

The Next Generation Science Standards (NGSS)

CHAPTER 1, LESSON 3 – THE UPS AND DOWNS OF THERMOMETERS

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

DISCIPLINARY CORE IDEAS

PS1.A: Structure and Properties of Matter

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)

Students observe the red liquid (colored alcohol) in a thermometer placed in hot and cold water. Students use their observations and what they have learned so far about the motion of molecules in a liquid to understand the up and down movement of the liquid in the thermometer based on the motion and arrangement of alcohol molecules when they are heated and cooled. Students also see that mercury and alcohol rise to different heights in a thermometer even at the same temperature. This indicates that mercury and alcohol have characteristic properties based on the atoms and molecules they are composed of.

SCIENCE AND ENGINEERING PRACTICES

Developing and Using Models

- Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4)

Engaging in Argument from Evidence

Students investigate the question: What makes the liquid in a thermometer go up and down? Along with observing the movement of the liquid in the thermometer, students see a molecular animation modeling the motion of the molecules when they are heated and cooled. Students use and further develop this molecular model and apply it to evidence

they have observed to explain their observations on the molecular level and to answer the question to investigate.

CROSSCUTTING CONCEPTS

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)

Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)

Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. (MS-PS1-3)

Students see and apply the cause and effect relationship between heating and cooling and the motion and arrangement of molecules. Students use a molecular level explanation to explain the macroscopic effect of the rising and falling of the liquid in a thermometer. Students also see that a thermometer is a cleverly designed device whose very thin glass tube-within-a-tube and special liquid can be used to indicate changes in temperature.