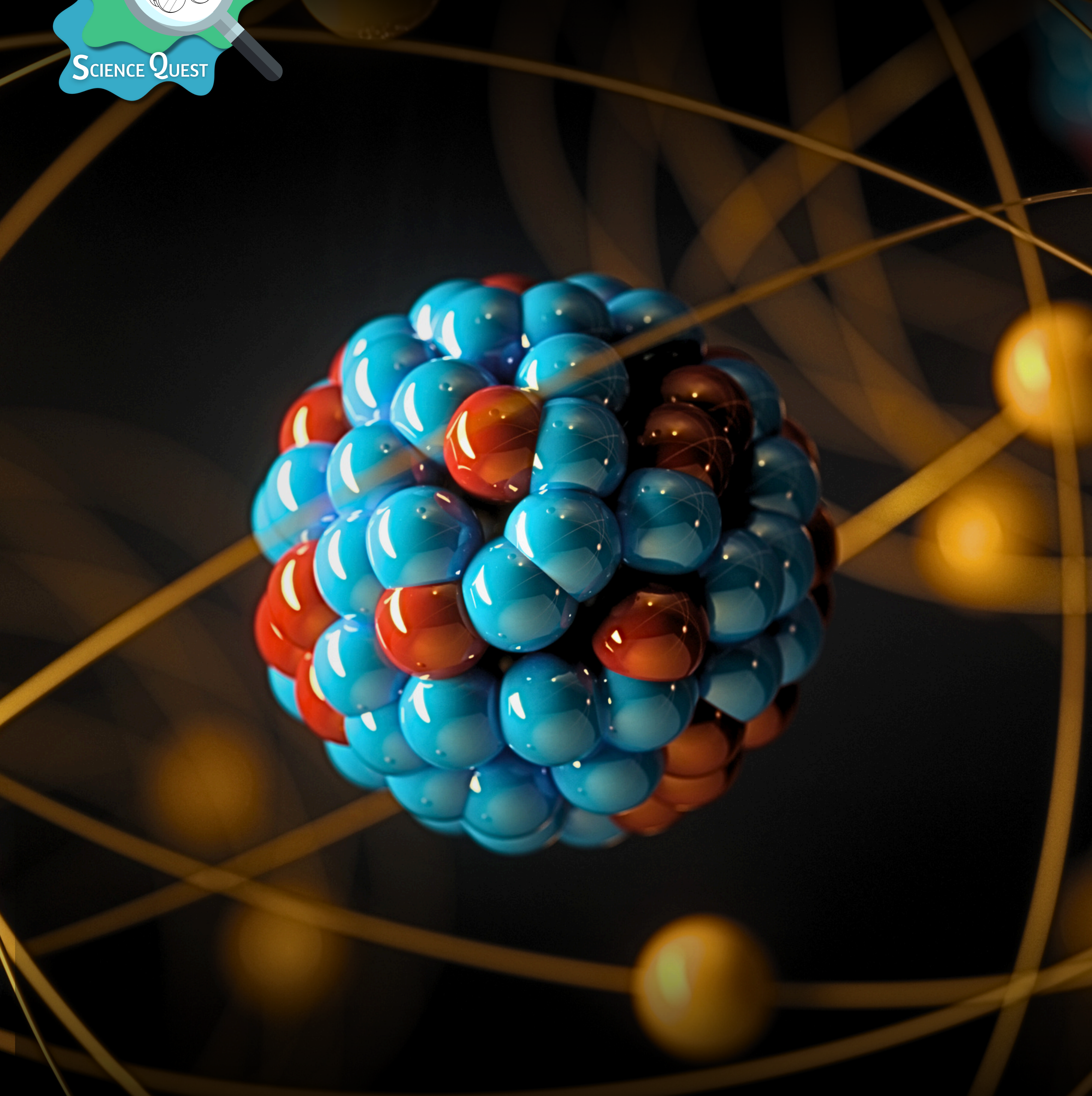
STEMPACT WV

discover

Science Quest



CHEMISTRY QUEST

CHEMISTRY QUEST

Session 1- Atoms & Periodic Table

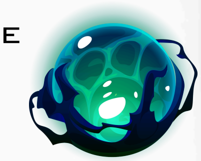
Session 2- Molecules & Bonding

Session 3- Chemical Reactions

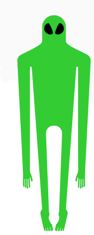
Session 4- DIY Polymer Project

YOUR MISSION

NASA's Deep Space Science Array has intercepted a mysterious repeating signal from the distant world Planet Chemicron.



The beings who live there — the Chemicrons — are powered by energy crystals that are now destabilizing. Their coded message matches the patterns of the Periodic Table.



You've been recruited to the NASA Young Chemist Task Force to decode these signals, discover the science behind them, and save their planet.
If you succeed, the Chemicrons will reward Earth with their secret formula for Alien Goo, a powerful glowing polymer that stores clean energy.

SESSION 1- ATOMS & PERIODIC TABLE

MISSION 1 — DECODING THE ALIEN ELEMENTS

MISSION BRIEFING

NASA HAS RECEIVED THE FIRST TRANSMISSION FROM PLANET CHEMICRON. THE SIGNAL IS FILLED WITH STRANGE REPEATING SYMBOLS THAT MATCH ELEMENTS FROM OUR PERIODIC TABLE.

YOUR MISSION

LEARN WHAT MATTER IS MADE OF, EXPLORE HOW ELEMENTS ARE ORGANIZED, AND DECODE THE FIRST PART OF THE CHEMICRON MESSAGE.

MISSION OBJECTIVES

- MAKE OBSERVATIONS AND COLLECT DATA ABOUT PHYSICAL AND CHEMICAL PROPERTIES OF ELEMENTS.
- IDENTIFY PATTERNS AND RELATIONSHIPS IN THE PERIODIC TABLE.
- DECODE THE CHEMICRON'S FIRST SIGNAL USING YOUR NEW CHEMISTRY SKILLS.

KEY VOCABULARY

MATTER · ATOM · ELEMENT · PROTON · NEUTRON · ELECTRON · NUCLEUS · PERIODIC TABLE · METAL · NONMETAL · PROPERTY

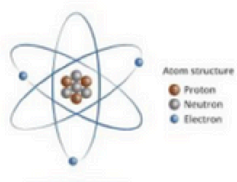
Lab 1: Matter or Not?

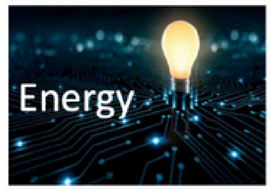
- Investigate which items are made of matter and fill out the chart below.

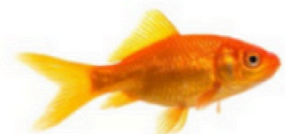
Object	Matter? (Y/N)	Evidence

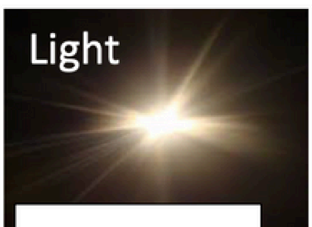
Matter or Not Practice

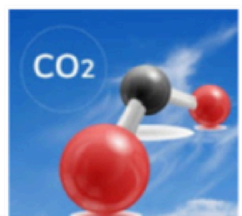
Determine whether each images shows somethings that is matter or not.

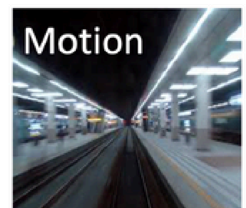


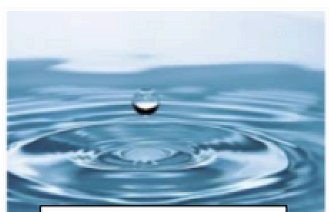












Questions

What makes something matter? ______________________________

____

____

How do you know energy like light or sound isn't matter? ______________________________

____

____

Lab 2: Mystery Box Models

How do scientists create models of things they can't directly observe?
They conduct experiments, collect as much data as possible, and look for patterns that make sense of their observations. Using this information, they form explanations—called models—that best match the evidence they have. As new discoveries are made, these models are often updated or replaced to reflect the latest findings.

When researchers first began investigating atoms, they had very limited knowledge about their structure and behavior. Through experimentation and the use of earlier scientific ideas, they gradually uncovered more details about atomic properties. Over time, the atomic model has undergone major changes. In this activity, you'll explore how scientific models of the atom have evolved and why earlier versions turned out to be incomplete.

Procedure:

1. Choose one of the boxes listed in the materials table.
2. Find the corresponding box number in your data chart or organizer.
3. Without opening the box, draw a diagram showing what you think the maze or interior layout looks like.
4. You may carefully lift, tilt, or shake the box to gather clues about what's inside.
5. Discuss your observations and ideas with your partner.
6. Repeat this process for all three boxes.

Box Number	**Observations (what you feel, hear, or notice when shaking or tilting)**	**Sketch of Predicted Maze/Interior**	**Reasoning (why you think it looks this way)**
Box 1			
Box 2			
Box 3			

Reading Passage: Exploring the Properties of Matter

Everything around us is made of matter. Matter is anything that has mass and takes up space — including solids, liquids, and gases. Even air is made of matter because it has mass, which is why a balloon filled with air weighs more than an empty one.

Scientists study different properties of matter to help identify substances and understand how they behave. These properties can be observed or measured without changing the substance itself.

Some important physical properties include:

- **Density:** how heavy something is compared to its size. For example, air is less dense than water, and helium is less dense than air, which is why helium balloons float.
- **Magnetism:** whether something is attracted to a magnet. Iron and some metals are magnetic, while others like aluminum are not.
- **Solubility:** how easily one substance dissolves in another. For instance, sugar dissolves in water.
- **Conductivity**: how well a material allows heat or electricity to pass through it. Metals are good conductors, which is why metal pots are great for cooking — they heat evenly.

When scientists or engineers study matter, they may perform experiments to learn more about these properties. For example, they might use density to tell two gases apart, or magnetism to identify which metal is which.

Sometimes, chemical properties also come into play. A chemical property is how a substance reacts with others. For example, Styrofoam dissolves in acetone because the two materials react chemically.

Knowing the properties of matter is very useful. It helps us choose the right materials for specific tasks — like using magnetic materials for electronics or lightweight materials for airplanes. Understanding matter also helps scientists design new products and solve everyday problems.

Discussion Questions:

1.Why does a balloon that's filled with air weigh more than one that's empty?

2. Which of the following is considered matter?

a. Energy b. Air c. Peace d. Love

3. What property can help tell the difference between Sodium and Iron?

4. Give an example of something that is lighter (less dense) than air.

5. What property can be used to separate two different gases?

6. True or false: The team used magnetism to tell clear liquids apart.

7. What is the term for when one substance dissolves into another?

a. Liquidity b. Density c. Viscosity d. Solubility

8. What makes Styrofoam break down when it's placed in acetone?

10. What physical property makes metal cookware useful in the kitchen?

11. Why do you think it's helpful to understand the properties of matter?

Lab 3: Seeing the Invisible (CO_2 & pH Colors)

Use a homemade cabbage pH indicator to "see" invisible gas reactions.

Procedure

1. Pour cabbage juice into a clear cup.
2. Blow gently into it with a straw for 20 seconds.
3. Record what happens.

Step	Observation
Before blowing	
After 10 seconds	
After 20 seconds	

Questions

1. Why did the color change? ______________________________
2. What invisible gas caused it? ______________________________
3. What does this tell you about how gases can react? ______________________________

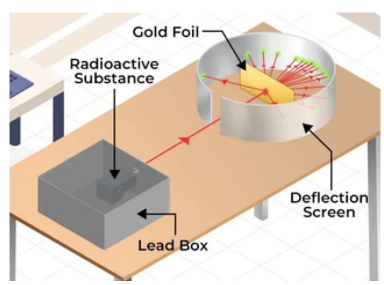
____

____

Mini Reading Passage: Seeing the Invisible

On Planet Chemicron — and here on Earth — scientists face a challenge: we can't actually see atoms, molecules, or many other things that make up matter. They're simply too small for even the strongest microscope! Instead, chemists act a lot like detectives. They look for clues and evidence to figure out what's happening inside invisible worlds. For example, when scientists shoot particles at a thin piece of gold, they can tell where atoms are based on how the particles bounce back — just like bouncing a ball off hidden walls in a maze.

In this way, we can build models to represent what we can't see directly. The Chemicrons' transmissions might seem mysterious, but by collecting data, testing patterns, and using scientific reasoning, you can uncover the secrets hidden inside the unseen structures of matter — just like real chemists do every day!



Atom Builder

Directions: Scan the QR code to use the atom model simulator to learn about protons, neutrons and electrons.

1. Everything around us is made up of different elements. Air has oxygen and nitrogen. Living things contain carbon. Hydrogen is in water and helium can be used in balloons. Use the atom builder to discover which particle (or particles) determine the name of the element that you build. What particle did you discover?

	Subatomic particles	What is the Element?	Circle the Element	Circle the Element
1	Protons: 6 Neutrons: 6 Electrons: 6		Protons Neutrons Electrons	H He Li Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
2	Protons: 7 Neutrons: 6 Electrons: 6		Protons Neutrons Electrons	H He Li Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
3	Protons: 6 Neutrons: 7 Electrons: 7		Protons Neutrons Electrons	H He Li Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr

What particle did you discover?	How do you make a neutral atom?	How do you make a +ion?	How do you make a -ion?

Lab 4: Element Detective

Mission Objective:

Chemicron scientists sent strange data from their surface scanners — showing glowing patches of different-colored materials across their planet.
NASA believes these might be elements, each with unique properties.
Your task: become an Element Detective and classify unknown samples by their physical and chemical properties to help the Chemicrons understand their materials!

Procedure

1. Mission Setup:
   Gather your materials and tools. Label your data table with each sample's name or number.
2. Visual Observation:
   For each sample, use your eyes and magnifier to observe color, luster (shiny/dull), and texture. Record in the chart.
3. Conductivity Test:
   Ask your teacher to connect the simple circuit tester or battery-light setup.
   Touch each sample between the wires to test if it conducts electricity.
   (If the light glows, it conducts!)
4. Magnetism Test:
   Test each sample with a magnet and record if it attracts.
5. Classify the Element:
   Based on your evidence, decide whether the sample is a metal, nonmetal, or metalloid.
6. Record Your Data:

Sample	**Symbol**	**Color**	**Luster (Shiny/Dull)**	**Conductive?**	**Magnetic?**	**Metal, Nonmetal, or Metalloid?**
Aluminum	Al					
Copper	Cu					
Sulfur	S					
Carbon	C					
Iron	Fe					
Plastic	—					

Each of these materials is made of a single element — pure substances that can't be broken down by ordinary means.

- **Metals-** (Al, Cu, Fe) are shiny, conductive, and often magnetic.
- **Nonmetals-** (C, S, polymers) are dull, brittle, and poor conductors.

Their atomic structure — especially electrons — determines these properties.

Analysis Questions

1. Which elements were conductors of electricity? ______________________________
____
2. Which samples were magnetic? ______________________________
____
3. What similarities did you notice among all the metals? ______________________________
____
4. How were the nonmetals different? ______________________________
____
5. What do these patterns tell you about how the Periodic Table is organized? ______________
____
6. If you discovered a new sample that was shiny, flexible, and conductive — where would you classify it? Why? ______________________________
____

Extension Challenge (Optional)

- Research one element you used today.
- Find its atomic number, symbol, and one real-world use (especially in WV or your region).

Example:
Copper (Cu), Atomic #29 — used in electrical wiring and plumbing due to its high conductivity.

Mission Reflection

- How might the Chemicrons use properties like magnetism or conductivity to build their energy systems?
- What property would be most important for creating stable, efficient power crystals?

TRANSMISSION: H – O – LI – P – U – S

Decode the Chemicrons' message! Use each element's atomic number and match it to the alphabet (A=1, B=2, etc.).

Element	Atomic #	Letter
H		
O		
Li		
P		
U		
S		

Message: ______________________________

(Hint: it begins with "HELP…")

Research Mission 1 — How Do Scientists Know Atoms Exist?

Use the internet and/or other resources to learn the major discovery of each scientist in the chart below. List their evidence for the discovery and how it changed scientific understanding.

Scientist	Discovery	Evidence	How It Changed Science
Dalton			
Thomson			
Rutherford			
Bohr			

Reflection:

Which scientist do you think made the biggest leap in understanding? Why?

Career Connection: Exploring Matter

Everyday people use the idea of matter and elements in WV and beyond!





- **Water Quality Technicians:** test water for contamination using indicators and data collection — just like you did with cabbage juice.
- **Coal Plant Operators and HVAC Technicians:** monitor gases, temperature, and pressure to keep systems safe and balanced.
- **Cosmetic Formulators and Chefs:** mix and observe materials to create new textures and reactions.

Quick Reflection:

Which of these jobs sounds most interesting to you, and what kind of observations might that person make each day?

SESSION 2- MOLECULES & BONDING

MISSION 1 — DECODING THE ALIEN ELEMENTS

MISSION BRIEFING

CHEMICRON'S SECOND TRANSMISSION SHOWS PATTERNS THAT LOOK LIKE MOLECULES. THEIR ENERGY CRYSTALS MIGHT BE BREAKING APART BECAUSE THEIR ATOMIC BONDS ARE UNSTABLE.

YOUR MISSION

YOU'LL NEED TO UNDERSTAND HOW ATOMS CONNECT — AND HOW THAT AFFECTS STABILITY.

MISSION OBJECTIVES

- MODEL HOW ATOMS FORM MOLECULES.
- DISTINGUISH BETWEEN IONIC AND COVALENT BONDING.
- EXPLAIN HOW BONDING AFFECTS ENERGY STABILITY.

KEY VOCABULARY

MOLECULE · BOND · IONIC · COVALENT · POLARITY · CRYSTAL · COMPOUND

LAB 1: BUILD-A-MOLECULE

Build models of simple molecules with marshmallows and toothpicks.

Molecule	Formula	Type of Bond	Number of Atoms
Oxygen	O_2	Covalent	2
Water	H_2O	Covalent	3
Carbon Dioxide	CO_2	Covalent	3
Salt	NaCl	Ionic	2
Silica	SiO_2	Network	3

Questions:

1. What patterns do you notice in how atoms bond? ______________________________

____

____

____

2. Which molecules form crystals? ______________________________

____

____

____

Lab #2: Sticky Molecules

Mission Objective:

The Chemicrons' scientists have noticed that some of their energy particles "stick" together and others drift apart. Your job is to investigate how molecular polarity — tiny electrical charges inside molecules — makes substances attract or repel.

Procedure:

- Activate Your Tool:
  - Rub the plastic spoon back and forth with the cloth for about 30 seconds.
  - (You are building up static electricity — electrons moving from one surface to another!)
- Form a Water Stream:
  - Turn on a faucet or use a pipette to make a thin, steady stream of water.
- Observe the Reaction:
  - Slowly bring the charged spoon near the stream of water — but don't touch it.
  - Watch closely what happens to the stream.
- Test Again:
  - Repeat the procedure after rinsing and drying the spoon.
  - Does the stream behave differently with a freshly rubbed or neutral spoon?
- Optional Extension:
  - Hold the charged spoon near small paper bits.
  - Record whether they move or stay still.

Trial	Spoon Type	Observation (Water Stream)	Attraction (Yes/No)	Explanation
1	Uncharged			
2	Charged			
3	Reset			

- Water (H_2O) is a polar molecule.
- Oxygen pulls electrons more strongly than hydrogen, making one side slightly negative (–) and the other slightly positive (+).
- This causes electrostatic attraction — the charged spoon interacts with water's polar sides, bending the stream.

Analysis Questions

1. **What happened when you brought the charged spoon near the water?**

2. **Why did the stream bend even though the spoon never touched it?**

3. **How does this demonstrate molecular polarity?**

4. **Why do you think water "sticks" to itself and forms drops?**

5. **If the Chemicrons' energy crystals contain polar molecules, how might this help them store or move energy?**

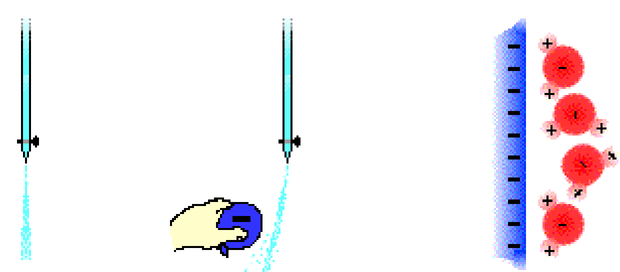
Mission Reflection

1. **How does invisible attraction between molecules help explain real-world things like water drops, soap bubbles, or even electricity on Planet Chemicron?**

Mini Reading Passage: Sticky Molecules — Why Some Things Stick and Others Don't

Have you ever noticed how water seems to cling to everything? Whether it's drops on a window or the way it runs down your hand, water acts a little bit "sticky." This stickiness happens because water molecules are polar — they have a positive end and a negative end, like a tiny magnet! Each molecule's oxygen atom pulls electrons a bit closer, making that side slightly negative (–), while the hydrogen side becomes slightly positive (+).

This charge difference causes water molecules to attract each other and to other charged objects. When you rub a spoon or comb with cloth, it picks up extra electrons, becoming charged. Bringing that spoon near a stream of water makes the polar molecules twist and bend toward it — even though they never touch! The same invisible forces that bend water here on Earth might help the Chemicrons keep their energy flowing through their crystal structures.



A stream of water falling vertically can… …be deflected by the presence of a charged object … … showing that water molecules are polar and can align themselves to be attracted to charged objects.

Develop Models:

Use the atom model kits to make models of the following substances.

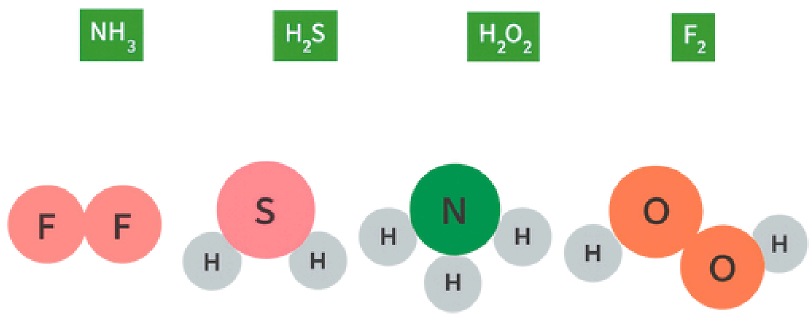
Substance	Molecular Formula	Elements in Substance
Oxygen	O2	Oxygen
Helium	He	Helium
Water	H2O	Hydrogen, Oxygen
Silica	SiO2	Silicon, Oxygen
Salt	NaCl	Sodium, Chlorine
Carbon Dioxide	CO2	Carbon, Oxygen

Draw your models:

Discussion Questions:

1. Do all substances contain the same number of atoms?
2. Do all substances contain the same number of elements?
3. What did you notice about the proportions of different elements in each substance?
4. Are there any similarities between these substances?

Draw a line to match each molecular formula to its model.



Use the molecular formula C2H4O2 to develop a labeled model of a vinegar molecule.

Lab #3: Comparing Molecules

Mission Objective:

The Chemicrons have transmitted complex molecular blueprints — some simple, others massive. Your task is to compare different types of molecules and identify patterns that make them behave differently.

- Mission Briefing:
  - Review the molecular diagrams provided.
  - Identify the elements, number of atoms, and bond types for each.
- Build or Draw Models:
  - Use colored materials to represent different atoms:
    - Hydrogen (H) – White
    - Oxygen (O) – Red
    - Carbon (C) – Black
    - Sodium (Na) – Yellow
    - Chlorine (Cl) – Green
    - Silicon (Si) – Blue
- Observe & Compare:
  - Look for differences between simple molecules (like O_2) and complex networks (like SiO_2).
  - Pay attention to shapes, ratios, and how atoms connect.
- Record Your Data:

Substance	Chemical Formula	Elements Present	# of Atoms	Type of Bond	Molecular Shape (describe or sketch)
Oxygen	O_2	O	2	Covalent	
Water	H_2O	H, O	3	Covalent	
Carbon Dioxide	CO_2	C, O	3	Covalent	
Salt	NaCl	Na, Cl	2	Ionic	
Silica (Sand)	SiO_2	Si, O	3	Covalent Network	

The Chemistry Behind It

- Molecules form when atoms bond by sharing or transferring electrons:
- Covalent bonds share electrons (H_2O, CO_2, O_2).
- Ionic bonds transfer electrons (NaCl).
- Network solids create repeating patterns (SiO_2).
- Different bond types and molecular structures explain why some substances dissolve easily, conduct electricity, or form crystals.

Analysis Questions

1. Which molecules contain the same element more than once? ______________________
   ____
2. Which molecules are made of both metals and nonmetals? ______________________
   ____
3. How does the type of bond change a molecule's properties? ______________________
   ____
   ____
4. Why does salt (NaCl) form crystals instead of soft molecules like water? ____________
   ____
   ____
5. How might the Chemicrons use molecules with strong bonds to build stable energy crystals? ______________________________________
   ____
   ____

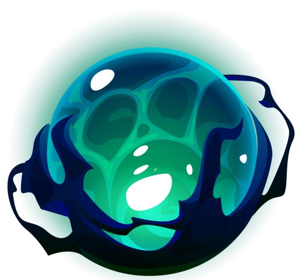
Mission Reflection

Think about the molecules you built or studied:

1. What patterns did you notice in their structure? ______________________________
   ____
2. How might those patterns predict whether a substance is hard, soft, flexible, or brittle? ______________________________________
   ____

Optional Challenge

- Design your own Chemicron "energy crystal" molecule!
- Choose 2–3 elements.
- Draw a model showing how they bond.
- Name your compound and explain what properties it might have.



Alien Code 2 — "Bond Builder Puzzle"

The Chemicrons sent another coded sequence: H_2O – N_2 – O_2 – C – Rb – F

Formula	Name	Letter
H_2O		
N_2		
O_2		
C		
Rb		
F		

Message: ____

(Hint: It explains what's wrong with the Chemicrons' crystals.)

Research Mission 2 — How Do Atoms Stick Together?

Research the following bond types using the internet and/or other materials and fill in the chart.

Bond Type	How It Forms	Example	Bond Strength	Conductivity
Ionic				
Covalent				

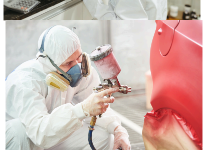
Compare & Contrast:

Which bonds form between metals and nonmetals? ______________________________

Which type is stronger? ____

Career Connection: Building Bonds in Real Life

Many careers in WV and beyond depend on understanding how substances interact.



- **Welder:** knows how metals bond to create strong, safe structures.
- **Pharmaceutical Chemist:** designs molecules that bond precisely to help the human body.
- **Automotive Paint Technician**: uses chemical bonding to make durable finishes.

Quick Reflection:

- Which of these jobs involves careful mixing or bonding, and why is that important? ____

  ____

  ____

  ____

SESSION 3- CHEMICAL REACTIONS

MISSION 3 — REACTION RESCUE

MISSION BRIEFING

THE CHEMICRONS' CRYSTALS ARE OVERHEATING AND BREAKING DOWN IN BURSTS OF ENERGY!

YOUR MISSION

TO HELP, YOU'LL EXPLORE CHEMICAL REACTIONS — HOW ATOMS REARRANGE, HOW ENERGY MOVES, AND HOW MATTER IS CONSERVED

MISSION OBJECTIVES

- IDENTIFY EVIDENCE OF CHEMICAL REACTIONS.
- OBSERVE ENERGY TRANSFER IN ENDOTHERMIC/EXOTHERMIC CHANGES.
- DEMONSTRATE CONSERVATION OF MATTER AND BALANCE EQUATIONS.

KEY VOCABULARY

REACTANT · PRODUCT · ENDOTHERMIC · EXOTHERMIC · CONSERVATION · EQUATION · CATALYST

Lab 1: Limewater Reactions

Blow gently into limewater and watch for changes. Analyze the mass before and after the reaction.   Equation: $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

Procedure:

1. Safety first: Put on your safety goggles before beginning the experiment.
2. Use a graduated cylinder or measuring cup to pour 30 mL of limewater into the plastic bottle.
3. Carefully place the rubber stopper system into the opening of the bottle to seal it securely.
4. Attach your straw mouthpiece to the end of the long flexible plastic tube.
5. Take a normal breath and gently blow once through the tube into the limewater.
6. Remove your straw mouthpiece from the tube when finished.
7. Observe what happens to the limewater and record your observations.
8. Have each group member repeat the blowing and observation steps so everyone contributes one breath.
9. Continue the process until a total of 10 breaths of air have been added to the limewater.
10. Record your final observations and note any changes in appearance.

Breath	Observations
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Limewater is calcium hydroxide dissolved in water. The chemical formula for calcium hydroxide is Ca(OH)2. You added carbon dioxide (CO2) to the limewater. Draw a model with labels of the reactants in this investigation.

Analyzing the Reaction — Modeling the Products

- Now that the reaction has occurred, it's time to show how the atoms have rearranged to form new substances.
- Use what you know about the reactants to reorganize the atoms and figure out which new compounds were produced.
- You should find that one product forms a white solid (precipitate) while the other remains a clear liquid.
- Create a labeled diagram or particle model showing the two products you identified. Be sure to include chemical formulas and label each substance clearly.

Reading Passage: What Happens When Atoms Rearrange

When two or more substances react, their atoms don't disappear — they simply rearrange to form something new. Every chemical reaction follows the Law of Conservation of Matter, meaning the total number of each type of atom stays the same before and after the reaction. The difference is how those atoms are connected. In this lab, you'll notice that one of the new products forms a white solid that wasn't there before — this is called a precipitate, a solid that appears when two liquids react chemically. The other product remains a clear liquid, showing that two different substances have formed. By modeling these new compounds, you can see exactly how the atoms have rearranged while still following the rule that no matter is lost or created.

Conservation of Matter

Calculate the mass of the atoms before and after the chemical reaction by counting the number of atoms of each element in the reactants (before) and the products (after).

BEFORE	AFTER

Use your models of the reactants and products to describe how mass is conserved in the chemical reaction between limewater and carbon dioxide.

Lab 2: Hot vs. Cold Reactions

Mission Objective:

The Chemicrons have reported that some of their crystal reactions give off too much heat while others freeze solid! Your team will explore how energy moves during chemical reactions to discover the difference between endothermic and exothermic changes.

Procedure

1. Label one cup "Reaction A" and the other "Reaction B."
2. In Cup A, mix 1tbsp baking soda and 2tbsp vinegar. Watch and feel what happens.
3. In Cup B, mix 1tbsp calcium chloride and 2tbsp water. Observe carefully.
4. Touch the outside of each cup (carefully) to note temperature change.
5. Record your observations in the table below:

Reaction	Reactants	Observed Change	Temperature (warmer/cooler)	Reaction Type
A	Baking soda + vinegar			
B	Calcium chloride + water			

The Chemistry of What's Going On:

When chemical reactions happen, bonds between atoms break and new bonds form. Breaking bonds requires energy, and forming new ones releases energy.

- If the reaction releases heat, it's exothermic (like the calcium chloride reaction).
- If it absorbs heat, it's endothermic (like the baking soda and vinegar reaction).
- This is the same kind of energy imbalance causing Chemicron's power crystals to overheat or freeze — understanding it helps stabilize their systems!

Mission Reflection & Analysis Questions

- 1. Which reaction released heat energy and which one absorbed it? How could you tell?
- 2. What observations (bubbles, temperature, fizzing) helped you decide if a chemical reaction occurred?
- 3. In both reactions, energy changed form. Where do you think the energy came from or went?
- 4. How would you describe the difference between an exothermic and an endothermic reaction in your own words?
- 5. If the Chemicrons wanted to store heat for later use, which reaction type would they study and why?

Extension Challenge

Design your own "Chemicron Heat Pack" using what you learned today. Which materials would you combine to create an exothermic reaction that gives off just the right amount of warmth for alien exploration?

Reading Passage: The Science Behind Chemical Reactions

Every material in the universe is made of atoms, and when those atoms rearrange, a chemical reaction takes place. The substances you start with are called reactants, and the new substances that form are called products. During a chemical reaction, atoms don't disappear or magically appear — they just change partners! This idea is known as the Law of Conservation of Matter, which means the total number of atoms before and after a reaction always stays the same. That's why if you start with 12 atoms of hydrogen, you'll still have 12 hydrogen atoms in your products — they'll just be combined in new ways.

You can tell a chemical reaction is happening by observing evidence such as color changes, temperature changes, bubbles (gas forming), light, or even a solid forming in a liquid (a precipitate). Unlike physical changes, such as melting or dissolving, these signals show that new substances with new properties have formed. Some reactions release heat (exothermic), while others absorb heat (endothermic). A catalyst can help a reaction happen faster without being used up — like yeast helping hydrogen peroxide break down in the Elephant Toothpaste experiment!

Scientists and engineers use their understanding of reactions every day. Firefighters study combustion, doctors understand how medicines react in the body, and energy scientists develop cleaner fuels. Whether it's baking cookies, rusting metal, or creating new materials, every chemical reaction follows the same powerful rule: matter can change form, but it can't be destroyed.

Questions

1.What is the difference between reactants and products in a chemical reaction?

2. List three clues that show a chemical reaction has occurred.

3. What is the Law of Conservation of Matter, and why is it important in chemical reactions?

4. How can you tell a chemical change apart from a physical one?

5. If you start with 8 atoms of oxygen in the reactants, how many oxygen atoms will there be after the reaction? Explain why.

6. Some reactions give off heat while others absorb it. What are these two types of reactions called?

7. What does a catalyst do in a reaction, and how can it affect the rate of change?

8. Give an example of a chemical reaction where a compound breaks down into simpler substances.

9. How do scientists or engineers use knowledge of chemical reactions in real life?

10.Write a simple chemical equation to show a reaction you've seen or learned about (for example, rusting iron or mixing vinegar and baking soda). Identify the reactants and products, and describe what evidence shows that a chemical reaction took place.

Lab 3: Color Change Chemistry

Mission Objective:

The Chemicrons have discovered that their atmosphere shifts colors during energy storms — could these be signs of chemical reactions? You'll use a natural indicator to test how acids and bases cause color changes when new substances form.

Procedure

1. Pour a small amount of cabbage indicator into three cups — label them A (vinegar), B (baking soda), and C (water).
2. Add 1 tablespoon of vinegar to Cup A and swirl. Record the color change.
3. Add 1 tablespoon of baking soda to Cup B and swirl. Record the color change.
4. Use Cup C with water as your control for comparison.
5. Write your observations in the table below:

Cup	Substance	Indicator Color	Acid, Base, or Neutral?
A	Vinegar		
B	Baking Soda		
C	Water		

The Science Behind It

Acids and bases are chemical opposites. Acids release hydrogen ions (H^+), while bases release hydroxide ions (OH^-). The cabbage juice acts as a pH indicator, changing color based on how acidic or basic a substance is. Vinegar (acidic) turns the indicator pinkish-red. Baking soda (basic) turns it greenish-blue. Water (neutral) stays purple. This color change shows that a chemical reaction has occurred — new ions form and interact with the indicator's pigment molecules. On Planet Chemicron, similar shifts might help scientists detect invisible energy reactions in their environment!

Mission Reflection & Analysis Questions

- What happened to the color of the indicator when you added vinegar, baking soda, and water?
- What do these color changes tell you about the acidity or basicity (pH) of each substance?
- Why did the cabbage indicator change color when mixed with acids or bases?
- How is this experiment evidence that a chemical reaction occurred instead of a physical change?
- If the Chemicrons used color shifts to detect unstable energy in their atmosphere, what might each color represent (safe, warning, danger)? Explain your reasoning.

Extension Challenge

Imagine you are a Chemicron scientist designing a new “energy storm detector.” How could you use indicators or color reactions to warn your planet when a dangerous energy change is about to occur?

Lab 4- Elephant Toothpaste Demo

Mission Objective:

The Chemicrons’ power cores are erupting with foamy energy bursts! To understand why, you’ll observe a rapid decomposition reaction that produces gas and heat — just like their unstable crystals.

Procedure

1. Safety check: Everyone wears goggles and stands back once the demo begins.
2. Pour hydrogen peroxide into the bottle or cylinder.
3. Add dish soap and a few drops of food coloring. Swirl gently.
4. In a separate cup, mix yeast and warm water for 30 seconds.
5. When ready, pour the yeast mixture into the bottle and quickly step back.
6. Watch as the foam shoots upward! Record your observations below.

Observation Type	**Before Reaction**	**During Reaction**	**After Reaction**
Temperature (feel)			
Bubbles/Foam			
Color/Smell			

The Science Behind It

This reaction shows how hydrogen peroxide (H_2O_2) breaks down into water (H_2O) and oxygen gas (O_2). The yeast acts as a catalyst — a helper that speeds up the reaction without being used up. The oxygen gas gets trapped in the soap, forming bubbles and creating foam. Because this process releases heat, it’s an exothermic reaction. The Chemicrons’ power crystals may be having similar uncontrolled exothermic reactions — your investigation helps NASA learn how to control energy release safely!

Mission Reflection & Analysis Questions

- Describe what you observed when the yeast solution was added to the hydrogen peroxide.
- What type of gas was released during the reaction? How do you know?
- Was this reaction endothermic or exothermic? What evidence supports your answer?
- What role did the yeast play in the reaction? (Hint: think about catalysts.)
- If the Chemicrons needed to control a powerful exothermic reaction safely, what strategies or materials might they use?

Extension Challenge

Compare this reaction to what happens in your own body when cells use oxygen to release energy from food. How is your body's chemistry similar to the Chemicrons' energy systems?



Career Connection: Controlling Reactions

Controlling reactions safely is critical in many fields in WV and beyond!

- **Chemical Plant Operator:** monitors pressure and temperature to prevent runaway reactions.
- **Chef or Baker:** uses exothermic and endothermic changes in cooking.
- **Automotive Technician:** balances fuel-air reactions for engine efficiency.

Quick Reflection:

Which of these jobs do you think requires careful observation of chemical changes every day?

Research Mission 3 — Evidence of Chemical Reactions

Use the internet and/or other sources to find chemical reaction examples for each of the type of evidence of reactions listed below. Complete the chart.

Evidence	Lab Example	What It Shows
Color Change		
Temperature Change		
Gas Formation		
Precipitate		

Reflection:

How do you know matter is conserved during a reaction?

Balancing Reactions Practice — Mission to Restore Energy Balance

The Chemicrons have sent another urgent signal:
"Energy unstable... atomic patterns uneven..."
To help them, you must learn to balance chemical reactions so that every atom that goes in comes back out — just rearranged into new compounds.

Background: The Law of Conservation of Matter

In every chemical reaction, matter is conserved — this means atoms are never created or destroyed, only rearranged. To show this in a chemical equation, the number of each type of atom must be the same on both sides of the arrow. Scientists use coefficients (numbers in front of chemical formulas) to make sure everything balances.

Example:
Hydrogen reacts with oxygen to form water.

Unbalanced:
H2+O2→H2O

This doesn't work because there are:
Left side: 2 H atoms, 2 O atoms
Right side: 2 H atoms, only 1 O atom

Balanced:
2H2+O2→2H2O

Now both sides have 4 H atoms and 2 O atoms.

The equation is balanced — matter is conserved!

Your Mission: Check the Balance

For each reaction below, count the total number of each atom before and after the arrow.
Then decide if the reaction is balanced (✔) or unbalanced (❌).
Remember: the subscript tells you how many atoms of that element are in the molecule, and the coefficient multiplies all atoms in that formula.

Reaction	**Balanced? (✔/❌)**	**Atoms In (Reactants)**	**Atoms Out (Products)**
$Na + Cl_2 \rightarrow NaCl$		Na = ___ , Cl = ___	Na = ___ , Cl = ___
$2Na + Cl_2 \rightarrow 2NaCl$		Na = ___ , Cl = ___	Na = ___ , Cl = ___

Discussion Questions:

- What changed when you added the “2” in front of sodium (Na)?
- Did this number change the atoms inside the formula or just how many molecules were counted?
- Why is balancing important in proving conservation of matter?

Science Connection:

In a real reaction, these numbers represent ratios — how many parts of each substance react. For example, 2 sodium atoms combine with 1 molecule of chlorine gas to make 2 sodium chloride (salt) units.

This is how scientists predict how much product will form — and how Chemicrons can keep their energy systems stable by balancing atomic reactions in their power cores.

ALIEN CODE 3 — “REACTION DECODER”

The Chemicrons’ energy crystals are now stable — thanks to your investigations into chemical reactions and energy transfer. To confirm that Earth’s mission succeeded, they’ve sent one final encrypted message. Each part of the message corresponds to a reaction type you explored in your labs. Your job: use your observations to match each reaction to its Chemicron symbol and uncover the message hidden within.

Reaction	Type of Reaction	Letter
Limewater	*(Gas formed / Precipitate / Neutral)*	
Hot Reaction	*(Exothermic)*	
Cold Reaction	*(Endothermic)*	
Conservation	*(Mass balanced)*	

KEY

Reaction Feature or Type	Chemicron Symbol	Secret Letter
Exothermic reaction (heat released)	🔥	**R**
Endothermic reaction (heat absorbed)	❄️	**E**
Gas formation (bubbles)	💨	**A**
Color change (indicator or solution)	🎨	**L**
Mass remains the same (balanced reaction)	⚖️	**P**
Energy absorbed into bonds	💎	**X**
Catalyst used	⚡	**H**
Solid precipitate forms	🧊	**K**

CHEMICRON TRANSMISSION (ENCODED MESSAGE)

“⚙️☄️___ 💎___ 🌌___ 🔮___ RECEIVED. ENERGY STABILIZATION COMPLETE.”

(Write the correct letter above each blank to complete the message.)

Mission Reflection Discussion Questions”

- Which pieces of evidence from your labs showed that energy can move or change form during a reaction?
- Why is it important that atoms are conserved and not destroyed during reactions?
- How did understanding chemical reactions help you decode the Chemicrons’ final message?
- What might Earth scientists and Chemicrons work together on next — now that both planets understand how to stabilize energy safely?

Session 4: Alien Goo — DIY Polymer Project

Mission Objective:
The Chemicrons have stabilized their power systems — and as thanks for your help, they've transmitted a recipe for their favorite energy material: Alien Goo!
This goo is a synthetic polymer — a stretchy, gel-like material similar to the compounds they use to store and move energy safely across Planet Chemicron.
Now, it's your turn to create it using Earth ingredients!

Materials Needed (per group or individual)

Safety Equipment:
- Non-latex gloves
- Safety goggles

Chemicals & Solutions:
- 1 tsp sodium alginate sample (polymer source)
- 1 tsp calcium chloride sample (crosslinker)
- Equipment:
- Beaker with 200 mL water
- Small plastic container with 500 mL water
- 2 glass stirrers
- Spoon
- Paper Bowls

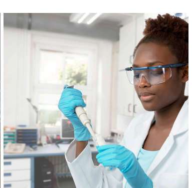
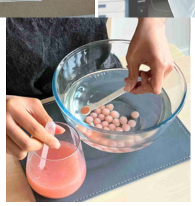
- Procedure: Creating Alien Goo
- Suit Up: Put on your gloves and goggles.
    - Prepare the Polymer Base:
        - Pour 200 mL of water into your beaker. Stir it rapidly with a glass stirrer.
        - Add Sodium Alginate:
        - While stirring, slowly sprinkle the sodium alginate into the water. Keep stirring until most lumps are gone.
        - If lumps form, skim them off gently with your spoon.
    - Prepare the Crosslinking Solution:
        - In your plastic container, add 500 mL of water and stir in the calcium chloride until dissolved.
    - Make the Polymer!
        - Slowly pour some of your sodium alginate solution into the calcium chloride solution while stirring gently.
    - Observe the Reaction:
        - You'll see the mixture instantly form a gel-like material — that's your Alien Goo!
    - Experiment:
        - Try changing the amount of sodium alginate solution you pour in and note any differences in texture and strength.
- Clean Up:
    - Dispose of gooey materials in the trash, not the sink. Rinse all containers and wash hands.

The Science Behind the Goo

- You just made a synthetic polymer — a long chain of repeating molecules connected together.
- The sodium alginate contains polymer chains from seaweed. When calcium chloride is added, the calcium ions (Ca^{2+}) link the chains together like “bridges” — a process called crosslinking.
- This turns the liquid alginate into a stretchy, squishy solid — a gel!
- This process is similar to how the Chemicrons stabilize their energy crystals: by controlling how molecules bond and form networks, they can trap and release energy safely.
- You can even find similar polymers in contact lenses, wound dressings, gummy candies, and bioplastics!

Analysis & Reflection Questions

- What two substances reacted to form the Alien Goo polymer?
- How did the amount of sodium alginate affect the final texture of your polymer?
- What kind of chemical process did you observe — physical change, chemical change, or both? Explain.
- How is this similar to what happens inside Chemicron’s energy crystals?
- What are some real-life uses of polymers on Earth?

Career Connection

Polymer science is everywhere!

- **Materials Engineers** design plastics, rubber, and gels for construction and technology.
- **Biomedical Scientists** create alginate-based gels for drug delivery and artificial organs.
- **Food Scientists** use calcium alginate to make edible films and shape foods like boba pearls!

In West Virginia, polymer chemistry is also used in manufacturing, environmental research, and plastics recycling — fields that rely on understanding how to control molecular reactions, just like you did today!

Mission Complete

Congratulations! You’ve successfully created a synthetic polymer and completed your mission to help the Chemicrons stabilize their energy systems. The knowledge you gained about chemical reactions, energy, and matter has made you an official Earth-Chemicron Science Ambassador!