Teaching Engineering Applications in Math and Science (TEAMS)
Template: Math/Science-Engineering connected Lesson Plan

Title of Lesson:	How can we measure the speed of sound in air?
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Grade level:	6-8th Grade
Content or Subject Areas:	Physics, engineering, mathematics, electricity, lab techniques, experimental data analysis
Duration of lesson:	50-60 minutes minimum; probably 2 or more sessions

General Objectives:	One clear sentence addressing the scope of the lesson and curricular goal as relates to engineering.	Students use practical skills and scientific knowledge to solve a problem: what is the speed of sound in air?
Learning Outcomes: (1-3 stated outcomes) After completion of the lessons, students will be able to: (use action verbs)	What do you want students to know and be able to do? What knowledge, skills, strategies, and attitudes do you expect students to gain? What important math/science and engineering applications will students learn?	Students will know the relationship between speed, distance, and time. Students will understand the strengths and weaknesses of two or more measurement methods. Students will practice standard laboratory procedures and documentation.

State Standards: (MT Math and/or Science Standards)	8th grade Benchmarks: Science Standard 1; 1. identify a question, determine relevant variables and a control, formulate a testable hypothesis, plan and predict the outcome of an investigation, safely conduct scientific investigation, and compare and analyze data. 2. select and use appropriate tools including technology to make measurements (in metric units), gather, process and analyze data from scientific investigations. 5. identify strengths and weakness in an investigation design. Science Standard 2: 3. describe energy and compare and contrast the energy transformations and the characteristics of light, heat, motion, magnetism, electricity, sound and mechanical waves.

	5. describe and explain the motion of an object in terms of its position, direction, & speed as well as the forces acting upon it. Math Standard 1: 1. formulate and solve multi-step and nonroutine problems using a variety of strategies. Generalize methods to new problem situations. 4. recognize and investigate the relevance and usefulness of mathematics through applications, both in and out of school. 5. select and use appropriate technology to enhance mathematical understanding. Appropriate technology may include, but is not limited to, paper and pencil, calculator, computer, and data collection devices. Math Standard 3: 1. understand the concepts of variable, expression and equation 2. represent situations and number patterns using tables, graphs, verbal rules, equations, and models. Math Standard 5: 1. estimate, make, and use measurements to describe, compare and/or contrast objects in real-world situations. 2. select and use appropriate units and tools to measure the level of accuracy required in a particular setting. 4. demonstrate understanding of the structure and use of systems of measurement, including English and metric. 5. use the concepts of rates and other derived and indirect measurements. Math Standard 6: 1. systematically collect, organize, and describe data. 3. draw inferences, construct, and evaluate arguments based on data analysis and measures of central tendency. 5. make predictions based on experimental results or probabilities.
National standards: (AAAS Benchmarks)	8th Grade Benchmarks: 2.B/M1: Mathematics is helpful in almost every kind of human endeavor—from laying bricks to prescribing medicine or drawing a face. 3A/M2: Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information. 3A/M3: Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems. They also usually have to take human values and limitations into account. 4.F/M2 Something can be "seen" when light waves emitted or reflected by it enter the eye—just as something can be "heard" when sound waves from it enter the ear. 4.F/M4 Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials.

Materials and Resources:	Provide a list of materials, people, and references that 1) you used to create the lesson and 2) are required to teach the lesson, including all physical materials, sources and resources outside the classroom.	• Each student (or group) needs a pencil, notebook, and hand calculator. • Two blocks of wood that can be clapped together to make a loud, impulsive sound. For Method 1: • A laptop or desktop computer with a microphone. • Audio recording and signal display software For Method 2: • An open area (50-100 meters) with a large reflecting surface, such as the wall of a large building. • Several digital stopwatches or watch chronographs. • A way to measure 100 meters outdoors (e.g., tape measure or measuring wheel).

Instructional Procedures: (include time estimates where possible)	Focusing Event: Why would your students care or want to know about this topic? What "big" questions will generate discussion about this topic?	Students are already familiar with speed of sound characteristics, like the delay between a lightning flash and the resulting thunder, or noticing the delay between the flash of a distant starting pistol at a track meet and hearing the report. They may also be familiar with sonic booms due to supersonic military aircraft (or the atmospheric reentry of the space shuttle). The "big" questions are: • Can we estimate the speed of sound based on informal observations? • Can we come up with a way to measure the speed reliably and repeatedly? • What mathematical relationships go into defining speed? • What measurement issues do we need to understand when we do an experiment like this? • What precision and what accuracy are associated with the experiments, and why?

	Teaching Methods and Student Activities: Sequentially list how you will carry out the various aspects of the lesson, including questions, examples, etc. What tasks will students complete? How will they build knowledge, skills, learn independently or with others? What instructional practices will you use with this lesson? How and where will your students work – labs, groups, stations?	[see separate document]
	Closure: To review what has been learned, to do a final check for understanding of the skill or concepts and to focus on the connection between previous, future and current lessons.	• Have students describe the sources of uncertainty in their experiment, e.g., limitations on measuring time and distance. • Ask the students to consider the implications of the fact that the speed of sound depends on the temperature of the air: slower in cold air, faster in hot air. Could they repeat the outdoor experiment early on a cold morning and then again on a hot afternoon and investigate the results? • Have the students make predictions based on the observations, e.g., ask them to imagine that they counted 8 seconds between a flash of lightning and the corresponding thunder, how far away is the lightning? • Ask the students to use other real-world experience to assess the speed of sound implications. For example, the students are probably aware that helium speech sounds squeaky compared to regular speech, but they may not be aware that this is because

		the speed of sound in helium is faster than the speed of sound in regular air.

Evaluation procedures:	Describe your formative and/or summative assessment methods used in this lesson, your goals for using them, and how you will use the results. How will you know your students have reached the lesson goal? What assessment tools will you use? How will students be involved in ongoing assessment? How will students assess themselves?	[instructor comments here]