Jenn Maeng
EDLF 739 Differentiating Instruction 2009
LP Differentiation workshop

## ***Lesson overview***

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| Subject: | Chemistry |
| Grade: | 10 -12 |
| Topic: | Changes of State |
| Concepts: | Kinetic Molecular Theory, Phases of Matter, Phase changes, Intermolecular forces |
| Essential questions: | • How do changes take place in systems?<br>• Why do changes occur in systems?<br>• How do changes on an atomic/ molecular level affect the properties of a substance? |

## ***Objectives***

✓ Students will know:

1K) Molecules are in constant, random motion.
2K) Changes in the energy of a system cause matter to change state.
3K) Different substances require different amounts of energy to be added to the system to change state based on the strength of their intermolecular forces.
4K) At the melting and boiling points of water, energy is added but the temperature remains constant until all ice is melted to liquid water or all liquid water is vaporized to gaseous water.
5K) The melting and freezing points occur at the same temperature.
6K) The vaporization and condensing points occur at the same temperature.

✓ Students will understand:

1U) changes on an atomic/ molecular level affect the macroscopic properties of a substance.

✓ Students will be able to do:

1D) Explain how changes in energy cause changes in state.
2D) Describe the role of intermolecular forces in changes of state.
3D) Describe the process by which a substance changes from a solid to liquid to gas.

**Checking points*.

- Do the "Know" objectives cover the essential information to be learned?
- Are the "Understand" objectives big and transferable ideas of the discipline?
- Are the "Do" objectives are observable and measurable? Do they encompass essential skills?
- Do the KUDs "fit together"-in other words, will they come together coherently?

## ***Lesson sequence***

| Lesson Sequence | REFLECTION |
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| Time allocation: 90 minutes | |
| **Resources:** | |

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| *Intro:* projector, computer, video of snow samples melting<br>*Analytical*: laptops with internet access and temperature probes, CBLs, beakers, Bunsen burners, ring stand and clamp,<br>*Creative:* laptops with internet access, colored pencils, markers, crayons, computer paper<br>*Practical*: laptops with internet access and temperature probes, CBLs, beakers, Bunsen burners, ring stand and clamp,<br>*Closure*: Bunsen burner, iodine crystals, ice, beaker, watch glass | |
| ***Strategies for learning profile differentiation:***<br>**Analytical:** Collecting and graphing data, interpreting parts of a graph, convey understandings through comparison of similarities and differences and graphically.<br>**Practical:** Collecting and graphing data, convey understandings by relating the process to environmental issues of the water cycle and glacial melting.<br>**Creative:** Working with a simulation to develop the concepts, conveying an understanding of the concepts through visual (comic) or creative writing representations<br>**Other:** Individual v. interpersonal preference (Students may choose to work on their assigned task individually or cooperatively in small groups), also the analytical may appeal to logical/ mathematical or kinesthetic, the practical may appeal to linguistic, and the creative may appeal to visual/spatial and linguistic | This lesson is differentiated on learning profile with respect to process (the analytical and practical groups are going to be doing an experiment, while the creative group is going to do a simulation), and product with respect to all three groups.<br>Additionally, students can choose whether they want to work independently or with a partner.<br>The creative group also has choice in that they can convey their understandings in either a visual or a written representation.<br>Finally, looking at Gardner's multiple intelligences, s. will have the option of working alone or in small groups. |
| ***Introduction (10 min)***<br>Q: What are the three states of matter?<br>*EA: Solid, liquid, gas*<br>*Q:* What is it called when a substance changes from S→L, L→G, G→L, L→S<br>EA: *melting, evaporation/ boiling, condensing, freezing*<br>Q: What causes matter to change state (or phase)?<br>*EA: heating it, cooling it*<br><br>T: Describes a short time-lapse video of two different masses of snow melting into water then evaporating into water vapor as it is heated on a hot-plate that is going to be shown to s.<br><br>Q: Which do you predict will melt faster? Why?<br>*EA: The one with less snow b/c there is less stuff present.*<br>Q: If the amount of heat applied is constant throughout the process, do you think it will take longer for melting or evaporation to occur?<br>*EA: could be either, must give justification*<br><br>T: Lets see what happens... (Show video) | This should be review from 8$^{th}$ grade physical science.<br><br>Students observe a short time-lapse video of something in nature they're very familiar with.<br><br>Asking them to make predictions, observations, and inferences allows them to think about what they know is going on, and what they think might be occurring on a deeper level.<br>This helps them to verbalize their ideas and may help the teacher get at possible misconceptions the students have even before the students begin exploring the phenomenon of phases changes. |

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| Q: What observations can you make about the snow?<br>*EA: It becomes liquid, it then becomes gas, the longer it's heated the more melted it gets.*<br>Q: What inferences can you make about where the energy is going?<br>EA: *It's causing the molecules to move faster so they break apart (again, a misconception), the molecules move faster so the IMFs have less influence*<br><br>Q: What type of intermolecular forces does water have?<br>*EA: H-bonding, dipole-dipole, and LDF*<br>Q: Which ones will be most important, why?<br>EA: *H-bonding, they're the strongest.*<br><br>Q: What inferences might you make, based on these observations and the IMFs that water has about the processes that are occurring as the snow is heated?<br>EA: *The molecules are moving faster the longer the heat is applied, the molecules break apart (this is a misconception – the molecules, as they change phases are still), the molecules spread out, the molecules aren't held as tightly together, the IMFs become weaker*<br><br>T: Today, we're going to explore the process you've just observed to determine whether or not your inferences are correct and to see what else we can learn about particle motion as phase changes occur. We're going to do this in three different ways. | This is a review of the concept of intermolecular forces that s. learned in the lessons immediately preceding this one. (K3)<br><br>By making inferences about what is going on a molecular level and about the role of energy in phase changes, the t. gives the students a rationale to "test" their inferences. |
| ***Body of lesson (70 min)***<br><br>*Teaching strategies and learning experiences*<br>T. breaks s. into groups based on identified learning profiles.<br>*Note: all students may choose to work individually or in small groups on their assigned task. (minor differentiation)* | |
| **Analytical**<br>*(will also appeal to kinesthetic and logical/ mathematical learners)**:***<br>**Part 1:** (30 min)<br>Group conducts experiment in which they heat a chunk of ice until it evaporates. (Lab procedure not attached, but I can send it to you if you want to look at it.)<br>They record temperature and time data throughout the heating process using temperature probes and a computer.<br>From this data, they will create a graph of time v. temperature. | Unlike the creative group that will use a simulation to "perform" the experiment, observe the molecular motion, and create a graph simultaneously, I deconstructed these concepts for this group such that they can "reconstruct" them to develop and understanding of how the component concepts are related.<br><br>Part 1: Given the analytical preference, these s. will be collecting their own data and making their own graph from their collected data. |

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| They will identify where the three phases (solid, liquid, and gas) appear on the graph and where processes of change occur (melting, evaporation). http://www.wwnorton.com/college/chemistry/gilbert/tutorials/interface.asp?chapter=chapter_09&folder=phase_diagrams, http://www.yteach.com/page.php/resources/view_all?id=heating_cooling_temperature_curve_expansion_volume_body_density_water_condensation_freezing&from=search (Part 5)<br>**Part 2:** (10 min)<br>They will then look at computer animations of molecules in the solid, liquid, and gas phases and those undergoing the processes of melting/freezing, evaporation/ condensation and match these to their graphs.<br>**Part 3:** (20 min)<br>Similarities and differences: s. will create a diagram or table in which they compare molecular motion in each of the three phases and compare these with molecular motion during the phase changes. They will also compare variations in intermolecular force during each of the phases and the processes. Based on this analysis, they answer the questions: What relationships between the flat areas and sloped areas of their graph? *(EA: flat = phase change, energy goes into weakening IMFs, not temp change; sloped, energy goes into temp change, molecular vibrations)* What would your graph look like were the water molecules going from steam to ice? What evidence do you have to support this? *(EA: Reverse, that evap/condens are opposite processes, same molecular motion would occur, etc)*<br><br>*Products:* graph of time v. temperature for phase changes of ice to steam, table analyzing molecular motion and IMFs in each phase and during the phase change processes, conclusion statements. | They will then interpret their graph. Objectives: 1U, 2K, 4K, 1D, 3D<br><br>Part 2: S. will synthesize information in tabular format based on their observations of the animation and relate this to their graph. (2U, 1K, 2D, 1D)<br><br>Part 3: Finally, these s. will draw conclusions based on their graph and table. (2U) (Objectives: 2K, 4K, 5K, 6K, 1D, 2D, 3D) |
| **Practical**<br>*(will also appeal to linguistic learners)***:**<br>**Part 1:** (10 min) Pretend you are a scientist reading about the importance of energy changes and the Earth's hydrologic cycle. S. skim the articles found at: http://www.cosis.net/abstracts/EGU05/07870/EGU05-J-07870.pdf and http://www.usatoday.com/weather/tg/wevapcon/wevapcon.htm<br>Today, we are going to do an experiment to model this process and see if we can determine what occurs during this process, how this process relates to the hydrolytic cycle, and | I honestly had the hardest time developing this "differentiated" activity for these chemical concepts, which is pretty sad in my opinion since I always tell the kids that chemistry is so practical and important in everyday life. I could think of some practical applications (like the hydrolytic cycle, rock cycle, and phase change materials), but I had difficulty integrating these substantively into an activity to meet the KUDs.<br>Ultimately, I decided that the hydrologic cycle would be a good way to tie the concepts of phase changes to practical importance given the emphasis on environmentalism by society b/c s. are familiar with this from previous |

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| hypothesize what effect disruptions in this process might have on environmental processes.<br>**Part 2:** (30 min)<br>Group conducts experiment in which they heat a chunk of ice until it evaporates, difference between this experiment and the "analytic" group experiment is that they heat their water samples to a vapor in a flask then immediately remove the heat, seal the flask (except for a temp probe) and cool the flask in a dry ice bath until it recondenses then freezes. (Lab procedure not attached, but I can send it to you if you want to look at it.)<br>They record temperature and time data throughout the heating and cooling process using temperature probes and a computer. From this data, they will create a graph of time v. temperature. They will identify where the three phases (solid, liquid, and gas) appear on the graph and where processes of change occur (melting, evaporation, condensing, freezing).<br>**Part 3:** (5 min)<br>They will then look at computer animations (same as analytical) of molecules in the solid, liquid, and gas phases and those undergoing the processes of melting/freezing, evaporation/ condensation and match these to their graphs.<br>**Part 4:** (15 min)<br>In a newsletter column for a local environmental group, s. will answer the questions: How is the process you experienced in the experiment related to the hydrolytic cycle? What do molecular motion, molecular properties, and energy have to do with it? What effect might disruptions in this process might have on environmental processes (present hypotheses with evidence).<br><br>*Products: graph of time v. temperature for phase changes of ice to steam and back to ice with molecular understanding indicated. Newsletter article discussing relationship between heating/cooling curve, phase changes, molecular motion, and the hydrolytic cycle, and potential importance for the environment.* | classes (6th grade science, Earth science) and because living in Virginia, all have at least some experience with it in nature.<br><br>Part 1: Setting up a practical problem for these s. to be scientists, explore the process, then relate to environmental effects using the water cycle and sci. readings. The entry point for these s. is differentiated to appeal to practical intelligence.<br><br>Part 2: I wanted these s. to experience "being a scientist" and conduct an experiment to help them understand the water cycle in nature. As with the analytical group, these s. will be collecting their own data and making their own graph from their collected data. They will then interpret their graph. Objectives: 1U, 2K, 4K, 5K, 6K, 1D, 3D<br><br>Part 3: S. will synthesize information from the animation and relate this to their graph. (2U, 1K, 2D, 1D)<br><br>Part 4: Comes back to original practical importance of understanding effects of energy on physical processes in the environment to create a product. |
| **Creative**<br>*(This will also appeal to visual/spatial and linguistic learners depending on the product they choose to create):*<br><br>**Part 1**: (30 min)<br>This group will be using a "phase change gizmo" simulation (www.explorelearning.com) to learn about changes of phase.) (Simulation procedure not attached, but I can send it to you if | I chose to have this group use a simulation instead of doing the lab, because I think it would be visually more effective for them to see simultaneously the apparatus heating the ice cube, the graph being created, and the molecular motion instead of breaking these out into discrete concepts and having the group "put them back together" as the analytical group does.<br>Given their creative tendencies, it should |

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| you want to look at it.)<br><br>**Part 2:** (40 min)<br>Once they have completed the gizmo, they will have an option of developing a cartoon strip depicting the phases, the processes of phase change, and the role of IMFs in these.<br>-or-<br>Write a creative story in which that describes the phases, the processes of phase change, and the role of IMFs in these<br><br>*Products:* cartoon strip or creative story. *(Rubrics attached as separate file)* | engage s. more to spend less time working through the science and more time working on a creative interpretation of the science.<br><br>Part 1: This group will use a computer simulation to learn about the relationship of energy to phase changes and IMFs (Objectives: 1U, 2U, 1K, 2K, 3K, 4K 1D, 2D, 3D)<br><br>Part 2: Historically, some of my s. have been phenomenal artists, and others have been amazing creative writers. I chose to have the option of these two products to meet these varied creative talents of my s. (Objectives: 1U, 2U, 1K, 2K, 3K, 4K 1D, 2D, 3D) |
| ***Closure (10 min)***<br>T. demos the sublimation of iodine crystals of going from solid to gas (by heating beaker w/ a few crystals until they form a gas)<br>Q: What are some observations you made?<br>*EA: The iodine crystals are shiny, the gas $I_2$ molecules are purple. Never saw a liquid.*<br>Q: What do you think the heating curve for this process would look like? Why?<br>*EA: sloped, flat, sloped, iodine doesn't go through a liquid phase at r.t.*<br>Q: How is this similar/ different from the water heating curve?<br>*EA: Similar: temp changes within a phase are sloped, differences: it only has one phase change to go from s. to g.*<br><br>T. demos deposition of $I_2$ vapor formed above going to solid by adding ice to a watch glass set on top of the beaker. Crystals form on the bottom surface of the watch glass.<br>Q: What did you observe?<br>*EA: Crystals form on the bottom surface of the watch glass.*<br>Q: What do you think the heating curve for this process would look like? Why?<br>*EA: sloped, flat, sloped in the opposite direction as the one we described above, iodine doesn't go through a liquid phase at r.t.* | This closure asks s. to come back together as a group.<br>All 3 groups made or saw a heating curve, explored the role of IMFs in phase changes, and explored the molecular processes that occur when E is added to produce a physical change.<br>In the closure, they are all asked to apply their knowledge and understandings to a new situation.<br>T. can assess how well they understand the influence of molecular properties on phase changes (U1) and types of changes that can occur – have the "normal ones" now lets apply to abnormal ones (U1). This demo also revisits IMF differences in molecules, which would have been taught in days preceding this lesson (3K)<br><br>Note: s. may not finish the last part of their respective products during class. They can take them home to work on them and bring them back completed.<br><br>Next class would be energy calculations with phase changes. (Moving from conceptual to mathmatical.) |