Matter: Properties and Change

6.P.2 Understand the structure, classifications and physical properties of matter.

6.P.2.1 Recognize that all matter is made up of atoms and atoms of the same element are all alike, but are different from the atoms of other elements.

6.P.2.2 Explain the effect of heat on the motion of atoms through a description of what happens to particles during a change in phase.

6.P.2.3 Compare the physical properties of pure substances that are independent of the amount of matter present including density, boiling point, melting point and solubility to properties that are dependent on the amount of matter present to include volume, mass and weight.

As a Matter of Fact

What makes up matter?

- The Greek philosopher Democritus thought matter could be divided into smaller units until you obtained a particle that could not be cut.

- He called this particle *atomos*, meaning "not able to be divided."

- Scientists have come to agree that matter is made up of small particles, and they use the term *atom* to describe them.

What makes up matter?

- An **atom** is the smallest particle into which an element can be divided and still be the same element.

- Scientists now know that atoms are made of even smaller particles, but the atom is the smallest unit that has the chemical properties of an element.

- There are many types of atoms that combine in different ways to make all substances.

Something Old, Something New

Who developed the atomic theory?

- In 1808, John Dalton published an atomic theory, stating that all matter is made up of atoms that cannot be created, divided, or destroyed.

- This theory also stated that all atoms of a certain element are identical, but they differ from atoms of all other elements.

- Every substance is made up of atoms combined in certain ways.

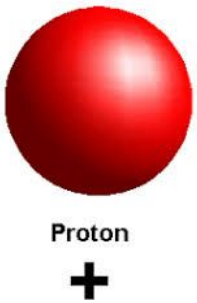
Who developed the atomic theory?

- In 1897, J. J. Thomson's experiments provided evidence that atoms contain negatively charged particles, which were later called **electrons**.

- Thomson thought that an atom was a positive sphere with the electrons mixed through it.

Who developed the atomic theory?

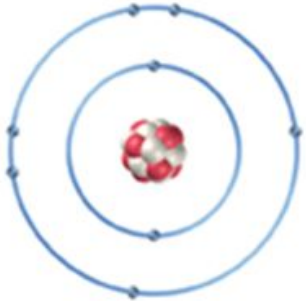
- In 1909, Ernest Rutherford's experiment suggested that atoms have a **nucleus**—a small, dense center that has a positive charge.



- Rutherford later found that the nucleus is made up of smaller, positively charged particles that he called **protons**.

Who developed the atomic theory?

- Niels Bohr suggested a model in which electrons move around the nucleus in circular paths, with each path at a certain distance from the nucleus.

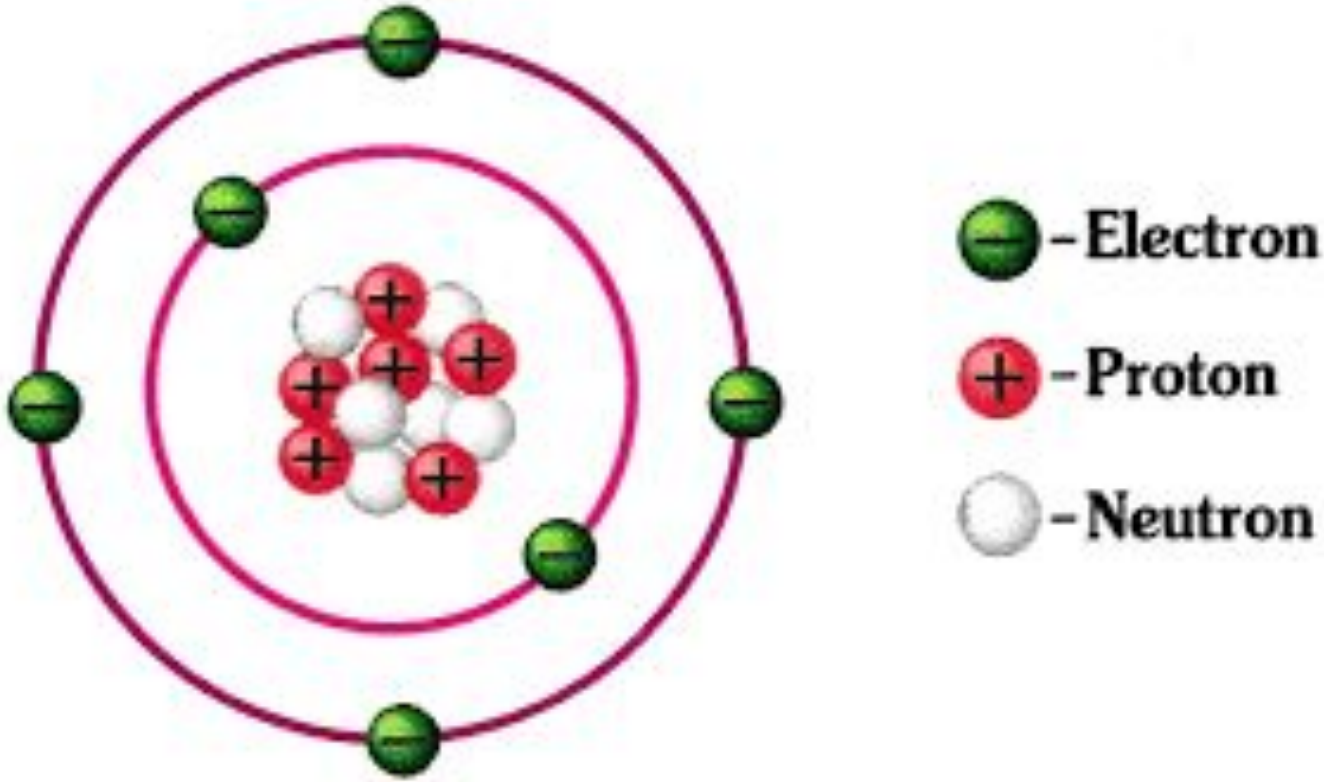


What is the current atomic theory?

- In 1932, James Chadwick discovered that the nucleus contains uncharged particles called **neutrons**.

- In the current atomic theory, electrons do not move in circular paths around the nucleus as Bohr thought.

- Instead, the current theory suggests that electrons move within an area around the nucleus called the **electron cloud**.


-Electron
-Proton
-Neutron

Up and Atom!

What are the parts of an atom?

- Atoms are made up of protons, neutrons, and electrons.
- Protons are the positively charged particles of atoms. The relative charge of a single proton is written as 1+.
- In the unified atomic mass unit (u), the mass of a proton is about 1 u.

What are the parts of an atom?

- Neutrons are particles that have no electrical charge.

- The mass of a neutron is slightly more than that of a proton, but it is still close to 1 u.

- Most atoms contain at least as many neutrons as protons.

What are the parts of an atom?

- Together, protons and neutrons form the nucleus of the atom.

- The overall charge of the nucleus is equal to the charge on the total number of protons in the nucleus.

- The nucleus is small but very dense.

What are the parts of an atom?

- The negatively charged particles of an atom are called electrons. The charge of a single electron is represented as 1-.

- It is not possible to determine the exact position and speed of an electron at the same time.

- So we picture the electrons as being in an electron cloud around the nucleus.

What are the parts of an atom?

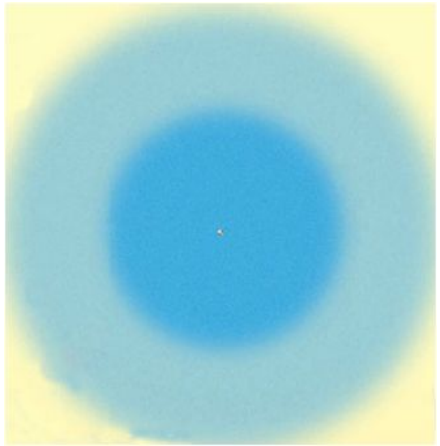
- Compared with protons and neutrons, electrons have very little mass.

- The number of protons and electrons in an atom are the same, so their charges are balanced and the atom has an overall charge of 0.

- An atom can gain or lose electrons to become an *ion,* which has a net positive or negative charge.

What are the parts of an atom?

- In this model of an atom, where is the nucleus and where are the electrons?



Take a Number!

How can we describe atoms?

- Different combinations of protons, neutrons, and electrons produce atoms with different properties.

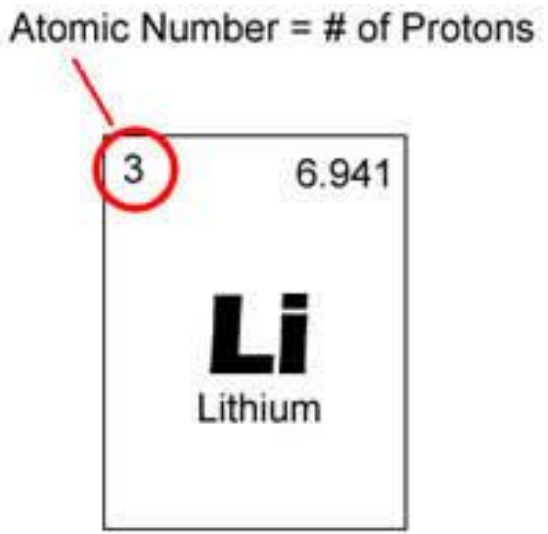
- The number of each kind of particle within an atom determines its unique properties.

- These different atoms combine to form the different substances all around us.

How can we describe atoms?

- The number of protons distinguishes the atoms of one element from the atoms of another.

- The number of protons in the nucleus of an atom is the **atomic number** of that atom.

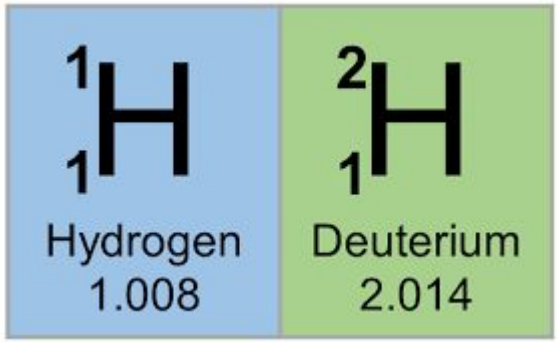


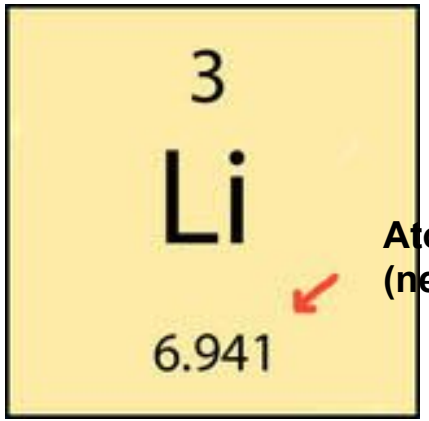
How can we describe atoms?

- The atoms of a certain element always have the same number of protons, but the number of neutrons may differ.

- *Isotopes* are atoms of the same element that have different numbers of neutrons.

- The total number of protons and neutrons in an atom's nucleus is its **mass number**.





Atomic mass (neutrons + protons

Particles in Motion

How do particles move in solids, liquids, and gases?

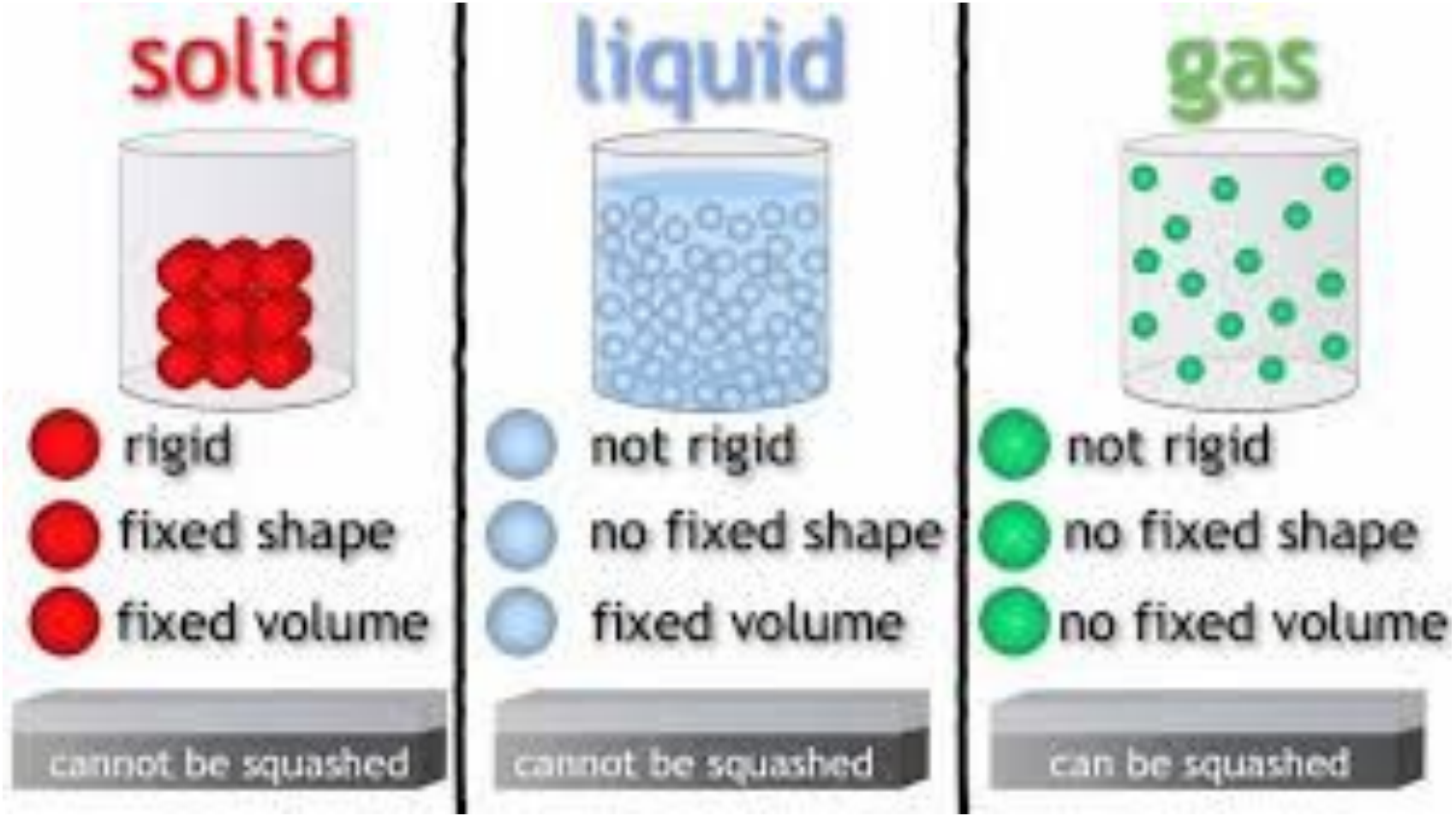
- The *kinetic theory of matter* states that all matter is made of tiny particles that are in constant motion.

- The state of matter is determined by how much particles move and how often they bump into each other.

Warmer a substance is, the faster its particles move.

How do particles move in solids, liquids, and gases?

- A **solid** is a substance with a definite volume and shape. Particles are close together and do not move freely.
- A **liquid** is a substance with a definite volume but not a definite shape.
- A **gas** is a substance that does not have a definite volume or shape.


solid
rigid
fixed shape
fixed volume
cannot be squashed
liquid
not rigid
no fixed shape
fixed volume
cannot be squashed
gas
not rigid
no fixed shape
no fixed volume
can be squashed

The Fact of the Matter

What happens when matter changes state?

- The three most familiar states of matter are solid, liquid, and gas.

- A change of state is the change of a substance from one physical form of matter to another.

- When a substance undergoes a physical change, it does not change its identity, just its appearance.

Worksheet for video

What happens when matter changes state?

- To change a substance from one state to another, energy must be added or removed.

- When a substance gains or loses energy, its temperature changes or its state changes.

What happens when matter changes state?

- All matter is made of tiny particles that are in constant motion. During a change of state, the motion of the particles changes.

- Particles can break away from each other and gain more freedom to move, or they may attract each other more strongly and have less freedom to move.

- During a change of state, a substance gains energy from or loses energy to the environment, but the total amount of energy is conserved.

Shape Up!

How does particle motion affect the properties of solids, liquids, and gases?

- Particles in a solid vibrate but remain in fixed positions.

- Solids cannot easily change shape or volume.
- Liquids take the shape of their container.

Particles in a liquid are close together but not tightly arranged.

How does particle motion affect the properties of solids, liquids, and gases?

- Particles in liquids slide past each other, creating flow.

- Particles in gases are far apart.

- The space between gas particles can change easily.
- Gases take on the shape of their container.

What happens when substances change state?

- The process in which a solid becomes a liquid is called *melting.*

- As a solid is heated, if the vibrations in the particles are fast enough, the particles break loose and slide past one another.

What happens when substances change state?

- When temperatures of a liquid are lowered, causing a solid to form, it is called *freezing.*

- Lower temperatures cause the particles to move slowly enough for the attractions between them to cause the liquid to become a solid.

What happens when substances change state?

- Water freezes at 0 °C, but other substances can freeze at room temperature.

- When substances lose or gain energy, one of two things can happen to the substance: its temperature can change or its state can change.

Particle Party

What is the kinetic theory of matter?

- The **kinetic theory of matter** states that all of the particles that make up matter are constantly in motion.

- Because the particles are in motion, they have kinetic energy.

- The faster they move, the more kinetic energy they have.

What is the kinetic theory of matter?

- The motion of the particles is random.

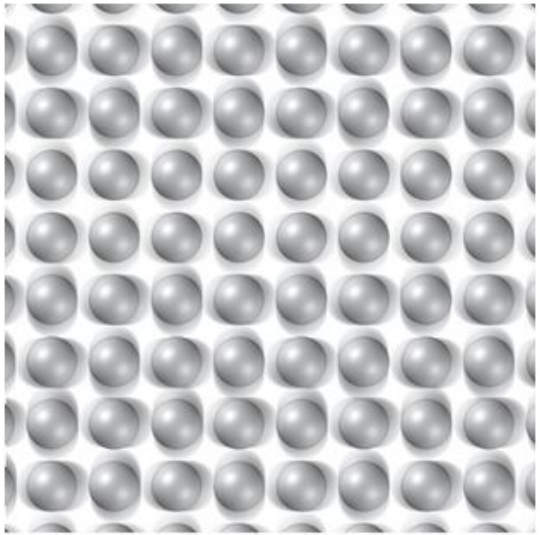
- The individual particles have different amounts of kinetic energy, but their average kinetic energy takes into account their different random motions.

- Solids, liquids, and gases have different average kinetic energies.

How do particles move in solids, liquids, and gases?

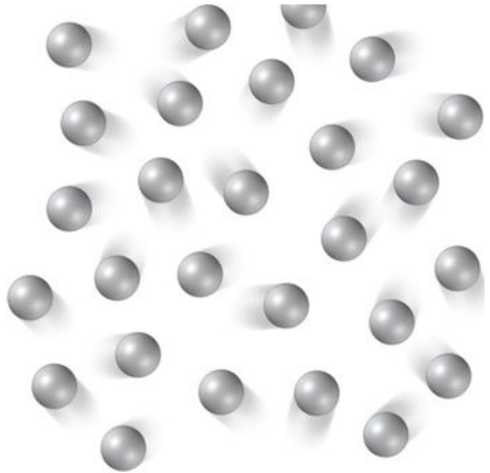
- The kinetic theory of matter explains the motion of particles in solids, liquids, and gases.

- The particles in a solid do not move around much.



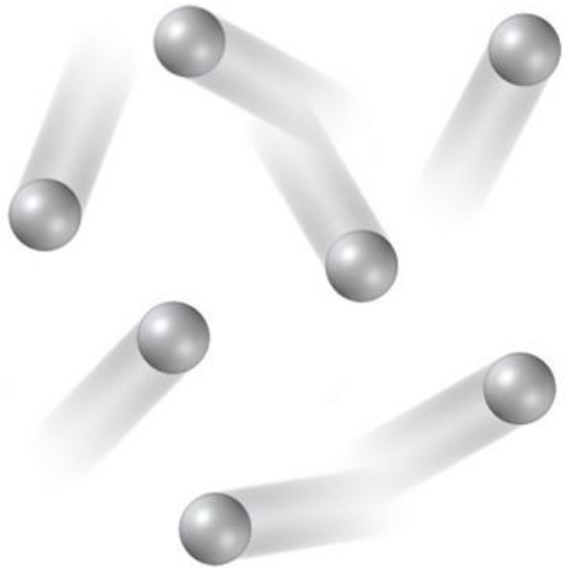
How do particles move in solids, liquids, and gases?

- The particles in a liquid move much more freely than the particles in a solid. They slide past and tumble over each other.



How do particles move in solids, liquids, and gases?

- The particles in a gas are far apart, move at high speeds, and collide with one another.



Mercury Rising

How does temperature relate to kinetic energy?

- **Temperature** is a measure of the average kinetic energy of all the particles in an object.

- The warmer a substance is, the faster its particles move.

How is temperature measured?

- There are three common temperature scales.
- They all measure the average kinetic energy of particles.
- The scales are called Celsius, Fahrenheit, and Kelvin.

How is temperature measured?

- In the Celsius and Fahrenheit scales, temperature is measured in units called degrees.

- **Degrees** (°) are equally spaced units between two points. The space between degrees can vary from one scale to another.

- In the Kelvin scale, no degree sign is used. The unit is just called a kelvin.
- Temperature is measured with a **thermometer**.

How is temperature measured?

- The Celsius scale is the temperature scale most commonly used around the world.

- The Fahrenheit scale is used most commonly in the United States.

How is temperature measured?

- The Kelvin scale is used most commonly by physicists.

Physical Education

What are physical properties of matter?

- A characteristic of a substance that can be observed without changing the identity of the substance is called a **physical property**.

- All of the senses can be used to observe physical properties.

What are physical properties of matter?

- Mass and volume are physical properties.

- Changing the mass or volume of a substance does not change the substance’s identity.

- The state of matter is a physical property. The state of matter is the physical form of the matter.

- Most matter exists as a solid, liquid, or gas.

What are physical properties of matter?

- Electrical conductivity is a measure of how well electric currents move through a substance.

- Density is the measure of the amount of matter in a given volume.

- Thermal conductivity is the rate at which a substance transfers heat.

What are physical properties of matter?

- Solubility is the ability of a substance to dissolve in another substance.

- Malleability is the ability of a substance to be rolled or pounded into various shapes.

- Magnetic attraction is also a physical property that can be observed.

What are physical properties of matter?

- The shine, or luster, of a metal can be easily observed.

- The melting point of a substance is the temperature at which it changes from a solid to a liquid.

- The boiling point of a substance is the point at which the substance boils.

Property Boundaries

What is the difference between physical and chemical properties?

- Physical properties can be observed without changing the identity of a substance.

- Chemical properties can be observed only by changing the identity of a substance.