Mechanical Waves (Bundle 4, Sub-Unit 11)

1. Time Frame	2 Weeks (Full Year), 1 Week (Block)
2. Selected Performance Expectation *Standards by Topic*	**HS-PS4-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]
3. Related Disciplinary Core Ideas ● *Read relevant section in Framework* ● Evidence Statements	**PS4.A: Wave Properties** ● The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. *Observable features of the student performance by the end of the course:* **1) Representation** a) Students identify and describe* the relevant components in the mathematical representations: i. Mathematical values for frequency, wavelength, and speed of waves traveling in various specified media; and ii. The relationships between frequency, wavelength, and speed of waves traveling in various specified media. **2) Mathematical modeling** a) Students show that the product of the frequency and the wavelength of a particular type of wave in a given medium is constant, and identify this relationship as the wave speed according to the mathematical relationship $v=f\lambda$. b) Students use the data to show that the wave speed for a particular type of wave changes as the medium through which the wave travels changes. c) Students predict the relative change in the wavelength of a wave when it moves from one medium to another (thus different wave speeds using the mathematical relationship $v=f\lambda$). Students express the relative change in terms of cause (different media) and effect (different wavelengths but same frequency). **3) Analysis** a) Using the mathematical relationship $v=f\lambda$, students assess claims about any of the three quantities when the other two quantities are known for waves travelling in various specified media. b) Students use the mathematical relationships to distinguish between cause and correlation with respect to the supported claims.

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4. Prior Disciplinary Core Ideas • *Note how idea progresses from K through 12 using Appendix E*	**K-2** Sound can make matter vibrate, and vibrating matter can make sound. **3-5** Waves are regular patterns of motion, which can be made in water by disturbing the surface. Waves of the same type can differ in amplitude and wavelength. Waves can make objects move. **6-8** A simple wave model has a repeating pattern with a specific wavelength, frequency, and amplitude, and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena including sound and light. Waves can transmit energy.
5. Related Science and Engineering Practice • *Read relevant practice in Appendix F for your grade band.* • *Read the related element (bulleted) for the practice*	**Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
6. Related Cross-cutting Concept • *Read relevant cross-cutting concept in Appendix G for your grade band* • *Read the related element (bullet) for the proactice*	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
7. Possible misconceptions • *Use online resources, Uncovering Students' Ideas Probes, Making Sense of Secondary Science, Misconceptions in Primary Science, Atlas for Science Literacy*	The matter a wave travels through travels with the energy of the vibration. All waves are transverse.
8. Potential Phenomena • *Read about grounding the learning in a phenomenon* • *Phenomena for NGSS* • *Nat Geo Phenomena*	Harmonics of sound Resonance Pitch of tuning forks Tacoma Narrows Bridge Earthquakes

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Critical Vocabulary	Topics/Content
Vibration Wave Medium Frequency Wavelength Wave Speed Amplitude Transverse Wave Longitudinal Wave Mechanical Wave Sound Pitch Doppler Effect Volume Wave Interference Seismic Wave	• Vibrations, Longitudinal Waves, Transverse (Conceptually) • Relationship between wave speed, wavelength and frequency ($v = \lambda f$) (Conceptually & Mathematically) • The effect of the medium on wave speed, wavelength & frequency (sound, seismic) (Conceptually, Mathematically & Analysis)

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1. What we figured out Answer to the focus question; claim	**2. Focus Question** Lesson-level questions	**3. Learning Target/"I can" Statements** Lesson Level PE; includes the practice, content, and CCC students used in experience	**4. Experiences/Activities** What experience(s) will students need to answer the focus question?