Chapter 3: States of Matter

Chapter 3, Lesson 1 Vocabulary

- gas - matter that has no definite volume and no definite shape
- liquid - matter with a definite volume but no definite shape
- solid - matter that has a definite volume and a definite shape
- surface tension - uneven forces acting on the particles on the surface of a liquid

Chapter 3, Lesson 1 Vocabulary

- vapor - gas state of a substance that is normally a solid or a liquid at room temperature
- viscosity - measurement of a liquid's resistance to flow

Chapter 3, Lesson 2 Vocabulary

- condensation - change of state from a gas to a liquid
- deposition - change of state of a gas to a solid without going through the liquid state
- evaporation - vaporization that occurs only at the surface of a liquid
- kinetic energy - kind of energy that an object has due to its motion

Chapter 3, Lesson 2 Vocabulary

- sublimation - change of state of a solid to a gas without going through the liquid state
- temperature - measure of the average kinetic energy of all the particles in an object
- thermal energy - total potential and kinetic energies of an object
- Vaporization - change of state of a liquid into a gas

Chapter 3, Lesson 3 Vocabulary

- Boyle's law - states that pressure of a gas increases if the volume decreases and pressure of a gas decreases if volume increases, when temperature is constant
- Charles's law - states that the volume of a gas increases with increasing temperature, if pressure is constant

Chapter 3, Lesson 3 Vocabulary

- kinetic molecular theory - an explanation of how particles in matter behave
- pressure - amount of force applied per unit of area

Lesson 1

Solids, Liquids, and Gases

Standards

- 7.PS1.6 - Create and interpret models of substances whose atoms represent the states of matter with respect to temperature and pressure.

Essential Questions

- How do particles move in solids, liquids, and gases?
- How are the forces between particles different in solids, liquids, and gases?

Describing Matter

- The three most common forms, or states of matter on Earth are solids, liquids, and gases.
- There is a fourth state of matter referred to as plasma, which is the most common state of matter in space.
- Plasma is high-energy matter consisting of positively and negatively charged particles.

Describing Matter

- There are many ways to describe matter.
  - Using Our Senses:
    - State
    - Color
    - Texture
    - Odor
  - Using Measurements:
    - Mass (g or kg)
    - Volume (L, cm^3 or m^3)
    - Density (g/cm^3 or g/m^3)

Particles in Motion

- Two main factors that determine the state of matter are: particle motion and particle forces.
- Particles (atoms, ions, or molecules) make up all matter.

Particles in Motion

- Regardless of how close particles are to each other, they all move in random motion – movement in all directions and at different speeds.
- Particles will move in straight lines until they collide with something.
- These collisions usually change the speed and direction of the particles' movement.

Forces Between Particles

- As the motion of particles increase, the particles go further away from one another.
- As the motion of particles decrease, the forces holding the particles together make them become more compact, or closer to one another.

Solids

- The particles in a solid are close together. This is a result of strong attractive forces between particles and slow motion of the particles themselves.

Solids

- Types of Solids
  - All solids don't look the same because the arrangement of their particles can vary.
  - See figure 3 on page 75.

Liquids

- Draw the circle of particles on Figure 4 to show the particles in a liquid.
- The particle motion in a liquid is faster than the particle motion in the solid state.
- Because of this increase in speed, particles are able to move a bit further away from each other.

Viscosity

- Viscosity is the measurement of a liquid's resistance to flow.
- The stronger the attraction between particles, the higher the viscosity.
- Viscosity increases as the liquid becomes colder and decreases as the liquid warms (generally).
- Honey has high viscosity while water has low viscosity.

Surface Tension

- The attraction between similar molecules is called cohesion.
- Molecules at the surface of a liquid have surface tension, the uneven forces acting on the particles on the surface of a liquid.
- Bubbles can form as a result of surface tension.

Gases

- Look at figure 7 on page 78. Draw what's in the circle to show the particles in a gas.
- The particles in a gas move even faster than a liquid, which allows the particles to be further away from one another.
- Gas particles lack attractive forces between particles.

Vapor

- The gas state of a substance that is normally a solid or a liquid at room temperature is called vapor.
- When water is in a gas state, we call it water vapor.
- Other substances that can form a vapor include: rubbing alcohol, iodine, mercury, and gasoline.

Lesson 1 Review

1. What state of matter is rarely found on Earth?
2. Compare particle movement and attractive forces in solids, liquids, and gases.
3. Hypothesize how you could change the viscosity of a cold liquid, and explain why your idea would work.

Lesson 2: Changes in State

Standards

- 7.PS1.6 - Create and interpret models of substances whose atoms represent the states of matter with respect to temperature and pressure.

I can…

- Create models of substances in a solid, liquid, or gas.

Essential Questions

- How is temperature related to particle motion?
- How are temperature and thermal energy different?
- What happens to thermal energy when matter changes from one state to another?

Kinetic Energy

- The particles that make up all matter have kinetic energy because they are in constant motion.
- Kinetic energy is the energy an object has due to its motion.
- The faster the particles move, the more kinetic energy they have.
- Which state of matter has the most kinetic energy? Why?
  - Gas…
  - …because its particles move the fastest.

Kinetic Energy

- What generally happens as the temperature increases in a substance?
  - It changes its state of matter!
- As it changes states of matter, the particles move faster from a solid to a liquid to a gas.
- So, an increase in temperature can also mean an increase in kinetic energy.

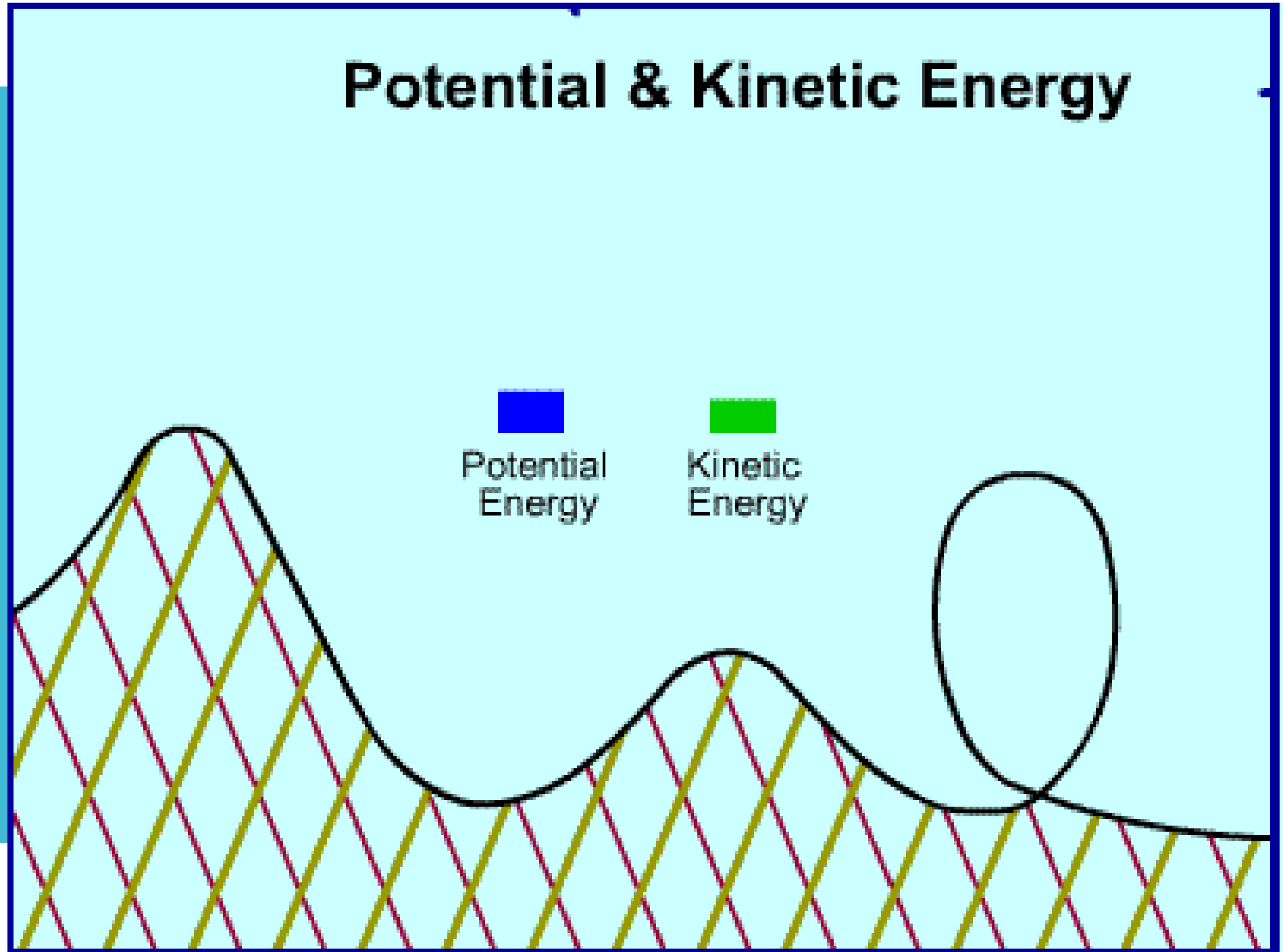
Potential Energy

- Potential energy is stored energy due to the interactions between particles or objects.
- For example, when you pick up a ball and then let it go, the gravitational force between the ball and Earth causes the ball to fall toward the Earth. Before you let the ball go, it had potential energy.

Potential Energy

- Potential energy typically increases when objects get farther apart and decreases when they get closer together.
- The potential energy between particles is the same way. The further apart the particles, the more potential energy they have.
- See figure 8 on page 83

https://phet.colorado.edu/sims/html/energy-skate-park-basics/latest/energy-skate-park-basics_en.html



Thermal Energy

- Thermal energy is the total potential and kinetic energies of an object.
- When you add thermal energy to an object, the particles either move faster (increased kinetic energy), or get farther apart (increased potential energy) or both.

Thermal Energy

- The opposite is true when you take thermal energy away. This can actually cause a change of state.

Solid -> Liquid ->Solid: Melting

- Thermal energy must be added to change a solid to a liquid.
- See figure 9 on page 84.

Solid -> Liquid ->Solid: Energy Changes

- Once a solid reaches its melting point, the average speed of particles does not change, but the distance between the particles does change as they move further apart.

Solid -> Liquid ->Solid: Freezing

- As a material cools, thermal energy leaves it.
- See figure 9 on page 84

Liquid -> Gas-> Liquid: Boiling

- The change in state of a liquid into a gas is vaporization.
- Vaporization that occurs inside a liquid is called boiling.
- The temperature at which the substance begins to boil is its boiling point.
- The kinetic energy increases until the substance reaches its boiling point.
- See figure 11 on page 85.

Liquid -> Gas-> Liquid: Evaporation

Liquid -> Gas-> Liquid: Condensation

Solid -> Gas -> Solid

- Sublimation is the change of state from a solid to a gas without going through the liquid state.
  - An example is dry ice
- Deposition is the change of state of a gas to a solid without going through the liquid state.
  - Thermal energy is released from the gas.
  - An example is frost on the grass.

Conservation of Mass and Energy

- When matter changes state, matter and energy are always conserved.

- https://www.youtube.com/watch?v=Xto88gMmDzw
- https://www.youtube.com/watch?v=7ZpuMBkf1Ss
- https://www.youtube.com/watch?v=BxUS1K7xu30

Lesson 3:

The Behavior of Gases

Standards

- 7.PS1.6 - Create and interpret models of substances whose atoms represent the states of matter with respect to temperature and pressure.

I can…

- Create models of substances in a solid, liquid, or gas.

Essential Questions

- How does the kinetic molecular theory describe the behavior of gas?
- How are temperature, pressure and volume related in Boyle's Law?
- How is Boyle's Law different from Charles' Law?

Understanding Gas Behavior

- Temperature, pressure, and volume changes affect gases more than they do solids and liquids.

Understanding Gas Behavior

- The kinetic molecular theory is an explanation of how particles behave in matter.

Understanding Gas Behavior

- One idea of this theory is that all matter is made of small particles.

Understanding Gas Behavior

- These particles are in constant, random motion.

Understanding Gas Behavior

- The particles collide with other objects around them.

Understanding Gas Behavior

- Energy is not lost when particles collide.

What is pressure?

- Pressure is the result of particles' colliding with their container.

What is pressure?

- Pressure is the amount of force exerted per unit of area.

Pressure and Volume

- When the volume of a sample of gas decreases, pressure increases.

Pressure and Volume

- Pressure increases because the gas is compressed and there are more collisions with the container.

Pressure and Volume

- When the volume of a sample of gas increases, pressure decreases.

Pressure and Volume

- Fewer collisions occur when the volume of a gas increases.

Boyle's Law

- The scientist Robert Boyle described the relationship between the pressure and the volume of a gas.

Boyle's Law

- Boyle's law states that when either volume or pressure increases, the other property decreases, when temperature is constant.

Temperature and Volume

- Gas behavior is also affected by temperature changes.

Temperature and Volume

- When temperature increases, the volume of gas particles also increases.

Temperature and Volume

- As kinetic energy increases, particles move faster, and volume increases.

Temperature and Volume

- In the same way, as kinetic energy decreases, particles move slower, and volume decreases.

Charles's Law

- Jacque Charles related volume and temperature of a gas, assuming pressure stays constant.

Charles's Law

- Charles's law states that the volume of a gas increases with increasing temperature if the pressure is constant.

Charles's Law

- As an example of Charles's law, when a balloon cools, its volume decreases, and the balloon appears partially deflated.

Charles's Law

- A graph of Charles's law might include -273°C, which is called absolute zero.

Charles's Law

- Absolute zero is theoretically the lowest possible temperature of matter.

Charles's Law

- At absolute zero, scientists theorize that particles do not move.