

1. Simplify the expression: $\sin\left(\frac{\pi}{2} + x\right) + \cos(\pi + x)$
(A) 0 (B) $2 \cos x$ (C) $-2 \cos x$ (D) $2 \sin x$ (E) NOTA
2. If $\sin 2\theta = \frac{7}{9}$ and $0 < \theta < \frac{\pi}{2}$, what is $\sin \theta + \cos \theta$?
(A) $\frac{4}{3}$ (B) $\frac{7}{6}$ (C) $\frac{5}{4}$ (D) $\frac{2}{3}$ (E) NOTA
3. For a given angle θ , find the value of $\cos \theta$ if $\tan \theta = \frac{2}{\sqrt{5}}$ and $\sin \theta < 0$.
(A) $\frac{2}{3}$ (B) $-\frac{2}{3}$ (C) $\frac{\sqrt{5}}{3}$ (D) $-\frac{\sqrt{5}}{3}$ (E) NOTA
4. Which of the following parametric equations represent the elliptic equation $25(x - 3)^2 + 4(y + 1)^2 = 100$?
A) $x = 5 \cos \theta + 3, y = 2 \sin \theta - 1$
B) $x = 5 \sin \theta - 3, y = 4 \cos \theta + 1$
C) $x = 2 \cos \theta + 3, y = 5 \sin \theta - 1$
D) $x = 2 \cos \theta - 3, y = 5 \sin \theta + 1$
E) NOTA
5. Which one of the following is positive value when the point $P(-4,5)$ is on the terminal side of angle θ in standard position?
(A) $\sin \theta \cos \theta$ (B) $\csc \theta \tan \theta$ (C) $\tan \theta \sin \theta$ (D) $\sin \theta \sec \theta$
(E) NOTA
6. Evaluate $\sum_{n=1}^{180} \cos n^\circ$.
(A) 0 (B) 1 (C) 2 (D) -1 (E) NOTA
7. If $\sin \theta$ and $\cos \theta$ are two roots of an equation $x^2 + ax + b = 0$ for some angle θ , which of the following must be true?
(A) $a^2 + 2b = -1$ (D) $a^2 + 4b = -1$
(B) $a^2 - 2b = 1$ (E) NOTA
(C) $a^2 - 4b = 1$
8. Which one of the following is equal to $\arcsin\left(\frac{1}{5}\right) + \arccos\left(\frac{1}{5}\right) + \arctan\left(\frac{1}{5}\right) + \operatorname{arccot}\left(\frac{1}{5}\right)$?
(A) 0 (B) $\frac{\pi}{2}$ (C) π (D) $\frac{3\pi}{2}$ (E) NOTA

9. Find the sum of all roots of the equation $\cos^2 x - \sin x = 1$ where $0 < x < 2\pi$.
- (A) $\frac{\pi}{2}$ (B) π (C) 2π (D) $\frac{5\pi}{2}$ (E) NOTA
10. Simplify $\arccos\left(\cos\frac{5\pi}{4}\right)$.
- (A) $\frac{\pi}{4}$ (B) $\frac{3\pi}{4}$ (C) $\frac{5\pi}{4}$ (D) $-\frac{\pi}{4}$ (E) NOTA
11. Which one of the following trigonometric expression is identical to $\cos x \cdot (\sec x - \cos x)$?
- (A) $\cos^2 x$ (D) $\sin x \cos x$
 (B) $\sin^2 x$ (E) NOTA
 (C) $\tan^2 x$
12. When $\cos \theta = -\frac{5}{13}$, what is the value of $\cos 2\theta$?
- (A) $\frac{25}{169}$ (B) $-\frac{50}{169}$ (C) $\frac{144}{169}$ (D) $-\frac{119}{169}$ (E) NOTA
13. What is the value of $\sin\left(2\arcsin\frac{1}{3}\right)$?
- (A) $\frac{2}{3}$ (B) $\frac{4\sqrt{2}}{3}$ (C) $\frac{4\sqrt{2}}{9}$ (D) $\frac{2}{9}$ (E) NOTA
14. Given that $\sin x - \sin y = \frac{4}{5}$ and $\cos x + \cos y = \frac{3}{5}$, find $\cos(x + y)$.
- (A) $\frac{3}{4}$ (B) $-\frac{3}{4}$ (C) $-\frac{1}{2}$ (D) $\frac{1}{2}$ (E) NOTA
15. Which of the following angles satisfies the inequality $2^{\cos x} + 2^{\sin x} < 2^{\cos x + \sin x} + 1$?
- (A) 36° (B) 110° (C) 292° (D) 310° (E) NOTA
16. Let $f(x) = \sin x$ and $g(x) = \cos x$ be two functions defined on $[0, \frac{\pi}{2}]$. Which of the four functions, $f(f(x)), f(g(x)), g(f(x)), g(g(x))$, are increasing over $[0, \frac{\pi}{2}]$?
- (A) $f(g(x))$ and $g(f(x))$ (D) $f(f(x))$ and $g(f(x))$
 (B) $f(f(x))$ and $g(g(x))$ (E) NOTA
 (C) $f(g(x))$ and $g(g(x))$
17. If $\tan \theta + \cot \theta = 5$, what is the value of $\csc^2 \theta + \sec^2 \theta$?
- (A) 2 (B) 5 (C) 23 (D) 25 (E) NOTA

18. When the solution set of the equation

$$[\sin x] + [2\sin x] + [3\sin x] = 1 \text{ for } x \text{ in } \left[0, \frac{\pi}{2}\right] \text{ is written as } \alpha \leq x < \beta,$$

what is $\cos(\alpha + \beta)$? ($[x]$ is the greatest integer function of x .)

(A) $\frac{\sqrt{6}}{3} + \frac{1}{6}$ (B) $\frac{\sqrt{6}}{3} - \frac{1}{6}$ (C) $\frac{\sqrt{6}}{6} + \frac{1}{3}$ (D) $\frac{\sqrt{6}}{6} - \frac{1}{3}$ (E) NOTA

19. Which of the following intervals can be a restricted domain of the function $f(x) =$

$$\frac{1}{\sqrt{1-4\sin^2 x}}?$$

(A) $-\frac{\pi}{3} < x < \frac{\pi}{3}$ (B) $\frac{\pi}{3} < x < \frac{2\pi}{3}$ (C) $\frac{\pi}{6} < x < \frac{5\pi}{6}$ (D) $\frac{5\pi}{6} < x < \frac{7\pi}{6}$
(E) NOTA

20. Which pair of the following graphs coincide?

a) $y = 3 \sin 2 \left(x - \frac{\pi}{4}\right)$

b) $y = -3 \sin 2x$

c) $y = -3 \cos 2x$

d) $y = 3 \cos 2 \left(x - \frac{\pi}{4}\right)$

(A) a and b (B) b and c (C) c and d (D) a and c (E) NOTA

21. Four points A, B, C, D lie on a circle to form a quadrilateral $ABCD$. Let $\alpha, \beta, \gamma, \delta$ denote four interior angles of the quadrilateral associated with A, B, C, D , respectively. Which of the following is NOT true?

(A) $\cos \beta \cos \delta = \sin \beta \sin \delta + 1$

(D) $\cos \beta + \cos \delta = 0$

(B) $\sin \alpha \cos \gamma + \cos \alpha \sin \gamma = 0$

(E) NOTA

(C) $\sin^2 \alpha + \cos^2 \gamma = 1$

22. What is $\cot 80^\circ \cot 55^\circ + \cot 80^\circ + \cot 55^\circ$?

(A) 0

(B) 1

(C) 2

(D) 3

(E) NOTA

23. Let a_n be a sequence which represents the number of intersecting points of two graphs, $y = \sin x$ and $y = \cos 2nx$, over the open interval $(0, 2\pi)$. Write the general term of the sequence a_n .

(A) $2n$

(B) $4n$

(C) $4n - 1$

(D) $8n - 5$

(E) NOTA

24. Which of the following is equal to the sum of the infinite geometric series

$$\sin x + \sin x \cos^2 x + \sin x \cos^4 x + \sin x \cos^6 x + \dots \text{ for } x \text{ in } (0, \pi)?$$

(A) $\sin x$

(B) $\csc x$

(C) $\cos x$

(D) $\cos x$

(E) NOTA

25. How many solutions to the equation $\cos^2 x - 3 \cos x - 4 = 0$ are there on the open interval $(0, 2\pi)$?
- (A) 1 (B) 2 (C) 3 (D) 4 (E) NOTA
26. Aaron and Bill watch a drone flying 120 feet above the horizontal ground. The angle of the elevation from Aaron to the drone is 45° and from Bill to the drone is 60° . Assuming that the positions of Aaron and Bill and the point of perpendicular projection from the drone to the ground form a line, what is the smaller possible distance between Aaron and Bill?
- (A) $120 - 40\sqrt{3}$ (B) $120 - 120\sqrt{3}$ (C) $120 + \sqrt{3}$
(D) $120\sqrt{3}$ (E) NOTA
27. Let F_n be the sequence with $F_1 = F_2 = 1, F_{n+2} = F_{n+1} + F_n$. Define a sequence, z_n , of complex numbers by $z_n = \cos F_n + i \sin F_n$. Which of the following is true for z_n ?
- (A) $z_{n+2} = z_{n+1} + z_n$ (D) $z_n^2 = z_{2n}$
(B) $z_{n+1} = 2z_n$ (E) NOTA
(C) $z_{n+2} = z_{n+1}z_n$
28. Let G_n be the sequence with $G_1 = 1, G_{n+1} = 2G_n$. Define a sequence, w_n , of complex numbers by $w_n = \cos G_n + i \sin G_n$. Which of the following is true for w_n ?
- (A) $w_{n+2} = w_{n+1} + w_n$ (D) $w_n^2 = w_{n+1}$
(B) $w_{n+1} = 2w_n$ (E) NOTA
(C) $w_{n+2} = w_{n+1}w_n$
29. Which of the following is equal to $\cos \frac{2\pi}{5}$?
- (A) $\frac{\sqrt{5}+1}{4}$ (B) $\frac{\sqrt{5}-1}{4}$ (C) $\frac{\sqrt{6}+\sqrt{2}}{4}$ (D) $\frac{\sqrt{6}-\sqrt{2}}{4}$ (E) NOTA
30. Evaluate the product: $\sin 10^\circ \sin 30^\circ \sin 50^\circ \sin 70^\circ$
- (A) $\frac{1}{8}$ (B) $\frac{1}{16}$ (C) $\frac{1}{32}$ (D) $\frac{1}{64}$ (E) NOTA