

Light Intensity Problems

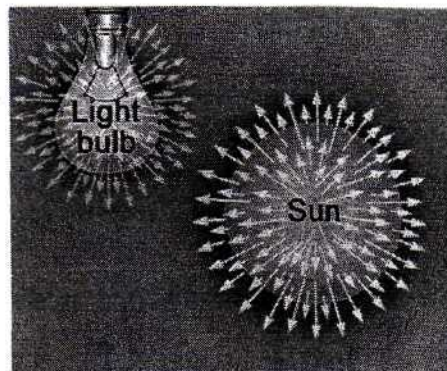


Light is a form of energy. *Light intensity* describes the amount of energy per second falling on a surface, using units of watts per meter squared (W/m^2). Light intensity follows an inverse square law. This means that the intensity decreases as the square of the distance from the source. For example, if you double the distance from the source, the light intensity is one-fourth its original value. If you triple the distance, the light intensity is one-ninth its original value.

Most light sources distribute their light equally in all directions, producing a spherical pattern. The area of a sphere is $4\pi r^2$, where r is the radius or the distance from the light source. For a light source, the intensity is the power per area. The light intensity equation is:

$$I = \frac{P}{A} = \frac{P}{4\pi r^2}$$

Remember that the power in this equation is the amount of light emitted by the light source. When you think of a "100 watt" light bulb, the number of watts represents how much energy the light bulb uses, not how much light it emits. Most of the energy in an incandescent light bulb is emitted as heat, not light. That 100-watt light bulb may emit less than 1 watt of light energy with the rest being lost as heat.



PRACTICE

Solve the following problems using the intensity equation. The first problem is done for you.

- For a light source of 60 watts, what is the intensity of light 1 meter away from the source?

$$I = \frac{P}{A} = \frac{P}{4\pi r^2} = \frac{60 \text{ W}}{4\pi(1 \text{ m})^2} = 4.8 \text{ W}/\text{m}^2$$

- For a light source of 60 watts, what is the intensity of light 10 meters away from the source?
- For a light source of 60 watts, what is the intensity of light 20 meters away from the source?
- If the distance from a light source doubles, how does light intensity change?
- Answer the following problems for a distance of 4 meters from the different light sources.
 - What is the intensity of light 4 meters away from a 1-watt light source?
 - What is the intensity of light 4 meters away from a 10-watt light source?
 - What is the intensity of light 4 meters away from a 100-watt light source?
 - What is the intensity of light 4 meters away from a 1,000-watt light source?
- What is the relationship between the watts of a light source and light intensity?