Unit 3 Summary and Pacing Guide
Chemical Structures

Standard(s):

Standard CHEM.2.1 Analyze data to predict the type of bonding most likely to occur between two elements using the patterns of reactivity on the periodic table. Emphasize the types and strengths of attractions between charged particles in ionic, covalent, and metallic bonds. Examples could include the attraction between electrons on one atom and the nucleus of another atom in a covalent bond or between ions in an ionic compound. (PS1.A, PS2.B)

Standard CHEM.2.2 Plan and carry out an investigation to compare the properties of substances at the bulk scale and relate them to molecular structures. Emphasize using models to explain or describe the strength of electrical forces between particles. Examples of models could include Lewis dot structures or ball and stick models. Examples of particles could include ions, atoms, molecules, or networked materials (such as graphite). Examples of properties could include melting point and boiling point, vapor pressure, solubility, or surface tension. (PS1.A)

Standard CHEM.2.3 Engage in argument supported by evidence that the functions of natural and designed macromolecules are related to their chemical structures. Emphasize the roles of attractive forces between and within molecules. Examples could include non-covalent interactions between base pairs in DNA allowing it to be unzipped for replication, the network of atoms in a diamond conferring hardness, or the nonpolar nature of polyester (PET) making it quick-drying. (PS1.A)

Standard CHEM.2.4 Evaluate design solutions where synthetic chemistry was used to solve a problem (cause and effect). Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution. Emphasize the design of materials to control their properties through chemistry. Examples could include pharmaceuticals that target active sites, teflon to reduce friction on surfaces, or nanoparticles of zinc oxide to create transparent sunscreen. (PS1.A, ETS1.A, ETS1.B, ETS1.C)

Standard CHEM.3.8 Obtain, evaluate, and communicate information regarding the effects of designed chemicals in a complex real-world system. Emphasize the role of chemistry in solving problems, while acknowledging unintended consequences. Examples could include ozone depletion and restoration, DDT, development of medicines, the preservation of historical artifacts, or use of bisphenol-A in plastic manufacturing. (PS1.A)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Students plan and conduct scientific investigations in order to test, revise, or develop explanations. **Analyzing and Interpreting Data**	**PS1.A Structure and Properties of Matter** **PS2.B Types of Interactions** **ETS1.A Defining and Delimiting an Engineering Problem** **ETS1.B Developing Possible Solutions**	**Structure and Function** Students relate the shape and structure of an object or living thing to its properties and functions.

Students analyze various types of data in order to create valid interpretations or to assess claims/conclusions. **Designing Solutions** Students design solutions to problems using observations that are consistent with current evidence and scientific principles.	**ETS1.C Optimizing the Design Solution**	

Big Ideas:

- Attraction and repulsion of electric charges at the atomic scale explain the structure, properties, and transformations of matter and the contact forces between material objects.
- The periodic table's patterns are now recognized as related to the atom's outermost electron patterns, which play an important role in explaining chemical reactivity and bond formation.
- Electrical attractions and repulsions between charged particles (i.e., atomic nuclei and electrons) in matter explain the structure of atoms and the forces between atoms that cause them to form molecules (via chemical bonds).
- The varied properties (e.g., hardness, conductivity) of the materials one encounters, both natural and manufactured, can be understood in terms of the atomic and molecular constituents present and the forces within and between them.
- Different materials with different properties are suited to different uses. The ability to image and manipulate placement of individual atoms in tiny structures allows for the design of new types of materials with particular desired functionality (e.g., plastics, nanoparticles).

Preceding Grade Bands:	**Target Grade Bands:**	**Following Grade Bands:**
• Matter can be described and classified by its observable properties (e.g., visual, aural, textural), by its uses, and by whether it occurs naturally or is manufactured. Different properties are suited to different purposes. • Measurements of a variety of properties (e.g., hardness, reflectivity) can be used to identify particular materials. • Atoms form molecules that range in size from two to thousands of atoms. Pure substances are made from a single type of atom or molecule; each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.	• Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. • The repeating patterns of the periodic table reflect patterns of outer electron states. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.	

Essential Question:
How does the structure of a chemical determine how the chemical will function?

Learning Goals:

Students will be able to:

- **3A** Analyze data from the Periodic Table to determine if atoms are likely to form a bond and the type of bond likely to form.
- **3B** Plan an investigation to determine the properties of substances with different bonds and intermolecular forces.
- **3C** Use evidence to explain how the molecular structure of a natural or designed chemical determines the properties of that material.
- **3D** Research how a designed chemical had both positive and negative social, cultural, environmental and/or economic impacts.

Summative Assessment: Please complete this **SURVEY** to request access to the summative assessments for the JSD High School Science Exemplar Units

Proficiency Scale:

4 **Advanced**	**3** **Proficient**	**2** **Approaching Proficiency**	**1** **Beginning Proficiency**
I can: **Analyze data** from the Periodic Table to accurately predict the type of bond that will form between elements AND **Plan and carry out an investigation** to generate accurate data that can be used to determine the structure of a compound (types of bonds and intermolecular forces). AND **Design a solution** to a problem by using valid evidence and scientific reasoning to justify why a material would be best suited for a particular application	I can: **Analyze data** from the Periodic Table to accurately predict the type of bond that will form between elements AND **Plan and carry out an investigation** to generate accurate data that can be used to determine the structure of a compound (types of bonds and intermolecular forces). AND **Design a solution** to a problem by using valid evidence and scientific reasoning to justify why a material would be best suited for a particular application	I can: **Analyze data** from the Periodic Table to predict the type of bond that will form between elements AND **Plan and carry out an investigation** to generate data that can be used to determine the structure of a compound (types of bonds and/or intermolecular forces). AND **Design a solution** to a problem by using some evidence and scientific reasoning to justify why a material would be best suited for a particular application based on the chemical	I can: **Analyze data** to describe patterns in the periodic table AND/OR **Plan and carry out an investigation** to determine the properties of a compound. AND/OR **Design a solution** to a problem involving a chemical structure.

based on the chemical structure of the material. AND Critique and revise the solution of others by providing supporting or refuting data.	based on the chemical structure of the material.	structure of the material.	

Summative Assessment	At the end of this unit, students will complete the assessment: Please complete this **SURVEY** to request access to the summative assessments for the JSD High School Science Exemplar Units.

Unit 1 Pacing Guide - (70 minute class periods)

This should take approximately **8 class periods** on a **block schedule**.

Day 1	Explore: Electronegativity simulation Explain: Notes on bonding (3A)
Day 2	Different types of solids (3B)
Day 3	Covalent and ionic bonds (3B)
Day 4	Explore: IMF simulations, boiling point lab Explain: IMF notes (3B)
Day 5	Explore: Lewis Structure and 3D geometry Explain: Article and molecule shapes (3C)
Day 6	Elaborate: Designed chemical project (3D)
Day 7	Designed chemical project continued (3D)
Day 8	Assessment

Day 1

Teacher's Summary

Activity Type	Engage
Learning Goal	
Materials	Indestructible Coating (link) Model-making materials: plain paper, colored pencils, etc. Put the Essential Question on the board, or on a student sheet. Let them know that this question will be explained over the course of the unit, but they

	should try to answer it based on background knowledge and the phenomena video.
Activity Summary & Notes	Essential Question: How does the structure of a chemical determine how the chemical will function? Making Models -Prompt students to create models of their thinking. These should be pictures or diagrams with explanations of their thinking. Generating Questions Have students generate questions individually, in groups, or both. Possible questions might include: What makes chemicals function the way they do? Why are some chemicals indestructible and some aren't? What properties does this substance have? How does the chemical structure of this substance give it these properties?
Connection to Anchor Phenomenon	
Formative Assessment	Models and student-generated questions

Teacher's Summary	
Activity Type	Explore and Explain
Learning Goal	Analyze data from the Periodic Table to determine if atoms are likely to form a bond and the type of bond likely to form
Materials	Electronegativity PHET simulation (link) Notes on bonding (link) Student practice (link) Crash Course chemical bonds (link) Student bond with a friend activity (link)
Activity Summary & Notes	Starter: Why does the H and O bond together to form water? Why do Na and Cl bond together to form salt? Explore: Ionic Bond introduction Review electronegativity Students try simulation Explain: Notes on ionic bonds Student practice simulation Explore: Covalent Bonds introduction Review or introduce octet rule Discussion: why elements might share electrons Explain: Notes on covalent bonds

	Student practice simulation Crash Course video for summary Student bond with a friend activity
Connection to Anchor Phenomenon	Discussion: Hypothesize how compounds with different types of bonds might have different characteristics.
Formative Assessment	Online quiz that will provide data (link)

Days 2, 3, and 4

Ionic/Covalent/Metallic

Teacher's Summary	
Activity Type	Explore
Learning Goal	Plan an investigation to determine the properties of substances with different bonds and intermolecular forces.
Materials	Different Types of Solids: (link) Key: (link) Lab substances tested: sucrose, ice melt (calcium chloride), table salt, zinc, wax, aluminum foil
Activity Summary & Notes	Students will explore the different types of solids and classify them as ionic, covalent, or metallic based on their properties.
Connection to Anchor Phenomenon	Based on the properties of Line-X what type of bond/ intermolecular forces do you think it is/has?
Formative Assessment	Students do the lab and answer the follow up questions.

Teacher's Summary	
Activity Type	Explain
Learning Goal	Plan an investigation to determine the properties of substances with different bonds and intermolecular forces.
Materials	Crash Course chemical bonds (link) Covalent and Ionic bond slides (link) Metallic Bonding (link) Bond Character Slides (link)
Activity Summary & Notes	Follow up on Different Types of Solids lab from the explore portion.
Connection to Anchor Phenomenon	CER: How could understanding ionic and covalent bonding help in creating materials or products that can be used to solve problems?
Formative Assessment	1. Revised Models 2. CER Paragraph 3. Student Discussions 4. Student answers to Questions 5. Quizzes

IMFs

Teacher's Summary	
Activity Type	Explore

Learning Goal	Plan an investigation to determine the properties of substances with different bonds and intermolecular forces.
Materials	Intermolecular Forces Simulation (link) Answer Key (link) Boiling point lab (link) use water, ethanol, hexane Answer Key (link)
Activity Summary & Notes	Students will first explore the online simulation, then complete the boiling point lab.
Connection to Anchor Phenomenon	How could understanding ionic and covalent bonding help in creating materials or products that can be used to solve problems?
Formative Assessment	Students do the simulation and lab and answer the follow up questions.

Teacher's Summary	
Activity Type	Explain
Learning Goal	Plan an investigation to determine the properties of substances with different bonds and intermolecular forces.
Materials	Explanation of IMFs (link) Crash Course chemical bonds (link) Covalent and Ionic bond slides (link)
Activity Summary & Notes	Follow up of the explore lab: Boiling Point lab
Connection to Anchor Phenomenon	How could understanding intermolecular forces help in creating materials or products that can be used to solve problems?
Formative Assessment	Intermolecular forces quiz (link) IMF follow up (link) answer key (link)

Day 5

Unit 3: Chemical Structures

Teacher's Summary	
Activity Type	Explore
Learning Goal	Use evidence to explain how the molecular structure of a natural or designed chemical determines the properties of that material.
Materials	Student sheet (link) Computers or references Model Kits (optional)
Activity Summary & Notes	If you have taught your students to draw lewis structures they can complete the worksheet that way. If not, the phet simulation (link) on shapes can help students complete the lewis structures for the assignment. Students could also build the molecules using a model kit.
Connection to Anchor Phenomenon	Why do different chemicals have different properties? How can these different properties be used to create new materials?
Formative Assessment	Have students predict which would have a higher boiling point N_2 or CO and explain why.

Teacher's Summary	
Activity Type	Explain
Learning Goal	Use evidence to explain how the molecular structure of a natural or designed chemical determines the properties of that material.
Materials	Article (link)
Activity Summary & Notes	Use the article to talk with students about how the shape of a molecule will change the boiling point and other properties of a substance.
Connection to Anchor Phenomenon	How does the shape of a molecule influence the characteristics of the substance that it makes up? How would this information influence how products are created?
Formative Assessment	Read the article on the allotropes of Carbon. Explain why different structures create different properties. (link)

Days 6 and 7

Teacher's Summary	
Activity Type	Explore/Explain (Should/could be elaborate?)
Learning Goal	Research how a designed chemical had both positive and negative social, cultural, environmental and/or economic impacts.
Materials	Students will need access to the internet to research Designed chemicals research project (explore/explain)
Activity Summary & Notes	Designed Chemicals Research (link) Links to get students started (link) Can a spider stick to teflon? Video (link) Teflon Video (link) Reactions the changed the world (link)
Connection to Anchor Phenomenon	What are some of the properties of synthetic materials? What properties are unique to synthetic materials?
Formative Assessment	Designed chemicals research project (explore/explain) Exit Tickets/Starters What is 1 synthetic chemical you use on a regular basis? Possible answers- artificial sweeteners, medicines, beauty products. CER paragraph that answers the question: How have designed chemicals helped and harmed us?