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Identify the symmetries of the curve below. Then sketch the curve.

$$r^2 = -\cos(\theta)$$

When a graph has symmetry about the x-axis, if the point (r,θ) lies on the graph, then the point $(r,-\theta)$ or $(-r,\pi-\theta)$ lies on the graph. When a graph has symmetry about the y-axis, if the point (r,θ) lies on the graph, then the point $(r,\pi-\theta)$ or $(-r,-\theta)$ lies on the graph. When a graph has symmetry about the origin, if the point (r,θ) lies on the graph, then the point $(-r,\theta)$ or $(r,\theta+\pi)$ lies on the graph.

To identify the symmetries of the curve, determine which of these conditions, if any, the given curve satisfies. First, determine if the curve has symmetry about the x-axis.

(r,θ) on the graph $\rightarrow r^2 = -\cos(\theta)$
$\rightarrow r^2 = -\cos(-\theta)$ Use the identity $\cos(-x) = \cos x$.
$\rightarrow (r,-\theta)$ on the graph

Therefore, the curve has symmetry about the x-axis. Next, determine if the curve has symmetry about the y-axis.

(r,θ) on the graph $\rightarrow r^2 = -\cos(\theta)$
$\rightarrow r^2 = -\cos(-\theta)$ Use the identity $\cos(-x) = \cos x$.
$\rightarrow (-r)^2 = -\cos(-\theta)$
$\rightarrow (-r,-\theta)$ on the graph

Therefore, the curve has symmetry about the y-axis. Next, determine if the curve has symmetry about the origin.

(r,θ) on the graph $\rightarrow r^2 = -\cos(\theta)$
$\rightarrow (-r)^2 = -\cos(\theta)$
$\rightarrow (-r,\theta)$ on the graph

Therefore, the curve has symmetry about the origin. To graph the curve, make a short table of values, plot the corresponding points, and use information about symmetry to connect the points with a smooth curve. Notice that r is only defined when $-\cos\theta$ is positive, or $\cos\theta$ is negative, that is, for values of θ between $\frac{\pi}{2}$ and $\frac{3\pi}{2}$. The calculations are shown rounded to two decimal places as needed.

θ	$r = \pm\sqrt{-\cos(\theta)}$
$\frac{\pi}{2}$	± 0
$\frac{2\pi}{3}$	± 0.71
$\frac{3\pi}{4}$	± 0.84

Continue the table. The calculations are shown rounded to two decimal places as needed.

θ	$r = \pm\sqrt{-\cos(\theta)}$
π	± 1
$\frac{4\pi}{3}$	± 0.71
$\frac{5\pi}{4}$	± 0.84
$\frac{3\pi}{2}$	± 0

Recall that the graph is symmetric about the x-axis, y-axis, and origin. Therefore, the correct graph of the curve is shown below.