**NACA UbD Unit Template**

[**Rob Unit 1 Feedback Form**](https://docs.google.com/forms/d/17qqCLnpNN-N1QI7VOwaw2CFAFyY2u0K9zk4Ju-isGWc/viewform?usp=send_form)

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| Designer: Rob Salazar | Unit #: 1 | Calendar Window: Weeks 3-9: 8/29-10/13 (33 days) |

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| Stage 1 - Desired Results |
| Unit Big Idea:  |
| Meaning (EQs and EUs) |
| Unit EQs: * What can we learn about the unseen properties of materials by studying the properties we can observe?
 | Unit EUs: * The properties of natural and designed objects and systems can be inferred from the molecular substructures of its various materials.
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| Outcomes (Knowledge and Skills) |
| Unity Knowledge Outcomes: Lesson 1* Attraction and repulsion between electric charges at the molecular scale explain the structure, properties, and transformations of matter

Lesson 2* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between molecules..

Lesson 3* Water’s ability to dissolve and transport materials, and lower the viscosities and melting points of rocks
 | Unit Skills Outcomes: Lesson 1Lesson 2Lesson 3Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidenceIn the design of investigations:* decide on types, how much, and accuracy of data needed to produce reliable measurements
* consider limitations on the precision of the data (e.g., number of trials, cost, risk, time)
* refine the design accordingly
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| Stage 2 - Assessment Evidence |
| **Transfer Statement**: I want my students to learn \_\_\_\_\_\_\_\_\_\_ so that in the long-run, on their own, they will be able to \_\_\_\_\_\_\_\_\_\_\_. (A transfer statement is the foundation of your unit summative assessment, described below.)* I want my students to learn to plan and conduct investigations so that in the long-run, on their own, they will be able to describe a phenomenon, or to test a theory or model for how the world works.
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| **Summative Assessment Rubric**

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| **Rubric Criteria**  |
| 1 Identifying the phenomenon to be investigated* a Students describe\* the phenomenon under investigation, which includes the following ideas:
	+ the relationship between the measurable properties (solubility) of a substance and the strength of the electrical forces between the particles of the substance.
	+ a connection between the properties of water and its effects on Earth materials and surface processes.
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| 2 Identifying the evidence to answer this question* a Students develop an investigation plan and describe\* the data that will be collected and the evidence to be derived from the data, including
	+ bulk properties of a substance (solubility)) that would allow inferences to be made about the strength of electrical forces between particles.
	+ Properties of water, including:
		- c) The polar nature of the water molecule due to its molecular structure.
	+ iv. Chemical effects of water on Earth materials that can be used to infer the effect of water on Earth’s surface processes. Examples can include:
		- a) The solubility of different materials in water, which can be used to infer chemical weathering and recrystallization;
* b Students describe\* why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including the following descriptions\*:
	+ i. The spacing of the particles of the chosen substances can change as a result of the experimental procedure even if the identity of the particles does not change (e.g., when water is boiled the molecules are still present but further apart).
	+ ii. Thermal (kinetic) energy has an effect on the ability of the electrical attraction between particles to keep the particles close together. Thus, as more energy is added to the system, the forces of attraction between the particles can no longer keep the particles close together.
	+ iii. The patterns of interactions between particles at the molecular scale are reflected in the patterns of behavior at the macroscopic scale.
	+ iv. Together, patterns observed at multiple scales can provide evidence of the causal relationships between the strength of the electrical forces between particles and the structure of substances at the bulk scale.
* b In their investigation plan, students describe\* how the data collected will be relevant to determining the effect of water on Earth materials and surface processes.
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| 3 Planning for the investigation* a In the investigation plan, students include:
	+ i. A rationale for the choice of substances to compare and a description\* of the composition of those substances at the atomic molecular scale.
	+ ii. A description\* of how the data will be collected, the number of trials, and the experimental set up and equipment required.
* a In their investigation plan, students include a means to indicate or measure the predicted effect of water on Earth’s materials or surface processes. Examples include:
	+ v. The role of the polarity of water in facilitating the dissolution of Earth materials;
* b Students describe\* how the data will be collected, the number of trials, the experimental set up, and the equipment required.
* b In the plan, students state whether the investigation will be conducted individually or collaboratively.
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| 4 Collecting the data* a Students collect and record data — quantitative and/or qualitative — on the bulk properties of substances.
* a Students collect and record measurements or indications of the predicted effect of a property of water on Earth’s materials or surface.
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| 5 Refining the design* a Students evaluate their investigation, including evaluation of:
	+ i. Assessing the accuracy and precision of the data collected, as well as the limitations of the investigation; and
	+ ii. The ability of the data to provide the evidence required.
* b Students evaluate whether the data can be used to infer the effect of water on processes in the natural world.
* b If necessary, students refine the plan to produce more accurate, precise, and useful data.
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 | **Summative Assessment**  |
| Unit Assessment Title and DescriptionInvestigation: Mineral Properties: Solubility in WaterGoal: Plan and conduct an investigation Role: Soil ScientistAudience: Community farmersSituation: Local farmers are considering adding mineral supplements to the soil because they are considered that over-watering is washing away the indigenous minerals. Product, Performance, and Purpose: Mineral solubility report and recommendations on whether mineral supplementation is recommended. |
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| Stage 3 - Plan for Learning |

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|  | ***Lesson Big Idea/Title and Topical EQ*** | Activities to Support the Lesson (feel free to link in electronic resources) | Unit Modifications (aligned to IEPs) | Formative Assessment of the Lesson |
| Lesson 1 | Big Idea/Title: Exploring MaterialsEQ:  | * Material sort and classification
* Presenting the Issue: Mineral Depletion in the Soil OR Soil Contamination
 | Scaffolded learning of investigation planning skillsGraphic organizer for [investigation pre-plan](https://docs.google.com/a/nacaschool.org/document/d/1wzCssJuhzJparBr7PnGybsuqs3v-_569NoAaQrzdvpM/edit?usp=sharing) and investigation plan | Descriptions of how properties used for classification |
| Lesson 2 | Big Idea/Title: ReviewEQ:  | * Review: Solids, Liquids, & Gases
* Review: Changes in State
* Review: Atoms & Molecules
* Review: Electrostatic Forces
* Review: Water Cycle
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| Lesson 3 | Big Idea/Title: Solid StructuresEQ: How to particles interact to form solid structures? | * Crystal Formation Explorations
* Crystal Structure Building
* Modeling: Crystal Structures
* Investigation: Testing Crystal Structure Theories
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| Lesson 4 | Big Idea/Title: Water’s Unique StructureEQ:  | * Water Crystal Formation
* Water Molecular Structure
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| Lesson 5 | Big Idea/Title: EQ:  |  |  |
| Lesson 6 | Big Idea/Title: Mineral Density InvestigationEQ:  | * Material Density Exploration
* Training: Measuring Volume (lxwxh method)
* Training: Measuring Volume (displacement method)
* Training: Measuring Mass (digital scale)
* Training: Calculating Density
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| Lesson 710/3-10/7 | Big Idea/Title: Salt Solubility vs. Temperature InvestigationEQ: How does the solubility of salt in water change with temperature? | * Investigation Overview
* Training: Solubility Testing (1 day)
* Team Pre-Planning (given ) (1 class)
* Team Planning (1 class)
* Team Experiment (1 class)
* Team Analysis Writing (1 class)
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| Lesson 810/10-10/134 days | Big Idea/Title: Mineral Solubility InvestigationEQ: How are mineral solubility in water and molecular structure related? | * Team Pre-Planning (1 class)
* Team Planning (1 class)
* Team Experiment (1 class)
* Team Analysis Writing (1 class)
 | [Investigation Pre-Plan](https://docs.google.com/a/nacaschool.org/document/d/1wzCssJuhzJparBr7PnGybsuqs3v-_569NoAaQrzdvpM/edit?usp=sharing)Investigation PlanInvestigation Conduct NotesInvestigation Report |
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|  Sorts natural and manufactured materials by weight | Classifies objects as liquids |
|  Explains that the amount of water in an open container will decrease because it goes into the air, but the amount of water in a closed container will remain the same Classifies materials according to their magnetism Recognizes that physical properties can be measured using tools Identifies tools used to measure length Recognizes that temperature is measured in degrees | Gives examples of gases Classifies objects as liquids Classifies objects as gases |
|  Explains that all matter is made of tiny particles called atoms Describes the shape of crystals Generalizes that all physical objects are made of matter Infers that the more matter in an object, the greater the mass of that object Classifies materials according to their magnetism Determines the volume of an object using the displacement method Recognizes that adding an object to a container of water will raise the water level within the container Relates density to the ability to sink or float Infers the mass of objects with identical volume, based on their buoyancy Describes ways to separate mixtures | Gives examples of solids Names the three different states of matter Describes basic properties of solids, liquids, and gases Classifies objects as solids, liquids, or gases Describes the process of evaporation Describes the process of melting Gives examples of forms of matter which have undergone a change from liquid to solid form |
|  Describes applications of differential expansion of metals Explains that all matter is made of tiny particles called atoms Defines matter as anything that takes up space and has mass Recognizes that a magnifier allows one to see details that are not otherwise visible Compares objects in terms of mass Determines the volume of an object using the displacement method Estimates length of common objects using metric units Compares objects in terms of density Predicts how changes in temperature will affect the density of an object Defines density Recognizes that when one divides mass by volume, one is calculating density Infers that an object is more dense than an object with the same volume, based on differences in mass (as measured by a double-pan balance) Defines mixture | Names the three different states of matter Describes the process of evaporation Recognizes that evaporation changes a liquid to a gas Gives examples of evaporation Relates surface area to evaporation Describes the process of evaporation in terms of the changes to the molecules involved Describes the process of freezingExplains that heating or cooling materials can cause their state to change Explains that matter can change from one physical state to another Explains that as heat is applied to a substance, the particles making up the substance increase their motion |
|  Explains that all matter is made of tiny particles called atoms Identifies the tools and units used to measure weight Recognizes that volume is measured in milliliters or liters Measures the volume of liquid in a graduated cylinder Understands that in the SI system, length is measured in meters, kilometers, centimeters Estimates length of common objects using metric units Recognizes that base unit for length in the SI system is the meter Predicts how changes in temperature will affect the density of an object Predicts how objects of differing density will behave when combined Explains that objects of differing density will layer when combined Describes characteristics of physical change Describes properties of solutions Describes properties of mixtures Gives examples of mixtures Understands that evaporation can be used to separate solutions | Describes properties of gasesClassifies unknown substances as liquids, based on their propertiesRecognizes properties of gasesDescribes the process of condensationDescribes the process of freezing in terms of phase changesExplains that removing heat will cause a substance to change from gas to liquid or from liquid to solid formGives examples of substances which have undergone a change of stateDescribes the relative freedom of motion of particles in solids, liquids, and gases Explains that as heat is applied to a substance, the particles making up the substance move farther apart Recognizes that as heat is applied to a solid, its molecules move farther and farther apart Interprets diagrams showing the relative spacing and movement of matter in different phasesDefines melting point Defines boiling point |
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| **Standards** |
| **NGSS - Performance Expectations** |
| * HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult’s law calculations of vapor pressure.]
* HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]
* MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth’s materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]
* MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth’s surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]
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| **NGSS - Science and Engineering Practices** |
| **Planning and Carrying Out Investigations**Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.* Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3), (HS-ESS2-5)
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| **NGSS - Disciplinary Core Ideas** |
| **PS1.A: Structure and Properties of Matter*** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6)

**PS2.B: Types of Interactions*** 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. (HS-PS2-6),(secondary to HS-PS1-1),(secondary to HS-PS1-3)

**ESS2.C: The Roles of Water in Earth's Surface Processes*** The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics. These properties include water’s exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

**FOUNDATIONAL****PS1.A: Structure and Properties of Matter (HS-PS1-1),(HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-7),(HS-PS2-6),(HS-ESS2-5)*** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
* Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3)
* Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
* In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
* Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)
* The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)

**PS2.B: Types of Interactions (HS-PS1-3),(HS-PS1-4),(HS-PS2-6)*** Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
* Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

**ESS2.C: The Roles of Water in Earth's Surface Processes (HS-PS1-2),(HS-PS1-3)*** Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
* Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations. (MS-ESS2-2)
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| **NGSS - Crosscutting Concepts** |
| **Patterns*** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1),(HS-PS1-2),(HS-PS1-3)

**Structure and Function*** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)
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| **CCSS - ELA/Literacy** |
| * RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS2-1),(HS-PS2-6),(HS-ESS3-2),(HS-ESS3-4),
* WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3), (HS-ESS2-5)
* WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
* WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
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| **CCSS - Mathematics** |
| * HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-7),(HS-PS2-6),(HS-ESS3-4)
* HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-7),(HS-PS2-6),(HS-ESS2-5),(HS-ESS3-4)
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| **Indigenous Standards** |
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