5E Integrated STEM Lesson Plan – Template

This template serves as a guide for developing a lesson that integrates across subject areas and includes the components of a quality STEM lesson. Please use it to support your work and engage in discussions with your instructors and peers when you have questions.

Lesson Title: *How does the Sun damage our skin and how do we protect ourselves?*

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Topic: *This lesson sequence is about UV radiation and how it damages skin. The focus is on how this occurs, how humans can project themselves from it, and how we can assess the reliability of claims made about this phenomenon in published materials*

Targeted Grade Level: *11th Grade Introductory Physics*

Time Needed: *2-4 classes, 90 minutes each*

Subject Integration: Science, Math, and Literacy

Justification: The goal of this unit will be for students to understand how and why UV radiation damages human skin. They will gather qualitative data in the Explore phase from which they will make claims about UV radiation. In addition, students will need to evaluate claims regarding this in already published materials. These two aspects of the lesson are aligned with CCSS.MATH.PRACTICE.MP3, where students need to "Construct viable arguments and critique the reasoning of others." Their data will serve as the foundation for the arguments they make, as well as some of the critiques they will make in the Elaborate section. Furthermore, students will need to know how to read the electromagnetic spectrum and how we characterize different types of electromagnetic radiation. Students will need to know this science concept, spelled out in NGSS standard PS4.B: Electromagnetic Radiation (full disciplinary core idea written below). Lastly, the work students do in the Elaborate section ("Evaluate the validity and reliability of claims in published materials") is directly aligned with CCSS.ELA-LITERACY.CCRA.R.7 and CCSS.ELA-LITERACY.CCRA.R.8. The full language of these standards is written below, but these standards, essentially, ask students to evaluate claims made in various types of media (e.g. visual, textual, etc).

Standards: *NGSS, Common Core, or related State standards. Write out (or copy and paste) standards completely. Please identify the point when each standard is addressed in the 5E template below. Each standard should be explicitly addressed within the lesson if it is to be included. Example: Reading aloud a non-fiction text does not solely qualify for ELA integration. Making a graph does not solely qualify for math integration. What concept is explicitly being taught?*

NGSS Performance Expectations

HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

- *[ClarificationStatement: Emphasis Is On The Idea That Photons Associated With different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary : Assessment is limited to qualitative descriptions.]*

Assessed in Elaborate and Evaluate

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Engaging in Argument from Evidence • Assessed in Engage, Explore, and Explain	***PS4.B: Electromagnetic Radiation*** • When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally	***Cause and Effect*** *Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about*

Obtaining, Evaluating, and Communicating Information • Assessed in Elaborate and Evaluate	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) • Assessed in all parts of the 5E lesson	*smaller scale mechanisms within the system.* Assessed in Evaluate

Common Core State Standards:

Math:

- *CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.*
- CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

ELA:

- *CCSS.ELA-LITERACY.RL.11-12.1 - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.*
- *CCSS.ELA-LITERACY.CCRA.R.7 - Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.1*
- *CCSS.ELA-LITERACY.CCRA.R.8 - Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.*

ITEEA Standards *(If applicable)*

Other Standards *(as needed)*

Measurable Student Learning Objectives: *Write the learning objectives as "students will be able to" statements. Be sure that your objectives are measurable and connect to the standards listed above.*

Students will be able to…

- *Identify the role sunscreen plays in the protection of skin*
- *Identify different types of Electromagnetic Waves by using the Electromagnetic Spectrum*
- *Collect data on UV sensitive beads that react to varying levels of UV exposure*
- *Use this data to make claims about how to best protect one's self from UV exposure*
- *Describe how UVA and UBA radiation affects/damages human skin*
- *Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter*

Nature of STEM:

This sequence of lessons is focused on, "Scientific Knowledge is Based on Empirical Evidence," Science is a Way of Knowing," and "Scientific Knowledge is Open to Revision in Light of New Evidence." Students will come into this sequence with a number of prior misconceptions and ideas around UV radiation, sunburns, and the factors that protect us from sunburns. Students will first gather their own empirical data by engaging in an activity with UV light sensitive beads. These beads change color when exposed to UV radiation and remain white when not. Students will have the opportunity to experiment with these beads for different levels of sun exposure (e.g. what happens when the bead is under the bill of a baseball hat?"). Afterwards, there will be time for direct instruction/video watching where students learn about the electromagnetic spectrum, the difference between UVA and UBA radiation, and how these radiations affect/damage human skin. There will also be time to discuss sunscreen and how to choose which ones to use. Finally, students will

touch upon this last Nature of STEM tenent ("...New Evidence") by reading some texts on different types of photoprotection where they have to assess the validity of arguments made.

Engaging Context/Phenomena:

I will start the lesson sequence with a grounding phenomenon/video, called "How the Sun Sees You." Students will make initial observations about how human skin looks when viewed through an ultraviolet camera. This video is intended to get the audience thinking about photoprotection against UV radiation and steps humans can take to protect themselves. The Explore activity (UV sensitive beads) directly builds off of this phenomenon and wonderings that might arise from the grounding phenomenon.

Data Integration:

Students will be collecting their own qualitative data in the Explore phase with the UV sensitive beads. They will gather data on the protection that different conditions/physical environments provide from UV radiation.

Differentiation of Instruction:

My school does something called "Unison Reading" where students read with each other to analyze and interpret texts. It is aimed at improving student literacy and promoting reading as an active process. When reading with a group, students must triangulate between the intended meaning of a text, their own cognitive processing, and the interpretation offered by others in their group. In addition, students are responsible for announcing when they don't understand something going on in the text. Not only does this format attempt to democratize student discussion, it also centers active student interpretation and their own pace of processing. Groups don't move on in a text until every member of the group comes to a common understanding about what the text/author is trying to convey. This collaborative process works nicely for this lesson sequence since it allows students to slow down and process, as well as collective support (i.e. from their peers) in this processing.

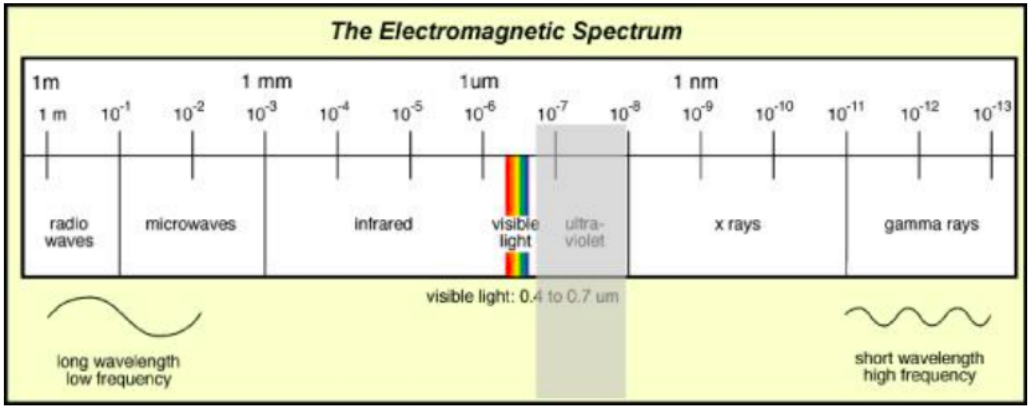
Real-life Connection: *We all are all exposed to UV radiation! There is a lot of misinformation regarding the types of protection we should take, when we should take it, and how often we should take it. These are also misconceptions around how skin tone and sun damage is related. While it is true that more melanin helps in protection against UBA radiation, that doesn't mean that people with darker skin should never use sunscreen. These are different risk factors that one needs to consider, and I hope to open up that conversation in this sequence of lessons (especially towards the end, with the texts provided in the Elaborate phase)*

Possible Misconceptions:

- *Only people with fair skin need to wear sunscreen*
- *You only need to wear sunscreen when it's sunny*
- *You only need to wear sunscreen in the summer*
- *You only need to apply sunscreen once during the day*

Lesson Procedure: *This is where you include each phase of the 5E. They should be extremely clear, well organized, and ready to be used by another educator. Be sure that each learning experience meets the guidelines for each "E". The template below will help you.*

5E Model	5E Objectives
Engage *Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.*	**Procedure:** I will start the lesson sequence with a grounding phenomenon/video, called "How the Sun Sees You." Students will make initial observations about how human skin looks when viewed through an ultraviolet camera. They will make these observations in a KWL chart, and we will share these observations via a class discussion. Students will cill out the K and W, and return to the L portion at the end of the sequence (In Evaluate) I will also ask this question at the end of the initial observation stage: What role does sunscreen play in the protection of skin? **Modifications** *The KWL chart will make it such that all students will be able to record their initial wonderings and observations. They will be able to refer to back this throughout the lesson sequence* **Standards Addressed** ***PS4.B: Electromagnetic Radiation***

	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) **Formative/Summative Assessments** Students will record their observations in the KWL chart **Resources** • **How the Sun Sees You** • **KWL Chart**
Explore *Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.*	**Procedure:** *1. Show students the electromagnetic spectrum chart. Ask them what they notice and prompt them to record their observations/wonderings in their KWL chart. At the end, I will mention that ultraviolet (UV) is a form of light that cannot be detected by our eyes but is emitted by the Sun and other stars.*  *2. Hand out beads and pipe cleaners, and bookmark materials if you wish to make them. Have participants assemble their bookmark, if necessary. Then have the students string their beads onto*

	the pipe cleaner or ribbon, put it through the hole in the bookmark, and twist or tie the ends together. *3. Now, ask the students to experiment with their beads! Hand out the worksheets and have participants determine which materials keep the beads, and hence themselves, safe from dangerous UV, and which materials don't. Have them test their beads with the various items on the worksheet – do they look white, faint, or colored? Can they think of other items to test?*

You be the scientist!

UV Bead Worksheet

	Your prediction (Do you think the beads will be white, faint, or colored?)	**Actual Color of Beads** (white, faint, or colored)	**Safe from UV?**	**Notes**
Under water				
In sunlight				
In shadow				
Using sunscreen				
Cloudy sky *(i.e. no direct sunlight)*				
Behind paper				
Behind sun glasses				
Behind eye glasses				
Under cloth				
Inside plastic orange medication bottle				
Behind window glass				
Behind car windshield				
Under brim of cap				
Behind plastic				
Sun at mid-day				
Sun at sunset/sunrise				
UV (black) light				
Fluorescent light				
Incandescent light				
LED light				

	Modifications Students will continue to use their KWL charts to map on their wonderings and learnings **Standards Addressed** ***PS4.B: Electromagnetic Radiation*** *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)* **Formative/Summative Assessments** *Ask students what patterns they are noticing from their data chart* **Resources** ● *UV Sensitive Beads Assignment*
Explain *Facilitate opportunities for students to explain their understanding of concepts and processes and make sense of new concepts.*	**Procedure:** *Ask students which of the materials tested are most effective at keeping you safe from dangerous UV light from the Sun? Is this consistent with their previous knowledge on UV radiation and exposure?* *Following this, I will show students an amended version of the EM spectrum first shown to them at beginning of the Explore sequence*

What wavelengths of light cause a color change in the UV beads?

Infrared 1000-700 nm	Visible 390-700 nm	UV-A 400-315 nm	UV-B 315-280 nm	UV-C 280-100 nm
Infrared light makes our skin feel warm and can be detected some animals such as snakes.	Visible light can be seen by our eyes. It includes all the colors of the visible rainbow.	Too much exposure to ultraviolet A can results in the same damage as UV-B but to a lesser degree.	Ultraviolet B light is needed for vitamin D synthesis in our bodies, but is a major cause of sunburn, skin cancer, cataracts, suppression of the immune systems, and photo-aging.	Ultraviolet C light is extremely dangerous, but completely absorbed by the ozone in the Earth's atmosphere and does not reach the Earth's surface.
				
Beads are white >360 nm		Beads are colors 360-300 nm		Beads are white 300 – 100 nm

Descriptive information from Educational Innovations

Discussion Questions

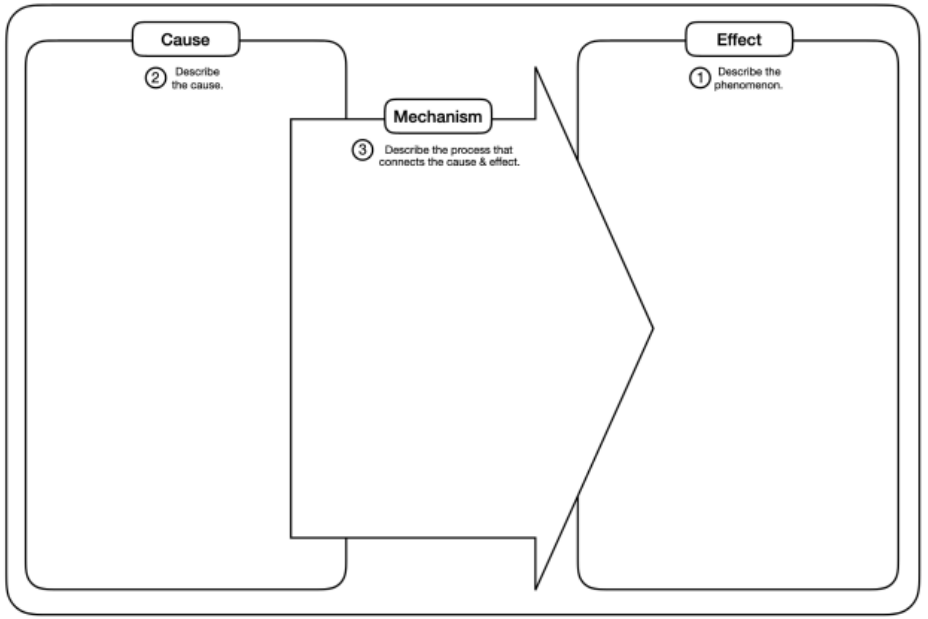
1. *You and your family want to buy tickets to a Mets game.The game is on a Sunday and it starts at 1:10 PM. Your sibling suggests that you buy tickets in section 304. Using the data you collected, as well as the amended EM spectrum provided, respond to your brother's suggestion. Should your family sit in Section 304? Why or why not? Use the Claim-Evidence-Reasoning Framework to provide a response. You can also use this shaded seats resource to help you identify the section of the stadium*
2. *Which section would you sit in, to provide the best protection from the Sun? Use the Claim-Evidence-Reasoning Framework to provide a response*

Modifications

Students will continue to use their KWL charts to map on their wonderings and learnings. In addition, promoting students to use the CER framework will hopefully push them to flesh out their arguments

	Standards Addressed ***Engaging in Argument from Evidence*** ***PS4.B: Electromagnetic Radiation*** *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)* **Formative/Summative Assessments** The questions above serve as the formative assessment (Claim-Evidence-Reasoning…students must engage in an argument from evidence) **Resources** ● *UV Sensitive Beads Assignment*
Elaborate *Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.*	**Procedure:** *As summer is approaching, a primary topic of interest is the debate on the efficacy of sunscreen in preventing cell damage. This debate has been fueled by the fact that skin cancer rates have increased sharply in the past 30 years due to changes in environmental factors. While a significant amount of information is readily available to the general public, bias can certainly be present in advertising, research, and other web resources. Review the sources below and evaluate them based on your understanding of physics.* ● *Sources Linked* (3 sources…Source 1 and 2 will act as one source) ● *Should Black People Wear Sunscreen? (Source 4)* ● *Do Black People Need Sunscreen? Yes - Here's Why? (Source 5)* ● *Will Your Melanin Protect You From the Sun? (Source 6)*

	Students will be in groups of 4-5 students. As mentioned above, students will read these texts in Unison reading. Each group will have one text they are responsible for. They will all have to answer the question “comment on the validity and reliability of your source? For those with text 4, 5, and 6, they will be asked to consider the role that melanin plays in photoprotection Once students are done with these texts (this might take a few classes), they will share their evaluations with the class. My school does daily, whole class student shares so this format is already built into our routines. **Modifications** As mentioned above, students will be unison reading these texts, where students will ask as scaffolds and support to each other. Students will record their learnings in the L section (Learn) of their KWL charts. **Standards Addressed** *HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.* **Formative/Summative Assessments** • *Comment on the validity and reliability of your source and explain why you think it is valid or not.* • *Based on your readings of Source 5, 6, and 7, do higher levels of melanin serve as a substitute for sunscreen?* **Resources** - Linked Above
Evaluate	**Procedure:**

Assess students knowledge, skills and abilities.	Identify the phenomenon being presented in the sources above. Then identify causes and the mechanism by which this happens.  **Modifications** - Before completing this assessment, students will document their learning in their KWL chart. Specifically, they will fill out the L (Learn) section. I will prompt students to record their learnings during the Whole Class Share described at the end of the Elaborate section. **Standards Addressed** **Cause and Effect -** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. **Formative/Summative Assessments** - See above!

	Resources - *Cause and Effect Assessment*

Teacher Background:

Teachers will need to know about the electromagnetic spectrum and the different types of electromagnetic waves. More specifically, the teacher will need to know how to identify electromagnetic waves on the spectrum via their wavelength and frequency. Furthermore, the teacher will need to know the difference between UVA and UBA radiation, as well as the mechanism for how UV radiation damages skin. Other than this, teachers will need to know for which conditions will the UV sensitive beads be damaged by UV radiation (as shown in the Explore phase)