Polar Battleship

4 Polar Rules:
1. \( r = \sqrt{x^2 + y^2} \)
2. \( tan \theta = \frac{y}{x} \)
3. \( x = r \cos \theta \)
4. \( y = r \sin \theta \)

Objective: As an admiral, you fire shots at your opponent’s armada until you have completely obliterated their naval force.

Setup: Place a battleship (4 coordinates), frigate (3 coordinates), and destroyer (2 coordinates) onto your sea by drawing an open circle in each position corresponding to one of your ships. Ship coordinates must either have the same radius or the same radian for each segment of ship. Ships may not overlap.

Game Play: Admirals need to have a reasonable name for naval warfare that reflects who they are. For example, Mr. Wytiaz typically sinks destroyers under the monikers Mathbeard (you can add the suffix –beard to almost anything) or Admiral Leibniz (my personal mathematics hero).

Once you have figured out your admiral names, randomly determine which admiral will fire first. The attacking admiral calls a polar coordinate in \((r, \theta)\) form and then the defending admiral declares whether the shot was a hit or a miss. The attacking admiral records the location of the shot on the Enemy Polar Sea (use O for a miss and X for a hit) and records the shot in polar form in the battle log. The defending admiral records the location of the shot in their sea but is not required to log the shot.

If a shot causes one of your vessels to be completely destroyed (each section has been hit), declare “You just sunk my <ship name>”.

When one force has been completely sunk, the game has ended.

After the game has ended, please complete each of the following:
1. On the battle log, convert all polar coordinates in your game into rectangular coordinates.
2. Work with your adversary to answer the questions on the worksheet attached.
Polar Battleship

Admiral ______________ VS Admiral ______________

My Polar Sea

Battleship:
(       ,        ),
(       ,        ),
(       ,        ),
(       ,        )

Frigate:
(       ,        ),
(       ,        ),
(       ,        )

Destroyer:
(       ,        ),
(       ,        )

Enemy Polar Sea

Battleship:
(       ,        ),
(       ,        ),
(       ,        ),
(       ,        )

Frigate:
(       ,        ),
(       ,        ),
(       ,        )

Destroyer:
(       ,        ),
(       ,        )
For each shot that you fired using the polar coordinate system, convert the shot into rectangular coordinates.

<table>
<thead>
<tr>
<th>Polar ((r, \theta))</th>
<th>Rect. ((x, y))</th>
<th>Polar ((r, \theta))</th>
<th>Rect. ((x, y))</th>
</tr>
</thead>
<tbody>
<tr>
<td>((3, \frac{\pi}{4}))</td>
<td>((2, \sqrt{2}))</td>
<td>((5, \frac{\pi}{3}))</td>
<td>((3, \pi))</td>
</tr>
<tr>
<td>((2, \frac{\pi}{6}))</td>
<td>((2\sqrt{3}, 2))</td>
<td>((4, 0))</td>
<td>((-10, e))</td>
</tr>
<tr>
<td>((3\sqrt{2}, -3\sqrt{2}))</td>
<td>((2, 5))</td>
<td>((2, \frac{2\pi}{3}))</td>
<td>((\sqrt{\frac{1}{2}}, \sqrt{\frac{1}{2}}))</td>
</tr>
</tbody>
</table>

**Working with the Enemy**

**Convert:**

1. Convert the polar coordinates to rectangular coordinates:

\[
(3, \frac{\pi}{4}) \quad \left(2, \frac{\pi}{6}\right) \quad \left(5, \frac{\pi}{3}\right) \quad (3, \pi) \quad (4, 0) \quad \left(2, \frac{2\pi}{3}\right)
\]

2. Convert the rectangular coordinates to polar coordinates \((r > 0, 0 \leq \theta < 2\pi)\):

\[
\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right) \quad (2\sqrt{3}, 2) \quad (3\sqrt{2}, -3\sqrt{2}) \quad (2, 5) \quad (-10, e)
\]
Problems:

3. State at least 3 more polar coordinate representations for the given polar point:

\[
\begin{align*}
(3, \frac{\pi}{2}) & \quad (2, \frac{5\pi}{6})
\end{align*}
\]

4. Graph and label each polar point on the polar axis:

A: \( \left(3, \frac{4\pi}{3}\right) \)
B: \( \left(2, -\frac{\pi}{6}\right) \)
C: \( \left(-2, \frac{\pi}{2}\right) \)
D: \( \left(-3, -\frac{3\pi}{4}\right) \)

5. Write each rectangular equation as a polar equation (solved for \( r \)):

\[
\begin{align*}
x & = -5 \\
y & = 3 \\
x^2 + y^2 & = 4
\end{align*}
\]

6. Write each polar equation as a rectangular equation:

\[
\begin{align*}
r & = \frac{5}{5 \cos \theta + 6 \sin \theta} \\
r & = \frac{2}{3 \cos \theta + 4 \sin \theta}
\end{align*}
\]