

3.9 Find an expression for the unit vector directed toward the origin from an arbitrary point on the line described by $x = 1$ and $z = -3$.

Solution: An arbitrary point on the given line is $(1, y, -3)$. The vector from this point to $(0, 0, 0)$ is:

$$\mathbf{A} = \hat{\mathbf{x}}(0 - 1) + \hat{\mathbf{y}}(0 - y) + \hat{\mathbf{z}}(0 + 3) = -\hat{\mathbf{x}} - \hat{\mathbf{y}}y + 3\hat{\mathbf{z}},$$

$$|\mathbf{A}| = \sqrt{1 + y^2 + 9} = \sqrt{10 + y^2},$$

$$\hat{\mathbf{a}} = \frac{\mathbf{A}}{|\mathbf{A}|} = \frac{-\hat{\mathbf{x}} - \hat{\mathbf{y}}y + \hat{\mathbf{z}}3}{\sqrt{10 + y^2}}.$$
