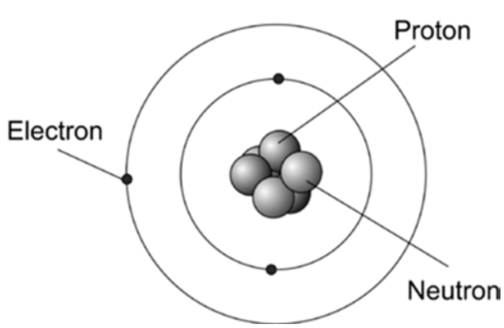
Getting to the Core

Chemistry Unit of Study

TEACHER EDITION

Structure and Properties of Matter



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Santa Ana Unified School District Common Core Unit Planner-Literacy

Unit Title:	**Structure and Properties of Matter**	
Grade Level/Course:	**High School Chemistry**	**Time Frame: 15 days**
Big Idea *(Enduring Understandings)*:	**Big Idea:** Forces attract, hold together, or repel. *Enduring Understandings:* Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles.	
Essential Questions:	1. How do intermolecular forces between particles explain the bulk properties of substances? 2. How is heat related to temperature and phase changes and the relevance of a heating curve? 3. What is the relationship between intramolecular forces (bonding) and intermolecular forces? 4. How does a change in temperature correlate with microscopic changes of the kinetic energy and the strength of the intermolecular force between water molecules, and to the overall macroscopic observation of phase changes? 5. How does the addition of a solute affect the intermolecular forces between water molecules and consequently, the freezing point of a pure solvent?	

Instructional Activities: Activities/Tasks

Lesson 1: Day 1 & 2: Surface Tension

Complex Text: Penny Drop Lab, Penny Drop Lab Re-design

- **Read 1** — Activity: Extended Anticipatory Guide
- **Read 2** — Activity: Penny Drop Lab and PowerPoint
- **Read 3** — Activity: Independent procedure writing

Lesson 2: Day 3 & 4: States of Matter

Complex Text: Zooming in on states of matter, Tree map, Extended Anticipatory Guide

- **Read 1** — Activity: Extended Anticipatory Guide 3 states of matter
- **Read 2** — Activity: Unencumbered (zooming in on states of matter)
- **Read 3** — Activity: Tree Map creation/oral presentation 3 states of matter

Lesson 3: Day 5 & 6: Water Related Articles

Complex Text: The Hidden Force in Water, What's Taking So Long?, Mr. Freeze-What phase are you?, What-er You Going To Do About Water Conservation

- **Read 1** — Activity: Water-Related Videos/ Quickwrite
- **Read 2** — Activity: Unencumbered Read of Water-Related Articles, Jigsaw Matrix, Clarifying Bookmarks
- **Read 3** — Activity: Base Group Discussion of Theme of Article, Class Discussion with student share out of Theme of Article

Lesson 4: Day 7 & 8: Heating Curve

Complex Text: Heating Curve of Water Lab

- **Read 1** — Activity: Unencumbered read of Heating Curve of Water
- **Read 2** — Activity: Orally present information in lab groups
- **Read 3** — Activity: Summarization of lab results

Lesson 5: Day 9 & 10: Intermolecular Forces of Attraction

Complex Text: Who Is the Strongest? Intermolecular Forces of Attraction, Card Sort of Compounds & Intermolecular Forces of Attraction

- **Read 1** — Activity: Analyze Card Sort of Compounds and IMFs
- **Read 2** — Activity: Unencumbered read of Who Is the Strongest?
- **Read 3** — Activity: Summary of IMFs in Pyramid

Lesson 6: Day 11 & 12: Let's Chill: Colligative Properties

Complex Text: Let's Chill Lab, Let's Chill Article/Discussion

- **Read 1** — Activity: Let's Chill Lab, Hypothesis, Data Collection, Data Analysis.
- **Read 2** — Activity: Let's Chill Lab Article – class read, unencumbered read
- **Read 3** — Activity: Lab team responds to Discussion Questions, Clarifying Bookmark

Lesson 7: Day 13: Review Activities

Complex Text: Quick Write Prompt, Student Resource Handbook, Extended Anticipatory Guide

- **Read 1** — Activity: Quickwrite – Water – What I Now Know, Pair-Share, Add Two New to List,
- **Read 2** — Activity: Summary of Most Important Water-Related Concept
- **Read 3** — Activity: Extended Anticipatory Guide (revisited to answer with evidence)

Lesson 8: Day 14 & 15: Assessments

Complex Text: Student Resource Handbook (as review tool), Boiling Point Elevation

- **Read 1** — Activity: Team Assessment
- **Read 2** — Activity: Individual Assessment
- **Read 3** — Activity:

21st Century Skills:	**Learning and Innovation:** ☒ Critical Thinking & Problem Solving ☒ Communication & Collaboration ☒ Creativity & Innovation **Information, Media and Technology:** ☒ Information Literacy ☒ Media Literacy ☒ Information, Communications & Technology Literacy

<table>
<tr><td rowspan="1">Essential Academic Language:</td><td>Tier II: (academic vocabulary other than chemistry)

Lesson 1: systematic

Lesson 2: Melting, freezing, boiling, condensing, states of matter, definite volume, indefinite volume, compressible

Lesson 3: Waste water, kinetic energy, transformation, density

Lesson 4: Bunsen burner

Lesson 5: Substance,

Lesson 6: Hypothesis, microscopic changes, macroscopic changes,

Lesson 7:

Lesson 8</td><td>Tier III: (Chemistry Specific)

Lesson 1: Cohesion, surface tension

Lesson 2: Fusion, solidification, evaporation, Non-Newtonian, Physical Change, plasma

Lesson 3: Evaporation, Condensation, Intermolecular forces of attraction, Intramolecular forces of attraction, vapor pressure, boiling point, heating curve, hydrogen bonds, covalent bond, ionic bond, phase

Lesson 4: Mixed phases, heating curve

Lesson 5: molar mass, Lewis-Dot structure, polar molecule, non-polar molecule, London-dispersion force,

Lesson 6: Freezing point, solute, solvent, colligative properties, phase changes, lowering, depression, ice/salt/water bath, freezing point-depression, solution

Lesson 7: heat, Phase change versus Temperature change

Lesson 8: boiling point-elevation</td></tr>
<tr><td colspan="2">What pre-assessment will be given?
Day 1 Extended Anticipatory Guide on three states of matter and intermolecular forces of attraction</td><td>How will pre-assessment guide instruction?
Teacher will use student answers and drawings to see if there are areas that are already understood or if there are areas which require special attention.</td></tr>
<tr><td colspan="3">End of Unit Performance Task:
Plan and conduct an investigation to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.</td></tr>
<tr><td colspan="2">Standards</td><td>Assessment of Standards (include formative and summative)</td></tr>
</table>

Content Standard(s): 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 include the melting point and boiling point, vapor pressure, and surface tension.] **Planning and Carrying Out Investigations** HS-PS1-3 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.	**Formative:** • Extended Anticipatory Guide Day 1/Day 13 (Lesson 1) • Procedure created for Penny Drop Lab Re-Design (Lesson 1) • Teacher observation of student discussion after viewing "What is it? A non-Newtonian substance" (Lesson 2) • Oral presentation/skits of different states of matter (Lesson 2) • Jigsaw group discussion of water-related articles (Lesson 3) • Group discussion of Heating Curve of Water lab and analysis questions (Lesson 4) • Discussion during Card Sort Activity (Lesson 5) • Sorting of IMF to create Pyramid of IMF (Lesson 5) • Class discussion of Let's Chill Lab Animation (Lesson 6) • Quick Write: Water-What I Now Know (Lesson 7) • Extended Anticipatory Guide Day1/Day 13 (Lesson 7) **Summative:** Day 1/13 Extended Anticipatory Guide (lesson 7) Team assessment (Lesson 8) Individual assessment (Lesson 8)	
Common Core Learning Standards Taught and Assessed (*include one or more standards for one or more of the areas below. Please write out the complete text for the standard(s) you include.)*	**What assessment(s) will be utilized for this unit?** *(include the types of both formative assessments (***F***) that will be used throughout the unit to inform your instruction and the summative assessments (***S***) that will demonstrate student mastery of the standards.)*	**What does the assessment tell us?**
Bundled Reading Informational Text Standard(s): 1. Cite specific textual evidence to support analysis of science and textual texts. 2. Determine the central ideas or conclusions of a text and summarize or paraphrase complex concepts, processes, or information in simple but still accurate terms. 3. Follow precisely a complex multistep procedure. 4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases. 5. Analyze how the text structures information or ideas and demonstrate understanding of the information or ideas.	**Lesson 2, 3, 5 (F)** Unencumbered reading of articles and associated analysis questions and matrix discussions.	**Lesson 2, 3, 5 (F)** This informs on students comprehension of complex text with significant introduction of unfamiliar academic vocabulary. Guides pacing of subsequent

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. 7. Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem. 8. Evaluate the hypotheses, data, analysis, and conclusions to verify the data and corroborate or challenge conclusions with other sources of information. 9. Synthesize information from a range of sources and resolve conflicting information when possible.	**Lesson 8: (S)** Team Assessment Individual Assessment	lessons. **Lesson 8: (S)** Demonstrates student's ability to think through given information and apply it to a similar, but new situation in a real-world situation
Common Core Learning Standards Taught and Assessed (*include one or more standards for one or more of the areas below. Please write out the complete text for the standard(s) you include.)*	**What assessment(s) will be utilized for this unit?** *(include the types of both formative assessments (**F**) that will be used throughout the unit to inform your instruction and the summative assessments (**S**) that will demonstrate student mastery of the standards.)*	**What does the assessment tell us?**
Bundled Writing Standard(s): 1. Write arguments focused on discipline-specific content. 2. Write informative/explanatory texts including scientific procedures/experiments, or technical processes. 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience. 7. Conduct short as well as more sustained research projects to answer a 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. 8. Gather relevant information; assess the strengths and limitations of each source; integrate information to maintain the flow of ideas. 9. Draw evidence from informational texts to support analysis,	**Lesson 1, 4, 6 (S)** These three lessons are lab **Lesson 7 &8 (F)** Quick Write (most important fact about water statement) Team Assessment and Individual Assessment	**Lesson 1, 4, 6 (S)** Comparing the lab conclusions produced in these three labs should demonstrate an increased integration of material learned in the lessons. An opportunity to ensure information is applied correctly and no misconceptions exist. **Lesson 7 &8 (F)** Students' ability to justify their answers using text, observations, diagrams, and data demonstrates ability to apply and create

reflection, and research.		rather than simply remember and regurgitate facts.
Bundled Speaking and Listening Standard(s): 1. Initiate and participate effectively in a range of collaborative discussions with diverse partners on grades 10-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. 2. Integrate multiple sources of information and evaluating the credibility and accuracy of each source. 3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. 4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective. 5. Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence to add interest. 6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.	**Lesson 1(s)** Protocol re-design **Lesson 3 (s)** Jigsaw and matrix completion **Lesson 5 (s)** Collaborative Annotation Discussion/Chart **Lesson 6 (s)** Let's Chill Lab discussion **Lesson 7 (F)**	**Lesson 1(s)** Discussion displays students' thought process and ability to express opinion, idea, or confusion **Lesson 3 (s)** Students must tie together multiple articles into a coherent web of knowledge. Students must learn by listening to each other and asking questions. **Lesson 5 (s)** Discussion displays students' thought process and ability to express opinion, idea, or confusion **Lesson 6 (s)** Discussion displays students' thought process and ability to express opinion, idea, or confusion. Students must also draw on knowledge gained from the video animation and lab observations. **Lesson 7 (F)**

	Team Assessment	Small group discussion and analysis of test questions displays each student’s mastery of the information and ability to apply it to a new situation.
Bundled Language Standard(s): 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. 3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening. 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies. 6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.	**Lesson 1, 4, 6 (S)** These three lessons are labs **Lesson 2 (s)** Creating of a skit **Lesson 8 (F)** Assessments	**Lesson 1, 4, 6 (S)** Conclusion statements and analysis questions demonstrates students command of the language and new vocabulary learned in this unit. **Lesson 2 (s)** Demonstrates students’ ability to take articles and translate it into action. **Lesson 8 (F)** To justify short answer questions, students must be able to use appropriate vocabulary and language conventions to express their ideas.
Resources/ Materials:	**<u>Complex Texts to be used</u>** **Informational Text(s) Titles:** Who is the Strongest? Intermolecular Forces of Attraction; The Hidden Forces in Water, What’s Taking so Long; Mr. Freeze-What Phase are You?; What-er You going to Do?; Zooming in on States of Matter; Heating Curve of Water Lab; Card Sort of Compounds & IMFs; The Power of Salt. **Literature Titles: N/A**	

<table>
<tr><td></td><td colspan="2">Primary Sources:

Media/Technology: Video clips from Science 360, MythBusters, National Geographic Wild

Other Materials: See individual activities for specific details. Beyond basic lab equipment, all supplies can be obtained from the dollar store. Ice can be made in the freezer.</td></tr>
<tr><td>Interdisciplinary Connections:</td><td colspan="2">Cite several interdisciplinary or cross-content connections made in this unit of study (i.e. math, social studies, art, etc.)
Science and Engineering Practices
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.
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.

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-PS1-3)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3)</td></tr>
<tr><td>Differentiated Instruction:</td><td>Based on desired student outcomes, what instructional variation will be used to address the needs of English Learners by language proficiency level?

• Pair share
• Multiple opportunities to speak and listen
• Provide students with a copy of the questions to refer to and take home
• Cooperative Groups based on skills or language ability
• Clarifying Bookmarks
• Language Support for Agreeing and for Disagreeing
• Multiple opportunities to read, write, speak, and listen
• Complex lab procedure to follow in groups
• Students can read the article aloud, in pairs, or solo.
• Articles differentiated by lexile level for far below basic to advanced readers.</td><td>Based on desired student outcomes, what instructional variation will be used to address the needs of students with special needs, including gifted and talented?

Special Needs:
• Pair share
• Provide students with a copy of the questions to refer to and take home
• Provide audio versions of the articles (either record the article or someone reads the article to the group)
• Provide simplified lab procedure
• Students can read the article aloud, in pairs, or solo.
• Adjusted-level reading article
• Clarifying Bookmarks

GATE:</td></tr>
</table>

		• Students can make Oobleck and design an experiment to demonstrate its properties. • They should then share what they learned with the class. • Use the 12 Clarifying Bookmarks instead of 6 Clarifying Bookmarks • Students can read the article aloud, in pairs, or solo. • Independent pacing of article reading • Articles differentiated by lexile level for far below basic to advanced readers. • Opportunity to explain topic/ reasoning/ thoughts with equally high-level readers.

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SAUSD Common Core High School Chemistry Unit – Structure and Property of Matter

Contents:

Big Idea: Forces attract, hold together, or repel.

Enduring Understandings: Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles

SAUSD Common Core Lesson Planner **Teacher:**

Unit: Matter **Day: 1 & 2** **Lesson: 1**	**Grade Level/Course:** High School Chemistry	**Duration:** 2 class periods **Date:**
Big Idea: Forces attract, hold together, or repel. **Essential Question:** 1. How do intermolecular forces between particles explain the bulk properties of substances? 2. How is heat related to temperature and phase changes and the relevance of a heating curve? 3. What is the relationship between intramolecular forces (bonding) and intermolecular forces?		
Common Core and Content Standards	**Content Standards:** 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. HS-PS1-3 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. **Reading Standards for Literacy in Science and Technical Subjects**: RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. **Writing Standards for Literacy in Science and Technical Subjects**: WHST.9-10.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented. **Speaking and Listening Standards (ELA):** SL.9-10.1d Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented. SL.9-10.1b Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.	
Materials/ Resources/ Lesson Preparation	**Day 1**: Teacher Resource: 1.1 Video Basilisk Lizard Student Resource: 1.1 Day 1/Day 13 Anticipatory Guide student sheet Student Resource: 1.2 Penny Drop Lab Teacher Resource: 1.2 Power Point for Penny Drop Lab Procedures	

	Day 2: Student Resource: 1.3 Penny Drop Lab Re-design worksheet. **Day 1 & 2:** Small beakers (50 or 100mls) two per lab group or pair of students 8 – 18 disposable plastic pipettes depending on teacher's choice of pairs/lab groups Soap (should be added by students so they determine how much to add) Pennies, one per pair/lab group Paper towels	
Objectives	**Content:** Students will be able to design a systematic approach to answering a question scientifically. Students will be able to understand that water is made up of many molecules attached to each other through attractive forces.	**Language:** Students will be able to verbalize possible sources of error, translate oral guidelines into a hands-on protocol, and incorporate information into a cohesive conclusion.
Depth of Knowledge Level	☐ **Level 1: Recall** ☒ **Level 3: Strategic Thinking**	☒ **Level 2: Skill/Concept** ☐ **Level 4: Extended Thinking**
College and Career Ready Skills	☒ **Demonstrating independence** ☐ **Building strong content knowledge** ☐ **Responding to varying demands of audience, task, purpose, and discipline** ☒ **Comprehending as well as critiquing** ☒ **Valuing evidence** ☐ **Using technology and digital media strategically and capably** ☐ **Coming to understand other perspectives and cultures**	
Common Core Instructional Shifts	☐ **Building knowledge through content-rich nonfiction texts** ☒ **Reading and writing grounded from text** ☒ **Regular practice with complex text and its academic vocabulary**	
Academic Vocabulary / **TEACHER PROVIDES SIMPLE**	**KEY WORDS ESSENTIAL TO UNDERSTANDING**	**WORDS WORTH KNOWING (covered in prior units)**
	Tension Atom vs. Molecule/Compound	Elemental (referring to the elements) Molecule Attractive Force Hypothesis

	STUDENTS FIGURE OUT THE	Surface Tension (more complex meaning) Cohesion (help with pronunciation)	Phase change Solid Liquid Gas Melting, Freezing, Boiling Ionic and Covalent Bond
Pre-teaching Considerations		**Before the unit:** Much of this unit requires teamwork and collaboration. Group students in teams of four. Mixed ability groups are fine. If you have a small group of students who are accelerated learners, group them together and challenge the whole group to take everything to a deeper level. Students have a wealth of background information with regards to water, surface tension, cohesion. Connect to their prior experiences—water on the sides of cold drinks or sodas, insects floating on top of water, droplets on windshield, flower petals, grass in the morning. When students complete the extended anticipatory guide, there will be several vocabulary terms that they will not know (intermolecular forces of attraction, hydrogen bonds, phase change, intramolecular forces of attraction). This is expected and is okay but gives them a look at the information they are expected to understand by the end of the unit. Students may have varying levels of comfort designing their own lab procedure and simply want to copy each other. Based on your class, you may want to brain storm one lab design together and then ask students to create an additional lab design to test the soapy water. This lab can be messy if students add water drops too quickly to their pennies. This lab can easily be carried out outside if desired.	
Lesson Delivery			
Instructional Methods		**Check method(s) used in the lesson:** ☐**Modeling** ☒**Guided Practice** ☒**Collaboration** ☒ **Independent Practice** ☒**Guided Inquiry** ☒ **Reflection**	
Lesson Continuum	**Lesson Open-ing**	**Preparing the Learner:** Prior Knowledge, Context, and Motivation: **Day 1** 1. Video clip on surface tension and Basilisk Lizard 2. Ask students to think independently and then pair-share about what allowed the lizard to run across the top of the water. If a student says “surface tension” ask him or her to go deeper and explain what surface tension is. 3. Ask students if they can run on top of water (maybe they have tried this in a pool)	

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding	**Interacting with text:** **Day 1** 1. Students will independently complete the Anticipatory Guide Day 1. Encourage them to guess the meaning of words they are unfamiliar with by looking at the roots of the words or for familiar words within a word (ex. Intermolecular has ‘inter” and “molecule”). Present Power Point procedure steps, having students take notes putting it into their own words on resource 1.2 “Penny Drop Lab”

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding		
		2. Have the students make a guess as to the number of drops that can fit on a penny. Ask the students if anyone had a guess of one million! The students will laugh. Ask them why they are laughing at one million. Let them realize they were already "educated" about their guess because they know the size of a penny and they have knowledge about water and understand what a "drop" means. 3. Discuss what a hypothesis is (prediction and reason) and why they were educated about their guess. 4. Dismiss the students back to the lab area to start their lab. 5. The lab is written such that the data obtained will have a wide range. This allows for discussion. 6. Once the students have written the average for their group on the board ask the students why the averages are so different. 7. This lab can be done at home without modifications if a student is given a clean plastic pipette. **Teaching Tips: (Post Lab Discussion Questions)** Ask the students why the averages are so different (too many variables) and discuss the following: -If anyone used the head side, if anyone used the tail side? -If the same student did all three trials or if each person in the lab group took turns. -If the surface in which the penny was on was completely flat. -If the penny was left wet or dried between trials. -If a new penny or an old penny had been used. -If the drop size could be varied by manipulating the thin stem. -Technique of dropping: height above penny, angle of pipette, pressure on bulb of pipette, rate of dropping, placement of drops onto penny **Day 2: Penny Drop Re-Design Lab resource 1.3** 1. Students will apply prior knowledge from previous day's introductory lab to design and write lab procedure steps for Penny Drop Lab comparing regular water to soapy water. 2. Students will complete the flow map with appropriate procedure steps, perform the lab steps, complete and label the data table, then write a conclusion paragraph. 3. For the most support, allow students sufficient time to write the conclusion in class or review the introduction on "cohesion" and "surface tension" as a class.	**Differentiated Instruction:** **English Learners:** • Students can write the lab procedure using pictures or words. • Students will create the re-design procedure in a team setting. • Cooperative lab groups • Multiple opportunities to speak **Special Needs:** • This lab can be done at home without modifications if a student is given a clean plastic pipette. This will allow for additional time to repeat the lab. • A procedure can be provided for the second part of the lab or created by the class as a whole.

Lesson Continuum

Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding

Extending Understanding:
Follow Up Lab Activity:
Have students repeat the lab using a different liquid such as rubbing alcohol, salt water, juice, syrup, etc. Students should have to support why they want to use a particular agent with evidence from previous lab examples or personal experience.
For Example:

- In the lab, I saw that…
- One case that illustrates this is…
- Remember in the demo or video we saw that…
- An example from my life

Follow up Demonstration and Discussion

1. Fill one beaker with soapy water and the other with tap water.
2. Drop a piece of string into each. The string placed into the soapy water will sink while the string placed into the tap water will float. This happens because the water molecules are disturbed by the soap and are unable to form as many hydrogen bonds.
3. Have students do a quick write about why they think this happened and ask them to share with a partner and practice elaborating on their ideas.
   For Example:
   - Can you elaborate on…?
   - What does that mean?
   - What do you mean by....?
   - Can you clarify the part about…?

GATE Extension: Have students investigate the meaning of these words and how they connect to the results they obtained in the lab.

- Soap and detergents as “wetting agents” or “surfactants”
- Surfactant: surface-active agent
- Wetting agent: substance that decreases surface tension of water. The “skin” of water can stretch and thus bubbles can be made.

Polar (water) vs. Nonpolar (oil) Detergents and soaps….how they work…..polar end that likes water and a nonpolar end that likes oil.

- Cooperative lab groups
- Enlarged prints given before class
- Provide electronic copy or hard copy of ppt to student.

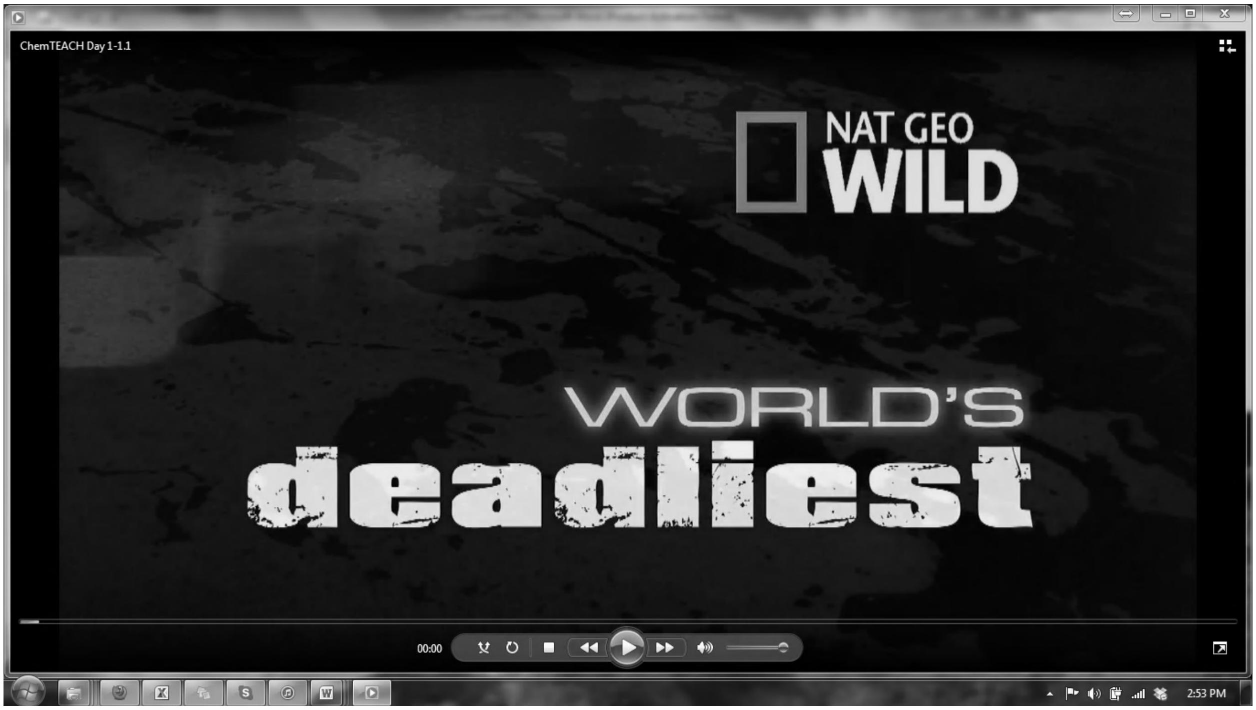
Accelerated Learners:

- Have student complete an independent or partner investigation of the terms wetting agent, surfactant, polar, or non-polar and how these terms relate to this lab.

Lesson Reflection

Teacher Reflection Evidenced by Student Learning/ Outcomes	

Surface Tension: Basilisk Lizard Running on Water



From Nat. Geographic Wild's Youtube website for Educational Purposes
Video Downloaded and on electronic copy (DVD)

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States of Matter and Forces of Attraction

Extended Anticipatory Guide Day 1/ Day 13

Question	Day 1		Day 13		Day 13
	Agree	Disagree	Support	No Support	Evidence from the text: Explain using your own words
1. Surface tension is an incredibly strong force that holds molecules of water together.					
2. The three different states of matter are different on an elemental level (have different types of elements and/or number of atoms).					
3. A single molecule of water, H_2O, is held together by intermolecular and intramolecular forces.					
4. Water melts and freezes at the same temperature.					
5. The temperature of water changes when it goes through a phase change.					

Question	Day 1		Day 13		Evidence from the text: Explain using your own words
	Agree	Disagree	Support	No Support	
6. As water transforms from a solid to a gas, the individual molecules move closer together.					
7. Intermolecular forces of attraction in order from strongest to weakest are: Hydrogen bonds, London-Dispersion forces, and Ionic/Covalent bonds.					
8. When graphing a heating curve of a substance, the graph is flat during a phase change.					
9. As a substance absorbs heat, the intermolecular forces between molecules weaken due to a decrease in kinetic energy.					
10. Intra-molecular bonds (between molecules) are weaker than inter-molecular bonds (between atoms of a single molecule).					

Name________________________

Penny Drop Lab

Question: How many drops of water can you get to fit onto the “heads up” side of a penny?

Directions: Create a flow chart from the instructions your teacher gives you on how to complete the penny drop lab. Remember this procedure should be clear enough for a non-chemistry student to complete the lab.

Hypothesis: I think the____
because ____

Trial #	Number of Drops of Water
1	
2	
3	
Average	

Conclusion & Analysis Paragraph. Three sentences minimum. (1) Support or reject your initial hypothesis; (2) compare your data to your hypothesis (use data numbers to prove your point); (3) suggest a reason for your observations.

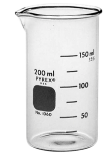
____
____
____
____
____
____
____

Penny Drop Lab Procedures

- Today we will do a simple lab to determine how many drops of water can fit on to the surface of a penny.
- Tomorrow you will write lab procedures and design a data table for a similar lab that includes today's activities plus an additional variable.

Procedure Steps

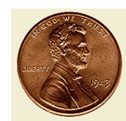
1. Obtain a plastic pipette and a 50-mL or 100-ml beaker.
2. Obtain a penny.
3. Half-fill the beaker with tap water.



Procedure Steps

4. Draw water up into the pipette and start dropping water onto the penny, counting drops until the penny cannot hold any more drops (water will spill off the penny)
5. Repeat the procedure until you have data for three trials.

Procedure Steps



6. Calculate the average and write the group's average on the front board.
7. Compile data:

Trial	Number of Drops
1	
2	
3	
Average	

Class Data Table

Team	Number of Drops on Penny
Class Average:	

Penny Drop Lab Re-Design

Background: Cohesion is when water molecules are attracted to other water molecules. The oxygen end of water has a negative charge and the hydrogen end has a positive charge. The hydrogens of one water molecule are attracted to the oxygen from other water molecules. This attractive force is what gives water its cohesive properties.

Surface tension refers to water's ability to "stick to itself". Surface tension is the name we give to the cohesion of water molecules at the surface of a body of water. The cohesion of water molecules forms a surface "film" or “skin.” Some substances may reduce the cohesive force of water, which will reduce the strength of the surface “skin” of the water.

Challenge: Re-design the penny drop lab with your team to see how soap (or another liquid-check with your teacher) will affect the surface tension of water. Make a hypothesis before you begin to explain your prediction.

Hypothesis: I think ____
because ____
____

Directions: There are many different ways you can set up this lab. Agree upon your procedure with your lab team. Complete the flow chart using words and/or pictures explain each step you will need to follow to complete the penny drop re-design. Make sure your procedure is clear and could be followed by anyone, not just a chemistry student. Add more boxes if necessary.

Add your own titles to the data table below based on your team's experiment. You may not need all the columns.

Trial #		
1		
2		
3		
Average		

Post Lab: Conclusion & Analysis Paragraph FIVE sentences minimum. (1) Reference your initial hypothesis about the amount of water you can get onto a penny—support or reject your hypothesis; (2) compare your data to that prediction; (3) compare regular water to soapy water data; (4) using the background information, explain what factor influenced the results; (5) how did surface tension change with your redesign?

If time permits: Extension Activity

What if the experimental question was "How does sugar affect the surface tension of water?" Describe how you would answer this question using the scientific method. If you have time, you can test this or another liquid.

SAUSD Common Core Lesson Planner **Teacher:**

Unit: Matter **Day:** 3 & 4 **Lesson:** 2	**Grade Level/Course:** High School Chemistry	**Duration:** 2 class periods **Date:**
Big Idea: Forces within particles hold matter together **Essential Question:** 1. How do intermolecular forces between particles explain the bulk properties of substances? 2. How do intermolecular forces between particles relate to the associated state of mater of a substance?		
Common Core and Content Standards	**Content Standards:** 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. **Reading Standards for Literacy in Science and Technical Subjects**: RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*. RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). **Writing Standards for Literacy in Science and Technical Subjects**: WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research. **Speaking and Listening Standards (ELA):** ELA-Literacy.SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task. ELA-Literacy.SL.9-10.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.	
Materials/ Resources/ Lesson Preparation	Teacher Resource: Day 3-2.1 Video Clip of Non-Newtonian Substance Student Resource: Day 3-2.1 Viewing Guide – What is it? Non-Newtonian Substances Student Resource: Day 3/Day 4- 2.2 Extended Anticipatory Guide: Three States of Matter Student Resource: Day 3-2.3 Article – Zooming in on States of Matter Student Resource: Day 4-2.4 Analysis Questions :Zooming in on States of Matter Student Resource: Day 4-2.5 Tree Map – States of Matter. Student Resource: Day 4-2.6 States of Matter Skit Activity Worksheet	

<table>
<tr><td colspan="2">Objectives</td><td>Content:
Students will be able to distinguish between the three phases of matter and connect the varying strengths on the intermolecular forces of attraction to the different characteristics of a solid, liquid, and gas.</td><td>Language:
Students will be able to verbalize specific properties and translate a reading into a skit.</td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☐ Level 1: Recall ☒ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☐ Demonstrating independence ☒ Building strong content knowledge
☒Responding to varying demands of audience, task, purpose, and discipline
☒ Comprehending as well as critiquing ☒Valuing evidence
☐Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="3">Academic Vocabulary (Tier II & Tier III)</td><td></td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>TEACHER PROVIDES SIMPLE EXPLANATION</td><td>Solid
Liquid
Gas
Phase Change</td><td>Characteristics
Physical change
Plasma
Non-Newtonian Substance</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>Fusion
Vaporization
Condensation
Solidification
Intermolecular Forces of Attraction
Boiling</td><td>Definite Volume
Indefinite Volume
Phase Change
Compressible</td></tr>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Before the unit:
• Much of this unit requires teamwork and collaboration. Group students in teams of four. Mixed ability groups are fine. If you have a small group of students who are accelerated learners, group them together and challenge the whole group to take everything to a deeper level.

• Students have a great wealth of background knowledge regarding the three states of matter from their everyday lives and will feel more comfortable with the material when it can be easily connected back to an experience they are familiar with.</td></tr>
</table>

<table>
<tr><td colspan="2"></td><td>

- If you are planning to do the extended learning activity for this lesson, you will need cornstarch. Ask students to bring in a box from the dollar store for a lollypop, extra credit, or brownie points with the teacher. Or consider doing it as a whole class demo so less material is required but students can still see and touch Oobleck.

</td></tr>
<tr><td colspan="3">Lesson Delivery</td></tr>
<tr><td colspan="2">Instructional Methods</td><td>

Check method(s) used in the lesson:

☐ **Modeling** ☐ **Guided Practice** ☒ **Collaboration** ☒ **Independent Practice**

☐ **Guided Inquiry** ☒ **Reflection**

</td></tr>
<tr><td rowspan="2">Lesson Continuum</td><td>Lesson Opening</td><td>

Preparing the Learner
Prior Knowledge, Context, and Motivation:

1. Teacher will need to have the video -“Non-Newtonian Fluid” clip open and ready to view.
2. At the beginning of class, the teacher will direct students to independently answer the two **Pre-Video** questions in the “What is it? Non-Newtonian Substance” worksheet.
3. Teacher will ask students to compare answers with their neighbor and add to their list if one student has an idea that another is missing.
4. Teacher directs students to the video and hits the “start” button on the video clip. Clip is short. Consider showing it twice.
5. When completed, teacher directs students to answer the Post-Video questions.
6. Teacher asks the class if they can decide what state of matter was actually featured in the video OR teacher asks the class to share their responses as to why it was difficult to determine if the substance was a solid or a liquid.
7. Partner share first to elaborate on individual ideas, and then ask for students to share out. Try to reach a consensus as a class.
Notes: Slime is actually classified as a “Non-Newtonian” fluid because its properties are so different from those of a solid or a liquid. Some additional examples of Non-Newtonian fluids are ketchup, soap, quicksand, white glue, and silly putty.

</td></tr>
<tr><td>Strategies/Technology/ Questioning/Engagement/Writing/ Checking for Understanding</td><td>

Interacting with the concept/text:
States of Matter Extended Anticipatory Guide

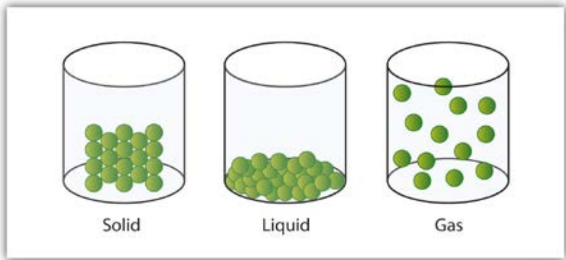
1. This lesson will have two parts, an extended anticipatory guide (Day 3 2.2) focusing on drawing the different states of matter broken up by a close reading activity about the different states of matter. The lesson will conclude with students creating a thinking map to represent the different states of matter. A tree map is great for this, but let students select the map they think fits best. Refer students to examples of thinking maps if they don’t remember the purpose of each.

</td></tr>
</table>

Lesson Continuum

Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding

2. Students should find the Extended Anticipatory Guide with the empty jars (Day 3 2.2) in their workbooks and create a preliminary drawing of what they think each of the three states of matter looks like at the molecular level if a solid, liquid, or gas were all placed in a closed container. (see picture example next page)



3. They are asked to draw arrows to show movement of molecules using arrows. Initially, they may not think the molecules in a solid or liquid is moving.

4. Students should begin reading the text "Zooming in on States of Matter" independently or in teams of three or four so that they can answer the "Zooming in on States of Matter Analysis Questions" (Day 3 2.4) and create their thinking map (Day 3 2.5). If time is running short, the thinking map could become homework or a quick warm up the next day.

Day 4 of Lesson 2

5. To summarize the reading, students will need to fill in the tree map on the 3 states of matter.
6. Have Students Go back to the Extended Anticipatory Guide (Day 3 2.2) and fill in "Day 4 Findings" and the "Support with Evidence from the Text" column.
7. Students should compare their work with teammates to make sure everyone agrees with what a solid, liquid, and gas look like at the molecular level. Any discrepancies between drawings should be discussed until all agree on one drawing. Students should refer to their reading to clarify what the different states of matter look like.
8. The final activity of the lesson is to divide the class into 3 large groups of 10-12 students. Each group will be secretly told what state of matter they need to act out and the other 2 groups will guess. Their skit should NOT include any speaking. Their actions should clearly explain what state of matter the team represents.
9. After each skit, the other teams will guess what state of matter was acted out AND cite evidence from the skit that explained what state of matter it was.

Differentiated Instruction: English Learners:

- Peer partnering of students who have a stronger grasp of English
- Teacher proximity for immediate feedback and support
- Provide students with a copy of the questions to refer to and take home

Special Needs:

- Provide students with a copy of the questions to refer to and take home
- Enlarge handouts for those in need
- Provide electronic copy so they can zoom in on text.

<table>
<tr>
<td rowspan="1">Lesson Continuum</td>
<td>Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding</td>
<td>Extending Understanding: (If time allows or as an extra credit assignment or as a whole class demo)

Have your students make a Non-Newtonian substance and examine its properties more closely.

Recipe for “Oobleck”
1. In a large bowl, add 1.5 cup of cornstarch and slowly add 1 cup of water.
2. You want it to feel like honey but be able to rip apart. You may need to tweak the amount of these to get a good consistency.
3. Add food coloring or paint if desired.
4. Do NOT pour down the drain when cleaning up.

Explanation: When left standing the particles of starch are surrounded by water. The surface tension of the water keeps the H_2O from completely flowing out of the spaces between the granules of cornstarch. The cushion of water provides quite a bit of lubrication and allows the granules to move freely between the water. But, if the movement is abrupt (like you squeeze it), the water is squeezed out from between the granules and the friction between them increases rather dramatically causing it to act more like a solid. (Adapted by SAUSD from Science Café)</td>
<td>Accelerated Learners:
• Students can make Oobleck and design an experiment to demonstrate its properties.
• They should then share what they learned with the class.</td>
</tr>
<tr>
<td colspan="4" align="center">Lesson Reflection</td>
</tr>
<tr>
<td colspan="2">Teacher Reflection Evidenced by Student Learning/ Outcomes</td>
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</tr>
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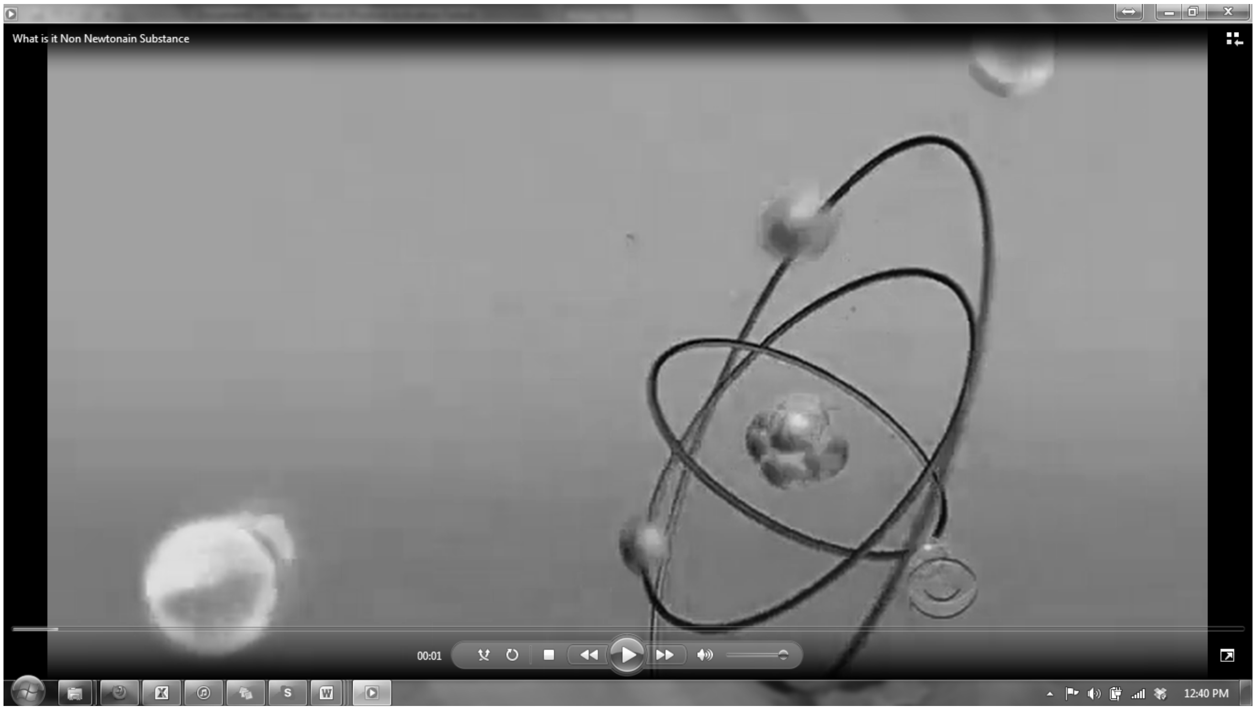
What is it? A Non-Newtonian Substance



A short clip from “Big Bang Theory” via youtube about how some substances act like a liquid and a solid. Technical jargon is thrown around, but can be ignored. The goal is for students to be curious about what is going on in this video.

What is it? Non-Newtonian Substances

Pre-Video Questions

1. Describe two characteristics of a solid.
   -

   -
2. Describe two characteristics of a liquid.
   -

   -

Discuss with your partner. Add any additional properties your partner may have included that you did not think of.

Post-Video Questions

1. What are four characteristics of the substance shown in this video clip?
   -
   -
   -
   -
2. Using your reasoning, what state of matter is the "slime" featured in this video clip? If you cannot decide, explain why you are undecided.

3. Jell-O is another substance like slime. What are two other substances that aren't easily classified as a solid or liquid?

   -

   -

TEACHER's GUIDE: Sample Responses: DON'T PUT UP AS KEY!

What is it? Non-Newtonian Substances

Pre-Video Questions

1. Describe two characteristics of a solid.
   - Definite shape and volume
   - Not compressible. Doesn't flow.
2. Describe two characteristics of a liquid.
   - Indefinite shape, definite volume
   - Not compressible, flows

Discuss with your partner. Add any additional properties your partner may have included that you did not think of.

Post-Video Questions

1. What are four characteristics of the substance shown in this video clip?
   They may describe color, how it bounces and moves, how it returns to its original shape when the music stops, etc.
2. Using your reasoning, what state of matter is the "slime" featured in this video clip? If you cannot decide, explain why you are undecided.

   Students may say this is a liquid because it moves with the music and looks like it is flowing. They may say it is a solid because when the music turns off, it stops moving and doesn't flow.

3. Jell-O is another substance like slime. What are two other substances that aren't easily classified as a solid or liquid?

- ketchup, soap, quicksand, white glue, and silly putty

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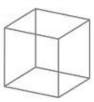
Day 3/Day 4 Extended Anticipatory Guide

	Day 3 **Hypothesis**	Day 4 **Findings**	Day 4 **Support with Evidence**
	Using a circle to represent an individual molecule, draw the molecules to represent each state of matter. Add arrows to show if the molecules move.	Using a circle to represent an individual molecule, draw the molecules to represent each state of matter. Add arrows to show if the molecules move.	Explain your molecular structure using <u>your own words</u>.
Solid 			
Liquid 			
Gas 			

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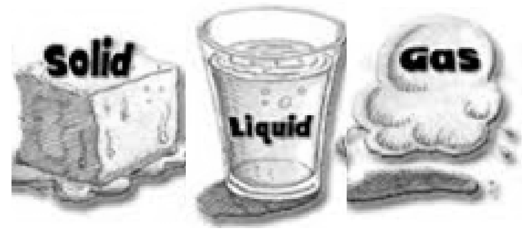
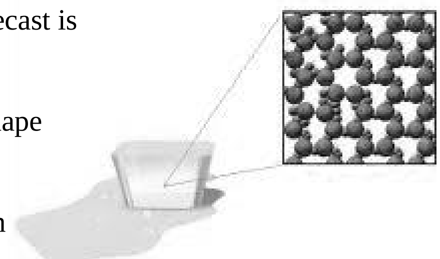
Zooming in on States of Matter



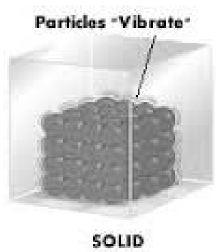
1. What makes a gas different from a liquid or solid? Why are some substances gases at room temperature, while others are not?

2. Solids, liquids, and gases are three states of matter. The fourth state of matter is called plasma (a man-made version is found in a plasma TV, but we'll save that topic for later). The following definitions will help you to identify a substance's state of matter and to describe the changes from one state to another.

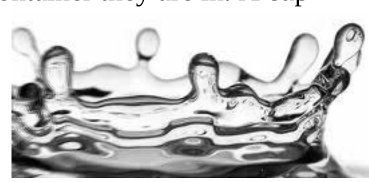
3. Before you being, make sure you know the following terms. "<u>Definite</u>" means a clearly defined or unchanging set of limits. For example, the sun will always rise in the East. This happens every day without fail. "<u>Indefinite</u>" means just the opposite where properties or limits are flexible, uncertain, and changeable. For example, the weather forecast is indefinite.



4. *Solids* have a definite shape and volume. True solids keep their shape and take up a definite volume for a given amount of mass. The particles are packed closely together in solids. They are "locked" into a fixed position. This happens because the forces of attraction between particles of a solid are very strong. Because of this tightly packed and highly organize arrangement, solids cannot be compressed and they are unable to flow like a liquid. All materials become solid if their temperatures are lowered enough or the pressure exerted on them becomes high enough. Many people will mistakenly believe that particles of a solid are not moving. They do move! If you could see the molecules with a high powered microscope you would see that they vibrate slightly. It's almost like they are buzzing. The solid state of H_2O (water) is ice.



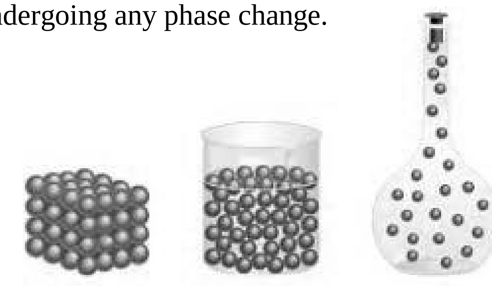
5. *Liquids* however do not have a definite shape and are not compressible. The particles in a liquid are close together. Liquids do have a definite volume for a given mass. This means that liquids are not easily compressed as they are NOT squishable. You might be able to squirt water through your fingers or slosh it around in the bathtub, but you cannot make the water take up less space (it is not compressible). Liquids, unlike a solid, will flow to take the shape of the container they are in. A cup of water will change its shape to fit in a bottle, a cup, or spilled on the table. This happens because there is slightly less attraction between the particles of a liquid substance than those of a solid. Therefore, they are able to move more than the particles of a solid. They are able to slip and slide over and around one another. The liquid state of H_2O is water.



6. *Gases* have no definite shape or volume of their own. Therefore, if the volume of a gas container changes, do does the volume of the gas. This means if you have a can of Axe Body Spray in the classroom and it cracks open, the volume of the gas will expand to take the shape of the classroom (the new container). The particles are very far apart in a gas because the attractive forces are so weak that they cannot hold the particle together, allowing them to move freely and independently of other gas molecules. All of these individual characteristics of gases are due to the fact that at room temperature the particles of a gas have almost no attraction for one another. The gas state of H_2O is

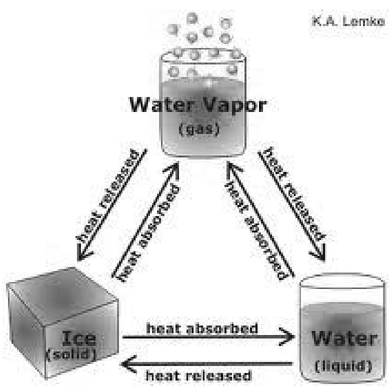
water vapor. Take note that individual molecules do not change size when they are vaporized (the fancy word for turning something into a gas), or when undergoing any phase change.

Intermolecular Forces of Attraction



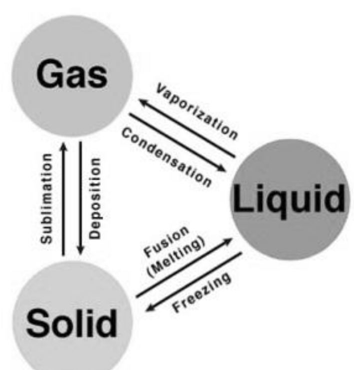
7. The fundamental difference between the states of matter is the space between the molecules due to the strength of the intermolecular forces (IMF) of attraction!

8. In the *solid phase*, the particles (atoms or molecules) are not able to move around much because they have a fairly strong attraction for one another that lock them in place. These intermolecular forces are electrical in nature with a positive charge attracting a negatively charged particle. IMFs are related to the number of electrons in a molecule. In a solid, particle motion consists only of vibrating in place, giving solids a definite volume and shape. Solids can be heated until the vibrations become so severe that the particles begin to break free from their place in the structure and become liquid. This happens because heat energy becomes kinetic (moving) energy and overcomes some of the intermolecular forces of attraction, allowing the solid to transform into a liquid. Solids have less kinetic energy than liquids.



9. In the *liquid phase*, the particles are still attracted to each other and are still in contact with each other. However, they are not locked into a fixed place by the attractive forces. The liquid particles are free to move past each other, as well as vibrate. Liquids have a definite volume but not a definite shape. A liquid can be heated until the kinetic energy of its particles overcomes the remaining forces of attraction and the substance becomes a gas. Gases have the highest kinetic energy of the three phases.

10. The intermolecular forces of attraction have not been changed by these phase changes. The process of going from solid to liquid to gas by adding heat energy can be reversed by cooling. By removing heat energy, a gas will become a liquid, and a liquid will become a solid. This happens because the particles are slowed enough that the still-present intermolecular forces of attraction exert their effect.



Changes of State: A Physical Change

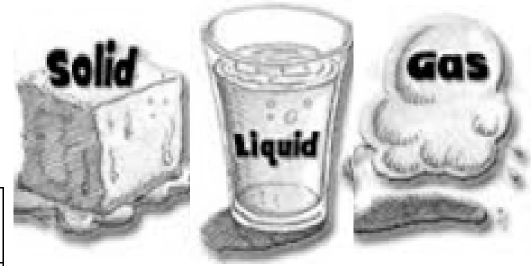
11. In your upcoming lab, you are exploring boiling, also called vaporization. Boiling is a change from a liquid to a gas phase.

12. The temperature at which this occurs for a given substances can also be called the condensation point. Condensation is when a gas becomes a liquid. The condensation point and the boiling point occur at the same temperature.

13. When water boils or steam condenses, a physical change takes place. A physical change is one that involves changes in the state or phase of a material. It does not involve the creation of new materials. The water boils and turns to water vapor (steam) and water vapor condenses to form liquid water. However, there is no change to

the molecular structure or size of the water molecules. It is still H_2O. The phase change does involve changes the heat though. To boil water, the water must gain heat energy and to condense water or freeze it, water must lose heat energy.

Zooming in on States of Matter Analysis Questions



Vocabulary: Define the following terms:

- Definite:
- Indefinite:

Definite or Indefinite?	**Solid**	**Liquid**	**Gas**
Shape			
Volume			

Change of state	**From**	**To**	**Heat Energy (gained or lost)**
Boiling	Liquid	Gas	Gained (added heat)
	Gas	Liquid	
Evaporation	Liquid		
Vaporization			
	Liquid	Solid	
Fusion			Gained (added heat)

What does it mean?

Chemistry explains the *macroscopic* phenomenon (what you observe) with a description of what happens at the *nanoscopic* level (atoms, molecules, bonding) using *symbolic* structures as a way to communicate. Complete the chart below:

MACRO	NANO (10^{-9})	SYMBOLIC
Describe two observable features (sight, touch, feel…) of water as a solid (ice), liquid and gas (vapor).	Compare and contrast the nanoscopic nature of a solid, a liquid, and a gas by examining the atoms, molecules, or intermolecular forces.	A phase change graph can be used to summarize the change from solid to liquid to gas. Create your own phase change graph.

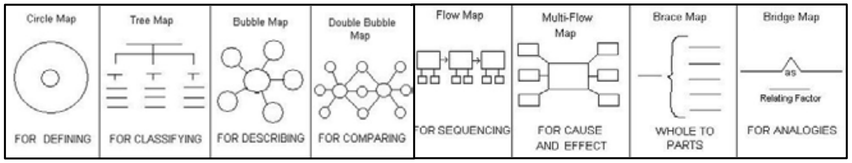
MACRO:____

NANO: ____

SYMBOLIC:

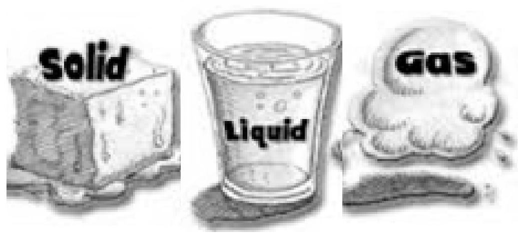
States of Matter

Directions: Using what you learned reading "Zooming in on states of matter," select a thinking map that best organizes your knowledge. Describe the bonds, the characteristics of each state, and/or include a picture to visually represent this information. Make sure to include at least four supporting details for each state of matter.



Last up: Create a frame of reference for your map by citing the paragraph number(s) where you found the information next to the fact.

States of Matter Skits



State of Matter	Cite Evidence from the Skit to Explain your Team's Guess

SAUSD Common Core Lesson Planner **Teacher:**

Unit: Matter **Day:** 5 & 6 **Lesson:** 3	**Grade Level/Course:** High School Chemistry	**Duration:** 2 class periods **Date:**

Big Idea: Forces attract, hold together, or repel.

Enduring Understandings: Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles.

Essential Question:

1. How do intermolecular forces between particles explain the bulk properties of substances?
2. How is heat related to temperature and phase changes and the relevance of a heating curve?
3. What is the relationship between intramolecular forces (bonding) and intermolecular forces?

Common Core and Content Standards	**Content Standards:** 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. **Reading Standards for Literacy in Science and Technical Subjects**: RST.9-10.1 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. RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **Writing Standards for Literacy in Science and Technical Subjects**: WHST.9-10.8 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. WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection and research. WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented. **Speaking and Listening Standards (ELA):** ELA-Literacy.SL.9-10.1b Initiate and participate effectively in a range of collaborative discussions with diverse partners on grades 9-10 topics, texts and issues, building on others' ideas and expressing their own clearly and persuasively. Work with peers to set rules for collegial discussions and decision making, clear goals and deadlines, and individual roles as needed. ELA-Literacys.SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, task.

<table>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="2">Student Resource 3.1-Water-Related Videos/Quick-write
Teacher Resource: 3.1a-Science 360 Videos (LINK provided on Teacher Form)
Teacher Resource: 3.1b-Discovery Education: Boiling water as a function of Altitude
Student Resource: 3.2. Clarifying Bookmarks (6 and 12 versions)
Student Resource: 3.3a. Article 1: “What-er” You Going To Do About Water Conservation?
Student Resource: 3.3b. Article 2: The Hidden Force In Water
Student Resource: 3.3c. Article 3: What’s Taking So Long?
Student Resource: 3.3d. Article 4: Mr. Freeze – What Phase Are You?
Student Resources: 3.4a Jigsaw Matrix Article 1: “What-er” You Going To Do About Water Conservation?
Student Resource: 3.4b. Jigsaw Matrix Article 2: The Hidden Force In Water
Student Resource: 3.4c. Jigsaw Matrix Article 3: What’s Taking So Long?
Student Resource: 3.4d. Jigsaw Matrix Article 4: Mr. Freeze – What Phase Are You?
Student Resource: 3.5-Theme of Water-Related Articles</td></tr>
<tr><td>Objectives</td><td>Content:
Students will be able to gain a perspective on the importance of water conservation, the role and function of intermolecular forces in connection with the physical properties of the states of matter and lastly, the correlation of kinetic energy and its effect on intermolecular forces and phase changes.</td><td>Language:
Students will verbally express opinions, observations, and evidence watched in a video and read in an article.</td></tr>
<tr><td>Depth of Knowledge Level</td><td colspan="2">☐ Level 1: Recall ☒ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☐ Level 4: Extended Thinking</td></tr>
<tr><td>College and Career Ready Skills</td><td colspan="2">☒ Demonstrating independence ☒ Building strong content knowledge
☐ Responding to varying demands of audience, task, purpose, and discipline
☒ Comprehending as well as critiquing ☒ Valuing evidence
☐ Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td>Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
</table>

<table>
<tr><td rowspan="2">Academic Vocabulary (Tier II & Tier III)</td><td></td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>TEACHER PROVIDES SIMPLE</td><td>Wastewater
Hydrogen bond
Kinetic energy</td><td>Molecule
Covalent bond
Density
Phase
Transformation</td></tr>
<tr><td></td><td>STUDENTS FIGURE OUT THE MEANING</td><td>Evaporation
Condensation
Intermolecular forces of attraction
Intramolecular forces of attraction
Vapor pressure
Boiling point
Heating curve</td><td>Melting
Freezing
Boiling
States of matter</td></tr>
</table>

Pre-teaching Considerations

Before the unit:

1. **Base Group:** the base group should be made up of 4 students, 1 from each Expert Group.
2. **Expert Group:** students should be grouped by reading ability as determined by CELDT/CST scores and understanding of content before this lesson.

Article	Lexile Level	Content Demand	Topic(s)
Article 3.3a	1237	Low	Water Conservation
Article 3.3b	1455	Medium-High (Long Article)	IMF in solids, liquids, gases Density
Article 3.3c	1385	Medium-High (Long Article)	Boiling at altitude Kinetic energy/IMF
Article 3.3d	1341	Content-High (New Info)	Heat of fusion, phase change, kinetic energy

* The reading difficulty of each article was considered to support the variety of reading levels in a classroom.

Recommendations:

a. Students should already be seated with their Base Group.
b. Before Day 5, Teacher should review Resource titled "Water-Related Videos/Quick-write" for a brief synopsis of each video.
c. Plan out four areas in your classroom for Stations #1 – 4 for the Expert Groups.

Lesson Delivery

Instructional Methods

Check method(s) used in the lesson:

☒**Modeling** ☐**Guided Practice** ☒**Collaboration** ☒ **Independent Practice**

		☒**Guided Inquiry** ☐**Reflection**
Lesson Continuum	**Lesson Open-ing**	**Preparing the Learner (20:00 mins: Suggested time)** Prior Knowledge, Context, and Motivation: 1. Students should be seated in their Base Groups of four. 2. In preparation of their Jigsaw on articles related to water to activate prior relevant knowledge and student interest, four videos will be shown. 3. Refer to Teacher Resource titled "Water-Related Videos/Quickwrite" for synopsis of videos. 4. VIDEO/QUICK-WRITE SEQUENCE: a. Click the **<u>LINK</u>** for Video #1. b. Students watch Video #1. (2:34 mins in length) c. Students independently reflect and write one sentence for <u>*Theme of the Video*</u> for Video#1 (1:00) d. Continue with steps (a) to (c) for Videos #2 – 4. (12:42 mins) e. Students rearrange to go into their Base Groups and each student shares one of their <u>*Theme of the Video*</u>. Tallest Student begins with <u>*Theme of the Video*</u> for Video #1. Rotate clockwise to second student for Video #2. (0:30) f. After Tallest Student shares his/her theme, student to the <u>right</u> of the Tallest student responds with *"I agree with _____ because…"* ***or*** *"I disagree with _____ because…"*. (0:30) g. Continue clockwise from the Tallest Student with steps 2 and 3 for Videos #2 – 4. (3:00) * If a Base Group is missing one student, Teacher will need to be the fourth student.
		Interacting With the Concept/Text (Day 5 - 35:00 min) <u>Water-related articles (10 copies) at Stations #1 - 4</u> ***NOTE**: See Pre-Teaching Considerations for Reading Level Breakdown 1. "WHAT-ER" YOU GOING TO DO ABOUT WATER CONSERVATION? 2. THE HIDDEN FORCE IN WATER 3. WHAT'S TAKING SO LONG? 4. MR. FREEZE WHAT'S YOUR PHASE? <u>Jigsaw Matrix Sequence (Day 5 – 35:00)</u> 1. Teacher will assign each student a number that corresponds to the Expert Group/Article and the station they will be going to. **NOTE**: Students should move away from their base group to read in proximity to the expert group reading the same article.

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding		Differentiated Instruction:
		2. Teacher excuses students to their station (Expert Group) with a pencil and highlighter (optional). (There should be 8-10 students per station in a class of 32-40). 3. **First Read (6:00):** Students silently read their article on their own for 6 minutes, marking key ideas and interesting ideas. The teacher will remind them that the goal is not necessarily to finish in the allotted time, but to understand what they do read. If they finish before time is called, the students should reread the article. The teacher will note the time and instruct students to begin reading. The teacher will call out when there are 2 minutes remaining. At the end, the teacher will remind students that it is acceptable if they did not finish. They will have other chances to finish reading the article. 4. Teacher will pair students within Expert Groups. 5. **Second Read (10:00):** Student 1 will read paragraph 1 to their partner. Student 1 will then choose one of the clarifying bookmark sentence starters to make a statement about the reading. Student 2 will then read paragraph 2 to their partner. Student 2 will then choose of the clarifying bookmark sentence starters to make a statement about the reading. The pair of students will continue until they have finished reading the article to one another. **NOTE:** Model this for students in the front of the classroom. This technique gets tedious so you might ask students to each use this skill three or four times so six to eight paragraphs are looked at closely. 6. **Third Read (10:00):** Students will review the article and answer the questions on the Jigsaw Matrix with their partner. Students should discuss their answers with other students in the Expert Group and add any information to their own papers that may be missing. **Interacting With the Concept/Text (Day 6)** <u>Jigsaw Matrix Sequence</u> 1. Students are sitting in their Base Groups.	**English Learners:** • Peer grouping for immediate feedback and support • Expert group 1 to support language with pictures • Clarifying Bookmarks • Language Support for Agreeing and for Disagreeing • Multiple opportunities to read, write, speak, and listen **Special Needs:** • Provide audio versions of the articles (either record the article or someone reads the article to the group). • Provide article ahead of time for pre-reading • Teacher proximity for immediate support

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding		
		2. Teacher will assign a random student to begin in each Base Group. This will ensure students do not listen to what groups near them are saying and change their own responses. **Base Group Share (about 8:00/student, 32 min total)** 3. Expert student #1 will share which article they read. He/She will read the first question out loud and then his/her answer. 4. Other members of the Base Group will take notes on their Jigsaw Matrix. This continues until all the questions/answers are read out loud. ***NOTE**: Watch for students swapping papers and copying. Prevent this by explaining this is a listening and paraphrasing activity. It takes too long to copy word for word, so rewrite it using own words. 5. The next Expert student (if Expert Group 2 went first then Expert Group 3 will go next) will share which article they read. The pattern of reading out loud question and answer will continue with other group members taking notes on their Jigsaw Matrix. This continues until all Experts have shared their article. **6.** Expert student #1 will share his/her one-sentence for article #2 (if the student was Expert Group #1 then he/she will share ***theme of*** **article** for Article #2). **7.** The student that is Expert Group 2 for Article #2 will then respond with *"I agree with _____ because…"* ***or*** *"I disagree with _____ because…."* **Base Group Discussion (about 10 mins)** 8. Students in Base Groups will independently review (skim and scan) and choose **one sentence directly from all four articles** as the ***theme of article*** and write this down on resource page titled "Theme of Water-Related Articles." (Day 5 3.5). **9.** This pattern continues with the next Expert student.	**Accelerated Learners:** • Use the 12 Clarifying Bookmarks instead of 6 Clarifying Bookmarks • Assign to expert group 4 • Students read an additional article and start on the extension activity early.

Class Discussion (about 10 mins)

10. Teacher will randomly select one student from each Base Group and they will share their ***theme of article*** that they shared (and was agreed on) in their Base Group out loud to the class.

11. Have students work in base groups to summarize the main point of each article in their own words.

Sentence Starters can be put on the overhead or smartboard:

- How can we summarize what we discussed?
- What have we discussed?
- How can we bring these ideas together?
- What is the main point we want to communicate after discussing this?
- What is our conclusion?
- We can say that…
- It boils down to…
- We can agree that…
- Even though some might think that…, we conclude that

Extending Understanding:

1. As a team, students go through each article and think about how each article applies to their lives. Students might also think of a time when they observed information from the article in real life or how they could apply the information to help them.
2. As an exit slip, students do a quick write to share one of these connections, citing the article.

Lesson Reflection

Teacher Reflection Evidenced by Student Learning/ Outcomes	

WATER-RELATED VIDEOS/QUICKWRITE

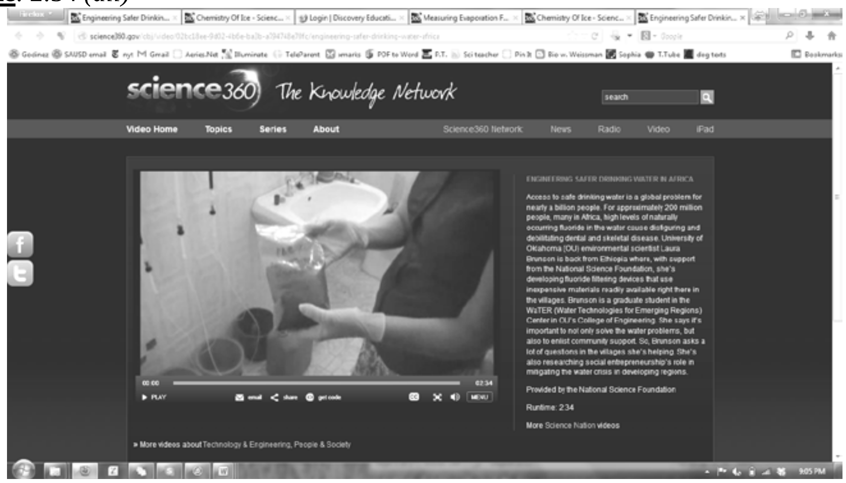
DIRECTIONS: **(1)** At the end of watching each video below, reflect upon the ***theme of the video.*** Write down your one sentence paraphrase of the ***theme of the video*** below. **(2)** At the end of watching all the videos, go into your Base Group and you will share ***one*** of your ***theme of the video*. (Tallest Student** in Base Group begins by sharing his/her ***theme for Video #1).*** **(3)** Student to the right of the Tallest Student responds with *"I agree with _____ because…"* ***or*** *"I disagree with _____ because…".* **(4)** Continue clockwise from the Tallest Student with steps 2 and 3 for Videos #2 – 4.

VIDEO:	**1. Engineering Safer Drinking Water in Africa** **LINK:** http://science360.gov/obj/video/02bc18ee-9d02-4b6e-ba3b-a794748e70fc/engineering-safer-drinking-water-africa **Time:** 2:34 (ALL)	**2. Chemistry of Ice** **LINK***:* http://science360.gov/obj/video/8037e238-41a8-4bbb-b903-9da2557caf9c/chemistry-ice **Time:** 5:22 (first 4:30)	**3. Boiling Point of Water as a Function of Altitude** **DISCOVERY EDUCATION**: Search for "Boiling Point as a Function of Altitude" **Time:** 3:28 (ALL)	**4. Measuring Evaporation From Crops** **LINK:** http://science360.gov/obj/video/5b86956d-b1b0-4d3f-8071-a2dcb8e2906c/measuring-evaporation-crops **Time:** 1:43 (ALL)
THEME OF THE VIDEO: (INDIVIDUAL REFLECTION)				

WATER-RELATED VIDEOS/QUICKWRITE
RELEVANT CONNECTIONS TO ACCOMPANY JIGSAW MATRIX READING ARTICLES

Article #1: **“WHAT-ER” YOU GOING TO DO ABOUT WATER CONSERVATION?**

Science 360 Video: “Engineering Safer Drinking Water in Africa”
Time: 2:34 *(all)*

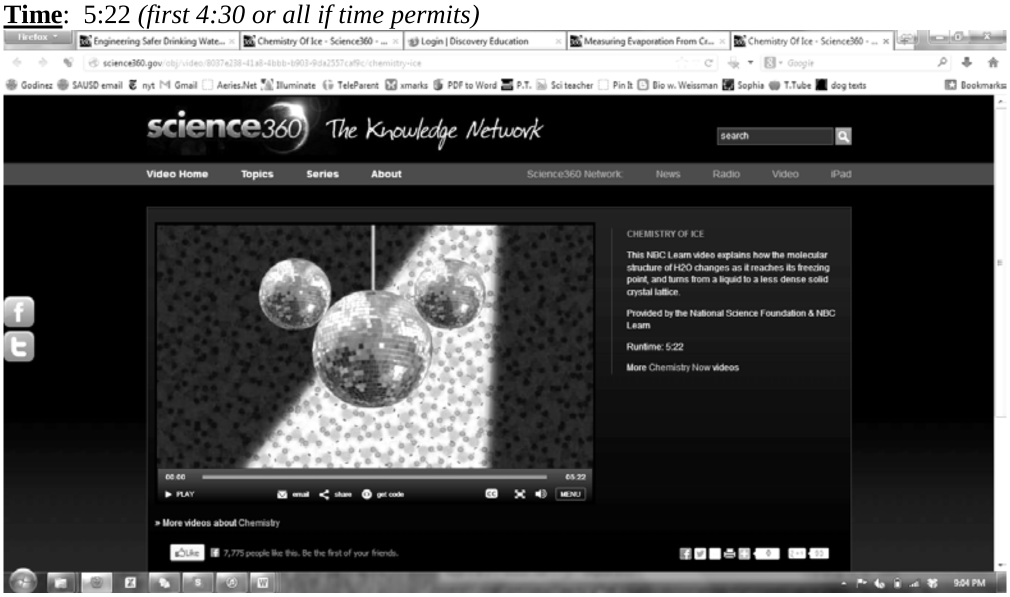


LINK: http://science360.gov/obj/video/02bc18ee-9d02-4b6e-ba3b-a794748e70fc/engineering-safer-drinking-water-africa

SYNOPSIS: Access to safe drinking water is a global problem for nearly a billion people. For approximately 200 million people, many in Africa, high levels of naturally occurring fluoride in the water cause disfiguring and debilitating dental and skeletal disease. University of Oklahoma (OU) environmental scientist Laura Brunson is back from Ethiopia where, with support from the National Science Foundation, she’s developing fluoride filtering devices that use inexpensive materials readily available right there in the villages.

Article #2: **THE HIDDEN FORCE IN WATER**

Science 360 Video: “Chemistry of Ice”
Time: 5:22 *(first 4:30 or all if time permits)*

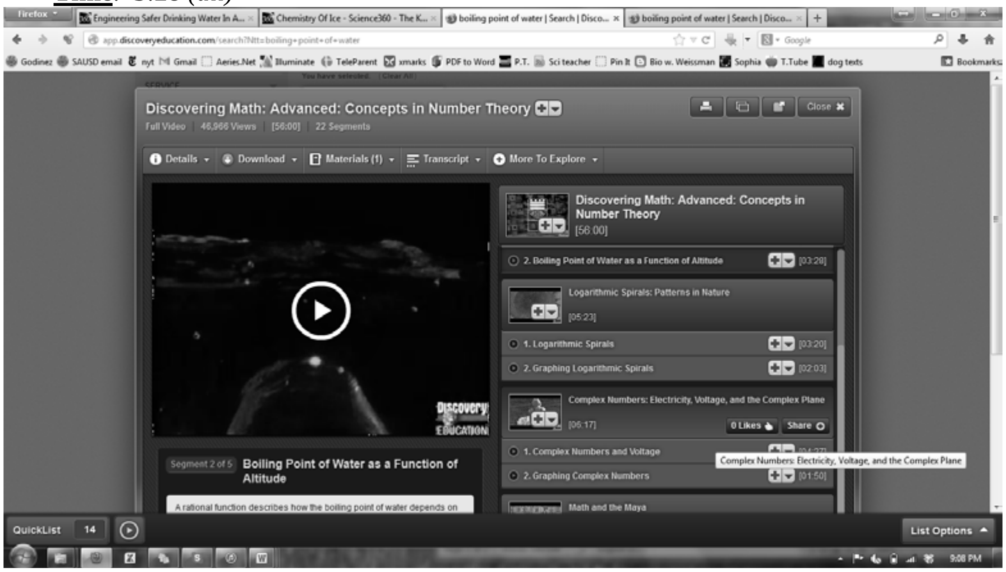


LINK: http://science360.gov/obj/video/8037e238-41a8-4bbb-b9039da2557caf9c/chemistry-ice

SYNOPSIS: This NBC Learn video explains how the molecular structure of H_2O changes as it reaches its freezing point, and turns from a liquid to a less dense solid crystal lattice.

Article #3: **<u>WHAT'S TAKING SO LONG? (District Log-in Required). Downloaded video in electronic Copy</u>**

<u>Discovery Education:</u> "Boiling Point of Water as a Function of Altitude"
<u>Time</u>: 3:28 *(all)*

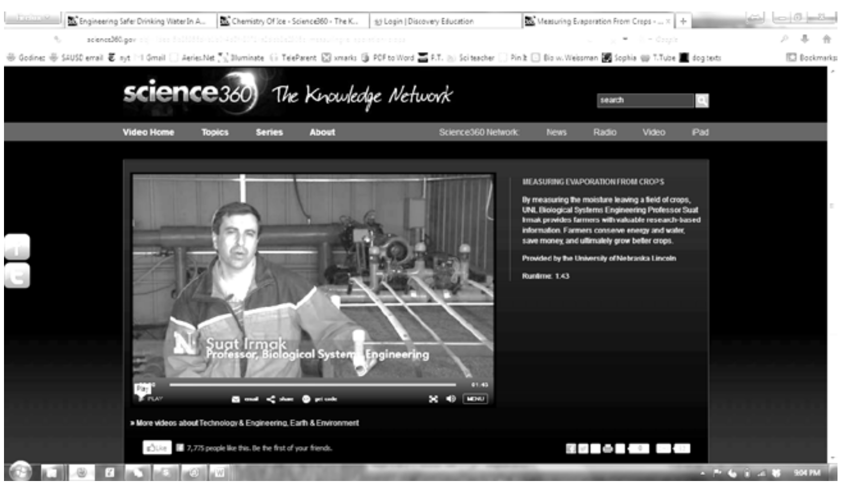


Video Downloaded and included on the "electronic copy" of this unit OR:
<u>Link</u>: <u>http://app.discoveryeducation.com/search?Ntt=boiling+point+of+water</u>

<u>SYNOPSIS</u>: A rational function describes how the boiling point of water depends on the altitude.

Article #4: **<u>MR. FREEZE – WHAT'S YOUR PHASE?</u>**

<u>Science 360:</u> "Measuring Evaporation From Crops"
<u>Time</u>: 1:43 minutes *(all)*



<u>LINK</u>: <u>http://science360.gov/obj/video/5b86956d-b1b0-4d3f-8071-a2dcb8e2906c/measuring-evaporation-crops</u>

<u>SYNOPSIS</u>: By measuring the moisture leaving a field of crops, UNL Biological Systems Engineering Professor Suat Irmak provides farmers with valuable research-based information. Farmers conserve energy and water, save money, and ultimately grow better crops. Provided by the University of Nebraska Lincoln.

Boiling Point of Water as a Function of Altitude

Discovery Education

6 Clarifying Bookmarks

What I can do	What I can say	How I can respond to my partner
I am going to think about what the selected text may mean.	I'm not sure what this is about, but I think it may mean…	*I agree/disagree because...*
	This part is tricky, but I think it means…	*I think I can help, this part means...*
	After rereading this part, I think it may mean…	
I am going to summarize my understanding so far.	What I understand about this reading so far is…	*I agree/disagree because...*
	I can summarize this part by saying…	*I don't understand, can you explain more?*
	The main points of this section are…	

12 Clarifying Bookmarks

What I can do	What I can say	How I can respond to my partner
I am going to think about what the selected text may mean.	I'm not sure what this is about, but I think it may mean…	*I agree/disagree because...*
	This part is tricky, but I think it means…	*I think I can help, this part means...*
	After rereading this part, I think it may mean…	
I am going to summarize my understanding so far.	What I understand about this reading so far is…	*I agree/disagree because...*
	I can summarize this part by saying…	*I don't understand, can you explain more?*
	The main points of this section are…	
I am going to use my prior knowledge to help me understand.	I know something about this from…	*I think I can help, I read/heard about this when...*
	I have read or heard about this when…	*I also know something about this, and I would like to add...*
	I don't understand the section, but I do recognize…	
I am going to apply related concepts and/or readings.	One reading/idea I have encountered before that relates to this is..	*Tell me more about _________; I don't think I studied about....*
	We learned about this idea/concept when we studied…	*I agree/disagree, I think the concept is related to...*
	This concept/idea is related to…	

"WHAT-ER" YOU GOING TO DO ABOUT WATER CONSERVATION?

Mini Joke

Q: What happens when you illegally park a frog?
A: It gets toad away!

FAST FACTS

About 780 million people around the world don't have access to safe drinking water.

Less than 1 percent of our planet's water is freshwater that we can drink.

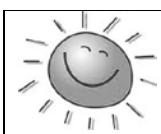
About 70 percent of the planet's freshwater is used for **irrigation**, or supplying water to land and crops.

2, 072 gallons of water is used to make four new tires.

The Water Cycle

Most decisions about water use are made by ordinary people, such as farmers and factory managers. Experts say children who learn about water at a young age can become leaders in meeting our planet's challenges.

We can begin with the water cycle. We never get "new" water. Nature recycles water over and over again. Here's how it works:

 1. The sun shines on lakes, rivers, streams and oceans. Heat turns water into invisible water vapor. This is called **evaporation**.	 2. The vapor rises into the sky, where it cools. When it gets cold enough, the vapor turns into clouds. This is **condensation**. Air currents move clouds all around the Earth.
 3. The clouds get cooler. Tiny drops of water vapor turn into rain, snow, sleet or hail. We call this **precipitation**. Snow may melt and turn into runoff, which flows into rivers and the ocean, as well as into the ground.	 4. Most precipitation falls back into the ocean, but some falls on land. Most of the water eventually finds its way back into the ocean through rivers and underground sources. Some of the runoff seeps into the ground. Plants use the water, and it evaporates from their leaves.

Used Water to "New" Water

What happens to the wastewater that flows from your toilet, kitchen sink, and bathroom shower?

The process below begins with how wastewater from homes in Orange County first travels to the Orange County Sanitation District (OCSD) before flowing to the Orange County Water District (OCWD).

Step One: Pre-Purification (at OCSD)

Wastewater is first treated at the Orange County Sanitation District (OCSD). OCSD collects more than 200 million gallons of wastewater per day and removes a high degree of impurities through several processes. A stringent source control program limits metals and chemicals flowing into OCSD's plants in Fountain Valley and Huntington Beach. The wastewater undergoes treatment through bar screens, grit chambers, trickling filters, activated sludge, clarifiers and disinfection processes before it is sent to the Groundwater Replenishment System at the Orange County Water District (OCWD) where it undergoes a state-of-the-art purification process consisting of microfiltration, reverse osmosis, and ultraviolet light with hydrogen peroxide.

Step Two: Microfiltration (at OCWD)

Microfiltration is a separation process that uses polypropylene hollow fibers, similar to straws, with tiny holes in the sides that are 0.2 micron in diameter (1/300 the diameter of a human hair). By drawing water through the holes into the center of the fibers, suspended solids, protozoa, bacteria and some viruses are filtered out of the water.

Step Three: Reverse Osmosis (at OCWD)

Reverse osmosis (RO) membranes are made of a semi-permeable polyamide polymer (plastic). During the RO process, water is forced through the molecular structure of the membranes under high pressure, removing dissolved chemicals, viruses and pharmaceuticals in the water. The end result is near-distilled-quality water so pure that minerals have to be added back to stabilize the water.

Step Four: Ultraviolet (UV) Light with H_2O_2 (at OCWD)

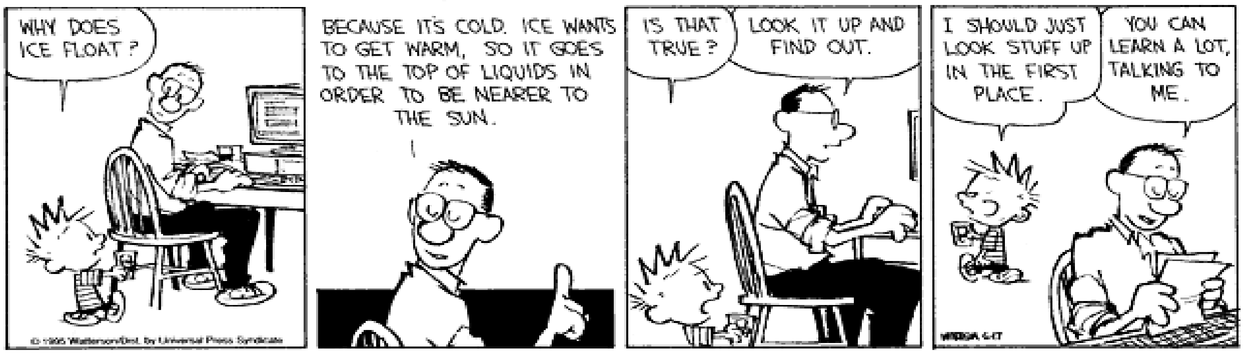
After RO, the water is exposed to high-intensity ultraviolet (UV) light with hydrogen peroxide (H_2O_2) to disinfect and to destroy any trace organic compounds that may have passed through the reverse osmosis membranes.

Approximately 35 million gallons per day of the GWRS water are pumped into injection wells to create a seawater intrusion barrier. Another 35 million gallons are pumped daily to Orange County Water District's percolation basins in Anaheim where the GWRS water naturally filters through sand and gravel to the deep aquifers of the groundwater basin that serve as an underground reserve of water.

Quick and Easy Water Conservation Tips

1. Water your lawns early in the morning before sunrise or in the evenings after sunset. This will maximize water **absorption** into the soil and minimize loss due to **evaporation**.
2. Take five-minute or less showers, and draw less water for baths.
3. Turn off the water while brushing your teeth or shaving.
4. Only wash laundry with full loads.
5. Use a bowl or fill up the sink to clean vegetables.
6. Wash the car with a bucket instead of the hose.
7. Use a broom instead of water to clean your sidewalks and driveways.

THE HIDDEN FORCE IN WATER



Calvin and Hobbes

A Molecular Comparison of Gases, Liquids, and Solids

Some of the characteristic properties of gases, liquids, and solids are listed in Table 1 below.

Table 1. Some Physical Properties of the States of Matter	
Gas	Assumes both the volume and shape of its container Is compressible Flows readily Diffusion within a gas occurs rapidly
Liquid	Assumes the shape of the portion of the container it occupies Does not expand to fill container Is virtually incompressible Flows readily Diffusion within a liquid occurs slowly
Solid	Retains its own shape and volume Is virtually incompressible Does not flow Diffusion within a solid occurs extremely slowly

These physical properties can be understood in terms of the energy of motion (kinetic energy) of the particles of each state by comparing them to the **intermolecular forces** between those particles. Intermolecular forces are the forces of attraction that exist *between molecules*. In other words, these forces of attraction are the "glue" that holds molecules together. On the other hand, forces of attraction *between atoms* in a molecule are **intramolecular forces.**

Gases consist of a collection of widely separated molecules in a constant, chaotic motion. The average energy of the attractions between the molecules is much smaller than their average kinetic energy. The lack of strong attractive forces between molecules allows a gas to expand to fill its container.

In liquids the intermolecular attractive forces are strong enough to hold molecules close together. Thus, liquids are much denser and far less compressible than gases. Unlike gases, liquids have a definite volume, independent of the size and shape of their container. The attractive forces in liquids are not strong enough, however, to keep the molecules from moving past one another. Thus, any liquid can be poured and it assumes the shape of whatever portion of its container it occupies.

In solids the intermolecular attractive forces are strong enough not only to hold molecules close together, but to virtually lock them in place. Solids, like liquids, are not very compressible because the molecules have little free space between them. Because the particles of a solid are not free to undergo long-range movement, solids are rigid.

Figure 1 below compares the three states of matter. *The state of a substance depends largely on the balance between the kinetic energies of the particles and the interparticle energies of attraction.* The kinetic energies, which depend on temperature, tend to keep the particles apart and moving. The interparticle attractions tend to draw the particles together. Substances that are gases at room temperature have weaker interparticle attractions than those that are liquids; substances that are liquids have weaker interparticle attractions than those that are solids.

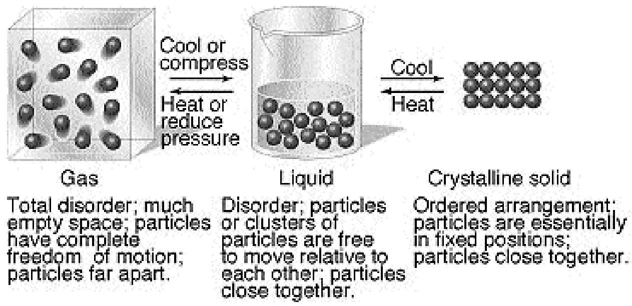


Figure 1. Molecular-level comparison of gases, liquids, and solids. The particles can be atoms, ions, or molecules.

Intermolecular Forces in Water

The strengths of intermolecular forces such as hydrogen bonding are generally much weaker than ionic or covalent bonds (Figure 2). Less energy, therefore, is required to **vaporize, or evaporate**, a liquid or to melt a solid than to **break** covalent bonds in molecules. For example, only about 4 kJ/mole to 25 kJ/mole of energy is required to overcome the intermolecular attractions between H_2O molecules in solid H_2O to melt it to liquid H_2O and then to vaporize it. In contrast, the energy required to break the covalent bond to dissociate (split apart) H_2O into H and O atoms is 463 kJ/mole. Thus, when a molecular substance like H_2O changes from solid to liquid to gas, the molecules themselves remain intact.

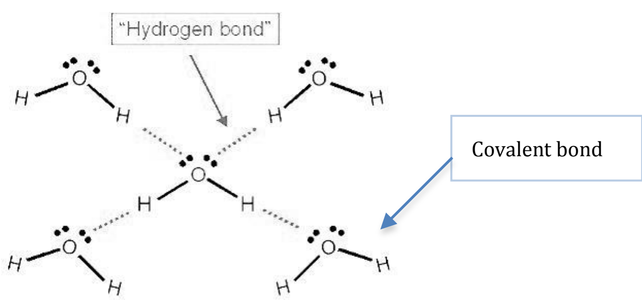
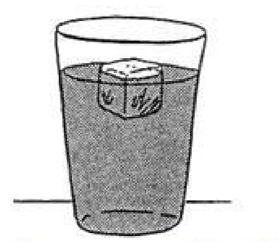


Figure 2. Intermolecular attraction. Comparison of a covalent bond (intramolecular force) and an intermolecular force (hydrogen bond).

One of the remarkable consequences of hydrogen bonding is found when the densities of ice and liquid water are compared. In most substances the molecules in the solid are more densely packed than in the liquid. Thus, the solid phase is denser than the liquid phase. However, the density of ice at 0°C (0.917 g/mL) is less than that of liquid water at 0°C (1.00 g/mL), so ice floats on liquid water (Figure 3).

Figure 3. Comparing densities of liquid and solid phases. The solid phase of water, ice, is less dense than its liquid phase, causing the ice to float on the water.



The lower density of ice compared to that of water can be understood in terms of hydrogen-bonding interactions between H_2O molecules. In ice the H_2O molecules assume an ordered, open arrangement as shown in Figure 4 below. This arrangement optimizes the hydrogen bonding interactions between molecules, with each H_2O molecule forming hydrogen bonds to four other H_2O molecules. These hydrogen bonds, however, create the open cavities shown in the structure. When the ice melts, the motions of the molecules cause the structure to collapse. The hydrogen bonding in the liquid is more random than in ice, but it is strong enough to hold the molecules close together. Consequently, liquid water has a more dense structure than ice, meaning that a given mass of water occupies a smaller volume than the same mass of ice.

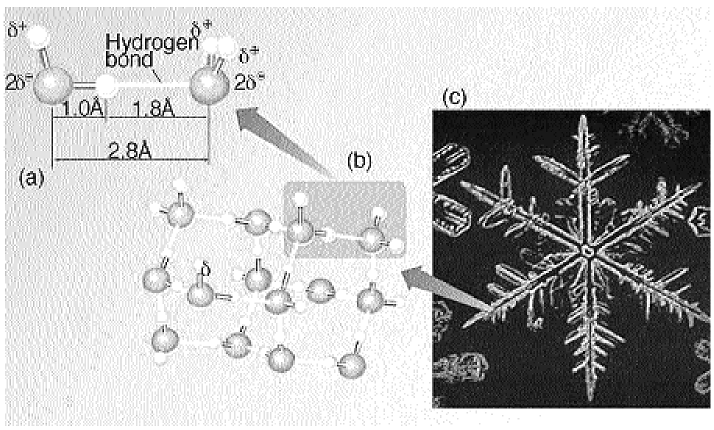


Figure 4. Hydrogen bonding in ice. (a) Hydrogen bonding between water molecules. (b) The arrangement of H_2O molecules in ice. Each hydrogen atom on one H_2O molecule is oriented toward an adjacent H_2O molecule. (c) As a result, ice has an open, hexagonal arrangement of H_2O molecules, characteristic of snowflakes.

The lower density of ice compared to liquid water profoundly affects life on Earth. Because ice floats (Figure 3), it covers the top of the water when a lake freezes in cold weather, thereby insulating the water below. If ice were denser than water, ice forming at the top of a lake would sink to the bottom, and the lake could freeze solid. Most aquatic life could not survive under these conditions. The expansion of water upon freezing (Figure 5) is also what causes water pipes to break in freezing weather.

Figure 5. Expansion of water upon freezing. Water is one of the few substances that expand upon freezing. The expansion is due to the open structure of ice relative to that of liquid water.

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WHAT' S TAKING SO LONG?

Mini Joke

Q: Is it dangerous to swim on a full stomach?
A: *Yes. It's better to swim in water.*

FAST FACTS

Water makes up 70 – 75% of your total body weight.

Reducing water in the body as little as 5% can result in as much as 20-30% drop in physical performance, 10% reduction can make you sick, and 20% can mean death.

39, 090 gallons of water are used to manufacture a new car, including tires.

Do We Really Need Water to Survive?

Water is a colorless and odorless liquid made up of molecules containing two atoms of **hydrogen** and one atom of **oxygen (H_2O)**. Water is essential for all life to exist, as it makes up more than 70 percent of most living things. While a human can survive more than a week without food, a person will die within a few days without water.

Water serves as a solvent (something that dissolves) for nutrients and delivers nutrients to cells, while it also helps the body eliminate waste products from the cells. Both the spaces **between cells** (**inter**cellular spaces) and the spaces **inside cells** (**intra**cellular spaces) are filled with water. Water lubricates joints and acts as shock absorbers inside the eyes and spinal cord. Amniotic fluid, which is largely water, protects the fetus from bumps and knocks.

Water also helps the body maintain a constant temperature by acting as a thermostat. When a person is too hot, whether from being in a hot environment or from intense physical activity, the body sweats. When sweat evaporates, it lowers the body temperature and restores homeostasis.

The most efficient way for the body to get water is for a person to drink water. It is recommended that an adult drink eight to ten eight-ounces of glasses of water a day. Athletes and active teens should drink at least ten to twelve glasses daily. However, many foods and beverages contain water, which can make up part of this daily intake. Fresh fruits and vegetables, cooked vegetables, canned and frozen fruits, soups, stews, juices, and milk are all sources of water. Most fruits and vegetables contain up to 90 percent water, while meats and cheeses contain at least 50 percent. Metabolic processes in the human body generate about 2.5 liters of water daily. So, yes! Water is essential to survive!

Bubbles Or No Bubbles?

Evaporation occurs when molecules have sufficient kinetic energy to escape the surface of a liquid into the gas (vapor) phase. Essentially, all liquids in an open container will evaporate but not necessarily boil. Some liquids have a higher rate of evaporation than others though. Why? The molecules on the surface of the liquid must possess sufficient kinetic energy to overcome the intermolecular forces of their neighbors and escape into the gas phase. Vapor pressure, the pressure exerted by molecules in the gas phase, thus depends on the intermolecular forces of molecules. The weaker the attractive forces, the larger the number of molecules that are able to escape and therefore, the higher is the vapor pressure. The stronger the attractive forces, the smaller the number of molecules that are able to escape and therefore, the smaller is the vapor pressure. Substances with high vapor pressure (such as gasoline) evaporate more quickly than substances with low vapor pressure (such as motor oil).

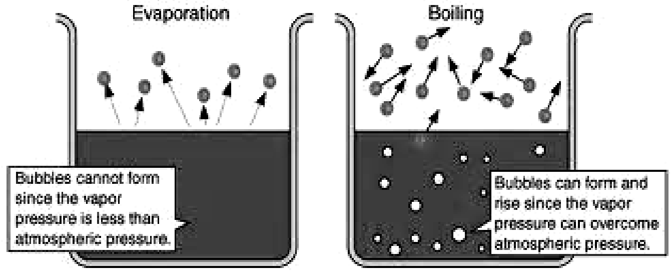

Figure 1. Evaporation versus Boiling Evaporation occurs when vapor escapes from the surface of the liquid. Boiling occurs when enough heat has been absorbed by the liquid and bubbles of vapor form within the liquid.

For water, hot water evaporates more quickly than cold water because vapor pressure increases with increasing temperature. As the temperature of liquid water increases, the molecules move more energetically and a greater number can therefore escape more readily from their neighbors and change from a liquid molecule of H_2O to a vapor molecule of H_2O. As Figure 1 illustrates, **evaporation** occurs without bubbles (vapor) forming while **boiling** occurs when bubbles (vapor) form in the liquid and consequently, a higher rate of vaporization occurs.

So when does water **boil?**

Why Does It Take Longer To Cook At Higher Altitudes?

A liquid boils when its vapor pressure **equals** the atmospheric pressure acting on the surface of the liquid. At this point bubbles of vapor are able to form within the liquid as shown in Figure 1. The following table shows the approximate boiling point of pure water at various altitudes:

Table 1 Boiling Point of Pure Water.

Place	**Altitude (feet)**	**Boiling Point (°F)**	**Boiling Point (°C)**
Dead Sea	- 1, 312	215	101.7
Sea Level (Orange County)	0	212	100.0
Mammoth Mountain (California)	11,060	191.3	88.5
Mount Everest (Himalayas)	29, 028	157	69.4

At sea level, water boils at 100.0 °C while at a higher altitude in Mammoth Mountain, water boils at lower temperature of 88.5°C. Why is there a difference in boiling point of water at different altitudes? At sea level, since there are a few miles of air above us, lots of stuff (molecules) in the air is all pulled to the earth by gravity. Thus, the amount of air pushing down on you increase. Conversely, as you go higher up in the atmosphere (11,060 feet), there is less atmospheric pressure (i.e. much less air pressing down on

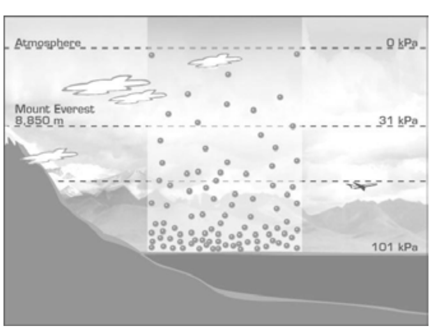

Figure 2. Molecules in the Air. More molecules at Earth's surface (sea level) result in a higher atmospheric pressure. Less molecules at high altitudes (mountains) result in a lower atmospheric pressure.

you). As Figure 2 shows above, more molecules at sea level (Earth's surface) results in a higher atmospheric pressure while at higher altitudes (mountains) there are less molecules and thus, a lower atmospheric pressure.

The same is true for being underwater: the closer to the surface you are, the less pressure you feel in your ears; the deeper you go, the greater the pressure. But as you go up in the atmosphere, the surrounding air pressure is less.

> **Question**: So why *does* it take more time to cook an egg in water at a higher altitude (11,060 feet) up in the atmosphere if the boiling point of water is lower at higher altitudes?

As long as water is present, the maximum temperature of the food being cooked is the boiling point of water. We now understand that water boils when the vapor pressure of the water equals the atmospheric pressure. When there is less atmospheric pressure, a lower vapor pressure is required to get the water boiling, hence a lower boiling temperature.

Even though the boiling point of water at the top of Mammoth Mountain is 88.5°C, which means water will boil sooner, the egg needs to be in the boiling water for a **longer time** before being *fully cooked*. Thus, the time to cook an egg in water at the top of Mammoth Mountain is 5 minutes 27 seconds while at sea level in Orange County, it only takes 3 minutes 29 seconds.

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MR. FREEZE – WHAT'S YOUR PHASE?

Ms. B. Haven: Freezy, I'm feeling hot.
Mr. Freeze: I find that unlikely.
Ms. B. Haven: Okay, so my hair is brittle and my skin is dry. I'd weather the blizzards just to have you. You're the most perfect man I've ever known. What do you say we heat things up?
Mr. Freeze: My passion thaws for my bride alone.
Ms. B. Haven: Ooh. Talk about your cold shoulder.

What Will Happen to Mr. Freeze With Heat Energy?

Batman: I saw what happened to your wife, I'm sorry.
Mr. Freeze: I'm beyond emotions. They've been frozen dead in me.
Batman: That suit you wear, a result of the coolant?
Mr. Freeze: Very good, a detective to the last. I can no longer survive outside a sub-zero environment.

Every **phase change** is accompanied by a change in energy (or heat) of the system. Mr. Freeze survives at *sub-zero* temperatures, at temperatures less than 0°C! Assuming Mr. Freeze is made of water molecules, where does this place him on the heating curve of water shown in Figure 1? If thermal energy (heat) is added to him, he does not change and melt from ice to liquid immediately. But something about Mr. Freeze does change. What do you notice happens to his *sub-zero* body temperature of -20°C when heat is added? *Mr. Freeze's body temperature increases to 0°C.*

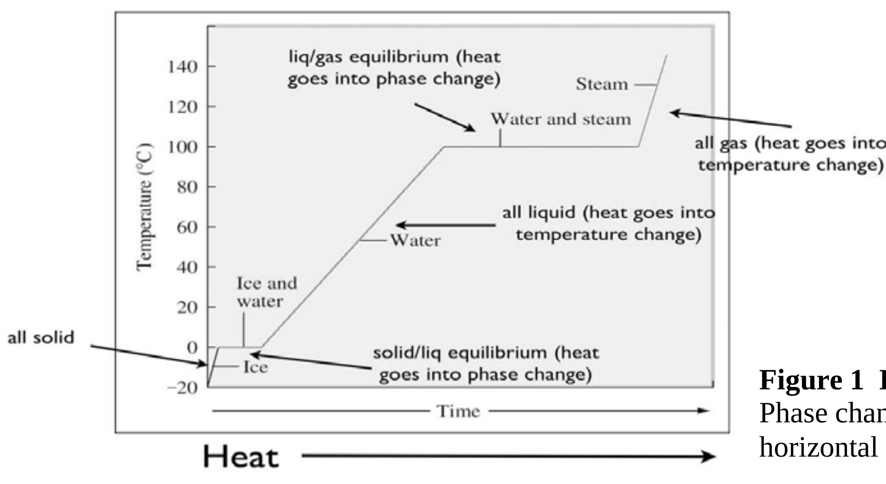

Figure 1 Heating Curve of Water. Phase changes only occur on the horizontal sections.

Question: So why did Mr. Freeze *not immediately* melt once heat was absorbed?

In a solid as Mr. Freeze (who is at a *sub-zero* temperature *less than 0°C*), the ice molecules of water are in a fixed position with respect to one another and closely arranged to minimize motion. The initial heat absorbed by Mr. Freeze is being used to **weaken** the intermolecular attractive forces that hold his ice molecules close together. As more and more heat is absorbed, the **kinetic energy** (energy of motion) of the solid ice molecules increases. The increasing vibration and movement of the ice molecules due to the increasing kinetic energy **causes** the temperature of the solid ice to increase. Mr. Freeze is still pure solid ice at this point.

Since water has a **normal melting point of 0°C**, the temperature at which water changes from a solid to a liquid state, any heat absorbed is used to bring the temperature of *sub-zero* Mr. Freeze **up to 0°C.** Therefore, it is *only when the ice molecules of Mr. Freeze have reached a temperature of 0℃* does Mr. Freeze *begin* to melt with continuous heat being added! At 0°C, Mr. Freeze experiences a **melting phase change**, from solid ice →liquid water.

Thus at 0°C, the water molecules of Mr. Freeze will **coexist** as a solid and as a liquid, in a solid/liquid **equilibrium**. The first horizontal section of the heating curve in Figure 1 represents this. Additional heat energy added to Mr. Freeze at this point *does not* change his temperature of 0°C. The heat absorbed (called the **Heat of Fusion)** is now transforming the solid ice to liquid water. Once enough heat is absorbed to overcome the attractive forces between all the ice molecules, Mr. Freeze has completely transformed into *Mr. Liquid,* existing as only liquid molecules. Mr. Freeze will essentially have thawed.

Batman: Freeze! *Mr. Freeze*: That's Mr. Freeze to you.

Can It Get Worse for Mr. Freeze?

Absolutely!

We have seen liquid water over several days begin to evaporate. In general, each state of matter (solid, liquid, or gas) can change into either of the other two states. For example, liquid water can change to solid water (ice) by losing heat (enthalpy decreases) or change to gas (water vapor) by absorbing heat (enthalpy increases). Figure 2 shows the name associated with each of these transformations. These transformations are called either **phase changes** or changes of state. **Changes of state** are changes in physical properties, not chemical properties. The water molecule is still H_2O whether it is ice, water, or steam (gas).

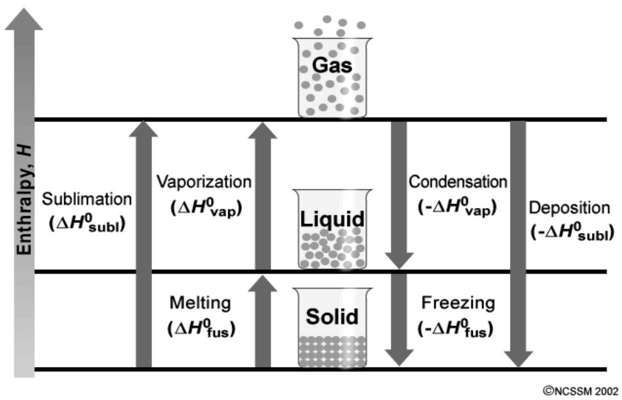

Figure 2. Phase changes and the names associated with them. The changes represented by red arrows indicate energy absorbed while the blue arrows indicate energy released.

Mr. Liquid's temperature, with additional heat energy added, increases as shown in section C of Figure 3. All the additional heat energy at this point is being used to overcome the intermolecular attractive forces of the liquid water molecules. *Mr. Liquid's* temperature will increase to100°C and at this temperature, *Mr. Liquid* will begin the **vaporization phase change**, transforming into *Mr. Vapor* and he will cease to exist in one location!

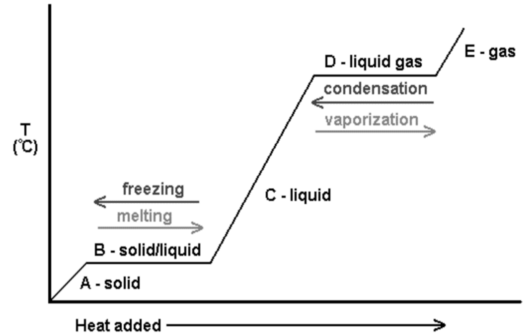

Figure 3. Heating Curve of Water. Heat absorbed at Sections A, C, and E are used to overcome intermolecular attractive forces. As a result, only temperature increases and no phase change occurs.

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#1: *"WHAT-ER" YOU GOING TO DO ABOUT WATER CONSERVATION?*

1. Evaporation and condensation are opposite processes; evaporation occurring when heat is absorbed by liquid water molecules that then change into gas water molecules. Compare and contrast the two processes by drawing a thinking map that best represents your information.

2. The article writes: "We never get new water." What is the implication of this statement regarding our usage of water and Africa's access to safe drinking water?

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3. Roughly 80 to 90 percent of Southern California's water is imported from Northern California or the Colorado River. The transportation of the water has been an environmental concern due to the deterioration of habitats for endangered species. The costs for recycling wastewater and importing water are about the same. In addition, a little known fact is that bottled water (i.e. Crystal Geyser and Arrowhead) is essentially the same as recycled water, minerals are just added to perfectly good drinking water for taste. <u>Your task</u>: Develop an argument that you will share with the staff and students at Godinez that explains the process of recycling wastewater and convincing them that the end product is perfectly good drinkable water without the extra cost of a plastic bottle.

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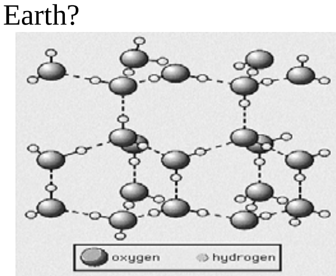
#2: *THE HIDDEN FORCE IN WATER*

1. Redraw Figure 2 from the article showing all the details. Your Task: (1) In the figure you have drawn, next to **hydrogen bond** and **covalent bond,** write the name of the corresponding force, **intermolecular forces** or **intramolecular forces**. (2) Above each bond/force, label with the **amount of energy** needed to overcome or break the bond/force. (3) Write one to two complete sentences using all of the bolded phrases from this prompt to explain the figure.
Figure 2:

2. For each category, order the three states of matter (solid, liquid, and gas) with respect to H_2O from **lowest (weakest) to highest (strongest).**

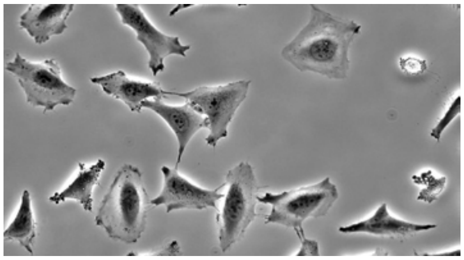
CATEGORY	ORDER (Lowest/Weakest→Highest/Strongest)
1. Strength of Intermolecular Forces (Interparticle Attraction)	Gas < Liquid < Solid
2. Ability to Flow (Move)	
3. Absorbed the Most Heat	
4. Amount of Kinetic Energy	
5. Density	

3. Examine the figure below. (1) What geometric shape are the water molecules forming and which state of matter does it represent? Explain. (2) "The density of ice (solid water) is fortunately less than the density of liquid water". Interpret this statement and how is this statement significant to life on Earth?

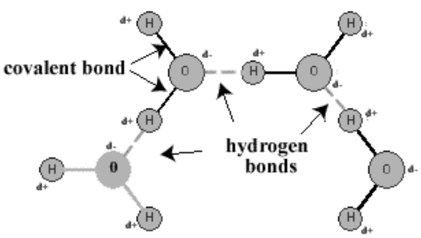


#3: *WHAT'S TAKING SO LONG?*

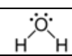
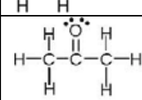
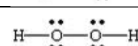
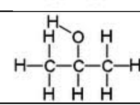
1. Examine the image below of human cells in a petri dish as seen from a microscope. Identify and label where the **<u>inter</u>cellular spaces** versus **<u>intra</u>cellular spaces** could be found. Write a complete sentence using the <u>all of the bolded phrases</u> from this prompt plus the words **between** and **inside** to explain your understanding.



2. Carefully examine the figure below of water (H_2O) molecules. Applying your knowledge of the difference between <u>inter</u>cellular space and <u>intra</u>cellular space, <u>match</u> **covalent bond** and **hydrogen bonds** with either **<u>inter</u>molecular forces** of attraction or **<u>intra</u>molecular forces** of attraction and label these **forces** in the figure. Explain your matching of the bond with the force using <u>all of the bolded phrases</u> plus the words **between**, **inside, molecule,** and **atoms**.



3. Analyze the substances, formulas and boiling points. <u>Your Task</u>: (1) In the table, predict the order of the substances' **vapor pressure** and **intermolecular forces (IMF)**. (1 = highest or strongest and 4 = lowest or weakest).

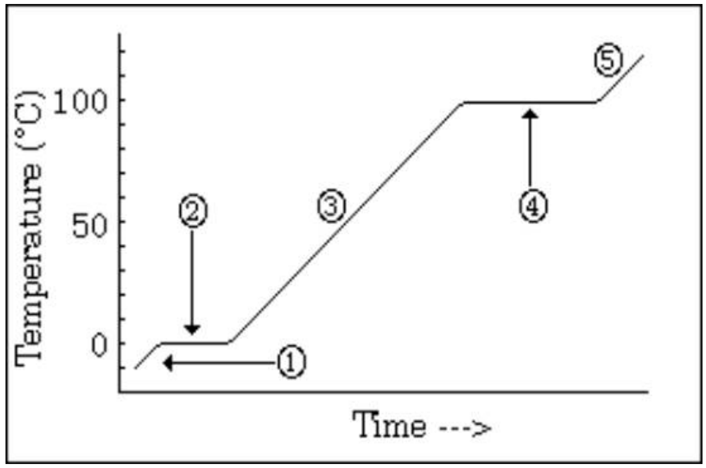
Substance	**Chemical Formula**	**Structural Formula**	**Boiling Point**	**Vapor Pressure**	**IMF**
Water	H_2O		100 °C		
Acetone	C_3H_6O		56 °C		
Hydrogen Peroxide	H_2O_2		150.2 °C		
Isopropyl Alcohol	C_3H_7OH		82.5 °C		

(2) Justify the order of your substances by explaining the relationship between **boiling point, vapor pressure** and **IMF**. (3) How and why will acetone's boiling point and vapor pressure change but not its IMF at the top of Mount Everest?

#4: *MR. FREEZE – WHAT' S YOUR PHASE?*

1. Examine the heating curve.

Your Task: (1) Label the phase(s), or states of matter, that exists at each part of the curve (*1 – 5*). (2) Explain why temperature remains constant during parts *2* and *4* of the curve although heat is continuously being absorbed. (3) What is the name of the endothermic transformation (phase change) occurring at part *4*



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2. Using the heating curve above: (1) Draw a dot on the curve to identify the **freezing point** of this substance and identify the temperature of this **freezing point**. (2) Compare and contrast **freezing point** with **melting point.**

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3. Referencing key information from the heating curve and relevant evidence from the article, identify and explain which phase will most likely exhibit the highest **kinetic energy** and how does this relate to the phase's **intermolecular forces** and the **distance between** the particles? Use all <u>bolded phrases</u> in this prompt in your response.

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THEME OF WATER – RELATED ARTICLES

#1: *"WHAT-ER" YOU GOING TO DO ABOUT WATER CONSERVATION?*

#2: *THE HIDDEN FORCE IN WATER*

#3: *WHAT'S TAKING SO LONG?*

#4: *MR. FREEZE – WHAT'S YOUR PHASE?*

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SAUSD Common Core Lesson Planner **Teacher:**

<table>
<tr><td>Unit: Matter
Day: 7 & 8
Lesson: 4</td><td>Grade Level/Course:
High School Chemistry</td><td>Duration: 2 Class Period
Date:</td></tr>
<tr><td colspan="3">Big Idea: Forces attract, hold together, or repel.
Enduring Understandings: Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles.
Essential Question:
1. How is heat related to temperature and phase changes and the relevance of a heating curve?
2. How are kinetic energy and intermolecular forces of attraction related to state of matter?</td></tr>
<tr><td>Common Core and Content Standards</td><td colspan="2">Content Standards:
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.
HS-PS1-3 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.
Reading Standards for Literacy in Science and Technical Subjects:
RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Writing Standards for Literacy in Science and Technical Subjects:
WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST.9-10.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
Speaking and Listening Standards (ELA):
ELA-Literacy.SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
ELA-Literacy.SL.9-10.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.</td></tr>
</table>

Materials/ Resources/ Lesson Preparation	Student Resource: Day 7-4.1 Heating Curve of Water Lab Student Resource: Day 8-4.2 Heating Curve of Water Lab Analysis Questions For Each Lab Group--250 ml Beaker, crushed ice cubes, thermometer, spatula, timers (only use cellphone times IF your teacher approves it), Bunsen burner set up (Bunsen burner, rubber tubing, ring stand, wire mesh, thermometer clamp), matches, timer. Alternatively use a hot plate. Safety goggles.	
Objectives	**Content:** Students will observe and record that heat can be used for two different things; increasing kinetic energy to raise the temperature OR to cause a phase change. When graphing, students will solidify the concept that during a phase change the temperature does not change, but IMF weaken.	**Language:** Students will discuss lab procedure and results and determine how to represent their data through a concluding statement.
Depth of Knowledge Level	☐ **Level 1: Recall** ☒**Level 2: Skill/Concept** ☒ **Level 3: Strategic Thinking** ☐ **Level 4: Extended Thinking**	
College and Career Ready Skills	☐ **Demonstrating independence** ☒**Building strong content knowledge** ☒**Responding to varying demands of audience, task, purpose, and discipline** **X Comprehending as well as critiquing** ☒**Valuing evidence** ☒**Using technology and digital media strategically and capably** ☐ **Coming to understand other perspectives and cultures**	
Common Core Instructional Shifts	☐ **Building knowledge through content-rich nonfiction texts** ☐**Reading and writing grounded from text** ☒**Regular practice with complex text and its academic vocabulary**	
Academic Vocabulary / **TEACHER PROVIDES SIMPLE**	**KEY WORDS ESSENTIAL TO UNDERSTANDING**	**WORDS WORTH KNOWING (covered in prior lessons)**
	Bunsen Burner Intermolecular forces of attraction	

<table>
<tr><td></td><td>STUDENTS FIGURE OUT THE MEANING</td><td>Solid
Liquid
Gas
Heating Curve</td><td>Phase Change
Mixed phase (multiple phases present at once)
Solidification
Condensation
Boiling
Melting</td></tr>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Before the unit:
1. Teacher may want to review intermolecular forces of attraction in a solid vs. a liquid vs. a gas covered in Lesson 3, day 5 and 6. The IMFs weaken as the substance absorbs energy which allows the molecules to move farther apart. This difference in distance between molecules is what gives a solid, liquid, or gas its distinct properties.
2. Teacher might have students add this information about IMF to their Tree Map created during Lesson 2, day 4. Additional information learned from lesson 3 could be added to the thing map (Day 3 2.)</td></tr>
<tr><td colspan="4">Lesson Delivery</td></tr>
<tr><td colspan="2">Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☒Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☒Guided Inquiry ☒Reflection</td></tr>
<tr><td>Lesson Continuum</td><td>Lesson Open-ing</td><td colspan="2">Preparing the Learner
Prior Knowledge, Context, and Motivation:

1. This lab is intended to be an exploratory lab where students see firsthand that during a phase change energy is absorbed but it does NOT cause a temperature change.
NOTE: Students may see slight changes in temperature during a phase change which can be ignored for the purpose of this lab. These temperature changes occur because the thermometer in ice is also reading the temperature of the air in between the ice cubes. Additionally our thermometers may not be calibrated accurately, so while the ice is 0° C, the thermometer may not read this.
2. The heating curve will not be perfect, with more inaccuracies at the beginning of the curve as the ice may begin melting before students begin recording temperature. If possible, keep ice in a freezer until the start of each class or add a block of dry ice to keep the ice as close to 0° C as possible.
3. This is a very straight forward lab for students and sometimes they will miss the purpose of it. Teacher can help emphasize this by reviewing the purpose of the lab and asking students to predict what their heating curve would look like during phase change based on the information given.</td></tr>
</table>

<table>
<tr>
<td>Lesson Continuum</td>
<td>Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding</td>
<td>

Interacting With the Concept/Text

1. Students should carefully read through the purpose, procedure, and the data table to make sure they understand what needs to be recorded during the lab.
2. When teacher is confident students understand the procedure, students should get lab materials and appropriate safety gear and set up for the lab. REMINDER: students should record temperature for five minutes BEFORE they light their Bunsen burners. This will help them get a longer, flatter melting curve.
3. After the water has boiled for 5 minutes, students can stop recording data points. Water should be at a strong boil.
4. After completing the lab, students should clean up their lab set up and begin on the graphing and data analysis questions.
5. Students should use their Tree Map and any other notes from this unit to answer the Graph Analysis and Post-Lab Questions.
6. During this time the teacher should be checking that students are graphing correctly and begin to notice the trends in the graph (temperature increases when only one phase is in the beaker but remains constant when more than one phase is in the beaker. This constant temperature represents a phase change, hence why there are two phases present in the beaker simultaneously.

Extending Understanding:

1. Have students compare their graph to other lab groups as well as to a more precise heating curve graph. Have them look closely for differences between the graphs.
2. Students may notice thermometers in class recorded different boiling or melting temperatures as well as how long it took for a phase change to occur.
3. Students should try to account for any sources or error in their lab and revise the procedure to try and eliminate some of the errors.
4. If time permits, students could re-run the lab and see how their two sets of data compare.

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Differentiated Instruction:

English Learners:

- Cooperative groups for immediate feedback
- Clarifying Bookmarks
- Language Support for Agreeing and for Disagreeing
- Multiple opportunities to read, write, speak, and listen

Special Needs:

- Provide audio versions of the articles or electronic copy to allow zooming
- Enlarge Clarifying Bookmarks.

Accelerated Learners:

- Use the 12 Clarifying Bookmarks instead of 6 Clarifying Bookmarks
- Multiple opportunities to share thoughts/ideas
- Complex lab procedure to follow in groups

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Lesson Reflection	
Teacher Reflection Evidenced by Student Learning/ Outcomes	

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Name ______________________________ Period________ Date ____________

Heating Curve of Water Lab

SAFETY GOGGLES MUST BE WORN AT ALL TIMES!

Purpose Create a graph to represent the heating curve of water. Observe that heat energy can be used to raise the temperature of a substance OR to weaken the intermolecular forces (a.k.a. bonds) in a substance and cause a phase change.

Materials: 250 ml Beaker, crushed ice cubes, thermometer, spatula, timers (only use cellphone times IF your teacher approves it), Bunsen burner set up (Bunsen burner, rubber tubing, ring stand, wire mesh, thermometer clamp), matches, timer. Alternatively use a hot plate.

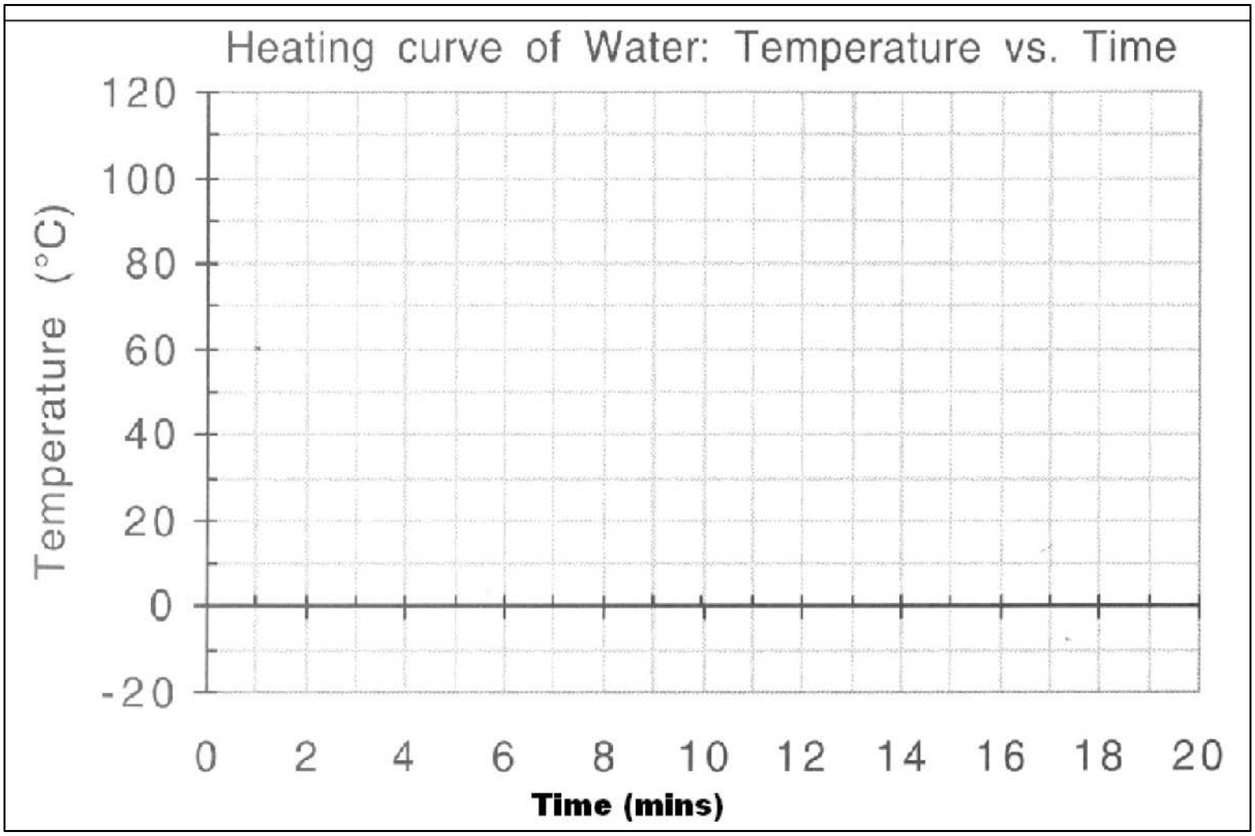
Procedure: *Remember: If you don't have a thermometer clamp, a hand MUST ALWAYS hold the thermometer when using it. Thermometer MUST stay in the beaker throughout the lab so it doesn't measure air temp*erature.

1. Set up your beaker on the wire mesh above the Bunsen burner OR on the hot plate. Do NOT turn it on.
2. Put about 100ml of crushed ice cubes into the beaker. Record this temperature at time 0. (*DO NOT let the thermometer rest on the glass).*
3. Record the temperature & phases WITHOUT adding heat for 5 minutes.
4. Adjust your Bunsen burner so medium heat is applied to your beaker with ice. If using a heating plate, turn the plate to LOW and stir the ice occasionally with a metal spatula.
5. Record the temperature & phases (solid, liquid, gas) every 1 minute until the water has been boiling (with LOTS of bubbles) for 5 minutes. *REMEMBER, there may be more than one phase present. Record all phases present.*
6. After water has boiled for 5 minutes, all remaining water can go into the sink. Dry off your lab bench and return all lab materials.
7. Work with your lab team to graph your data and answer the questions below.

Data/Observations:

Time (1 minute)	Temp. °C	Phase/Phases water is in	Time (1 minute)	Temp. °C	Phase/Phases water is in
Starting Temp	0 °C	Ice (solid phase)	10		
0			11		
1			12		
2			13		
3			14		
4			15		
5			16		
6 (light Bunsen burner!)			17		
7			18		
8			19		
9			20		

Graphing: Use your data from above to create a "Line Graph"



Graph Analysis: Label the following points on the graph above

1. Phase change between solid and liquid as "A"
2. Phase change between liquid and gas as "B"
3. Heating the liquid as "C"

Post Lab Analysis:

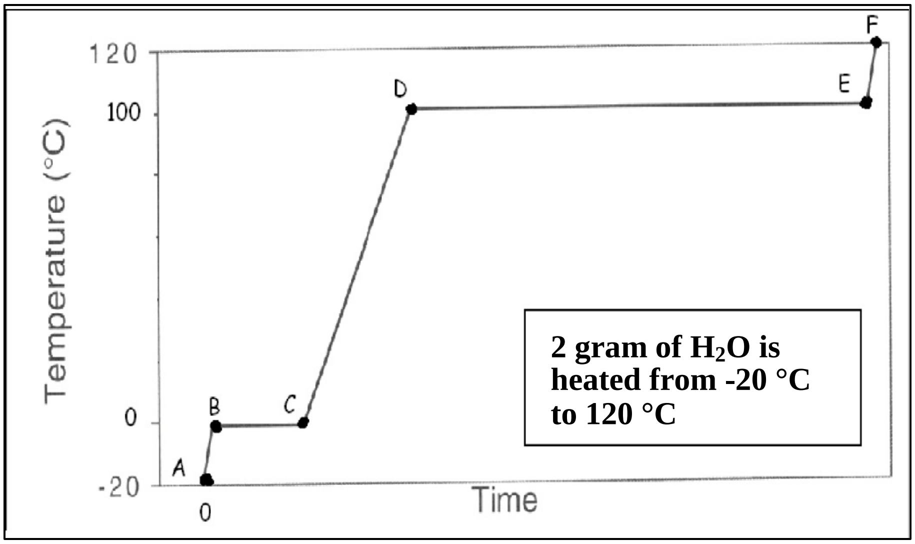
1. What is the chemistry term for a phase change when a solid becomes a liquid?
2. What is the chemistry term for a phase change when a liquid becomes a gas?
3. Describe the phase change that occurs during solidification:
4. Describe the phase change that occurs during condensation:
5. What happens to the intermolecular forces of attraction inside an ice cube when it melts?
6. Why did the temperature of the liquid stop right around 100°C even though you continued heating the water?

Name ______________________________ Period__________ Date___________

Heating Curve of Water Lab: Analysis Questions

Purpose: Examine the heating curve of H_2O and determine what is happening at the molecular level at each stage and why.

Heating Curve of Water: The graph is not drawn to scale, but it is drawn to emphasize differences in the amount of time required for each of the 5 steps.



Point on the Graph	Phase or phases of matter (s, ℓ, g)	Point on the Graph	Phase OR Temp. Change?	If it is a phase change, name it.
A		A→B		
B		B→C		
C		C→D		
D		D→E		
E		E→F		
F		B→A		

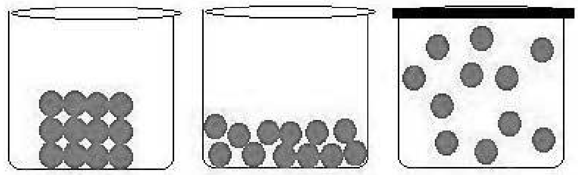
1. Write in the following 4 phase changes in the appropriate location on the graph above:

Vaporization ℓ →g Condensation g→ ℓ Fusion s→ ℓ Solidification ℓ →s

2. At what point (A,B, C, D, E, or F) on the graph
 a. Is all the ICE gone? __________ b. Is all of the LIQUID gone?_________

3. **Heat** and **temperature** are related, yet different. During phase changes, the water is being heated, yet the temperature does not increase. What is the heat being used to do during these phase changes?

4. Label the substances in the containers below as solid, liquid, or gas. The round dots represent the individual molecuels in each substance.



5. Using the pictures above, identify two differences between the molecule arrangement or intermolecular force strength of a liquid and a solid.
   -

   -

6. Using the pictures above, identify two differences between the molecule arrangement or intermolecular force strength of a gas and a solid.
   -

   -

7. Looking at the graph above, why does it take so much more time & heat to **boil water completely** than to **melt ice completely?** ***HINT:*** *Think about the intermolecular force strength in a solid versus a gas.*

Conclusion: In this two day lab you learned what a heating curve for water looks like as well as what occurs at the molecular level during the phase changes. Use this knowledge to:
1) Describe the difference between a phase change and a temperature change.
2) Explain the 3 different states of matter and how the intermolecular force strength changes as the phase changes.

SAUSD Common Core Lesson Planner **Teacher:**

Unit: Matter **Day:** 9 & 10 **Lesson: 5**	**Grade Level/Course:** High School Chemistry	**Duration:** One class period **Date:**
Big Idea: Forces attract, hold together, or repel. *Enduring Understandings:* Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles. **Essential Question:** 1. How does the arrangement of electrons influence the relative charge of a molecule and its associated bonding? 2. How do intermolecular forces between particles explain the bulk properties of substances? 3. What is the relationship between intramolecular forces (bonding) and intermolecular forces?		
Common Core and Content Standards	**Content Standards:** 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. **Reading Standards for Literacy in Science and Technical Subjects**: RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **Writing Standards for Literacy in Science and Technical Subjects**: WHST.9-10.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. **Speaking and Listening Standards (ELA):** SL.9-10.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.	
Materials/ Resources/ Lesson Preparation	Teacher Resource: Day 9 -5.1 Card Sort of Compounds & IMFs Student Resource: Day 9 -5.1 Card Sort of Compounds & IMFs Student sheet Student Resource: Day 9-5.2 Card Sort Analysis questions Student Resource: Day 9- 5.3 Who is the Strongest? Intermolecular Forces Article Student Resource: Day 10 –5.4 Collaborative Annotation Chart Student Resource: Day 10 – 5.5.Pyramid of Intermolecular Forces & Summary	

<table>
<tr><td rowspan="1" colspan="2">Objectives</td><td>Content:
Students will be able to understand that nonpolar molecules are a result of atoms pulling equally on electrons, while polar molecules are a result of unequal pulling on electrons, creating a charge.

Students will understand how IMFs and intramolecular forces hold water molecules together.

Students will be able to differentiate between the three different IMF and which is the strongest.</td><td>Language:
Students will discuss the relative importance of key terms and determine meaning of vocabulary terms to complete the Collaborative Annotative Chart.</td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☐ Level 1: Recall ☒Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☒ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☒ Demonstrating independence ☒ Building strong content knowledge
☐Responding to varying demands of audience, task, purpose, and discipline
☒ Comprehending as well as critiquing ☒Valuing evidence
☐Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="2">Academic Vocabulary</td><td rowspan="2">TEACHER PROVIDES SIMPLE</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>Intra-molecular Force(s) (bonds between atoms)
Inter-molecular Force(s) (bonds between molecules)
Annotation</td><td>Substance
Boiling Point
Melting Point
Molar Mass
Lewis Dot Structure</td></tr>
</table>

<table>
<tr><td></td><td>STUDENTS FIGURE OUT THE MEANING</td><td>Hydrogen Bonds
London-Dispersion Forces
Polar Molecule
Non-Polar Molecule
Dipole</td><td>Ionic bonds
Covalent bonds
Attractive Forces
IMF = Intermolecular forces of attraction</td></tr>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Before the unit
Students will need to work in groups for this activity and will benefit having a partner of similar reading ability and skills to foster a functional conversation. Consider placing your more advanced readers together so they remain challenged. Pairs can be mixed back up for activities involving groups of four, such as filling in the Pyramid of IMF</td></tr>
<tr><td colspan="4">Lesson Delivery</td></tr>
<tr><td colspan="2">Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☐Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☒Guided Inquiry ☒ Reflection</td></tr>
<tr><td>Lesson Continuum</td><td>Lesson Open-ing</td><td colspan="2">Preparing the Learner: Prior Knowledge, Context, and Motivation:
Day 9
1. Card Sort that includes topics such as boiling and melting points which should be common knowledge, as well as topics learned earlier in the year in Chemistry such as molecular formulas and Lewis dot structures.
2. Students will work in groups to sort the strips of data table into a reasonable order, discussing their reasoning with group members. This card sort is slightly different in that there is no one correct way of sorting the slips, it functions more as a platform to get the students to discuss the trends, similarities and differences in the compounds on the data table. Students will need to justify their reasoning for sorting.
3. Students interacting with the Card Sort activity may be unsure what they are looking at. Review the heading to ensure students are familiar with the vocabulary. They may still be uncomfortable with inter- and intra- molecular forces
Day 10
1. When students read the article “Who’s the Strongest?” they will need to annotate the article in preparation for the “Collaborative Annotation” conversation.
2. Help students see that annotations are simply another way of highlighting and taking notes when reading an article, but more effective because they remind students what they were thinking when they made a note or put a star next to a paragraph.
3. Allow students time to ask questions about what the different symbols mean.
4. Have students read the first paragraph independently and use at least 2 of the symbols.
5. Ask students to share what they marked with their neighbor or to ask for help if they are still confused.
6. Check students understand how to use the different marks by listening to a few of their comments and marking them on an overhead. Do an additional paragraph is the class is still confused.
7. It will be slow at first as students need to refer back to the cart, but will because an easy task as they learn what each symbol represents.</td></tr>
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<tr>
<td rowspan="1">Lesson Continuum</td>
<td>Activities/Tasks/ Strategies/Technology/
Questioning/Engagement/Writing/Checking for Understanding</td>
<td>Interacting with text: Day 9
1. Students are analyzing the different cards and discuss the trends, similarities and differences in the compounds on the data table.
2. Students will need to justify their reasoning for sorting. There is no one correct way of sorting the slips.
3. Students will record their card sort onto the data table in the Student Resource Handbook.
Day 10
1. Students will read the article independently “Who is the strongest? Intermolecular Forces” annotating it as they read with the suggested marks (?, *, !, O).
2. Students will then discuss the text with their partner, using the Collaborative Annotation Chart as a tool to guide their discussions on what they marked in the text, with a comment/ question/ response, along with their partners comment/ question/ response to their comment.
3. These questions can be submitted for a grade or finished as homework if incomplete.

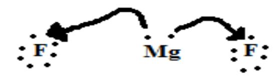
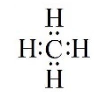
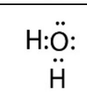
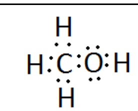
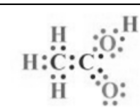
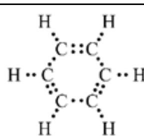
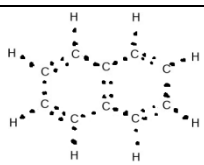
Extending Understanding: Day 10
1. Students will take information gained in article and card sort and sort knowledge into the pyramid graphic organizer.
2. They will apply knowledge to compare and contrast the strength of the forces between two different compounds and explaining what influence intermolecular forces have on determining if a substance is a gas at room temperature.
3. Students will need to look back at their Card Sort Table and Article in order to completely fill out the pyramid graphic organizer.
4. As a class or in teams, have students answer the two summary questions. Remind students to paraphrase and use their own words when they write, rather than copying down phrases from the text.</td>
<td>Differentiated Instruction: English Learners:
• Students can read the article aloud, in pairs, or solo.
• Pair Share
• Cooperative groups
•Multiple opportunities to speak

Special Needs:
• Peer grouping for immediate support
• Teacher proximity for feedback and guidance
• Students can read the article aloud, in pairs, or solo.

• Provide article the day before

Accelerated Learners:
• Independent reading
•Opportunity to explain topic/ reasoning/ thoughts with equally high-level readers.</td>
</tr>
<tr>
<td colspan="4">Lesson Reflection</td>
</tr>
<tr>
<td colspan="2">Teacher Reflection Evidenced by Student Learning/ Outcomes</td>
<td colspan="2"></td>
</tr>
</table>

CUT APART THE HORIZONTAL ROWS
PLACE IN ENVELOPE. 1 PER TEAM

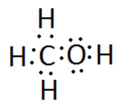
Substance	**Formula**	**Melting Point (˚C)**	**Boiling Point (˚C)**	**Molar Mass**	***Intra*-molecular Force(s) (bonds between *atoms*)**	***Inter*-molecular Force(s) (bonds between *molecules)***	**Lewis Dot Structure**
Sodium Chloride	$NaCl$	800	1,413	58.5	Ionic	Ionic	
Magnesium Fluoride	MgF_2	1,248	2,260	62	Ionic	Ionic	
Potassium Iodide	KI	681	1,330	166	Ionic	Ionic	
Methane	CH_4	- 183	- 162	16	Covalent	London Dispersion	
Water	H_2O	0	100	18	Covalent	Hydrogen (dipole-dipole)	
Hydrogen Fluoride	HF	- 83	19	20	Covalent	Hydrogen (dipole-dipole)	
Methanol	CH_3OH	- 98	65	32	Covalent	Dipole-dipole	
Hydrochloric Acid	HCl	- 144	- 85	36.5	Covalent	Dipole-dipole	
Acetic Acid	CH_3COOH	16	118	60	Covalent	Dipole-dipole	
Benzene	C_6H_6	5	80	78	Covalent	London dispersion	
Naphthalene	$C_{10}H_8$	80	218	128	Covalent	London dispersion	

Adapted by SAUSD from Prentice Hall, *AP Chemistry, The Central Science*

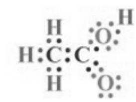
Directions: After arranging your Sort Cards and checking your work with the teacher, carefully fill in the Table below

Substance	**Formula**	**Melting Point (˚C)**	**Boiling Point (˚C)**	**Molar Mass**	***Intra*-molecular Force(s) (bonds between *atoms*)**	***Inter*-molecular Force(s) (bonds between *molecules)***	**Lewis Dot Structure**

Name ____________________________________



Card Sort Analysis Questions



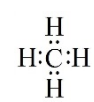
Directions: With your group, look at the Card Sort Table you created and answer the questions below to explain your thinking. Be specific with each of your responses.

1. Explain how did you sort your table? Which columns were the main characteristics in determining order? Why did you use these characteristics?

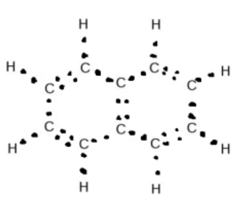
2. Which compound is a liquid for the narrowest range of temperatures?

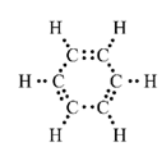
3. Find two compounds in the table with similar molar masses. Compare their melting points. Which of the characteristics listed appears to correlate with the differences in melting point?

4. Compare the covalent compounds with the ionic compounds and make a generalization about structure and melting point.

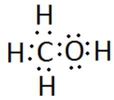


5. Compare the characteristics of methane, benzene, and naphthalene. What factor seems to be responsible for the differences in melting?

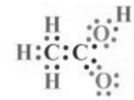




Name ___________________________________



TEACHER: Card Sort Analysis Questions

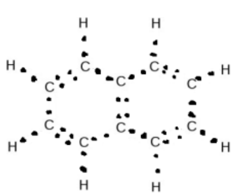


REMINDER: Make sure resource 5.1 is cut apart BEFORE students are given the strips.

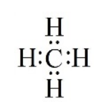
Directions: With your group, look at the Card Sort Table you created and answer the questions below to explain your thinking. Be specific with each of your responses.

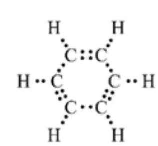
1. Explain how you sorted your table? Which columns were the main characteristics in determining order? Why did you use these characteristics?
    - Sorted by melting point or boiling point. Sorted by bond type. Sorted by molar mass. There is no correct answer. The goal is to observe and justify.
    - Reasons will vary for which characteristics were used to determine order. Students may cite arranging substances from high to low temperatures or lightest to heaviest. Students may use multiple categories to sort.
2. Which compound is a liquid for the narrowest range of temperatures?
    - Focus is seeing that a compound is a liquid after it melts but before it boils.
    - Hydrochloric Acid is only a liquid for 59 degrees (all of which are subzero)
3. Find two compounds in the table with similar molar masses. Compare their melting points. Which of the characteristics listed appears to correlate with the differences in melting point?
    - Sodium Chloride & Magnesium Fluoride. Melting point differs by 613 degrees. Both ionic bonds.
    - Methane & Water & Hydrogen Fluoride. Melting points range by 183 degrees. All covalent bonds. Hydrogen bonds/London Dispersion bonds
    - Methanol & Hydrochloric Acid. Melting points only differ by 46 degrees. Covalent bonds and both dipole-dipole.
4. Compare the covalent compounds with the ionic compounds and make a generalization about structure and melting point.
    - More covalent compounds than ionic. All covalent have hydrogen. All covalent have two non-metals. Covalent bonds have multiple kinds of inter-molecular forces. Melting points are lower. Highest melting point is 80°C and that's for Naphthalene which is much larger than all the other compounds.
    - Not as many ionic compounds. No hydrogen in them. Electrons are moving. All inter-molecular forces are ionic. Melting points are much higher.

5. Compare the characteristics of methane, benzene, and naphthalene. What factor seems to be responsible for the differences in melting?



Methane= -98°C
Benzene= 5°C
Naphthalene= 80°C
The larger the compound or the more carbon or the more double bonds the higher the temperature.
NOTE: Remind students the **::** is a double bond

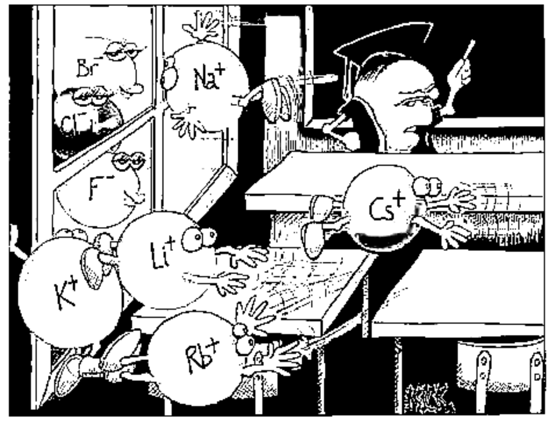




Who is the STRONGEST?
Intermolecular Forces of Attraction

Directions: As you read this article, use the annotation chart below to mark up text. Be sure to read the information provided in the figures as well as the main body text.

Symbol/ Section	Comment/ Question/ Response
?	▪ Questions I have ▪ Wonderings I have ▪ Confusing parts for me
*	▪ Key ideas expressed ▪ Author's main points
!	▪ Surprising details/claims ▪ Emotional response
O	▪ Ideas/sections you connect with ▪ What this reminds you of



"Perhaps one of you gentlemen would mind telling me just what it is outside the window that you find so attractive...?"

Solids, Liquids, and Gases

In solids, such as ice, the particles are not able to move around much because they have a fairly strong attraction for one another. When energy is added to the ice, the heat energy becomes kinetic energy and overcomes or "breaks" some of the intermolecular forces of attraction. These intermolecular forces are electrical in nature, meaning they are related to the number and position of electrons. Intermolecular forces are weaker than either ionic or covalent bonds but we should not underestimate the importance of these forces.

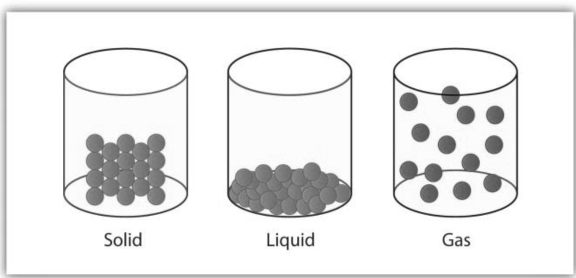
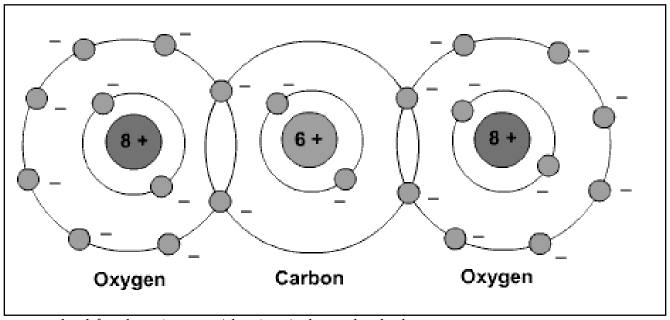


Figure 1. Intermolecular forces are not changed by phase changes from solid to liquid to gas. In gases the molecules are moving too fast for the intermolecular forces to have any effect, so it is almost like they do not exist. But in solids, the particles are slowed enough for the intermolecular forces of attraction to exert their effect and draw the molecules close together.

The strength of these attractive forces are responsible for determining if a compound is a gas, liquid, or a solid at room temperature. The more tightly they cling to each other, the more compressed the molecules in the compound. The most tightly attracted particles are found in solids and the compounds with the weakest attractions between molecules are in a gas.

Intermolecular Forces of Attraction in Non-polar Molecules

Nonpolar molecules, such as the halogens (F_2, Cl_2, Br_2), oxygen (O_2), nitrogen (N_2), carbon dioxide (CO_2), and methane (CH_4) have shapes and bonds that are symmetrical (Fig. 2). The electrons of these molecules are distributed evenly so that there is no permanent electrical charge anywhere on the molecule, and the intermolecular forces are small. The balanced and symmetrical shapes of nonpolar molecules cause them to have very little attraction to each other. Small, nonpolar molecules tend to be gases or liquids with low boiling points.

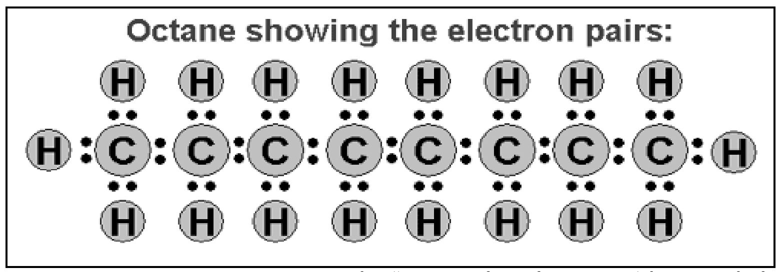


www.school-for-champions.com/chemistry/polar_molecules.htm

Figure 2. If you drew a line through the middle of this CO_2 molecule, both sides would be identical, including the location of the electrons. Because electrons are balanced, neither side of the molecule is more negative than the other side. Overall, a non-polar molecule is neutral (has no charge).

When there are larger sized nonpolar molecules, such as a hydrocarbon found in gasoline, octane (C_8H_{18}), the attractive forces between molecules begins to increase (Fig. 3). Larger molecules have more electrons. When there are more electrons, which are in constant motion, there is more chance that they may be distributed unevenly, causing one part of the molecule to briefly have a greater number of electrons. Because the electron distribution is uneven, there is a temporary partial negative charge, with one part of the molecule having an abundance of electrons and another part having a deficiency in electrons. This makes the molecule temporarily polar (having two poles) and can trigger the formation of more dipole molecules

Figure 3. Octane's larger structure has many more electrons. The Lewis Dot Diagram (right) does not accurately show that the electrons are constantly moving around the hydrogen and carbon atoms.



http://www.green-planet-solar-energy.com/what-is-octane.html

These attractive forces, called London dispersion forces, are much weaker than ionic or covalent bonds which hold atoms together by sharing or giving up electrons. When larger molecules have London dispersion forces, the molecules are more difficult to separate, which is what happens when a substance boils. Because of this, larger molecules tend to have higher boiling points and can be liquids or solids at room temperature. They simply require more energy (heat) to break apart the London dispersion forces holding the molecules together.

Intermolecular Forces of Attraction in Polar Molecules

Not all molecules share electrons equally like covalent bonds. Polar molecules have permanent, separated charges as a result of their shape and the types of atoms in the molecule. Some atoms, particularly oxygen, nitrogen, and fluorine, have a greater tendency to pull the electrons of a covalent bond toward themselves when bonded to different elements. This property is called electronegativity and is one of the trends on the periodic table. In water, oxygen has a stronger pull on the electrons than hydrogen, so the oxygen portion of the atom is slightly negative while the hydrogen ends are slightly positive (Fig. 4).

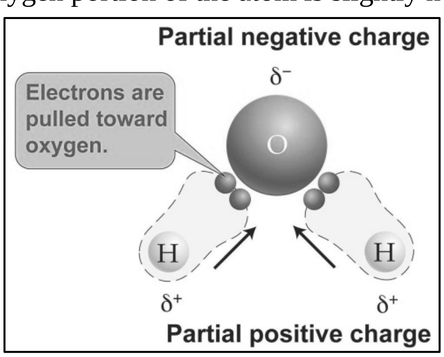
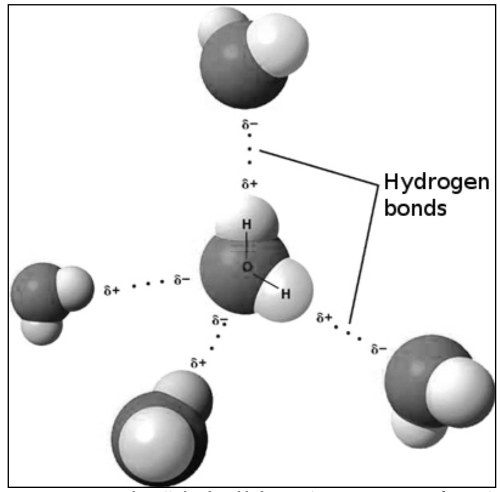


Figure 4. Oxygen wants the electrons to complete its octet shell and pulls strongly on each hydrogen's electron. The electrons are closer to oxygen than they are to the hydrogen atoms, giving the oxygen end of water a slightly negative charge. The hydrogen ends, therefore, are slightly positive in charge.

The positive hydrogen atoms are attracted to the negative oxygen atoms of nearby water molecules and form hydrogen bonds. While hydrogen bonds are not real bonds, they are importance intermolecular forces. In terms of strength, they are much weaker than ionic bonds, and located between covalent bonds and the weak London dispersion forces.

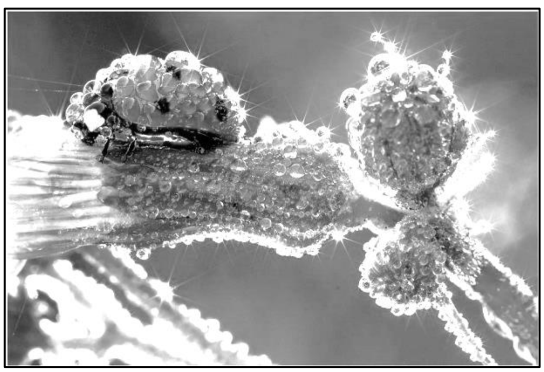
Figure 5. Because of the slight charges on either end of a single water molecule, and the fact that "opposites attract," additional water molecules are attracted. They are held together using hydrogen bonds. Take note that the water molecules are arranged so the hydrogen atom of one water molecule orients itself to face an oxygen atom of another water molecule.

You observed the cumulative power of hydrogen bonds when you completed the Penny Drop Lab and were able to fit many water drops onto a single penny.

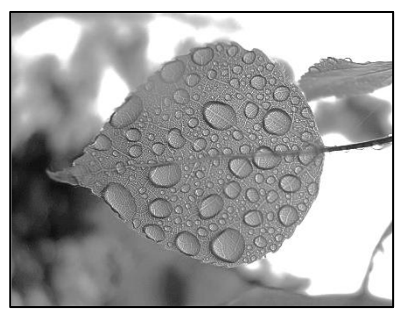


http://schoolworkhelper.net/unique-properties-of-water/.

The strong attractions between water molecules cause the water to pull together into small drops rather than spread out over the surface of your car's windshield. Surface tension, the attraction of water molecules to other water molecules, allowed us to fit 20, 30 or even 50 drops of water on the surface of one penny.



This and many of the other unique properties of water are a result of hydrogen bonding. A water molecule has only 3 atoms with a low molar mass of 18amu, but has a relatively high freezing point of 0ºC and high boiling point of 100ºC. A similarly sized nonpolar compound, methane, CH_4, has a boiling point of -161ºC. This is because it is much easier to pull the molecules of methane apart as it lacks hydrogen bonds.



When there is a strong attraction between molecules, the substances are probably liquids or solids at room temperatures, and inversely, when there are weaker attractive forces, the substances are probably gases at room temperature.

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Who is the Strongest? Intermolecular Forces

Collaborative Annotation Chart

Directions: After you have read and annotated the article, discuss the various comments and marks you and your partner made. You will need to record the comments you made on the article as well as your partners responses in the table below. Use the “sample language support” to get your discussion flowing.

Symbol/ Section	**Comment/ Question/ Response**	**Sample Language Support**
?	▪ Questions I have ▪ Wonderings I have ▪ Confusing parts for me	▪ The statement, “…” is confusing to me because… ▪ I am unclear about the following sentence(s) ▪ I don’t understand what s/he means when s/he states…
*****	▪ Key ideas expressed ▪ Author’s main points	▪ One significant idea in this text is… ▪ The author is trying to convey…
!	▪ Surprising details/claims ▪ Emotional response	▪ I was surprised to read that… ▪ How can anyone claim that…
O	▪ Ideas/sections you connect with ▪ What this reminds you of	▪ This section reminded me of… ▪ This connects with my experience in that…

Symbol/ Section	**Comment/ Question/ Response**	**Partner’s Comment/ Question/ Response**

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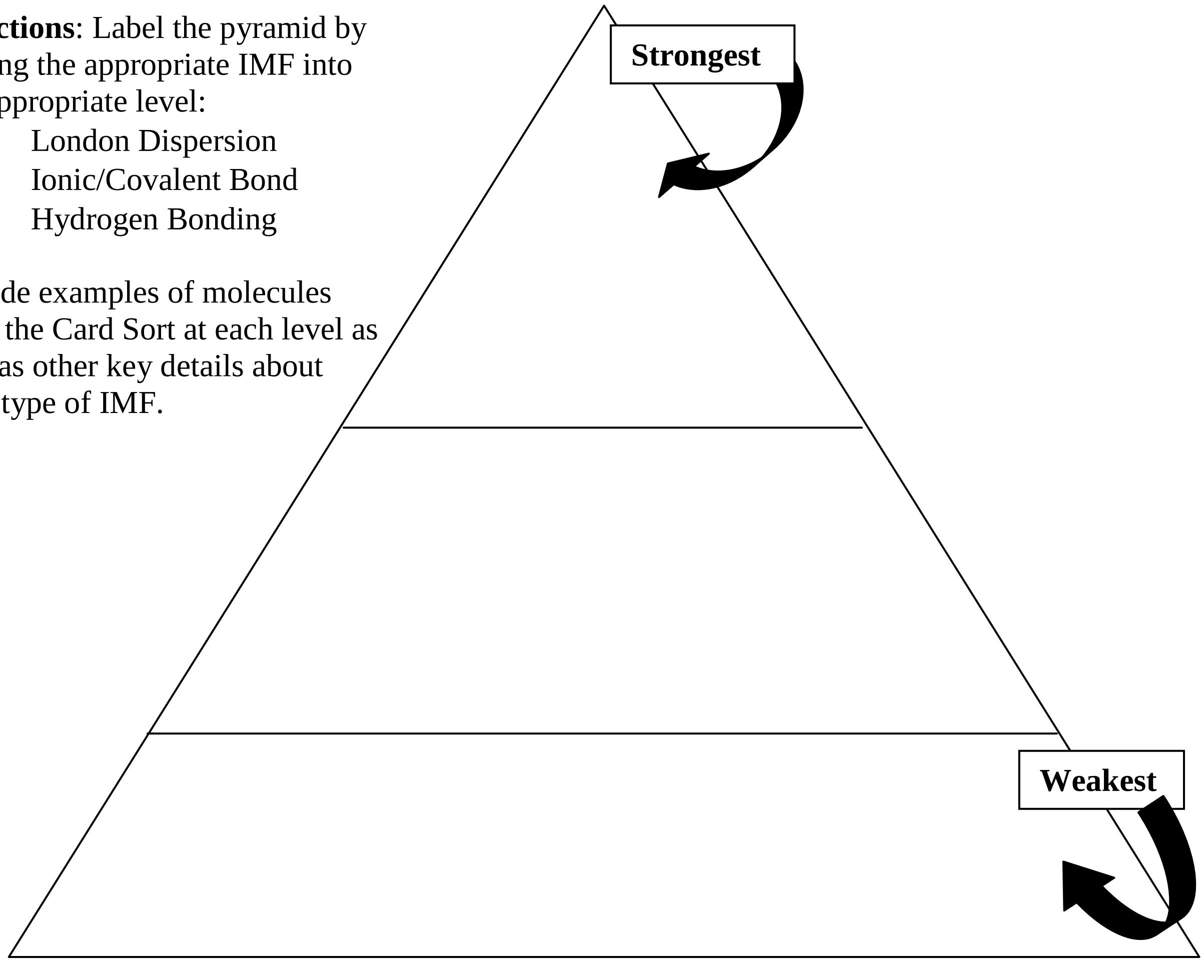
Name ______________________________

Pyramid of Intermolecular Forces

Directions: Label the pyramid by placing the appropriate IMF into the appropriate level:

- London Dispersion
- Ionic/Covalent Bond
- Hydrogen Bonding

Include examples of molecules from the Card Sort at each level as well as other key details about each type of IMF.



Summary:

What influence do Intermolecular forces have on determining if a substance is a gas at room temperature (review Card Sort Table if needed)?

Compare and contrast the intermolecular forces between benzene and water (3 sentences minimum).

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SAUSD Common Core Lesson Planner **Teacher:**

<table>
<tr><td>Unit: Matter
Day: 11 & 12
Lesson: 6</td><td>Grade Level/Course:
High School Chemistry</td><td>Duration: 2 class periods
Date:</td></tr>
<tr><td colspan="3">Big Idea: Forces attract, hold together, or repel.
Enduring Understandings: Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles
Essential Question:
1. How do intermolecular forces between particles explain the bulk properties of substances?

2. How does a change in temperature correlate with microscopic changes of the kinetic energy and the strength of the intermolecular force between water molecules, and to the overall macroscopic observation of phase changes?

3. How does the addition of a solute (NaCl) affect the intermolecular forces between water molecules and consequently, the freezing point of a pure solvent (H_2O)?</td></tr>
<tr><td>Common Core and Content Standards</td><td colspan="2">Content Standards:
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.
HS-PS1-3 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.
Reading Standards for Literacy in Science and Technical Subjects:
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.9-10.6 Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
RST.9-10.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
Writing Standards for Literacy in Science and Technical Subjects:
WHST.9-10.1Write arguments focused on discipline-specific content.
WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.
Speaking and Listening Standards (ELA):
SL.9-10.1Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on</td></tr>
</table>

	grades 10-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.9-10.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
Materials/ Resources/ Lesson Preparation	Teacher Guide: 6.1"Let's Chill" Lab Student Guide: 6.1 "Let's Chill" Lab Teacher Resource: 6.2 Myth Busters Cooling a Soda Video Teacher Resource: 6.2a The Power of Salt Article/Discussion Questions Student Resource: 6.2 The Power of Salt /Discussion Questions Computer Access for Online Simulation: "Why Does Salt Melt Ice?" http://antoine.frostburg.edu/chem/senese/101/solutions/faq/why-salt-melts-ice.shtml. **"Let's Chill" Lab Materials** (for a class of 36 with 12 teams of 3 students) 1. 2400 grams (~5.5 lbs) of ice minimum for class of 36 (200 grams per team) 2. One 2 Liter bottle of soda per class (or individual cans of 12oz cans) 3. 720 grams NaCl minimum (60 grams per team) 4. Tap water 5. 6 or 12 Digital balances, 500 gram capacity recommended (1 per team or 1 shared by 2 teams) 6. 24 thermometers, preferred range of -20°C to 100°C (2 per team) 7. 24 600-mL or 1000-mL beakers (2 per team) 8. 24 100-mL beakers (2 per team) 9. 12 100-ml graduated cylinder (1 per team) 10. 12 spatulas (1 per team) 11. Refrigerator (required if testing Sample #3) 12. Freezer (required if testing Sample #4 13. Goggles (1 per student)

Objectives	**Content:** Students will be able to conduct an investigation to determine how the freezing point, a bulk property, of water, is affected by the addition of a solute, sodium chloride. Students will be able to hypothesize a real-world situation using prior knowledge, conduct an experiment to collect data, and analyze the data to	**Language:** Students will independently write and verbalize an explanation to support their hypothesis. Students will analyze complex text and collaborate to discuss responses to text-dependent questions.

<table>
<tr><td colspan="2"></td><td>draw a conclusion that requires them to compare and contrast their hypothesis with relevant evidence.

Students will be able to incorporate their prior learning related to phase changes and intermolecular forces to explain how microscopic changes result in a macroscopic change of freezing-point depression (a colligative property).</td><td></td></tr>
<tr><td colspan="2">Depth of Knowledge Level</td><td colspan="2">☒ Level 1: Recall ☒Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☒ Level 4: Extended Thinking</td></tr>
<tr><td colspan="2">College and Career Ready Skills</td><td colspan="2">☒ Demonstrating independence ☒Building strong content knowledge
☒Responding to varying demands of audience, task, purpose, and discipline
☒Comprehending as well as critiquing ☒Valuing evidence
☒Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td colspan="2">Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒Reading and writing grounded from text
☒Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="3">Academic Vocabulary (Tier II & Tier III)</td><td rowspan="2">TEACHER PROVIDES SIMPLE EXPLANATION</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>Microscopic changes
Macroscopic changes</td><td>Lowering
Depression
Ice/salt/water bath
Initial
Final</td></tr>
<tr><td>STUDENTS FIGURE OUT THE MEANING</td><td>Freezing point
Colligative properties
Intermolecular forces of attraction
Boiling point
Freezing-point depression
Kinetic energy
Solution
Hypothesis</td><td>Solute
Solvent
Colligative properties
Phase changes
Sodium chloride</td></tr>
</table>

<table>
<tr><td colspan="2">Pre-teaching Considerations</td><td>Day 11
Before the lab:
1. Check availability of ice.
2. Prepare in a central location (or at student lab benches) the materials and chemicals needed by students:
a. Glassware
b. Thermometers
c. NaCl (fine or rock)
d. Spatulas
e. Pre-poured, room temperature soda
f. Digital balances
g. Goggles
3. Teacher will group students into teams of three and assign them a lab station.
4. Computer Access for MythBusters video: “Cooling a 6-pack of Soda”
5. Computer Access for Online Simulation: “Why Does Salt Melt Ice?” http://antoine.frostburg.edu/chem/senese/101/solutions/faq/why-salt-melts-ice.shtml</td></tr>
<tr><td colspan="3">Lesson Delivery</td></tr>
<tr><td colspan="2">Instructional Methods</td><td>Check method(s) used in the lesson:
☒Modeling ☐Guided Practice ☒Collaboration ☒ Independent Practice
☒Guided Inquiry ☒Reflection</td></tr>
<tr><td>Lesson Continuum</td><td>Lesson Opening</td><td>Preparing the Learner (~10 minutes. All times are suggested. Adapt as needed for your classroom and students)
Prior Knowledge, Context, and Motivation:

Day 11
1. Turn to the page titled “Let’s Chill – An Inquiry Lab to Freezing-Point Depression.”
2. Teacher will read out loud as students read along, the prompt to the <u>Hypothesis.</u> Model the setup of a hypothesis
3. Students will independently take 3 minutes to complete the TASK to the <u>Hypothesis</u>.
4. To their seat partner, students take turns to share their ordering and read their explanation.
5. Teacher takes a class poll of which chilling option will require the least amount of time. Record this (on the board?) as it will be revisited at the end of the lesson.
6. Teacher will randomly select (name cards are an option) a student to read the purpose.
7. Teacher reviews procedure, materials/chemicals to be used.
8. Teacher directs students to begin the lab.</td></tr>
</table>

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding	Content	Differentiated Instruction
		9. Students complete and collect data for Parts I and II (Procedure). **<u>TEACHER NOTE REGARDING PART II</u>**: If a refrigerator and/or freezer are unavailable, a cooler may be used in place with ice inside. Part II is OPTIONAL, though students should have sufficient soda to carry out in lab teams or as a whole class. 10. Students complete Data Analysis in their lab teams and reach a consensus about which method was the most effective at cooling the soda. Students must justify their answer with facts. 11. Teacher asks students to identify their conclusion by moving to a specific corner of the room. Assign each corner of the room as one method and have students move to that corner. Remind students it is all about THEIR results (if they did something wrong, they don't get to make up their data and go where they think they should go). 12. Ask students to talk in their corner group and determine how effective the method was (what was the temperature change?). Teacher does not need to confirm or negate student conclusion. **NOTE**: If all students end up in the same corner, have them arrange themselves by how well this technique worked with the smallest temperature change on one side of the classroom and the largest temperature change on the other end of the line. Students have to analyze their data to do this and discuss results. 13. In lab groups or as a whole corner if not too large, ask students to predict WHY they think that method worked the best. Give students 3 minutes. 14. Ask for a volunteer or randomly call on someone from each corner to explain as time permits. 15. Have students return to their seats and listen carefully to segment of MythBuster video (3:13 minutes): "Cooling a Six-Pack of soda" [Time Frame to Show: 4:57 – 8:10]. <u>Purpose of Video Segment:</u> Shows a test of similar chilling methods used in the "Let's Chill" Lab to determine how quickly, and with which chilling method, is best to cool a drink. ****NOTE: If time does not permit, step 12-14 can be completed on Day 12.**	**Differentiated Instruction:** **English Learners:** • Peer grouping in labs for immediate support • Clarifying Bookmarks • Language support for agreeing and for disagreeing • Partner with student of equal reading speed • Model for students hypothesis writing **Special Needs:** • Provide audio versions of the articles (either record the article or someone reads the article to the group) • Give extra time for lab completion • Teacher proximity for immediate feedback

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding	Day 12 (50:00)	Accelerated Learners:
		Day 12 (50:00) 1. Brief class recap of Day 11 results and analysis. 2. (If any steps were not completed, start with those before moving forward). 3. Teacher directs students to sit together with their lab team. 4. Teacher brings up online simulation, "Why Does Salt Melt Ice?" for discussion: http://antoine.frostburg.edu/chem/senese/101/solutions/faq/why-salt-melts-ice.shtml **Steps and Discussions with Students:** 5. Click on the link above to bring up the simulation. 6. Once the site is open, click the "RESET" option in the simulation window. Discuss with students that the simulation currently displays molecules of water in the solid and liquid phase at equilibrium at 0°C. 7. **Temperature Increase**: Increase temperature to "10°C" by placing the cursor to the left of the "0" and then input "1". Discuss the increase in temperature is due to heat added and as a result, the increase in kinetic energy of water molecules increases temperature. In addition, there is a corresponding decrease in strength of the intermolecular force between water molecules. 8. **Add Solute**: Click "RESET" to return to solid/liquid phase equilibrium at 0°C. Click "ADD SOLUTE". Discuss how addition of solute lowers the number of water molecules that "re-freeze". There is an increase in number of water molecules that melt from solid to liquid and now move with higher kinetic energy with weaker intermolecular forces of attraction between molecules. Thus, the temperature must be lower than 0°C to extract the additional kinetic energy from liquid water molecules in order for them to "re-freeze". **Purpose**: A visual simulation of how the kinetic energy and consequently, the strength of the intermolecular force (H-bonding) between water molecules are affected by an increase in temperature and the addition of a solute. 9. First Read of article: Students independently and silently reads with a pencil "The Power of Salt (NaCl): A Look at Freezing-Point Depression." 10. Second Read of article: Students reread independently and annotate the article with the symbols below and write a comment/question/or response about what they just read.	**Accelerated Learners:** • Use the 12 Clarifying Bookmarks instead of 6 Clarifying Bookmark • Peer grouping with equally accelerated learners • Have student explore the simulation at home or before class and have the student lead the simulation for the class

		11. When the students finish reading (at their own pace), partner up and have a chat using the language support about at least three of their comments. Students practice paraphrasing each other to record the conversation rather than writing their response word for word. 12. Then students take turn in their table teams or lab teams to read out loud each Discussion Question before discussing and agreeing on a response. Students independently write a response to each Discussion Question. Clarifying Bookmarks are used between students. 13. Teacher's discretion of method(s) to recap the concept of colligative properties, freezing-point depression, solute, solvent, and solution in connection with lab, article, and discussion questions. **Extending Understanding:** 1. Teacher shares with students that over 250 species of fish that live in the below freezing Antarctic waters have developed antifreeze in their blood to overcome the problem of ice crystals forming in their blood. 2. Students apply their prior knowledge and learning from the Let's Chill Lab to develop a written explanation of the purpose and role of antifreeze in the fish's blood, on a microscopic scale. Students should think through their answers by Building on and Challenging Ideas with their partner in conversation before writing. • How can we add to this idea of… • What other ideas or examples relate to this idea? • What else could support this idea? • Do you agree?	

Lesson Reflection	
Teacher Reflection Evidenced by Student Learning/ Outcomes	

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Name ______________________Lab Partners __________________ & ___________________
Date____________ Period_____

LET'S CHILL
An Inquiry Lab to Freezing-Point Depression

TEACHER NOTES (DAY 11)

1. Check for availability of ice (crushed recommended) for Day 11.

2. Assign students in lab teams specific responsibilities/roles for lab, for example:
   a. Getting goggles and returning them getting ice, serving as time keeper and thermometer holder, data and observations recorder, task manager
   b. Getting glassware (if not at lab bench), cleaning them and returning them, cleaning off lab bench

3. Part II (Procedure): Substitute "soda in ice cooler" for "soda in freezer" and "soda in refrigerator" if a freezer and/or refrigerator is unavailable.

4. Recommend completing through Data Analysis including lab team share-out to class of their Data Analysis.

5. If time permits after Data Analysis share-out, show segment of MythBuster video (3:13 minutes): "Cooling a Six-Pack of Soda" [Time Frame to Show: 4:57 – 8:10].
   Purpose of Video Segment: Shows a test of similar chilling methods used in the "Let's Chill" Lab to determine how quickly, and with which chilling method, is best to cool a drink.

Hypothesis

It's a warm day in the summer and a lone can of soda sits on a shelf in the kitchen cabinet. You're wishing for a cold soda and wonder how to chill it as quickly as possible in the least amount of time. You have four chilling methods listed below.

Your Task: Using your best judgment, number the chilling methods below from one to four (one represents requiring the least amount of time to chill). Explain and justify your hypothesis.

Chilling Options	I think … because …
____ *Soda in freezer*	____
____ *Soda in refrigerator*	____
____ *Soda in an ice/water bath*	____
____ *Soda in an ice/salt/water bath*	____
	____

Purpose

(1) Understand and explain how changes in temperature correlate with microscopic changes of the kinetic energy and the strength of the intermolecular force between water molecules, and to the overall macroscopic observation of phase changes.
(2) Evaluate changes to the *freezing (melting) point* of water with the addition of a solute such as NaCl with explanations correlating with microscopic changes to kinetic energy and intermolecular forces.
(3) Become familiar with colligative properties, more specifically, *freezing-point depression (lowering)* and how it relates to drivers on the road and party hosts chilling drinks.

Materials/Chemicals

****NOTE**: Teacher provided 2000ml of soda/class. The works out to about 150 ml per lab team (assuming 12 lab teams of 3 for 36 student class) with ~200ml for a demo or a spill.

1. Ice, crushed
2. 150 ml of soda
3. Solid NaCl (sodium chloride)
4. Tap water
5. Digital balance (500 g capacity required)
6. Thermometer (2)
7. 600-mL or 1000-mL beakers (2)
8. 100-ml beakers (2)
9. 100-ml graduated cylinder
10. Spatula
11. Freezer
12. Refrigerator
13. Goggles

Procedure

Part I

1. Acquire the materials/chemicals listed above if not already at your lab bench.
2. Ice/Water Bath (1000-ml beaker #1):
   A. Use graduated cylinder to measure out 100-ml tap water and pour into 1000-ml beaker.
   B. Use digital balance to measure out 100 g of ice into 1000-ml beaker. Swirl the beaker to help ice squish together.
3. Ice/Salt/Water Bath (1000-ml beaker #2):
   A. Use digital balance and a spatula to measure out 60 grams of NaCl into 1000-ml beaker.
   B. Use graduated cylinder to measure out 100-ml tap water and pour into 1000-ml beaker.
   C. Swirl the beaker to dissolve the NaCl in the tap water to create a salt/water solution.
   D. Use digital balance to measure out 100 g of ice into 1000-ml beaker. Swirl the beaker.
4. Use graduated cylinder to measure out 50 mL of soda into two 100-mL beakers.
5. Using separate thermometers, concurrently read the initial temperature (T_0) of the soda in both 100-ml beakers. *Record your values in the Data Table.*
6. At the same time, place each 100-ml beaker of soda into the two different 1000-ml beakers and begin a countdown of 5 minutes.
7. Observe the 1000-ml beakers of ice/water and of ice/salt/water with the following questions in mind: What is happening to the ice? What phase change(s) are occurring? Is there evidence of a change in intermolecular forces between the water molecules in the ice? *Record your observations below.*
8. At the end of 5 minutes, read the final temperature (T_5) of the soda. *Record your values in the Data Table.*

Part II (OPTIONAL)

****NOTE: Every lab group has 50ml of soda left to conduct this experiment.**

****NOTE: Could be done as a whole class activity, all students combine soda together to test both conditions.**

1. Use graduated cylinder to measure out 25 mL of soda into two 100-mL beakers.
2. Using separate thermometers, concurrently read the initial temperature (T_0) of the soda in both 100-ml beaker. *Record your values in the Data Table.*
3. At the same time, place one of the 100-ml beakers in the refrigerator and one in the freezer and begin a countdown of 5 minutes.
4. At the end of 5 minutes, take the samples out of the refrigerator and the freezer and read the final temperature (T_5) of the soda. *Record your values in the Data Table.*

Data Table

Sample	T_0 (initial temperature) ^0C	T_5 (final temperature) ^0C
1. Soda in ice/water bath		
2. Soda in ice/salt/water bath		
3. Soda in refrigerator (optional)		
4. Soda in freezer (optional)		

Observations

____
____
____
____

Data Analysis

Revisit your hypothesis. How did your hypothesis compare to your results? Which "chilling method" would you choose to chill your soda? Support your claim using evidence from your data table and observations. *Underline These Key Words: (1) temperature; (2) initial; (3) final; (4) hypothesis; (5) results; and (6) compare.*

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Name ______________________Lab Partners __________________ & ___________________
Date____________ Period_____

LET'S CHILL
An Inquiry Lab to Freezing-Point Depression

Hypothesis
It's a warm day in the summer and a lone can of soda sits on a shelf in the kitchen cabinet. You're wishing for a cold soda and wonder how to chill it as quickly as possible in the least amount of time. You have four chilling methods listed below.

Your Task: Using your best judgment, number the chilling methods below from one to four (one represents requiring the least amount of time to chill). Explain your hypothesis.

Chilling Options ____

____ *Soda in freezer* ____
____ *Soda in refrigerator* ____
____ *Soda in an ice/water bath* ____
____ *Soda in an ice/salt/water bath* ____
____

Purpose
(1) Understand and explain how changes in temperature correlates with microscopic changes of the kinetic energy and the strength of the intermolecular force between water molecules, and to the overall macroscopic observation of phase changes.
(2) Evaluate changes to the *freezing (melting) point* of water with the addition of a solute such as NaCl with explanations correlating with microscopic changes to kinetic energy and intermolecular forces.
(3) Become familiar with colligative properties, more specifically, *freezing-point depression (lowering)* and how it relates to drivers of automobiles and party hosts chilling drinks.

Materials/Chemicals
1. Ice, crushed
2. 150ml of soda
3. Solid NaCl (sodium chloride)
4. Tap water
5. Digital balance (500 g capacity required)
6. Thermometer (2-you may need to share)
7. 600-mL or 1000-mL beakers (2)
8. 100-ml beakers (2)
9. 100-ml graduated cylinder
10. Spatula
11. Freezer
12. Refrigerator
13. Goggles

Procedure
Part I
1. Acquire the materials/chemicals listed above if not already at your lab bench.
2. Ice/Water Bath (1000-ml beaker #1):
   A. Use graduated cylinder to measure out 100-ml tap water and pour into 1000-ml beaker.
   B. Use digital balance to measure out 100 g of ice into 1000-ml beaker. Swirl the beaker.
3. Ice/Salt/Water Bath (1000-ml beaker #2):
   A. Use digital balance and a spatula to measure out 60 grams of NaCl into 1000-ml beaker.
   B. Use graduated cylinder to measure out 100-ml tap water and pour into 1000-ml beaker.
   C. Swirl the beaker to dissolve the NaCl in the tap water to create a salt/water solution.
   D. Use digital balance to measure out 100 g of ice into 1000-ml beaker. Swirl the beaker.
4. Use graduated cylinder to measure out 50 mL of soda into two 100-mL beakers.

5. Using separate thermometers, concurrently read the initial temperature (T_0) of the soda in both 100-ml beakers. *Record your values in the Data Table.*
6. At the same time, place one 100-ml beaker of soda into the 1000-ml beakers and begin a countdown of 5 minutes.
7. Observe the 1000-ml beakers of ice/water and of ice/salt/water with the following questions in mind: What is happening to the ice? What phase change(s) are occurring? Is there evidence of a change in intermolecular forces between the water molecules in the ice? *Record your observations below.*
8. At the end of 5 minutes, read the final temperature (T_5) of the soda. *Record your values in the Data Table.*

Part II (OPTIONAL)

1. Use graduated cylinder to measure out 25 mL of soda into two 100-mL beakers.
2. Using separate thermometers, concurrently read the initial temperature (T_0) of the soda in both 100-ml beaker. *Record your values in the Data Table.*
3. At the same time, place one of the 100-ml beakers in the refrigerator and one in the freezer and begin a countdown of 5 minutes.
4. At the end of 5 minutes, take the samples out of the refrigerator and the freezer and read the final temperature (T_5) of the soda. *Record your values in the Data Table.*

Data Table

Sample	T_0 (initial temperature) ^{0}C	T_5 (final temperature) ^{0}C
1. Soda in ice/water bath		
2. Soda in ice/salt/water bath		
3. Soda in refrigerator (optional)		
4. Soda in freezer (optional)		

Observations

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Data Analysis

Revisit your hypothesis. How did your hypothesis compare to your results? Which "chilling method" would you choose to chill your soda? Support your claim using evidence from your data table and observations. *Underline These Key Words: (1) temperature; (2) initial; (3) final; (4) hypothesis; (5) results; and (6) compare.*

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Myth Busters: How to cool a Soda

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The Power of Salt (NaCl): A Look at Freezing-Point Depression

Water alone, without any substance dissolved in it, is called a *pure solvent.* Water, with sodium chloride dissolved in it, is no longer a pure solvent but is now a *solution. Solutions* are homogeneous mixtures that contain two or more different substances. The major component is called the *solvent*, and the minor component is called the *solute*. From the lab, the ice/salt/water bath prepared was a solution of 200 grams total of water *(solvent*) and 60 grams of NaCl (*solute*).

One of the physical properties of pure water is a freezing point of 0°C, but solutions with water as the solvent freeze at *lower* temperatures below 0°C. The opposite affect is observed for the boiling point. Pure water has a boiling point of 100°C but once a solute is added to water to form a solution, the boiling point of the solution is now *above* 100°C. The *lowering of the freezing point* and the *raising of the boiling point* are physical properties that depend on the *quantity* of the solute particles added to the pure solvent but *not* on the *kind* or *identity* of the solute particles. Such properties are called **colligative properties.**

A common application of the principles of *freezing-point depression* and *boiling-point elevation* is the coolant in radiators of cars. Ethylene glycol ($C_2H_6O_2$, antifreeze) is added to the water (coolant) in cars to lower the freezing point of the water below 0°C and raise the boiling point of water above 100°C. Cars can thus withstand subfreezing temperatures without freezing up in Minnesota and the engine can operate at a higher temperature without over-heating in Arizona. Another useful application of the principle of *freezing-point depression* is the sprinkling of salt (NaCl) on an icy road or sidewalk to make them safer for people to drive or walk on them. Adding the salt (NaCl) essentially melts the ice by lowering the freezing point of water.

How does the addition of a solute (NaCl) to a pure solvent (water) lower the freezing point of water (ice)?

When water freezes at 0°C the hydrogen bonds give water a rigid structure (water expands as it freezes) as shown in Figure 1.

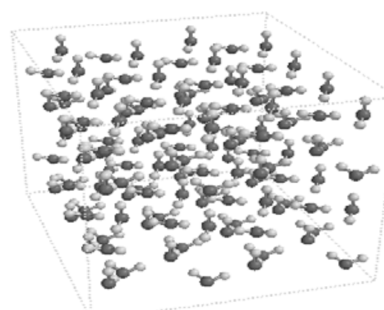

Figure 1 The solid water has a definite crystalline structure as a result of the hydrogen bonding.

Ice (solid water) is typically coated with a thin film of liquid water. Once salt is sprinkled on the ice, the ice begins to melt to form an increasing amount of liquid water and essentially, a *salt solution* is formed with a *lower freezing point* of 0°C. The presence of the salt in the water disrupts the crystalline structure of the ice and *interferes* with the attraction of the hydrogen bonds between the water molecules. In other words, the salt prevents the melting ice from *re-freezing.* As a result, water molecules experience a weaker attraction to each other and move with a greater amount of kinetic energy. In order for the liquid water in the salt solution to re-freeze, the temperature must be lower than 0°C to extract the additional kinetic energy from these liquid water molecules. The freezing point of this salt solution is thus lower than the freezing point of pure water. This difference between the freezing point of a solution and the freezing point of the pure solvent is referred to as the ***freezing-point depression***.

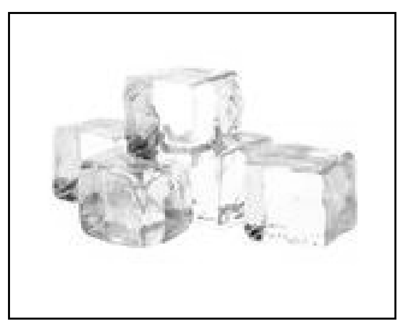

Figure 2 Salt melts ice by lowering the freezing point of the water around the ice. The ice melts and is unable to re-freeze except at a much lower temperature.

Collaborative Annotation Chart

Directions: As you reread independently, annotate the article with the symbols below and write a comment/question/or response about what you read. When you and your partner are each finished reading, have a conversation using the language support about at least three of your comments. As you record your partner's response, paraphrase in your own words what your partner said rather than writing their response word for word.

Symbol	Comment/Question/Response	Sample Language Support
*	• Article's main points • Key ideas expressed • Significant ideas	• One significant idea in this text is… • The article is trying to explain that…
!	• Shocking statements or parts • Emotional response • Surprising details/claims	• I was shocked to read that …(further explanation) • How part about…made me feel…
O	• Ideas/sections you connect with • Something you have seen in your personal life • What this reminds you of	• I can connect with what the author said because… • This experience connects with my own experience that…

Symbol and Paragraph #	Comment/Question/Response	Paraphrase your Partner's Comments/Question/Response

Discussion Questions related to Let's Chill Lab

1. Use at least two of the four articles from Lesson 3 (Day 5 and 6) to respond to the following:
   a) Explain how the intermolecular force that exists between water molecules in the solid phase is different in the liquid phase?
      - The IMF in liquids is stronger than the IMF found in the gas phase, but it is not strong enough to lock molecules into place, so liquids take the shape of their container.
      - Because solids are held together by IMFs that lock molecules into place, solids have a rigid structure (3.3a)
      - As a solid, ice molecules are in a fixed position that prevents them from moving (3.3d)

   b) Why does ice float in liquid water?
      - Ice floats because it expands when it freezes, giving it a lower density than water.
      - This happens because of how the hydrogen bonds rigidly arrange themselves when freezing. They form a box arrangement which leaves an open cavity in the middle of the structure, reducing density of the molecule. Liquid water is much more random in hydrogen bond arrangement and actually holds the molecules closer together. (3.3a)

2. Using your observation notes from the Heating Curve of Water and article 3.3d, how does a change in temperature correlate with <u>microscopic changes</u> of the kinetic energy and the strength of the intermolecular force between water molecules in the solid phase, and to the overall <u>macroscopic observation</u> of phase changes?

   - As temperature increases, kinetic energy increases and molecules move faster. (3.3d)
   - The increase in kinetic energy starts to weaken IMFs. (3.3d)
   - As molecules move faster, the temperature of a solid starts to increase (3.3d)
   - Macroscopically, we saw this because the ice began to melt! (lab)
   - Melting is a phase change (lab). We saw this again when the water boiled in another phase change (lab).
   - Melting occurs when there is enough heat to overcome all attractive forces between the ice molecules.

3. How does the addition of a solute (NaCl) change the kinetic energy and the intermolecular forces of the water molecules in the solid phase (ice) and prevent the liquid water molecules from "re-freezing"?
   - When salt is added it disrupts the crystalline structure of the ice and this makes it harder for hydrogen bonds to form (salt is in the way). The salt makes it harder to reform the hydrogen bonds and prevents it from refreezing as easily (at 0°C). This allows the water to drop below zero degrees and remain unfrozen.

4. What are colligative properties and how does the knowledge of *freezing-point depression (lowering)* benefit drivers of an automobile? Or party hosts trying to chill their drinks for their guests?
   - Colligative properties are physical properties that depend on the amount of the solute particles added to a pure solvent. It does not matter what kind of solute is added.
   - It benefits automobile drivers because salting roads melts ice AND makes it harder for ice to reform.
   - It is helpful for party hosts because it helps get the water temperature below freezing and cools drinks faster than using just ice which is only at zero degrees. This only works for closed beverages (Don't add salt to your soda ☺)

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The Power of Salt (NaCl): A Look at Freezing-Point Depression

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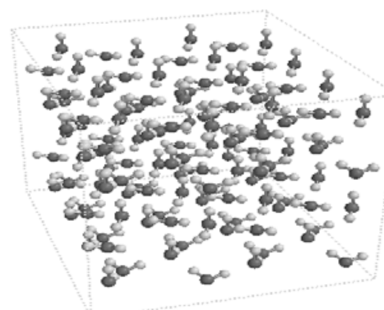

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   ____
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SAUSD Common Core Lesson Planner **Teacher:**

Unit: Matter **Day:** 13 **Lesson:** 7	**Grade Level/Course:** High School Chemistry	**Duration:** 1 day **Date:**

Big Idea: Forces attract, hold together, or repel.
Enduring Understandings: Substances with different bulk properties undergo phase transformations that result in changes to the attractive forcers between the particles
Essential Question:
1. How do intermolecular forces between particles explain the bulk properties of substances?
2. How is heat related to temperature and phase changes and the relevance of a heating curve?
3. What is the relationship between intramolecular forces (bonding) and intermolecular forces?

Common Core and Content Standards	**Content Standards:** 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. **Reading Standards for Literacy in Science and Technical Subjects**: RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently. RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently. **Writing Standards for Literacy in Science and Technical Subjects**: WHST.9-10.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. **Speaking and Listening Standards (ELA):** SL.9-10.1b Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed. SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

<table>
<tr><td>Materials/ Resources/ Lesson Preparation</td><td colspan="2">Student Resource: Day 1/13-1.1 States of Matter and Forces of Attraction: Extended Anticipatory Guide
Student Resource: Day 13-7.1-Card Sort Extension Questions</td></tr>
<tr><td>Objectives</td><td>Content:
Students will be able to solidify their knowledge about how IMFs are related to the three phases of matter.

Students will be able to find supporting information by rereading previous texts, labs, and activities to answer the essential questions regarding this unit on matter.</td><td>Language:
Students will evidence to support their answers in the extended anticipatory guide, summarize information they have read, and discuss it with their group until a consensus regarding the validity of the information is reached.</td></tr>
<tr><td>Depth of Knowledge Level</td><td colspan="2">☐ Level 1: Recall ☐ Level 2: Skill/Concept
☒ Level 3: Strategic Thinking ☒ Level 4: Extended Thinking</td></tr>
<tr><td>College and Career Ready Skills</td><td colspan="2">☒ Demonstrating independence ☒ Building strong content knowledge
☐Responding to varying demands of audience, task, purpose, and discipline
☒ Comprehending as well as critiquing ☒Valuing evidence
☐Using technology and digital media strategically and capably
☐ Coming to understand other perspectives and cultures</td></tr>
<tr><td>Common Core Instructional Shifts</td><td colspan="2">☒ Building knowledge through content-rich nonfiction texts
☒ Reading and writing grounded from text
☒ Regular practice with complex text and its academic vocabulary</td></tr>
<tr><td rowspan="2">Academic Vocabulary (Tier II & Tier III)
TEACHER PROVIDES SIMPLE EXPLANATION</td><td>KEY WORDS ESSENTIAL TO UNDERSTANDING</td><td>WORDS WORTH KNOWING</td></tr>
<tr><td>This is a review day. Vocabulary should already have been learned. Teacher may act to clarify terms that still cause confusion</td><td></td></tr>
</table>

STUDENTS FIGURE OUT THE MEANING	IMFs Intermolecular vs. intramolecular Phase change v.s Temperature change Polar vs. Non-Polar Hydrogen Bonds London-Dispersion Forces Ionic Bonds Covalent Bonds	Solid, Liquid, Gas Condensation Evaporation Fusion Solidification Surface Tension Cohesion Kinetic energy Heat
Pre-teaching Considerations	**Before the unit:** This is a review lesson. Depending on the comfort level of your students and their areas of weakness or strength, you may choose to review specific questions or skip certain questions as a class. Be mindful of students who are copying teammates and consider limiting groups to two students so everyone is involved in looking up all of the answers.	
Lesson Delivery		
Instructional Methods	**Check method(s) used in the lesson:** ☒**Modeling** ☒**Guided Practice** ☒**Collaboration** ☒ **Independent Practice** ☒**Guided Inquiry** ☒ **Reflection**	
Lesson Continuum — **Lesson Open-ing**	**Preparing the Learner** 1. This lesson is intended to help students answer questions by going back to the text to find the answers. 2. Resist the urge to tell students where the answers are, but ensure that everyone has his or her student handbook. 3. Ensure that every student has his or her handbook for this lesson as well as any additional resources used during this unit	
Lesson Continuum — Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding	**Interacting with the concept/text:** **General Review Activity (Limit time to 15 minutes MAX)** 1. Students begin by taking 2 minutes to review their student handbook, looking at the lessons, articles, activities, and labs from the past 12 days. 2. Students then take 5 minutes to write down 10 different water-related concepts learned. The use of new academic vocabulary and language should be use. Complete sentences are not required 3. When completed, have students pair up with someone in the classroom. Does not need to be their elbow partner. 4. The youngest student shares everything on their list while the second student listens for anything not on their list. These items should be added to their list. Students switch roles. 5. If students have all of the same ideas (or similar ideas), together they must come up with two NEW concepts together.	

Lesson Continuum

Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding

6. When both students have shared, they should discuss what they think were the most important properties of water and write 3-4 sentences to answer and justify this.

There is no correct answer to this question, but students should provide justification for why a specific fact is the "most" important fact about water

Focused Review Activity (40 minutes)

7. Students will be completing Day 13 of the Extended Anticipatory Guide by finding supporting pieces of information throughout the previous texts, labs, and activities they have completed.
8. Give students sufficient time to look back through the text, and remind students that they need to agree with their teammates on the evidence they choose before writing it down.
9. Every student should work to find supporting evidence for each question, rather than dividing the questions among a group. To help ensure this, keep groups small so collaborative work is easier.
10. Require students to translate the writing into their own words, rather than copying the text directly.

Extending Understanding:

If there is extra time in class or to be assigned as a homework assignment or extra credit assignment

1. Have students in pairs of two create a quiz consisting of five essential concepts covered on one specific day of this unit. Assign topics to student teams so topics are only repeated 2 times.
    a. IMFs
    b. Intermolecular vs. Intramolecular
    c. Water's properties
    d. Surface Tension and Cohesion
    e. Solid
    f. Liquids
    g. Gases
    h. Solids vs. liquids vs. gases
2. Have students self-assess which topics are their weaker topics and then have them work to answer those topic's questions.
    a. Additional copies of the questions could be made or posted on the teacher's website for students to answer at home as another way to study for the final assessment.

Differentiated Instruction:

Students who Need Additional Support

•Peer grouping to provide immediate feedback
•Multiple opportunities to speak
Teacher proximity for immediate feedback.
•Students determine working pace.
•Can be easily completed at home without modifications
•Teacher can limit resources student uses to complete the E.A.Guide

Accelerated Learners:

• Multiple opportunities to speak and share thoughts/ideas/ questions
•Self-determined pace
• Grouping with equal ability students

Lesson Reflection	
Teacher Reflection Evidenced by Student Learning/ Outcomes	

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Quick Write: *"Water – What I Now Know"*

TASK #1: Review the lessons, articles, activities, labs, etc. from the past 12 days (six lessons).

You ONLY have TWO minutes. READY, SET, GO!!

TASK #2: **TOP TEN -** Recall and write down ten different water-related concepts that demonstrates the learning that you have accomplished in the six lessons. Refer back to the resources if needed. Complete sentences are not required. Use all the NEW academic vocabulary/language that you have learned.

You ONLY have FIVE minutes. GO!

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

TASK #3: Find your partner and sit together ASAP. Youngest person reads their list first. If you are listening, listen for a concept that you do not have on your list. Add this concept to your TOP TEN if you do not have ten; otherwise, add the concept below. Ask your partner to re-read the concept if needed. Switch roles. *IF you and your partner have 10 concepts that are very similar, then together you will come up with 2 NEW concepts. Take the challenge!*

You ONLY have FIVE minutes! GO!

1. ______________________________
2. ______________________________

TASK #4: You and your partner must decide which water-related concepts were the most important, intriguing, or fascinating. Three complete sentences are required. Provide justification for your choices.

You ONLY have THREE minutes! GO!

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SAUSD Common Core Lesson Planner **Teacher:**

<table>
<tr><td>Unit: Matter
Day: 14 & 15
Lesson: 8</td><td>Grade Level/Course:
High School Chemistry</td><td>Duration: 2 days
Date:</td></tr>
<tr><td colspan="3">Big Idea: Forces attract, hold together, or repel.
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Reading Standards for Literacy in Science and Technical Subjects:
RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Writing Standards for Literacy in Science and Technical Subjects:
WHST.9-10.1b Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience’s knowledge level and concerns.
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SL.9-10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</td></tr>
</table>

Materials/ Resources/ Lesson Preparation	Teacher Resource: 8.1 – Team Assessment "Heating Curve of Ethanol" Teacher Resource: 8.2 – Team Assessment Key --"Heating Curve of Ethanol" Teacher Resource: 8.3 – Individual Assessment	
Objectives	**Content:** Students will be able to synthesize a number of topics learned over the past 13 days and apply them to a real world situation.	**Language:** Students will analyze complex text and translate it into a well-organized graph and short answer questions.
Depth of Knowledge Level	☒ **Level 1: Recall** ☒ **Level 2: Skill/Concept** ☒ **Level 3: Strategic Thinking** ☒**Level 4: Extended Thinking**	
College and Career Ready Skills	☒ **Demonstrating independence** ☐ **Building strong content knowledge** ☒**Responding to varying demands of audience, task, purpose, and discipline** ☒ **Comprehending as well as critiquing** ☒**Valuing evidence** ☐**Using technology and digital media strategically and capably** ☐ **Coming to understand other perspectives and cultures**	
Common Core Instructional Shifts	☒ **Building knowledge through content-rich nonfiction texts** ☒ **Reading and writing grounded from text** ☒ **Regular practice with complex text and its academic vocabulary**	

Academic Vocabulary (Tier II & Tier III)		**KEY WORDS ESSENTIAL TO UNDERSTANDING**	**WORDS WORTH KNOWING**
	TEACHER PROVIDES SIMPLE	This is an assessment day. Students should have a strong understanding of all unit-related vocabulary terms.	
	STUDENTS FIGURE OUT THE		Compare and contrast Elevated Depressed

<table>
<tr><td colspan="2">Pre-teaching Considerations</td><td colspan="2">Before the unit:
The team assessment is designed to be a “Closed Book” assessment.
The individual assessment, however, is designed to be an “Open Book” assessment, referring to the student resource handbook. You may choose to disclose this to students or not or only allow use of certain activities.
If you inform students the assessment is “Open Book,” remind them that they will run out of time trying to complete the assessment if they need to look up every answer.
You may choose to give the whole assessment or to modify it on the electronic copy. This resource is not included in the Student Resource Handbook and copies will need to be made for each class.</td></tr>
<tr><td colspan="4">Lesson Delivery</td></tr>
<tr><td colspan="2">Instructional Methods</td><td colspan="2">Check method(s) used in the lesson:
☒Modeling ☒Guided Practice ☒Collaboration ☒ Independent Practice
☒Guided Inquiry ☐ Reflection</td></tr>
<tr><td rowspan="2">Lesson Continuum</td><td>Lesson Open-ing</td><td colspan="2">Preparing the Learner
Carefully consider the groupings you place students in for the team assessment. Grouping by grade in the class or previous assessment might be a good way to ensure teams are equal in skill/ability.
If students are unfamiliar with team-assessments, you might consider the following set up for the assessment.
-All students within a team must complete every question or short answer on their own test paper.
-When everyone is done, the team staples all of their tests together and the teacher grades one test out of every pile. Any blank answer is zero for the team.</td></tr>
<tr><td>Activities
Tasks
Strategies
Tech
Questioning
Engagement
Writing
Checking for Under-standing</td><td>Interacting with the concept/text:
Day 14: Team Test (Closed Book)
Students should read the instructions and background information very carefully when completing this portion of the assessment.
After completing the graphing activity and labeling of the graph, students should work together to construct a response to the short answer questions.
Day 15: Individual Test (<u>Designed to be completed with use of Student Resource Handbook</u>)
Students will complete the short answer questions, the fill in the blank questions as well as the text passage.
If the teacher chooses, the students may use the <u>Student Resource Handbook</u>. The goal of allowing use of the handbook is to encourage students to read and re-read the text and to promote the highest quality of answers.</td><td>Differentiated Instruction:

Students Who Need Additional Support
Group work for peer support
Extended time
Using the resource room to take assessment
Use of student resource handbook</td></tr>
</table>

Lesson Continuum	Activities/Tasks/ Strategies/Technology/ Questioning/Engagement/Writing/Checking for Understanding	**Extending Understanding:** 1. When the assessments are graded and returned to students, require all students to complete test corrections for every question that was incorrect. Require students to include an explanation of their corrected information as well as a reference to the activity, article, or lab they used to find the correct answer. 2. Students might work in teams to correct the team portion of the test and individually to do the solo part of the test.	• Assessment given ahead of time to pre-read or work through with case manager • Teacher proximity for immediate support **Accelerated Learners:** • Like-ability grouping to challenge students • Individually paced work

Lesson Reflection	
Teacher Reflection Evidenced by Student Learning/ Outcomes	

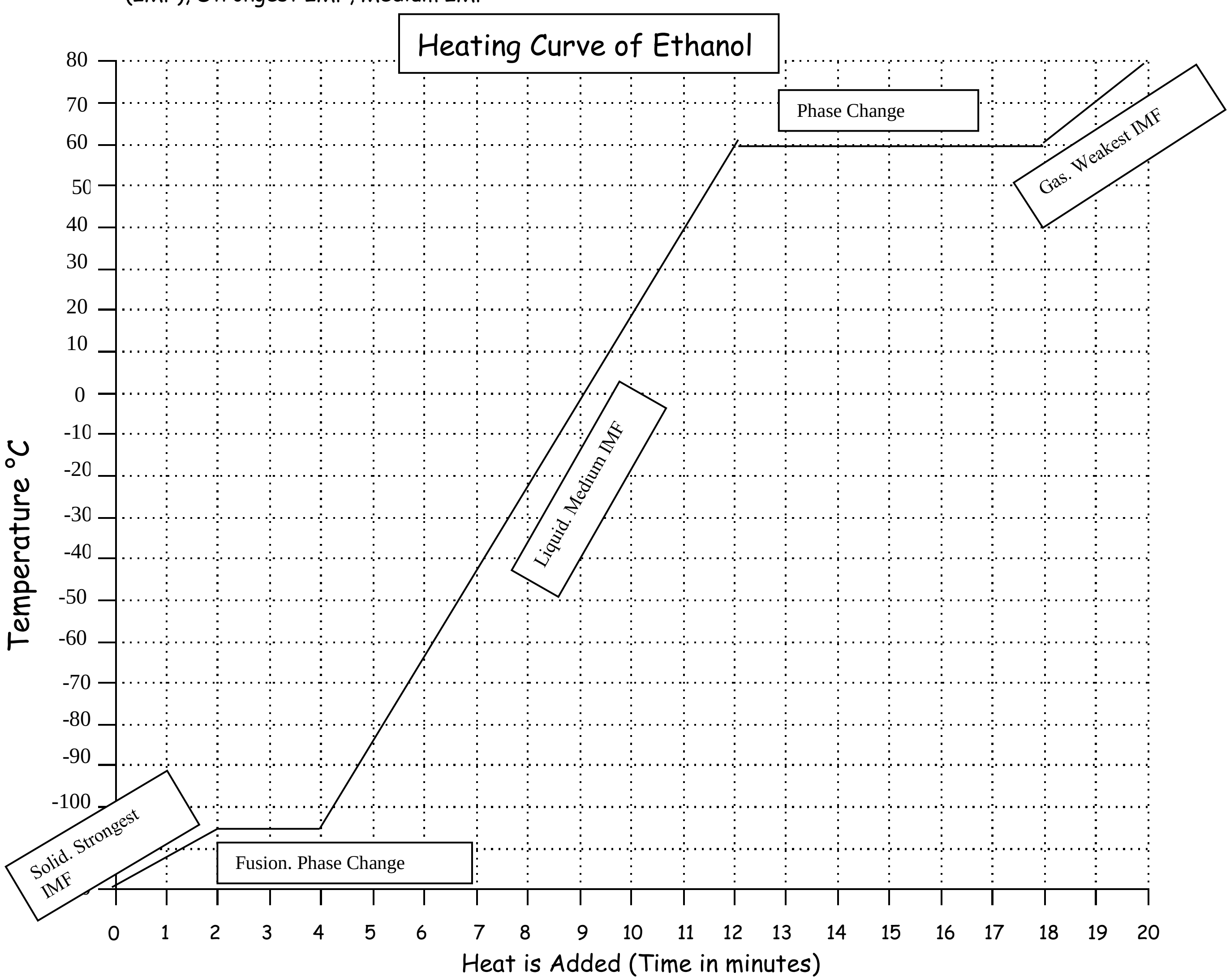
Names: ___________________
Teammates Names: __________________, ____________________, __________________

Create a Heating Curve: The Team Assessment

Directions: Graph the heating curve of Ethanol using the information given below. Check off each box as you add the additional information to your graph so that nothing is missed. Each teammate MUST complete his or her own graph.

Background Information: Boiling point of ethanol is 60°C. Ethanol's starting temperature is -120°C. The melting point of ethanol is -105°C.

- ☐ After 2 minutes, freezing cold ethanol starts to melt. It takes 2 minutes to melt completely.
- ☐ After 8 more minutes it begins to boil. It boils for 6 minutes.
- ☐ Heat is added for 2 more minutes until ethanol reaches 80°C.
- ☐ Label "Fusion" where this takes place
- ☐ Label "Phase Change" everywhere a phase change occurs
- ☐ Indicate where ethanol is only a SOLID (S), only a LIQUID (l), and only a GAS (g).
- ☐ Of these three phases, label which phase has the: Weakest Intermolecular Forces of Attraction (IMF), Strongest IMF, Medium IMF



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Names: ___________________
Teammates Names: _________________, ____________________, __________________

Create a Heating Curve: The Team Assessment

Directions: Graph the heating curve of Ethanol using the information given below. Check off each box as you add the additional information to your graph so that nothing is missed. Each teammate MUST complete his or her own worksheet.

Background Information: Boiling point of ethanol is 60°C. Ethanol's starting temperature is -120°C. The melting point of ethanol is -105°C.

- ☐ After 2 minutes, freezing cold ethanol starts to melt. It takes 2 minutes to melt completely.
- ☐ After 8 more minutes it begins to boil. It boils for 6 minutes.
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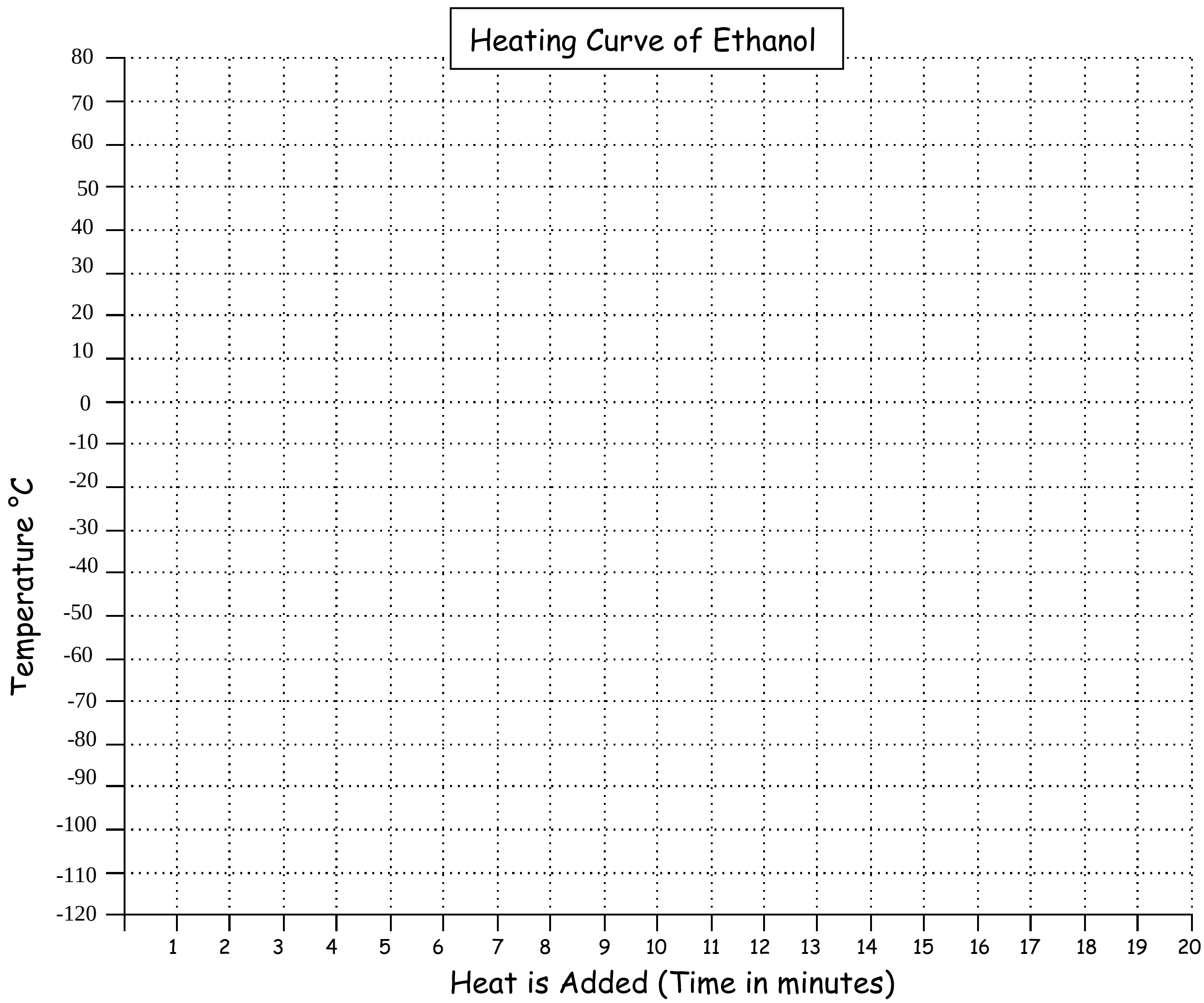
- ☐ Of these three phases, label which phase has the:
  Weakest Intermolecular Forces of Attraction (IMF), Strongest IMF, Medium IMF



Short Answer: Intermolecular forces are continually weakened when heat is added to a substance. Compare and contrast what happens during a phase change versus a temperature change. Reference the heating curve of ethanol to explain your answer.

As a team, brainstorm an answer for the question below and then construct your response. Each team member must complete the short answer question or the whole team will receive a zero for the question.

Brainstorming Space:

Answer:

Name ________________________________ Date__________ Period___________

Individual Assessment

Short Answer: Provide a clear and concise explanation for each of the questions below.

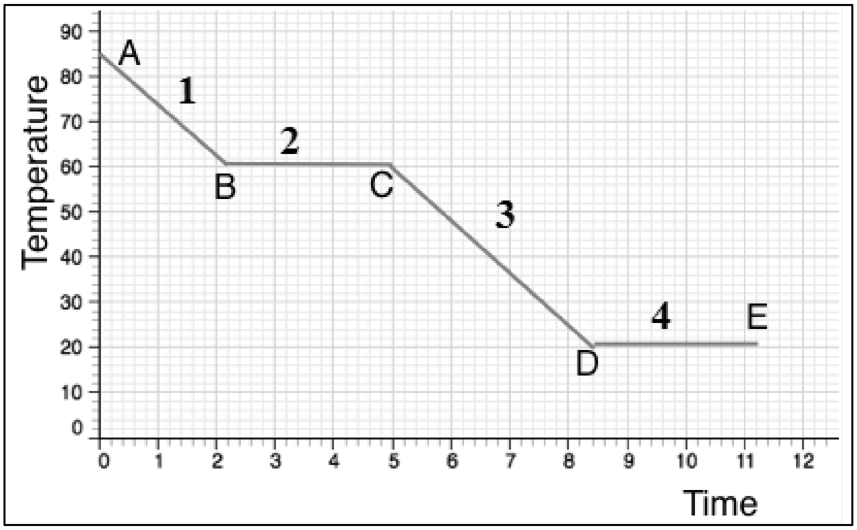
Substance	Melting Point	Boiling Point
Methane (CH_4)	- 183 °C	- 162 °C
Water (H_2O)	0 °C	100 °C

1. Identify the intermolecular force(s) present in methane and in water based on the table above.
   - IMF in water is hydrogen bonding. Intramolecularly bonded by covalent bonds. IMF in methane is London Dispersions. Intramolecularly methane has covalent bonds.

2. Based on the given melting and boiling points in the table above, infer the strengths of the substances by comparing and contrasting their intermolecular forces. Use data from the table to support your logic and answer.
   - The IMF in water is much stronger than in methane. This can be inferred by the lower melting and boiling point of methane. The lower boiling point means it requires less energy to break apart the bonds holding together the molecules in methane than in water.

3. Explain how hydrogen bonds create surface tension in water. Discuss polarity. Include relevant observations from the penny drop lab.
   - Hydrogen bonds create surface tension by creating an interlocking web of water molecules all bonded together with hydrogen bonds. Hydrogen bonds form like this because water is a polar molecule with one end being slightly positively charged and the other end being slightly negative. This polarity of water means water molecules are attracted to each other. Surface tension is what held together the water droplets on top of the penny. Without hydrogen bonds, only a few drops would have remained on top of the penny. With hydrogen bonds holding all of the water molecules together, students are able to get ~30 drops of water to stick onto of a penny.

Graph Analysis:



4. What phase(s) exist at each of the numbered sections above?

Point 1. _____Gas
Point 2. ______Liquid/Gas
Point 3. ______Liquid
Point 4. ______Solid/Liquid

5. At what temperature is this substance condensing? ___60 degrees

6. At what temperature is this substance freezing? ________20 degrees

7. At which numbered section(s) is/are phase changes occurring? ___2 and 4

8. At which numbered section(s) is/are the kinetic energy of the molecules the greatest? ____1

9. Relate your answer to #8 to the associated intermolecular force of attraction.
   - In section 1, intermolecular forces of attraction are at their lowest because the IMFs have been weakened until they broke apart allowing the substance to become a gas in section 1.

10. Evaluate the change in temperature from point A to E with regards to heat.
    - Heat is lost as the substance cools off from Point A to E (exothermic)

11. From point A to E, the intermolecular forces of attraction and the kinetic energy of the substance are changing. Discuss these two changes, comparing each at Point A and Point E on the graph.
    - At Point A the kinetic energy is much higher than at Point E. You can tell because of the relative temperature.
    - At point A the intermolecular forces have been overcome by the increase in kinetic energy (that's what let the substance become a gas). At point E the IMF are very strong, holding the substance in a rigid form (solid).

12. Draw in the missing section of this heating curve on the graph and label the phase that best fits. Using the terms temperature and heat, justify (prove) your chosen phase.
    - Should extend below Letter E to represent the solid phase.

13. You are in a competition to make hot chocolate as quickly as possible. Which order of operation is best? Heat the milk alone and then add the bar of chocolate OR add the bar of chocolate to the milk and then heat together? Apply your knowledge from the "Let's Chill" lab and "The Power of Salt (NaCl)" article to justify your decision. Refer to the following excerpt to guide your response.

Reading Passage:
Pure water boils at a temperature of 100°C. Once a solute such as sodium chloride is added to water, the salt dissolves and forms a salt solution with a boiling point higher than 100°C. The higher boiling point is due to the fact that sodium chloride particles dissociate into sodium (Na^+) and chloride ions (Cl^-) that are now strongly attracted to the surrounding polar water molecules. Additional heat is now needed to weaken the intermolecular forces of attraction between water molecules plus the sodium and chloride ions attached to the water molecules. In other words, the addition of salt causes an elevation of the boiling point of a pure solvent.

Name ___________________________________ Date__________ Period___________

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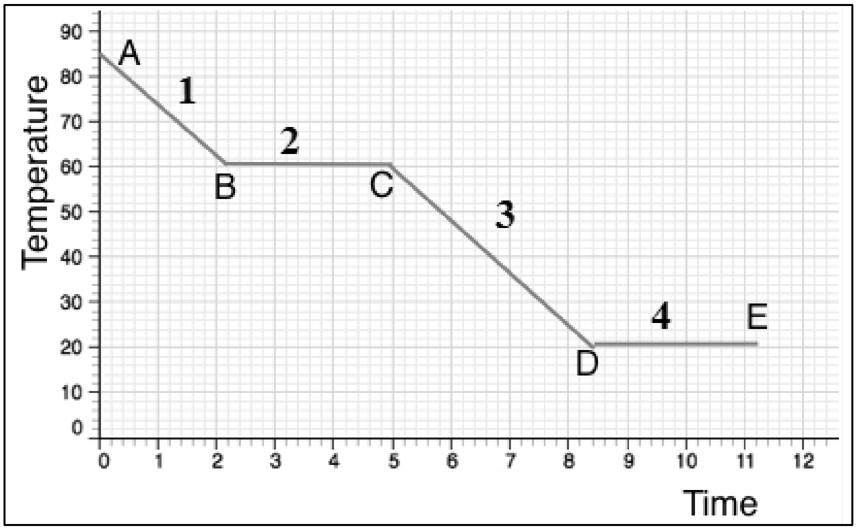

4. What phase(s) exist at each of the numbered sections above?

Point 1. ____

Point 2. ____

Point 3. ____

Point 4. ____

5. At what temperature is this substance condensing? ___________________________________

6. At what temperature is this substance freezing? _____________________________________

7. At which numbered section(s) is/are phase changes occurring? ___________________________

8. At which numbered section(s) is/are the kinetic energy of the molecules the greatest? _________

9. Relate your answer to #8 to the associated intermolecular force of attraction.

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