Shedding Light on the Standards

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Wilson Stem Academy

This curriculum unit is recommended for:
Integrated Science 8

Keywords: bioluminescence, phosphorescence, chemiluminescence, ecosystem, adaptations, chemistry, biology

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: In this unit, scholars will explore how the worlds of chemistry, biology, energy and earth history are woven together by focusing on fluorescence in its many forms. We will let the question "How do things glow and why?" lead us down this path of discovery. Using academic articles, documentary style videos, and hands on activities scholars will be able to relate the ideas to everyday life. The idea of glowing throughout nature that has led to mimicry in our technology use will be displayed by several videos that will show scholars things they are otherwise not able to experience live. However, some activities will be performed in the lab to give students direct understanding of the proximity of this information. This unit corresponds with North Carolina standards on ecosystems, earth systems, energy, matter, biotechnology, and evolution. The culmination of this unit will give students the ability to create a project using at least 3 of the standards included to explain their interdependency on one another using fluorescence.

I plan to teach this unit during the coming year to 80 students in Integrated Science 8

Introduction

In the science classroom, many students find the material to be unrelatable. Since this is often the case in many units for our scholars I am sure to start class with a "hook". The wonderful thing about fluorescence is that it can be a "hook" in and of itself. The introduction of fluorescence to scholars will be giving a name and definition to something they are already familiar with. Students will start off by watching a video from National Geographic about organisms that demonstrate bioluminescence. This will pique their curiosity about what could possibly be happening. As we conclude that portion, students will post on a discussion board their thoughts, and questions on the matter. This will kick off the unit with some excitement and inspection of the unknown.

As the unit progresses, the scholars will move from Marine ecosystems, to land based ecosystems to explore the way things use bioluminescence outside of ocean life. This unit will progress to learn about things they have used in the past such as glow sticks, to discover the world of chemiluminescence. This will give students a way to tie what would normally be advanced concepts to real world application. They will then transition to what will be likely the most relevant for them, electroluminescence. Students will come to understand through a series of hands on activities and articles, how the principle of excited states of electrons that drives all fluorescence, is also integral to the technology they hold so dear.

Rationale

In this unit students will be guided through a series of videos, articles, and hands on activities to deepen their understanding of different ways that things fluoresce. The emphasis will be placed on a connection of the standards to the material and then a connection from the material to their lives. Because there are in total 7 standards that will be touched with this information there is considerable scaffolding that will need to be done as one unit will tie into the next. The fact there is slight overlap in some of the units means the scholars will have access to review those lessons that will be impactful for them to know for life and for the End of Grade Test.

The standards that will be included in this curriculum unit will encompass over 80% of the EOG. This curriculum aims at giving students an opportunity to cement this learning by making the real-world connections with them that will keep their minds engaged. The link to the standards will not be enough for students to simply memorize facts on fluorescence. The crucial piece is the link to students lives. Building the bridge between academics and the things that they actually care about. By incorporating the knowledge of living organisms, and technology, this unit will solidify the information in such a way as to make the information relevant to each scholar.

Demographics

Our school is Wilson Stem Academy. We are in the Northwest Learning Community of Charlotte. This 2020-2021 school year will only be our 3rd year open since being closed for several years. Wilson is a S.T.E.M. school that incorporates technology in

several ways even before the virtual atmosphere. Our scholars have several options for Project Lead The Way elective classes. They range from App Designing to Computer Science to Flight and Space courses. Our school also has a magnet component that allows students that are not zoned to attend Wilson to apply to participate in some of our Technology courses.

Our current enrollment for this school year is 474 students. 335 or 70.7% are African American, 96 or 20.3% are Hispanic, 24 or 5.1% are Asian, 5 or 1.1% are two or more races and 1 student identifies as American Indian. Our school is split at 226 females and 248 males in attendance. We have 55 English learning students and 59 students with disabilities. We also have 10 McKinney-Vento students; these are students who are housing insecure. Our enrollment has decreased about 10% since last year.

I teach 8th grade Integrated Science. Every scholar takes this science course as a part of their core curriculum. I have four classes that include one honors and one ESL focused class. The class is a year long course and it includes an EOG test in May. There is also an Earth and Environmental Science course offered to advanced students that will mirror some information from this class but will be granted high school credit.

Goals

The goals for this unit are to have students be able to answer each essential question to each standard correctly. The standards regarding evolution, marine ecosystems and ecosystems at large will have students to be able to answer the question, "How do adaptations within a species help the species to thrive over time and fit into its niche within its ecosystem?" By completing the specific activities and vocabulary for the curriculum students will also be able to ascertain information about the elements that are the building blocks for life: Oxygen, Carbon, Hydrogen, and even sometimes Nitrogen. Once these foundations are established, scholars can link this knowledge into second tier learning to explore and understand biotechnology and how fluorescence is used to aid in medical and criminology fields. The goal for the energy unit is to tie the information into how students use energy responsibly.

The end goal is for students to be able to use this one main idea to see how all branches of science are dependent on one another. Using one string to tie together chemistry, biology and even a little physical science, will allow students to retain the knowledge better to master the content and be successful on the EOG.

Content Research

Chemical Background Knowledge

Atoms are the smallest part of what makes up everything in the universe. Each element on the periodic table is made up of 1 atom. For example, the element Carbon means that there is one atom of Carbon. When we start to mix elements such as Hydrogen and Oxygen to make water, there are 2 atoms of Hydrogen and 1 atom of Oxygen that combine chemically to create that molecule. What makes up a single atom is a combination of electrons, protons, and neutrons. The number of each is what makes Oxygen a way different element than Gold for instance. These subatomic particles also influence how the elements will

react with one another. The molecules that go into a chemical reaction are called reactants and the molecules that come out of the reaction are called the products. On both sides of the equation the amounts of all elements will be the same. This is the law of conservation mass. Matter cannot be created or destroyed. Here is an example relevant to Lesson Plan 1.

"The chemical reaction actually occurs in two steps. First, there is a double displacement reaction in which acetic acid in the vinegar reacts with sodium bicarbonate to form sodium acetate and carbonic acid:

$NaHCO_3 + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + H_2CO_3$

Carbonic acid is unstable and undergoes a decomposition reaction to produce the carbon dioxide gas:

$H_2CO_3 \rightarrow H_2O + CO_2$" (Helmenstine, 2020)

In chemical reactions that involve chemiluminescence, visible glow can be seen.

Electromagnetic spectrum

The electromagnetic (EM) spectrum is the range of all types of EM radiation. Radiation is energy that travels and spreads out as it goes – the visible light that comes from a lamp in your house and the items that luminesce in this curriculum unit are all a part of the spectrum. (The Electromagnetic Spectrum, 2013) This spectrum determines what we can see and what we cannot. That is important when it comes to the science of glow because we can only detect certain light frequencies with our naked eyes.

Fluorescence

Fluorescence is the visible light is which molecules absorb energy in the form of photons which excite the electrons from ground state to singlet state and back again. (Heygi and Heygi 2016 89-94) In this process of returning from excited state to ground state, there is light emitted as well as heat. This light can sometimes be seen by the naked eye and sometimes require the use of an outside light source such as a black light.

The following processes that have fluorescence is chemiluminescence and bioluminescence, electroluminescence, and photoluminescence. (Pohl 2019) These spheres of fluorescence cover "glow" in many different arenas. They are categorized by different energy flow. Some examples are solar energy conversion, OLED's, photosynthesis, and glow sticks. Chemiluminescence, bioluminescence, and photoluminescence have an excited state generation similarity. Electroluminescence and chemiluminescence and bioluminescence have a solid-state emission similarity. Last but not least electroluminescence and photoluminescence have a charge transfer similarity. (Walter 2020)

In photoluminescence, light energy is responsible for the excitation of the electrons. One example of this is when the sun takes electrons and excites them to an excited singlet state and on the way down (called relaxation state) electricity is created. This is the workings of

a photovoltaic cell. (Solar Voltaic Cell Basics) This will get incorporated into standard 8.P.2.2 when you go over renewable energy resources.

Photoluminescence

Photoluminescence can also be processed with artificial light, through blacklight or UV light. In the same way that sunlight can excite electrons a UV light can be absorbed by a molecule, then some energy is lost as heat, and the object then fluoresces. Highlighters are a fantastic way to demonstrate this process. It can also be seen in brown eggs under blacklight where they glow red! (Walter 2020) Glow in the dark stars will also be introduced as a way for students to differentiate fluorescence from phosphorescence. Even thought they both fall under the category of photoluminescence; one will last longer than the other. In phosphorescence you will see a lingering effect because of the ability of this process to store some of the energy from the light. This does not happen in fluorescence.

Chemiluminescence

Chemiluminescence relies on a chemical reaction to achieve the same excited state. The energy source for this reaction is the chemical potential. This can best be demonstrated with a look into a glow stick. When you break a glow stick a tube inside releases a hydrogen peroxide solution. This mixes with a chemical compound. The product is unstable and as it decays into CO_2, it gives off energy. All compounds are different depending on the color of the dyes that will absorb the energy given off from the decay. This is when the fluorescence can be seen. (Walter 2020)

Chemiluminescence is also a key player in forensics and criminal investigation since many bodily fluids fluoresce. A mixture of Luminol and hydrogen peroxide is used to illuminate the area around blood splatter. In these situations, the blood splatter will glow causing investigators to see where the body fluid is. This reaction does not last long however and is the reason that pictures must be taken soon after the solution is applied. (Whyte 2015) Standard 8.P.1.3 and .4 can be intertwined into this section as you teach students about reactants and products. Also, it will be a good time to incorporate the law of conservation mass to explain to students why when this reaction happens, just as much that goes in must come out. It will also segue well into bioluminescence that uses a similar reaction but in living beings.

Bioluminescence

The energy source in bioluminescence is chemical potential but, in this case, it is catalyzed by an enzyme. The chemical is called Luciferin and the enzyme is Luciferase. (Bioluminescence 2018) This section will tie into the 8.E.1.2 unit when you talk about marine ecosystems as there are hundreds of organisms that demonstrate this phenomenon. Students will learn about algae, worms, shellfish, sea stars, fish sharks, and bacteria. Organisms use bioluminescence in order to feed, attract mates, and protect themselves. (Bioluminesence 2018) Scholars will then be able to tie this directly into standard 8.L.4.2

that delves into genetic variation and adaptations. As many species developed the ability to bio luminesce or host bioluminescent organisms through dozens of adaptations.

This same process applies to land ecosystems as well in standard 8.L.3.2. The best-known example of this is of course fireflies. There are thousands of species of these bioluminescent species that glow. In fireflies there is a reaction between a form of oxygen and a naturally occurring chemical called luciferin. Luciferin from Latin meaning light-bearing. Luciferin does more than just create this beautiful reaction in summer bugs, it is also being used in a human imaging capacity for tumors and to make anti-cancer drugs which you can tie into standard 8.L.2.1. (Bittel 2015)

Electroluminescence

In electroluminescence an electrical current is what sends the electrons into an excited state. This process gives us such wonderful technology as Organic Light Emitting Diodes (OLED) that are used in televisions and cell phone screens. Molecular semiconductors are used with in screens to aid in giving the bright colors, that glow that we want from our electronic devices. They allow for efficiency and portability due to being printable and foldable. (OLED 2020) This section can also be coupled with the previous energy standard as electroluminescence does tie in with solar cells as well.

Instructional Implementation

Teaching Strategies

Vocabulary

Allowing students to explore a list of familiar and unfamiliar vocabulary words will make this curriculum less daunting. A combination will be used of Quizlet and taking notes on vocabulary in their electronic notebooks. When each standard has begun students will be given the list of vocabulary to make their own flashcards in Quizlet. The program allows them to select the best definition as well as add a picture that will allow the students to remember the context of the information much better. They can also play games with this program in order to familiarize themselves easily with the language of fluorescence.

Reading

A list of articles that are on grade level will be provided to give students a deeper understanding of the material. Many websites have been identified that will give scholars easy to understand yet challenging articles to push the limits of learning this topic. Reading will be followed up by questions that support the essential question goals.

Videos

This unit goes into a myriad of topics that are hard to perceive if you have never seen them. For some of those topics including some that we will encounter hands, videos are often a

good hook to connect the knowledge for the students. National Geographic and other scientific researchers have published a great many videos that will lend themselves to capturing the attention of middle school students.

Class Discussion

Not every topic in this unit is set in stone. Using some of the more controversial up and coming methods of fluorescent based biomedical technology, class discussion can be stimulated. Students will pick sides but will ultimately be responsible for knowing both opinions to validly defend their points.

Experiments/Labs

Hands on experiments will be the jewel of this curriculum. We will use hands on activities to demonstrate all the facets of fluorescence. Glow stick demonstrations and bioluminescent activities with luciferin and highlighter activities will all give students a real reference point that is steeped in things they see everyday.

Nearpod

Converting any portion of this curriculum unit into a Nearpod is recommended. It can be used to aid in keeping the content more organized. It can also be used to increase engagement as you embed check for understandings throughout the lesson. It is recommended to use the quiz or poll section to determine where students may need more reinforcement.

<u>Lessons/Activities</u>

Lesson One: Chemical Reactions

Learning Objective: Students will be able to define chemical reactions and explain at least 3 indicators of a chemical reaction

Materials: Baking Soda and Vinegar, Glass Container, balloon Slide deck regarding chemical reactions

Introduction: Chemical reactions take place when two or more chemicals are combined and a new compound is formed. Ask students to think of 2 things they think will classify as a chemical reaction based on the definition.

Explicit Instruction: See slide deck. Once you have gone through the slides use the lab sheet (see Appendix 2) to instruct students through the experiment of mixing baking soda and vinegar together. Have students to fill in hypothesis and observations.

Individual Practice: Have students complete a worksheet that gives them information on the other indicators of chemical reaction. See appendix 2.

Assessment: To prepare for the next class bring out a glow stick, break It and shake It. Have students make hypothesis regarding if they think a glow stick is a chemical reaction or not and if so, how does it work.

Lesson Two: Chemiluminescence

Learning Objective: Students will be able to complete a lab report accurately and use it to predict the outcomes of chemiluminescence and bioluminescence experiments.

Materials: Glow Sticks, 2 glasses, tape, razor blade and Blank Lab Sheet, slide deck

Introduction/Warm-Up: Introduce the idea of chemiluminescence versus bioluminescence with this video. Give students a poll to see what they think the difference Is. (This can serve as a recap for the previous lesson on chemical reactions)

https://www.youtube.com/watch?v=oKjFVBVGad0 The brilliance of Bioluminescence by Leslie Kenna

Explicit Instruction: See slide deck

Individual Practice: Have students fill out lab form starting with the Question. Model some examples that students can use for questions or have them use their own. Ex. Will heat be a result of this reaction?

Have students fill in a hypothesis based on what they have learned in the lesson about the experiment. Give examples. ex. I think that the glow stick will get warmer after broken.

Give students time to complete the experiment and write down at least 3 observations. Students should then use their knowledge of what transpired and use it to make a conclusion that accurately decides if their hypothesis was correct or not.

Assessment: Use an exit ticket to see if students can identify what items you would look for in a chemical reaction.

Lesson Three: Bioluminescence in Marine Animals

Learning Objective: Following the completion of all parts of this lesson, all students will be able to complete the check for understanding exit ticket with an 80% or better, demonstrating mastery of marine ecosystem knowledge.

Materials: Vocabulary Sheet, https://www.youtube.com/watch?v=9HXXQBz6Vv0, worksheet on adaptations over time within a marine ecosystem

Introduction: Start with the national geographic video to hook students for introduction. Explain the things that make certain marine organisms' glow. Model a food chain based on one animal found in the video to explain the benefits of the adaptations.

Explicit Instruction: See slide deck

Individual Practice: Students will draw out a food chain that will include a bioluminescent organism in Nearpod or in their notebooks and use the open ended question tool to explain why the organism they chose must glow to meet its niche in the food chain

Assessment: To get 100% students will need to 1. Correctly identify a 4-step food chain in a marine ecosystem. 2. Be sure that at least one organism displays bioluminescence 3. Explain the reason the glow has given the animal or plant an advantage over other organisms

Lesson Four: Fluorescence and Phosphorescence

Learning Objective: Students will be able to define fluorescence and phosphorescence. They will also be able to cite 3 or more examples from their lives that fall into one category or the other.

Materials: Highlighter, clear glass of water, black light, glow-in-the-dark stars
Introduction: Watch video that introduces the 2 types of glow. https://www.youtube.com/watch?v=OzPCzFu472Y

Explicit Instruction: See slide deck. Explain some of the differences between the two types of photoluminescence. In this section be sure not to divulge the length of glow for each type of luminescence. This will allow students to deeper their understanding by making these connections themselves.

Individual Practice: Allow students to use the blacklight to observe the glow in both the highlighter water and the glow in the dark stars. Instruct them to notate in their notebooks what the difference is in the two luminescent reactions.

Assessment: Exit Ticket: Have students fill out a Venn diagram that compares and contrasts the differences between fluorescence and phosphorescence

Lesson Five: Electroluminescence

Learning Objective: Students will learn different ways that electroluminescence is used to aid in biotechnology to better our lives.

Materials: PowerPoint, notebooks, colored wires, worksheet

Introduction: Watch the video to introduce the uses of electroluminescence. Use the colored wires to allow hands on understanding of what something that is luminescing from electric input looks like.

Explicit Instruction: See slide deck

Individual Practice: Give students a worksheet to complete that talks about electroluminescent examples in real life. Also, how solar cells are the inverse of this process.

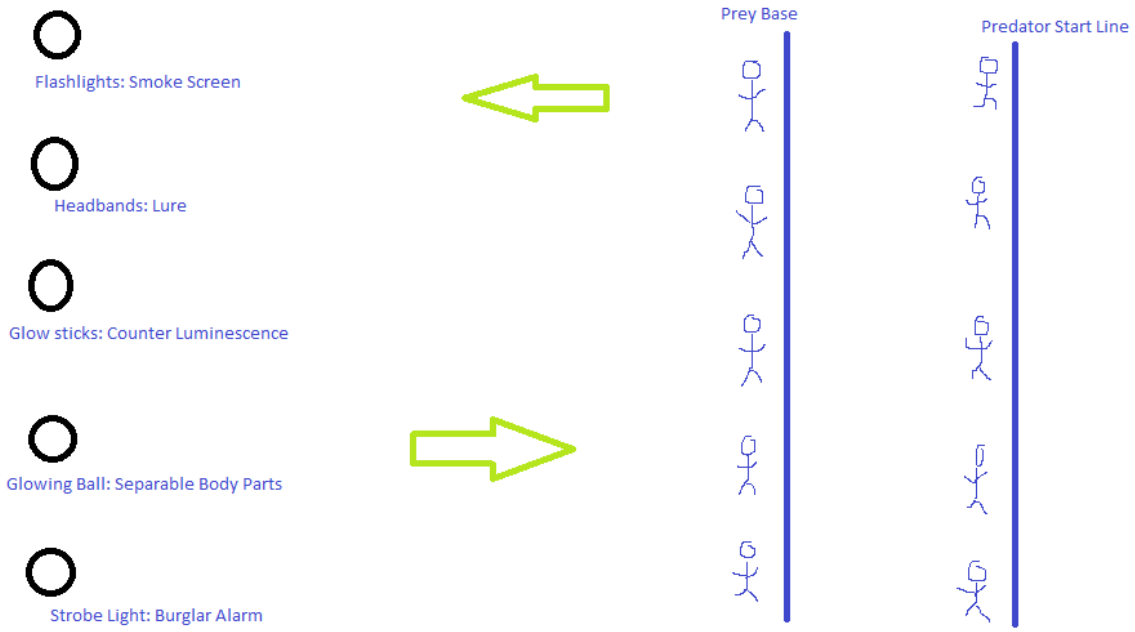
Assessment: Use a Padlet to quiz students on their understanding of electroluminescent aspects of real life. Ex. Exit signs are electroluminescent. How do they work?

Optional Activities

For Lesson Plan 1 you may substitute the baking soda and vinegar experiment for Pop Rocks and soda. If you choose to do this the instructions for that experiment are in teacher resources.

For Lesson Plan 2 you may use this game as a check for understanding or a fun way to reinforce the ways and reasons marine animals use bioluminescence.

Bioluminescence Game
Goal: Avoid your opponent using your bioluminescent tactics! Team with the most people left after 7 minutes is the winner.
Materials: Light up Bouncy Balls, Flashlights, glow sticks, Glow Headband with baubles, strobe light ball, flag football flags of 2 colors
How to Play: 1. There are 2 teams split evenly: 1 team predator and 1 team prey
2. In the gymnasium or outdoor facility, there will be 5 baskets available representing each type of bioluminescence on one side.
3. Prey will start on one line 5 feet closer to the baskets than the Predator team.
4. When the whistle is blown the students will run towards the baskets. The preys' goal is to grab a type of bioluminescence from the basket and use it correctly to defend themselves from a predator. If they are successful, the predator turns into prey. The bioluminescence can only be used 1 time per person to get you safely back to start.
5. The predator's goal is to "eat" or grab the flag of a prey student if they are successful the prey turns into a predator.
6. The start line and the baskets are "base" for prey for 4 seconds.
7. The team who flips the other team to make 100% prey or predators wins the game or the team with the most students on their team after 7 minutes.



Appendix 1: Teaching Standards

8.P.1.3: Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.
Curriculum Unit Relevance: The introduction to chemistry is included in the curriculum unit. You will be able to use the first lesson plan to give your students a basic understanding of chemical reactions and what are the indicators of a chemical reaction.

8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.
Curriculum Unit Relevance: Once students have a basic understanding of chemical reactions you can use the experiments in the curriculum, especially lesson plan 1 and 2, to show how to balance equations and to explain the law of conservation mass. The first simple experiment also has the chemical formula in the content research to allow for ease of teaching.

8.E.1.2 Summarize evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms: Estuaries Marine ecosystems Upwelling Behavior of gases in the marine environment Value and sustainability of marine resources Deep ocean technology and understandings gained
Curriculum Unit Relevance: You can use lesson plan 3 to guide your students through an understanding of bioluminescence. Bioluminescence is one of the most ubiquitous characteristics of marine ecosystems. You can use this unit to explain adaptations within marine ecosystems as well as food chains within this ecosystem.

8.L.4.2 Explain the relationship between genetic variation and an organism's ability to adapt to its environment.
Curriculum Unit Relevance: You can use lesson three to talk about the variations of organisms that display bioluminescence. Since it is a characteristic that lends to their survival, you can use this CU to demonstrate evolution, natural selection and adaptation to one's environment to survive.

8.L.2.1 Summarize aspects of biotechnology including: Specific genetic information available careers
Curriculum Unit Relevance: This curriculum supports the standard as it speaks on criminal investigatory tools within our communities. Luminol which is used in bodily fluid detection is a part of biotechnology and is a result of chemiluminescence. Also electroluminescence lends itself to the growing technology of electronics and can be introduced in this unit as well.

8.P.2.1 and 2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.
Curriculum Unit Relevance: Electroluminescence is the reverse of how solar cells work. The curriculum unit explains this process. Since solar power and photovoltaic solar cells are a source of renewable energy, this will give students a basis for understanding.

Teacher Resources

"| CK-12 Foundation." Accessed November 16, 2020. https://www.ck12.org/chemistry/chemical-reaction/.
This resource is a great start when introducing the chemical reaction unit. It will provide visuals, reading and questions to dive into this material with your students. I chose this one because of the ease of the visuals but there are others in this CK-12 page.

Britannica Kids. "Chemical Reaction." Accessed November 16, 2020. https://kids.britannica.com/students/article/chemical-reaction/623708.
An alternate resource to jump start students learning on chemical reactions. This site goes into types of reactions, differences between chemical and physical changes, and chemical equations. It can be used to dive into the material past the point of this CU.

"Bioluminescence | Smithsonian Ocean." Accessed November 16, 2020. http://ocean.si.edu/ocean-life/fish/bioluminescence.
This article from the Smithsonian gives students some great background on bioluminescence that they can use to either go before or after your lesson. It gives the ins and outs of the information without using so much science speak as to confuse new comers to the topic.

"Bioluminescence on Camera | National Geographic - YouTube." Accessed November 16, 2020. https://www.youtube.com/watch?v=9HXXQBz6Vv0&feature=youtu.be
This video is an intriguing way to begin the bioluminescence topic. National Geographic captures several animals that glow and show humans interacting with the environment. This video is also linked in the slide deck to begin the topic.

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In The Loop. "Crime Scene Chemistry – Luminol, Blood & Horseradish," February 18, 2015. https://www.in-the-loop.net.au/crime-scene-chemistry-luminol-blood-horseradish/.
Use this if you decide to go more in depth with your students regarding luminol and how it is used in crime scene investigation. It is a quick article with only a few paragraphs that give some facts and visuals on crime scene investigation.

"Don't Let the Lights Go Out! Self Luminous Exit Signs | Statcomm Inc." Accessed November 16, 2020. https://www.statcomm.com/blog/dont-let-the-lights-go-out-self-luminous-exit-signs/.
This site can be used as a resource to dig deeper into photoluminescent signs that students see everyday. It will serve as teacher background knowledge only.

KiwiCo. "Fizzy Candy Balloon." Accessed November 16, 2020. https://www.kiwico.com/diy/Science-Projects-for-Kids/3/project/Fizzy-Candy-Balloon/2783.
This is a site that gives information on an experiment that can be done in place of the baking soda and vinegar or in addition. It essentially gives a similar enough chemical reaction that your students will still understand the law of conservation mass and chemical equations through it

Helmenstine, Anne. "How Glow in the Dark Stars Work." *Science Notes and Projects* (blog), August 5, 2015. https://sciencenotes.org/what-are-glow-in-the-dark-stars-made-of/.

This is background knowledge for teachers to use when allowing students to discover phosphorescence with the glow in the dark stars vs. highlight activity. The information contained in the blog will allow for deeper explanation should the need arise during the activity.

National Geographic News. "How Do Fireflies Glow? Mystery Solved After 60 Years," July 24, 2015. https://www.nationalgeographic.com/news/2015/07/150724-fireflies-glow-bugs-summer-nation-science/.

This National Geographic resource will give teachers a background on non-marine bioluminescence should they need it. It can also be given to students if a teacher chooses to introduce bioluminescence in the ecosystem unit versus the Hydrosphere (marine ecosystem unit). It will also be a good segue if a teacher would like to explore the biomedical topics relating to bioluminescence.

"How to Uncover Traces of Hidden Blood - YouTube." Accessed November 16, 2020. https://www.youtube.com/watch?v=8AaX7vPGRIo&has_verified=1.

This is the video linked in the slide deck to introduce luminol and chemiluminescence.

"Mechanism and Application of Fluorescence and Phosphorescence - YouTube." Accessed November 16, 2020. https://www.youtube.com/watch?v=L7ACivhHQeo.

This is a basic and short video to reinforce fluorescence versus Phosphorescence.

"Mobile Phones and Smartphones with OLED Screens | OLED-Info." Accessed November 16, 2020. https://www.oled-info.com/oled-devices/mobile-phones.

This site can give information regarding phones that now contain OLED technology. This can be used as a hook or attention grabber when introducing electroluminescence. This would be background knowledge for the teacher to implement if needed.

Energy.gov. "Solar Photovoltaic Cell Basics." Accessed November 16, 2020. https://www.energy.gov/eere/solar/solar-photovoltaic-cell-basics.

This site will provide background knowledge for teachers on the workings of a photovoltaic cell. When a teacher goes over the electroluminescent portion of the lesson, they can preview this site to be prepared for auxiliary questions.

."What Is the Difference between Fluorescence, Phosphorescence and Luminescence?" Accessed November 16, 2020. https://www.enzolifesciences.com/science-center/technotes/2019/december/what-is-the-difference-between-fluorescence-phosphorescence-and-luminescence?/.

This site contains 3 of the unit topics: chemiluminescence, fluorescence, and phosphorescence. There are also visuals that can be used to explain the connection between the electromagnetic spectrum and the information in the curriculum unit.

Student Resources

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Appendix 2: Vocabulary List and Materials List

Bioluminescence	Chemiluminescence	Photoluminescence
Electromagnetic Spectrum	Electroluminescence	Photon
Electron	Fluorescence	Product
Reactant	Phosphorescence	Adaptation
Mutation	Evolution	Chemical change
Food Web	Niche	Survival

Materials List

1. Students will need notebooks digital or otherwise to write down information from the lessons.
2. Vocabulary list
3. Power point/Google Slides
4. Handouts for Independent Practice
5. Highlighters for photoluminescence experiment
6. Glass of water for photoluminescence experiment
7. Glow sticks for chemiluminescence
8. Black light for multiple experiments
9. LED colored wires for electroluminescence experiment
10. Baking soda and vinegar for Chemical Reaction experiment
11. Glow in the Dark Stars for phosphorescence experiment
12. Blank lab sheets
13. Luminescence Master Chart for Reference

Lab Name:

Materials: What do we need to complete this lab?	
Procedure: What steps do we take to complete this lab?	
Question: What question do you hope to answer?	
Hypothesis: What do you think will happen?	
Experiment: What steps did you take to complete the experiment?	
Data: What were the results of your experiment? (Use numbers where possible)	
Analysis: Did what you thought would happen, actually happen? Do you know why or why not?	

Slide Deck for Lessons

Illuminating the Standards

A guide to Luminescence

Intro to Luminescence

Essential question: What is luminescence and how does it apply to everyday life?

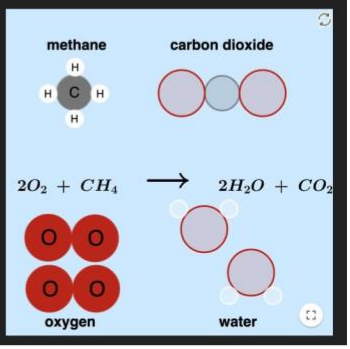
https://www.youtube.com/watch?v=0TRx_iA7T-0

Let's Start with Chemical Reactions

- -Atoms are the smallest part of an element
- -Different amounts of atoms of elements combine to make compounds or molecules
- For example H2O is 1 molecule of water
- When molecules mix together chemically they form new substances
-

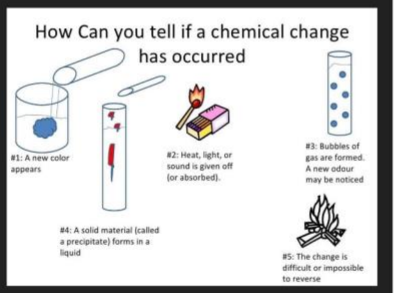
Then what?

- What happens then is the electrons from one element may create different bonds with other elements
- The molecules rearrange
- The molecules on the left side are called reactants
- THe molecules on the left are called products
- There are the same number of Oxygen, Carbon, and Hydrogen atoms on each side of the equation
- This is called the Law of Conservation Mass



How do you know a reaction has occurred?

- Color Change
- Formation of a Precipiate
- Heat, light, sound given off or absorbed
- Formation of a Gas
- Can it be reversed?



Let's Try it

What will we use:

- Baking Soda
- VInegar
- A soda bottle
- A balloon

Lesson 2: Chemiluminescence

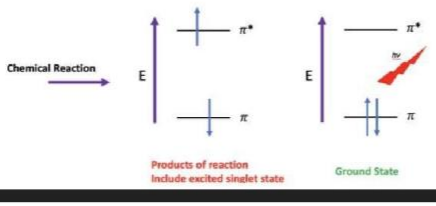
https://www.youtube.com/watch?v=8AaX7vPGRIo&has_verified=1

What is chemiluminescence?

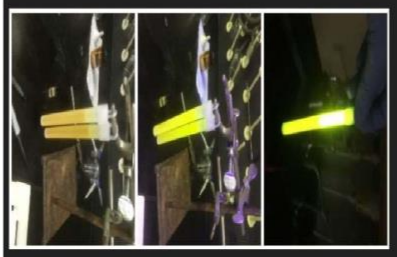
- Chemiluminescence relies on a chemical reaction to make the electrons excited!
- When the electrons come back down, they emit a light.
-
- Glow sticks are a great way to see this in action.
- Other examples: Luminol and biomedical uses

The Science Behind Chemiluminescence

Chemiluminescence = Reaction leads to Excited State



Glow Sticks Unleashed!



What is in a glow stick:

Inside the glass: Hydrogen Peroxide mixture

Inside the plastic: dye, a catalyst (something that makes something happen),

Lesson 3: Bioluminescence

https://www.youtube.com/watch?v=9HXXQBz6Vv0

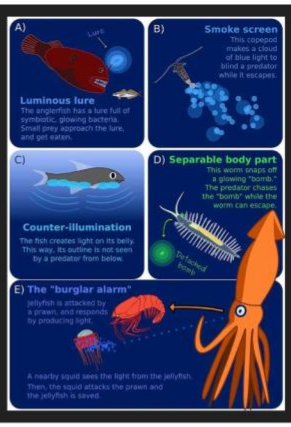
How do they do that?

- Bioluminescence is the production and emission of light by a living organism.
- The light emitted by a bioluminescent organism is produced by energy released from chemical reactions occurring inside (or ejected by) the organism.
- The energy source in bioluminescence is chemical potential but in this case it is catalyzed(or caused to react) by an enzyme.
- Enzymes are proteins that make a chemical reaction happen or catalyze a reaction in living things.
- The chemical is called Luciferin and the enzyme is Luciferase.

Okay, but why?

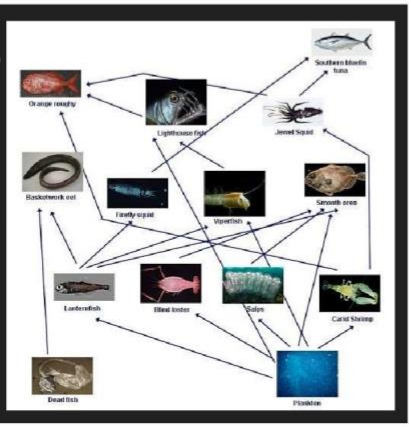
To survive!

- ★ Communicate
- ★ Mating and reproduction
- ★ Deter predators
- ★ Camouflage
- ★ Warn predators they are dangerous to eat
- ★ Attract food



Can they live without it?

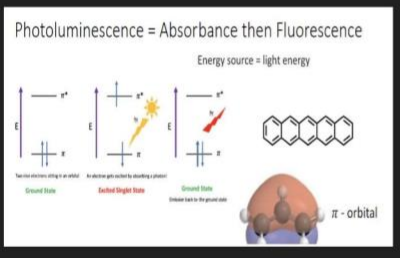
- ❖ In a food chain each organism plays a role, that is called its niche.
- ❖ Some organisms must luminesce to maintain their spot, or niche in the food chain.
- ❖ Organisms have adapted over thousands or millions of years to possess the qualities that allow them to survive.



Lesson 4: Fluorescence vs. Phosphorescence

https://www.youtube.com/watch?v=OzPCzFu472Y

Photoluminescence



- → What gives the electrons energy is light.
- → Light goes into the system and causes a different light to come out.
- → The light that goes in to our experiments is black light or UV light.
- → This will cause fluorescent dyes to glow.

But what is the difference?

Fluorescence

The chemicals used in highlighters to be able to see the glow are:

Fluorescein

Rhodamine B

Phosphorescence

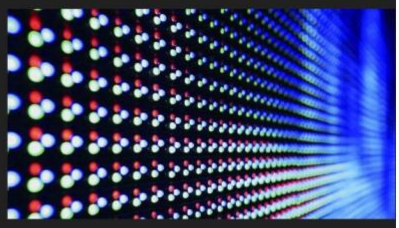
The chemicals used in glow in the dark stars are: Zinc Sulfide is the most popular

Try it!

Complete the activity to find out the other big difference between Fluorescence and Phosphorescence!

Lesson 5: Electroluminescence

- In electroluminescence an electrical current is what sends the electrons into an excited state.
- When this process is used in reverse you can create a solar cell.
- Uses for Electroluminescence: OLED TVs and cellphones, colored wires, exit signs, and solar energy.



Electroluminescence

- ★ Unlike regular light bulbs, LED, or Light Emitting Diodes are more efficient in that they release very little heat in the process.
- ★ Newer phones also take advantage of the LED including the Google Pixel 5 and the Iphone 12.

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