1.2.1. Find the vector $\mathbf{A}$ that connects the two opposite corners of a cube whose volume is a^3. One corner of the cube is located at the center of a Cartesian coordinate system. Also write this vector in terms of the magnitude time a unit vector.

The vector begins at $(0, 0, 0)$ and ends at (a, a, a), so

$$\mathbf{A} = \begin{pmatrix} a \\ a \\ a \end{pmatrix}.$$

The magnitude of $\mathbf{A}$ is

$$\begin{aligned} ||\mathbf{A}|| &= \sqrt{A_x^2 + A_y^2 + A_z^2} \\ &= \sqrt{a^2 + a^2 + a^2} \\ &= \sqrt{3}a. \end{aligned}$$

Therefore, $\mathbf{A}$ may also be written as

$$\mathbf{A} = \sqrt{3}a \begin{pmatrix} \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \end{pmatrix}.$$