Chapter 2 Problem 80 [†]

Given
$\vec{F} = \{98.0\hat{i} + 132.0\hat{j} + 32.0\hat{k}\}\ N$

Solution
a) What is the magnitude of the pulling force?

The magnitude of a vector is given by

$$F = \sqrt{(F_x)^2 + (F_y)^2 + (F_z)^2} = \sqrt{(98.0)^2 + (132.0)^2 + (32.0)^2} = 167\ N$$

b) What angle does the leash make with respect to the vertical?

The easiest way to find this angle is to use the relationship between the Cartesian form of the dot product and the polar form of the dot product. This gives

$$\vec{A} \cdot \vec{B} = \|\vec{A}\|\|\vec{B}\| \cos\theta = A_x B_x + A_y B_y + A_z B_z$$

The angle is given by

$$\theta = \cos^{-1}\left(\frac{A_x B_x + A_y B_y + A_z B_z}{\|\vec{A}\|\|\vec{B}\|}\right)$$

The angle between the leash and vertical can then be found by using this formula where $\vec{A} = \vec{F}$ and $\vec{B} = \hat{k}$.

$$\theta = \cos^{-1}\left(\frac{F_x(0) + F_y(0) + F_z(1)}{\|\vec{F}\|\|\hat{k}\|}\right)$$

$$\theta = \cos^{-1}\left(\frac{98.0(0) + 132.0(0) + 32.0(1)}{(167)(1)}\right)$$

$$\theta = \cos^{-1}\left(\frac{32.0}{167}\right) = \cos^{-1}(0.1916) = 79.0^\circ$$

[†]Problem from University Physics by Ling, Sanny and Moebs (OpenStax)