Name:_____ Class:_____ Date:_____

Sound

# Problem A

## INTENSITY OF SOUND WAVES

### PROBLEM

Kåre Walkert of Sweden reportedly snores loudly, with a record intensity of $4.5 \times 10^{-8}$ 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.

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

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

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

### ADDITIONAL PRACTICE

1. Blue whales are the loudest creatures; they can emit sound waves with an intensity of $3.0 \times 10^{-3}$ 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 $1.0 \times 10^{-12}$ W/m$^2$.
3. Estimate how far away a cicada can be heard if the lowest audible intensity of the sound it produces is $1.0 \times 10^{-12}$ W/m$^2$ and the power of a cicada's sound source is $2.0 \times 10^{-6}$ 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 $3.0 \times 10^{-4}$ W. If the threshold of hearing of a human is assumed to be $1.1 \times 10^{-13}$ 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 $1.0 \times 10^{-4}$ W. What was the sound's intensity at 2.5 m?
6. In 1988, Simon Robinson produced a sound having an intensity level of $2.5 \times 10^{-6}$ W/m$^2$ at a distance of 2.5 m. What power was associated with Robinson's scream?

Name:_____ Class:_____ Date:_____

## INTENSITY OF SOUND WAVES

### PROBLEM

Your friend whispers a secret to you with a power output of $2.05 \times 10^{-10}$ W. If the whisper has a sound intensity $4.1 \times 10^{-10}$ W/m$^2$, how far are you from your friend?

### SOLUTION

**Given:** $Intensity = 4.1 \times 10^{-10}$ W/m$^2$ $P = 2.05 \times 10^{-10}$ W

**Unknown:** $r = ?$

**Choose the equation(s) or situation:**

Use the equation for the intensity of a spherical wave.

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

$$r = \sqrt{\frac{P}{4\pi(Intensity)}} = \sqrt{\frac{2.05 \times 10^{-10}\ \text{W}}{(4\pi)(4.1 \times 10^{-10}\ \text{W/m}^2)}} = \boxed{0.20\ \text{m}}$$

### ADDITIONAL PRACTICE

1. Your friend tells you about what happened last weekend with a power output of $5.88 \times 10^{-5}$ W and a sound intensity of $3.9 \times 10^{-6}$ W/m$^2$. How far are you from your friend?
2. The power output of heavy street traffic is $1.57 \times 10^{-3}$ W. At what distance is the sound intensity of the traffic $5.20 \times 10^{-3}$ W/m$^2$?
3. A subway train in New York City produces sound with a power output of 4.80 W and an intensity of $7.2 \times 10^{-2}$ W/m$^2$. How far are you from the subway train?
4. A loud clap of thunder has a power output of 151 kW and a sound intensity of 0.025 W/m$^2$. How far are you from the thunder's source?
5. What is the intensity of the sound waves produced by the jet engine of a plane taking off at a distance of 32 m when the power radiated as sound from the engine is 402 W? Assume that the sound waves are spherical.
6. Calculate the intensity of the sound waves from a car stereo at a distance of 0.50 m when the sound has power output of 3.5 W.
7. At a maximum level of loudness, the power output of portable radio headphones radiated as sound is $2.76 \times 10^{-2}$ W. What is the intensity of these sound waves to a jogger whose ear is 5.0 cm from the headphone's speaker?
8. If the intensity of a mosquito's buzzing is $9.3 \times 10^{-8}$ W/m$^2$ at a distance of 0.21 m, how much sound power does that mosquito generate?
9. How much power is radiated as sound from a vacuum cleaner whose intensity is $4.5 \times 10^{-4}$ W/m$^2$ at a distance of 1.5 m?
10. To perforate an eardrum, an intensity of $1.0 \times 10^{4}$ W/m$^2$ at a distance of 1.0 m is required. Calculate how much sound power must be generated.