**32.66. Model:** A magnetic field exerts a magnetic force on a moving charge given by $\vec{F} = q\vec{v} \times \vec{B}$. Assume the magnetic field is uniform.

**Visualize:** Please refer to Figure P32.66. The magnetic field points in the $+z$-direction. If the charged particle is moving along $\vec{B}$, $F = 0$ N. If $\vec{v}$ is perpendicular to $\vec{B}$, the motion of the charged particle is a circle. However, when $\vec{v}$ makes an angle with $\vec{B}$, the motion of the charged particle is like a helix or a spiral. The perpendicular component of the velocity is responsible for the circular motion, and the parallel component is responsible for the linear motion along the magnetic field direction.

**Solve:** From the figure we see that $v_y = v\cos30^\circ$ and $v_z = v\sin30^\circ$. For the circular motion, the magnetic force causes a centripetal acceleration. That is,

$$ev_y B = \frac{mv_y^2}{r} \Rightarrow r = \frac{mv_y}{eB} = \frac{\left(9.11 \times 10^{-31} \text{ kg}\right) \left(5.0 \times 10^8 \text{ m/s}\right) \cos30^\circ}{\left(1.60 \times 10^{-19} \text{ C}\right) \left(0.030 \text{ T}\right)} = 0.82 \text{ mm}$$

The time for one revolution is

$$T = \frac{2\pi r}{v_y} = \frac{2\pi \times \left(8.2 \times 10^{-4} \text{ m}\right)}{\left(5.0 \times 10^8 \text{ m/s}\right) \cos30^\circ} = 1.2 \times 10^{-9} \text{ s}$$

The pitch $p$ is the vertical distance covered in time $T$. We have

$$p = v_z T = \left(5.0 \times 10^8 \text{ m/s}\right) \sin30^\circ \left(1.2 \times 10^{-9} \text{ s}\right) = 3.0 \times 10^{-3} \text{ m} = 3 \text{ mm}$$