International Baccalaureate
Baccalauréat International
Bachillerato Internacional

**3D Science Unit Planner**

**Marietta City Schools**

MARIETTA CITY SCHOOLS

| **Grade & Course**: Physical Science | **Topic: Waves** | **Duration: S2 3.5 weeks** |
|---|---|---|
| **Teachers: Physical Science PLC** | | |

**Georgia Standards and Content:**

**SPS9. Obtain, evaluate, and communicate information to explain the properties of waves.**

**a.** Analyze and interpret data to identify the relationships among wavelength, frequency, and energy in electromagnetic waves and amplitude and energy in mechanical waves.

**b.** Ask questions to compare and contrast the characteristics of electromagnetic and mechanical waves.

**c.** Develop models based on experimental evidence that illustrate the phenomenon of reflection, refraction, interference, and diffraction.

**d.** Analyze and interpret data to explain how different media affect the speed of sound and light waves.

**e.** Develop and use models to explain the changes in sound waves associated with the Doppler Effect.

**Review and Revisit:**

**SPS7.a.** Construct explanations for energy transformations within a system? (*Clarification statement:* Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear).

**Topics to Cover:**

**Core Ideas:**

- Waves carry energy that can be transferred or transformed through interactions with matter or other waves.
- The pitch of a sound is a measure of its frequency.
- Although electromagnetic and mechanical waves share some characteristics, they are different in the way they are generated and transfer energy.
- The speed at which sound travels is dependent upon the material in which it travels.
- As a wave encounters another medium, it may be reflected and/or refracted.
- As a wave encounters an obstacle or opening, it may be reflected, refracted, or diffracted.
- Two waves that meet will create a pattern of interference.
- The energy of a wave can be determined from the wave's physical characteristics.

## Narrative / Background Information

**Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)**

**Units 1-5 Atomic Structure and Nuclear Reactions, Periodic Table, Chemical Bonding and Chemical Reactions, Energy and Atomic & Molecular motion laid the foundation for completion of this unit.**

The students rising to 9th grade in Fall 2021 may never have seen the 8th grade science classroom at all.

Link to GSE 8th Grade Science

These students have not been exposed to the 8th Science GSE that lay the foundation for the high school Physical Science standards.

For this Unit and the ones that follow:

**Students will need a basic knowledge of algebra and sometimes working with triangles.**

**Basic knowledge of energy transformations**

**Unit Phenomena (LEARNING PROCESS)**

Why does the pitch of a siren appear to change as it moves closer/farther away?

**Inquiry Statement:** Modeling allows us to examine patterns and changes in wave behavior in order to identify relationships between energy, frequency, wavelength, and amplitude.

**Global Context/Exploration:**

Identities and Relationships

**Science & Engineering Practices:**

- **Analyzing and Interpreting data**
- **Developing and Using Models**
- **Asking Questions and Defining Problems**

- NOS Connection: Science models, Laws, and Mechanisms, and Theories Explain Natural Phenomena

**Disciplinary Core Ideas: (KNOWLEDGE & SKILLS)**

**PS3.D: Energy in Chemical Processes and Everyday Life**

- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (HS-PS4-5)

**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. (HS-PS4-1)
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), (HS-PS4-5)
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it

**Crosscutting Concepts: (KNOWLEDGE & SKILLS)**

Stability and Changes
Cause and Effect
Patterns
Systems and System Models

**Key and Related Concepts:**

Key: Change
Related:Energy and Patterns

**Approaches to Learning (ATLs):**

ATL's need to be taught explicitly using a noncontent example then move into using them directly with content.

**Thinking (or critical thinking):** Draw justifiable conclusions based on processing, interpreting and evaluating data gained from scientific investigations.

**Communication (or interaction):** Use appropriate scientific terminology, data tables and graphs to make the meaning of your findings clear to an audience of your peers.

- **Use models and simulations to explore complex systems and issues**
- **Collect, record, and verify data**

  - Use thinking maps to show students how to organize information thinking-maps-overview-71525044.jpeg
  - Provide students with an example of how to make inferences and draw conclusions Making Inferences & Drawing Conclusions
  - Demonstrate how to collect, record and verify data from a very practical easy investigation
  - Give students a data set to analyze and then take the steps to determine strengths and weaknesses of the investigation used to collect the data

**Thinking**

VIII. Critical-thinking skills
- Analyzing and evaluating issues and ideas
- Troubleshoot systems and applications

IX. Creative-thinking skills
- Generating novel ideas and considering new perspectives

| | | |
|---|---|---|
| | can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)<br>**PS4.B: Electromagnetic Radiation**<br>● Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)<br>● When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)<br>● Photoelectric materials emit electrons when they absorb light of a high-enough frequency. | ● Design improvements to existing machines, media and technologies<br>X. Transfer skills<br>● Using skills and knowledge in multiple contexts<br>● Combine knowledge, understanding and skills to create products or solutions |

| | | |
|---|---|---|
| | (HS-PS4-5)<br>PS4.C: **Information Technologies and Instrumentation**<br>● Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5) | |

**Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)**

**Some of the common ones that you will find include:**

- **Students may have difficulty visualizing how waves transfer energy, rather than matter.**
- **Students may confuse the relationship between wavelength, frequency, and amplitude in electromagnetic vs. mechanical waves.**
- **Students may have difficulty interpreting electromagnetic spectrum diagrams. Students should be exposed to a variety of EM spectrum diagrams (ex. highest to lowest frequency vs. lowest to highest frequency).**
- **Students may confuse the types of wave behaviors with one another.**
- **Students may have difficulty conceptualizing that the apparent shift in frequency that occurs during the Doppler Effect is dependent upon the position of the observer.**

**Content/Key Vocabulary: (KNOWLEDGE & SKILLS)**

Mechanical Waves, Electromagnetic Waves, Transverse, Longitudinal, Crest, Trough, Compression, Rarefaction, Electromagnetic Spectrum, Energy, Radiation, Vacuum, Gamma Ray, X-Ray, Microwave, Radio Waves, Visible

Light, Ultraviolet, Infrared, Light , Sound, Emit, Reflection, Refraction, Diffraction, Interference, Medium (Media), Density, Elasticity, Wave speed, Frequency (High, Low), Wavelength (Long, Short), Amplitude (High, Low), Pitch, Perpendicular, Parallel, Doppler Effect, normal (center line)

**These questions are related directly to the key concepts, related concepts, and global context and statement of inquiry. These are taking a step further from the content questions.**

**Inquiry Questions:**

**Factual** -

What is a wave?
What are the categories of waves?
What is the anatomy of a wave?
What are the relationships among wavelength, frequency, and energy in electromagnetic waves?
What is the relationship between amplitude and energy in mechanical waves?
What is the Doppler Effect?

What are examples of typical wave behaviors?

**Conceptual** –

How are electromagnetic and mechanical waves similar/different?

How can I use the electromagnetic spectrum to determine whether a wave is high energy or low energy?

How will the speed of a wave be affected as it transitions from one medium to another?

How does a phenomenon like the Doppler effect occur?

**Debatable** -

How might life be different if light and/or sound did not travel in waves?
What part of the electromagnetic spectrum is the most essential

| | | |
|---|---|---|
| **MYP A**<br>**CSA Written component**<br><br>**MYP B and C**<br>Slinky Lab (B, C) | **Formative Assessments:**<br>**CFA** | **Summative assessment: CSA SPS9abcde**<br>**Relationship between summative assessment task(s) and statement of inquiry:**<br>**In the Unit Assessment, students will be exposed to a variety of models depicting the anatomy and behaviors of waves. Using their prior experience with hands-on classroom experiences and digital simulations, students will be required to interpret patterns of wave behavior, identify wave characteristics and key aspects of a wave's structure, and predict a wave's behavior and change in speed when encountering various media. They will also be required to demonstrate an understanding of a wave's energy by analyzing frequency, wavelength, and amplitude, as appropriate.** |

**Unit Objective Obtain, evaluate, and communicate information to explain the properties of waves.**

| Learning Activities and Experiences | Inquiry & Obtain: (LEARNING PROCESS) | Evaluate: (LEARNING PROCESS) | Communicate: (LEARNING PROCESS) |
|---|---|---|---|
| **Week 1** | 1. Introduction: Have visuals of multiple types of waves (water, light, sound, earthquake, microwave, medical equipment, spectators in stadium)<br>What do each of these have in common?<br>Notes + Graphic Organizer: Lesson 1 – The Nature of a Wave<br>-transverse vs. longitudinal<br>-electromagnetic (light) vs. mechanical (sound)<br>(May use DE: Wave Characteristics) | 1. Activate/Assess Prior Knowledge: Given images, students should attempt to identify types, anatomy, and behaviors of waves. | |
| | 2. PhET SIM: Wave on a String or PC: Simple Wave Simulator (or other related SIM – DE: Describing Waves)<br>Purpose: Students to gather and develop their own explanations for the main characteristics of waves: frequency, wavelength, amplitude, and speed | 2. Wave Anatomy & Characteristics Practice Problems<br>Sample: https://www.physicsclassroom.com/class/waves/Lesson-2/The-Anatomy-of-a-Wave | 2. Students share their discoveries w/teacher providing support and direction as needed (Lesson 2 – Properties of a Wave). |

| | | | |
|---|---|---|---|
| | 4. Phenomenon: Straw in a Cup<br>Notes: Wave Speed + Variables Affecting Wave Speed | 3.Slinky Lab: Modeling Wave Properties/Characteristics & Their Interactions (see Resources below)<br><br>SIM: Bending Light: Evaluating Light Wave Speed Through Various Media + Practice Problems<br>https://www.physicsclassroom.com/class/waves/Lesson-2/The-Speed-of-a-Wave | 3. Group Demonstrations: Wave Properties/Characteristics Using Slinkies<br><br>CFA: Formative Check: Wave Types, Anatomy, & Characteristics |
| **Week 2** | 1. Student Research: Demystifying the Electromagnetic Spectrum<br>(May use DE Exploration)<br><br>4. Notes: Wave Energy in Electromagnetic vs. Mechanical Waves<br>https://www.physicsclassroom.com/class/waves/Lesson-2/Energy-Transport-and-the-Amplitude-of-a-Wave | 2. Building the EM Spectrum Drawing, Frequency, Wavelength, Uses<br><br>4. Student Practice: Visuals: Interpreting Wave Energy (Mechanical and EM Wave Examples)<br><br>5. Student Formative Check: Compare/Contrast: EM vs. Mechanical Waves + Deriving Questions for EM vs. Mechanical Waves | 3. Presenting the EM Spectrum + Argumentation: Why My Range is the Most Important<br><br>5. Waves in Movies: Phenomenon: Movie Clip – Explosion in Space!<br>What is wrong with this? + Other Wave Errors in Movies/Wave Phenomenon |
| **Week 3** | | Days 1-4:<br>Station Rotation Week: Wave Behaviors: Hands-On (TRL) & SIMs: | |

| | | | |
|---|---|---|---|
| | Day 5:<br>1. Introduction to Phenomenon: the Doppler Effect (video, SRO vehicle, Doppler demo)<br>What do students notice/wonder? | Station 1: Reflection<br>Station 2: Refraction<br>Station 3: Diffraction<br>Station 4: Interference<br><br>Day 5:<br>2. Activate/Assess Prior Knowledge: Doppler Modeling (TRL): Students work in teams to propose a model that explains what they are hearing, based upon what they have learned about wave characteristics and behaviors. (Consider having students do this at the beginning of the unit, then compare diagrams at the end.) | Discussion of student models involving the Doppler Effect |
| **Week 4** | | Day 1:<br>1. Waves Review<br><br>Days 3-4<br>1. Waves Remediation/Extension | Day 2: Waves Unit Assessment<br><br>Day 5: Flex Day |

**Differentiation Strategies:**

- **Student Choice**
- **Shared interest centers**
- **Immediate Feedback with opportunities to re-submit without penalty**
- **3D Assessments / Tiered Assessments**
- **Go Further Activities**

**Resources (hyperlink to model lessons and/or resources):**
**Resources are created and shared within the professional learning community (PLC) of all Physical Science Teachers. We collaborate on creating quality learning experiences for all students within the classroom environment.**

NGSS Physical Science Framework:
https://www.nextgenscience.org/sites/default/files/HS%20PS%20topics%20combined%206.12.13.pdf

Discovery Education: Chemistry Science Techbook
DE Explorations:
Describing Waves
The Electromagnetic Spectrum
Wave Characteristics

**Holt Science Spectrum Physical Science Textbook**

**Work and Energy**
**https://drive.google.com/file/d/10HV3hWx9fHyHIBI8oucRBhVmzvrvvTwH/view?usp=sharing**

**Student Resources**

**https://drive.google.com/file/d/1NN2OCNKH42kwSedtmhHF9XzIY6lxsEaY/view?usp=sharing**

**Other Sites for Interactives and Practice:**
**Positive Physics**
**The Physics Classroom**
**Phet Simulations**
PhET SIMs: https://phet.colorado.edu/en/simulations
Bending Light
Radio Waves and Electromagnetic Fields
Sound
Wave Interference
Wave on a String
Waves Intro

**Interactive: Catch the Waves**
http://history.amazingspace.org/resources/explorations/light/CatchWaves_activation-frames.html

**GSE Website for Physical Science**
**https://www.georgiastandards.org/Georgia-Standards/Pages/Science-Physical-Science.aspx**
General DE Chapter Resources:
Interactive Periodic Table
Interactive Glossary
Engage & Explore Activities
Explorations
Virtual Labs
Skill Builders
Video Segments
CK12 High School Chemistry Flexbook/Adaptive Practice
cK-12: Radio Waves
cK-12: Electromagnetic Waves
cK-12: Mechanical Waves
cK-12 Wave Speed
Wave Properties Labs/Demos
Snell's Law Lab

Shared Physical Science Resources
https://marietta.schoology.com/group/4621413779/materials?f=231800526#/group/4621413779/materials

**Reflection: Considering the planning, process and impact of the inquiry**

| Prior to teaching the unit | During teaching | After teaching the unit |
|---|---|---|
| | | |