The Mathematics of Sound

Team G

Review Vocabulary

- exponent

Before You Start

You are studying to become an otologist, a specialized doctor who deals with the structure and function of the human ear. Your current studies focus on the power and intensity of sounds.

Source of Sound	Watts
Fire truck siren	10^3
Turbo propeller plane at take-off	10^2
Sonic boom	1
Medium-loud rock concert	10^{-1}
Helicopter	10^{-2}
Heavy city traffic	10^{-3}
Alarm clock	10^{-4}
Normal conversation	10^{-5}
Busy restaurant	10^{-6}
Average home	10^{-7}
Refrigerator running	10^{-8}
Breathing	10^{-11}

Activity

Threshold of hearing	10^{-12}

The power of sound is measured in watts. The table at the right lists the power of a variety of sounds in watts.

1. Write the number of watts of the sound made by a busy restaurant as a fraction and as a decimal.

_____

2. Write the power of each sound without using an exponent.

a. Fire truck siren

_____

b. Breathing

_____

c. Normal conversation

_____

3. The power of the sound of breathing is how many times as great as the threshold of hearing?

_____

4. The power of the sound of a trubo propeller plane at take-off is how many times as great as the power of the sound of a busy restaurant.

_____

5. Use your answers to Questions 1-4 to explain the pattern you see with exponents and powers of 10.

_____

As you move father from the source of a sound, the sound's intensity *I* decreases. The intensity, measured in watts per square meter, is given by the equation $I = 0.08Pd^{-2}$. In the formula, *P* is the power of the sound in watts and *d* is the distance in meters from the sound's source.

6. Use the formula to find the intensity of the various sounds.

a. Normal conversation at a distance of 5 meters

_____

b. Medium-loud rock concert at a distance of 2 meters

c. Helicopter at a distance of 1 meter

7. a. Find the intensities of a fire truck siren at distances of 5 m, 10 m and 20 m.

b. What is the relationship among the intensities you found in part (a)?

8. QUICK REPORT Use your results from this activity to complete the report below. In the first column, write the power of the sound. For the sounds in the middle and right columns, write the intensity of the sound.

Normal Conversation	Medium-Loud Rock Concert ($d = 2$ m)	Fire Truck Siren ($d = 20$ m)

9. REFLECT Explain how you used each skill in this activity.

a. simplifying powers with positive exponents

b. simplifying powers with negative exponents

1. $\frac{1}{1{,}000{,}000}$; 0.000001

2. **a.** 1,000 watts

b. 0.00000000001 watt

c. 0.00001 watt

3. 10

4. 1,000,000,000,000

5. for each power of 10, there is a zero

6. **a.** 0.000000032 watt per square meter

b. 0.002 watt per square meter

c. 0.0008 watt per square meter

7. **a.** 3.2 watts per square meter; 0.8 watt per square meter; 0.2 watt per square meter

b. As the distance doubles, the intensity is 4 times less.

8.

Normal Conversation	Medium-Loud Rock Concert (d = 2 m)	Fire Truck Siren (d = 20 m)
0.00001 watt	0.002 watt per square meter	0.2 watt per square meter

9. Answers may vary. Sample answers are given.

a. I simplified powers with positive exponents when I determined the power of a fire truck siren. I also simplified powers with positive exponents when I compared the intensities of a fire truck siren at different distances.

b. I simplified powers with negative exponents when I determined the powers of various sounds. I also simplified powers with negative exponents when I calculated intensities of objects at different distances.