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Your JEE Guide

MP Board Class XII · Higher Mathematics

Sample Question Paper 6 · 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 relation R = {(1, 1), (2, 2), (3, 3), (1, 2), (2, 1)} on {1, 2, 3} is: (a) reflexive but not symmetric (b) symmetric but not reflexive (c) transitive but not symmetric (d) an equivalence relation	1
	(ii) The value of $\cot\left(\tan^{-1} a + \cot^{-1} a\right)$ is: (a) 2a (b) a (c) 0 (d) 1	1
	(iii) If $A = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$, then |A| is: (a) –1 (b) 1 (c) $\cos 2\theta$ (d) 0	1
	(iv) The derivative of |x| at x = 2 is: (a) 1 (b) 0 (c) 2 (d) –1	1
	(v) $\int \frac{e^x}{1+e^x}\,dx$ equals: (a) $e^x + C$ (b) $\log(1+e^x) + C$ (c) x + C (d) $\frac{1}{1+e^x} + C$	1
	(vi) If P(A ∩ B) = 0.15 and P(B) = 0.5, then P(A | B) is: (a) 0.3 (b) 0.35 (c) 0.65 (d) 0.075	1

2.	**(i)** *Fill in the blanks:* A function f: A → B that is one-one and onto is _____.	1
	(ii) $\tan^{-1} 1 + \tan^{-1}(-1)$ = _____.	1
	(iii) The number of matrices of order 2 × 2 with each entry 0 or 1 is _____.	1
	(iv) $\frac{d}{dx}(xe^x)$ = _____.	1
	(v) $\int_0^{2\pi} \sin x \, dx$ = _____.	1
	(vi) A vector of magnitude 1 is called a _____ vector.	1
3.	**(i)** *Write True or False:* f: $\mathbb{N} \to \mathbb{N}$, $f(x) = x^2$ is one-one.	1
	(ii) $\sin^{-1} x$ is defined for x = 2.	1
	(iii) The inverse of an invertible symmetric matrix is symmetric.	1
	(iv) cos x is strictly decreasing on (0, π).	1
	(v) The degree of the differential equation $(y'')^2 + y' = 0$ is 2.	1
	(vi) If A and B are independent events, then A and B′ are also independent.	1
4.	Match column A with column B:	7

Column A	Column B
(i) $\frac{d}{dx} \sin 2x$	(a) $-\frac{1}{1+x^2}$
(ii) $\frac{d}{dx} \tan^{-1} \frac{1}{x}$	(b) $\frac{1}{2}$
(iii) $\int \frac{dx}{2\sqrt{x}}$	(c) 0
(iv) $\int_0^1 x \, dx$	(d) 1
(v) $\hat{a} \cdot \hat{a}$ for a unit vector $\hat{a}$	(e) $\sqrt{x} + C$
(vi) P(A ∪ B) for mutually exclusive A and B	(f) 2 cos 2x
(vii) $\cos^{-1}(\cos 0)$	(g) P(A) + P(B)

5.	**(i)** *Write the answer in one word or one sentence:* If $f(x) = (3 - x^3)^{1/3}$, write (f ∘ f)(x).	1
	(ii) Write the principal value of $\cot^{-1}(-1)$.	1
	(iii) Write the number of elements in a square matrix of order 4.	1
	(iv) If $y = e^{-x}$, write $\frac{dy}{dx}$.	1

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	(v) Write $\int 3x^2\,dx$.	1
	(vi) Write the angle between $\vec{a}$ and $\vec{b}$ if $\vec{a}\cdot\vec{b} = \lvert\vec{a}\rvert\lvert\vec{b}\rvert$.	1
	(vii) A coin is tossed twice. Write the probability of getting at least one head.	1
6.	Is f: $\mathbb{R}\to\mathbb{R}$, $f(x) = x^2$ one-one? Justify.	2
7.	Find the value of $\cos^{-1}\left(\cos\frac{13\pi}{6}\right)$.	2
8.	If $A = \begin{bmatrix}1 & 0\\ 2 & 1\end{bmatrix}$, find A^3.	2
9.	Without expanding, show that $\begin{vmatrix} a & b & c\\ a+2x & b+2y & c+2z\\ x & y & z\end{vmatrix} = 0$.	2
10.	Find $\frac{dy}{dx}$ if $x = 2at^2$ and $y = at^4$.	2
11.	Find the intervals in which $f(x) = x^2 - 4x + 6$ is increasing or decreasing.	2
12.	Find $\int \frac{1+\cot x}{x+\log\sin x}\,dx$.	2
13.	Evaluate $\int_0^{\pi/8} \sec^2 2x\,dx$.	2
14.	If $\lvert\vec{a}\rvert = 2$, $\lvert\vec{b}\rvert = \sqrt{3}$ and $\vec{a}\cdot\vec{b} = 3$, find the angle between $\vec{a}$ and $\vec{b}$.	2
15.	A bag has 7 white and 3 black balls. Two balls are drawn without replacement. Find the probability that both are white.	2
16.	Show that the relation R on $\mathbb{R}$ given by R = {(a, b): a – b is an integer} is an equivalence relation. **OR** Prove that $\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{5} = \tan^{-1}\frac{7}{9}$.	3
17.	If $y = 3e^{2x} + 2e^{3x}$, show that $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$. **OR** Find $\frac{dy}{dx}$ if $y = (\log x)^{\cos x}$, x > 1.	3
18.	Find $\int \frac{dx}{1+3\sin^2 x}$. **OR** Evaluate $\int_0^{\pi} \lvert\cos x\rvert\,dx$.	3

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19.	In a school, 55% of the students are girls. 10% of the girls and 20% of the boys wear spectacles. A student chosen at random wears spectacles. Find the probability that the student is a girl. **OR** A random variable X has P(X = 0) = k, P(X = 1) = 2k, P(X = 2) = 3k and P(X = 3) = 4k. Find k and the mean of X.	3
20.	Solve by the matrix method: 2x + y + z = 3, x − y + 2z = 3, 3x + 2y − z = −2. **OR** Express $A = \begin{bmatrix} 1 & 2 & 4 \\ 6 & 8 & 1 \\ 3 & 5 & 7 \end{bmatrix}$ as the sum of a symmetric and a skew-symmetric matrix.	4
21.	Find the points on the curve $x^2 = 2y$ that are nearest to the point (0, 5). **OR** Find the local maximum and local minimum values of $f(x) = x^3 - 27x + 10$.	4
22.	Using integration, find the area of the region bounded by the parabola $y = x^2$ and the line y = 3x. **OR** Find $\int \frac{x^2 + 2}{(x-1)(x-2)}\,dx$.	4
23.	Solve the differential equation $\frac{dy}{dx} + y = \cos x$. **OR** Solve graphically: Minimise Z = 5x + 7y subject to 2x + y ≥ 8, x + 2y ≥ 10, 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) **(d)** an equivalence relation. *Working:* It is reflexive, symmetric and transitive.

(ii) **(c)** 0. *Working:* $\tan^{-1} a + \cot^{-1} a = \frac{\pi}{2}$ and $\cot \frac{\pi}{2} = 0$.

(iii) **(b)** 1. *Working:* $\cos^2 \theta + \sin^2 \theta$.

(iv) **(a)** 1. *Working:* Near x = 2, |x| = x.

(v) **(b)** $\log(1 + e^x) + C$. *Working:* The numerator is the derivative of the denominator.

(vi) **(a)** 0.3. *Working:* 0.15 ÷ 0.5.

Question 2

(i) invertible.

(ii) 0.

(iii) 16.

(iv) $e^x(x + 1)$.

(v) 0.

(vi) unit.

Question 3

(i) True.

(ii) False: its domain is [–1, 1].

(iii) True.

(iv) True: its derivative –sin x is negative there.

(v) True: the highest derivative y″ occurs with power 2.

(vi) True.

4. (i) – (f) 2 cos 2x; (ii) – (a) $-\frac{1}{1+x^2}$; (iii) – (e) $\sqrt{x} + C$; (iv) – (b) $\frac{1}{2}$; (v) – (d) 1; (vi) – (g) P(A) + P(B); (vii) – (c) 0

Question 5

(i) x.

(ii) $\frac{3\pi}{4}$.

(iii) 16.

(iv) $-e^{-x}$.

(v) $x^3 + C$.

(vi) 0.

(vii) $\frac{3}{4}$.

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6. No (1): f(1) = f(–1) = 1, but 1 ≠ –1 (1).

7. $\cos\frac{13\pi}{6} = \cos\left(2\pi + \frac{\pi}{6}\right) = \cos\frac{\pi}{6}$ (1). Since $\frac{\pi}{6}$ is in [0, π], the value is $\frac{\pi}{6}$ (1).

8. $A^2 = \begin{bmatrix}1 & 0\\ 4 & 1\end{bmatrix}$ (1). $A^3 = A^2A = \begin{bmatrix}1 & 0\\ 6 & 1\end{bmatrix}$ (1).

9. Apply $R_2 \to R_2 - R_1 - 2R_3$ (1). R_2 becomes a row of zeros, so the determinant is 0 (1).

10. $\frac{dx}{dt} = 4at$, $\frac{dy}{dt} = 4at^3$ (1). $\frac{dy}{dx} = t^2$ (1).

11. f′(x) = 2x – 4 (1). f is increasing on (2, ∞) and decreasing on (–∞, 2) (1).

12. The numerator is the derivative of $x + \log\sin x$ (1). Integral = log |x + log sin x| + C (1).

13. $\left[\frac{1}{2}\tan 2x\right]_0^{\pi/8}$ (1) $= \frac{1}{2}\tan\frac{\pi}{4} = \frac{1}{2}$ (1).

14. $\cos\theta = \frac{3}{2\sqrt{3}} = \frac{\sqrt{3}}{2}$ (1), so $\theta = \frac{\pi}{6}$ (1).

15. P = $\frac{7}{10} \times \frac{6}{9}$ (1) $= \frac{7}{15}$ (1).

16. a – a = 0 is an integer: reflexive (1). If a – b is an integer, so is b – a = –(a – b): symmetric (1). If a – b and b – c are integers, so is their sum a – c: transitive (1).

OR Since $\frac{1}{2}\cdot\frac{1}{5} < 1$ (½), the sum is $\tan^{-1}\frac{\frac{1}{2}+\frac{1}{5}}{1-\frac{1}{10}}$ (1) $= \tan^{-1}\frac{7/10}{9/10} = \tan^{-1}\frac{7}{9}$ (1½).

17. $y' = 6e^{2x} + 6e^{3x}$ (1). $y'' = 12e^{2x} + 18e^{3x}$ (1). $y'' - 5y' + 6y = (12 - 30 + 18)e^{2x} + (18 - 30 + 12)e^{3x} = 0$ (1).

OR log y = cos x · log(log x) (1). $\frac{1}{y}\frac{dy}{dx} = -\sin x\log(\log x) + \frac{\cos x}{x\log x}$ (1). $\frac{dy}{dx} = (\log x)^{\cos x}\left[\frac{\cos x}{x\log x} - \sin x\log(\log x)\right]$ (1).

18. Dividing by $\cos^2 x$: $\int \frac{\sec^2 x}{\sec^2 x + 3\tan^2 x}dx = \int \frac{\sec^2 x}{1+4\tan^2 x}dx$ (1). Put t = tan x: $\int \frac{dt}{1+4t^2}$ (1) $= \frac{1}{2}\tan^{-1}(2\tan x) + C$ (1).

OR cos x ≥ 0 on [0, π/2] and ≤ 0 on [π/2, π] (1). Value $= \int_0^{\pi/2}\cos x\,dx - \int_{\pi/2}^{\pi}\cos x\,dx$ (1) = 1 + 1 = 2 (1).

19. P(G) = 0.55, P(B) = 0.45, P(S | G) = 0.1, P(S | B) = 0.2 (1). P(G | S) $= \frac{0.55\times0.1}{0.55\times0.1 + 0.45\times0.2}$ (1) $= \frac{0.055}{0.145} = \frac{11}{29}$ (1).

OR k + 2k + 3k + 4k = 1, so k = 1/10 (1½). Mean = (0 + 2 + 6 + 12)/10 = 2 (1½).

20. $A = \begin{bmatrix}2 & 1 & 1\\ 1 & -1 & 2\\ 3 & 2 & -1\end{bmatrix}$, |A| = 2(1 – 4) – 1(–1 – 6) + 1(2 + 3) = 6 (1). $\operatorname{adj} A = \begin{bmatrix}-3 & 3 & 3\\ 7 & -5 & -3\\ 5 & -1 & -3\end{bmatrix}$ (1½). $X = \frac{1}{6}\begin{bmatrix}-6\\ 12\\ 18\end{bmatrix}$ (1), so x = –1, y = 2, z = 3 (½).

OR $P = \frac{1}{2}(A + A') = \begin{bmatrix}1 & 4 & \frac{7}{2}\\ 4 & 8 & 3\\ \frac{7}{2} & 3 & 7\end{bmatrix}$, symmetric (1½). $Q = \frac{1}{2}(A - A') = \begin{bmatrix}0 & -2 & \frac{1}{2}\\ 2 & 0 & -2\\ -\frac{1}{2} & 2 & 0\end{bmatrix}$, skew-symmetric (1½). P + Q = A (1).

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21. For a point (x, y) on the curve, $D = x^2 + (y-5)^2 = 2y + (y-5)^2$ is the square of the distance (1). $\frac{dD}{dy} = 2 + 2(y-5) = 0$ gives y = 4 (1). $\frac{d^2D}{dy^2} = 2 > 0$, a minimum (1). The points are $(\pm 2\sqrt{2}, 4)$, at distance 3 (1).

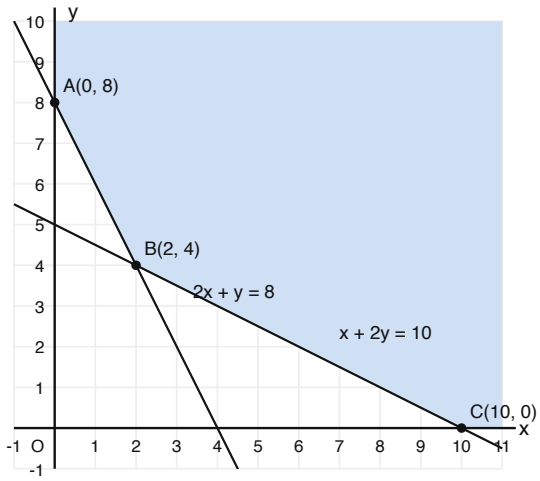
OR f′(x) = 3x² – 27 = 0 gives x = ±3 (1). f″(x) = 6x: f″(–3) < 0, f″(3) > 0 (1). Local maximum f(–3) = 64 (1); local minimum f(3) = –44 (1).

22. $x^2 = 3x$ gives x = 0, 3 (1). Area $= \int_0^3 (3x - x^2)\,dx$ (1) $= \left[\frac{3x^2}{2} - \frac{x^3}{3}\right]_0^3$ (1) $= \frac{27}{2} - 9 = \frac{9}{2}$ square units (1).

OR $\frac{x^2+2}{(x-1)(x-2)} = 1 + \frac{3x}{(x-1)(x-2)}$ (1). $\frac{3x}{(x-1)(x-2)} = \frac{-3}{x-1} + \frac{6}{x-2}$ (1½). Integral $= x - 3\log|x-1| + 6\log|x-2| + C$ (1½).

23. IF $= e^{\int dx} = e^x$ (1). $ye^x = \int e^x \cos x\,dx$ (1) $= \frac{e^x(\sin x + \cos x)}{2} + C$ (1), so $y = \frac{\sin x + \cos x}{2} + Ce^{-x}$ (1).

OR Feasible region (unbounded) (1½):



Corners A(0, 8), B(2, 4), C(10, 0): Z = 56, 38, 50 (1). The half-plane 5x + 7y < 38 has no point in common with the region, so the minimum is 38 at x = 2, y = 4 (1½).

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