1). P = 1/4 × 1/4 = 1/16 (1).

16. Let $A = \cos^{-1}\frac{4}{5}$, $B = \cos^{-1}\frac{12}{13}$; then $\sin A = \frac{3}{5}$, $\sin B = \frac{5}{13}$ (1). $\cos(A+B) = \frac{4}{5}\cdot\frac{12}{13} - \frac{3}{5}\cdot\frac{5}{13} = \frac{33}{65}$ (1). A + B lies in [0, π], so $A + B = \cos^{-1}\frac{33}{65}$ (1).

OR f(a) = f(b) ⇒ 5a + 7 = 5b + 7 ⇒ a = b: one-one (1). For any real y, x = (y − 7)/5 gives f(x) = y: onto (1). $f^{-1}(x) = \frac{x-7}{5}$ (1).

17. For x ≠ 3, $\frac{x^2-9}{x-3} = x + 3$ (1). $\lim_{x\to 3} f(x) = 6$ (1). For continuity f(3) = 6, so k = 6 (1).

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

18. x + 1 = ½(2x + 6) − 2 (1). $\frac{1}{2}\int \frac{2x+6}{\sqrt{x^2+6x+10}}dx = \sqrt{x^2+6x+10}$, and $\int \frac{dx}{\sqrt{(x+3)^2+1}} = \log\left|x+3+\sqrt{x^2+6x+10}\right|$ (1). Integral $= \sqrt{x^2+6x+10} - 2\log\left|x+3+\sqrt{x^2+6x+10}\right| + C$ (1).

OR Put $t = x^2$, dt = 2x dx (1). $\frac{1}{2}\int_0^1 \frac{dt}{1+t^2}$ (1) $= \frac{1}{2}\cdot\frac{\pi}{4} = \frac{\pi}{8}$ (1).

19. P(D) = 0.01, P(H) = 0.99, P(+ | D) = 0.99, P(+ | H) = 0.02 (1). By Bayes' theorem, P(D | +) $= \frac{0.01\times 0.99}{0.01\times 0.99 + 0.99\times 0.02}$ (1) $= \frac{0.0099}{0.0297} = \frac{1}{3}$ (1).

OR P(X = 0) = 1/8, P(X = 1) = 3/8, P(X = 2) = 3/8, P(X = 3) = 1/8 (2). Mean = (3 + 6 + 3)/8 = 3/2 (1).

20. $A = \begin{bmatrix} 1 & 1 & -1 \\ 2 & -1 & 1 \\ 1 & -2 & 3 \end{bmatrix}$, |A| = 1(−3 + 2) − 1(6 − 1) − 1(−4 + 1) = −3 (1). $\operatorname{adj} A = \begin{bmatrix} -1 & -1 & 0 \\ -5 & 4 & -3 \\ -3 & 3 & -3 \end{bmatrix}$ (1½). $X = -\frac{1}{3}\begin{bmatrix} -9 \\ -3 \\ -6 \end{bmatrix}$ (1), so x = 3, y = 1, z = 2 (½).

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OR |A| = 1 (1). $\operatorname{adj} A = \begin{bmatrix} 1 & -2 & 1 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix} = A^{-1}$ (2). $AA^{-1} = \begin{bmatrix} 1 & -2+2 & 1-4+3 \\ 0 & 1 & -2+2 \\ 0 & 0 & 1 \end{bmatrix} = I$ (1).

21. Base side x, height h: $x^2 h = 32$, so the sheet area $S = x^2 + 4xh = x^2 + \frac{128}{x}$ (1). $\frac{dS}{dx} = 2x - \frac{128}{x^2} = 0$ gives x = 4 (1). $\frac{d^2S}{dx^2} = 2 + \frac{256}{x^3} > 0$, a minimum (1). Base 4 m × 4 m, height 2 m (1).

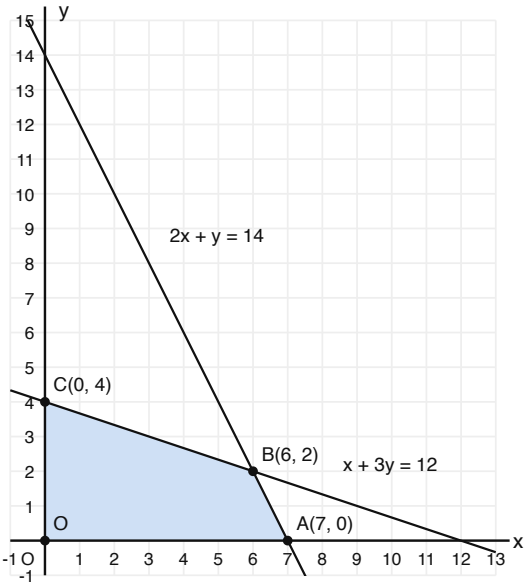
OR f′(x) = 6x² – 24 = 0 gives x = 2 in [1, 3] (1). f(1) = 85, f(2) = 75, f(3) = 89 (2). Absolute maximum 89 at x = 3; absolute minimum 75 at x = 2 (1).

22. The curve meets the x-axis at x = 0 and x = 6 (1). Area $= \int_0^6 (6x - x^2)\,dx$ (1) $= \left[3x^2 - \frac{x^3}{3}\right]_0^6$ (1) $= 108 - 72 = 36$ square units (1).

OR $\frac{3x+1}{(x-1)(x+2)(x-3)} = \frac{A}{x-1} + \frac{B}{x+2} + \frac{C}{x-3}$: x = 1 gives $A = -\frac{2}{3}$, x = –2 gives $B = -\frac{1}{3}$, x = 3 gives C = 1 (2). Integral $= -\frac{2}{3}\log|x-1| - \frac{1}{3}\log|x+2| + \log|x-3| + C$ (2).

23. Separating: $3y^2\,dy = (2x+1)\,dx$ (1). Integrating: $y^3 = x^2 + x + C$ (1). x = 0, y = 1 gives C = 1 (1). Solution: $y^3 = x^2 + x + 1$ (1).

OR Feasible region (1½):



Corners O(0, 0), A(7, 0), B(6, 2), C(0, 4): Z = 0, 28, 34, 20 (1½). Maximum Z = 34 at x = 6, y = 2 (1).

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