Test 1

Preliminaries

Consider the the cylinder, shown in Fig. 1, of radius r_0 and height z_0 with center point c and endpoint e. The radial surface of the cylinder is defined by $r = r_0$, and $0 \leq z \leq z_0$. Given any point on the radial surface, the inward-directed normal at that point, $\overrightarrow{n}$, is directed along $-r$, as shown in Fig. 2. All surface source distributions, $Q(\overrightarrow{\Omega})$ are defined in terms of $\mu = \overrightarrow{\Omega} \cdot \overrightarrow{n}$, and are uniform over the axial surface of the cylinder.

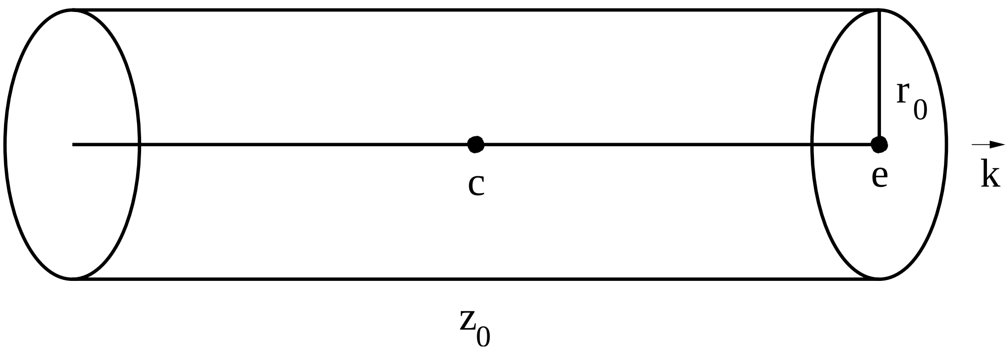

Figure 1: Geometry for cylinder of radius r_0 and height z_0.

1. Given an isotropic surface source distribution,

$$Q(\overrightarrow{\Omega}) = \frac{Q_0}{4\pi} \quad (p/(cm^2 - sec - steradian),$$

   (a) Calculate the scalar flux, ϕ $(p/cm^2 - sec)$, at point c.

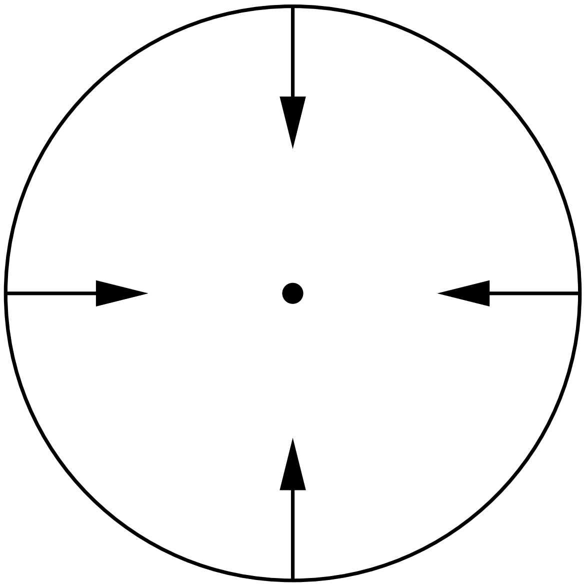

Figure 2: Inward-directed axial surface normals at four points as viewed looking down the axis of the cylinder.

(b) Calculate the z-component of the current, $(\overrightarrow{J} \cdot \overrightarrow{k})$ $(p/(cm^2 - sec)$, at point c.

(c) Calculate the scalar flux, ϕ $(p/cm^2 - sec)$, at point e.

(d) Calculate the z-component of the current, $(\overrightarrow{J} \cdot \overrightarrow{k})$ $(p/(cm^2 - sec)$, at point e.

2. Given an anisotropic surface source distribution,

$$Q(\overrightarrow{\Omega}) = \frac{Q_0 \mu}{4\pi} \quad (p/(cm^2 - sec - steradian),$$

(a) Calculate the scalar flux, ϕ $(p/cm^2 - sec)$, at point c.

(b) Calculate the z-component of the current, $(\overrightarrow{J} \cdot \overrightarrow{k})$ $(p/(cm^2 - sec)$, at point c.

(c) Calculate the scalar flux, ϕ $(p/cm^2 - sec)$, at point e.

(d) Calculate the z-component of the current, $(\overrightarrow{J} \cdot \overrightarrow{k})$ $(p/(cm^2 - sec)$, at point e.

3. Evaluate the solutions to Problem 1 in the limit as $z_0 \to \infty$.

4. Evaluate the solutions to Problem 2 in the limit as $z_0 \to \infty$.

5. Evaluate the solutions to Problem 1 in the limit as $r_0 \to \infty$.

6. Given a uniform isotropic source,

$$Q(\overrightarrow{\Omega}) = \frac{Q_0}{4\pi} \quad (p/(cm^2 - sec - steradian),$$

on the surface of a sphere of radius r_0,

(a) Calculate the scalar flux $(p/(cm^2 - sec)$ at the center of the sphere,

(b) Evaluate the solution to the above problem in the limit as $r_0 \to \infty$.

7. Solve the 1-D slab-geometry differential transport equation on $[x_L, x_R]$ for an isotropic surface source,

$$Q(\mu) = \frac{Q_0}{4\pi} \quad (p/(cm^2 - sec - steradian),$$

located at $x = x_L$, with $\sigma_t = \sigma_a$, and a vacuum boundary condition at $x = x_R$.