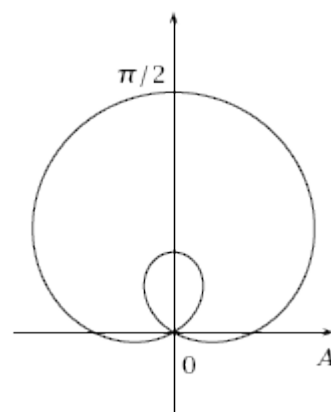


1. What type of polar graph is shown to the right?

- A) Cardioid C) Rose E) NOTA
 B) Lemniscate D) Limacon



2. Which of the following polar coordinates is equivalent to the rectangular coordinates $(-2, 2\sqrt{3})$?

- A) $(4, 120^\circ)$ C) $(4, 150^\circ)$
 B) $(-4, 120^\circ)$ D) $(-4, 150^\circ)$

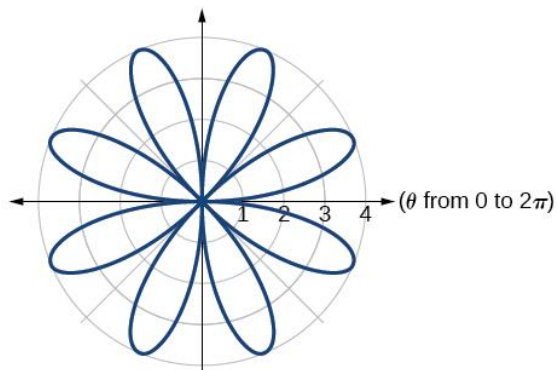
E) NOTA

3. What is the diameter of a circle that has an intercepted arc of length $\frac{2\pi}{3}$ corresponding to an interior angle of $\frac{\pi}{8}$ rad?

- A) $\frac{32\pi}{3}$ D) $\frac{64}{3}$
 B) $\frac{32}{3}$ E) NOTA
 C) $\frac{64\pi}{3}$

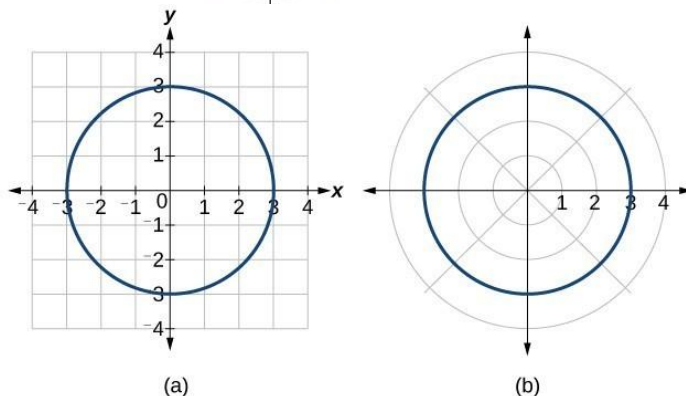
4. Find the equation of the polar graph given:

- A) $r = 4 \cos(4\theta)$
 B) $r = 8 \sin(4\theta)$
 C) $r = 4 \sin(8\theta)$
 D) $r = 4 \cos(4\theta)$
 E) NOTA



5. Find the rectangular (a) and polar (b) equations for the graphs given:

- A) $x^2 + y^2 = 3$; $r = 3$
 B) $x^2 + y^2 = 3$; $r = 3\theta$
 C) $x^2 + y^2 = 9$; $r = 3$
 D) $x^2 + y^2 = 9$; $r = 3\theta$
 E) NOTA

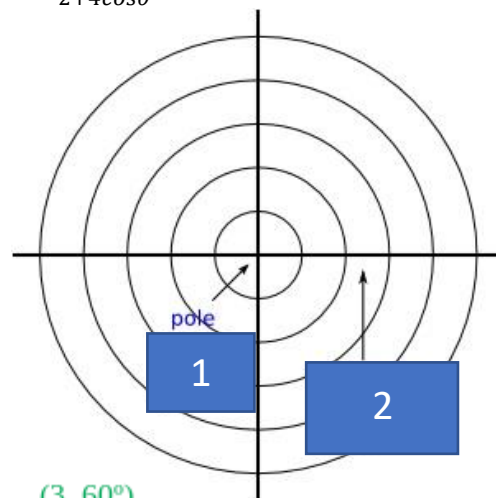


6. Find the distance between the following polar points: $(-4, \frac{\pi}{3})$ and $(5, \frac{3\pi}{4})$.

- A) $\sqrt{41 - 10\sqrt{2} + 10\sqrt{6}}$ B) $\sqrt{41 + 10\sqrt{2} + 10\sqrt{6}}$
 C) $\sqrt{41 - 10\sqrt{2} - 10\sqrt{6}}$ D) $\sqrt{-41 + 10\sqrt{2} + 10\sqrt{6}}$ E) NOTA

7. What kind of symmetry does this polar graph have: $r = \frac{12}{2+4\cos\theta}$?

- A) About x-axis
 B) About y-axis
 C) About origin
 D) No symmetry
 E) NOTA

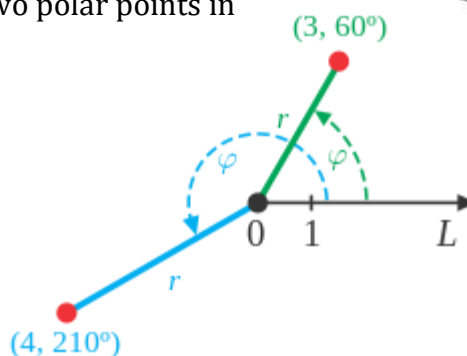


8. Fill in the missing information for a polar graph:

- A) 1. Polar Point, 2. Polar Axis
 B) 1. Polar Point, 2. X Axis
 C) 1. Pole, 2. Traverse Axis
 D) 1. Pole, 2. Polar Axis
 E) NOTA

9. Find the midpoint between the two polar points in rectangular form:

- A) $\left(\frac{3}{2} + \sqrt{3}, \frac{3\sqrt{3}}{2} - 1\right)$
 B) $\left(\frac{3}{4} - \sqrt{2}, \frac{3\sqrt{2}}{4} - 1\right)$
 C) $\left(\frac{3}{4} + \sqrt{3}, \frac{3\sqrt{3}}{4} - 1\right)$
 D) $\left(\frac{3}{4} - \sqrt{3}, \frac{3\sqrt{3}}{4} - 1\right)$
 E) NOTA



10. Simplify $[-4 + 4i]^4$ and leave in the trigonometric form of a complex number.

- A) $1024[\cos\pi + i\sin\pi]$
 B) $16\sqrt{2}[\cos\pi + i\sin\pi]$
 C) $1024[\cos 2\pi + i\sin 2\pi]$
 D) $16\sqrt{2}[\cos 2\pi + i\sin 2\pi]$
 E) NOTA

11. Simplify $(3 + 3i)(-2 - 2\sqrt{3}i)$ and leave in the trigonometric form of a complex number.

- A) $16\sqrt{2}[\cos 285^\circ + i\sin 285^\circ]$
 B) $16\sqrt{2}[\cos 195^\circ + i\sin 195^\circ]$
 C) $12\sqrt{2}[\cos 285^\circ + i\sin 285^\circ]$
 D) $12\sqrt{2}[\cos 195^\circ + i\sin 195^\circ]$
 E) NOTA

16. Classify the polar conic section and find the polar coordinates of its vertex/vertices:

$$r = \frac{24}{3-2\sin\theta}$$

A) *Hyperbola* $(24, \pi/2), (24/5, 3\pi/2)$

B) *Hyperbola* $(24, 0), (24/5, \pi)$

C) *Ellipse* $(24, \pi/2), (24/5, 3\pi/2)$

D) *Ellipse* $(24, 0), (24/5, \pi)$

E) NOTA

17. Find the area enclosed by the following set of parametric equations:

$$x = 6\sin\theta \quad y = 6\cos\theta$$

A) 36π

B) 24π

C) 36

D) 24

E) NOTA

18. Which of the following polar coordinates would not be in the Quadrant shown?

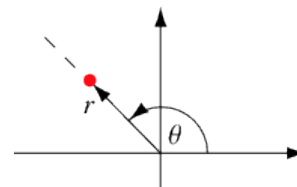
A) $(-4, -\pi/3)$

B) $(-4\pi, -0.1)$

C) $(4, 5)$

D) $(-4, 5)$

E) NOTA



19. What type of spiral has the equation: $r = a/\theta$ where a is some constant?

A) Hyperbolic

B) Elliptic

C) Euler

D) Gaussian

E) NOTA

20. This special case of the Cassinian Oval has the equation $r^2 = a^2 \cos(2\theta)$.

A) Lemniscate of Euler

B) Lemniscate of Pythagoras

C) Lemniscate of Bernoulli

D) Lemniscate of Archimedes

E) NOTA

21. A clock has hands with endpoints at polar coordinates $(-5, -\pi/12)$ and $(3, -\pi/8)$. What time is it to the nearest 15 minutes?

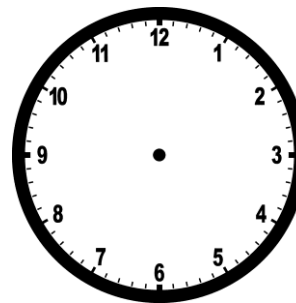
A) 3:45

B) 4:15

C) 4:45

D) 5:00

E) NOTA



22. Air Traffic Control (ATC) is monitoring two incoming aircraft: NWA131 and DAL624. The first is 300 miles from ATC and the second is 310 miles away. If NWA131 is at an angle of 30 degrees and DAL624 is at an angle of 240 degrees, and they stay at their current heading, what is the minimum speed that they can fly to both reach the polar axis in 40 minutes?



- A) 450
B) 465
C) 480
D) 500
E) NOTA

23. Find the equation of the directrix on the graph of the following polar conic:

$$r = \frac{8}{1 - \cos\theta}$$

- A) $r = -8\cos\theta$
B) $r = -8\sin\theta$
C) $r = -8\sec\theta$
D) $r = -8\csc\theta$
E) NOTA

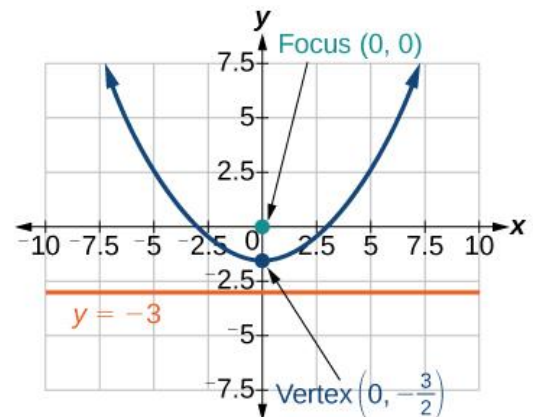
24. A submarine's sonar sweeps an angle of $2\pi/9$ searching for ships. If an enemy ship is on the sonar screen, what is the probability that it will be within the swept area?



- A) 1/18
B) 1/9
C) 1/4
D) 2/9
E) NOTA

25. Find the polar equation of the conic section with given information from the graph:

- A) $r = \frac{3}{2 - \cos\theta}$
B) $r = \frac{3}{1 - \cos\theta}$
C) $r = \frac{3}{2 - \sin\theta}$
D) $r = \frac{3}{1 - \sin\theta}$
E) NOTA



26. A lighthouse with height of 240 feet looks down on a boat with an angle of depression of 30 degrees. If the base of the lighthouse is level with the water, what are the polar coordinates of the boat if the base of the lighthouse acts as the pole of the polar axis and the line from the base of the lighthouse to the boat acts as the positive polar axis?



- A) $(240\sqrt{3}, 0)$
 B) $(-240\sqrt{3}, 0)$
 C) $(240\sqrt{2}, 0)$
 D) $(240\sqrt{2}, \pi)$
 E) NOTA

27. Solve the polar equation for any angles corresponding to points at the pole of the graph: $r = \cos^3\theta - \cos\theta$ if $0 \leq \theta < 2\pi$.

- A) $\theta = 0, \pi/2, \pi, 3\pi/2$
 B) $\theta = 0, \pi/2, \pi, 3\pi/2, 2\pi$
 C) $\theta = 0, \pi/3, \pi, 4\pi/3$
 D) $\theta = 0, 2\pi/3, \pi, 5\pi/3$
 E) NOTA

28. Find the point of intersection of the polar graphs in rectangular coordinates:

$$r = 4\csc\theta \quad r = -2\sec\theta$$

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

29. The complex number $2 - 2i$ is graphed on the Argand plane. What polar coordinate pair is in the same location on the polar plane?

- A) $(2, -\pi/4)$
 B) $(2\sqrt{2}, -\pi/4)$
 C) $(2, \pi/4)$
 D) $(2\sqrt{2}, \pi/4)$
 E) NOTA

30. What is the slope of the line with the polar equation: $\theta = -2018\pi/6$?

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