Inverse Trigonometric Functions

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The principal value of $\cos^{-1}(1/\sqrt{2})$ is:

(a) π/4 **(b)** −π/4 **(c)** 3π/4 **(d)** π/6

2. $\tan^{-1}(\tan(4\pi/3))$ equals:

(a) π/3 **(b)** 4π/3 **(c)** −π/3 **(d)** 2π/3

3. $\cot(\cos^{-1}(5/13))$ equals:

(a) 5/12 **(b)** 12/5 **(c)** 12/13 **(d)** 5/13

4. If $\text{cosec}^{-1}\, x = 2\pi/7$, then $\sec^{-1}\, x$ equals:

(a) −2π/7 **(b)** 2π/7 **(c)** 5π/7 **(d)** 3π/14

5. The principal value branch of $\sin^{-1}$ is:

(a) (0, π) **(b)** [−π/2, π/2] **(c)** [0, π] **(d)** (−π/2, π/2)

6. $\tan^{-1}(5/6) + \tan^{-1}(1/7)$ equals:

(a) $\tan^{-1}(41/37)$ **(b)** $\tan^{-1}(29/47)$ **(c)** $\tan^{-1}(41/42)$ **(d)** $\tan^{-1}(41/47)$

7. If $\sin^{-1} x = 7\pi/18$, then $\sin^{-1}(-x)$ equals:

(a) π/9 **(b)** 11π/18 **(c)** 7π/18 **(d)** −7π/18

8. Assertion (A): $\cos^{-1}(\cos(\pi/2)) = \pi/2$.
Reason (R): $\cos^{-1}(\cos\theta) = \theta$ only when θ lies in the principal branch of $\cos^{-1}$.

(a) Both A and 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.

Section B — Short answer — 8 × 2 = 16 marks

9. Find the principal values of (a) $\sec^{-1}(2/\sqrt{3})$, (b) $\sin^{-1}(1)$, (c) $\sin^{-1}(-1/\sqrt{2})$.

10. Find the value of $\cos^{-1}(1/2) + \sec^{-1}(-2) - \sec^{-1}(-1)$.

11. Find the value of $\tan^{-1}(\tan(4\pi/3))$.

12. Find the value of $\tan(\cos^{-1}(12/13))$.

13. Find the value of $\cos(\cos^{-1}(\sqrt{3}/2) + \operatorname{cosec}^{-1}(-2/\sqrt{3}))$.

14. Solve $\cot^{-1}(4x + 5) = \pi/4$.

15. Show that $\tan^{-1}(5/6) + \tan^{-1}(1/11) = \pi/4$.

16. Find the domain of $f(x) = \sin^{-1}(3x - 4)$.

Section C — Word problems — 4 × 4 = 16 marks

17. Find the principal values of $\operatorname{cosec}^{-1}(2/\sqrt{3})$, $\cot^{-1}(\sqrt{3})$, $\sec^{-1}(-1)$, and hence the value of their sum.

18. Write $\tan^{-1}(4/7) + \tan^{-1}(1/3)$ as a single inverse tangent, and say why the formula applies.

19. Let $\theta = \cos^{-1}(9/41)$. Find $\sin\theta$, $\cos\theta$, $\tan\theta$, $\sin 2\theta$ and $\cos 2\theta$.

20. Solve $\tan^{-1} 6x + \tan^{-1} 20x = \pi/4$.

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Answer key

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Q	Answer	Working
1	**(a) π/4**	the value must lie in the principal branch of $\cos^{-1}$
2	**(a) π/3**	4π/3 is outside the principal branch; tan(4π/3) = tan(π/3) and π/3 lies in it
3	**(a) 5/12**	a right triangle with opposite side 12, adjacent side 5, hypotenuse 13
4	**(d) 3π/14**	$\operatorname{cosec}^{-1} x + \sec^{-1} x = \pi/2$
5	**(b) [−π/2, π/2]**	—
6	**(a) $\tan^{-1}$ (41/37)**	$\tan^{-1} a + \tan^{-1} b = \tan^{-1}((a + b)/(1 - ab))$ for ab < 1: (41/42)/(37/42)
7	**(d) −7π/18**	$\sin^{-1}(-x) = -\sin^{-1} x$
8	**(a) Both A and R are true, and R is the correct explanation of A.**	A is true: π/2 lies in the principal branch of $\cos^{-1}$. R is true and explains A.
9	**(a) π/6; (b) π/2; (c) −π/4**	pick the angle in each principal branch
10	**0**	$\cos^{-1}(1/2) = \pi/3$, $\sec^{-1}(-2) = 2\pi/3$, $\sec^{-1}(-1) = \pi$
11	**π/3**	tan(4π/3) = tan(π/3), and π/3 is in the principal branch
12	**5/12**	let $\theta = \cos^{-1}(12/13)$; the triangle has sides 5, 12, 13
13	**√3/2**	π/6 − π/3 = −π/6
14	**x = −1**	4x + 5 = cot(π/4) = 1
15	**π/4**	(a + b)/(1 − ab) = (61/66)/(61/66) = 1, and ab < 1
16	**[1, 5/3]**	−1 ≤ 3x − 4 ≤ 1
17	**$\operatorname{cosec}^{-1}(2/\sqrt{3}) = \pi/3$, $\cot^{-1}(\sqrt{3}) = \pi/6$, $\sec^{-1}(-1) = \pi$; sum = 3π/2**	each value from its principal branch
18	**$\tan^{-1}$ (19/17)**	ab = 4/21 < 1, so $\tan^{-1} a + \tan^{-1} b = \tan^{-1}((a + b)/(1 - ab)) = \tan^{-1}((19/21)/(17/21))$
19	**sin θ = 40/41, cos θ = 9/41, tan θ = 40/9, sin 2θ = 720/1681, cos 2θ = −1519/1681**	$\sin 2\theta = 2 \sin\theta \cos\theta$; $\cos 2\theta = \cos^2\theta - \sin^2\theta$
20	**x = 1/30**	$(26x)/(1 - 120x^2) = 1 \Rightarrow 120x^2 + 26x - 1 = 0 \Rightarrow x = 1/30$ or x = −1/4; the negative root makes the left side negative, so reject it

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