HW# Matter
Name:_______________________________
Class: 8 ___

Date:______________

Properties of Matter

Martin is walking to school on a February morning. To get there, he has to cross a railroad track near his home. The steel rails have tiny gaps between them, gaps of maybe a centimeter or so. *Sloppy*, thinks Martin. *Why couldn't they have made the tracks fit just right?*

Six months pass. It's a blazing summer day. Martin is dragging himself to a baseball game at his school's baseball diamond. It's almost too hot to play. As he crosses the train tracks, Martin notices something. The gaps between the tracks are gone. They've closed up completely. *When did that happen?* thinks Martin. *I never saw anyone working on the tracks*. And nobody did. Maybe Martin will read the rest of this review and find out what happened.

Phases of Matter

In the visible universe, matter exists in four different states called **phases**. When matter changes from one phase to another, it undergoes what scientists call a **physical change**. For example, when a block of ice melts, it undergoes a physical change from the solid phase to the liquid phase. The chemical properties of the matter are the same in each phase, but the physical properties of the matter change from phase to phase. The three main phases of matter are as follows.

- solid: matter has both a definite shape and a definite volume
- liquid: matter has a definite volume but not a definite shape
- gas: matter has neither a definite volume nor a definite shape

Which phase(s) of matter could flow through a tube? ______________________

Which phase(s) of matter could not flow through a tube? ______________________

The Kinetic Theory of Matter

One of the most important theories about matter is the kinetic theory of matter. The word *kinetic* comes from a Greek word meaning "to move." The **kinetic theory of matter** states three things:

1. The universe is made of invisibly tiny particles with empty spaces between them.
2. All of these particles move all the time. This is where the "kinetic" part comes from.
3. The motion of the particles is random.

If the universe is mostly empty space, would it be possible for the universe to shrink and become denser? If so, do you think this would have any effect on how the particles move?

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Heat Energy and Phase Changes

All particles are always in motion—even those particles that make up solid objects. **Heat energy** is the energy that causes the particles of a substance to move faster. The more heat energy that is put into a substance, the faster the particles of that substance will move. The faster the particles move, the higher the temperature of the substance becomes. **Temperature** is the measure of the average energy of motion of all the particles in a substance. The relationship between particles, heat energy, and temperature is important for understanding how matter changes from one phase to another.

Explain in your own words why temperature is the measure of the "average" energy of motion of all the particles within a substance.

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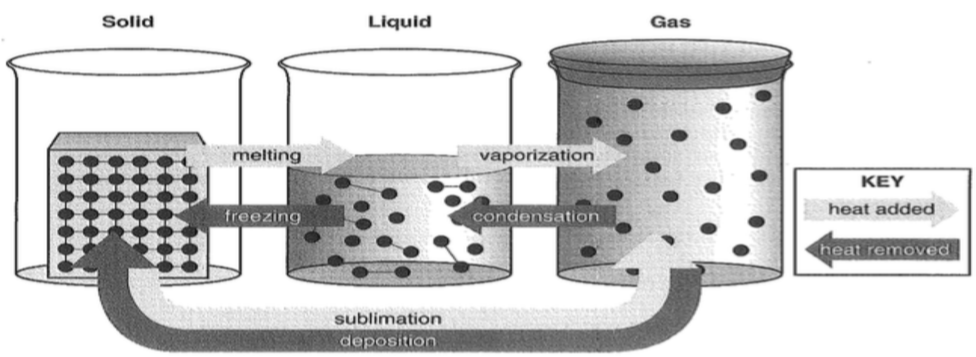
Let's examine phase changes at the level of particles. In a solid, the attraction between the particles is stronger than the energy of motion of those particles. This means that the particles that make up a solid will vibrate, but the particles' attraction to each other keeps them locked in the same places and tightly packed together.



If heat energy is put into a solid, the particles' energy of motion will increase. Eventually, the particles' energy of motion is strong enough to overcome the attraction between the particles, and the solid melts into a liquid. The particles in a liquid are still attracted to each other, but those particles have enough energy of motion to move around easily and slide past each other. If we continue to add heat energy to the liquid, the particles move even faster. Eventually, the particles move so fast that they escape from the liquid and form a gas. The phase change from liquid to gas is called **vaporization**. In the gaseous state, there is little attraction between particles. Each particle has so much energy of motion that it moves independently of the other particles. The particles move so quickly in all directions that they occupy all the available space.

Suppose you inflate a balloon at room temperature, put the balloon into a freezer, and come back an hour later. What will the balloon look like?

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When a liquid becomes a solid, where does the heat energy in the liquid go?

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All phase changes are reversible. A gas can turn into liquid, which can then turn into a solid. The phase change from a gas to a liquid is called **condensation**. For example, water vapor in the air will condense on the surface of a glass that holds a cold drink. Another phase change, called **sublimation**, occurs when a substance changes from a solid to a gas without going through the liquid phase. Sublimation can be seen with blocks of "dry ice," which is made of frozen carbon dioxide. When frozen carbon dioxide warms up, a vapor starts swirling around it. The vapor is produced when the solid carbon dioxide changes directly to a gas. **Deposition** is the opposite of sublimation: Gas particles become a solid without going through the liquid stage.

Write the term that refers to each change of phase.

A pot of water boils away on a heated stove: ____________________

Water vapor forms frost on a window: ____________________

Water vapor in a cloud turns into rain: ____________________

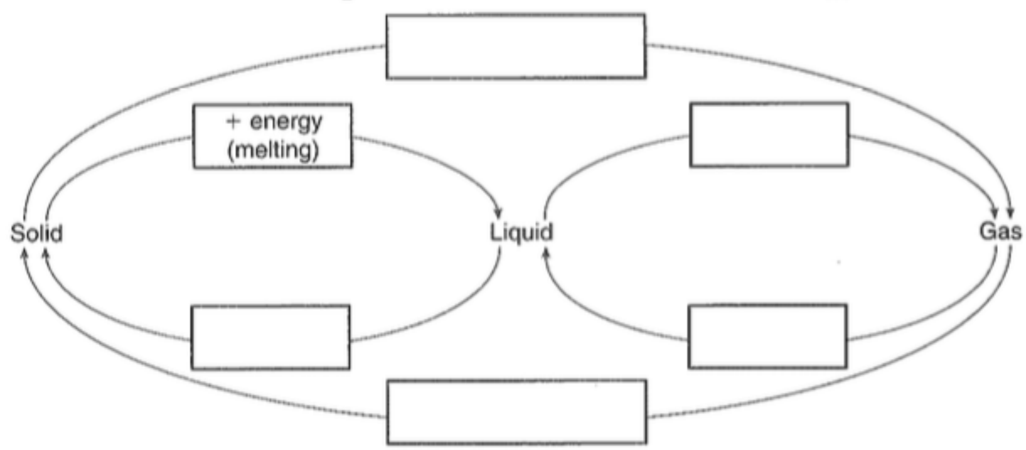
Ice in Antarctica goes directly into the atmosphere: ____________________

Study the following diagram. Write the following in the boxes:

- the name of the phase change in which matter goes from one state to another
- whether this phase change is caused by energy being added or removed. Use a (+) to indicate when energy is added and a (−) to indicate when energy is removed.

One box has already been filled in as an example.

Phase Changes and the Movement of Heat Energy



Melting and Boiling Points

One way to classify different substances is by comparing the temperatures at which they change phase. The **melting point** is the temperature at which a solid becomes a liquid. You know that water has a melting point of 0° C. Iron has a melting point of 1,538° C. Nitrogen, on the other hand, melts at −210° C, which is why on Earth you find solid nitrogen only in artificial situations such as science laboratories.

Review the description of how particles act during the phase change from solid to liquid. Suggest why iron's melting point is so much higher than water's, and why nitrogen's is so much lower than both iron's and water's.

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A substance's **boiling point** is the temperature at which a substance changes phase from liquid to gas. As more heat energy is put into a liquid, the particles move faster and exert a pressure called **vapor pressure**. When the vapor pressure is equal to the air pressure, the liquid starts boiling and the particles escape from the liquid and become a gas. As with the melting point, a substance's boiling point depends on the strength of attraction between the particles of the substance. The stronger the attraction between the particles, the higher the boiling point.

At sea level, water boils at 100° C. On top of Mount Everest, water boils at 71° C. Explain the difference. (Hint: How does air pressure change with altitude?)

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A substance's boiling point, melting point, and freezing point are all independent of the amount of the substance. A liter of water will boil at 100° C; so will 1 mL of water. (Of course, it takes a lot more heat energy to bring 1 L of water to a boil than to bring 1 mL of water to a boil.)

If 10 kg of iron melts at 1,538° C, at what temperature will 5 kg of iron melt?

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Which would require the most heat energy to melt: 50, 100, or 150 kg of iron?

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Other Properties of Matter

There are many properties of matter other than shape, volume, mass, density, and temperature. We can determine some of these properties just by using our senses.

What property of matter would you use to distinguish rough sandpaper from smooth sandpaper?

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What would happen if you put a chocolate bar and a piece of chalk on a windowsill on a sunny day?

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What property of the chocolate bar and the piece of chalk would cause the difference?

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