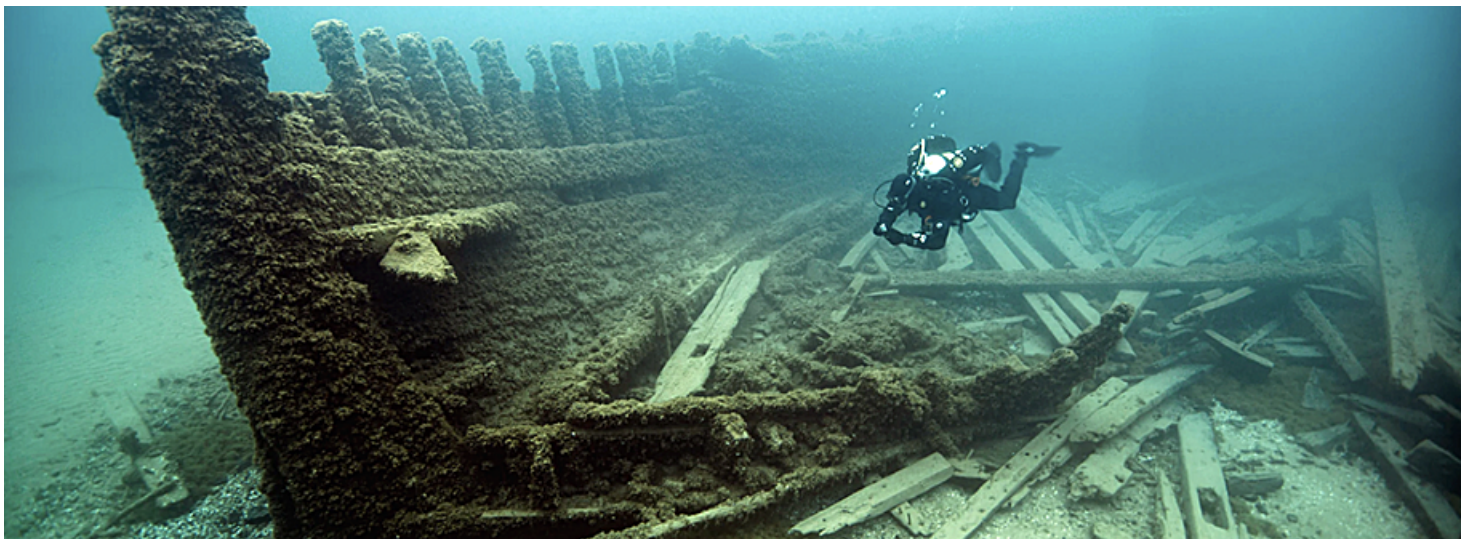
GREAT LAKES LEARNING

LESSONS & ACTIVITIES BASED ON THE MONTHLY GREAT LAKES NOW PROGRAM

EPISODE 2307 | GLASSBOTTOM BOATS

SURVEYING SHIPWRECKS



OVERVIEW

This lesson will explore the phenomenon of **corrosion** as students learn about sunken ships in the Great Lakes and the glass-bottomed tour boats that take people to explore them. In doing so, they'll delve into such science topics related to exploring shipwrecks as gas laws and more.

LESSON OBJECTIVES

- **Know** what corrosion is and why it happens
- **Understand** how gas pressure changes with depth underwater affecting scuba divers
- **Be able to** model the chemical change process of corrosion

WHAT YOU'LL NEED

- Computer or mobile device with Internet access to view video and online resources
- Notebooks and pencils
- Chart paper
- Sticky notes
- Markers
- Lab supplies (see individual activities for a full list)
- Copies of the Student Handouts

INTRODUCTION

The Titanic might be the most famous of all sunken ships, but one thing almost all shipwrecks have in common is corrosion. Corrosion is a chemical change that occurs to certain metals, like iron, when they are exposed to water for long periods of time. When steel-based ships sink, because steel is a metal alloy comprised of iron and other substances, they are susceptible to corrosion as the iron is exposed to the water they are submerged in. When iron corrodes, it reacts with oxygen and water to form iron oxide, commonly known as rust. As the ships remain underwater for more and more time, they corrode further contributing to the unique look of a sunken ship. In order for people to explore these shipwrecks, they need to dive underwater, where they face the effects of increasing pressure at increasing depths of water.

This lesson includes multiple activities, including lab activities, that can span the course of several sessions or be adapted to fit the needs of your group's meeting format.

Some prior knowledge* with which students should be familiar includes:

- states of matter
- properties of matter
- chemical and physical change
- units of pressure and volume
- particle diagrams

Follow this QR Code or hyperlink to the Episode Landing Page!

Check out our full collection of lessons for more activities related to topics like these.

****The sequence of these activities is flexible, and can be rearranged to fit your teaching needs.***

NGSS CONNECTIONS

Phenomenon: Corrosion

- MS-PS1-1
- MS-PS1-2
- MS-PS1-4
- SEP 2
- SEP 3
- SEP 4
- SEP 6
- SEP 7

During the course of the lesson, students will progress through the following sequence** of activities:

- Class discussion to elicit and activate prior knowledge about **corrosion** and the Statue of Liberty
- Teacher notes on **the bends** and corrosion
- Watch a segment from *Great Lakes Now*
- Class discussion to debrief the video
- Experiment with the effects of different liquids on various metal objects
- Make a Cartesian Diver to simulate scuba diving and learn about pressure
- Investigate the relationship between pressure, volume, and density by crushing a soft drink can
- Read about **a 1914 Shipwreck**

The lesson progresses through three major sections: **launch, activities, and closure.** After the launch of the lesson, you are ready to begin the lesson activities. Once finished with the activities, students will synthesize their learning in the closure. You can select the activities that are best suited for your learners and teaching goals, and then sequence them in a way that makes sense within your learning progression and the scaffolds of the lesson.

If you use this lesson or any of its activities with your learners, we'd love to hear about it!

Contact us with any feedback or questions at:
GreatLakesNow@DPTV.org

LESSON LAUNCH

A. Warm Up

The warm up is intended to be structured as teacher-facilitated, whole-group student discussion activities. It helps students to begin thinking about the topic at the center of the lesson.

1. Ask students to list out on a piece of paper five things that come to mind when thinking of **chemical change**.
2. Have students pair up with a partner to share their five ideas with each other. If any ideas appear on both lists, have students circle those.
3. Then, engage students in a whole-group discussion to ask them to share any ideas that were circled.
4. Generate a list of the circled ideas.
5. Ask for volunteers to share any ideas that were not circled that they think are really important to include in this topic.
6. Generate a separate list of those ideas.
7. At the end of making the two lists, have students copy down one single list of all the circled ideas and important ideas in their notebooks or on their paper.
8. Ask students individually to rank the ideas in the list from most to least relevant.
9. Ask for some students to share which term should be most relevant and why they think that is. Engage the whole group in discussion to arrive at consensus about the most relevant idea related to **chemical change** that they already know about or that came to mind during this exercise.

B. Bridge to Learning

Activate prior knowledge and get students thinking about the chemical change of corrosion, ask them to consider the Statue of Liberty.

1. Ask how many of them have ever seen the statue in person.
2. Ask them what color it is (greenish)
3. Show a photo of it
4. Ask them if they know what color it was when it was originally dedicated in 1886 (copperish).
5. Have them discuss with a partner why it went from copper colored originally to green colored today.
6. Invite a few students to share their partner talk ideas and engage the class in a little discussion until they reach some consensus.
7. Guide them (if they don't mention corrosion) to consider that the statue is made of metal and is outside in all weather and all seasons. Extend their thinking to consider what happens when metal is exposed to the air and water.

C. Notice and Wonder

Show the video **Why is the Statue of Liberty Green?** from PBS Digital Studios that gives an overview of the chemistry of the color change of Lady Liberty.

Have students complete the **Notice and Wonder** student handout for the video. Then, give them time to discuss their noticing and wondering with a small group before eliciting some ideas from the whole group of what everyone noticed and wondered from the video. Conclude this activity by summarizing the chemical change process involved in the color change of the Statue of Liberty.

D. Background Information Notes

Explain that we are about to learn more about corrosion and how it affects shipwrecks. Then, give the **Teacher Background Notes** to students.

TEACHER BACKGROUND INFORMATION

by Gary G. Abud, Jr., Great Lakes Now Contributor

**This information can be presented by the teacher as notes to students at the teacher's discretion.*

Corrosion is a chemical process that happens when certain materials, like metals, react with substances in their environment, like water or air. It's a bit like when an object, like a bicycle or a car, starts to get rusty. Rust is a form of corrosion that happens specifically to iron and steel.

When metal objects are exposed to water or moisture, a chemical reaction occurs between the metal and the water molecules. This reaction is called **oxidation**. It causes the metal to break down and form a new substance called **rust**. Rust is a brownish-red powdery solid substance that flakes off from the metal surface. Some everyday examples of corrosion that you may have seen include a sunken ship, a rusty bicycle, the Statue of Liberty, a corroded coin such as an old penny, a rusty nail, or corroded batteries.

Corrosion can be prevented or minimized by keeping metals from exposure to air and water. This can be accomplished by storing them in dry places, keeping them away from humidity, or using protective coatings like paint to create a barrier between the metal and the environment. But when corrosion cannot be prevented, it happens because of a special interaction between chemicals called oxidation. Since matter is made up of tiny particles called atoms—and all atoms have even tinier particles that make them up, which include electrons—when atoms transfer electrons to other atoms, the process is called oxidation for the atom that's giving up its electrons. For the atom that's receiving the electrons it's called **reduction**. Through the process of oxidation between a metal and oxygen, a new compound comprised of iron and oxygen (commonly known as rust) is formed. Rust has a different chemical structure and different properties than either the metal or the oxygen originally did. And since the product of the oxidation reaction is not just physically different but made up of different atoms than the original reactants that formed it, the overall process is called a **chemical change**. It's a rearrangement of atoms to form new substances. And where the metals touch the air or water, that's where corrosion happens—at the surface of the metal—and that's why sunken ships corrode over time.

When scuba divers investigate a shipwreck, it requires them to swim below the water's surface. Even though they are in the water, the effects of different gases are at play when they dive. The deeper they dive the more **pressure** they feel, because the weight of all the water above them is heavy. As they swim, they need to use a special pressurized oxygen tank to help them breathe like they do when they are on land. The pressure **regulator** on the oxygen tank counter balances the pressure and makes it easier to breathe normally for the diver.

Imagine you have a balloon. If you squeeze it, making it smaller, the air inside gets compressed, and the pressure increases. But if you let the balloon expand, the air inside has more **volume**, and the pressure decreases. This is known as **Boyle's Law** and it's similar to what happens when someone scuba dives deeper. But when divers swim upward to resurface, they have to be careful to do it slowly, so their body can adjust to the pressure decrease. Otherwise, they can develop an uncomfortable health condition known as **the Bends**, or decompression sickness.

Let's think of it like a soda bottle. When you shake a closed soda bottle and then quickly open it, the carbon dioxide gas inside the soda comes out really fast and makes bubbles. It's similar to what happens in your body with the bends. When you're deep underwater, the high pressure forces more nitrogen gas into your body tissues. Nitrogen is like the gas in the soda bottle. When you come up too quickly, the pressure around you decreases rapidly, and the extra nitrogen wants to escape quickly, forming bubbles in your body. These bubbles can block the blood vessels and cause problems. It's like the bubbles getting stuck in the bottle and making it hard for the soda to flow out smoothly. This can make you feel sick and have pain in your joints and muscles. That's why it's called "the bends" because it can make you bend over in pain.

To prevent the bends, divers have to swim up slowly and take breaks at different depths to allow their bodies to adjust to the changing pressure. This lets the extra nitrogen escape slowly and safely, just like opening a soda bottle slowly and letting the gas out gradually.

ACTIVITY 1: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment of a glass-bottomed boat tour in Thunder Bay National Marine Sanctuary in Alpena, MI that explores the 200+ shipwrecks in the waters nearby. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from episode 2307 of *Great Lakes Now* called **The Catch**. The first part of the segment looks at the shipwreck tours.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video related to what we discussed earlier during the lesson launch activities?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the launch activities earlier in the lesson about what they knew about **corrosion.**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 2: READ ABOUT A 1914 SHIPWRECK

In this activity, students will read about initiatives like Circular Cleveland that are promoting a circular economy to create jobs, reduce waste, and improve the environment by advocating for policies that encourage sustainable practices like reuse, recycling, and remanufacturing at the state and national level.

In this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article **Michigan researchers find 1914 shipwrecks in Lake Superior** by Kathleen Foody of the *Associated Press*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Last, have each group craft a summary statement of the most important point from their discussion and ask for a volunteer in each group to share that key point with the whole group. As student groups share their most important point, record their ideas on the board and have students copy the list of student ideas down into their notebooks. Once the shareout is complete, ask students to return to their groups and discuss one last question based on the article:

What do you think is the biggest challenge researchers face when trying to discover and preserve 100-year-old shipwrecks?

You can keep this as a class discussion based on the article itself, or this can be extended into a writing assignment, presentation project, or further research on the topic to allow students to engage more deeply with the issue.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

ACTIVITY 3: INVESTIGATING CORROSION

The purpose of this activity is to explore the process of corrosion by examining the effects of different liquids on various metal objects.

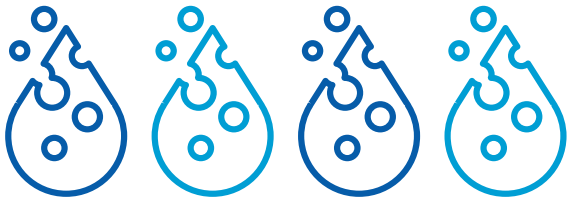
Materials

- Three small metal objects (nails, paperclips, or coins)
- Clear plastic cups/containers, 3 per group
- Water
- Saltwater (mix salt in water to create a solution)
- Vinegar
- Baking soda solution (mix baking soda in water to create a solution)
- Labels or markers
- Paper towels or cotton swabs
- Safety goggles
- Notebook or loose leaf paper

First, inform students that they will be working with a small group to investigate **corrosion**. Begin by discussing what corrosion is and its effects on metals. Explain that corrosion is a natural process that occurs when metals react with substances in their environment. Emphasize that different liquids can have varying effects on metals, and this experiment will help them observe and compare those effects.

Next, divide students into small groups and provide them with the necessary materials. Assign each group one metal object (nail, paperclip, or coin) and three cups labeled as Water, Saltwater, and Vinegar. Remind students to wear safety goggles to protect their eyes during the experiment.

Then, instruct students to fill each cup with the corresponding liquid: water in one cup, saltwater in another, and vinegar in the third cup. Have students place their assigned metal object in each cup, ensuring that each object is fully submerged in the liquid.



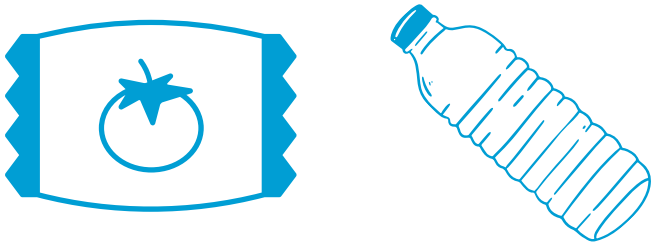
Explain that the experiment will run for a certain duration (e.g., overnight). Have students make predictions about which liquid they think will cause the most corrosion on the metal object and write them down. During the waiting period, students should make particle diagrams of the object that's in each container to represent what they think is happening before, during, and after the change. They can discuss their predictions with their groups, make observations, or note changes they observe in the cups as they wait.

Last, after the designated time has passed, have students carefully remove the metal objects from each cup and examine them. Provide paper towels or cotton swabs for students to dry and clean the metal objects. Instruct students to compare the appearance of each metal object, noting any differences, changes in color, texture, or signs of corrosion. Have them compare their findings to their predictions and to draw a particle diagram that they think represents what actually happened.
Facilitate a class discussion where students share their observations and compare their predictions with the actual outcomes.

Extension Idea

Make this lab quantitative by have students take the mass of their metal objects before putting it in the saltwater, vinegar, or baking soda, and then massing it again after the designated time to sit in the container and after cleaning it off and drying it. They should see a change in mass, and their particle diagrams can help to interpret what this means happened.

ACTIVITY 4: SAUCE PACKET CARTESIAN DIVER



The purpose of this activity is for students to create a Cartesian diver using a water bottle and a ketchup packet to understand the relationship between pressure, volume, and density. They will observe how changes in pressure affect the movement of the "diver" (condiment packet) inside the water bottle.

Materials:

- Empty plastic disposable water bottle
- Unopened ketchup, hot sauce or other small condiment packet
- Water
- Scissors
- Optional: Food coloring & waterproof markers

Inform students that they will be making something called a Cartesian Diver to visualize the relationship between pressure, volume, and density. Like a scuba diver needs to go between different depths of the water, the Cartesian Diver will do something similar.

First, demonstrate to students how to prepare a Cartesian Diver by filling an empty water bottle with water to about 80% full. If you want to make the diver more visible, add a drop of food coloring or draw a small face on the condiment packet using waterproof markers. Insert the packet into the bottle, top off the water, and tighten the cap.

Note: if your condiment packet doesn't float, select another packet that does.

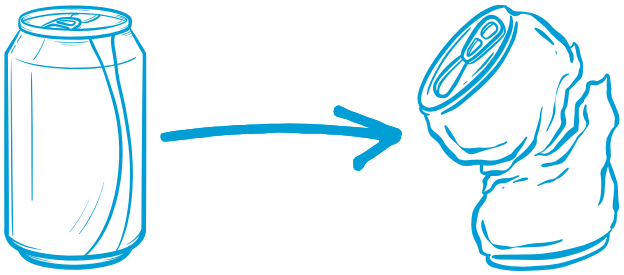
Next, have students make their own Cartesian Divers according to the same procedure that you just showed them. They can do this in pairs, or if you have enough supplies, everyone can make their own. Encourage them to make a prediction about what will happen to the sauce packet when the bottle undergoes more or less pressure.

Then, after students have made their Cartesian Divers, instruct them to gently squeeze the bottles and observe what happens. Have them release the bottle and observe what happens. Challenge them to see if they can get the condiment packet to hold exactly in the middle of the water bottle.

Last, have students make a particle diagram of the diver and water bottle before and after the squeeze/release. Have them discuss their results, reflecting on their predictions, and making connections to their particle diagrams to explain how the pressure, volume, and density of the condiment packets change in the system. Facilitate a whole-class discussion to debrief what happened in the Cartesian Diver and to get them to think about the questions:

- Explain why the ketchup packet changes its position inside the water bottle when you squeeze it.
- How would the diver be affected if you used a different amount of water inside the bottle?

ACTIVITY 5: CRUSH A SOFT DRINK CAN USING PRESSURE



The purpose of this multi-day experiment is to investigate the effects of different storage methods on the rate of food spoilage, simulating real-world scenarios to understand how proper storage can reduce food waste.

Materials:

- Empty soda can
- Stovetop or hot plate
- Beaker tongs or heat-resistant gloves
- Bowl or container of cold water
- Safety goggles

First, inform students that they will be conducting an experiment to investigate how air pressure, temperature and volume are all related. Have them partner up and get the necessary supplies. (Ahead of time you can the students bring in an empty cleaned out soft drink can to use for this experiment.)

Next, demonstrate the can crush experiment for them so that they know how to do it. (Make sure to put on your safety goggles to protect your eyes during the demonstration; have students do the same when they do the experiment.)

Procedure

- Take an empty soft drink can and make sure it's clean and dry. You don't want any soda residue inside.
- Add a little bit of water to the inside of the can and place the soda can on a hot plate or other heat source, making sure it's stable and won't tip over during heating.
- Turn on the heat source to medium-high heat. Wait for a few minutes to let the can heat up.
- While the can is heating, prepare a container of ice cold water by filling it with ice cubes or adding ice-cold water.
- Once the can has been heated for a few minutes, and steam is seen rising from the inside, use tongs or heat-resistant gloves to carefully pick it up and quickly turn it upside down.
- Immediately place the mouth of the can into the ice water, ensuring that the can mouth is fully submerged.
- Observe the reaction that takes place. You should see the can rapidly collapse or get crushed.

Last, have all the students discuss their results with their partners, and perhaps even drawing before/after particle diagrams to represent the situation. Continue to engage the students in a whole-class discussion about what was going on in the experiment with the can crush. Help them to understand that when the can is placed on the heat source, the air and water molecules inside gain energy and move faster. This increased motion of the air molecules increases the pressure inside the can, because an increase in temperature causes an increase in pressure. When you turn the can upside down and place it into the cold water, the surrounding temperature decreases rapidly. This causes the air and water molecules inside the can to lose energy and move slower. As a result, the pressure inside the can decreases—fast. The pressure inside the can becomes lower than the atmospheric pressure outside the can to the point that the difference in pressure between the inside and outside of the can causes the higher atmospheric pressure to crush or collapse the can.

Discussion Questions

1. What would a particle diagram look like of the inside of the can before/after the change?
2. If you were to repeat the experiment with a larger can, do you think the same crushing effect would occur? Why or why not?
3. How would the can crush demonstration be affected if the can was completely sealed?
4. How does the can crush serve as a model to help us understand what scuba divers experience when diving to and from water depths to explore shipwrecks?

LESSON CLOSURE

After the conclusion of all the activities, help students to make connections* between everything they did in the lesson and what they learned overall.

A. Free Recall

Group students in pairs or triads (e.g., in groups of 2-3 partners) and distribute the **Free Recall Protocol handout**, Alternatively, you can have students do this in their notebooks. Set a 3-min timer and have students generate a list of everything they can remember learning about in this lesson related to the central topic of the lesson. This doesn't have to be in depth, just whatever each group can call to mind. Have them draw lines between any terms that relate to one another. After the timer finishes, give groups a chance to volunteer to share aloud 2-3 things from their free recall lists and any of the connections that they made with those. Jot down any ideas that come up multiple times during the shareout for the whole group to see.

B. Lesson Synthesis

Give students individual thinking and writing time in their notebooks to synthesize their learning, by jotting down their own reflections using the **Word, Phrase, Sentence Protocol.**

In the Word-Phrase-Sentence Protocol, students write:

- A **word** that they thought was most important from the lesson
- A **phrase** that they would like to remember
- A **sentence** that sums up what they learned in the lesson

C. Cool Down

After the individual synthesis is complete, students should share their synthesis with a partner.

After sharing their syntheses, have students complete a **3, 2, 1 Review** for the lesson with their partner, recording in their notebooks or, optionally, on exit ticket slips to submit, each of the following:

- **3 things** that they liked or learned
- **2 ideas** that make more sense now
- **1 question** that they were left with

Invite several students to share aloud what they wrote in either the synthesis or 3, 2, 1 Review.

Lastly, ask one student volunteer to summarize what has been heard from the students as a final summary of student learning.

**Optionally here, the teacher can revisit the learning objectives and make connections more explicit for students.*

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

NAME: _____

A Word, Phrase, Sentence Protocol

What is a **word** that you thought was most important from this lesson?

What is a **phrase** that you would like to remember from this lesson?

What is a **sentence** that sums up what you learned in this lesson?

3, 2, 1 Review Protocol

What are **3 things that you liked or learned** from this lesson's activities?

-
-
-

What are **2 ideas that make more sense** now to you?

-
-

What is **1 question that you were left with** after this lesson?

-

NAME: _____

Notice & Wonder Protocol

NOTICE	WONDER
Things that you noticed about the topic	*Things that you wondered about the topic*

NAME: _____

Rose, Thorn, Bud Protocol

ROSE

Something that "blossomed" for you in your learning

THORN

Something that challenged your thinking or was difficult to understand

BUD

Something that's new and growing in your mind — a "budding" idea

NAME: _____

4 Notes Summary Protocol

OOOH!

Something that was interesting to you

AAAH!

Something that became clearer; an "ah-ha" moment

HMMM...

Something that left you wanting to learn more

HUH?

Something you questioned or wondered

Sum It Up Statement:

Summarize your group discussion about your 4 Notes Summaries below:

NAME: _____

Think Pair Square Protocol

THINK

Write down your own individual ideas

PAIR

Summarize what you and your partner discussed

SQUARE

Summarize what your group discussed

NAME: _____

Free Recall Protocol

With 1-2 partners, generate a list of everything you can remember learning about in this lesson related to the central topic of the lesson. Draw lines between any terms that relate to one another.