

Ch. 16 Prob 53

$$P_1 = 100 \text{ W} \quad r_1 = ?$$

$$P_2 = 75 \text{ W} \quad r_2 = 10 \text{ m}$$

Find the distance of the 100 W lightbulb that has the same intensity of a 75 W lightbulb at 10 m.

Intensity is given by $I = \frac{P}{A} = \frac{P}{4\pi r^2}$

(assuming radiating equally in all directions.)

The intensities of both bulbs are the same, so

$$\frac{I_1}{I_2} = \frac{P_1}{4\pi r_1^2} = \frac{P_2}{4\pi r_2^2} = I_2$$

Solving for r_1 gives

$$\frac{P_1}{4\pi r_1^2} = \frac{P_2}{4\pi r_2^2}$$

$$4\pi r_2^2 P_1 = 4\pi r_1^2 P_2$$

$$\frac{4\pi r_2^2 P_1}{4\pi P_2} = r_1^2$$

$$\sqrt{r_2^2 \frac{P_1}{P_2}} = r_1$$

$$r_1 = r_2 \sqrt{\frac{P_1}{P_2}} = 10 \text{ m} \sqrt{\frac{100 \text{ W}}{75 \text{ W}}} = \boxed{11.5 \text{ m}}$$