Chemical Reactions and the Sun's Lifespan

Companion Lesson to X-STEM All Access Episode "Meteorology in Space"

Grade/ Grade Band 9-12	**Topic:** Space Systems	

Brief Lesson Description: This lesson looks at the northern lights as a way of connecting students' understanding of chemical reactions, radiation, Earth's atmosphere, and space science.

Performance Expectation(s):

HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.

Specific Learning Outcomes:

Students will be able to explain the chemical reaction that creates the aurora borealis.
Students will be able to describe the impact of the sun's radiation on the Earth's atmosphere as it relates to the aurora borealis.

Narrative / Background Information

Prior Student Knowledge:

Students should be able to identify and describe chemical reactions.
Students should be familiar with flame tests for ions.
Students should understand the geomagnetic field and how it impacts the Earth.
Students should be able to describe how the sun's energy reaches the Earth.

Science & Engineering Practices:

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulation, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future (HS-PS1-2)

Developing and Using Models Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s)

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)

Disciplinary Core Ideas:

PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2)

PS3.D: Energy in Chemical Processes and Everyday Life

- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (HS-ESS1-1)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-2)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)

Possible Preconceptions/Misconceptions:

Students have difficulty distinguishing between a physical change and a chemical change. Students need to understand that a chemical change involves the production of a new substance. Students often misrepresent the difference between atoms and molecules as particles

in sketches.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Begin today's lesson watching Meteorology in Space with Capt. Sophia Schwalbe. While watching the video have students write 3-5 questions they have about the work Capt. Schwalbe does.

After the video, students share the questions and they may answer any questions they think they know the answer to.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Prior to starting the elaboration section of this lesson, you will need to gather the following materials (for demo):

- 1 large flask
- Splints (to ignite gas)
- 200 ml water
- 20 ml HCL (concentrated)
- 5-6 g Copper chloride
- Aluminum foil

Before conducting the demonstration of northern lights, have students respond to the following (guesses are fine at this point; share pictures if they are unfamiliar):

1. What are the northern lights? What do you know about the northern lights?
2. What colors do you think would be most common in the northern lights displays?
3. Describe how the northern lights move.
4. Do you think there is energy in the lights?

Conduct the demo:

1. Place the conical flask on a heat proof mat, surrounded by a plexiglass screen/shield (it is important to keep students back from the reaction at least 1 meter wearing protective eyewear)
2. Add water to the flask
3. Carefully pour HCl into the flask
4. Next add the copper chloride
5. Add aluminum foil
6. Turn off the lights
7. Let the reaction happen for a minute then lite the splint to ignite the hydrogen gas that's built up
8. Observe (you can ignite the hydrogen gas multiple times)

Have students revisit their responses to the questions.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Share this video about the Auroras. Then ask students to read an article about the formation of the northern lights and an article about the mythology surrounding the northern lights and write a summary:

What Causes The Northern Lights? Scientists Finally Know For Sure, NPR
What causes an aurora, the northern or southern lights?, EarthSky
Aurora, National Geographic

Mythology Articles
Native American Northern Lights Mythology
Mythology of the Northern Lights, The Aurora Zone
History of the Northern Lights: myths and legends

After reading the articles, discuss how the demonstration illustrated the northern lights. Explain that auroras occur when charged particles like electrons and protons collide with gasses. The demonstration shows the displacement of copper from copper chloride by aluminum. The copper forms around the aluminum. HCl was used to remove the aluminum oxide layer so the reaction can occur, and will also produce hydrogen gas in reaction with the aluminum. Then the hydrogen gas can be ignited which produced green/blue flames

Vocabulary:
Aurora- a natural light display in the sky that is caused by particles from the sun interacting with the planet's magnetic field
Earth's magnetic field- is generated in our planet's interior and extends out into space, creating a region known as the magnetosphere
solar winds- stream of protons and electrons from the sun's outermost atmosphere/the corona
ionosphere- an atmospheric layer, 30-600 miles above the Earth's surface where sun radiation causes electrons to break free from their atoms

ELABORATE: Applications and Extensions:
Prior to starting the elaboration section of this lesson, you will need to gather the following materials (per student): colored pencils/markers and photocopies of a cartoon strip template (canva or edit).

Students will create a 5-6 panel comic strip illustrating how the northern lights are an example of the sun's radiation impact on the Earth. The illustration should include a model of photon particles from the sun interacting with Earth's magnetic field and accurately identify the flame colors ions would produce.

EVALUATE:
Formative Monitoring (Questioning / Discussion): Student predictions and notes during the demo and summary of the readings
Summative Assessment (Quiz / Project / Report): Comic strip illustrating how the sun's radiation can ignite a chemical reaction on earth.

Elaborate Further / Reflect: Enrichment: Students create their own myths about the northern lights

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: SELF-AWARENESS and SELF-MANAGEMENT
The ability to understand and manage one's own emotions, thoughts, and values is key to identifying personal strengths and limitations. Today's activity will help students develop skills to cope with rejection. In the video, Capt. Schwalbe discusses how she had to overcome obstacles like not getting accepted to her 1st choice for college and being waitlisted at her 2nd choice. It was a real bummer but it turned out she attended her 3rd choice which was best for her and after careful reflection she learned something about herself that would help her in future endeavors.

Tell students **rejection** is a natural part of life and in this activity they are going to explore strategies for building resilience and coping with rejection.
Instructions:

1. Ask students to reflect on a time when they experienced rejection and to write down their thoughts and feelings about the experience. Noting what happened, how they felt at the time, how they feel about it now, how they handled the situation, what they might do differently if confronted with the same experience.
2. Ask for volunteers to share their experiences and what they learned from them.
3. Introduce the concept of resilience; explaining that it is the ability to bounce back from a challenge or a setback and it's a skill that one can develop over time.
4. Ask students to name resilient people (i.e. athletes, entrepreneurs, historical figures - examples: QB Jalen Hurts, Nelson Mandela) then ask students to list the qualities that these people have in common (possible answers: competence, confidence, connection, sense of humor, reflective).
5. Based on the list of qualities students stated, ask them to identify which qualities they possess and have them write down how they could use it when they encounter rejection (examples: strong connection with others-talk to a trusted friend, competent-practice, reflective-journal your thoughts and feelings).
6. Now it's time to practice these coping strategies students have written down with a role play. In pairs or small groups, students will role play a scenario in which one person is rejected and they use the strategies they identified previously.

After the role playing, bring the class together to discuss that rejections happen to everyone at some time or another and in order to bounce back quickly and thrive in the face of adversity they must develop their coping skills.

INTERDISCIPLINARY CONNECTIONS/IDEAS

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
WHST.9-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes

Materials Required for This Lesson/Activity

Quantity	Description
1 500 ml	conical flask
3-4	Splints (to ignite gas)
200 ml	water
20 ml	HCL (concentrated)
5-6 g	Copper chloride

20x20 cm piece	Aluminum foil

Lesson Created by Stacy Douglas - For questions, please contact info@usasciencefestival.org