SUCCESS
ACADEMY
EDUCATION
INSTITUTE

Physical Science: Unit 3

From Alchemy to Reality - How Can We Create New Substances: Lessons

Lesson 1: Changes

Lesson Objective: Scholars understand that changes to a substance can be classified as physical or chemical. They should be able to identify some common markers of physical changes (such as changes in texture, color, and shape). Materials Needed

- For the teacher: candle, matches
- For each group: a set of the **Physical or Chemical Change? Cards**
- For each scholar: computer

Prep

- Materials Prep:
    - Ensure that scholars have access to the videos for each scenario.
    - Cut out a set of the **Physical or Chemical Change? Cards** for each group.
- Intellectual Prep:
    - Watch the **Reaction of Iron with Sulfur Video** by ChemToddler (1 minute, 46 seconds).

What are scholars doing in this lesson?

- Scholars observe four scenarios to gather new information to contrast physical and chemical changes.

Do Now

- Follow the **Do Now plan**.

Launch

- Perform demonstration:
    - Light a candle using a match.
    - Extinguish the candle.
- Ask:
    - What did you notice when I burned the candle?
    - Scholars debate whether a new substance was created or if any substances “appeared” or “disappeared.” Push scholars to provide reasoning but do not reach any conclusions about physical and chemical changes or the law of conservation of mass.
- Show the **Reaction of Iron with Sulfur Video** by ChemToddler (1 minute, 46 seconds).
    - Note: Begin the video at the 12-second mark, as starting at the beginning will give information away!
    - Introduce the unit’s Essential Question: How can we explain the surprising reaction between iron and sulfur?
        - Allow scholars to share their initial ideas. Scholars likely will guess that they observed one or more chemical changes. Use this as a bridge into the virtual lab!
- Explain that this unit is going to focus on chemical reactions and how matter changes. Ask:
    - What are examples of changes in matter you have seen in class this year?
- Ask a scholar to explain the difference between a physical change and a chemical change.
    - Explain that a **chemical change** occurs when there is a change to the actual chemical makeup of a substance. Conversely, in a **physical change**, the molecules themselves have not changed.
        - Ask scholars to provide an example of a physical change. They may say melting, freezing, or evaporation.

Activity

- Scholars watch four scenarios and record their observations on the changes to matter in their Lab Notebooks:
    - Scenario 1: **Melting Money (1,000 Coins) || Cash into Trash Video** by Random Hands (1:24–4:28)
    - Scenario 2: **Fire Tornado in Slow Motion 4K Video** by the Slo Mo Guys (3 minutes, 6 seconds)
    - Scenario 3: **Disappearing Coca Cola Can Experiment | Sodium Hydroxide (Lye) Reaction** by Lifehacker and Experimenter (4 minutes, 11 seconds)
    - Scenario 4: **Old Faithful Geyser - Yellowstone National Park (HD) Video** by David Ellis (2 minutes, 36 seconds)
- Scholars identify evidence of physical and chemical changes, and develop a method to categorize physical and chemical changes.
- Scholars use the **Physical or Chemical Change? Cards** to list more examples of each type of change in their Lab Notebooks.
- As scholars are working, circulate and take notes on scholars' prior knowledge and misconceptions.

Discourse Debrief activity:

- Ask: What are signs that a chemical change has occurred? A physical change?
- Ask: Would a change in odor indicate a physical or chemical change? Why?
- Revisit the demonstration from the launch. Is a burning candle an example of a physical or chemical change?

Make connections to the Essential Question:

- Ask: Do you think the reaction between iron and sulfur represents a physical or chemical change? Why?
- Ask: What other information might help us answer the Essential Question?

Make broader connections:

- Ask: Is eating and digesting food a physical or chemical change?
    - Scholars learned about mechanical and chemical digestion in Life Science (Lower Middle). Support scholars in connecting mechanical digestion (like chewing) to physical changes and chemical digestion to chemical changes.

Accountability (Exit Ticket) Kayla performs a series of experiments in science class. She wrote down observations about what she saw after each reaction.

1. Use Kayla's observations to classify each change as physical or chemical. [5]

Reaction Observations	Physical or Chemical Change?

1	Ice melted into water when heat was added.	Physical
2	Wood gave off smoke after being burned.	Chemical
3	Bread was broken down into crumbs when crushed.	Physical
4	Two clear liquids turned cloudy when combined.	Chemical
5	A cut apple turned brown after sitting outside for an hour.	Chemical

2. Which of the following statements about chemical reactions is true? [1]
   1. Chemical reactions produce solids, liquids, or gases.
   2. Chemical reactions produce solids and gases, but not liquids.
   3. Chemical reactions occur between liquids but not between gases or solids.
   4. Chemical reactions occur between solids and liquids but not between solids and gases.
3. True or false: Chemical reactions always result in fire. _____false___________

Explain. [1]

There are other events that indicate chemical reactions, such as bubbling or the formation of a precipitate.

Scoring Award points as follows:

1. Award one point for each correctly classified change (up to five points).
2. Award one point for answer A.
3. Award one point for a scientifically correct explanation.

Lesson 2: Reactants and Products

Lesson Objective: Scholars understand that in a chemical reaction, reactants combine to form one or more new substances. The difference between reactants and products is that reactants go into a reaction while products are made from a reaction. Changing the amount of reactants affects the yield of products. Materials Needed

- For the teacher: baking soda, vinegar, detergent solution, large graduated cylinder, large beaker or other clear glass/plastic waste container, dump bucket
- For each group: baking soda, vinegar, small cup of detergent solution, dropper, 50 mL graduated cylinder, measuring spoons (must include â…Ÿ8, ¼, and ½ tsp), water for rinsing materials between trials

Prep

- Materials Prep:
  - Create a detergent solution for each group by mixing 1 part liquid dish soap with 6 parts water.
    - Divide this into smaller cups for scholars to use. Keep a large batch for demonstration.

What are scholars doing in this lesson?

- Scholars are challenged to conduct an experiment so that the foam produced reaches an exact, prescribed volume, without overflowing the container!

Do Now

- Follow the **Do Now plan**.

Launch

- Demonstrate the mixing of baking soda and vinegar. Describe the reaction using the vocabulary **reactants** and **products**, relating it to what the scholars see.
  - Procedure:
    - Use a graduated cylinder to measure 10 mL of vinegar.
    - Place about ½ tsp of baking soda in a clear plastic cup.
    - While scholars watch, pour the vinegar into the baking soda.
- Ask: How do you know that a **chemical reaction** occurred?
  - Define **interaction**.
- Ask: How can you change your chemical reaction to create more product?
  - Define **yield**.
- Demonstrate the reaction for the lab, mixing detergent, baking soda, and vinegar, using the following procedure:
  - Use a graduated cylinder to measure 10 mL of vinegar.
  - Pour the vinegar into a small cup and add 1 drop of detergent. Swirl gently to mix.
  - Add ½ tsp baking soda to the empty graduated cylinder.
  - Hold the graduated cylinder over the large beaker/waste container.
  - Pour the vinegar and detergent from the cup into the graduated cylinder.
  - Note: You should expect that white foam will rise up in the graduated cylinder and overflow.

- Ask: What could you change to create a foam that rises as close as possible to the top of the cylinder without overflowing?
    - Explain that today scholars will try to tackle this exact challenge!

Experiment Adapted from American Chemical Society **Lesson 6.2: Controlling the Amount of Products in a Chemical Reaction**

- Scholars work in groups to try to get the foam to reach the top of the graduated cylinder without overflowing.
    - Sample procedure:
        - Decide on how much vinegar and baking soda to use. Record amounts.
        - Use a graduated cylinder to measure the amount of vinegar.
        - Pour vinegar into the small cup and add 1 drop of detergent. Mix.
        - Add baking soda to the empty graduated cylinder.
        - Pour vinegar and detergent mixture into the cylinder. Observe level of foam.
        - Rinse out the graduated cylinder and repeat until foam reaches the top of the graduated cylinder.
- As scholars are working, circulate and ask scholars about their thought process for creating a winning procedure. Ask:
    - How have you decided the amount of reactants to use?
    - What should change to yield the result you want? Why?

Discourse Debrief experiment:

- Ask: What did you do from one trial to the next to try to meet your goal?
    - Ask: Did you use any actual quantitative measurements to guide you? Did you notice any patterns? Explain.
- Ask a group that tried changing the amount of just one reactant: Why did changing the amount of one reactant not necessarily change the yield?
- Ask: If we doubled the amount of each reactant, what would happen to the yield?

Make connections to the Essential Question:

- Ask: What new information do you have that will help us to answer the Essential Question?
    - Scholars should state that they know that iron and sulfur are the reactants, and that the end result of the chemical reaction (which they do not know the name of yet) is the product. A quick search online will reveal for the class that the product is known as iron sulfide!

Make broader connections:

- Ask: What do your findings imply more generally about chemical reactions?

Accountability (Exit Ticket) Many people use a propane gas stove to cook when camping. When propane gas burns, a chemical reaction occurs. In this chemical reaction, propane reacts with oxygen to form carbon dioxide and water.

The model below represents what happens during the chemical reaction.

Image Credit: American Chemical Society

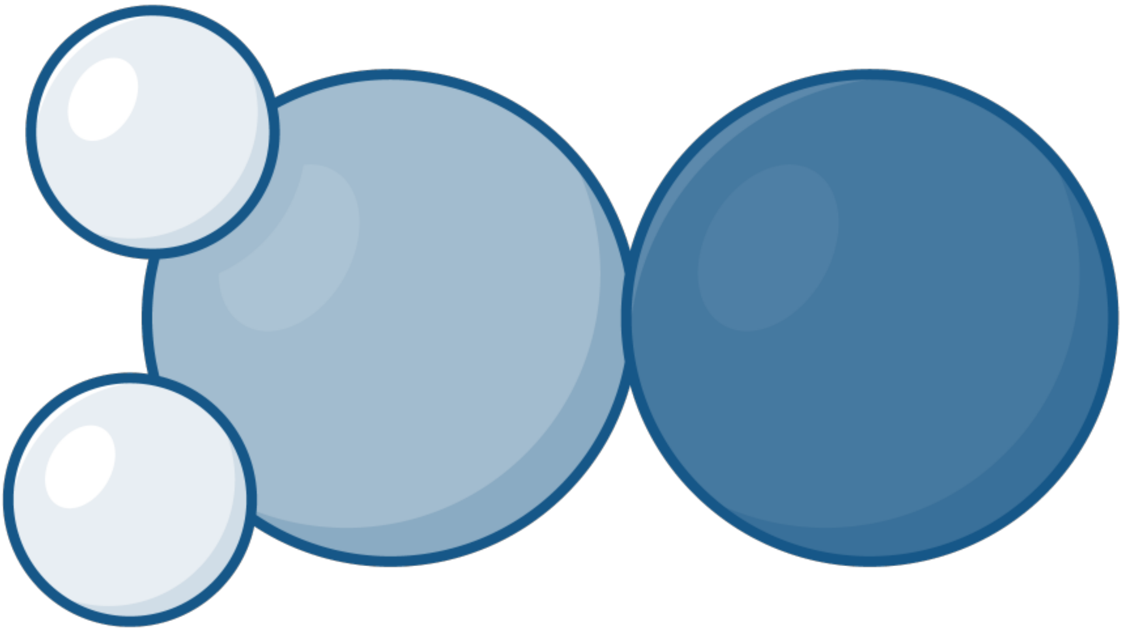
Use the model and what you know about chemical reactions to answer the question.

1. A group of friends on a camping trip want to increase the amount of carbon dioxide produced in the reaction. They list their ideas. Which would lead to an increase in the amount of carbon dioxide produced? [1]

1. Increasing the amount of propane and oxygen
2. Decreasing the amount of propane and oxygen
3. Increasing the amount of propane and decreasing the amount of oxygen
4. Increasing the amount of oxygen and decreasing the amount of propane

1. I
2. II
3. III
4. IV
5. I, II, and IV

2. Could the following diagram of a molecule be the yield of a chemical reaction between sulfur and oxygen? Explain and justify your response.



The molecule could not be the yield of a chemical reaction between sulfur and oxygen. A carbon atom is present in the reactants. During today's experiment, we noticed that if you put more of a reactant into the chemical reaction, there would be more of that reactant at the end. If there was no carbon to begin with, there would be no carbon yielded in the reaction.

Scoring Award points as follows:

1. Award one point for answer A.
2. Do not score the second question. Instead, use it to gauge the level of understanding about reactants and products on a molecular level. Scholar understanding about reactants is incomplete and will be addressed in upcoming lessons.

Lesson 3: Chemical Equations Revealed

Lesson Objective: In a chemical reaction, atoms arrange themselves differently and bond again to form new products. Atoms in the products only come from the reactants. There are no other atoms introduced. No new atoms are created, and no atoms are destroyed. Scholars understand how to use a chemical equation to represent a reaction. Materials Needed

- For the teacher: candle, matches, jar, **Chemical Reaction between Methane and Oxygen Image** by American Chemical Society (pulled up on a viewable screen)
- For each scholar: blank sheet of paper, **100-Atom Molecular Model Set** from Carolina Biological Supply Company (or any similar modeling kit)

Prep

- Materials Prep:
    - Create a modeling set for each scholar:
        - 8 red balls (to represent oxygen)
        - 2 gray balls (to represent carbon)
        - 8 white balls (to represent hydrogen)
        - Leave a set of bonds on the table for scholars to share and take as needed.

[**Materials Management Tip:** Scholars can work in pairs if there are not enough pieces for each individual scholar. You can choose to leave the kits out on each table and have scholars take the materials they need, but preparing a kit for each scholar will save instructional time.]

What are scholars doing in this lesson?

- Scholars use a model to understand how chemical equations are used to represent chemical reactions.

Do Now

- Follow the **Do Now plan**.

Launch

- Explain that you will again light a candle using a match. Light the candle.
- Ask: What are the reactants in this chemical reaction?
    - Scholars often say that the string or wick is burning. It is true that the string of the wick does burn, but it's the wax on the string and not the string itself that keeps the candle burning. Explain that the molecules that make up the wax combine with oxygen in the air to make the products carbon dioxide and water vapor.
- Ask: What will happen if one of the reactants (wax or oxygen) is no longer available?
    - Place a jar over the candle until it extinguishes.
- Ask:
    - Why does the flame go out when I put a jar over the candle?
    - When a candle burns for a while, it eventually gets smaller and smaller. Where does the candle wax go?
- Project the image below of the chemical reaction between methane and oxygen. Elicit observations from scholars. Introduce the term **chemical equation**, but don't give away that it is a balanced equation yet. Let scholars come to this understanding.

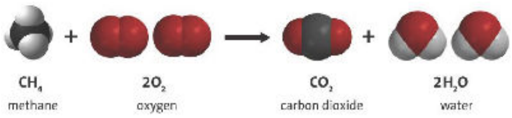


Image Credit: American Chemical Society

- Explain that wax is made of long molecules called paraffin, which is made up of only carbon atoms and hydrogen atoms bonded together. Molecules made of only carbon and hydrogen are called hydrocarbons. Tell students that you will use the simplest hydrocarbon (methane) as a model to show how the wax, or any other hydrocarbon, burns.
- Note: Seeing all four Hs in the methane is a little tricky for some scholars. Point this out and explain the 3D nature of the model.
- Explain that today, scholars will have the opportunity to model this reaction and manipulate each atom to draw connections between the reactants and products in a chemical equation.

Activity Adapted from American Chemical Society **Lesson 6.1 “What is a Chemical Reaction?”**

- Scholars make a model to track the path each atom takes in the chemical reaction between methane and oxygen.

[**Tip:** Leave the image from the Launch displayed on a visible screen or print it for scholars to reference during the activity.]

- Scholars follow the procedure below:
    - Prepare the atoms:
        - Lay out the molecules in your kit
        - Red represents oxygen
        - Gray represents carbon
        - White represents hydrogen
    - Build the reactant side of the equation:
        - Using the chemical bonds, attach the molecules to each other to form the reactants.
        - Place your model on a piece of blank paper.
        - Write the chemical formula under each molecule of the reactants. Also draw a plus sign between the reactants.
    - Build the products:
        - Using the chemical bonds, attach the molecules to each other to form the reactants.
        - Place your model on a piece of blank paper.
        - Write the chemical formula under each molecule in the products. Also draw a plus sign between the products.

- Scholars count the number of atoms on each side of the equation.
- As scholars are working, circulate and press scholars to make connections between how they manipulate the model to what is happening to the real molecules during a reaction.

Discourse Debrief activity:

- Ask: How many carbon, hydrogen, and oxygen atoms are in the reactants compared to the number of carbon, hydrogen, and oxygen atoms in the products?
- Ask: Are atoms created or destroyed in a chemical reaction? How do you know?
    - Ask: What does this make you think about the reactants and products in the reaction we saw during Lesson 1? Was something new created? If so, where did it come from?
        - Note: Chemical reactions are generally more complicated than the simplified model shown in equations. The equation shows that bonds between atoms in the reactants are broken, and that atoms rearrange with and form new bonds to make the products. At a higher level, scholars will learn that the reactants need to collide and interact with each other in order for their bonds to break and rearrange. Additionally, the equation implies that all of the atoms in the reactants come apart and rearrange to form the products. But in many chemical reactions, only some bonds are broken, and groups of atoms stay together as the reactants to form the products.
- Review: In a physical change, like changing state from a solid to a liquid, does the substance itself change? How is a chemical change different from a physical change?

Make connections to the Essential Question:

- Ask: Is there a way that we can find the chemical equation of the reaction that occurs between iron and sulfur?
    - A scholar should be able to find this easily online, or you can look it up together

Accountability (Exit Ticket) Directions: Use the diagram below to answer the question.

Diagram 1

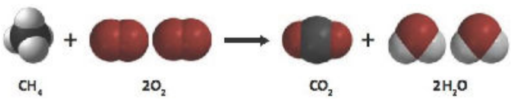


Image Credit: American Chemical Society

1. Complete Table 1 by counting the number of atoms on each side of the equation above. [2]

Table 1: Reactants and Products

Atom	Reactant Side	Product Side

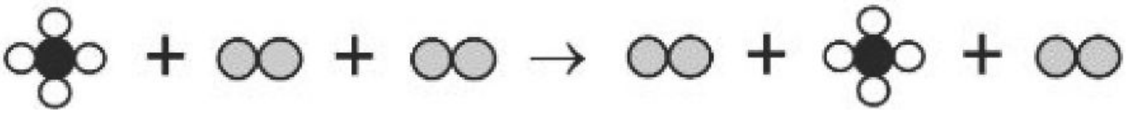
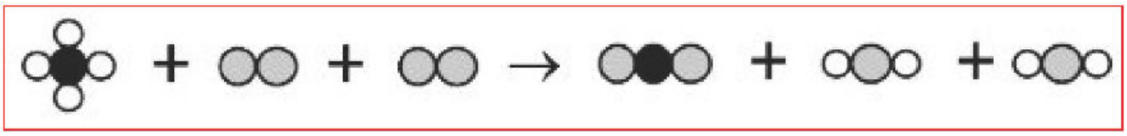
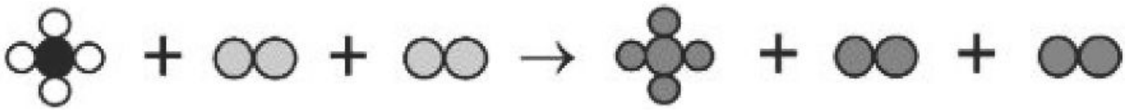
Carbon	1	1
Hydrogen	4	4
Oxygen	4	4

2. Does Diagram 1 represent a balanced chemical equation? [1] (Circle one) **Yes No**
3. Based on the diagram, in the reaction above, did physical or chemical changes occur? Explain and justify your response. [3]

Diagram 1 shows chemical changes. I know this because when a chemical change occurs, one or more new products are formed. In the equation above, CO_2 and H_2O are only present as products, and are completely different from the reactants that were there before the change occurred.

In the models below, atoms are represented by circles, and molecules are represented by circles that are connected to each other. The different-colored circles represent different kinds of atoms.

4. Which of the following could represent a chemical reaction? [1]

1. 
2. 
3. 
4. 

Scoring Award points as follows:

1. Award two points for correctly identifying and counting all of the atoms on each side of the equation.
    - Award partial credit of one point if there is one error in the table.
2. Award one point for circling "yes."
3. Award one point for each of the following:
    - Stating that there is evidence that chemical changes took place in Diagram 1
    - Identifying at least one piece of evidence from the diagram that supports the claim
    - Justification/reasoning that explains or supports the evidence accurately
4. Award one point for answer C.

Lesson 4: Forming a Precipitate

Lesson Objective: Scholars understand that in some chemical reactions, molecules in a solution can react to form a solid precipitate (an insoluble solid sometimes formed when two solutions are mixed). Like the foam when mixing baking soda and vinegar, the precipitate is evidence of a chemical reaction because it has different properties than the reactants. Materials Needed

- For the teacher: sodium carbonate, magnesium sulfate (epsom salt), 2 clear plastic cups, water
- For each group: baking soda, calcium chloride, water, graduated cylinder, triple beam balance, 2 clear plastic cups, masking tape, permanent marker

Prep

- Materials Prep:
    - Prepare the solutions for demonstration:
        - Pour 100 mL of water into a plastic cup. Add 10 g of magnesium sulfate and stir until clear.
        - Pour 50 mL of water into another plastic cup. Add 5 g of sodium carbonate and stir.

What are scholars doing in this lesson?

- Scholars conduct an experiment to see the formation of a precipitate, a sign of a chemical change.

Do Now

- Follow the **Do Now plan**.

Launch

- Perform the following demonstration for the class:
    - Mix magnesium sulfate and sodium carbonate solution so a precipitate will form.
- Ask: Did a chemical reaction occur? How do you know?
- Explain that a **precipitate** is an insoluble solid that forms during a chemical reaction.
    - Watch out for this possible misconception: While a change of state is usually evidence of a physical change, a formation of a precipitate signals a chemical change. A precipitate is a chemically different substance from its reactants.
    - Explain to scholars that they will have the opportunity to see the formation of a precipitate firsthand in today's lab!

Experiment Adapted from American Chemical Society **Lesson 6.3: Forming a Precipitate**

- Scholars create salt solutions that combine to form a precipitate using the following procedure:
  - Label each cup “baking soda” and “calcium chloride.”
  - Add 20 mL of water to each cup.
  - Add 2 g of baking soda to the labeled cup. Swirl until clear.
  - Add 2 g of calcium chloride to the labeled cup. Swirl until clear.
  - Pour baking soda cup solution into the other cup, avoiding pouring undissolved powder.
  - Observe and record.
- As scholars are working, circulate and press scholars to connect precipitate to topics from the previous lessons. Ask:
  - How might you yield more precipitate? Why?
  - Do all chemical reactions have precipitate? Why or why not?

Discourse Debrief experiment:

- Ask: What did you observe when the solutions were mixed?
- Ask: Was this a chemical reaction? How do we know?
  - Ask scholars to use physical evidence from the experiment to justify their claim.
- Display the **Calcium Chloride and Sodium Bicarbonate Chemical Equation** for this reaction. Ask:
  - What products of the reaction do you recognize?
  - Note: Students should recognize NaCl, H_2O, and CO_2.
  - Which product do you think is the precipitate?
- Explain that the salt and water are clear and colorless as a solution, and the carbon dioxide is the gas produced in the bubbles, so the precipitate must be $CaCO_3$ (which is ordinary chalk)!
  - Ask: How does the number of atoms in the products compare to the number of atoms in the reactants?

Make connections to the Essential Question:

- Ask: Was a precipitate formed in the reaction we observed during Lesson 1? (Show the video again for reference if needed.)

Accountability (Lab Notebook)

- Score scholar conclusions from the experiment in their Lab Notebooks.

Scoring

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork.
    - Look for the following when scoring scholar responses:
        - A clear claim that identifies the outcome of their experiment
        - Specific evidence from their experiment that supports their claim
        - Justification/reasoning for why the evidence provided explains or supports their claim
        - High effort shown in writing with complete sentences and proper grammar/ punctuation seen throughout the response

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Lesson 5: The Law of Conservation of Mass

Lesson Objective: The law of conservation of mass states that matter cannot be created or destroyed. This means that all atoms found in the products of a chemical reaction must come from the reactants, and all atoms from the reactants are still present after the reaction. In a closed system, mass is always conserved. However, human error is common and can affect experimental results. For example, some gas may have been released into the air in this experiment. Materials Needed

- For the teacher: Erlenmeyer flask, water, balloon, antacid tablets
- For each group: Erlenmeyer flask, water, balloon, 2 antacid tablets, triple beam balance or digital scale

Prep

- Intellectual Prep:
    - Watch the **The Law of Conservation of Mass - Todd Ramsey Video** by TED-Ed (4 minutes, 34 seconds).

What are scholars doing in this lesson?

- Scholars design and conduct an experiment to determine if mass is conserved in chemical reactions.

Do Now

- Follow the **Do Now plan**.

Launch

- Post the following problem on the board:
    - A scientist combines 14 grams of potassium and 23 grams of water in a beaker. If the chemical reaction that results produces 3 grams of gas, is it possible to predict the mass of the rest of the contents of the beaker?
- Have scholars debate using their knowledge from previous investigations.
    - Ask: If the atoms in a chemical reaction are neither created nor destroyed, what might that mean about the mass of the reactants and the mass of the products?
- Introduce the reaction that occurs between water and the antacid tablets.
    - Explain to scholars that they will have the opportunity to use these materials to look for patterns in the mass of the reactants and products!
    - Demonstrate the use of the triple beam balance, provide scholars with printed instructions, or provide a digital scale.
    - Note: Scholars should have used triple beam balances in fifth grade, but may need a refresher.

Experiment

- Scholars develop and perform a procedure to discover whether the mass of reactants and products before and after a reaction follows a predictable “rule” using antacid tablets, water, and a balloon.
    - Sample procedure:
        - Pour water into the flask.
        - Take mass of water and flask. Record.
        - Crush an antacid tablet and place in a balloon.
        - Take mass of balloon and antacid dust Record.
        - Stretch the lip of the balloon over the lip of the flask.
        - Tilt balloon so antacid dust falls into the water.
        - Take mass of the product, balloon, and flask. Record.
        - Determine if the mass of the water + flask + antacid tablet + balloon = the product + flask + balloon.
- As scholars are working, circulate and press scholars to make connections between conservation of mass and the representation of chemical reactions in chemical equations.

Discourse Debrief experiment:

- Show scholar procedures and data under the document camera. Ask:
    - What happened to the mass during the experiment?
        - Answers will vary, but evidence for the **law of conservation of mass** should be available from scholar results.
        - Ask: How does this relate to what you learned about the reactants and products in a chemical reaction in previous lessons?
- Ask: Why did we use the balloon? Would the results have been different if we used a bowl or beaker?
    - Ensure that scholars understand the concept of a closed system. Relate this back to the experiments they did in the last unitâ€” when measuring changes in temperature, for example, the surrounding air in the room affected the experimental materials over time.
- Ask: Does the fact that the numbers did not match suggest that the law of conservation of mass is not always followed?
    - Discuss different types of experimental error.
    - Ask scholars what type of error could have occured in their experiments.

[**Tip:** Guard against the misconception that volume is also conserved in a reaction. Press scholars to apply their knowledge from the previous unit about the properties of different states of matter to help them understand.]

Make connections to the Essential Question:

- Look back at the equation we found to represent the reaction between iron and sulfur.
- Ask scholars to look closely at the equation; ask how conservation of mass can explain the results. (Scholars should see that every atom from the reactants is accounted for in the product.)

Accountability (Exit Ticket) A scientist wrote on her notepad:

I measured out 13 g of sodium hydroxide and 15 g of hydrochloric acid, and then combined the two reactants in a closed beaker. After mixing, I measured 15 g of table salt and 8 g of water as products.

1. Do the scientist's findings follow the Law of Conservation of Mass? [1]
    1. Yes, the mass of the reactants is 28 while the mass of the products is 23 g.
    2. Yes, the mass of the reactants is 23 while the mass of the products is 28 g.
    3. No, the mass of the reactants is 28 while the mass of the products is 23 g.
    4. No, the mass of the reactants is 23 while the mass of the products is 28 g.
2. The same scientist broke down carbon monoxide into carbon and oxygen. She started with 15 g of carbon monoxide. The reaction produced 8 g of carbon. How much oxygen would be produced, in grams, if the reaction follows the Law of Conservation of Mass? [1]
    1. 22 g
    2. 15 g

3. 8 g
4. 7 g

A student has two different liquids in open jars. She pours the liquid from one jar into the other jar, and she observes bubbles. After the bubbling stops, she finds that the total mass of the liquids is now less than the total mass of the liquids before they were mixed together.

3. How can her observation be explained? [2]

Some of the gas escaped into the air. Gas, like all matter, has mass.

Scoring Award points as follows:

1. Award one point for answer C.
2. Award one point for answer D.
3. Award one point for each of the following:

    - Identifying that gas escaped into the air
    - An explanation with scientifically sound reasoning

Lesson 6: Balancing Equations

Lesson Objective: Scholars understand that chemical equations must be balanced because mass is conserved in chemical reactions. A balanced equation has equal numbers of each type of atom on each side of the equation. Scholars understand that in a chemical equation, a coefficient represents the amount of each molecule in a chemical formula, while a subscript represents the number of atoms of one element in a molecule. Materials Needed

- For each scholar: computer

Prep

- Materials Prep:
    - Make the **Balancing Chemical Equations Simulation Link** by PhET Interactive Simulations available to scholars in advance of the lesson.

What are scholars doing in this lesson?

- Scholars develop a procedure for balancing chemical equations and test their ideas using an online game.

Do Now

- Follow the **Do Now plan**.

Launch

- Post the following chemical equation on the board: $H_2 + O_2 \rightarrow OH_2$

- Ask: What do **subscripts** and **coefficients** in a chemical equation tell us?
    - Could this reaction really exist according to the Law of Conservation of Mass? Why or why not?
        - How can we change this chemical equation so that it follows the Law of Conservation of Mass without changing the type of molecules in the equation?
- Explain to scholars that they will have a real challenge today: to develop a procedure for balancing any equation! Once they think they have a procedure that can be followed every time, they will test their theory using an online game!

Activity Adapted from Balancing Chemical Equations by **PhET Interactive Simulations**, University of Colorado Boulder

- Scholars use the introduction section of the **Balancing Chemical Equations Simulation Link** by PhET Interactive Simulations to create a procedure for balancing chemical equations. Scholars test one another's procedures and provide feedback.
    - Note: A "smiley face" indicates successful creation of a material, as shown below:

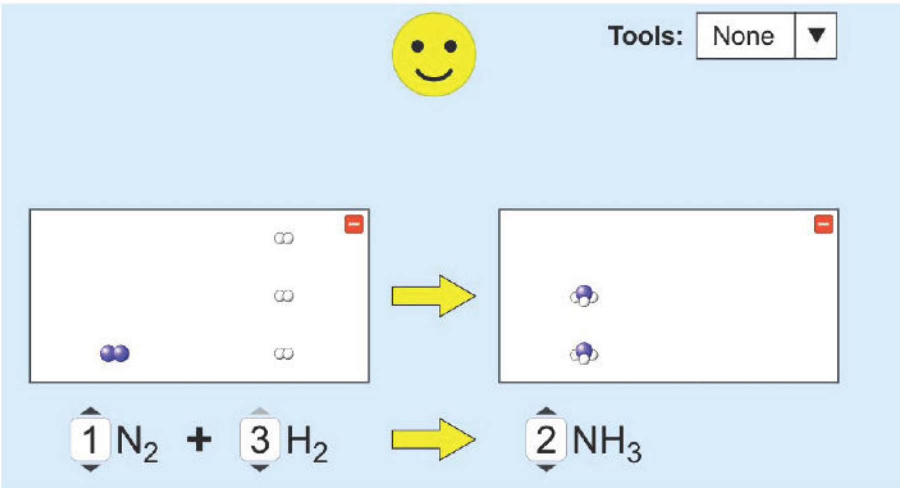

Image Credit: PhET Interactive Simulations University of Colorado Boulder

- After revising their procedures, scholars complete the three levels of the "Game" section of the PhET site, starting with Level 1.

[**Tip:** To access the game, scholars may need to reload the page using the original link.]

- Note: When playing the game, the "smiley faces" do not pop up on their own. Instead, scholars must attempt to create the balanced equation and then click the "Check" button to see if their response is correct.
- As scholars are working, circulate and press scholars to explain how they developed their procedures and why they made certain revisions.

Discourse Debrief activity:

- Ask: Why must a chemical equation be balanced?
- Ask: How can you tell if a chemical equation is balanced?
- Ask: Why can you change the coefficients in the chemical equation but not the subscripts?
    - Scholars should articulate that changing the subscripts changes the substance itself. Use water as an example.
        - Ask: If the second hydrogen is removed from a water molecule, can it still be water?
- Ask: Can a coefficient be placed in the middle of a chemical formula? Explain.
- Ask: If all of the coefficients in a balanced equation are multiplied by two (or multiplied by any whole number), does the equation still adhere to the law of conservation of mass? What if you added two to each of the coefficients?

[**Tip:** Draw or write examples to support the discourse. Many of the questions above will be difficult for scholars to comprehend without a visual.]

Make connections to the Essential Question:

- Revisit the reaction between iron and sulfur. Ask scholars to verify that the chemical equation is in fact balanced.

Accountability (Exit Ticket)

1. Determine whether the chemical equations are balanced. Write "Yes" next to the ones that are balanced and "No" next to the ones that are not. [2]

____Yes___ $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

____No___ AgI + Na2S → Ag_2S + 1 NaI

Sometimes, two or more reactants are combined directly to form a single product. An example is the reaction in which sodium (Na) combines with chlorine (Cl_2) to form sodium chloride, or table salt (NaCl).

2. Write a balanced chemical equation that represents the above scenario. [2]

$2Na + Cl_2 \rightarrow 2NaCl$

Scoring Award points as follows:

1. Award one point for each correctly labeled equation.
2. Award one point for each of the following:
    - Placing the components of the chemical equation in the correct place (products, reactants, addition sign, and yield sign)
    - Placing the correct coefficients in front of each molecule

Lesson 7: Mystery Powder

Lesson Objective: Scholars understand that unique substances have characteristic chemical properties that can be used for identification. The chemical properties of matter describe the "potential" to undergo some chemical change or reaction. A substance's chemical properties cannot be observed without changing the chemical composition of the material. For example, we do not know if a substance has the ability to burn unless we try to burn it. Materials Needed

- For the teacher: iodine solution, cup of baking soda, cup of cornstarch
- For each group: 5 plastic spoons, 10 small plastic cups, small samples of baking soda, baking powder, cream of tartar, cornstarch, water, vinegar, iodine solution, universal indicator, dropper bottles, colored pencils, 2 laminated sheets of paper

Prep

- Materials Prep:
    - Prepare "testing charts" for each group:
        - Draw a grid on the papers with a marker before laminating them so that scholars have a pre-prepared "testing chart" upon which to deposit and test their powders. An example is shown below.

- Prepare powders:
- Label five cups "baking soda," "baking powder," "cream of tartar," "cornstarch," and "unknown."
- Place a small amount of each powder into its respective cup.
- Place baking powder in the cup labeled unknown.
- Prepare test solutions:
- Label four cups "water," "vinegar," "iodine," and "indicator."
- Place about 5 mL of each test solution into the cup.
- Intellectual Prep:
    - Watch the **The Chemistry of Cookies - Stephanie Warren Video** by TED-Ed (4 minutes, 29 seconds).

What are scholars doing in this lesson?

- Scholars conduct tests to identify a mystery substance.

Do Now

- Follow the **Do Now plan**.

Launch

- Show scholars samples of baking soda and cornstarch. Ask them to share observations about each substance.
- Demonstrate the effects of putting iodine into baking soda and cornstarch by pouring iodine into each cup. Scholars will see that the cornstarch turns yellow.
- Ask:
    - Both powders looked nearly the same to start. How do we know they are different?
    - Is the color change you observed indicative of a physical or chemical change? What's your evidence?
- Pose the lab question:
    - Can you use the ways substances react to tell similar-looking substances apart?

Experiment Adapted from American Chemical Society **Lesson 6.6: Using Chemical Change to Identify an Unknown**

- Scholars test five powders (four known and one unknown) with four testing solutions to determine the identity of the unknown powder.
- Procedure:
    - Use a spoon to transfer baking soda samples into four locations on the laminated paper.
    - Add 5 drops of water to the first sample. Record observations.
        - Repeat with each testing solution. Record observations.
    - Repeat the whole process with the next powder. Be sure to use a new spoon for the transfer.
- As scholars are working, circulate and press scholars to use their observations to identify the mystery powder.

Discourse Debrief experiment:

- Explain how you determined the identity of the unknown powder.
    - Identify the changes you saw when mixing substances as chemical or physical.
    - Ask: Can you tell what an object's chemical properties are just by looking at it?
        - How can you determine an object's chemical properties?

Make broader connections:

- Ask: Imagine that you're confronted with a white powdery substance while hanging out in the kitchen. Without tasting the substance, how could you determine its identity?

- Ask: Based on your answer to the previous question, why do scientists care so much about the chemical properties of substances?
    - Reinforce that in order to determine these chemical properties, we actually have to try to change the chemical composition of the substance. Ask scholars how we did that in the first lesson. Wait for them to answer that this was done by burning the substances.

Make connections to the Essential Question:

- Ask: What experiments could we conduct to confirm the identity of the product(s) we think we observed in the video during Lesson 1?
    - How would knowing the identity of the products help us better understand the reaction?

Accountability (Exit Ticket) Miranda found a plastic cup containing an unknown powder in her science classroom. She poured half of the powder into Beaker 1 and the other half into Beaker 2. In Beaker 1, she dropped 10 droplets of water on the powder, and noticed fizzing. In Beaker 2, she dropped 10 droplets of chlorine and noticed a color change.

Table 1: Properties of Elements at Room Temperature

Element Symbol	**State**	**Reactivity with Water and** Chlorine
Ca	solid	reacts with water; reacts with chlorine to form $CaCl_2$
Cu	solid	does not react with water; reacts with chlorine to form CuCl or $CuCl_2$
Ar	gas	does not react with either
B	solid	does not react with water; reacts with Cl to form BCl_3

1. Based on the data provided, place a check mark next to the element listed below that could be the unknown powder. [1]

✓ Ca

☐ Cu

☐ Ar

B

2. Why did Miranda conduct tests to determine the identity of the substance instead of just looking at it carefully? Explain. [2]

Possible Exemplars:

Miranda conducted tests because it is impossible to know the chemical properties of a substance just by looking at it. Chemical properties are only observable during a reaction, so she made reactions occur purposefully so she could compare the results to those of other substances she already knows about.

Miranda had to conduct tests for her safety. She can’t just assume she knows what the substance is based on appearance, as that could be dangerous when she uses it in other experiments later (it could explode or something unexpectedly and hurt her). To be sure of what the mystery substance was, she had to run tests to check its chemical properties.

Scoring Award points as follows:

1. Award one point for selecting Ca.
2. Award one point for each of the following:

    - Demonstrates understanding of chemical properties
    - Shows a reasonable, evidence-based line of reasoning

Lesson 8: Energy Changes in Chemical Reactions

Lesson Objective: Energy is absorbed when chemical bonds are broken and released when chemical bonds are being formed. Chemical reactions that release heat are exothermic, while chemical reactions that absorb heat are endothermic. Materials Needed

- For each group: 10 mL vinegar, ½ tsp baking soda, 10 mL baking soda solution, ½ tsp calcium chloride, water, thermometer, 2 small cups

Prep

- Materials Prep:
    - Make baking soda solution for each group by combining 2 tbsp of baking soda with 1 cup of water.
- Intellectual Prep:
    - Read **What Is an Exothermic Reaction?** by Scientific American.
    - Watch **What Are Endothermic & Exothermic Reactions? Video** by FuseSchool (4 minutes, 17 seconds).
    - Watch **Exothermic and Endothermic Reactions - High School Energy Video** by American Chemical Society (4 minutes, 52 seconds).

What are scholars doing in this lesson?

- Scholars conduct an experiment to determine how temperature changes during a chemical reaction.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask: Can chemical reactions create temperature changes?
  - Show the **Thermite Reaction Video** by the University of Nottingham's Periodic Table of Videos (27 seconds).
  - Show **Nitrogen Triiodide Detonation Video** by Sciencevidds (23 seconds).
- Ask: Can chemical reactions cause a decrease in temperature?
  - Explain to scholars that today they will experiment to find out!

Experiment Adapted from American Chemical Society **Lesson 6.7: Energy Changes in Chemical Reactions**

- Scholars measure the change in temperature of a baking soda and vinegar reaction, and a baking soda and calcium chloride reaction.
  - Sample Procedure:
    - Place the thermometer into 50 mL of vinegar. Read the thermometer and record the temperature in degrees Celsius.
    - While the thermometer is in the cup, add 1 tsp (approximately 5 mL) of baking soda to the cup.
    - Observe the change in temperature.
    - Repeat with 50 mL of baking soda solution and 1 tsp (approximately 5 mL) of calcium chloride.

[Engagement Tip: Experiment with different ratios of each ingredient in advance to determine appropriate quantities. Consider sharing information with the class in advance regarding the best approximate ratio so they do not waste time trying to produce a measurable reaction.]

- As scholars are working, circulate and press scholars to think about the cause of the temperature change and what is happening to the reactant molecules during the chemical reaction.

Discourse Debrief experiment:

- Show the **Endothermic Reaction Animation** by American Chemical Society.
    - Ask: Would you expect the temperature to increase or decrease as the molecules react? Why?
    - Have a scholar define **endothermic** (this is a review term from the previous unit) and state examples of endothermic reactions in real life.
- Show the **Exothermic Reaction Animation** by American Chemical Society (on the next slide).
    - Ask: Would you expect the temperature to increase or decrease as the molecules react? Why?
    - Have a scholar define **exothermic** (this is a review term from the previous unit) and state examples of exothermic reactions in real life.
- Show American Chemical Society's **chemical equation** for the baking soda and vinegar reaction. Ask:
    - Based on your data, is this an endothermic or exothermic reaction?
    - Why is energy being taken in or released (in the form of heat) during chemical reactions?
- Ask: How does energy relate to the formation of new products? Push scholars to use the concepts of potential and kinetic energy in their responses.

Make broader connections:

- Ask: How does energy relate to phase changes?

Make connections to the Essential Question:

- Ask: Do you think the reaction we observed during Lesson 1 was endothermic or exothermic? Why? (Replay the video for reference if needed.)

Accountability (Exit Ticket)

1. The list below describes five reactions. Classify each reaction as endothermic (EN) or exothermic (EX) by writing the appropriate letters on the line next to the corresponding description. [3]

____EX____	A. When two substances are mixed, a large amount of gas is produced. Over the course of the reaction, the temperature of the system rises 3 degrees.
____EN____	B. A cake bakes in an oven.
____EX____	C. A log burns in a fireplace.

_____EX_____ D. A combination of detergent powder and water feels hot to the touch.

_____EN_____ E. A plant takes in energy from the sun to complete photosynthesis.

2. Label the statements about energy levels during reactions as true or false. [2]

_____True___ When temperature is constant, kinetic energy stabilizes.

_____True___ During exothermic reactions, potential energy is converted to kinetic energy.

_____False__ Endothermic reactions use no energy.

Scoring Award points as follows:

1. Award three points for five correct responses.
    - Award partial credit of two points for four correct responses
    - Award partial credit of one point for three correct responses
2. Award two points for three correct responses.
    - Award partial credit of one point for one or two correct responses

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Lesson 9: Types of Chemical Reactions

Lesson Objective: Scholars understand that chemical reactions can be defined and labeled as synthesis, decomposition, replacement or combustion. Materials Needed

- For each group: **100-Atom Molecular Model Set** from Carolina Biological Supply Company (or any similar modeling kit)
- For each scholar: computer

Prep

- Materials Prep:
    - Select websites for scholars to use for research and provide them with the appropriate links prior to the start of class. Two potential resources:
        - **Simple Chemical Reactions** by Thought Co.
        - **Types of Reactions** by CK-12

- Intellectual Prep:
    - Watch **Major Types of Chemical Reactions Video** by Tyler DeWitt (12 minutes, 53 seconds).

What are scholars doing in this lesson?

- Scholars research and then model different types of chemical reactions to better understand how to classify them.

Do Now

- Follow the **Do Now plan**.

Launch

- Explain that chemical reactions can be classified by the changes that take place during it. Introduce the four types of reactions (but do not define them yet).
    - **Synthesis reaction** (**combination reaction**)
    - **Decomposition reaction**
    - **Combustion reaction**
    - **Replacement reaction**
- Allow scholars to predict what might occur during each type of reaction based on their names.
- Introduce the activity for the dayâ€" scholars will research and model the four types of reactions.

Activity

- Scholars research the four types of reactions and model each reaction with the molecular modeling kit.
    - As scholars are building and modeling each reaction, circulate and ask them to explain how each reaction occurs and if the number of atoms is the same before and after each reaction.
- After modeling, scholars should create an illustration and a one- to two-sentence description of each type of reaction.
- Scholars should also include at least one real example of each reaction.

Discourse Debrief activity:

- Ask a scholar to use the molecular modeling kit to represent each type of reaction. Ask the class to evaluate the work for clarity and accuracy.
- Ask: What is the difference between the types of reactions? What makes each type unique?

- Ask: What evidence of a chemical change would you expect to see in a synthesis reaction? Combustion? Decomposition? Replacement? Why?
    - Scholars should give evidence for their answers.

[**Engagement Tip:** If time allows, find examples of each reaction online to show to the class.]

Make connections to the Essential Question:

- Revisit the unit's Essential Question and replay the video from Lesson 1.
    - Ask: What kind of reaction do you think occurred here? What's your evidence?
        - Press scholars to refer back to the chemical equation they found for the reaction to help them answer this question!

Accountability (Exit Ticket)

1. Label each reaction in the table below. [3]

Reaction	**Type of Reaction**
$O_3 \rightarrow O + O_2$	Decomposition
$2Na + Cl_2 \rightarrow 2NaCl$	Synthesis
$Pb + FeSO_4 \rightarrow PbSO_4 + Fe$	Replacement

2. What type of reaction is shown below? [1]

Chemical Reaction between Methane and Oxygen

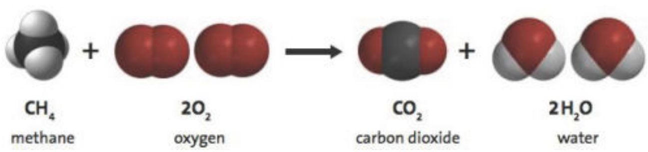

Image Credit: American Chemical Society

1. Decomposition
2. Synthesis
3. Replacement
4. Melting
5. Combustion

Scoring Award points as follows:

1. Award one point for each correctly classified reaction (up to three points).

2. Award one point for selecting choice E.

Lesson 10: Natural Resources and Synthetic Materials (Three Days)

Lesson Objective: Scholars understand that the creation of new synthetic materials has a significant impact on our daily lives. Synthetic substances are man-made materials, and chemical reactions allow us to create synthetic substances with desired properties. Synthetic materials are created by chemically altering natural substances. Materials Needed

- For each scholar: computer

Prep

- Materials Prep:
    - Determine websites for scholar research and make links available prior to the start of class.
        - A list of possible resources can be found in **Natural Resources & Synthetic Materials** by American Chemical Society.
            - Various resources can be found listed in "Resource Links" under the "Downloads" heading
            - Several resources for thirteen different synthetic products can be found listed under the "Explore" heading in section 8
    - Determine the method through which scholars will self-assess their work process and final product at the end of day two.

What are scholars doing in this lesson?

- Scholars research different synthetic materials and create a presentation to share with the class.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Ask: What is a **synthetic** substance?
    - Explain that there are two types of materials, naturally occurring and synthetic. Naturally occurring materials exist in nature, either on Earth or in other parts of the universe. They do not have to be made. Synthetic materials start with a **natural resource** but are transformed by humans. Scientists sometimes make synthetic versions of natural materials (such as vitamins).
- Ask: Why would scientists try to synthesize substances already found in nature? Why would they try to create new substances?
- Explain that scholars will research one synthetic product of their choice from a provided list of resources and create a presentation to teach others about it.

Research Adapted from American Chemical Society **Lesson 6.12: Natural Resources & Synthetic Materials**

- Scholars choose a synthetic product to begin researching and creating a presentation to answer the following three questions:
    - What natural resources are used to make the synthetic product?
    - What chemical processes are used to make the synthetic product?
    - What are the pros and cons of making and using the synthetic product, compared with making and using a more natural product with a similar function?
- As scholars are working, circulate and press scholars to consider the social, economical, and environmental impacts of making and using their synthetic product.

Discourse Debrief research:

- Have scholars share why they chose the synthetic material they are researching.
- Discuss how social, economical, and environmental impacts of synthetic materials can influence their use in society.
- Display scholar work to the class. Have scholars critique one another's work and offer suggestions for improvement.
- Ask: How can we effectively communicate our ideas through this presentation?

Make broader connections:

- Ask: Why is it important for scientists to clearly communicate their findings and ideas?

Accountability (Lab Notebook)

- Score scholar notes from their research in their Lab Notebooks.

Scoring Awards points as follows:

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork.
    - Look for the following when scoring scholar work:
        - A clear answer to each question
        - Specific evidence and details from their research
        - Justification/reasoning for why the evidence and details provided explains or supports their claim (more so for the third question)
        - High effort shown in writing with complete sentences and proper grammar/ punctuation seen throughout the response

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Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Remind scholars of their task and explain that their goal by the end of the day is to have a completed presentation to share with the class.
- Show an example of a “medium-level” presentation that is in progress and ask the class to offer feedback and support to improve the work.
    - If scholars are working in pairs/groups, they should take a few minutes to review their progress so far, discuss any takeaways from the whole-group feedback that they will apply to their own work, and assign “jobs” for the day before starting.

Activity Adapted from American Chemical Society **Lesson 6.12: Natural Resources & Synthetic Materials**

- Scholars continue researching and creating a presentation to answer the following three questions:
    - What natural resources are used to make the synthetic product?
    - What chemical processes are used to make the synthetic product?
    - What are the pros and cons of making and using the synthetic product, compared with making and using a more natural product with a similar function?
- As scholars are working, circulate and press scholars to apply the feedback from the previous day’s Discourse to improve their presentations.

Discourse Debrief activity:

- Display scholar work to the class. Have scholars critique one another's work and offer suggestions for improvement.

[**Tip:** Allow scholars more time to work on their presentation by having a short Discourse in the middle of their work time. This way, scholars can incorporate feedback before submitting their final presentations at the end of class.]

Accountability (Classwork)

- Score submitted scholar presentations.

Scoring Award points as follows:

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork.
    - Look for the following when scoring scholar presentations:
        - A clear answer to each of the questions with specific evidence and details from their research
        - Justification/reasoning for why the evidence and details provided explains or supports their claim (more so for the third question)
        - High effort shown in writing with complete sentences and proper grammar/punctuation seen throughout the presentation
        - Slides display elements of effective design
            - Fonts, colors, backgrounds, etc., are effective, consistent, and appropriate to the topic and audience.
            - Animations and/or sounds have been used to emphasize important points. They do not distract from the content.
            - Text is clear and easy for the audience to see.

Day Three

Do Now

- Follow the **Do Now plan**.

Launch

- Set expectations for scholar presentations.

Presentations Adapted from American Chemical Society **Lesson 6.12: Natural Resources & Synthetic Materials**

- Scholars present their research synthetic materials to the class in short presentations.
- As scholars are presenting, take informal notes on scholars' abilities to justify/reason the pros and cons of their synthetic material.

[**Engagement Tip:** Allow scholars to give one another one to two compliments and pieces of constructive feedback between presentations.]

Discourse Debrief the presentations:

- Have scholars debate whether synthetic materials should continue to be made and used.

Make broader connections:

- Ask: Why is it important that scientists share information about synthetic materials?

Accountability (Exit Ticket)

1. Explain how the study of chemical reactions by scientists and engineers has directly affected you. Include information about synthetic substances in your response. [4]

The study of chemical reactions has benefitted me directly. It has allowed for people to create new products that I use. For example, aspirin is a synthetic product that helps me when I have a headache sometimes. Another example is the fabric nylon, which is a part of a lot of the clothes that I wear (especially in dance class). The creation of these products that help me in everyday life would not have been possible without someone understanding chemical reactions, because synthetic products do not exist in the natural world and must be created by people.

Scoring Award points as follows:

- Award one point for each of the following:
    - An accurate claim relating the study of chemical reactions to one or more direct effects on the scholar/scholar's life
    - Evidence from class presentations or other background knowledge that support the claim (up to two points)
    - Justification/reasoning that further supports the evidence (must add additional value to the response and cannot just restate the claim)

Lesson 11: Identifying and Describing Chemical Reactions

Lesson Objective: Scholars demonstrate mastery of all key unit concepts as they classify several reactions, describe them, and create balanced chemical equations. Materials Needed

- For each scholar: computer

Prep

- Materials Prep:
    - Watch and share links to these videos of reactions for scholars to evaluate:
        - **Reaction of Oxygen and Magnesium** by Science Skool
        - **Decomposition of Hydrogen Peroxide** by DrBodwin
        - **Electrolysis of Water** by profferings
        - **Hydrogen and Hydrochloric Acid Reaction** by Tanya Katovich
        - **Silver Nitrate and Sodium Chloride Reaction** by Tyler Buroker
        - **Whoosh Bottle Experiment** by kentchemistry.com
        - **Methane and Oxygen Reaction** by Shauna Brougher

What are scholars doing in this lesson?

- Scholars apply everything they have learned to classify different chemical reactions and explain the mysterious reaction from the first lesson.

Do Now

- Follow the **Do Now plan**.

Launch

- Show the **Top 15 Chemical Reactions That Will Impress You Video** by Thoisoi2 - Chemical Experiments! (2 minutes 9 seconds).
    - Ask: What have we learned about chemical reactions?
        - Review:
            - Each of those chemical reactions can be represented with a chemical equation.
            - Each of those reactions conserve mass.
            - Each of those reactions can be classified as synthesis, decomposition, replacement, and combustion reactions.

Activity

- Scholars choose any three of the provided videos to observe the chemical reactions.
- Scholars record a description of the reaction, the balanced formula for the reaction, and the classification of the reaction.
- When scholars are finished, they then evaluate the video they watched in Lesson 1.
    - Note: Scholars will need to research some of the substances to determine their chemical composition. Consider whether you will provide a resource for scholars to conduct this research or let them find their own sources. If they find their own sources, ask them to record them as they work.
- As scholars are working, circulate and press scholars to use their knowledge from the unit to explain their classifications.

Discourse Debrief activity:

- Share two of the shorter videos with accompanying scholar work samples. Ask:
    - What evidence helped you classify the reaction?
    - How can you judge whether your chemical equation is balanced?

Make connections to the Essential Question:

- Revisit the **Reaction of Iron and Sulfur** video (1 min, 46 sec) from the beginning of the unit. Allow scholars to use the information in their Lab Notebooks to answer the Essential Question as a group.
    - Press scholars to synthesize their takeaways from each lesson to form a more robust response. Press them to consider the questions below.
    - Note: Allow scholars to conduct a little supplemental research in the moment as needed!
        - Was there evidence of a physical change or a chemical change?
        - Before the materials were heated, how did they behave? What changed after they were heated? Why?
        - What else changes when heated?
        - What were the reactants and products in the chemical change that occurred?
        - Did a precipitate form?
        - Was mass conserved in this reaction? What is your evidence?
        - How might we record a chemical equation to represent this reaction?
        - Was the reaction endothermic or exothermic?
        - Is this a synthesis, decomposition, replacement, or combustion reaction?

[**Tip:** This is a great opportunity to review the terms *mixture* and *compound*!]

Accountability (Lab Notebook)

- Score scholar notes from their research in their Lab Notebooks.

Scoring

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork.
    - Look for the following when scoring scholar work:
        - Accurate details about the reaction in the “Observations” box
        - The balanced equation for the reaction
        - Correct classification(s) of the reaction (endothermic/exothermic, synthesis/combustion/replacement/decomposition)
        - High effort shown in writing with complete sentences and proper grammar/punctuation seen throughout the work

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Unit Vocabulary

Vocabulary List

- **chemical change**
- **physical change**
- **reactant**
- **product**
- **chemical reaction**
- **interaction**
- **yields**
- **chemical equation**
- **precipitate**
- **law of conservation of mass**
- **subscript**
- **coefficient**
- **endothermic**
- **exothermic**
- **synthetic substance**
- **natural resource**
- **synthesis reaction**
- **decomposition reaction**
- **combustion reaction**
- **replacement reaction**