Phase Change

Teacher's Guide

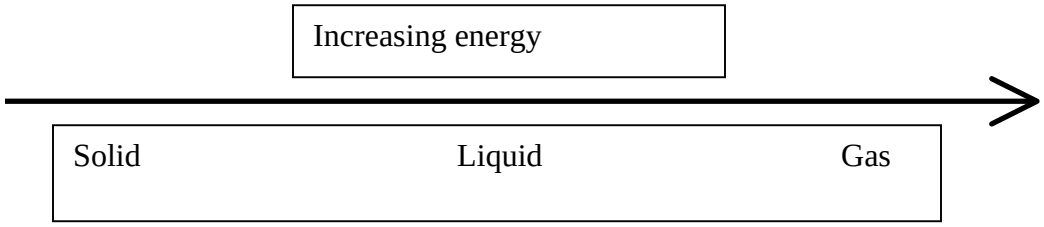
1.0 Summary

Phase Change the seventh activity to be done after the pre-test. This activity should take approximately 20 minutes to complete.

2.0 Learning Goals

Driving Question: How does temperature affect phase changes?

This activity allows students to experiment with the relationship between temperature and phase change. In general, when heat is added to a substance, the energy is either used to increase the temperature of a substance or cause a phase change. The phase changes occur as this added energy is used by the molecules to overcome attractive forces between other atoms or molecules. When a substance gives up heat energy, these attractive forces become more significant and substances move to a less energetic phase.

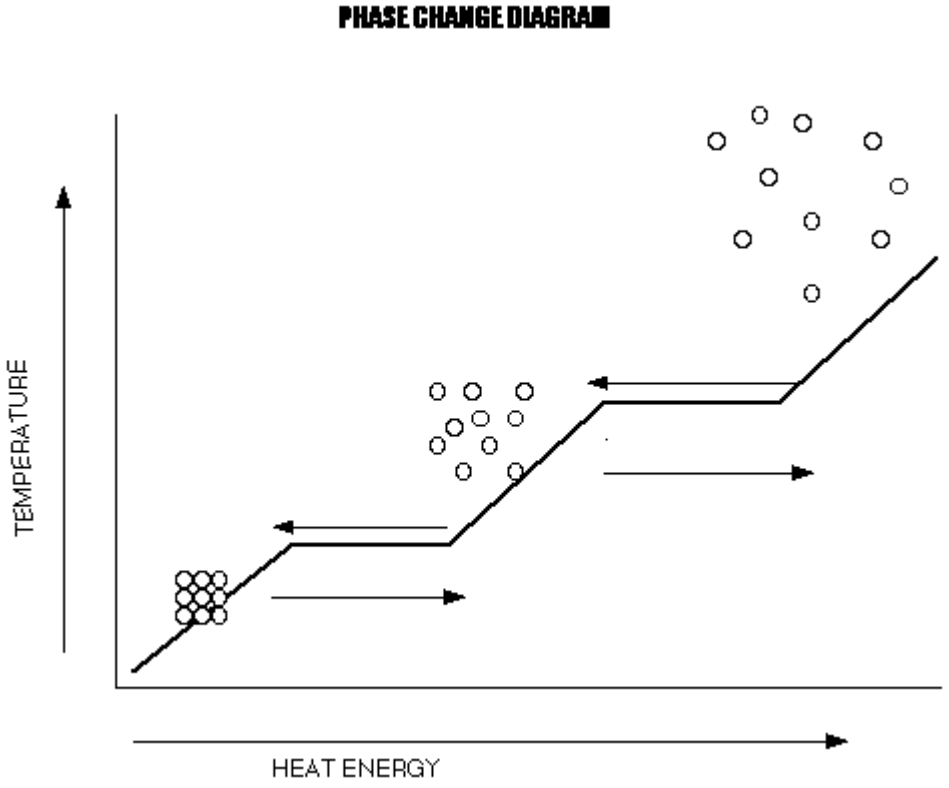


Learning Goals

- Students will understand that phase changes involve energy changes.
- Students will understand that increasing temperature increases energy.
- Students will understand that decreasing temperature decreases energy.
- Students will be able to recognize different phases of matter as they appear in the model.
- Students will develop a visual model for the process that occurs during a phase change.

Additional Teacher Background

Phase changes occur when the attractive force between molecules is overcome by the kinetic energy of the molecules. During the phase change energy is being used to break the attractive forces between molecules or atoms. This means that although heat energy is being absorbed there is no temperature increase. This can be seen in the following graph:



Although heat energy is constantly being added, there are regions of no temperature increase. These regions occur when the energy is being used to separate the molecules. When heat energy is removed temperatures also remain constant during condensation and freezing. These lines tend to be straight for pure substances. Mixtures did not generally do not give such pronounced regions on the graph.

3.0 Standards Alignment

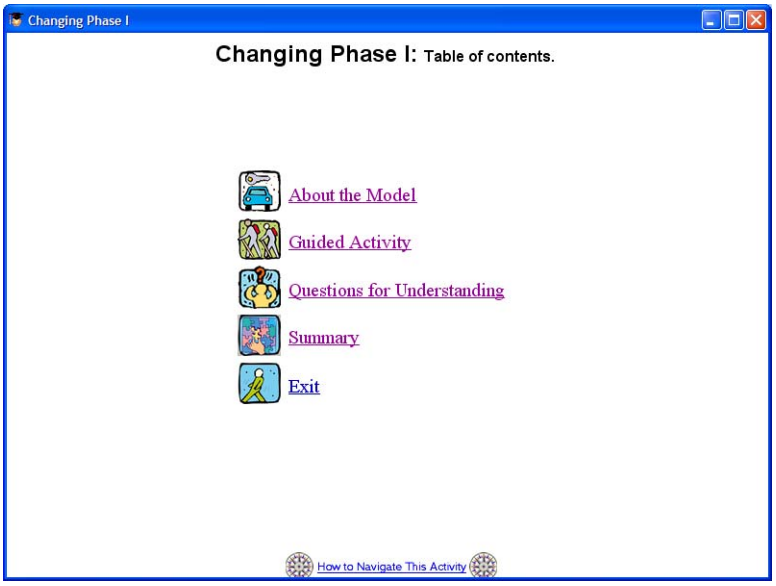
Alignment to National Math and Science Standards (NCTM or NSES)

Objective	Standards
Students will why phase changes occur	• Varies by state.
Students will understand how temperature affects phase changes	• Varies by state.
Students will understand that forces between molecules or atoms affect phase changes.	• Varies by state.
Students will understand that gases have the most energy and solids have the least	• Varies by state.

4.0 Activity Sections

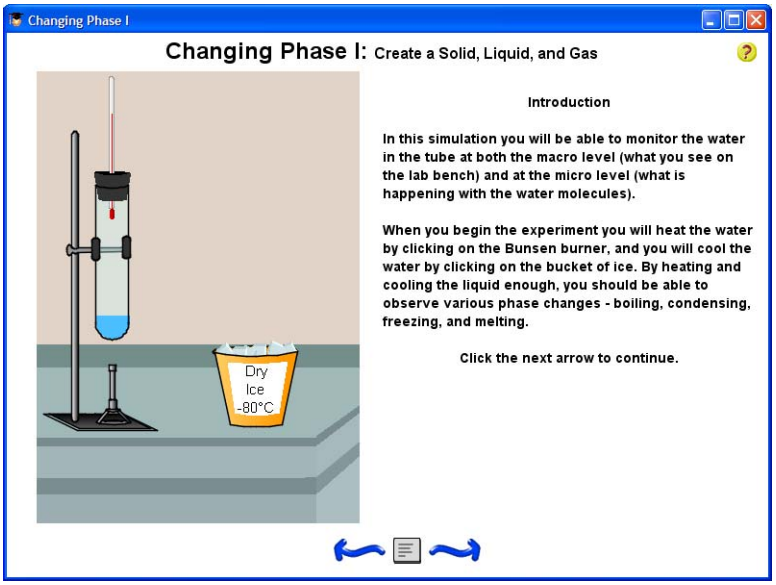
4.1 Table of Contents

This activity has 4 sections.



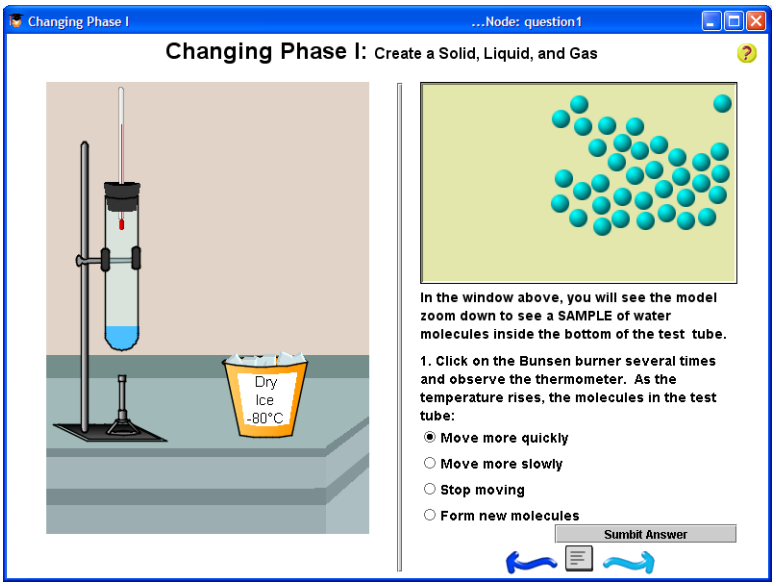
4.2 About the model

In this step students are introduced to the heating and cooling model. Clicking on the Bunsen burner adds heat energy to the system. Clicking on the ice bucket removes energy form the system. Note the rise and fall in temperature with the thermometer.



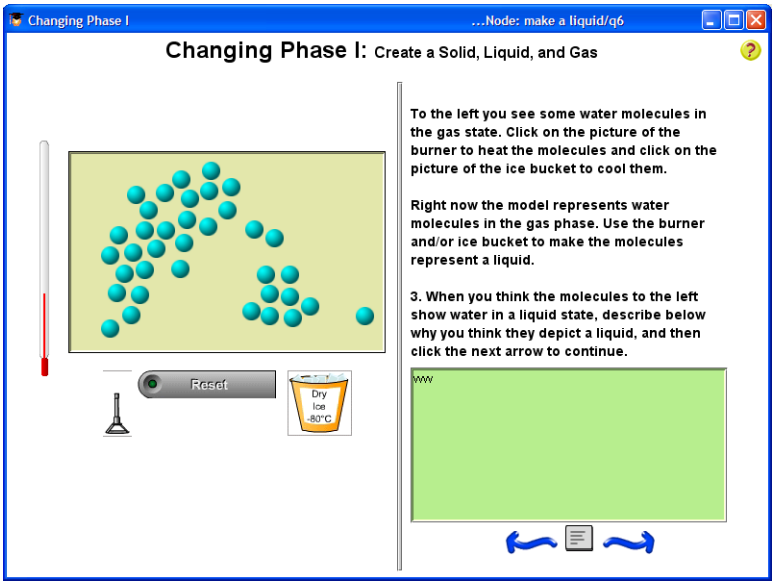
4.3 Guided activity

The first activity asks students to observe the affect of a temperature increase on the movement of the molecules. In general, increasing the temperature will usually cause the molecules to move more quickly. It is worth noting that during a phase change there will be no increase in the speed of the molecules; the energy will be used to break down the attractive forces between the molecules or atoms:

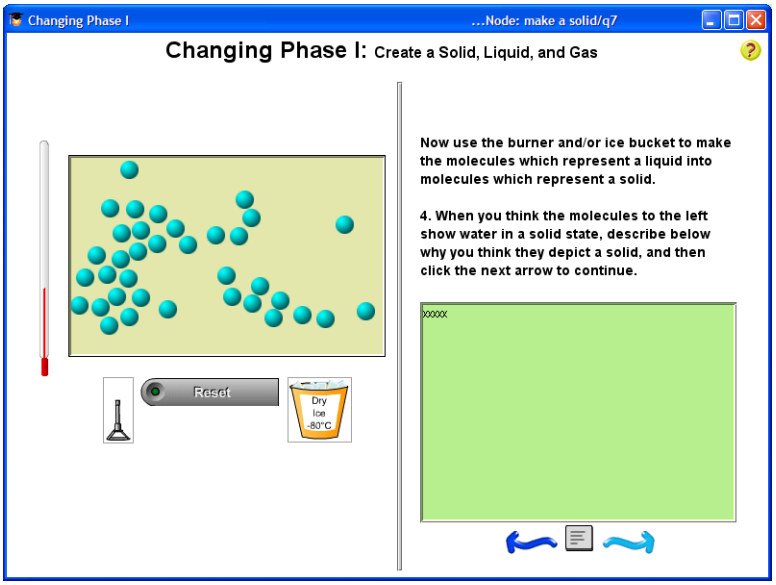


Conversely the next screen asks what will happen when the temperature goes down. In general, the molecules will move more slowly.

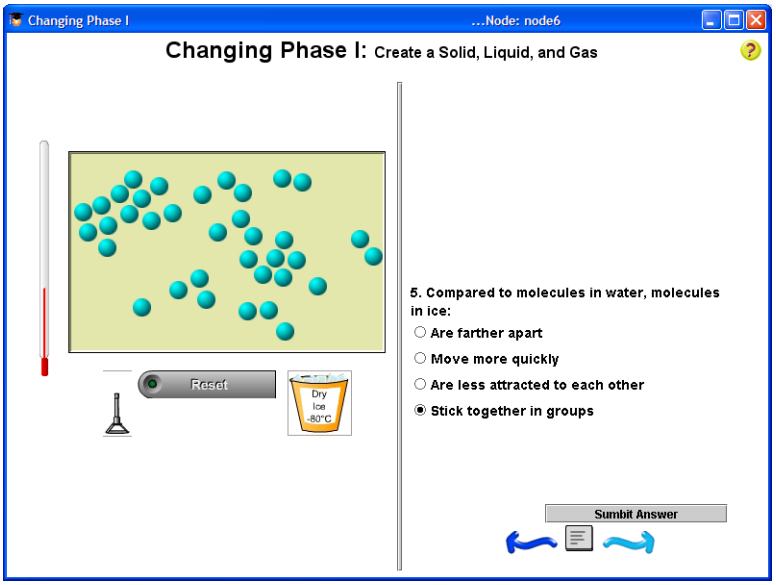
On the screen below, students change steam to water by using the ice bucket. Once the molecules are less energetic and are tending to clump together, they have changed to water. As we have learned from earlier modules liquid molecules will have close contact with other molecules, but will retain the ability to move around each other.



On this screen, students continue cooling the liquid into a solid. When the substance is very cool, the molecules will be clumped together in a fairly rigid pack. Solids tend to be packed closely together and do not retain the ability to slide past each other:



Now, students compare solid and liquid molecules. Molecules of ice tend to stick together in clumps:



4.4 Questions for understanding

The first question asks students to compare water in all three of its usual phases. Students should generate a written answer that summarizes:

State	Speed	Space
Solid	slow	touching
Liquid	medium	usually touching
Gas	fast	rarely touching

The last question asks if molecules in ice are moving or if they are completely still. It is worth noting that all molecules have movement if they are above absolute zero, a condition that is impossible to obtain. Even at absolute zero the electrons would still be in motion.

4.5 Summary

This section shows student answers to all the questions. There is an icon on the lower left that will print each student's answers. After the students click the icon, s/he will be asked to type in their name. This is only for the printout; their name is not saved in our database. Then, a web page is generated with the answers. This process may take a few moments. The standard print dialog box will open and the student can select the appropriate printer.

5.0 Student Reports

Your students' work with the Changing Phase activity is logged and viewable on the MAC Project Web Portal at http://mac.concord.org. For each student, you can view a report containing questions and answers. van der Waals is the next activity in the Chemica sequence.