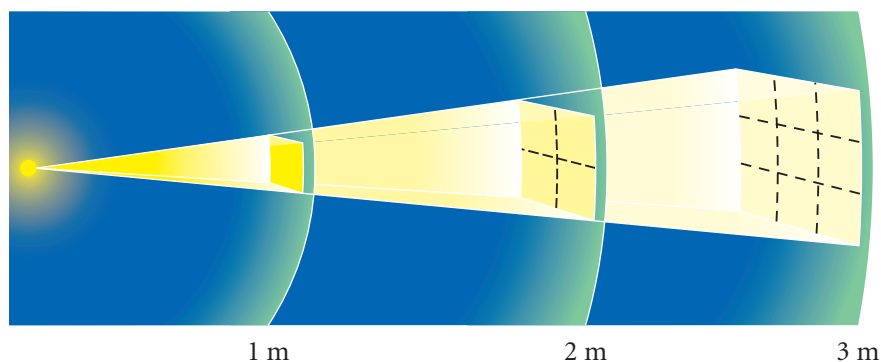


## Illuminance decreases as the square of the distance from the source

You have probably noticed that it is easier to read a book beside a lamp using a 100 W bulb rather than a 25 W bulb. It is also easier to read nearer to a lamp than farther from a lamp. These experiences suggest that the intensity of light depends on both the amount of light energy emitted from a source and the distance from the light source.

Light bulbs are rated by their power input (measured in watts) and their light output. The rate at which light is emitted from a source is called the *luminous flux* and is measured in *lumens* (lm). Luminous flux is a measure of power output but is weighted to take into account the response of the human eye to light. The idea of luminous flux helps us understand why the illumination on a book page is reduced as you move away from a light source. Imagine spherical surfaces of different sizes with a point light source at the center of the sphere, shown in **Figure 4**. A

point source of light provides light equally in all directions. The principle of conservation of energy tells us that the luminous flux is the same on each sphere. However, the luminous flux divided by the area of the surface, which is called the *illuminance* (measured in  $\text{lm}/\text{m}^2$ , or *lux*), decreases as the radius squared when you move away from a light source.



**Figure 4**

Less light falls on each unit square as the distance from the source increases.

## SECTION REVIEW

- Identify which portions of the electromagnetic spectrum are used in each of the devices listed.
  - a microwave oven
  - a television set
  - a single-lens reflex camera
- If an electromagnetic wave has a frequency of  $7.57 \times 10^{14}$  Hz, what is its wavelength? To what part of the spectrum does this wave belong?
- Galileo performed an experiment to measure the speed of light by timing how long it took light to travel from a lamp he was holding to an assistant about 1.5 km away and back again. Why was Galileo unable to conclude that light had a finite speed?
- Critical Thinking** How bright would the sun appear to an observer on Earth if the sun were four times farther from Earth than it actually is? Express your answer as a fraction of the sun's brightness on Earth's surface.