

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

1. What is the center of the conic with equation $x^2 - y^2 - 2x + 4y - 8 = 0$?

- A) $(2, -4)$ B) $(0, 0)$ C) $(-2, 4)$ D) $(1, 2)$ E) NOTA

2. The profit growth rate of some local coffee shops is represented below, where x represents the number of days it takes to make a profit of $\$100 \cdot y$. For example, Jojo's Coffee relates these variables by the equation $3y - 4x = 0$, meaning in 3 days, Jojo's Coffee earns $\$400$ profit. Given similar equations for Bean Bonanza ($7y - x = 0$), Jacked Up ($9y - 8x = 0$), and Espresso Express ($5y - 6x = 0$), which shop has the highest profit growth rate?

- A) Jojo's Coffee B) Bean Bonanza C) Jacked Up D) Espresso Express E) NOTA

3. The circle with equation $x^2 + y^2 - 6x - 7 = 0$ is inscribed in a square with four points of tangency. What is the area of the space inside the square but outside the circle?

- A) $16 - 4\pi$ B) $7 - 4\pi$ C) $64 - 16\pi$ D) $64 - 4\pi$ E) NOTA

4. Which of the following is the equation for the line with slope $-\frac{1}{2}$ that passes through the point $(2, 3)$?

- A) $x + 2y = 7$ B) $x + 2y = -7$ C) $x + 2y = -8$ D) $x + 2y = 8$ E) NOTA

5. Find the midpoint of the line segment that joins the points $(6, m - 1)$ and $(2, m - 3)$.

- A) $(8, 2m - 4)$ B) $(4, m - 2)$ C) $(3, m - 2)$ D) $(5, 2m - 4)$ E) NOTA

6. If the points $(7, 6)$, $(9, 1)$, and $(1, 2)$ are three vertices of a parallelogram contained entirely within the first quadrant, what is the fourth vertex of the parallelogram?

- A) $(-1, 7)$ B) $(3, -3)$ C) $(15, 5)$ D) $(15, 7)$ E) NOTA

7. The distance from the point (x, y) to the y -axis is which of the following?

- A) y B) $|y|$ C) x D) $|x|$ E) NOTA

8. What is the equation of a hyperbola with foci at the points $(0, \sqrt{7})$ and $(0, -\sqrt{7})$ and whose distance between vertices is 4?

- A) $\frac{y^2}{4} - \frac{x^2}{3} = 1$ B) $\frac{y^2}{3} - \frac{x^2}{4} = 1$ C) $\frac{y^2}{16} - \frac{x^2}{9} = 1$ D) $\frac{y^2}{9} - \frac{x^2}{16} = 1$ E) NOTA

9. If the origin is one endpoint of the diameter of a circle whose center is at the point $(1, 2)$, then which of the following is the other endpoint of the same diameter?

- A) $(2, 4)$ B) $(-1, -2)$ C) $(-2, -4)$ D) $(1, 4)$ E) NOTA

10. The line with equation $y = x$ intersects parallel lines with equations $4x + 2y = 9$ and $2x + y = 6$ at points P and Q , respectively. If T represents the origin, what is the value of the ratio of $|TP|$ to $|TQ|$?

- A) $\frac{4}{9}$ B) $\frac{3}{4}$ C) $\frac{9\sqrt{2}}{4}$ D) $\frac{2\sqrt{2}}{3}$ E) NOTA

11. Consider the equation $\frac{(x-3)^2}{1-r} - \frac{(y+2)^2}{1+r} = 1$ for some real value $r > 1$. By what shape is the graph of this equation represented?

- A) parabola B) hyperbola C) ellipse D) circle E) NOTA

12. What point is the focus of the parabola with equation $x^2 - 8x + 2y + 7 = 0$?

- A) $(\frac{9}{2}, 4)$ B) $(4, \frac{9}{2})$ C) $(4, 4)$ D) $(0, -\frac{1}{2})$ E) NOTA

13. What are the equations of the asymptotes of the hyperbola with equation

$$\frac{(x+3)^2}{25} - \frac{(y-1)^2}{16} = -1?$$

- A) $y - 1 = \pm \frac{4}{5}(x + 3)$ B) $y = \pm \frac{4}{5}x$ C) $y - 1 = \pm \frac{5}{4}(x + 3)$ D) $y = \pm \frac{5}{4}x$ E) NOTA

14. The equation $\frac{x^2}{1-r} + \frac{y^2}{r-3} + 1 = 0$ for real value r represents an ellipse only if r satisfies which of the following inequalities?

- A) $r < 3$ B) $1 < r < 3$ C) $r > 1$ D) $r > 3$ E) NOTA

15. What is the area enclosed by the convex quadrilateral with vertices at the points $(143,64)$, $(158,56)$, $(143,48)$, and $(128,56)$?

- A) 64 B) 169 C) 240 D) 289 E) NOTA

16. Find the point in the fourth quadrant that has a distance of 4 from both the points $(3,0)$ and $(9,0)$.

- A) $(\sqrt{7}, -6)$ B) $(6, -\sqrt{7})$ C) $(\sqrt{7}, 6)$ D) $(6, \sqrt{7})$ E) NOTA

17. Two vertices of a triangle are at the points $(3,-5)$ and $(-7,4)$. If the centroid of the triangle is at the point $(2,-1)$, at what point is the third vertex of the triangle?

- A) $(10,-2)$ B) $(10,2)$ C) $(-10,2)$ D) $(-10,-2)$ E) NOTA

18. The point $(-3,7)$ divides \overline{AB} , where $A(-5,11)$ and $B(4,-7)$, into two segments. What is the ratio of the length of the shorter segment to the length of the longer segment?

- A) 2:5 B) 2:7 C) 1:3 D) 3:7 E) NOTA

19. What is the equation for the parabola with horizontal axis of symmetry whose vertex is at the origin and which passes through the point $(-2,4)$?

- A) $8y = -x^2$ B) $8y = x^2$ C) $8x = -y^2$ D) $8x = y^2$ E) NOTA

20. The line passing through the points $(5m, 6-m)$ and $(4+m, 4+3m)$ has slope m . Find the positive value of m .

- A) $\frac{-1+\sqrt{5}}{2}$ B) $\frac{\sqrt{3}}{2}$ C) $\frac{\sqrt{6}+\sqrt{2}}{4}$ D) $\frac{\sqrt{2}}{2}$ E) NOTA

21. The endpoints of the minor axis of an ellipse are $(5, -3)$ and $(-1, -3)$, and the foci of the ellipse are at the points $(2, -3 + \sqrt{7})$ and $(2, -3 - \sqrt{7})$. What is the area enclosed by the ellipse?

- A) 144π B) 12π C) 432π D) $12\sqrt{3}\pi$ E) NOTA

22. Every point on the graph of the equation $0 = 2x^2 - 12x - y + 22$ is moved 3 units to the right and 4 units up. What is the equation of the new graph?

- A) $0 = 2x^2 - 24x - y + 80$ B) $0 = 2x^2 + 24x - y + 80$ C) $0 = 2x^2 - y + 8$
D) $0 = 2x^2 - 24x - y + 72$ E) NOTA

23. Find the product of the real values a such that the equation $ax^2 + 2y^2 - 4y + 2(1 - a) = 0$ represents an ellipse with latus rectum of length 1.

- A) 32 B) $16\sqrt{2}$ C) 16 D) $8\sqrt{2}$ E) NOTA

24. At what point do the lines with equations $2x + y = 31$ and $5x + 7y = 91$ intersect?

- A) $(3, 14)$ B) $(14, 3)$ C) $(17, -3)$ D) $(-3, 17)$ E) NOTA

25. The polar graph with equation $r = \frac{1}{2 - \cos\theta}$ has what shape?

- A) circle B) ellipse C) parabola D) hyperbola E) NOTA

26. The line $x = k$ is a directrix of the conic section with equation $\frac{(x+1)^2}{64} - \frac{(y+2)^2}{225} = 1$.

Find the greater value of k .

- A) $\frac{49}{15}$ B) $-\frac{7}{15}$ C) $\frac{47}{17}$ D) $-\frac{9}{17}$ E) NOTA

27. For the parabola with equation $y^2 + 4wx = 0$, what is the distance between the focus and the directrix?

- A) $2|w|$ B) $|w|$ C) $\frac{|w|}{2}$ D) $\frac{|w|}{4}$ E) NOTA

28. Two conic sections have the same center and vertices (points where the major axis intersects the conic section). The first one has equation $2x^2 + y^2 - 4x - 2y - 3 = 0$, and the second one's eccentricity is the multiplicative inverse of that of the first one. Find the equation of the second conic section.

- A) $2x^2 - 3y^2 - 4x + 6y + 17 = 0$ B) $x^2 - 2y^2 - 2x + 4y + 11 = 0$
C) $2x^2 - y^2 - 4x + 2y + 7 = 0$ D) $x^2 - y^2 - 2x + 2y + 6 = 0$ E) NOTA

29. Which point is the circumcenter of the triangle whose vertices are at the points $(-3, 8)$, $(-3, -4)$, and $(5, 2)$?

- A) $(\frac{5}{4}, 2)$ B) $(-\frac{5}{4}, 2)$ C) $(-\frac{1}{3}, 2)$ D) $(\frac{1}{3}, -2)$ E) NOTA

30. Find the eccentricity of the conic section with equation $y = \frac{2011!}{2017}(x - 61!)^2 - \frac{41}{23}$.

- A) $\frac{2017}{2011!}$ B) $\frac{8068}{2011!}$ C) 1 D) $\frac{61! \cdot 23 \cdot 2011!}{41 \cdot 2017}$ E) NOTA