



# NASA Spotlite Interactive Lesson

## Evidence of Chemical Change

### Grades 5-8



Image Credit: NASA/JPL-Caltech

## Teacher Packet



# NASA Spotlite Interactive Lesson



This NASA eClips™ Spotlite Interactive Lesson supports existing curriculum and should be used as one of many strategies to build students' understandings of science content. The goal of this 5E lesson is to address a science misconception. Through watching a student-produced video (Engage), completing activities (Explore), explaining relevant concepts while applying new vocabulary collectively using a Frayer Model (Explain), and applying new information (Extend/Elaborate), students will develop an understanding of the science content and how to correct the science misconception.

This PDF document should be downloaded to use the interactive features. The hyperlinks included in this document open PDFs or webpages and may perform differently based on the device being used. Links may have to be cut and pasted into a web browser to open.

Try using Adobe Acrobat Reader and Flash Player for optimal performance of all interactive features included in this guide. An accompanying student packet is located on the NASA eClips™ Website.

## What are NASA Spotlites?

NASA Spotlites are 90-120 second student-produced video segments that address common science misconceptions as determined by reputable assessment sources such as the National Assessment of Educational Progress (NAEP),

Progress (NAEP), National Science Foundation (NSF) Factual Knowledge Questions, and the Misconceptions-Oriented Standards-based Assessment Resources for Teachers (MOSART).

NASA Spotlites are designed to increase scientific literacy in a standards-based classroom. By producing Spotlite videos, students gain production experience, as well as deepen their understanding of science content. Approved NASA Spotlites can be found at the NASA eClips website.

<https://nasaclips.arc.nasa.gov/>

## Animated 5E Instructional Model



NASA eClips™ Guides use the 5E constructivist model developed by Biological Sciences Curriculum Study. Constructivism is an educational philosophy that promotes student-centered learning where, students build their own understanding of new ideas. The 5E instructional model consists of five stages for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate.

# Lesson Information

## Science Misconception

Mars is red because it is hot.

## Standards

Next Generation Science Standards

PS1.A: Structure and Properties of Matter

Matter and Its Interactions

5-PS1-3 Make Observations and measurements to identify materials based on their properties.

## Objective

In this lesson, students will address the common misconception that Mars is red because of its temperature. As students develop their understanding of chemical change in matter through explore activities, they will learn new vocabulary that applies to new concepts. Students will apply the vocabulary as they explain that Mars has a reddish tint due to the reaction of the rocks to its atmosphere.

## Time Frame

Between two and three 45-minute class periods:

Day 1 - Engage and Explore

Day 2 - Explain and Elaborate/Extend

Day 3 – Evaluate



This icon identifies the suggested directions and information to read to students.

## Save



Remind students to save responses. Suggested steps:

Under "file" choose "save as."

Type your name in front of the document name. Choose "save."

## Materials

### Assessment

Per student:

copy of pretest and posttest

Frayer Model Activity

Per classroom:

chart paper for posting final vocabulary definitions

Per small group:

copy of a digital Frayer Model (alternatively, this can be printed)

## Explore

For each group of students:

clear plastic cups (3) - 100 mL

steel wool (Fe) - 3 pieces

vinegar ( $\text{CH}_3\text{COOH}$ ) - 100 mL

water ( $\text{H}_2\text{O}$ ) - 50 mL

1 whole apple

1/2 of a lemon

1 latex balloon

1 empty water bottle - 12 oz

3 tablespoons baking soda ( $\text{NaHCO}_3$ )

1 sheet of paper

1 cotton swab or paintbrush

For the class

a heat lamp (incandescent bulb)

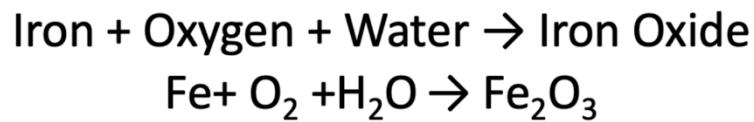
## Safety

- Review digital citizenship before students use online resources.
- Make sure students wear safety goggles to protect their eyes.

## Background Information

Students need to understand that all substances containing iron (Fe) have the potential to rust when in contact with oxygen (O<sub>2</sub>). Many factors contribute to the rate of the chemical reaction commonly known as rusting.

Rusting is a slow combination of iron with oxygen. When rusting occurs, heat energy is released. The heat released by the rusting of the iron causes the liquid in the thermometer to expand and rise. Rust is a chemical reaction with identifiable products. Iron or steel wool will turn reddish-brown when it rusts.



Vinegar is an acid that removes any protective coating from the steel wool, allowing the iron in the steel to rust quicker. Water also allows a reaction between the iron and oxygen; only it occurs at a slower rate. Air will also rust the steel wool, but at an even slower rate due to the protective coating on the strands of steel wool.

Mars is called the "Red Planet" because iron minerals in the Martian dirt oxidize, or rust, causing the surface to look red.

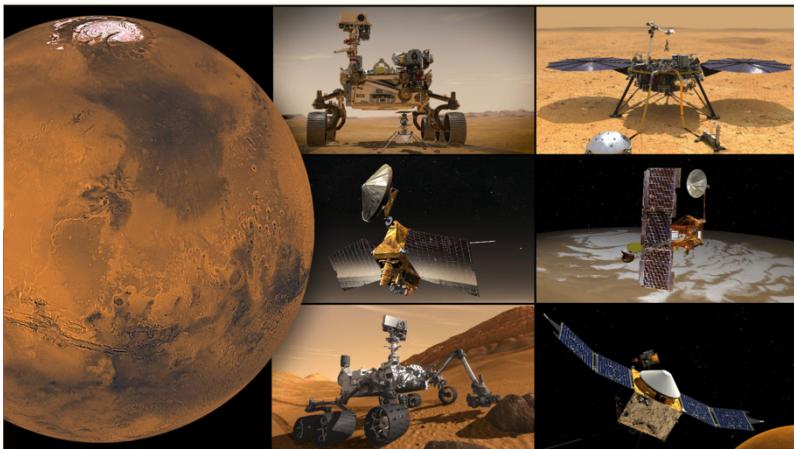


Image Credit: NASA/JPL-Caltech

## Target Vocabulary

corrosion, chemical change, physical change, reaction, rust, oxidation

# Engage

## Pre-assessment

Probe for students' prior knowledge using the pre-assessments.

1. [Pretest items are located at this link](#). Student packets contain a pretest.
2. Essential question
3. Discussion questions

## Essential Question

What happens to metals during a chemical change?



## Today's Lesson

In today's lesson you will learn about the characteristics of chemical changes. The activities you will participate in will let you explore and develop an understanding of the chemical process of rusting and the factors that affect rusting. Using the interactive Frayer Models, you will learn key vocabulary that will help you explain why Mars is red.

What do you already know about the color of Mars? What do you already know about chemical change and physical change?

## True or False

Mars is red because of its temperature.

## NASA Spotlite Video



Next you will watch this clip about Mars' surface. As you watch this video, identify a misconception about Mars.

NASA Spotlite: Evidence of Chemical Change



NASA eClips Website Link: TBD

NASA eClips YouTube link: <https://youtu.be/CVleZuNRxks>

## Class Discussion

Use these questions to lead the class in a discussion.

1. What do you already know about the color of Mars?
2. Recreate the demonstration. What were your results? Were they the same as those of Charlotte?

# Explore

## Explore Activities



Next, you will complete activities to learn what light does in different environments.

Next, you will complete some activities to explore chemical change.

Set up stations for each activity. Review instructions and safety rules for each station. Allow students time to rotate through stations and record observations.

### Activity 1 - Observe what happens to sliced apples when exposed to air.

1. Slice a piece off an apple. Does slicing an apple change the apple into a different substance?
2. Leave the sliced apple's flesh exposed to air.
3. Make and record observations after 15 minutes.

### Activity 2 - Test the effect of heat on dried lemon juice.

1. Squeeze the juice from half a lemon into a cup and add a few drops of water.
2. Dip a cotton swab or paintbrush into the lemon juice and water solution and write a word on a piece of white paper.
3. Let the paper dry. Can you read the word?
4. Hold the paper over a hot incandescent bulb.
5. Make and record observations.

### Activity 3 - Test the effect water, air and vinegar have on steel wool.

1. Label 3 clear cups. On the first cup write water, on the second cup write the word vinegar, and on the third write air.
2. Add 50 mL of water to the water cup and 50 mL of vinegar to the vinegar cup.
3. Submerge a piece of steel wool into each cup.
4. Make and record observations after 20 minutes, and again after an hour, and the next day.

### Activity 4 - Test the effect of combining baking soda and vinegar.

1. Put 3 tablespoons of baking soda into a round balloon that is not inflated.
2. Add 1/4 cup of vinegar into an empty water bottle.
3. Attach the balloon to the mouth of the plastic bottle, then lift the balloon upright so the baking soda falls into the water bottle.
4. Make and record observations.

### Think-Pair-Share

1. How did the activities demonstrate chemical change?
2. Which of the activities would help to correct the misconception that Mars is red because it is hot? How does the demonstration debunk this misconception?

Wear safety goggles when completing the activities.

Vinegar and lemon juice can damage certain materials. Place materials on plastic trays.

# Explain



Let's compare answers.

## Activity 1

When the flesh of apples is exposed to air it reacts with the oxygen in the air. The reaction is a chemical change called oxidation which makes the white flesh turn brown



## Activity 2

Lemon juice is a substance that oxidizes and turns brown when heated. Adding water to the lemon juice makes a solution that is very hard to notice when you apply it the paper.



## Activity 3

The vinegar removes the protective coating of the steel wool and allows the iron in the steel to rust. Rusting (or oxidation) is a chemical reaction between iron and oxygen.

Putting the steel wool in a jar with oxygen and water starts a chemical reaction. The iron and the oxygen react to form a new reddish-brown substance, called iron oxide or rust.



## Activity 4

Mixing baking soda with vinegar produces carbon dioxide gas. This is evident because of the formation of bubbles in the foaming mixture.

# Explain

## Mars in a Minute: Is Mars Red Hot?

Watch this video to learn about the temperature on Mars.

## Mars in a Minute: Is Mars Red Hot?



[https://mars.nasa.gov/resources/20100/mars-in-a-minute-is-mars-red-hot/?utm\\_source=canva&utm\\_medium=iframe](https://mars.nasa.gov/resources/20100/mars-in-a-minute-is-mars-red-hot/?utm_source=canva&utm_medium=iframe)

## Mars in a Minute: Is Mars Really Red?

Watch this video to learn about the color of Mars.

## Mars in a Minute: Is Mars Really Red?



<https://mars.nasa.gov/resources/20029/mars-in-a-minute-is-mars-really-red/>

# Explain

## Vocabulary Development

It's almost impossible to learn science concepts without also learning vocabulary words. Those vocabulary words help people discuss science concepts, so they're important. However, knowing vocabulary words is not the same as understanding science concepts. This section is designed to help your students do more than memorize definitions as they connect the vocabulary to the science concepts that they have explored.

1. Place the word "refraction" in the center of the graphic organizer. ([Fillable Frayer Model linked here](#)). Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. Ask students to brainstorm characteristics of "refraction" and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources including their textbook and notes.
4. Next, ask students to add examples and non-examples in the Frayer Model. Emphasize the higher-level thinking skill of comparing and contrasting.



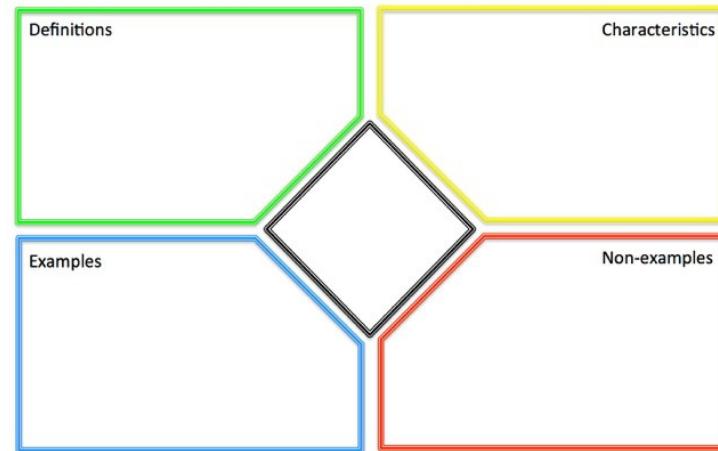
### How are the examples alike/different than the non-examples?

5. Using the information provided, ask students to develop their own definition of the word "refraction" that is clear and concise. An example is in the Answer Key section of this document (page 15).
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively.



Now complete a new Frayer Model with your group using your assigned word and fill in the graphic organizer. We will share some as a class.

**Frayer Model for Vocabulary Development**  
Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word. Refer to definitions in the Resources section (page 12).
8. Compile and post final definitions so all students have access for later reference.



You will review key vocabulary. Pay attention to how your definitions compare.

# Elaborate / Extend

It is important for the students to explain what's going on by applying what they have learned. It is not unusual for students to have a bit of difficulty with elaborate activities. Students are not used to doing "novel" activities and being asked to apply what they know.



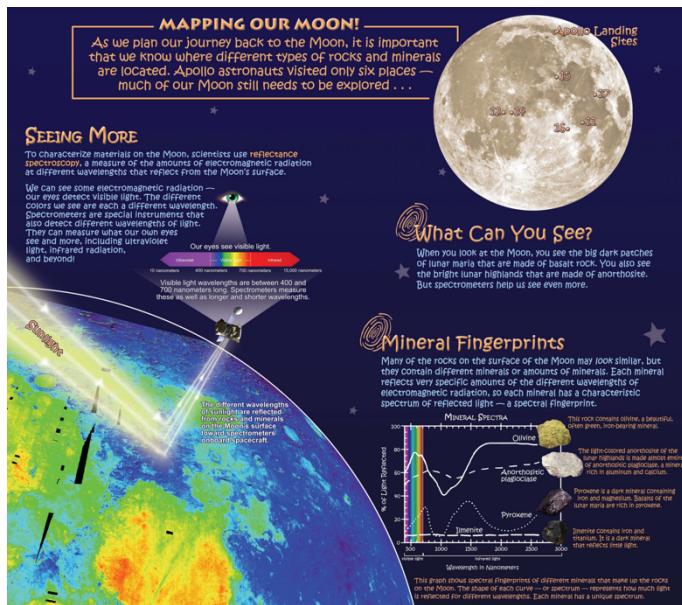
## NASA CONNECTION

### Could rust form on Earth's Moon?

NASA's Lunar Reconnaissance Orbiter (LRO) found iron and titanium oxides under the surface of the Moon. The Moon's highlands have rocks with smaller amounts of metal-bearing minerals like those found on Earth.

The Moon's atmosphere is thin and weak. Unlike Earth's atmosphere, the atmosphere on the Moon does not provide any protection from the Sun's radiation or impacts from meteoroids.

**Use your knowledge about the chemical change process that forms rust on Mars to determine if it is possible for rust to form on the Moon.**



The Sun releases a constant stream of particles and magnetic fields called the solar wind. This solar wind slams worlds across the solar system with particles and radiation — which can stream all the way to planetary surfaces unless thwarted by an atmosphere, magnetic field, or both. Here's how these solar particles interact with a few select planets and other celestial bodies.

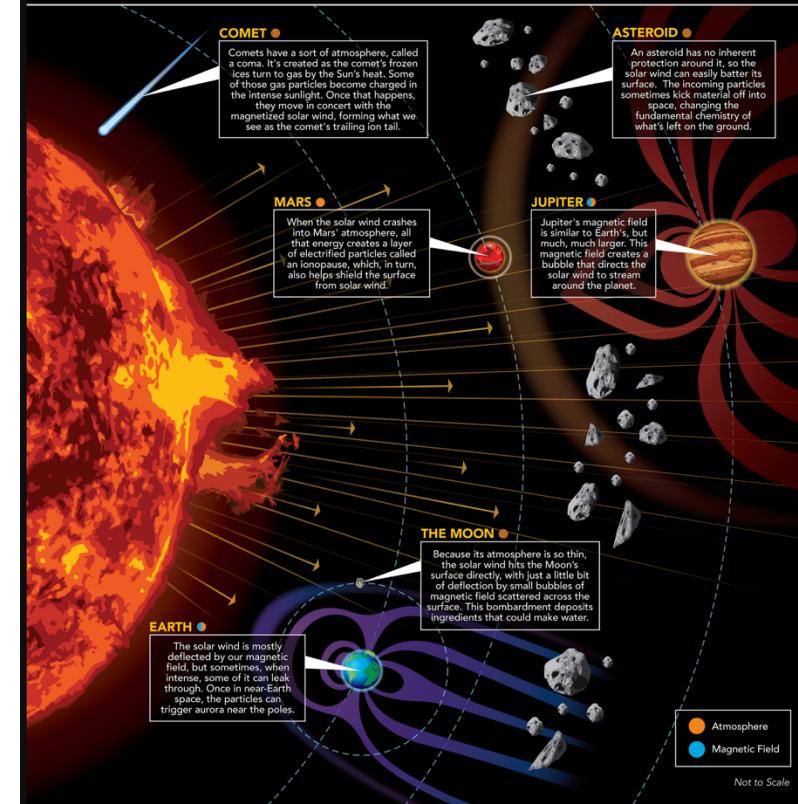


Figure 1 Image Credit: NASA's Goddard Space Flight Center/Mary Pat Hrybyk-Keith - [https://www.nasa.gov/sites/default/files/thumbnails/image/solar\\_wind\\_infographic\\_final.jpg](https://www.nasa.gov/sites/default/files/thumbnails/image/solar_wind_infographic_final.jpg)

Figure 2 Link to Our Moon in a New Light poster - <https://www.lpi.usra.edu/education/moonPosters/Poster2/poster-2-frontfull-508.pdf>

# Evaluate

## Post-Assessment

Check students' understanding with these activities.

1. Identify misconception
2. Discussion questions
3. Vocabulary Review
4. [Posttest items are located on at this link.](#)

## Identify Misconception

What is a common misconception people have about the color of Mars?

## Discussion Question(s)

- Why is Mars red?
- What role does chemical change play in the color of Mars?
- How is a chemical change different from a physical change?

## NASA Spotlite Video

Carefully re-watch the NASA Spotlite video about Mars. Create an illustration or multimedia presentation to show the rusting process.

NASA Spotlite: Why is Mars Red?



NASA eClips Website Link: TBD

NASA eClips YouTube link: <https://youtu.be/CVleZuNRxks>

## Vocabulary Review

Using your new vocabulary words and illustrations, explain what happens to metals during a chemical change.

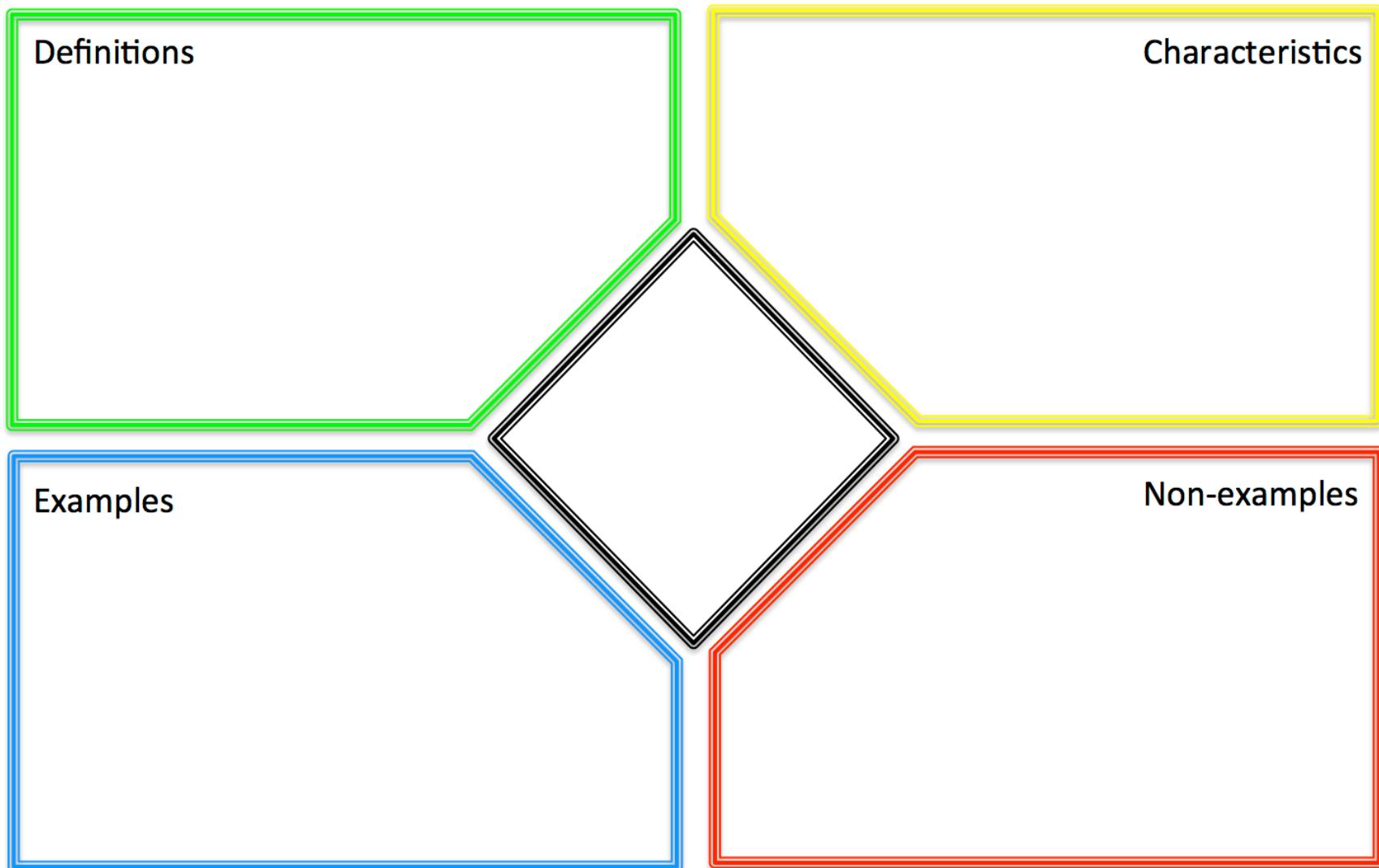
rust  
chemical changes  
changed  
oxygen  
water  
reacts  
iron  
oxidation

\_\_\_\_\_ occur when one substance with a certain set of properties is \_\_\_\_\_ into a different substance with different properties. \_\_\_\_\_ is a new substance formed when \_\_\_\_\_ and \_\_\_\_\_ from the air react with \_\_\_\_\_. This process is called \_\_\_\_\_

# Resources

## Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



# Resources

## Vocabulary Words

### chemical change

-a chemical reaction forms new products that may be identified by color, odor or temperature



Image credit: Free Stock Photo

### oxidation

-occurs when an atom, molecule, or ion loses one or more electrons in a chemical reaction



Image credit: canva.com

### reaction

-process that leads to the chemical transformation of one set of chemical substances to another



Image credit: Nasky, Shutterstock.com

### corrosion

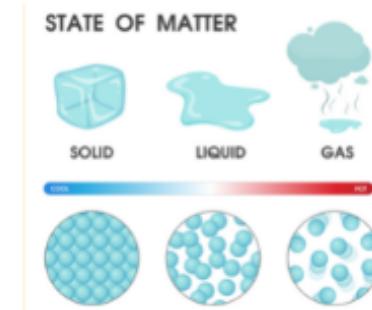
-breakdown of materials due to chemical reactions



Image credit: OSweetNature, Shutterstock.com

### physical change

-matter changes form but not its chemical identity



### rust

-rust forms when iron and oxygen react in the presence of water or moisture in the air



Image credit: OSweetNature, Shutterstock.com

# Resources

## NASA Spotlite Interactive Lesson: Evidence of Chemical Change Pretest / Posttest

Read each question and select the best choice.

1. Which of these does NOT happen during a chemical change?
2. Which shows evidence that a chemical change has occurred
3. All of the following are evidence of a chemical change EXCEPT-
4. Which of the following observations is the best indicator that a new substance has been formed?
5. Which of the following examples shows that a chemical reaction has occurred?
6. You write a note using invisible ink made from lemon juice that is clear when it dries on paper. The invisible ink turns brown when a burning candle is held under the paper. Once it is heated, the ink never becomes invisible again. What type of change is occurring when the paper is heated?
7. Which of the following characteristics is shared by all chemical reactions?
8. Which of the following is an example that includes evidence of a chemical reaction?
9. Which of the following is NOT an example of a chemical change?

# Answer Key

## NASA Spotlite Interactive Lesson: Evidence of Chemical Change Pretest / Posttest

Read each question and select the best choice.

- Which of these does NOT happen during a chemical change?

Select the best answer.

- A) Atomic bonds are formed or break apart
- B) The number of atoms in the reaction stays the same
- C) New substance(s) are formed with different chemical properties
- D) The chemical properties of the beginning substance(s) are the same as those of the end product(s)\*\*\*

- Which shows evidence that a chemical change has occurred

Select the best answer.

- A) slicing potato
- B) apple/potato turns brown\*\*\*
- C) biting apple
- D) peeling apple/potato

- All of the following are evidence of a chemical change EXCEPT-

Select the best answer.

- A) change in state of matter\*\*\*
- B) formation of a gas
- C) color change
- D) precipitate forms (an insoluble solid that emerges from a liquid solution)

- Which of the following observations is the best indicator that a new substance has been formed?

Select the best answer.

- A) A solid becomes a liquid.
- B) A substance changed color. \*\*\*
- C) A solid dissolved in a liquid.
- D) The volume of a substance increased.

- Which of the following examples shows that a chemical reaction has occurred?

Select the best answer.

- A) A rock breaks into smaller pieces when it is struck with a hammer.
- B) Rust forms on a metal chain that has been left outside too long. \*\*\*
- C) A cup of water turns pink when a few drops of red food coloring are added.
- D) A solid is formed when heat is removed from a sample of water.

- You write a note using invisible ink made from lemon juice that is clear when it dries on paper. The invisible ink turns brown when a burning candle is held under the paper. Once it is heated, the ink never becomes invisible again. What type of change is occurring when the paper is heated?

Select the best answer.

- A) chemical change\*\*\*
- B) physical change
- C) incomplete change
- D) temporary change

# Answer Key

7. Which of the following characteristics is shared by all chemical reactions?

Select the best answer.

- A) a precipitate forms -- an insoluble solid emerges from a liquid solution
- B) a color change occurs
- C) heat energy is released
- D) new substances with different properties are formed \*\*\*

8. Which of the following is an example that includes evidence of a chemical reaction?

Select the best answer.

- A) A piece of zinc is placed in water and it settles to the bottom.
- B) A solid block of ice is heated, and it completely melts into a liquid.
- C) Sugar is burned, and it gives off an odor and turns brown and then black. \*\*\*
- D) A tomato is placed into a blender and chopped up into smaller pieces.

9. Which of the following is NOT an example of a chemical change?

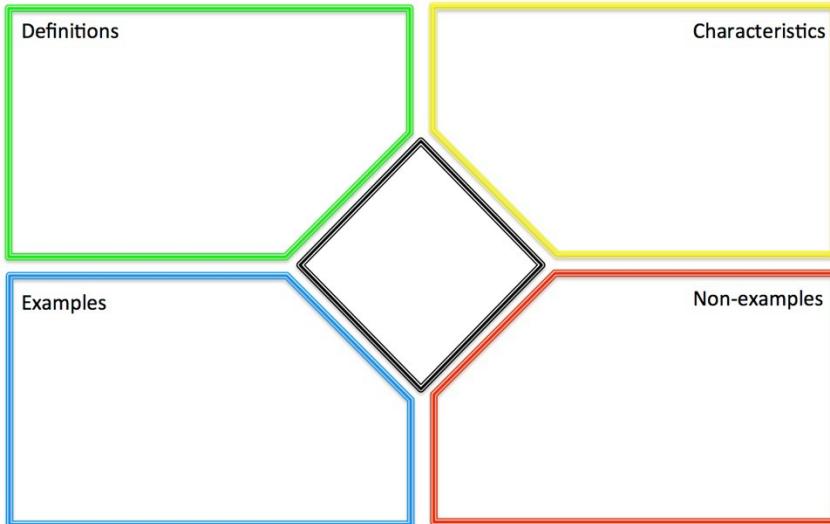
Select the best answer.

- A) burning match
- B) car rusting
- C) baking a cake
- D) melting ice \*\*\*

# Answer Key

## Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



### Word

Refraction

### Characteristics

- Light changes speed as it enters a different medium
- Light bends a different amount as it enters a different medium

### Examples

- light moving from air into water making a pencil appear to be bent where the air and water meet

### Non-examples

- absorption
- reflection
- transmission

### Definition

Refraction is the bending of light as it passes from one material to another. Reflected light is light that is absorbed and then re-radiated off in a new direction.

# Product Information

This product has been developed by the National Institute of Aerospace's Center for Integrative STEM Education.

This document is based upon work supported by NASA under award No. NNX16AB91A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration (NASA).

Published 2022