

NOTA means "None of the above"

1. $\sin^{-1}\left(\cos\frac{19\pi}{6}\right)=?$

- a)
- $\frac{-\pi}{3}$
- b)
- $\frac{-\pi}{6}$
- c)
- $\frac{4\pi}{3}$
- d)
- $\frac{5\pi}{3}$
- e) NOTA

2. Find the cosine of the acute angle formed by vectors $\langle 3, -2, 1 \rangle$ and $\langle -1, 2, 5 \rangle$

- a)
- $\frac{-\sqrt{420}}{210}$
- b)
- $\frac{-\sqrt{406}}{203}$
- c)
- $\frac{-\sqrt{105}}{105}$
- d)
- $\frac{2\sqrt{273}}{105}$
- e) NOTA

3. Find the equation of the tangent line that intersects the circle $x^2 + y^2 - 12x + 8y + 7 = 0$ at the point (3,2). Answer must be in $Ax + By = C$ form, with $A > 0$ and A, B, and C are relatively prime.

- a)
- $x - 2y = -1$
- b)
- $3x - 2y = 5$
- c)
- $2x - y = 4$
- d)
- $2x + y = 8$
- e) NOTA

4. The cable of a suspension bridge has supporting towers that are 24 yards high and 80 yards apart. The cable lies in a parabolic shape. If the lowest point of the cable is 4 yards above the floor of the bridge, find the height in yards of a supporting rod 30 yards from the center of the span.

- a)
- $\frac{51}{4}$
- b)
- $\frac{25}{4}$
- c)
- $\frac{131}{8}$
- d)
- $\frac{61}{4}$
- e) NOTA

5. Find the sum of the smallest and largest real solutions for: $y^5 + 3y^4 - 3y^3 - 9y^2 - 4y - 12 = 0$.

- a) 1 b) -5 c) -3 d) -1 e) NOTA

6. Nine Mu Alpha Theta competitors are getting ready for a ciphering competition. If 3 of the competitors are clearly superior competitors to the rest and are sure to be in the top three, in how many ways can the competition end?

- a) 720 b) 726 c) 4320 d) 12,960 e) NOTA

7. If $\sin x + \cos x = k$, evaluate $\cos^2(2x)$ in terms of k.

- a)
- $-2k^2$
- b)
- $-2k^2 - 2k$
- c)
- $-k^4 + 2k^2$
- d)
- $k^4 - 2k^2 + 1$
- e) NOTA

8. If $\tan \theta = \frac{3}{4}$, $0 \leq \theta < \frac{\pi}{2}$ and $\sin \beta = \frac{-5}{13}$, $\pi \leq \beta < \frac{3\pi}{2}$, find $\cos(\theta + \beta)$.

- a)
- $\frac{-33}{165}$
- b)
- $\frac{-27}{65}$
- c)
- $\frac{33}{165}$
- d)
- $\frac{63}{65}$
- e) NOTA

9. A vertical pole casts a shadow 12 units wide at one time and 4 units at a later time, when the angle of the line of sight to the sun and the horizontal is doubled. Find the height of the pole.

- a) 20 b) 15 c) 6 d) $4\sqrt{3}$ e) NOTA

10. If X varies inversely as the square of Y. What happens to X if Y is cut in half?

- a) Divided by 4 b) Quadruples c) Halved d) Doubles e) NOTA

11. The graph of $g(x)$ has domain $-4 \leq x \leq 4$ and range $-3 \leq y \leq 2$. What is the range of

$$|g(x-2)| - 4?$$

- a) $[-7, -2]$ b) $[-4, -1]$ c) $[-4, 1]$ d) $[-4, -2]$ e) NOTA

12. Solve for k: $(1-i)^k = 4096$. $i = \sqrt{-1}$.

- a) 12 b) 18 c) 24 d) 48 e) NOTA

13. Find the area of the convex quadrilateral with the following vertices: F(1,2), A(2,7), S(4,5), and T(-6,1).

- a) 23 b) 46 c) 3 d) 24 e) NOTA

14. Solve for x: $2(e^{\ln(x+3)})(\ln e^{(2x-3)}) = \frac{1}{2}e^{\ln(-6x+20)}$

- a) -4 b) $\frac{7}{4}$ c) $\frac{9}{4}$ d) $\frac{-9+8\sqrt{7}}{8}$ e) NOTA

15. Find the slope of the line that passes through the intersection points of the curves $y = 4 \cos x$ and $y = 2 \csc x$, where $0 \leq x \leq 2\pi$

- a) 0 b) $\frac{-4\sqrt{2}}{\pi}$ c) $\frac{\pi}{4}$ d) $\frac{-\pi}{4}$ e) NOTA

16. If $\csc^2 \frac{\theta}{7} + \csc^2 \frac{2\theta}{7} + \csc^2 \frac{3\theta}{7} + \csc^2 \frac{4\theta}{7} = \frac{5}{7}$, then what does $\cot^2 \frac{\theta}{7} + \cot^2 \frac{2\theta}{7} + \cot^2 \frac{3\theta}{7} + \cot^2 \frac{4\theta}{7} = ?$

- a) $\frac{-2}{7}$ b) $\frac{-23}{7}$ c) $\frac{23}{7}$ d) $\frac{33}{7}$ e) NOTA

17. If $\tan 2\theta = \frac{3}{4}$ for $\left(\frac{\pi}{2} < \theta < \pi\right)$, then the value of $\cos \theta$ is?

- a) $\frac{-3\sqrt{10}}{10}$ b) $\frac{3\sqrt{10}}{10}$ c) $\frac{-\sqrt{10}}{10}$ d) $\frac{\sqrt{10}}{10}$ e) NOTA

18. If the coefficient of the 4th and 10th terms in the expansion of $(w - f)^n$ are equal, find the 8th term.

- a) $-3003w^6f^7$ b) $-330w^5f^7$ c) $-495w^5f^7$ d) $-792w^5f^7$ e) NOTA

19. What is the sum of the real solutions to the equation: $y^{\log y} = \frac{y^5}{1000000}$?

- a) 100 b) 1100 c) 100010 d) 1000000.1 e) NOTA

20. The latus rectum of the parabola with equation $(x - 2)^2 = 12(y - 4)$ coincides with the diameter of a circle. If the equation of the circle is written in the form $x^2 + y^2 + dx + ey + f = 0$, what does $d + e + f = ?$

- a) -28 b) -1 c) 26 d) 36 e) NOTA

21. Given a right triangle with legs equal to $\log x$ and $2\sqrt{\log x}$ and hypotenuse $2\sqrt{3}$ with $x > 1$. What does $\sin \theta$ equal if θ is the angle opposite the side whose length is $\log x$?

- a) $-\sqrt{3}$ b) $\sqrt{3}$ c) $\frac{\sqrt{3}}{3}$ d) $\frac{\sqrt{6}}{3}$ e) NOTA

22. Given $\sin(4\theta) = \frac{8}{17}$ find $(\cos \theta - \sin \theta)^2$. (assume $0 < \theta < 22.5$).

- a) $\frac{-15}{17}$ b) $\frac{15}{17}$ c) $\frac{\sqrt{17}}{17}$ d) $\frac{17 - \sqrt{17}}{17}$ e) NOTA

23. If $\cot \phi = x$ and $\cot \theta = y$, find $\cot(\phi - \theta)$ in terms of x and y , for $xy \neq 0$, and $|x| \neq |y|$.

- a) $\frac{xy - 1}{x + y}$ b) $\frac{xy + 1}{y - x}$ c) $\frac{x - y}{xy + 1}$ d) $\frac{y - x}{xy + 1}$ e) NOTA

24. Find the radius of the circle that passes through the points $(1, -2)$, $(5, 4)$, and $(10, 5)$.

- a) $\sqrt{82}$ b) $\sqrt{65}$ c) $\sqrt{29}$ d) $2\sqrt{13}$ e) NOTA

25. If $(x + 3)$ is a factor of $x^3 - x^2 - kx + 21$. Which of the following is the product of the remaining roots?

- a) 7 b) -7 c) 5 d) -5 e) NOTA

26. Find n so that the function defined by $f(x) = \frac{x+5}{x+n}$ will be its own inverse.

- a) -1 b) 1 c) 4 d) 5 e) NOTA

27. f is an even function, g and h are odd functions, all three are polynomials. Given:

$$f(1) = 0 \quad f(4) = 2 \quad f(3) = 6$$

$$g(1) = -1 \quad g(-2) = 4 \quad g(5) = 3$$

$$h(1) = 2 \quad h(3) = 5 \quad h(6) = 3$$

Find $f(g(h(1))) + g^{-1}(h(f(-3))) + h(f(g(-1)))$

- a) -1 b) 1 c) -7 d) 7 e) NOTA

28. How many odd numbers between 450 and 700 can be formed using only the digits 3, 4, 5, 6, 7, and 8?

- a) 32 b) 37 c) 45 d) 48 e) NOTA

29. What is the product of the solutions: $\log_{243} x - \log_x 9 = \frac{3}{5}$.

- a) $\frac{1}{9}$ b) 3 c) 27 d) 729 e) NOTA

30. The following table defines the operation $\&$ on a set of four elements: 0, 1, 2, and 3. For example, $1\&3 = 2$, because 2 is in the box to the right of 1 and below 3 in the table. What is the identity element for $\&$?

$\&$	0	1	2	3
0	1	0	0	3
1	1	0	1	2
2	1	0	2	1
3	1	0	3	0

- a) 0 b) 1 c) 2 d) 3 e) NOTA