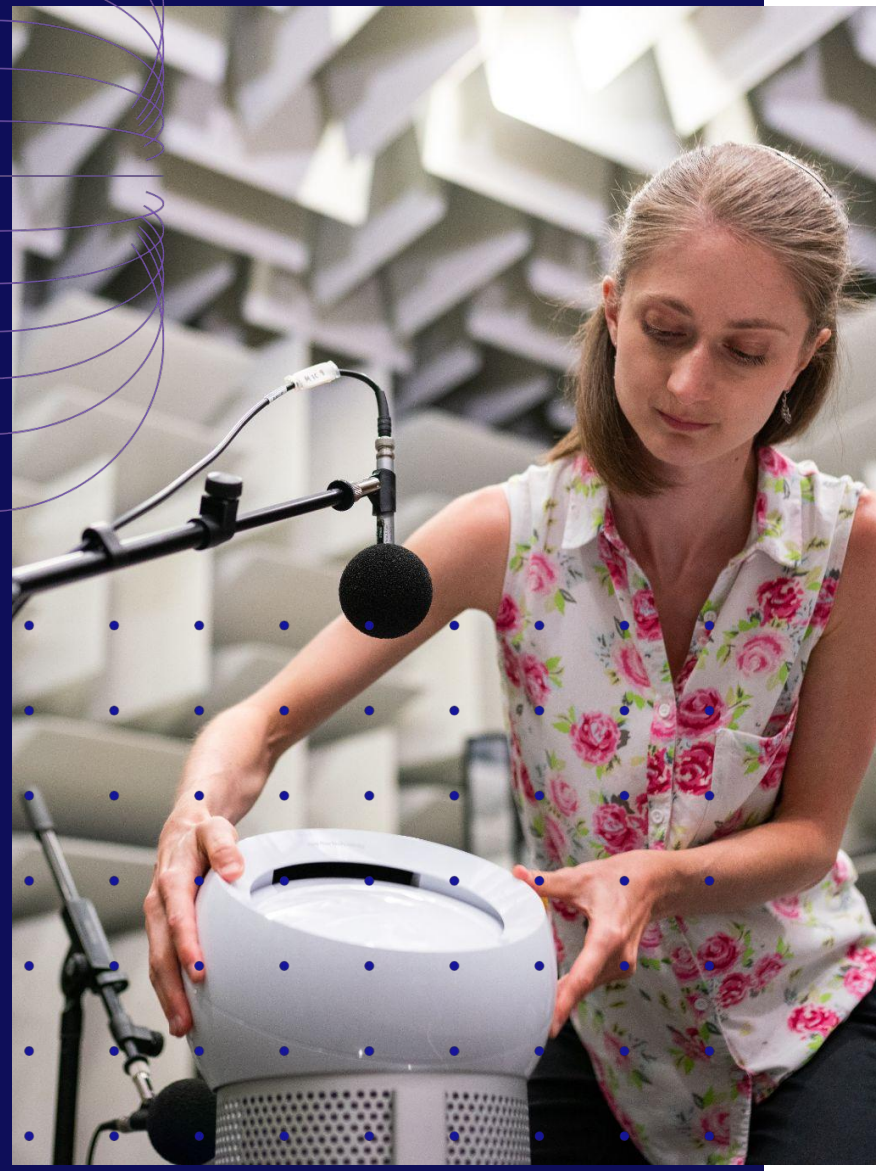


Engineering Tomorrow

Sound & Acoustics

Mitigating Noise Pollution

GOAL

To learn about sound and design a solution to combat noise pollution

2024-08-15_v1.0

Breakout Development Team

DYLAN WEBER

College: Fairfield University
Major: Mechanical Engineering

TRAVIS SLUSS

College: SUNY Purchase, BS ‘07
Major: Studio Production
Industry Experience: MacInspires, Red Lotus Productions

JULIAN CENTENO

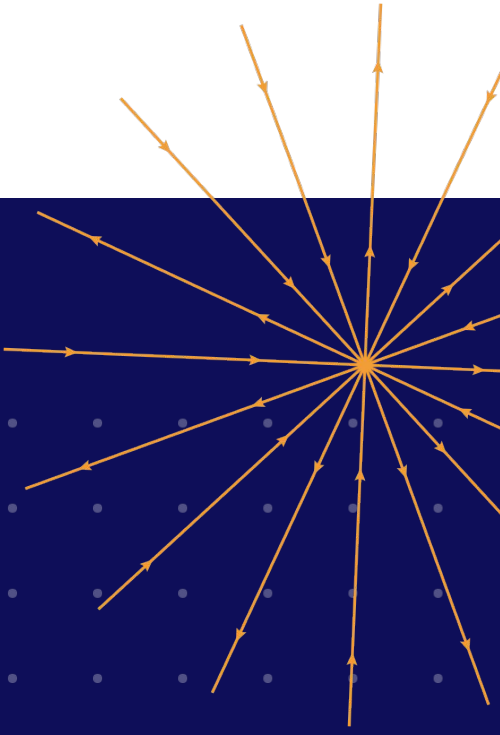
College: SUNY Polytechnic Institute ‘23
Major: Mechanical Engineering Technology

CAROLINE GILLESPIE

College: University of Notre Dame ‘23
Major: Mechanical Engineering

PART 1

Conceptual Basics



Sound Fundamentals

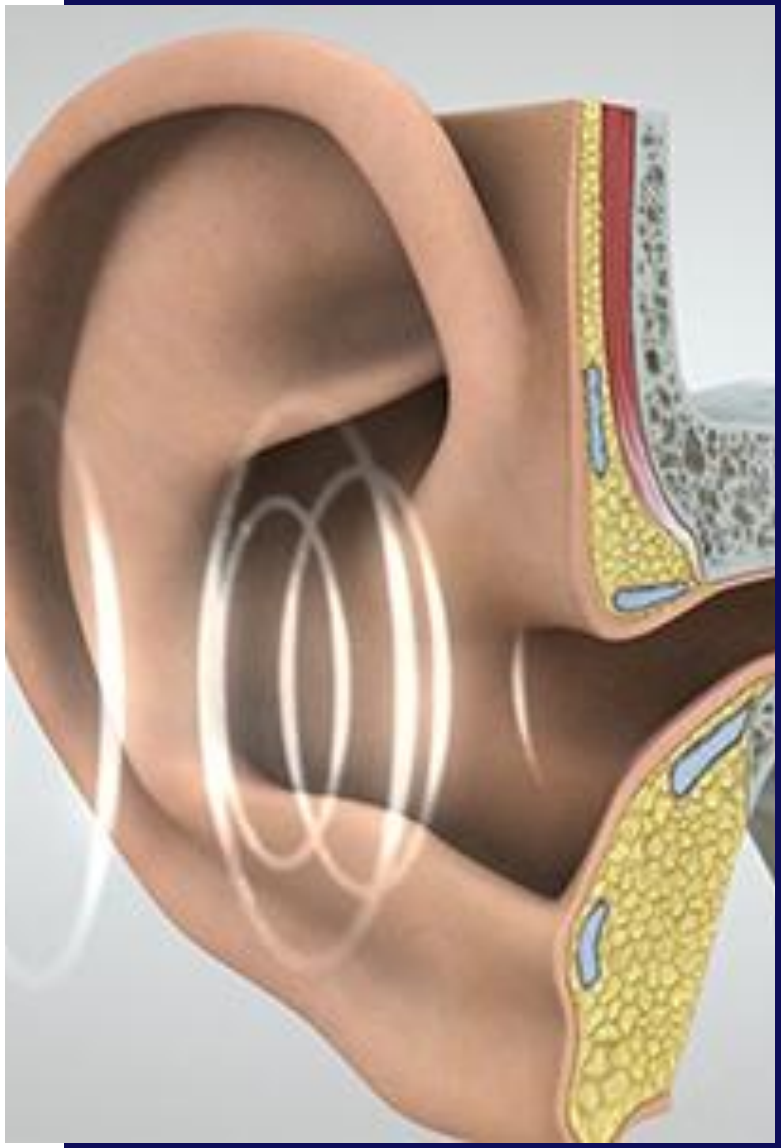
Video Recap

ANSWER ME! List three new things you learned about sound!

List your answers here.

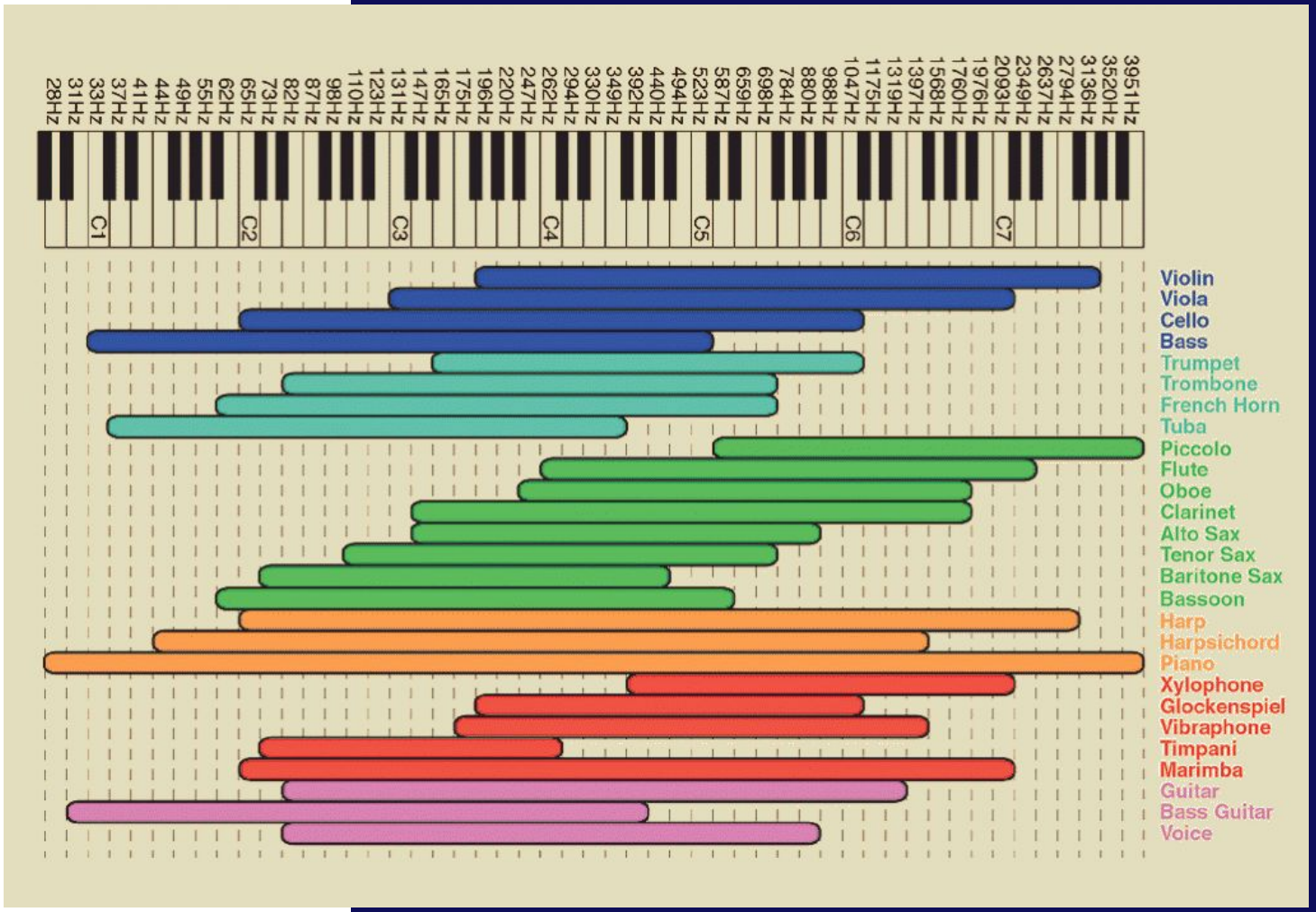
What is Sound: Summary

- Sound is created when something vibrates and sends out waves of energy
- Vibrations travel through mediums, which include:
  - Air
  - Water
  - Solids
- Stronger vibrations = more energy = louder sound



Pitch and Frequency

- Sound changes depending on speed of vibration
- Pitch is the quality of a sound (high / low)
  - Depends on frequency of vibration
  - Fast vibration = high pitched sound
  - Slow vibration = low pitched sound
- Frequency is # of times per second that a sound pressure wave repeats itself
  - Units of frequency are called Hertz (Hz)
  - Humans hear sounds between 20-20,000 Hz



Test your Ears!

ANSWER ME!

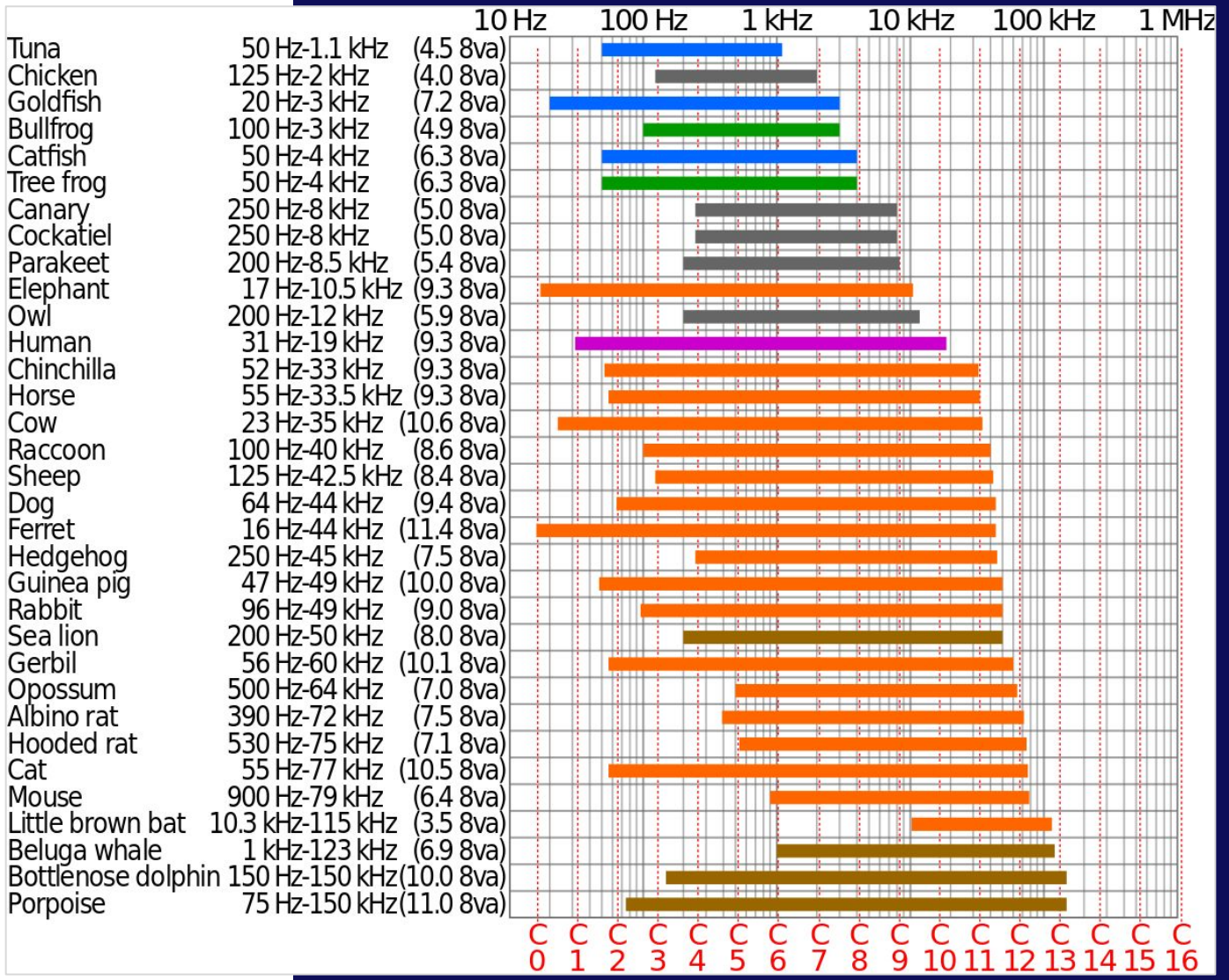
What was the highest frequency you could hear?

Type your answer here.

What Frequency Range do Animals Hear?

Frequency Activity

- Go to this website: https://onlinetonegenerator.com
- Listen to 440 hertz
- Change it to 880, an octave up, and listen
- Change it to 1K and listen. Sound familiar?
- Change it to 5k and listen.
- What's the highest frequency you can hear?
- What do you think it would be like to be able to hear higher pitched sounds like many of the animals listed on this chart?



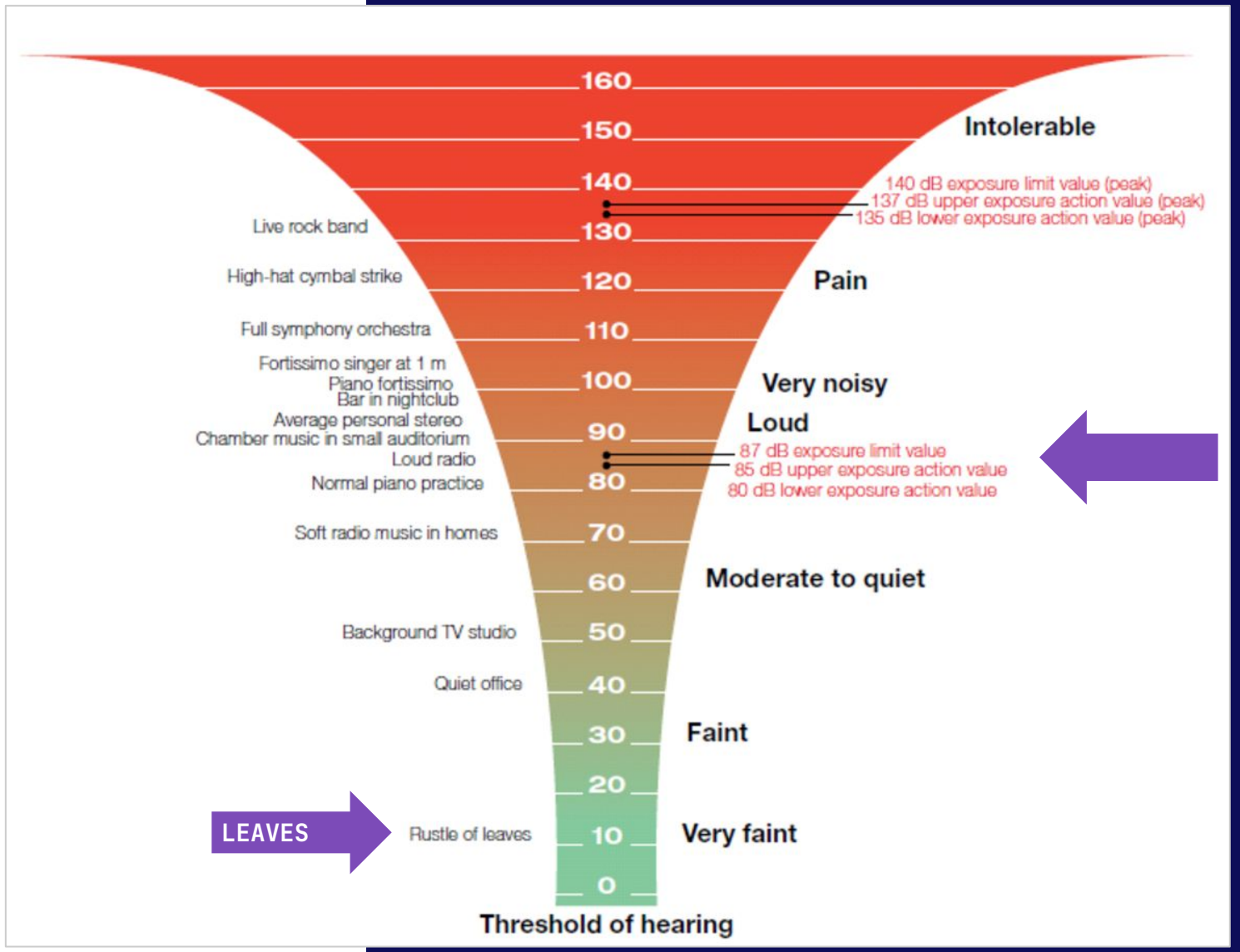
Measuring Sound

Sound measured in decibels (dB)

- Rustling leaves (20 - 30 dB)
- Thunderclap (120 dB)
- Siren (120 - 140 dB)

Sounds that reach 85 decibels or higher can harm a person's ears.

- Power lawn mowers (90 decibels)
- Subway trains (90 to 115 decibels)
- Rock concerts (110 to 120 decibels)



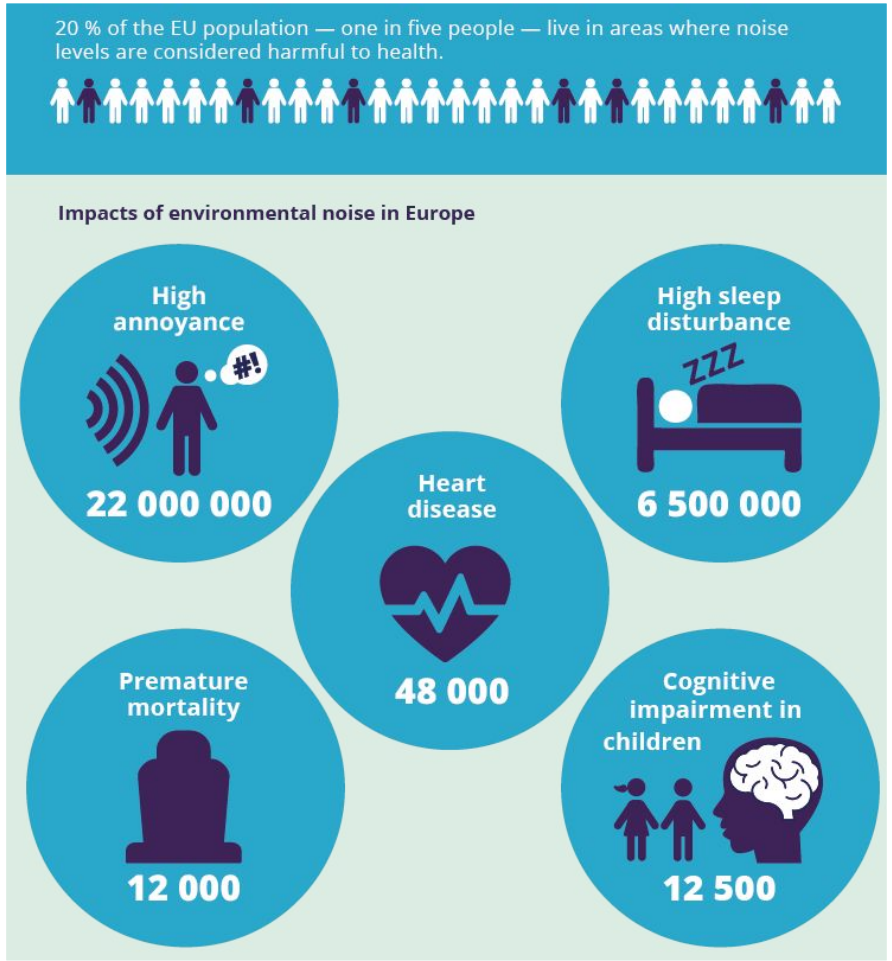
Noise Pollution

Noise pollution is considered to be any unwanted or disturbing sound that affects the health and well-being of humans and other organisms.

Noise pollution impacts millions of people on a daily basis. The most common health problem it causes is Noise Induced Hearing Loss (NIHL).

These health problems can affect all age groups, especially children. Many children who live near noisy airports or streets have been found to suffer from stress and other problems, such as impairments in memory, attention level, and reading skill.

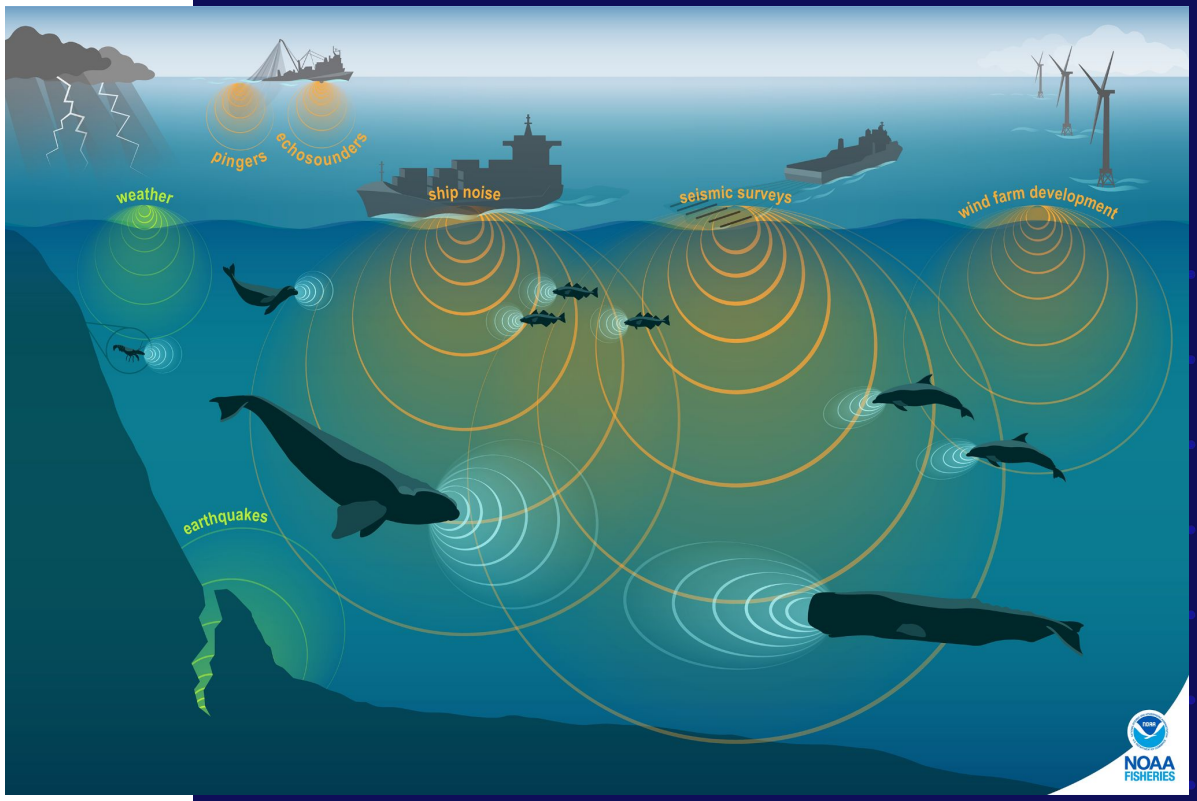
Health Effects of Noise Pollution



Noise Pollution and Wildlife

Noise pollution also impacts health and well-being of wildlife; for example:

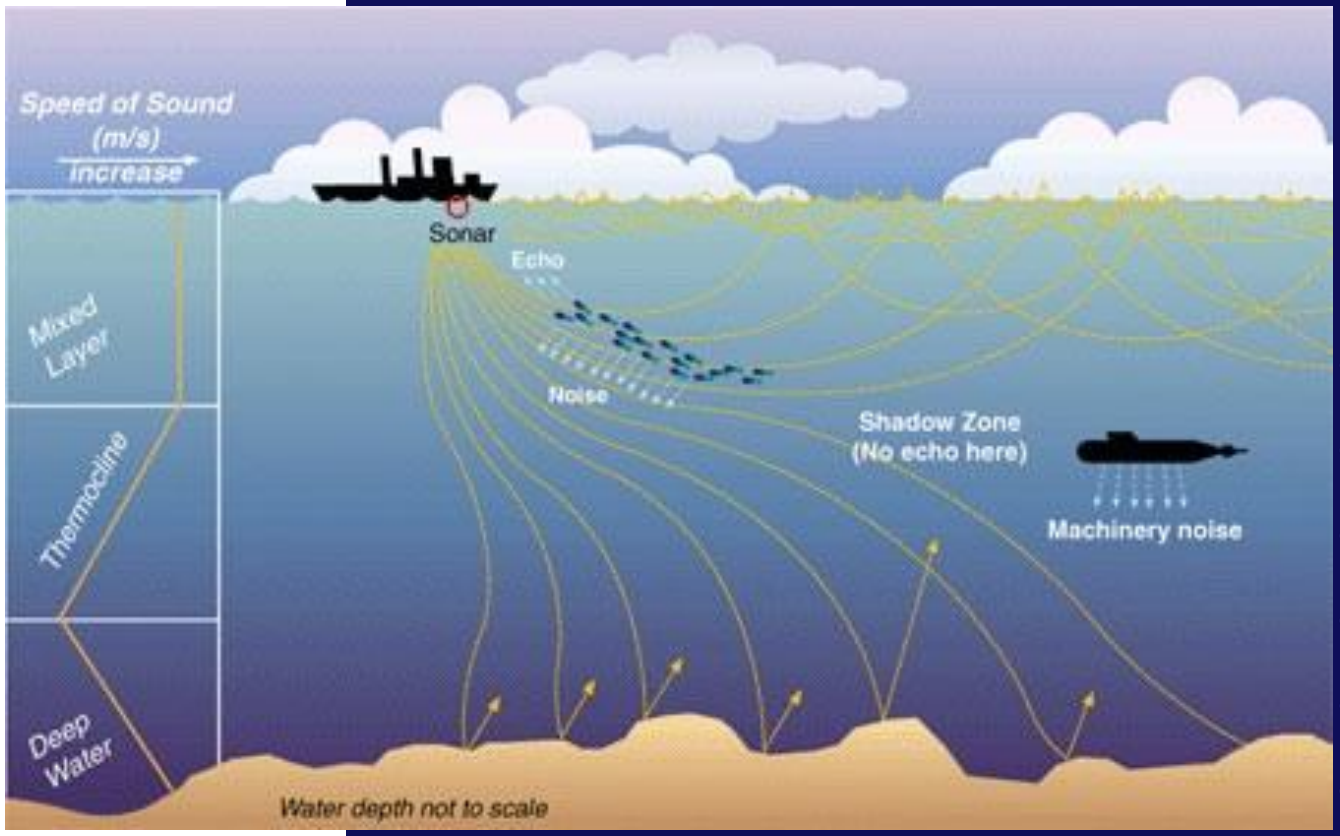
- Caterpillars' hearts beat faster
- Bluebirds have fewer chicks
- For animals that use sound for navigation, food, to find mates, or avoid predators:
    - Noise pollution makes it difficult to accomplish these tasks → decreasing survival rate



Noise in Other Mediums

Sound waves travel faster in denser substances, like water, because:

- There are more closely packed particles to vibrate
- ex- There are 800 times more particles in a bottle of water than the same bottle with air → sound travels faster in water than air



BUBBLE CURTAIN SOUND REDUCTION EXAMPLE: DOSITS.ORG

How Can We Reduce Sound Pollution?

Existing Systems

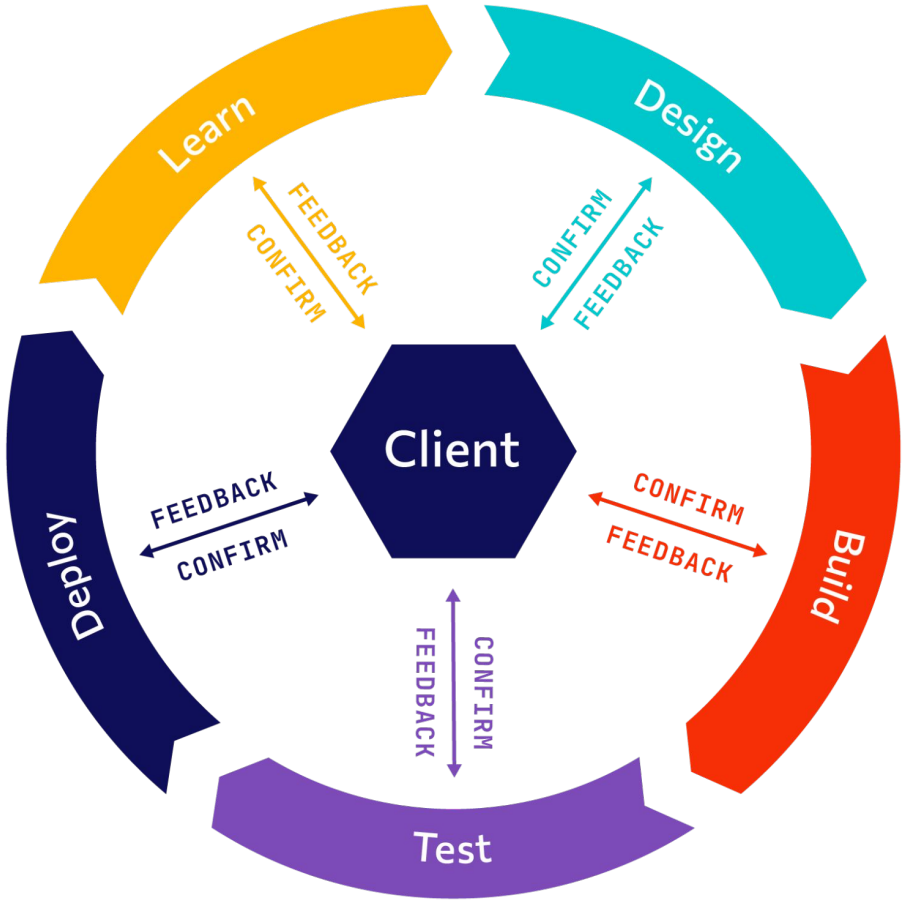
How Absorptive Noise Barrier Walls Reduce Noise

- A noise barrier or sound wall made with absorptive materials literally diffuses the sound so that there is little to no sound being reflected back into the environment.
- Hard surfaces, such as concrete, reflect sound, sending it back into the environment (sometimes even making the sound louder!) not having any benefit for noise reduction.

PART 2

Build Your Own Noise Pollution System

The Engineering Design Process



Click HERE for more information on the Engineering Design Process!

THINK

Imagine you are a team of acoustical engineers.

- How can you use the Engineering Process to create a sound barrier to reduce noise pollution?

What action would you do with each step of the process?

The Components for Sound & Acoustics

1 x Acoustic Panel

1 x Buzzer

1 x AA Battery

1 x Single Battery Holder

3 x Jumper Wire

Masking Tape Strip (if needed in assembly)

Lab Instructions

1. Download a volume meter app (decibel level meter) such as: https://apps.apple.com/us/app/niosh-sound-level-meter/id1096545820 or "Sound Meter" for Android: https://play.google.com/store/apps/details?id=com.gamebasic.decibel
2. Place the buzzer 90 cm (36 inches) away from the bottom of the phone.
3. Measure and record the dB volume level of the buzzer on the provided Activity Sheet.
4. As a team, brainstorm and create a sound barrier with the provided materials as well as materials from around your house or school.
5. Place the sound barrier between the buzzer and the phone and take measurements.
6. Iterate on your team's design and continue to notate measurements as you fill out the Activity Sheet. Keep in mind the amount of space the noise barrier takes up is a real-life concern. It would be easier to reduce noise if we could take up more and more space. Keep your designs less than 50 cm thick.
7. Fill out the remainder of your Activity Sheet. Which designs worked the best? Why?

Step One: Identify the Problem

ANSWER ME! What problem or challenge is your team trying to solve with your barrier?

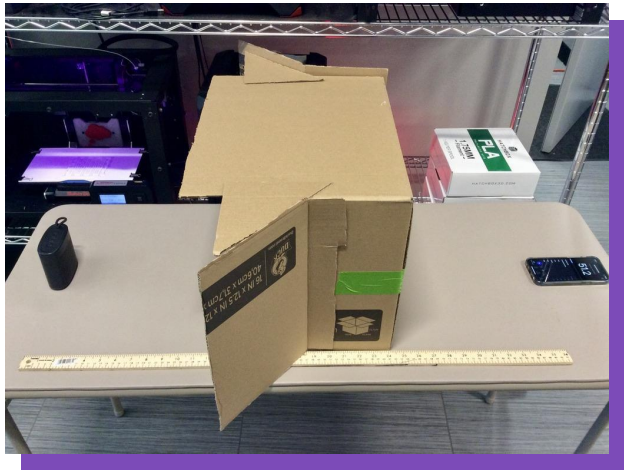
Type your answer here.

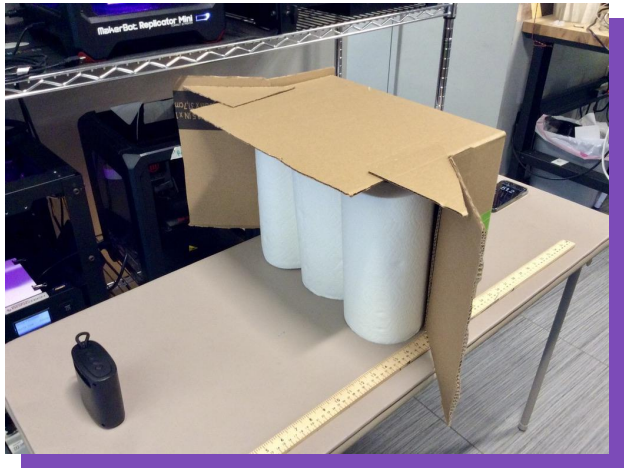
Step Two: Research

ANSWER ME! What solutions already exist to manage noise pollution?

Type your answer here

Some Examples





Step Three: Design your Solution

ANSWER ME! Using what you have observed from your research, draw out a diagram of your team's first design for a noise pollution solution.

Insert photos or drawings here.

Step Four: Build your First Prototype

ANSWER ME! Using the materials provided and whatever else you find around your house or school, construct your first sound pollution barrier!

Insert images of your design here.

Step Five: Test - Activity Sheet

ANSWER ME! Fill in the chart with the measurements collected from your designs.

Control Test		Distance from Buzzer	dB Level
No obstructions between microphone and buzzer		**N/A**	
Iteration Number	Key Design Aspects	Distance from buzzer	dB Level
1			
2			
3			
4			
5			
6			

Step Six: Analyze Your Results

ANSWER ME! Use your observations & data to answer the following questions:

Did your design effectively reduce noise pollution?	What are some changes you could make to your design?	Which testing iteration was most successful and why?
Write your answer here	Write your answer here	Write your answer here

Reflect on Your Design and Results

ANSWER ME!

What do you think went well when completing this activity?	What is something you would do differently if you were to do this again?
Write your answer here	Write your answer here

Complete the mandatory 5-minute **Exit Ticket** by clicking here!

Continue to Explore

IF YOU LIKED TODAY'S BREAKOUT, YOU MAY BE INTERESTED IN THESE TOPICS:

- Noise Pollution
- Architectural Acoustics
- Musical Acoustics
- Sound Design - Engineering in the Entertainment Industry

TYPES OF ENGINEERING RELEVANT TO TODAY'S BREAKOUT:

- Acoustical Engineering
- Sound Engineering
- Electrical Engineering
- Mechanical Engineering
- Materials Science

OPTIONAL

Post-Lab Activities

Extension Activities

EFFECTS OF NOISE POLLUTION

- Construction Noise Pollution
- Effects of Noise Pollution on Human Health and the Environment
- Consequences to Underwater Noise
- How Animals are Affected and Respond to Noise Pollution

LEARN MORE ABOUT ACOUSTIC ENGINEERING

- About Acoustic Engineers
- Try your own Acoustic Engineer Project!
- Acoustic Engineering of Various Buildings and Rooms

Extension Activities: Feedback

ANSWER ME!

What is echolocation	Name 1 or more activities that can harm sea-life's ability to use echolocation.	Make a sound file by creating, combining, and manipulating sounds.
Write your answer here	Write your answer here	Upload your file here

Thank you!

Engineering
Tomorrow