For all questions, answer choice "E) NOTA" means none of the above answers is correct.

1. What is the measure of the acute angle formed by the vectors $\langle 3,4,5\rangle$ and $\langle -1,2,2\rangle$?

A) $\sqrt{2}/2$ B) $\sqrt{3}/2$ C) 30° D) 45° E) NOTA

2. What is the smaller value of the two slopes of the asymptotes of the graph of $x^2+2xy-y^2=1$?

A) $1+\sqrt{2}$ B) $1-\sqrt{2}$ C) $\sqrt{2}-1$ D) $-\sqrt{2}-1$ E) NOTA

3. What is the shortest distance between two points on the graphs of $y=\sqrt{-4x-x^2}$ and $y=11-2x$, one point on each graph?

A) $\frac{11\sqrt{5}}{10}$ B) 5 C) $3\sqrt{5}$ D) $\frac{11\sqrt{5}-20}{10}$ E) NOTA

4. The vertices of a pentagonal region are, in order, $(1,8)$, $(3,4)$, $(-1,-2)$, $(0,4)$, and $(-7,3)$. What is the area enclosed by this region?

A) 28.5 B) 36.5 C) 49 D) 24.5 E) NOTA

5. The points $(2,1,3)$, $(-1,2,1)$, and $(4,0,5)$ define a plane. Which of the following points is also on the plane?

A) $(92,5,2)$ B) $(213,4,3)$ C) $(-11,1,5)$ D) $(-156,-2,9)$ E) NOTA

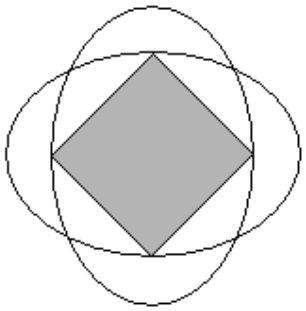
6. What is the focus of the parabola defined by the equations $x=8t^2+6$ and $y=4t-2$?

A) $(6.5,-2)$ B) $(5.5,-2)$ C) $(-2.5,6)$ D) $(-1.5,6)$ E) NOTA

7. The graph of $y=\sqrt{3+2x-x^2}+2$ is reflected across the x-axis, then rotated 90° clockwise around the point $(-3,-4)$. What is the largest y-value of a point on the resulting figure?

A) -2 B) -4 C) -6 D) -8 E) NOTA

8. The figure to the right shows two ellipses whose major axes are perpendicular to each other. Each ellipse passes through the other ellipse's foci (which form a square when connected, as shown). Given that the square encloses an area of 16, what is the area enclosed by one of the ellipses?



A) $4\pi\sqrt{2}$ B) $8\pi\sqrt{2}$ C) 16π D) $16\pi\sqrt{2}$ E) NOTA

9. The slope of the line drawn tangent to the curve $y=\sin x$ at the point where $x=a$ is equal to $\cos a$. Use this fact to find the value of x on the graph of $y=\sin x$ for which the distance between the graphs of $y=\sin x$, restricted to the domain $[0,\pi]$, and the line $x+2y=6$ is minimized.

A) $\pi/3$ B) $\pi/2$ C) $2\pi/3$ D) $5\pi/6$ E) NOTA

10. Which of the following transformation matrices A rotates the point (x,y) counterclockwise around the origin 90°, then projects the resulting point onto the x-axis? Note that transformations occur by $A\begin{bmatrix}x\\y\end{bmatrix}=\begin{bmatrix}x'\\y'\end{bmatrix}$.

A) $\begin{bmatrix}0 & -1\\0 & 0\end{bmatrix}$ B) $\begin{bmatrix}1 & 0\\0 & 0\end{bmatrix}$ C) $\begin{bmatrix}0 & 0\\1 & 0\end{bmatrix}$ D) $\begin{bmatrix}-1 & 0\\0 & 0\end{bmatrix}$ E) NOTA

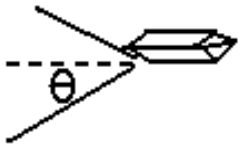
11. Find the length of the shortest path that can be drawn from the point $(6,3)$ to the point $(2,8)$ such that the path touches both the x-axis and the y-axis once.

A) $3\sqrt{5}+2\sqrt{17}$ B) $\sqrt{149}$ C) 14 D) $\sqrt{185}$ E) NOTA

12. In the Cartesian coordinate system, consider the fixed points $c_1=(-4,0)$ and $c_2=(2,0)$. The measure of the acute angle formed by the x-axis and the segment drawn from c_1 to some other point P is 30°. The measure of the acute angle formed by the x-axis and the segment drawn from c_2 to P is 60°. If $P=(m,n)$, what is the sum of all possible positive products mn?

A) $\frac{57\sqrt{3}}{4}$ B) $15\sqrt{3}$ C) $\frac{63\sqrt{3}}{4}$ D) $\frac{33\sqrt{3}}{2}$ E) NOTA

13. The waves that propagate from the sides of a boat and the boat's axis of symmetry form an acute angle θ (as shown in the diagram to the right). $\tan\theta$ is inversely proportional to the boat's speed, in miles/hour. If $\sin\theta = 1/2$ when the boat is traveling at 15 miles/hour, what is $\cos\theta$ when the boat is traveling at 20 miles/hour?



A) $4/5$ B) $\sqrt{51}/17$ C) $\sqrt{57}/19$ D) $\sqrt{3}/4$ E) NOTA

14. If $\vec{u} = \langle 6,4 \rangle$ and $\vec{v} = \langle 4,7 \rangle$, find the vector that is the projection of $\vec{u}$ onto $\vec{v}$.

A) $\left\langle \frac{8}{5}, \frac{14}{5} \right\rangle$ B) $\left\langle \frac{12}{5}, \frac{21}{5} \right\rangle$ C) $\left\langle \frac{16}{5}, \frac{28}{5} \right\rangle$ D) $\left\langle \frac{28}{9}, \frac{49}{9} \right\rangle$ E) NOTA

15. How many petals are on the graph of $r = 2\sin 9\theta$?

A) 4 B) 9 C) 18 D) 36 E) NOTA

16. Determine the positive value of k such that the lines $3kx + 4y = 18$ and $2x - 5\sqrt{k}y = 3$ are perpendicular.

A) $10/3$ B) $100/9$ C) $3/10$ D) $9/100$ E) NOTA

17. A triangle has vertices at the points $(1,3)$, $(4,5)$, and $(7,1)$. What is the length of the longest altitude of the triangle?

A) $9\sqrt{10}/20$ B) $9\sqrt{10}/10$ C) $9\sqrt{13}/13$ D) $18\sqrt{13}/13$ E) NOTA

18. The set of all points in space equidistant from the points $(2,3,2)$ and $(-4,1,4)$ is given by the equation $x + By + Cz = D$ for real values B, C, and D. What is the value of $B + C + D$?

A) $-2/3$ B) $-4/3$ C) $-5/3$ D) -2 E) NOTA

19. Determine the area enclosed by the polar equation $r = 6\sin\theta - 2\cos\theta$.

A) 8π B) 10π C) 12π D) 16π E) NOTA

20. The perpendicular bisector of the line segment with endpoints $(2,3,2)$ and $(-4,1,4)$ passes through the point $(-3,6,1)$ and has equation of the form $\frac{x+3}{a}=\frac{y-6}{b}=\frac{z-1}{c}$, where a, b, and c are relatively prime integers with $a>0$. Evaluate $abc-(a+b+c)$.

A) -1 B) -2 C) -3 D) -4 E) NOTA

21. Determine the length of the latus rectum of the conic section given by $r=\frac{2}{3-3\sin\theta}$.

A) $1/3$ B) $2/3$ C) $4/3$ D) $8/3$ E) NOTA

22. The foci of an ellipse are located at the points $(2,4)$ and $(2,-2)$. The point $(4,2)$ lies on the ellipse. If a and b represent the lengths of the semi-major and semi-minor axes, respectively, what is the value of $(ab)^2$?

A) $26+10\sqrt{10}$ B) $6+10\sqrt{10}$ C) $68+22\sqrt{10}$ D) $6+22\sqrt{10}$ E) NOTA

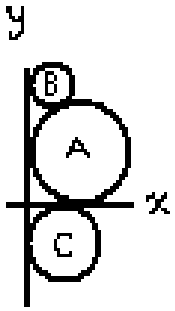
23. The conic section given by $4x^2-24x-2y^2+8y+44=0$ has eccentricity ε. What is the smallest positive degree value of a such that $2\sin a=\varepsilon$?

A) 30° B) 45° C) 60° D) 90° E) NOTA

24. Consider the lines $2x-y=-1$ and $x-2y=-5$. The circle of radius 2 that lies completely in the first quadrant and is tangent to both lines has center at the point (a,b). Evaluate ab.

A) $10+14\sqrt{5}$ B) $13+8\sqrt{5}$ C) $18+10\sqrt{5}$ D) $23+8\sqrt{5}$ E) NOTA

25. Circle A with radius 4 is tangent to both the positive x- and y-axes. Circle B with radius 1 is tangent to the positive y-axis and externally tangent to circle A. Circle C is tangent to the positive x-axis and negative y-axis. A line passes through the centers of circles A, B, and C. What is the radius of circle C? Figure not drawn to scale.



A) 16 B) 18 C) 24 D) 28 E) NOTA

26. Define a Chelsea circle to be a circle that is tangent to at least one of the x- or y-axes. Consider circle O, which has the form $x^2+cx+y^2+dy=0$, where c and d are positive real numbers. Which of the following is true?
I) If $c=d$, then circle O is a Chelsea circle.
II) There exist distinct values for c and d such that circle O is a Chelsea circle.

A) neither is true B) I only C) II only D) I & II E) NOTA

27. Consider the piecewise function $f(x)=\begin{cases} x^2-a, \text{ if } x<3 \\ b\sqrt{x-2}+a, \text{ if } 3\le x<6 \\ 2x+b, \text{ if } x\ge 6 \end{cases}$. Given that f is continuous, evaluate $f(1)+f(3)+f(7)$.

A) 36 B) 39 C) 42 D) 45 E) NOTA

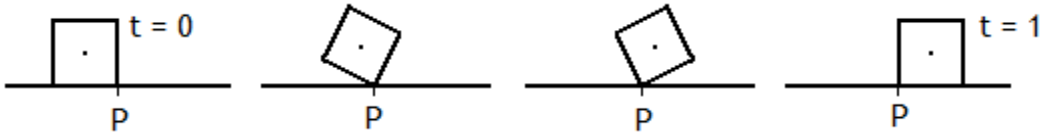
28. Determine the distance between the parallel lines $4x-3y=9$ and $4x-3y=18$.

A) 1.6 B) 1.7 C) 1.8 D) 2 E) NOTA

29. Determine the product of the slopes of the asymptotes of the hyperbola with equation $9x^2-18x-4y^2+16y-43=0$.

A) $-9/4$ B) $-4/9$ C) $-81/16$ D) $-16/81$ E) NOTA

30. A square of side length 2 rotates about a pivot point (labeled P). Which set of equations models the motion of the center of the square on the interval $[0,1]$? At $t=0$ the center of the square is at the point $(0,1)$, and the square completes one 90° turn at $t=1$.



A) $\begin{cases} x=1-\sqrt{2}\cos\left(\pi/4(2t-1)\right) \\ y=\sqrt{2}\sin\left(\pi/4(2t-1)\right) \end{cases}$ B) $\begin{cases} x=1-\sqrt{2}\sin\left(\pi/4(2t-1)\right) \\ y=\sqrt{2}\cos\left(\pi/4(2t-1)\right) \end{cases}$

C) $\begin{cases} x=1-\sqrt{2}\sin\left(\pi/4(2t+1)\right) \\ y=\sqrt{2}\cos\left(\pi/4(2t+1)\right) \end{cases}$ D) $\begin{cases} x=1-\sqrt{2}\cos\left(\pi/4(2t+1)\right) \\ y=\sqrt{2}\sin\left(\pi/4(2t+1)\right) \end{cases}$ E) NOTA