Name: _____ Date: _____

Guided Learning: Phases of Matter

Learning goals
After completing this activity, you will be able to …

- Compare solids, liquids, and gases in terms of compressibility, structure, shape, and volume.
- Understand how a substances temperature affects the phase it is in.

Vocabulary: gas, kinetic energy, liquid, solid

Warm-up questions:

1. What do you think is causing this butter to melt?

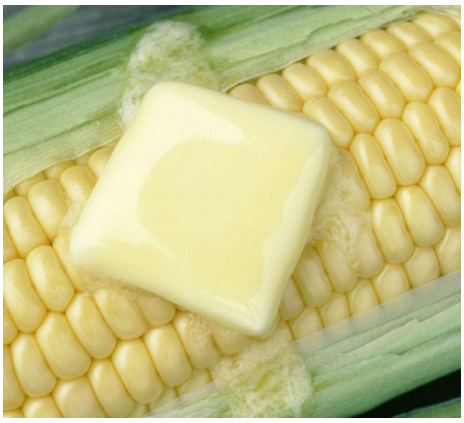
_____

_____

2. What could you do to stop the butter from melting?

_____

_____



Activity A: Solids, liquids, and gases
The pat of butter in the picture above is a **solid**. But as the corn heats it up, the butter is melting into a **liquid**. Solids and liquids are two different phases of matter with different properties. Solids are materials that have a definite shape and volume. This means that the shape and volume of a solid won't change if you carry it around with you or put it in a different container. You *can* change the shape or volume of a solid if you do something like bend it or cut it. However, once you have finished altering the solid it will hold its volume and shape until it is altered again.

Another characteristic of solids is that the molecules making up a solid tend to be packed closely together. They also tend to have some type of orderly arrangement. Being composed of a dense, orderly group of molecules is what allows solids to maintain their shape and volume. While solids do have a definite volume, in many cases they can be compressed. This is mainly true of low-density solids such as a sponge or Styrofoam™. In some cases, pressure can cause a solid to change from one crystalline phase to another. For example, extreme pressure can cause graphite to transform into diamond.

Like solids, liquids also have a definite volume, but liquids do not have a definite shape. They take the shape of whatever container is holding them. Liquids are able to flow and change shape like this because the molecules making up liquids, while being relatively close together, are not arranged in an orderly way. The can move a great deal in relation to one another.

Try this experiment: Fill up a 2-liter plastic soda bottle to the very top with water, then screw on the cap. Try squeezing the bottle. No matter what you do, the bottle won't budge! Liquids are almost completely incompressible. Even under extreme pressure, water will only change in volume a tiny amount.

This balloon is filled with helium gas.

Gas is a third phase of matter. Examples of gases include air, helium (such as the helium filling the balloon pictured here), and water vapor. Gas is different from solids and liquids in that it does not have a definite shape or a definite volume. The molecules that make up gas are spaced far apart and can move in a completely random fashion.

Because gas does not have a definite volume, it can be compressed. Have you ever seen balloons filled using helium stored in a metal cylinder? The cylinder holds enough helium to fill hundreds of balloons. These balloons together would have a much greater volume than the volume of the cylinder. The gas inside the cylinder is compressed, allowing the cylinder to hold much more gas than a balloon of equal volume.

1. Give an example of a solid, liquid, and gas. _____

_____

2. Use the table below to compare the properties of solids, liquids, and gases.

Phase	Compressibility	Structure	Shape	Volume
Solid				
Liquid				
Gas				

Activity B: Kinetic energy and phases of matter

Matter can exist in all three phases. For example, water can be a solid (ice), liquid, or gas (water vapor). When a substance changes into a different phase, it does not change chemically. Thus, melting and freezing are types of physical changes not chemical changes.

So, what causes a substance to change phases? If you knew why the butter was melting in the Warm-up activity, then you instinctively already know the answer to this question. Substances change phases when their temperatures change. Temperature is a measure of the **kinetic energy** of the molecules making up a substance.

The more kinetic energy a molecule has, the faster it will move. So, when you add kinetic energy to a molecule by heating it up, the molecule moves faster. If the molecule loses kinetic energy (and thus cools down), the molecule slows down.

Particles in solids do not move freely. Instead, they vibrate in place. This is why particles in solids are closely packed and well-organized. Their low amount of kinetic energy allows them to maintain their shape and volume. If you heat a solid, its particles get more kinetic energy and vibrate more violently. Soon the particles shake free of the bonds holding them in place and start to move freely. At this point, the solid changes phases into a liquid.

If you continue to heat the liquid, the molecules will gain even more kinetic energy. The molecules will soon speed up enough that they become spread out and their movements are completely random. At this point, the liquid changes phases into a gas.

1. Suppose the temperature of a glass of water increases. How does this affect the water molecules inside the glass? _____

2. Explain phase changes in terms of kinetic energy. _____