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| **Name: Molly Hamilton** | **Contact Info:** [**hamilmo@cpsboe.k12.oh.us**](mailto:hamilmo@cpsboe.k12.oh.us) | **Date: 2/28/18** |

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| **Lesson Title : Can you hear it?** | **Unit #:**  **1** | **Lesson #:**  **2** | **Activity #:**  **4** |
| **Activity Title: How loud can you make it?** |

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| **Estimated Lesson Duration:** | **Five 45 minute classes** |
| **Estimated Activity Duration:** | **Four 45 minute classes** |

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| **Setting:** | **In class** |

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| **Activity Objectives:** |

* Determine how amplify a sound.
* Use logarithms and apply them to sound.

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| **Activity Guiding Questions:** |

Why would we want to increase the volume of a sound?

How can we amplify a sound?

Does the frequency determine how a sound can be amplified?

What does a decibel change really mean?

How can I double or triple the sound?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☒ Cause and effect |
| ☒ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☐ Systems and system models |
| ☒ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☒ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| ☒ Engaging in argument from evidence | ☐ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

| **Ohio’s Learning Standards for Science (OLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☒ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Ohio’s Learning Standards for Math (OLS) and/or**  **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☒ Make sense of problems and persevere in solving them | ☒ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☒ Attendto precision |
| ☒ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☒ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, OLS and/or CCSS):** |

LE.A.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

IF.C.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm’s law V = IR to highlight resistance R.

REI.D.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

Noise amplifier challenge handout.

<https://docs.google.com/a/cpsboe.k12.oh.us/viewer?a=v&pid=sites&srcid=Y3BzYm9lLmsxMi5vaC51c3xtb2xseS1hLWhhbWlsdG9uLTIwMTd8Z3g6N2U1MmZlZmYxNDg1OGRkMg>

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| **Teacher Advance Preparation:** |

Make copies of the challenge handout.

Make sure you have enough materials.

Make copies of posttest.

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| **Activity Procedures:** |

1. Challenge will be generated in activity one from student input to create a noise amplifier. Supplies will be provided, or students can bring in extras from home, work, etc.
2. Students will use the EDP process to refine their amplifier.
3. Before the final test, students will be given an additional constraint that they have to double or triple the intensity of the sound.
4. In groups, students will create a PSA video, announcement, or brochure to present their findings from the unit to the class.
5. Posttest.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Design options.

<https://docs.google.com/a/cpsboe.k12.oh.us/viewer?a=v&pid=sites&srcid=Y3BzYm9lLmsxMi5vaC51c3xtb2xseS1hLWhhbWlsdG9uLTIwMTd8Z3g6N2U1MmZlZmYxNDg1OGRkMg>

Product test.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Communicate Solution.

Unit 4 Post-assessment.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* Extended time for IEP students.
* Creating selected groups to maximize student participation.
* Students will be working at their own pace.
* Students are given a choice in how to present their knowledge and challenge results.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

Overall, the students were engaged and all groups were able to create a sound amplifier that worked for at least one of the four sounds that were tested. Students gained a better understanding of logarithmic scales and why they are used. Most of the associated math still had to be taught after the challenge. Some students stated that they wish the math was introduced earlier, but I wanted them to learn it as they needed it.