Mind Curve Mid Term Mock Test Series 2026–27

Class XII | Test 01 – Answer Key (Step-by-Step Format)

Chapters 1–2: Relations & Functions and Inverse Trigonometric Functions

Q.No	Step-by-Step Solution	Marks per Step
	SECTION – A (Q1–10, 1 mark each)	
1	f : N ⟶ N is defined by f(n) = 2n + 1 If f(n_1) = f(n_2), then $2n_1 + 1 = 2n_2 + 1 \Rightarrow n_1 = n_2$, so f is one-one (injective) Range of f = {3, 5, 7, ...} (only odd numbers from 3 onwards), which is a proper subset of N So f is not onto, hence not surjective and not bijective **Answer: (b) injective**	*1 mark for the correct option.*
2	A bijective function from a set to itself is simply a permutation of its elements Number of permutations of a set with 106 elements = 106! **Answer: (c) 106!**	*1 mark for the correct option.*
3	$\frac{3\pi}{5}$ lies outside the principal range $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ of $\tan^{-1}$, since $\frac{3\pi}{5} > \frac{\pi}{2}$ Use $\tan^{-1}(\tan\theta) = \theta - \pi$ when $\theta \in (\frac{\pi}{2}, \pi]$ $\tan^{-1}(\tan(\frac{3\pi}{5})) = \frac{3\pi}{5} - \pi = -\frac{2\pi}{5}$ **Answer: (b) $-\frac{2\pi}{5}$**	*1 mark for the correct option.*
4	For a set with n elements, the number of reflexive relations = $2^{n^2 - n}$ Here n = 2 (A = {2,4}), so number of reflexive relations = $2^{4-2} = 2^2 = 4$ **Answer: (b) 4**	*1 mark for the correct option.*
5	f : R+ ⟶ R defined by f(x) = 4x + 3, where R+ is the set of non-negative reals f has slope 4 ≠ 0 on its domain, so $f(x_1) = f(x_2) \Rightarrow x_1 = x_2$, hence f is one-one For x ≥ 0, f(x) = 4x+3 takes values only in [3, ∞), which is a proper subset of the codomain R So f does not cover all of R, hence f is not onto **Answer: (a) One-one but not onto**	*1 mark for the correct option.*
6	$\cot^{-1}(-\sqrt{3})$: principal range of $\cot^{-1}$ is (0, π), and $\cot\left(\frac{5\pi}{6}\right) = -\sqrt{3}$, so $\cot^{-1}(-\sqrt{3}) = \frac{5\pi}{6}$ $\frac{\pi}{6} + \cot^{-1}(-\sqrt{3}) = \frac{\pi}{6} + \frac{5\pi}{6} = \pi$ $\cos(\pi) = -1$ **Answer: (a) -1**	*1 mark for the correct option.*
7	The graph is decreasing, starts at π when x = -1, passes through $\frac{\pi}{2}$ at x = 0, and ends at 0 when x = 1 This is exactly the shape of $y = \cos^{-1}x$, whose range is [0, π] and which is strictly decreasing on [-1, 1] **Answer: (b) $y = \cos^{-1}x$**	*1 mark for the correct option.*
8	$x^2 - 4xy + 3y^2 = 0$ factorises as $(x-y)(x-3y) = 0$, so R holds when x = y or x = 3y	*1 mark for the correct option.*

Q.No	Step-by-Step Solution	Marks per Step
	Reflexive: putting y = x gives $x^2 - 4x^2 + 3x^2 = 0$, always true, so $(x,x) \in R$ for every x — R is reflexive Symmetric: take $(3,1) \in R$ since $3 = 3(1)$; check (1,3): $1 - 12 + 27 = 16 \neq 0$, so $(1,3) \notin R$ — R is not symmetric **Answer: (b) reflexive but not Symmetric**	
9	Assertion (A): $\tan^{-1}(-1) = \frac{\pi}{4}$ — but the correct principal value is $\tan^{-1}(-1) = -\frac{\pi}{4}$, since $\tan\left(-\frac{\pi}{4}\right) = -1$ and $-\frac{\pi}{4}$ lies in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ So Assertion (A) is FALSE Reason (R): $\tan^{-1} : R \to \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ correctly states the domain and principal-value range of $\tan^{-1}$, so R is TRUE **Answer: (d) Assertion (A) is false, but Reason (R) is true**	*1 mark for the correct option.*
10	Assertion (A): $\cos\left[\cos^{-1}\left(\frac{2}{3}\right) + \sin^{-1}x\right] = 0 \Rightarrow \cos^{-1}\left(\frac{2}{3}\right) + \sin^{-1}x = \frac{\pi}{2}$ (since $\cos\left(\frac{\pi}{2}\right) = 0$) $\Rightarrow \sin^{-1}x = \frac{\pi}{2} - \cos^{-1}\left(\frac{2}{3}\right) = \sin^{-1}\left(\frac{2}{3}\right)$, using the identity $\sin^{-1}y + \cos^{-1}y = \frac{\pi}{2}$ $\Rightarrow x = \frac{2}{3}$, so Assertion (A) is TRUE Reason (R): $\sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$ is the standard identity used above, so R is TRUE and is the correct explanation of A **Answer: (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)**	*1 mark for the correct option.*
	SECTION – B (Q11–13, 2 marks each)	
11	**(A)** $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right) = \frac{\pi}{6}$ $2 \times \left(\frac{\pi}{6}\right) = \frac{\pi}{3}$, and $\sin\left(\frac{\pi}{3}\right) = \frac{\sqrt{3}}{2}$ $2 \times \left(\frac{\sqrt{3}}{2}\right) = \sqrt{3}$ $\tan^{-1}\left(\sqrt{3}\right) = \frac{\pi}{3}$ **Answer:** $\frac{\pi}{3}$	*1 mark for simplifying inside; 1 mark for the final value.*
11	**(B) [OR]** Let $x = \cos\theta$, so $\theta = \cos^{-1}x$, with $0 < x < \frac{1}{\sqrt{2}} \Rightarrow \theta \in \left(\frac{\pi}{4}, \frac{\pi}{2}\right)$ $2x^2 - 1 = 2\cos^2\theta - 1 = \cos 2\theta$, so $\frac{1}{2x^2-1} = \frac{1}{\cos 2\theta} = \sec 2\theta$ $\sec^{-1}(\sec 2\theta) = 2\theta$, valid since $2\theta \in \left(\frac{\pi}{2}, \pi\right)$ lies in the principal range of $\sec^{-1}$ **Answer: $2\cos^{-1}x$**	*1 mark for the substitution; 1 mark for the final simplified form.*
12	$\cos^{-1}\left(\frac{\sqrt{3}}{2}\right) = \frac{\pi}{6}$ $\cos^{-1}\left(-\frac{1}{2}\right) = \frac{2\pi}{3}$ Sum $= \frac{\pi}{6} + \frac{2\pi}{3} = \frac{\pi}{6} + \frac{4\pi}{6} = \frac{5\pi}{6}$ **Answer:** $\frac{5\pi}{6}$	*1 mark for evaluating both terms; 1 mark for the final sum.*

Q.No	Step-by-Step Solution	Marks per Step
13	Let $\cot^{-1}\left(-\frac{5}{12}\right) = \theta$, so $\theta \in (0, \pi)$ and $\cot\theta = -\frac{5}{12}$ Since $\cot^{-1}$ of a negative value lies in $\left(\frac{\pi}{2}, \pi\right)$, θ is in the second quadrant: $\sin\theta = \frac{12}{13}$, $\cos\theta = -\frac{5}{13}$ $\sin 2\theta = 2\sin\theta\cos\theta = 2 \times \left(\frac{12}{13}\right) \times \left(-\frac{5}{13}\right) = -\frac{120}{169}$ **Answer:** $-\frac{120}{169}$	*1 mark for finding sinθ, cosθ; 1 mark for the final value.*
	SECTION – C (Q14–15, 3 marks each)	
14	**(A)** $f : A \rightarrow B$, $A = R-\{3\}$, $B = R-\{1\}$, $f(x) = \frac{x-2}{x-3}$ One-one: let $f(x_1) = f(x_2) \Rightarrow \frac{x_1-2}{x_1-3} = \frac{x_2-2}{x_2-3} \Rightarrow (x_1-2)(x_2-3) = (x_2-2)(x_1-3)$ Expanding both sides and cancelling the $x_1\ x_2$ and constant terms gives −3x1−2x2 = −3x2−2x1 ⇒ $x_1 = x_2$, so f is one-one Onto: let y ∈ B; set $y = \frac{x-2}{x-3} \Rightarrow y(x-3) = x-2 \Rightarrow x(y-1) = 3y-2 \Rightarrow x = \frac{3y-2}{y-1}$, defined since $y \neq 1$ Checking $x \neq 3$: x = 3 would need 3y−2 = 3y−3, i.e. −2 = −3, which is impossible, so x ∈ A always Every y ∈ B has a pre-image x ∈ A, so f is onto **Answer: f is both one-one and onto, hence bijective.**	*1 mark for proving one-one; 2 marks for proving onto.*
14	**(B) [OR]** $f : R \rightarrow R$, $f(x) = 2x^2 + 3$ Not one-one: f(1) = 2(1)+3 = 5 and f(-1) = 2(1)+3 = 5, so f(1) = f(-1) but $1 \neq -1$ Not onto: for all x, $f(x) = 2x^2+3 \geq 3$, so range of f is $[3, \infty)$, a proper subset of the codomain R A value like y = -1 ∈ R has no pre-image, confirming f is not onto **Answer: f is neither one-one nor onto.**	*1 mark for disproving one-one; 2 marks for disproving onto.*
15	$1 + \sin x = \sin^2\left(\frac{x}{2}\right) + \cos^2\left(\frac{x}{2}\right) + 2\sin\left(\frac{x}{2}\right)\cos\left(\frac{x}{2}\right) = \left[\sin\left(\frac{x}{2}\right) + \cos\left(\frac{x}{2}\right)\right]^2$ $\cos x = \cos^2\left(\frac{x}{2}\right) - \sin^2\left(\frac{x}{2}\right) = \left[\cos\left(\frac{x}{2}\right) - \sin\left(\frac{x}{2}\right)\right]\left[\cos\left(\frac{x}{2}\right) + \sin\left(\frac{x}{2}\right)\right]$ $\frac{\cos x}{1+\sin x} = \frac{\cos\left(\frac{x}{2}\right) - \sin\left(\frac{x}{2}\right)}{\cos\left(\frac{x}{2}\right) + \sin\left(\frac{x}{2}\right)}$ Dividing numerator and denominator by $\cos\left(\frac{x}{2}\right)$: $= \frac{1 - \tan\left(\frac{x}{2}\right)}{1 + \tan\left(\frac{x}{2}\right)} = \tan\left(\frac{\pi}{4} - \frac{x}{2}\right)$ $\tan^{-1}\left[\frac{\cos x}{1+\sin x}\right] = \tan^{-1}\left[\tan\left(\frac{\pi}{4} - \frac{x}{2}\right)\right] = \frac{\pi}{4} - \frac{x}{2}$, valid for $-\frac{\pi}{2} < x < \frac{\pi}{2}$ **Answer:** $\frac{\pi}{4} - \frac{x}{2}$	*1 mark for rewriting cosx and 1+sinx; 1 mark for simplifying to a single tangent; 1 mark for the final answer.*
	SECTION – D (Q16–17, 4 marks each)	
16	**(i)** A = {1,2,3,4,5,6}, R = {(x,y) : y is divisible by x} For every x ∈ A, x is divisible by x (x|x is always true), so (x,x) ∈ R for all x ∈ A **Answer: R is reflexive.**	*(i) 1 mark for reflexive with reason.* *(ii) 1 mark for symmetric check.* *(iii) 1 mark for the count.*

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	(ii) Take x = 1, y = 2: 2 is divisible by 1, so (1,2) ∈ R Check (2,1): is 1 divisible by 2? No, so (2,1) ∉ R **Answer: R is not symmetric.** **(iii)** Number of reflexive relations on a set with n elements = 2^{n^2-n} Here n = 6, so the count = $2^{36-6} = 2^{30}$ **Answer:** 2^{30} **(iv)** R = {(1,2),(2,2),(1,3),(3,4),(3,1),(4,3),(5,5)} on A = {1,2,3,4,5,6} For R to be reflexive, (x,x) must be in R for every x ∈ A, but (1,1), (3,3), (4,4) and (6,6) are all missing **Answer: R is not reflexive, so R is not an equivalence relation.**	*(iv) 1 mark for the justification.*
17	**Symmetric?** R = {(L1,L2) : L1 is parallel to L2} on the set L of rail lines If L1 is parallel to L2, then L2 is also parallel to L1 **Answer: R is symmetric.** **Transitive?** If L1 is parallel to L2, and L2 is parallel to L3, then L1 is parallel to L3 **Answer: R is transitive.** **Set of lines related to y = 3x + 2** The line y = 3x + 2 has slope 3 Any line parallel to it must also have slope 3, i.e. of the form y = 3x + c for some real number c **Answer: {y = 3x + c : c ∈ R}**	*1 mark for symmetric.* *1 mark for transitive.* *2 marks for the set of parallel lines.*
SECTION – E (Q18–19, 5 marks each)		
18	(a,b) R (c,d) ⟺ ad(b+c) = bc(a+d). Dividing both sides by abcd (all natural numbers, so nonzero) simplifies this to $\frac{1}{a}-\frac{1}{b}=\frac{1}{c}-\frac{1}{d}$ Reflexive: for (a,b), $\frac{1}{a}-\frac{1}{b}=\frac{1}{a}-\frac{1}{b}$ trivially, so (a,b) R (a,b) for every (a,b) ∈ N×N Symmetric: if $\frac{1}{a}-\frac{1}{b}=\frac{1}{c}-\frac{1}{d}$, then clearly $\frac{1}{c}-\frac{1}{d}=\frac{1}{a}-\frac{1}{b}$, so (c,d) R (a,b) too Transitive: if $\frac{1}{a}-\frac{1}{b}=\frac{1}{c}-\frac{1}{d}$ and $\frac{1}{c}-\frac{1}{d}=\frac{1}{e}-\frac{1}{f}$, then $\frac{1}{a}-\frac{1}{b}=\frac{1}{e}-\frac{1}{f}$, so (a,b) R (e,f) Since R is defined by equality of the fixed quantity $\frac{1}{a}-\frac{1}{b}$, it is reflexive, symmetric and transitive, hence an equivalence relation For [(1,1)]: need $\frac{1}{c}-\frac{1}{d}=\frac{1}{1}-\frac{1}{1}=0$, i.e. c = d **Answer: R is an equivalence relation; [(1,1)] = {(c,c) : c ∈ N} = {(1,1),(2,2),(3,3),...}.**	*1 mark for reducing the condition to 1/a − 1/b = 1/c − 1/d.* *1 mark for reflexive.* *1 mark for symmetric.* *1 mark for transitive.* *1 mark for finding [(1,1)].*

Q.No	Step-by-Step Solution	Marks per Step
19	f : R+ → [-5, ∞), f(x) = 9x² + 6x − 5 = $(3x+1)^2 - 6$ One-one: let f(x_1) = f(x_2), i.e. 9x1² + 6x1 − 5 = 9x2² + 6x2 − 5 $9(x_1{}^2 - x_2{}^2) + 6(x_1 - x_2) = 0$ $9(x_1 - x_2)(x_1 + x_2) + 6(x_1 - x_2) = 0$ $(x_1 - x_2)[9(x_1 + x_2) + 6] = 0$ Since $x_1, x_2 \in$ R+, $x_1+x_2 \geq 0$, so $9(x_1+x_2)+6 \geq 6 > 0$, i.e. this factor is never zero So $x_1 - x_2 = 0$, giving $x_1 = x_2$, hence f is one-one Onto: find the range of f. Let y = f(x) = 9x² + 6x − 5; rewritten as a quadratic in x (treating y as a constant): 9x² + 6x − (5+y) = 0 By the quadratic formula, x = $\frac{-6 \pm \sqrt{D}}{18}$, where D = b² − 4ac = 6² − 4(9)(−(5+y)) D = 36 + 36(5+y) = 36(6+y) Let s = $\sqrt{6+y}$ then D = 36s², so $\sqrt{D}$ = 6s x = $\frac{-6 \pm 6s}{18} = \frac{-1 \pm s}{3}$, which gives two roots: x = $\frac{-1+s}{3}$ or x = $\frac{-1-s}{3}$ Since the domain is R^+ (x ≥ 0), the root x = $\frac{-1-s}{3}$ is rejected: So the only usable root is x = $\frac{-1+s}{3}$ For x to be real at all, need 6+y ≥ 0, i.e. y ≥ −6 (this is the discriminant condition, D = 36(6+y) ≥ 0) But x must also satisfy x ≥ 0 (domain R+): $\frac{-1+s}{3} \geq 0 \Leftrightarrow s \geq 1 \Leftrightarrow 6+y \geq 1 \Leftrightarrow y \geq -5$ This means every y in [−5, ∞) — precisely the given codomain — has a valid pre-image, so the range of f is [−5, ∞) Since range of f = codomain, f is onto **Answer: f is both one-one and onto, hence bijective.**	*2 marks for proving one-one (algebraic factoring method).* *3 marks for proving onto (quadratic-in-x / discriminant method).*