SOLIDS AND LIQUIDS

States of Matter

There are _____ states of matter. A solid is a form of matter that has its own definite _____ and volume. A solid cannot _____. The particles can vibrate but cannot move around. The particles of matter in a solid are very tightly _____; when heated, a solid expands, but only slightly. A liquid is a form of matter that flows, has _____ (definite) volume, and takes the _____ of its container. The particles in a liquid are not rigidly held in place and are _____ closely packed than are the particles in a solid; liquid particles are able to move past each other. A liquid is not very _____. Like solids, liquids tend to expand when heated. A gas is a form of matter that flows to conform to the _____ of its container and fills the entire _____ of its container. Compared to solids and liquids, the particles of gases are very far apart. Because of the significant amount of space between particles, gases are easily compressed. _____ is composed of electrons and positive ions at temperatures greater than _____ °C. The sun and other stars are examples of plasma.

- Identify the following as a property of a solid, liquid or gas. The answer may include more that one state of matter.
    1. flows and takes the shape of a container
    2. compressible
    3. made of particles held in a specific arrangement
    4. has definite volume
    5. always occupies the entire space of its container
    6. has a definite volume but flows

The word_____ refers to the gaseous state of a substance that is a solid or a liquid at room temperature. For example, steam is a vapor because at room temperature water exists as a liquid. Some substances are described as _____, which means that they change to a gas easily at room temperature. Alcohol and gasoline are _____ volatile than water. Kinetic-molecular theory predicts the constant motion of the liquid particles. Individual liquid molecules do not have fixed positions in the liquid. However, forces of _____

between liquid particles limit their range of motion so that the particles remain closely packed in a fixed volume. These attractive forces are called _____ forces. Inter = between. Molecular = molecules. A liquid diffuses more _____ than a gas at the same temperature, however, because intermolecular attractions interfere with the flow. _____ is a measure of the resistance of a liquid to flow. Viscosity decreases with _____ temperature. Particles in the middle of the liquid can be attracted to particles above them, below them, and to either side. For particles at the surface of the liquid, there are no attractions from above to balance the attractions from _____. Thus, there is a net attractive force pulling down on particles at the surface. _____ _____ is a measure of the inward pull by particles in the interior. Soaps and detergents decrease the surface tension of water by disrupting the _____ bonds between water molecules. For a substance to be a solid rather than a liquid at a given temperature, there must be strong attractive forces acting between particles in the solid. These forces limit the motion of the particles to _____ around fixed locations in the solid. Thus, there is more order in a solid than in a liquid. The particles can only vibrate and revolve in place. Because of this order, solids are much less _____ than liquids and gases. In fact, solids are not classified as fluids. Most solids are more _____ than most liquids. A crystalline solid is a solid whose atoms, ions, or molecules are arranged in an orderly, geometric, three-dimensional structure. Most solids are _____. Amorphous solids lack an orderly internal structure. Think of them as _____ liquids. Examples of amorphous solids include _____ and glass.

Phase Changes

If a substance is usually a liquid at room temperature (as water is), the gas phase is called a _____. Vaporization is the process by which a liquid changes into a gas or vapor. Vaporization is an endothermic process - it requires _____. When vaporization occurs only at the _____ of an uncontained liquid (no lid on the container), the process is called evaporation. Molecules at the surface break away and become gas. Only those with enough _____ energy (KE) escape. Evaporation is a _____ process. It requires heat, which is endothermic. _____ pressure is the pressure exerted by a

vapor over a liquid. As temperature increases, water molecules gain kinetic energy and vapor pressure _____. When the vapor pressure of a liquid equals atmospheric pressure, the liquid has reached its boiling point, which is 100°C for water at sea level. Recall that standard atmospheric pressure equals _____ atm. At this point, molecules throughout the liquid have the energy to enter the gas or vapor phase. The temperature of a liquid can never _____ above its boiling point. Boiling is an _____ process. It requires the addition of heat. As you go up into the mountains (increase in elevation), atmospheric pressure _____. Lower external pressure requires _____ vapor pressure. Lower vapor pressure means lower _____ point. As a result, spaghetti cooks slower in the mountains than at the beach. When you use a pressure cooker to can vegetables, the external pressure around the mason jars rises. This raises the vapor pressure needed in order for water to boil. In turn, the boiling point is raised so the food cooks _____.

Some phase changes release energy into their surroundings. For example, when a vapor loses energy, it may change into a _____. Condensation is the process by which a gas or vapor becomes a liquid. It is the _____ of vaporization. In a closed system, the rate of vaporization can equal the rate of condensation. When first sealed, the molecules gradually _____ the surface of the liquid. As the molecules build up above the liquid, some condense back to a liquid. Equilibrium is reached when the rate of vaporization _____ the rate of condensation. Molecules are constantly changing phase. The total amount of liquid and vapor remains _____.

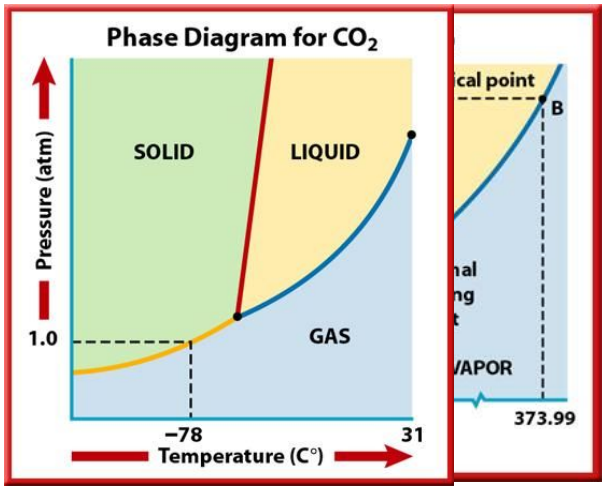
The melting point of a solid is the temperature at which the _____ holding the particles together are broken and the solid becomes a liquid. When heated the particles vibrate more _____ until they shake themselves free of each other. The freezing point is the temperature at which a liquid becomes a _____ solid. The freezing point is the _____ as the melting point. The process by which a solid changes directly into a gas without first becoming a liquid is called _____. Solid air fresheners and dry ice are examples of solids that sublime. When a substance changes from a gas or vapor directly into a solid without first becoming a liquid, the process is called _____. Deposition

is the reverse of sublimation. _____ is an example of water deposition.

- Classify the following phase changes.
  1. dry ice (solid carbon dioxide) to carbon dioxide gas _____
  2. ice to liquid water _____
  3. liquid water to ice _____
  4. water vapor to liquid water _____

Phase Diagrams

Temperature and _____ control the phase of a substance. A phase diagram is a graph of pressure versus temperature that shows in which phase a substance exists under different conditions of temperature and pressure. A phase diagram typically has _____ regions, each representing a different phase and three curves that _____ each phase.



The points on the curves (lines) indicate conditions under which two phases coexist. The critical point indicates the critical pressure and the critical temperature above which a substance cannot exist as a _____. The triple point is the point on a phase diagram that represents the temperature and pressure at which three phases of a substance can _____. The _____ slope of the solid-liquid line in the phase diagram for water indicates that the solid floats on its liquid.

- What happens to solid CO_2 at -100 ºC and 1 atm pressure as it is heated to room temperature?
- What happens to water at 1 atm as the temperature rises from -15°C to 60°C?
- What state of matter is water at 50°C and 20 atm?
- At what temperature does the triple point occur for water?
- At what temperature does the critical point occur for carbon dioxide?
- At standard pressure and -78°C, what phase change occurs for carbon dioxide?
- What state of matter is carbon dioxide at -80°C and 2 atm?