

Problem 1.7

Find the separation vector \mathbf{z} from the source point $(2, 8, 7)$ to the field point $(4, 6, 8)$. Determine its magnitude $|\mathbf{z}|$, and construct the unit vector $\hat{\mathbf{z}}$.

Solution

The position vector to the field point is

$$\mathbf{r} = \langle 4, 6, 8 \rangle,$$

and the position vector to the source point is

$$\mathbf{r}' = \langle 2, 8, 7 \rangle.$$

The separation vector is the displacement vector from the source point to the field point.

$$\begin{aligned}\mathbf{z} &= \mathbf{r} - \mathbf{r}' \\ &= \langle 4, 6, 8 \rangle - \langle 2, 8, 7 \rangle \\ &= \langle 2, -2, 1 \rangle\end{aligned}$$

Its magnitude is

$$|\mathbf{z}| = \sqrt{2^2 + (-2)^2 + 1^2} = 3.$$

The unit vector pointing from the source point to the field point is

$$\hat{\mathbf{z}} = \frac{\mathbf{z}}{|\mathbf{z}|} = \frac{\langle 2, -2, 1 \rangle}{3} = \left\langle \frac{2}{3}, -\frac{2}{3}, \frac{1}{3} \right\rangle = \frac{2}{3}\hat{\mathbf{x}} - \frac{2}{3}\hat{\mathbf{y}} + \frac{1}{3}\hat{\mathbf{z}}.$$