(1.1) \( A \) on the curve \( r, \theta \) starting at \( (1, 1) \) is spiraling in. We know that at a generic \((x, y)\), since the dog is always pointing toward the dog starting at \((-1, 1)\), it is headed toward \((-y, x)\). That allows us to compute the slope as

\[
\frac{dy}{dx} = \frac{x - y}{-y - x} = \frac{-y + x}{x - y} = \frac{-r \sin \theta + r \cos \theta}{r \cos \theta - r \sin \theta}.
\]

We know the slope on a generic polar curve is given by \( \frac{dy}{dx} = \frac{r \sin \theta + r \cos \theta}{r \cos \theta - r \sin \theta} \).

It is clear by inspection that (1) \& (2) coincide if \( r' = r \).

The differential equation (3) has a general solution of \( r = Ce^{-\theta} \).

Substituting the initial data gives,

\[
r_{1}(\theta) = \sqrt{2} e^{-\theta} \quad r_{2}(\theta) = \sqrt{2} e^{-\frac{\theta}{4}} \
\]

and \( r(\theta) = \sqrt{2} e^{-\frac{\theta}{4}} \) and \( r_{4}(\theta) = \sqrt{2} e^{-\frac{\theta}{4}} \).

To find the arc length we note, by (3) \( r' = r \) so

\[
ds = \sqrt{r^2 + (r')^2} \, d\theta = \sqrt{r^2 + r^2} \, d\theta = \sqrt{2} \, r \, d\theta.
\]

\[
s = \int_{\frac{\pi}{4}}^{\infty} \sqrt{2} \cdot \frac{1}{2} e^{-\frac{\theta}{2}} \, d\theta = -2 e^{-\frac{\theta}{2}} \bigg|_{\frac{\pi}{4}}^{\infty} = 2 \quad \text{(Curiously, the distance they started sprint.)}
\]

\section{5 seconds}

\subsection{since \( \frac{\pi}{4} \leq \theta < \infty \) in 5 seconds, they got pretty dizzy.}

It is worth noting that after one revolution each has covered a distance of \( 2 \cdot \frac{2}{e^{10}} \approx 1.996 \), i.e. within 4 cm of the total distance.