Unit 3: What powers a hurricane?

Investigation 1: Why is water special?				
Investigation 1: Why is water special? ***NGSS PE:*** 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.				
Activity	**What did we observe?**	**What did we figure out?**	**Model/Explanation**	**NGSS Dimensions**
1: How re water and other liquids similar and different?	• Compressing sealed syringes filled with water and with air • Bending different solvents with charged rod demo	Different liquids interact differently with the charged rod. Water bends towards the charged rod, hexane does not	Start thinking about how to explain interactions between charged rod and different liquids	<u>DCI</u>: *Structure and properties of matter:* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. <u>CCC</u>: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize that classifications or explanations used at one scale may not be useful or may need revision using a different scale, thus requiring improved investigations and experiments. <u>SEP</u>: *Asking questions and defining problems:* Ask questions ○ that arise from careful observations of phenomena, or unexpected results, to clarify and/or seek additional information and relationships. ○ to clarify and refine a model, an explanation, or an engineering problem. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
2: Why is water different from other liquids?	• Observe how pouring honey is different from pouring water • Timing evaporation of water vs acetone	Polar substances are more viscous, have higher boiling points and take longer to	• Start developing model of polar and nonpolar interactions.	<u>DCI:</u> *Types and properties of interactions:* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. <u>CCC</u>: *Patterns:* Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in

	• Comparing boiling point and viscosities of polar and nonpolar liquids	evaporate than nonpolar ones		supporting their explanations of phenomena. They recognize that classifications or explanations used at one scale may not be useful or may need revision using a different scale, thus requiring improved investigations and experiments. <u>SEP</u>: *Analyzing and interpreting data:* • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
3: Is oxygen really that special?	• Partial charges simulation • Electronegativity and larger molecules simulation	Electronegativity is ability of atoms of various elements to attract electrons. Atoms with higher electronegativity have higher affinity for electrons. In a molecule, atoms with higher electronegativity will have more electron density around them, creating charge separation within the molecule. Permanent charge separation leads to molecules being polar. If atoms of similar electronegativity values form molecules, they are nonpolar since there is no charge separation within those molecules.	Include ideas of electronegativity, polarity and partial charges to the model of electrostatic interactions.	<u>DCI</u>: *Types and properties of matter:* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. <u>CCC</u>: Students suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They recognize changes in systems may have various causes that may not have equal effects. <u>SEPs</u>: *Obtaining, evaluating, and communicating ideas:* Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).
4: How does electron distribution impact our observations?	• Pulling apart molecules simulation • Atoms forming a nonpolar molecule simulation • Nonpolar molecules interacting simulation • Polar molecules boiling simulation	Polar molecules form strong interactions that form via permanent partial charges and therefore are harder to overcome, causing polar molecules to have higher boiling points	Given an atom's electronegativity, students will make and support claims about the polarity of molecules. Predict how electron distribution within molecules affects the way molecules interact with each other.	<u>DCI:</u> *Structure and properties of matter:* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. <u>CCC</u>*: Scale, proportion, and quantity:* Students understand that the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize that patterns observable at one scale may not be observable or exist at other scales and that some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.

			Predict and explain the effect that differences in polarity of molecules of a substance have on observable phenomena.	SEPs: *Developing and using models:* Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Investigation 2: What happens to the energy of water molecules during hurricanes?

NGSS PEs:

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

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.

Activity	What did we observe?	What did we figure out?	Model/Explanation	NGSS Dimensions
1: What does boiling do to water molecules?	• Testing water experiment: water vapor consists of water molecules • Compare what happens when a balloon filled with water vapor is touched by a flame to what happens when a balloon filled with a mixture of hydrogen and oxygen is touched by a flame • Balloon water vapor demo	Water molecules remain intact during boiling.	○ During boiling, water molecules are converted to gas phase. The bonds in water molecules don't break during boiling.	DCI: *Structure and properties of matter:* The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. CCC: *Scale, proportion, and quantity:* Students understand that the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize that patterns observable at one scale may not be observed or exist at other scales and that some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. SEP *Scale, proportion, and quantity:* Students understand that the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize that patterns observable at one scale may not be observed or exist at other scales and that some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
2: How hot can water get?	• Boiling water activity • Breaking molecules vs pulling molecules apart simulation	Water does not get hotter no matter how long you boil it. Temperature stays constant during boiling because the energy supplied goes to increasing potential energy of the system (aka increasing the	The energy supplied by the heating source does not go to increasing molecular speed, which is why temperature is constant during boiling. Instead, the intermolecular interactions between water molecules are	DCI: *Definitions of energy:* • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles).

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		distance between water molecules as the transition to gas phase).	overcome during boiling and the distance between the molecules increases when they are in gas phase.	<u>CCC</u>: *Systems and system models:* Students investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. <u>SEP</u> *Analyzing and interpreting data:* • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
3: How does energy change when evaporation is reversed?	• Energy changes when pulling apart molecules simulation	• Energy is released when molecules condense to liquid phase and form intermolecular interactions. The more molecules condense, the larger the amount of energy released.	Intramolecular interactions (such as the formation of chemical bonds) and intermolecular interactions (such as the formation of hydrogen bonds) involve similar kinds of electrostatic interactions. However, the former involves interactions between full charges, and the latter involve interactions between partial charges. Therefore, the magnitude of each type of interaction is different; the interaction is stronger for chemical bonds and weaker for intermolecular interactions.	<u>DCI</u>: *Definitions of energy:* • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). <u>CCC</u>: *Energy and matter:* Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. <u>SEP</u>: *Developing and using models:* • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.