

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 1: WHAT IS DENSITY?

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### DISCIPLINARY CORE IDEAS

*PS1.A: Structure and Properties of Matter*

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)

*Students calculate the density of eight different cubes, all with the same volume but different masses. Students use illustrations of the atoms and molecules that make up the different cube materials to begin to understand how the atoms and molecules of a substance determine its characteristic properties, including density, and can be used to identify it.*

### SCIENCE AND ENGINEERING PRACTICES

*Developing and Using Models*

- Develop a model to describe unobservable mechanisms. (MS-PS3-2)

*Planning and carrying out investigations*

*Analyzing and interpreting data*

*Using mathematics and computational thinking*

*Engaging in Argument from Evidence*

*Students investigate the question: Can density be used to identify eight cubes made of different materials? Students measure the mass of eight different cubes, calculate the density of each cube, and use this information along with data given in a chart, to identify the material the cubes are made from (4 metal, 2 plastic, and 2 wood). Students see molecular model illustrations of metal, plastic, and wood. 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)

*Students use molecular-level models of different substances to explain how these sub-microscopic characteristics affect the macroscopic observable characteristic of density.*

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 2: FINDING VOLUME – THE WATER DISPLACEMENT METHOD

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### DISCIPLINARY CORE IDEAS

*PS1.A: Structure and Properties of Matter*

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)

*Students calculate the density of five different rods that all have the same mass but different volumes. Students use illustrations of the atoms and molecules that make up the different rod materials to further develop their understanding of how atoms and molecules determine a material's characteristic properties, including density, and can be used to identify it.*

### SCIENCE AND ENGINEERING PRACTICES

*Developing and Using Models*

- Develop a model to describe unobservable mechanisms. (MS-PS3-2)

*Planning and carrying out investigations*

*Analyzing and interpreting data*

*Using mathematics and computational thinking*

*Engaging in Argument from Evidence*

*Students investigate the question: Can density be used to identify five rods made of different materials? Students measure and calculate the volume of the five rods using the water displacement method. They then use the mass and volume to calculate the density of each rod. Students use this information, and data given in a chart, to identify the substance each rod is made from (2 metal and 3 plastic). Students use a molecular model based on the size, mass, and arrangement of atoms of the different rod materials 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)

*Students use molecular-level models of different substances to explain how these sub-microscopic characteristics affect the macroscopic observable characteristic of density.*

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 3: DENSITY OF WATER

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### DISCIPLINARY CORE IDEAS

#### *PS1.A: Structure and Properties of Matter*

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)
- Students find the density of different amounts of water and see that the density is the same regardless of the size of the sample. Students use illustrations and animations of water molecules and see that they are in constant motion, packed close together, and spread evenly throughout a sample. Students further develop their understanding of how atoms and molecules determine a material's characteristic properties, including density, and can be used to identify it.

### SCIENCE AND ENGINEERING PRACTICES

#### *Developing and Using Models*

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

#### *Planning and carrying out investigations*

#### *Analyzing and interpreting data*

#### *Using mathematics and computational thinking*

#### *Engaging in Argument from Evidence*

*Students investigate the question: Do different volumes of water have the same density? Students discover a method for finding the mass of 100ml, 50ml, and 25ml of water. They then use the mass and volume to calculate the density of each sample. Students discover that each sample, regardless of the volume, has the same density. Students graph the volume vs. the mass and get a straight line and then use the graph to predict the mass of a given volume and calculate its density. Students realize that the density of water is 1*

*gram/cm<sup>3</sup> for any volume chosen. Students develop a molecular model of water to understand why any volume of water has the same density. 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 use molecular-level models of water to explain how these sub-microscopic characteristics affect the macroscopic observable characteristic of density.*

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 4: DENSITY – SINK AND FLOAT FOR SOLIDS

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### DISCIPLINARY CORE IDEAS

#### *PS1.A: Structure and Properties of Matter*

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)

*Students investigate why a piece of clay sinks in water while a heavier candle floats. Students use illustrations of the atoms and molecules that make up wax, water, and clay to help understand why wax is less dense than water and why clay is more dense than water. Students further develop their understanding that atoms and molecules determine a material's characteristic properties, including density, and can explain why it sinks or floats in water.*

### 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: Why does a heavier candle float and a lighter piece of clay sink? Students compare the mass of equal volumes of water, wax, and clay to determine their relative densities. Students use a molecular model of water, wax, and clay to understand the relative densities of these substances on the molecular level. 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)

### *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 use molecular-level models of water, wax, and clay to explain how these sub-microscopic characteristics affect the macroscopic observation that wax floats in water and clay sinks in water. An explanation is also given as to how a ship, made from a dense substance like steel, can be made to float. If the ship's structure has a large enough volume, the density becomes low enough for the ship to float.*

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 5: DENSITY – SINK AND FLOAT FOR LIQUIDS

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### DISCIPLINARY CORE IDEAS

*PS1.A: Structure and Properties of Matter*

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)

*Students see that isopropyl alcohol floats on vegetable oil and that vegetable oil floats on water. Students compare the mass of equal volumes of the liquids and look at molecular model illustrations of alcohol, oil, and water to help explain why these liquids either float or sink relative to each other. Students develop their understanding that atoms and molecules determine a material's characteristic properties, including density, and can explain why a liquid sinks or floats in another liquid.*

### SCIENCE AND ENGINEERING PRACTICES

*Developing and Using Models*

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

*Planning and carrying out investigations*

*Analyzing and interpreting data*

*Using mathematics and computational thinking*

*Engaging in Argument from Evidence*

*Students investigate the question: Why does water sink in oil but alcohol floats on oil? Students measure the volume and mass of a sample of each liquid and calculate the density of each. Students also use a molecular model of alcohol, oil, and water to understand the relative densities of these substances on the molecular level. 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)

*Students use molecular-level models of water, wax, and clay to explain how these sub-microscopic characteristics affect the macroscopic observation that oil floats on water and alcohol floats on oil.*

# The Next Generation Science Standards (NGSS)

## CHAPTER 3, LESSON 6: TEMPERATURE AFFECTS DENSITY

**MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**

### 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)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)

*Based on a demonstration and activity, students see that hot water floats on cold water and that cold water sinks in hot water. Students use a molecular model animation and illustrations of water molecules at different temperatures to help explain why hot water is less dense than cold water. Students develop their understanding that the spacing between the moving molecules of a liquid can be affected by heating and cooling.*

### SCIENCE AND ENGINEERING PRACTICES

*Developing and Using Models*

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

*Planning and carrying out investigations*

*Engaging in Argument from Evidence*

*Students investigate the question: Is there a density difference between hot and cold water? Students place hot water (colored yellow) and cold water (colored blue) into room temperature water and observe that the hot water floats to the top and the cold water sinks to the bottom. Students use molecular model drawings to better understand why hot water is less dense than room temperature water and why cold water is more dense than room temperature water. 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)

*Students use molecular-level models of hot, room-temperature, and cold water to explain how these sub-microscopic characteristics affect the macroscopic observation that hot water floats on room-temperature water and cold water sinks in room-temperature water.*