Data: https://spacemath.gsfc.nasa.gov/

Engaging Context:
85dB is the threshold at which damage to human hearing begins. Students will gather sound intensity data, via DeciBel app, to determine which areas of the school are safe for unprotected hearing or if earplugs should be used as they compare their data to a list of common noises and their decibel levels.
(I've downloaded and tried all suggested apps from the NASA page, even SPLnFFT Noise Meter for $3.99, and decided that the free DeciBel app will suffice for this lesson.)
Students will collect acoustic data around the school building to determine which area is the quietest, or safest for students' ears, or the loudest, the area most likely to cause hearing damage.

Measureable Objectives:
• Students will be able to understand the general function of the human ear and how it transmits acoustic information to the brain after watching How Your Ears Work. (DOK 2)
• Students will be to construct a model that demonstrates how sound waves interact with the ear so that hearing occurs. (DOK 4)
• Students will be able to measure and save the sound intensity of an assigned area in the school using the DeciBel app. (DOK 2)
• Students will be able to save their DeciBel app data for comparison with benchmark sounds on a decibel scale. (DOK 2)
• Students will be able to rank the class measurements as to quietest to loudest area(s) in the school building. (DOK 3)
• Students will be able to design and construct a *sound intensity obstruction device* (ear muffs) that protects their hearing. (DOK 4)

Standards:
CCSS-M: 6.SP.1: Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.
CCSS-M: 6.SP.2: Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.
CCSS-M: 6.SP.3: Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values very with a single number.

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.

Science and Engineering Practices
• Develop a model using an analogy, example, or abstract representation to describe a scientific principle.
• Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Nature of Science: Scientific Knowledge is based on empirical evidence: Science findings are based on recognizing patterns.
Disciplinary Core Ideas
PS4A: Wave Properties
• Wave of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

ETS1.C Optimizing The Design Solution
• Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Crosscutting Concepts
Patterns
• Similarities and differences in patterns can be used to sort and classify phenomena.
• Similarities and differences in patterns can be used to sort and classify design products.

Connections to Engineering, Technology, and Applications of Science
Interdependence of Science, Engineering, and Technology
• Knowledge of relevant scientific concepts and research findings is important in engineering

Evidence:
1. Students will model on paper their ideas how sound energy reaches their ears.
2. Students will watch [How Your Ears Work](#) and revise their model for sound energy reaching their ears.
3. Students will be assigned to groups of 3 or 4.
4. Students will take a baseline measurement of their classroom by which they will judge the other areas in the school building.
   a. This baseline reading should be done for 1 minute with no talking.
   b. Another baseline reading should be done with students talking normally for 1 minutes.
   c. The teacher will demonstrate high decibel sounds with
      i. Results are recorded by classroom teacher after each measurement, such as Mr. Mac's room#1, Mr. Mac's room#2, and so forth.
      ii. Students will also note their proximity to the observed students and the observed teacher, administrator, or staff member.
5. Students will go to different classrooms (which the teachers will be informed prior to students' arrival) in the Bennet Elementary School building to measure the acoustic intensity of that classroom for 1 minute using the DeciBel app on their smartphone or on students' Chromebook.
   a. Students will position themselves around the room as discreetly as possible to gather a true measure of the classroom noise level and not interrupt instruction.
6. Students will store their data on their device for future retrieval.
7. Repeat this process until all data for assigned rooms' noise levels have been gathered.

8. Students will compare their data within their group.
    a. Why weren't the data exactly the same?
        i. Students were in the same classroom at the same time.
    b. Record on observation sheet.
    c. As teacher circulates around the room, talk to each group about the variances in their data.
        i. Why do they think this happened?
9. Students will fill out a data table (supplied by the teacher) for their collected data.
10. Teacher will instruct students on students on calculating the range, mean, median, and mode using their collected data.
11. Graph data on graph paper
    a. Teacher will instruct students on students how to transfer data from data table to graph.
        i. Graphs needs to be titled and axes need to be labeled.
        ii. Discuss graph intervals with students.
    b. Students will write a conclusion about the hearing health of our school building.
        i. Which classrooms should they go into that will not damage their hearing?
        ii. Which classrooms should they avoid?
12. Have students present their data and their interpretations of their data to the class.
13. Students will construct hearing protection devise with their assigned group.
    a. Students will research the topic.
    b. Students will brainstorm ideas with their members.
    c. Students will plan, construct, and test their devices.
    d. Students will revise their devices.
        i. Students will record this process on paper.
        ii. This could be incorporated into a slide presentation (possibly).
    e. Students will present their hearing protection to the class.