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# MP Board Class XII · Higher Mathematics

Sample Question Paper 2 · 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:*<br>If $f(x) = x^2$ and g(x) = x + 1, then (f ∘ g)(2) is:<br>(a) 4 (b) 9<br>(c) 3 (d) 5 | 1 |
| | **(ii)** The value of $\sin^{-1} 1 + \cos^{-1} 1$ is:<br>(a) $\pi$ (b) $\frac{\pi}{4}$<br>(c) $\frac{\pi}{2}$ (d) 0 | 1 |
| | **(iii)** If A is a square matrix with \|A\| = 4, then \|A′\| is:<br>(a) –4 (b) $\frac{1}{4}$<br>(c) 16 (d) 4 | 1 |
| | **(iv)** $\frac{d}{dx}\cos(x^2)$ equals:<br>(a) $-2x\sin(x^2)$ (b) $-2\sin x$<br>(c) $-\sin(x^2)$ (d) $2x\sin(x^2)$ | 1 |
| | **(v)** $\int_0^{\pi} \sin x\, dx$ equals:<br>(a) 0 (b) 1<br>(c) $\pi$ (d) 2 | 1 |
| | **(vi)** The integrating factor of $\frac{dy}{dx} + y = e^x$ is:<br>(a) $\log x$ (b) $e^x$<br>(c) $e^{-x}$ (d) x | 1 |

| | | |
|---|---|---|
| **2.** | **(i)** *Fill in the blanks:*<br>A relation R on a set A is called _____ if (a, a) ∈ R for every a in A. | 1 |
| | **(ii)** $\cos^{-1}\left(\cos\frac{\pi}{3}\right)$ = _____. | 1 |
| | **(iii)** A matrix having only one row is called a _____ matrix. | 1 |
| | **(iv)** $\frac{d}{dx}(e^x \sin x)$ = _____. | 1 |
| | **(v)** $\int e^x\,dx$ = _____. | 1 |
| | **(vi)** The scalar projection of $\vec{a}$ on $\vec{b}$ is _____. | 1 |
| **3.** | **(i)** *Write True or False:*<br>The identity function on $\mathbb{R}$ is one-one and onto. | 1 |
| | **(ii)** $\tan^{-1}(-x) = -\tan^{-1} x$ for every real x. | 1 |
| | **(iii)** If \|A\| = 0, the matrix A is singular. | 1 |
| | **(iv)** The function $e^x$ is strictly increasing on $\mathbb{R}$. | 1 |
| | **(v)** $\int \frac{dx}{1+x^2} = \tan^{-1} x + C.$ | 1 |
| | **(vi)** Two events A and B are independent if P(A ∩ B) = P(A) + P(B). | 1 |
| **4.** | Match column A with column B: | 7 |

| Column A | Column B |
|---|---|
| (i) $\int \frac{dx}{\sqrt{1-x^2}}$ | (a) $\frac{1}{1+x^2}$ |
| (ii) $\int \frac{dx}{1+x^2}$ | (b) $\sin^{-1} x + C$ |
| (iii) $\frac{d}{dx}\cos x$ | (c) $\hat{i}$ |
| (iv) $\frac{d}{dx}\tan^{-1} x$ | (d) $\tan^{-1} x + C$ |
| (v) $\int e^x[f(x) + f'(x)]dx$ | (e) $e^x f(x) + C$ |
| (vi) $\frac{d}{dx}a^x$ | (f) $a^x \log a$ |
| (vii) $\hat{j} \times \hat{k}$ | (g) $-\sin x$ |

| | | |
|---|---|---|
| **5.** | **(i)** *Write the answer in one word or one sentence:*<br>How many elements are there in a matrix of order 3 × 2? | 1 |
| | **(ii)** If $f(x) = x^3$, write f′(1). | 1 |
| | **(iii)** Write the value of $\int_{-1}^{1} x\,dx$. | 1 |
| | **(iv)** Write the order of the differential equation $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} = 0$. | 1 |

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| | | |
|---|---|---|
| | **(v)** Write the unit vector in the direction of $\hat{i} + \hat{j}$. | 1 |
| | **(vi)** If P(A ∩ B) = 0.2 and P(B) = 0.5, write P(A \| B). | 1 |
| | **(vii)** Write the direction ratios of the line $\frac{x-1}{2} = \frac{y+3}{4} = \frac{z}{5}$. | 1 |
| **6.** | Is the relation R = {(a, b): a ≤ b} on $\mathbb{R}$ symmetric? Justify. | 2 |
| **7.** | Prove that $\tan^{-1} 1 + \tan^{-1} 2 + \tan^{-1} 3 = \pi$. | 2 |
| **8.** | If $A = \begin{bmatrix} 1 & -1 \\ 2 & 3 \end{bmatrix}$, find $A^2$. | 2 |
| **9.** | Find x if $\begin{vmatrix} x & 4 \\ 2 & 2x \end{vmatrix} = 0$. | 2 |
| **10.** | Find $\frac{dy}{dx}$ if $y = \sin^{-1}(x^2)$. | 2 |
| **11.** | Show that $f(x) = x^3 + 2x$ is strictly increasing on $\mathbb{R}$. | 2 |
| **12.** | Find $\int \sin^2 x \, dx$. | 2 |
| **13.** | Evaluate $\int_1^2 \frac{dx}{x}$. | 2 |
| **14.** | Find the angle between $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$. | 2 |
| **15.** | A die is thrown twice. Find the probability that the sum of the numbers is 9. | 2 |
| **16.** | Show that f: $\mathbb{R} \to \mathbb{R}$, f(x) = 3x + 1 is one-one and onto, and find its inverse.<br>**OR**<br>Find the inverse of $A = \begin{bmatrix} 3 & 1 \\ 4 & 2 \end{bmatrix}$ using the adjoint. | 3 |
| **17.** | If $y = \log\left(x + \sqrt{x^2+1}\right)$, prove that $(x^2+1)\frac{d^2y}{dx^2} + x\frac{dy}{dx} = 0$.<br>**OR**<br>If $y = e^{2x} + e^{-3x}$, show that $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = 0$. | 3 |
| **18.** | Find $\int \frac{3x+2}{(x+1)(x+2)}\,dx$.<br>**OR**<br>Evaluate $\int_0^{\pi/4} \tan x \, dx$. | 3 |

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| | | |
|---|---|---|
| **19.** | A box contains 6 red and 4 white balls. Two balls are drawn at random without replacement. Find the probability that one is red and the other white.<br>**OR**<br>A coin is tossed twice. Find the probability distribution of the number of heads and its mean. | 3 |
| **20.** | Solve by the matrix method: x + 2y + z = 8, 2x – y + z = 3, x + y – z = 0.<br>**OR**<br>(a) Using determinants, find the area of the triangle with vertices (2, 7), (1, 1) and (10, 8). *[2]*<br>(b) Find k if the points (1, k), (2, 5) and (3, 8) are collinear. *[2]* | 4 |
| **21.** | Of all rectangles of area 100 cm², find the one with the least perimeter.<br>**OR**<br>Find the absolute maximum and minimum values of $f(x) = x^3 - 12x^2 + 45x$ on [0, 7]. | 4 |
| **22.** | Using integration, find the area of the region bounded by the curve $y = x^2$, the x-axis and the lines x = 1 and x = 3.<br>**OR**<br>Evaluate $\int_0^{\pi} x \sin x \, dx$. | 4 |
| **23.** | Solve the differential equation (x + y) dx – x dy = 0, x > 0.<br>**OR**<br>Solve graphically: Minimise Z = 3x + 5y subject to x + 2y ≥ 4, 3x + y ≥ 6, 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)** 9. *Working:* g(2) = 3 and f(3) = 9.

**(ii)** **(c)** $\frac{\pi}{2}$. *Working:* $\frac{\pi}{2} + 0$.

**(iii)** **(d)** 4. *Working:* A matrix and its transpose have equal determinants.

**(iv)** **(a)** $-2x\sin(x^2)$. *Working:* Chain rule.

**(v)** **(d)** 2. *Working:* $[-\cos x]_0^{\pi} = 1 + 1$.

**(vi)** **(b)** $e^x$. *Working:* $e^{\int 1\,dx}$.

**Question 2**

**(i)** reflexive.

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

**(iii)** row.

**(iv)** $e^x(\sin x + \cos x)$.

**(v)** $e^x + C$.

**(vi)** $\frac{\vec{a}\cdot\vec{b}}{|\vec{b}|}$.

**Question 3**

**(i)** True.

**(ii)** True.

**(iii)** True.

**(iv)** True: its derivative $e^x$ is always positive.

**(v)** True.

**(vi)** False: the condition is $P(A \cap B) = P(A)\,P(B)$.

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

**Question 5**

**(i)** 6.

**(ii)** 3.

**(iii)** 0.

**(iv)** 2.

**(v)** $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$.

**(vi)** 0.4.

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**(vii)** 2, 4, 5.

**6.** No (1): (1, 2) ∈ R since 1 ≤ 2, but (2, 1) ∉ R (1).

**7.** As 2 × 3 > 1, $\tan^{-1}2+\tan^{-1}3=\pi+\tan^{-1}\frac{5}{1-6}=\pi-\frac{\pi}{4}$ (1). Adding $\tan^{-1}1=\frac{\pi}{4}$ gives π (1).

**8.** $A^2=\begin{bmatrix}1-2 & -1-3\\ 2+6 & -2+9\end{bmatrix}$ (1) $=\begin{bmatrix}-1 & -4\\ 8 & 7\end{bmatrix}$ (1).

**9.** $2x^2-8=0$ (1), so $x=\pm2$ (1).

**10.** $\frac{1}{\sqrt{1-x^4}}\cdot 2x$ (1) $=\frac{2x}{\sqrt{1-x^4}}$ (1).

**11.** $f'(x)=3x^2+2$ (1), which is positive for every real x (1).

**12.** $\sin^2x=\frac{1-\cos 2x}{2}$ (1); integral $=\frac{x}{2}-\frac{\sin 2x}{4}+C$ (1).

**13.** $[\log x]_1^2$ (1) = log 2 (1).

**14.** $\cos\theta=\frac{\vec a\cdot\vec b}{|\vec a||\vec b|}=\frac{1}{\sqrt2\sqrt2}=\frac12$ (1), so $\theta=\frac{\pi}{3}$ (1).

**15.** Favourable: (3, 6), (4, 5), (5, 4), (6, 3), i.e. 4 of 36 (1). P = 1/9 (1).

**16.** f(a) = f(b) ⇒ 3a + 1 = 3b + 1 ⇒ a = b: one-one (1). For any y, x = (y − 1)/3 gives f(x) = y: onto (1). $f^{-1}(x)=\frac{x-1}{3}$ (1).

**OR** |A| = 6 − 4 = 2 (1). $\operatorname{adj}A=\begin{bmatrix}2 & -1\\ -4 & 3\end{bmatrix}$ (1). $A^{-1}=\frac12\begin{bmatrix}2 & -1\\ -4 & 3\end{bmatrix}$ (1).

**17.** $\frac{dy}{dx}=\frac{1}{x+\sqrt{x^2+1}}\left(1+\frac{x}{\sqrt{x^2+1}}\right)=\frac{1}{\sqrt{x^2+1}}$ (1). So $\sqrt{x^2+1}\,y'=1$; differentiating: $\sqrt{x^2+1}\,y''+\frac{x}{\sqrt{x^2+1}}y'=0$ (1). Multiplying by $\sqrt{x^2+1}$ gives the result (1).

**OR** $y'=2e^{2x}-3e^{-3x}$ (1). $y''=4e^{2x}+9e^{-3x}$ (1). $y''+y'=6e^{2x}+6e^{-3x}=6y$ (1).

**18.** $\frac{3x+2}{(x+1)(x+2)}=\frac{A}{x+1}+\frac{B}{x+2}$; x = −1 gives A = −1, x = −2 gives B = 4 (1½). Integral $=-\log|x+1|+4\log|x+2|+C$ (1½).

**OR** $\int\tan x\,dx=-\log|\cos x|$ (1). Value $=-\log\cos\frac{\pi}{4}+\log1=-\log\frac{1}{\sqrt2}$ (1) $=\frac12\log2$ (1).

**19.** P(red then white) = $\frac{6}{10}\cdot\frac{4}{9}$ and P(white then red) = $\frac{4}{10}\cdot\frac{6}{9}$ (1½). Total $=2\cdot\frac{24}{90}=\frac{8}{15}$ (1½).

**OR** P(X = 0) = 1/4, P(X = 1) = 1/2, P(X = 2) = 1/4 (2). Mean = 0 + 1/2 + 2/4 = 1 (1).

**20.** $A=\begin{bmatrix}1 & 2 & 1\\ 2 & -1 & 1\\ 1 & 1 & -1\end{bmatrix}$, |A| = 1(0) − 2(−3) + 1(3) = 9 (1). $\operatorname{adj}A=\begin{bmatrix}0 & 3 & 3\\ 3 & -2 & 1\\ 3 & 1 & -5\end{bmatrix}$ (1½).

$X=\frac19\begin{bmatrix}0 & 3 & 3\\ 3 & -2 & 1\\ 3 & 1 & -5\end{bmatrix}\begin{bmatrix}8\\3\\0\end{bmatrix}=\frac19\begin{bmatrix}9\\18\\27\end{bmatrix}$ (1), so x = 1, y = 2, z = 3 (½).

**OR** (a) $\frac12|2(1-8)+1(8-7)+10(7-1)|$ (1) $=\frac12|-14+1+60|=\frac{47}{2}$ square units (1).
(b) The area must be zero: 1(5 − 8) + 2(8 − k) + 3(k − 5) = 0 (1), so k − 2 = 0 and k = 2 (1).

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**21.** With sides x and 100/x, P = 2(x + 100/x) (1). $\frac{dP}{dx} = 2\left(1 - \frac{100}{x^2}\right) = 0$ at x = 10 (1). $\frac{d^2P}{dx^2} = \frac{400}{x^3} > 0$, a minimum (1). The rectangle is a square of side 10 cm, perimeter 40 cm (1).

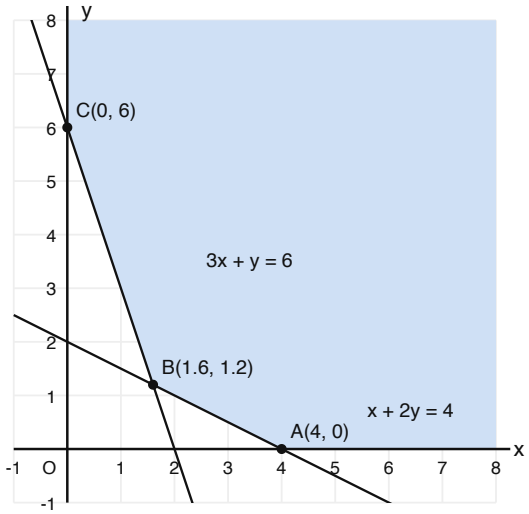
**OR** f′(x) = 3(x − 3)(x − 5) = 0 at x = 3, 5 (1). f(0) = 0, f(3) = 54, f(5) = 50, f(7) = 70 (2). Absolute maximum 70 at x = 7; absolute minimum 0 at x = 0 (1).

**22.** Area $= \int_1^3 x^2\,dx$ (1) $= \left[\frac{x^3}{3}\right]_1^3$ (1) $= 9 - \frac{1}{3}$ (1) $= \frac{26}{3}$ square units (1).

**OR** By parts: $\int x \sin x\,dx = -x\cos x + \sin x$ (2). Value $= \left(-\pi\cos\pi + \sin\pi\right) - 0$ (1) $= \pi$ (1).

**23.** $\frac{dy}{dx} = 1 + \frac{y}{x}$: homogeneous; put y = vx (1). $v + x\frac{dv}{dx} = 1 + v$, so $dv = \frac{dx}{x}$ (1). v = log x + C (1), i.e. $y = x\log x + Cx$ (1).

**OR** Feasible region (unbounded) (1½):




Corners A(4, 0), B(1.6, 1.2), C(0, 6): Z = 12, 10.8, 30 (1½). The half-plane 3x + 5y < 10.8 has no point in common with the region, so the minimum is 10.8 at x = 1.6, y = 1.2 (1).

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