NAME _____ DATE _____ CLASS _____

Sound

Problem A

INTENSITY OF SOUND WAVES

PROBLEM

Kåre Walkert of Sweden reportedly snores loudly, with a record intensity of 4.5×10^{-8} W/m^2. Suppose the intensity of Walkert's snores are measured 0.60 m from her mouth. What is the power associated with the record snore?

SOLUTION

Given: Intensity $= 4.5 \times 10^{-8}$ W/m^2

$r = 0.60$ m

Unknown: $P = ?$

Use the equation for the intensity of a spherical wave.

$$\text{Intensity} = \frac{P}{4\pi r^2}$$

$$P = 4\pi r^2(\text{Intensity}) = 4\pi(0.60 \text{ m})^2(4.5 \times 10^{-8} \text{ W/m}^2)$$

$$P = \boxed{2.0 \times 10^{-7} \text{ W}}$$

ADDITIONAL PRACTICE

1. Blue whales are the loudest creatures; they can emit sound waves with an intensity of 3.0×10^{-3} W/m^2. If this intensity is measured 4.0 m from its source, what power is associated with the sound wave?
2. The whistling sound that is characteristic of the language known as "silbo," which is used on the Canary Island of Gomera, is detectable at 8.0 km. Use the spherical wave approximation to find the power of a whistler's sound. Sound intensity at the hearing threshold is 1.0×10^{-12} W/m^2.
3. Estimate how far away a cicada can be heard if the lowest audible intensity of the sound it produces is 1.0×10^{-12} W/m^2 and the power of a cicada's sound source is 2.0×10^{-6} W.
4. Howler monkeys, found in Central and South America, can emit a sound that can be heard by a human several miles away. The power associated with the sound is roughly 3.0×10^{-4} W. If the threshold of hearing of a human is assumed to be 1.1×10^{-13} W/m^2, how far away can a howler monkey be heard.
5. In 1983, Roy Lomas became the world's loudest whistler; the power of his whistle was 1.0×10^{-4} W. What was the sound's intensity at 2.5 m?
6. In 1988, Simon Robinson produced a sound having an intensity level of 2.5×10^{-6} W/m^2 at a distance of 2.5 m. What power was associated with Robinson's scream?

Sound

Additional Practice A

Givens *Solutions*

1. $Intensity = 3.0 \times 10^{-3}\ \text{W/m}^2$

$r = 4.0\ \text{m}$

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

$$P = 4\pi r^2(Intensity) = 4\pi(4.0\ \text{m})^2(3.0 \times 10^{-3}\ \text{W/m}^2)$$

$$P = \boxed{0.60\ \text{W}}$$

2. $r = 8.0 \times 10^{3}\ \text{m}$

$Intensity = 1.0 \times 10^{-12}\ \text{W/m}^2$

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

$$P = 4\pi r^2(Intensity)$$

$$P = 4\pi(8.0 \times 10^{3}\ \text{m})^2(1.0 \times 10^{-12}\ \text{W/m}^2) = \boxed{8.0 \times 10^{-4}\ \text{W}}$$

3. $Intensity = 1.0 \times 10^{-12}\ \text{W/m}^2$

$P = 2.0 \times 10^{-6}\ \text{W}$

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

$$r = \sqrt{\frac{P}{4\pi(Intensity)}}$$

$$r = \sqrt{\frac{2.0 \times 10^{-6}\ \text{W}}{4\pi(1.0 \times 10^{-12}\ \text{W/m}^2)}} = \boxed{4.0 \times 10^{2}\ \text{m}}$$

4. $Intensity = 1.1 \times 10^{-13}\ \text{W/m}^2$

$P = 3.0 \times 10^{-4}\ \text{W}$

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

$$r = \sqrt{\frac{P}{4\pi\ Intensity}} = \sqrt{\frac{(3.0 \times 10^{-4}\ \text{W})}{4\pi(1.1 \times 10^{-13}\ \text{W/m}^2)}} = \boxed{1.5 \times 10^{4}\ \text{m}}$$

5. $P = 1.0 \times 10^{-4}\ \text{W}$

$r = 2.5\ \text{m}$

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

$$Intensity = \frac{(1.0 \times 10^{-4}\ \text{W})}{4\pi(2.5\ \text{m})^2} = \boxed{1.3 \times 10^{-6}\ \text{W/m}^2}$$

6. $Intensity = 2.5 \times 10^{-6}\ \text{W/m}^2$

$r = 2.5\ \text{m}$

$$P = 4\pi r^2(Intensity)$$

$$P = 4\pi(2.5\ \text{m})^2(2.5 \times 10^{-6}\ \text{W/m}^2)$$

$$P = \boxed{2.0 \times 10^{-4}\ \text{W}}$$

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