Problem 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 $z = 2$.

Solution: An arbitrary point on the given line is $(1, y, 2)$. The vector from this point to $(0, 0, 0)$ is:

$$\mathbf{A} = \hat{\mathbf{x}}(0-1) + \hat{\mathbf{y}}(0-y) + \hat{\mathbf{z}}(0-2) = -\hat{\mathbf{x}} - \hat{\mathbf{y}}y - 2\hat{\mathbf{z}},$$

$$|\mathbf{A}| = \sqrt{1+y^2+4} = \sqrt{5+y^2},$$

$$\hat{\mathbf{a}} = \frac{\mathbf{A}}{|\mathbf{A}|} = \frac{-\hat{\mathbf{x}} - \hat{\mathbf{y}}y - \hat{\mathbf{z}}2}{\sqrt{5+y^2}}.$$