

## Practice Problems

16.1 Illumination  
pages 431–438

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1. A lamp is moved from 30 cm to 90 cm above the pages of a book. Compare the illumination on the book before and after the lamp is moved.

$$\begin{aligned} \frac{E_{\text{after}}}{E_{\text{before}}} &= \frac{\left(\frac{P}{4\pi d_{\text{after}}^2}\right)}{\left(\frac{P}{4\pi d_{\text{before}}^2}\right)} = \frac{d_{\text{before}}^2}{d_{\text{after}}^2} \\ &= \frac{(30 \text{ cm})^2}{(90 \text{ cm})^2} = \frac{1}{9}; \text{ therefore, after} \end{aligned}$$

the lamp is moved the illumination is one-ninth of the original illumination.

2. What is the illumination on a surface that is 3.0 m below a 150-W incandescent lamp that emits a luminous flux of 2275 lm?

$$E = \frac{P}{4\pi d^2} = \frac{2275 \text{ lm}}{4\pi(3.0 \text{ m})^2} = 2.0 \times 10^1 \text{ lx}$$

3. Draw a graph of the illuminance produced by a 150-W incandescent lamp between 0.50 m and 5.0 m.

Illuminance of a 150-W bulb

$$P = 2275, d = 0.50, 0.75, \dots, 5.0$$

$$E(d) = \frac{P}{4\pi d^2}$$



4. A 64-cd point source of light is 3.0 m above the surface of a desk. What is the illumination on the desk's surface in lux?

$$P = 4\pi(64 \text{ cd}) = 256\pi \text{ lm}$$

$$\text{so } E = \frac{P}{4\pi d^2} = \frac{256\pi \text{ lm}}{4\pi(3.0 \text{ m})^2} = 7.1 \text{ lx}$$

5. A public school law requires a minimum illuminance of 160 lx at the surface of each student's desk. An architect's specifications call for classroom lights to be located 2.0 m above the desks. What is the minimum luminous flux that the lights must produce?

$$E = \frac{P}{4\pi d^2}$$

$$P = 4\pi E d^2$$

$$= 4\pi(160 \text{ lm/m}^2)(2.0 \text{ m})^2$$

$$= 8.0 \times 10^3 \text{ lm}$$

6. A screen is placed between two lamps so that they illuminate the screen equally, as shown in **Figure 16-7**. The first lamp emits a luminous flux of 1445 lm and is 2.5 m from the screen. What is the distance of the second lamp from the screen if the luminous flux is 2375 lm?



Figure 16-7 (Not to scale)

$$E_1 = E_2$$

$$\text{So } \frac{P_1}{d_1^2} = \frac{P_2}{d_2^2}$$

$$\text{or } d_2 = d_1 \sqrt{\frac{P_2}{P_1}}$$

$$= (2.5 \text{ m}) \sqrt{\frac{2375}{1445}}$$

$$= 3.2 \text{ m}$$

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**Eugene Hecht**



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