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 $v_y = v\cos30°$ and $v_z = v\sin30°$. For the circular motion, the magnetic force causes a centripetal acceleration. That is,

$$ev_yB = \frac{mv_y^2}{r} \Rightarrow r = \frac{mv_y}{eB} = \frac{(9.11\times10^{-31}\text{ kg})(5.0\times10^6\text{ m/s})\cos30°}{(1.60\times10^{-19}\text{ C})(0.030\text{ T})} = 0.82\text{ mm}$$

The time for one revolution is

$$T = \frac{2\pi r}{v_y} = \frac{2\pi(8.2\times10^{-4}\text{ m})}{(5.0\times10^6\text{ m/s})\cos30°} = 1.2\times10^{-9}\text{ s}$$

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

$$p = v_zT = (5.0\times10^6\text{ m/s})\sin30°(1.2\times10^{-9}\text{ s}) = 3.0\times10^{-3}\text{ m} = 3\text{ mm}$$