

# The Next Generation Science Standards (NGSS)

## CHAPTER 2, LESSON 4: CHANGING STATE – FREEZING

**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)
- Solids may be formed from molecules, or they may be extended structures with repeating sub-units (e.g. crystals). (MS-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (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 use ice and salt to make a can cold enough so that water vapor from the air condenses and then freezes on the outside of the can. Students also see a demonstration showing that when water freezes to form ice, the ice takes up more space than the water did before it was frozen. Students use their observations and what they have learned so far about the motion, attractions, and arrangement of molecules in a liquid and in a solid to begin to understand this observation. Students learn that the open crystal structure formed by water molecules as water freezes is contrary to what would be expected. Students also see that different substances have characteristic temperatures at which they freeze based on the molecules they are made 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: How can you make the water vapor in air condense and then freeze? After seeing ice form on the outside of a cold can, students see a molecular model of the arrangement of water molecules in ice. 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.*

## CROSCUTTING 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)

*Students see and apply the cause and effect relationship between cooling, decreasing molecular motion, and the molecules moving apart and becoming fixed to form a solid. Students use a molecular-level explanation to explain the macroscopic effect of the water vapor changing to liquid water on the side of the cold can and then freezing to form ice.*