7.9 An RHC-polarized wave with a modulus of 2 (V/m) is traveling in free space in the negative z direction. Write the expression for the wave's electric field vector, given that the wavelength is 3 cm.

Solution:

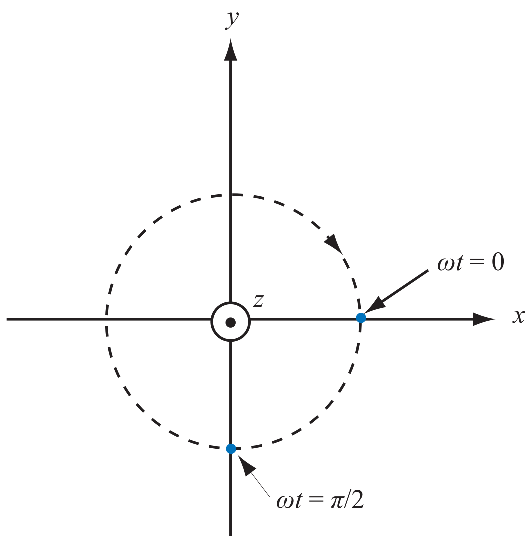

Figure P7.9 Locus of **E** versus time.

For an RHC wave traveling in $-\hat{\mathbf{z}}$, let us try the following:

$$\mathbf{E} = \hat{\mathbf{x}} a \cos(\omega t + kz) + \hat{\mathbf{y}} a \sin(\omega t + kz).$$

Modulus $|E| = \sqrt{a^2 + a^2} = a\sqrt{2} = 2$ (V/m). Hence,

$$a = \frac{2}{\sqrt{2}} = \sqrt{2}.$$

Next, we need to check the sign of the $\hat{\mathbf{y}}$-component relative to that of the $\hat{\mathbf{x}}$-component. We do this by examining the locus of **E** versus t at $z = 0$: Since the wave is traveling along $-\hat{\mathbf{z}}$, when the thumb of the right hand is along $-\hat{\mathbf{z}}$ (into the page), the other four fingers point in the direction shown (clockwise as seen from above). Hence, we should reverse the sign of the $\hat{\mathbf{y}}$-component:

$$\mathbf{E} = \hat{\mathbf{x}} \sqrt{2} \cos(\omega t + kz) - \hat{\mathbf{y}} \sqrt{2} \sin(\omega t + kz) \qquad \text{(V/m)}$$

with

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{3 \times 10^{-2}} = 209.44 \qquad \text{(rad/m)},$$

and

$$\omega = kc = \frac{2\pi}{\lambda} \times 3 \times 10^8 = 2\pi \times 10^{10} \qquad \text{(rad/s)}.$$