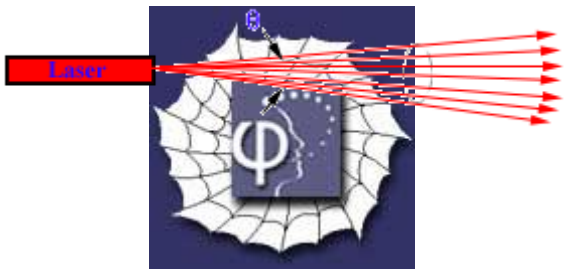
**563.**

**Problem 41.23 (RHK)**

*A HeNe laser, radiating at* 632.8 nm, *has a power output of* 3.10 mW *and a full-angle beam divergence of* 172 $\mu$rad. *We have to find* (a) *the intensity of the beam* 38.2 m *from the laser*; (b) *and calculate the power output of an isotropic source that provides the same intensity at the same distance*.




**Solution:**

(a)

The area subtended by a cone of angular size $\theta$ at a distance $r$ from its vertex is $\frac{1}{4}\pi(r\theta)^2$

Therefore, the area subtended by the laser beam of full-angle divergence of 172 $\mu$rad at a distance of 38.2 m will be

$$A=\frac{\pi}{4}\left(172\times10^{-6}\times38.2\right)^2\ \text{m}^2=33.9\times10^{-6}\ \text{m}^2.$$

The power output of the HeNe laser is 3.10 mW.

Therefore, the intensity of the laser beam at a distance of 38.2 m from the laser will be

$$I = \frac{3.10 \times 10^{-3}}{33.9 \times 10^{-6}} \text{ W m}^{-2} = 91.4 \text{ W m}^{-2} = 9.14 \text{ mW cm}^{-2}.$$

(b)

The power output of an isotropic source that will provide the intensity of 9.14 mW $\text{cm}^{-2}$ at a distance of 38.2 m will therefore be

$$P = \left(4\pi \times 38.2^2\right) \times 91.4 \text{ W} = 1.676 \text{ MW}.$$