Light, Sound, EM Spectrum

Waves, Sound & Light

- **Timeline :** ~ 19 days
- **Competencies:**
  - Modeling
  - Obtaining & evaluating information
- **Key Concepts:**
  - Identify parts of a wave.
  - Describe the wave parts (wavelength, frequency, amplitude) and what changing them does.
  - Describe parts and properties of the EM Spectrum
  - Describe what light/color is.
  - Identify properties of light/color.
  - Describe how light interacts with other light, objects, lenses, mirrors, etc. (optics)
  - Describe how light reflects off different mirrors (flat, concave, convex)
  - Describe how light refracts through different lenses and materials.

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.*]

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-PS4-3. **Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [*Assessment Boundary: Assessment does not include using quantum theory.*]

PS4.A: Wave Properties

- [From the 3–5 grade band endpoints] 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 can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.)

PS4.B: Electromagnetic Radiation

- 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.

Day 1: Phenomenon glass shattering + teach modeling

Learning Target: I can begin to model a scientific phenomenon.
Competency: Modeling → Details & Student Thinking (THEM 1)
Hook: Phenomenon glass shattering video (watch till 27 seconds)
Lesson:

- Ask students why they thought this phenomenon happened.
- Tell students that I am going to ask them to create a model of this phenomenon.
    - Students will likely not know what this means, so I will elicit their ideas about what a model is
    - Then I will take those ideas and help guide them to a drawing that makes the unobservable observable. (drawing + words)
- First have students try to individually model this on small whiteboards.
    - When students start getting stuck, stop to have a discussion about what components of a good model are (give them the modeling rubric at this point)
        - Initially starting with including details and making student thinking clear, we will discuss what components are needed to do these things.
- Then have students continue their models (5 min)
- Then pair students up and have them discuss their models with their partners and have them combine their whiteboard models onto a desk sized piece of butcher paper.
    - Ask students to self assess their model (put the day's date in the box they think they fall into 0-4) (details + student thinking THEM 1)
    - Put all models on the board and have students identify one or two models that have the strongest details and the clearest thinking
        - Talk about what makes these things good
    - Talk about how some of the others could be improved to make them clearer or include more details.
- Ask students to re-assess their models based on the conversations.

Day 2: Waves Content (computers)
Learning Target: I can identify & measure the key components of a wave.
Competency: Obtaining + Evaluating Information → Obtaining information (THEM 1)

Hook: 

Ask students what all of these images have in common. Students may or may not be able to figure it out, hopefully they can, they are all showing either a wave or the result of a wave!

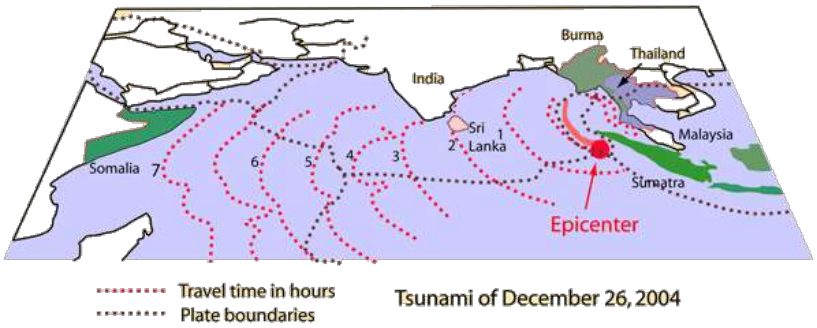
Lesson: **Waves Mini-lesson part 1** **+** **Waves Mini-lesson** **+** **Waves Tutorial**

- Talk about how waves are all around them, and ask if they can think of any other types of waves than the ones we just mentioned.
- Continue by introducing them to some wave vocab, using the waves mini-lesson part 1, waves mini lesson + wave tutorial. Or some combination of the three depending on the needs of the students. (obtaining information THEM 1)
- Now come back to student's models from the previous day, tell them to brainstorm in what ways this new information might relate to their model and the phenomenon of the glass breaking.
    - Compile a list as a class of the things in this lesson that they thought related to the phenomenon (similar to knows + need to knows list)
- Ask them what questions they still have about the phenomenon… include this on their need to knows list.

Day 3: Waves Stations

Learning Target: I can use measurements I take of transverse waves to calculate speed of a wave.

Competency: Modeling → scientific accuracy (THEM 1)



Hook:

Talk about tsunamis, these are devastating events, how can we use what we've been learning to help prevent the loss of life… CALCULATE SPEED OF THOSE WAVES!!!! (:

Lesson: Waves Stations

- Take students to the physics lab to measure and calculate different parts of a wave. (Scientific Accuracy Them 1)
    - Students will be in pairs chosen by me for this based on the models they created in phenomenon day.
    - While students are working, I will be moving around the lab, questioning students about how this might relate to our glass breaking phenomenon.
- Students will go around to different waves in the lab and will have to measure each part of the wave and then calculate the speed of the wave given a time for each wave.
- Students will need to calculate the frequency using this time and then use that frequency to calculate wavelength.
- Once student have measured and calculated speed, we will debrief as a class on a couple of the more challenging waves and have a quick discussion of how this activity related to the phenomenon.

Day 4: Revisit Phenomenon + Wave Practice

Learning Target: I can revise my explanation about the phenomenon based on new knowledge.

Competency: Modeling → Revisions (THEM 1) & Utilizing Information (THEM 1)

Hook: Replay Phenomenon Video (Phenomenon glass shattering)

Ask students to brainstorm with their modeling partner things that they could use to help inform them about the phenomenon. (Utilizing information THEM 1) **(3 min)**

Lesson:

- Have students share out what they thought of during their brainstorm time
- Add these to the knows/need to knows list
- Give students a chance to make revisions to their models
    - After about 5 minutes, discuss what a meaningful revision would include.
    - Go over this section of the rubric, students will see that they need to get feedback before making revisions.
- Then, modeling pairs will be paired with another pair and will give each other feedback on their model
    - I will circulate the room reminding students that when they give feedback, they should be looking at the entire rubric and writing down comments and notes
        - Students will then explain their feedback to each other
- Then students will make revisions to their model based on the new information they thought of during brainstorming and based on the feedback they received
- Students will be given waves practice sheets and I will tell them to work on those and use some of that information to incorporate into their revisions
    - During the last five minutes of class, students will self-assess their revisions and give reasoning for that score

Day 5: Sound Webquest
Learning Target: I can relate sound vocabulary to the parts of a wave I have learned before.
Competency: obtaining information (US)
Hook: Hit a drumstick on a desk and hit tuning fork on a desk at the same time. Ask students to share what they noticed about the sounds they make. Why is the tuning fork still making sound? What is causing that sound? Why are the sounds so different? Students may not know how to articulate their thoughts about sound, so answers will likely be very superficial.
Lesson:

- This hook, will lead into students realizing that they don't know how to describe sound, so they will do the sound webquest to learn some vocabulary about sound, as well as to explore what sound is and how it relates to waves.
- While students are working, I will be questioning them about how the things they are seeing in the webquest relate to what I did with the demo at the beginning of class.
    - I will help students that are struggling with finding the information and questioning them on how it relates to waves and to the in class demo.
- At the end of class, we will debrief on the quest and I will ask students to share out how this webquest relates to both the demo from today and to the glass shattering phenomenon that we have been investigating.
    - Add some ideas to the knows/need to knows list to be revisited next time we revise our models

Day 6: Sound Stations
Learning Target: I can describe the relationship between sound and waves.

Competency: Obtaining information **(THEM 2)**
Hook: None. Stations take entire class period
Lesson: Sound Stations Student Sheet & Sound Stations

- Take students to the physics lab to work on the sound stations
- These stations are students chance to make connections between waves and sound and the different aspects of sound waves. (obtaining information them 2)
    - Throughout the lab, I will be approaching students and questioning them about what they think is happening, what their noticings are, and how these stations relate to our phenomenon

Day 7: Waves/sound assessment
Learning Target: I can explain why sound waves can break a glass
Competency: Modeling

Day 8, 9, 10: EM Spectrum research + Create Product to Present
Learning Target: I can use sources that will help to explain how a device uses my part of the EM spectrum.
Competency: Obtaining & Evaluating Information → using sources THEM 1
Hook: Show students the em spectrum and ask them where they've seen these words before. How are these things related?
Lesson:

- Students will spend the next 3 days researching and putting together a presentation on one of the 7 parts of the em spectrum
- They will be researching how their wave type is used by a device and sharing this with the class.

Day 11: EM Spectrum Presentations
Learning Target: I can use information from the presentations to inform my knowledge about the EM Spectrum.
Competency: Obtaining information
Hook: Do you think the other parts of the spectrum could be used in the device you researched? Why or why not?
Lesson:

- Students will be sharing about their type of wave and how it is used in a technological device
- Students not presenting will use the note sheet to gather data about the other types of waves

Day 12: EM Spectrum assessment
Learning Target: I can describe how technological devices use waves from the EM spectrum.
Competency: Utilizing Information
Lesson:

- Students will be doing the EM spectrum assessment, which requires them to compare the type of wave they researched to one of the other ones that their peers presented, and also describe how one of their peers EM wave is used by a technological device.

Day 13: Pre-assessment of color & Color vision phet
Learning Target: I can explore what happens when mixing different colored lights
Competency: Making predictions
Hook: Show students video of mixing colored lights, and have students guess what mixed colored lights will look like. Show them each individual color of light and ask what happens when you mix them. predictions
Lesson:

- Then students do the color vision phet to further explore why mixing colored light gives us the results that we see.

Day 14: Color debrief + Colored Filters demo lab
Learning Target: I can determine the color the paper will appear depending on a color filter.
Competency: Making predictions
Hook: Have the song la vie en rose playing in the background when students come in. Ask students if they know what that title means, life in pink translated literally, and life through rose colored glasses figuratively. Ask students if they looked through rose(magenta colored glasses) what color different objects would be? Ask them to hypothesize for their do now.
Lesson:

- Then tell them to solve this problem, we will try this with different colors through a filter.
- Have students make predictions about what each color paper will look like through each color filter
    - Ask students to explain their thinking about why they think that (think, pair, share)
- Perform this lab as a demo with class.
- Then have students try to explain why if the results were different than what they hypothesized.
- Revisit the hook, ask students if they would change their answers from before?
    - Have students decide if they'd change, explain to a partner why or why not
    - Then share out to the class
- Now with a pair of clear glasses colored pink, ask volunteers to look through the glasses at these objects to see what colors the objects look through the glasses
    - Have students discuss if their predictions were right
    - If they were not, why weren't they right?

Day 15: Color Assessment link
Learning Target: I can explain why the color of different colored objects appears the way they do when light is filtered differently.

Competency: Claim, Evidence, Reasoning
Lesson: **Color Assessment Sheet**

Day 16: Light mini-lecture + Light Webquest (computers)
Learning Target: I can identify key features of light waves
Competency: Obtaining information + Claim, Evidence, Reasoning

Hook:  Ask students why this pencil looks like this in water. Some might know the word refraction, but won't be able to explain what it is.
Lesson: Light mini-lecture + Light Webquest

- For the first 20 minutes of class after trying to explain why the pencil looks like that in water, I will allow students to explore some concepts about the behavior of light by working on the light webquest independently.
- Once students are done or after the 20 minutes is up, I will ask again for an explanation about the pencil in the water, students will make their explanations on paper, and while they are doing this, I will go around reading them, taking note of where I see gaps in their knowledge
- I will then ask students to talk to their neighbors, and share out their explanations.
- Then using the light mini-lecture, I will help students to fill in any gaps in their explanation about why the pencil looks broken in the water.

Day 17: Light stations + Student Sheet
Learning Target: I can use observations I make to derive an explanation about phenomenon.
Competency: Observations
Hook: Ask students how eyeglasses work. How do they make my vision better? What are they doing to light to make my vision better? Why don't my glasses make everyone's vision better? What is happening????
Lesson:

- Students will perform a series a demo labs that will help them to explore different aspects of light and lenses.
- As they move from station to station, I will question them about what they are seeing/noticing/wondering about what is happening.
- I will also be questioning them about how these stations relate to the pencil in the water and how they relate to why eyeglasses work.
    - Tell them to make notes about those ideas on the bottom of their student sheet.

Day 18: Light debrief & create model (Light assessment)
Learning Target: I can create a model that explains what is happening to the light going through the bottle.
Competency: Modeling
Lesson:

- Debrief on the light stations from the day before
- Discuss with class how these stations can help us explain some of the phenomenon we have seen since talking about light, like the pencil in the water and how glasses work.
    - Have them think about this, and then share their thoughts with their peers, then share with class
- Then introduce them to the assessment above. (Modeling)

Day 19: Peer Review Models and Revise models
Learning Target: I can make revisions to my model based on peer feedback.
Competency: Revisions
Lesson:

- Students need to get peer feedback from two peers based on their models
- Students will then make revisions to their model

#3: Modeling Rubric

	4	3	2	1	0

Details	All relevant details are present in the model to explain unobservable mechanisms and show input/output with no extraneous details.	All relevant details are present in the model to explain unobservable mechanisms and show input/output with some extraneous details.	Missing relevant details in the model to explain unobservable mechanisms and show input/output. May include extraneous details.	Details are inadequate in explaining unobservable mechanisms and show input/output.	No relevant details to show the science behind the phenomenon.
Scientific Accuracy	The model is an accurate representation and integrates all relevant concepts that are scientifically accurate.	The model is an accurate representation and some relevant concepts are missing.	The model is a partially accurate representation due to some concepts being integrated inaccurately.	The model is an inaccurate representation due to the misconception of concepts.	The model is not an accurate representation because no scientific concepts are expressed.
Student Thinking	Student clearly communicates all aspects of their thinking to others through models.	Student communicates their thinking to others through the model that contain fully developed connections but requires assumptions by the reader to understand.	Student communicates their thinking to others through a model with partially developed connections.	Student attempts to communicate their thinking to others through a model but thoughts are fragmented/disorganized.	The student does not communicate beyond observation.
Predictions	The model can predict all situations that have not been encountered yet by the student.	The model can predict most situations that have not been encountered yet by the student.	The model can predict several situations that have not been encountered yet by the student.	Some predictive capabilities.	No predictive capability.
Revisions	The model has been revised based on feedback to include all relevant new understandings and/or new evidence.	The model has been revised, based on feedback, to include some relevant new understandings and/or new evidence.	The model has been revised, based on feedback, but does not include any relevant new understandings.	The model has not been revised to include relevant new understandings and/or new evidence, but students have received feedback for revision.	The model has not been revised.

*Clearly- Can be understood by another without further explanation.
*Relevant- closely connected or appropriate to what is being done or considered.
*Model- Models include diagrams with explanations, physical replicas, mathematical representations, analogies, and computer simulations

#7: Obtaining and Evaluating Information

Students can use multiple relevant sources to obtain information that explains phenomena or supports a claim.

	4	3	2	1	0
Obtaining Information	Extracts and synthesizes information specifically related to problems or phenomena.		Extracts little information and synthesizes information related to problems.		Does not extract information and/or relates it to problems or phenomena.
Utilizing Information	Utilizes extracted information to support claims and arguments.		Utilizes extracted information and is able to support some claims and/or arguments.		Does not utilize extracted information to support claims, or the information does not support claims or arguments.
Uses Sources	References and cites utilized sources		Appears to use evidence but does not cite sources		Does not reference and/or cite sources.