

# The Next Generation Science Standards (NGSS)

## CHAPTER 1, LESSON 4 – MOVING MOLECULES IN A SOLID

**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*

- 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)
- Solids may be formed from molecules, or they may be extended structures with repeating sub-units (e.g. crystals). (MS-PS1-1)

*Students observe a metal ball-and-ring demonstration in which the ball is heated and cooled. The ball fits through the ring at room temperature but becomes too large to fit through when heated. Students apply what they've learned so far to begin to understand the attractions, arrangement, and motion of the atoms in a solid and how these properties are affected when the solid is heated and cooled.*

### 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: How does heating and cooling affect the atoms of a solid? In addition to observing the actual metal ball and ring, students see a molecular model animation of a solid being 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 ball expanding and contracting when it is heated and cooled. Students also see that the expanding and contracting of a solid is a problem in road construction on bridges. Students see that scientists and engineers have developing flexible materials and movable joints to solve this problem.*