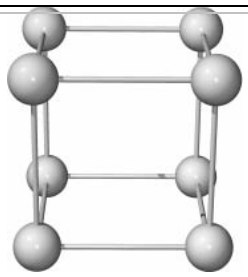
CHEMISTRY ♦ DR. BRESLYN ⓘ	Name: Date:
Matter exists in four different states: solid, liquid, gas, and plasma. **Kinetic theory** states that the particles in each form of matter are in constant motion. When we heat a substance, we add energy. The result is more motion, called **kinetic energy**.	
Temperature: the average kinetic energy of the particles in a substance. The Kelvin scale provides a direct relationship between average kinetic energy and temperature. ⓘ What happens to the average kinetic energy when we heat to a substance?	Particles at 200K have twice as much average kinetic energy as particles at 100K. ***Cryogenics*** *is the study of the behavior of matter at very low temperatures.*
Gases **Gas pressure** results from the collisions of gas particles with an object. **Barometers** are used to measure gas pressure. ⓘ Why does the gas pressure increase when a closed container of gas is heated?	*You must be able to interpret the motion of particles in each state using Kinetic Theory.* The SI unit for gas pressure is the Pascal (Pa) 1 atm = 101.3kPa
Liquid particles are able to move around freely. Their particles mostly spin and vibrate but can also slide past each other. As a result, liquids are able to **flow**. **Note**: liquid particles are attracted to each other -- gas particles are not. **Evaporation** is when particles have enough KE to break away from the *surface* of a liquid (below the boiling point). The more KE, the higher the rate of evaporation. In a closed container at constant temperature, evaporation and condensation happen at the same rate. This is **dynamic equilibrium**. Evaporation $\rightleftharpoons$ Condensation **Vapor pressure**: in a closed container – the increase in pressure caused by collisions of the evaporated liquid with the walls of the container. **Boiling point**: when vapor pressure = external pressure **Normal boiling point**: boiling point at 101.3kPa. (H_2O = 100°C)	Liquid particles are held together by **intermolecular forces**. This prevents many particles from leaving the liquid. ⓘ Use Kinetic Theory to differentiate between boiling and evaporation. **Boiling point** is a physical property and can be used to determine the identity of an unknown liquid.

Solids are highly organized and have particles that mostly vibrate in place.

Solids are dense and incompressible. Most solids are crystalline.

When heated the particles in solids will begin to vibrate and rotate more. If enough energy is added the solid will change to a liquid.

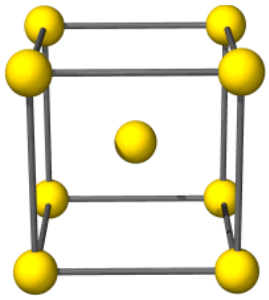
The temperature at which a solid changes to a liquid is called its **melting point**.



Simple Cubic

Crystalline solids are made up of regularly repeating patterns of atoms.

Unit cells are the most basic group of particles in a crystal. The simple cubic and body-centered cubic are shown in the column on the right.



Body-Centered Cubic

Amorphous solids do not have an internal order. Examples are rubber, glass, and plastic.

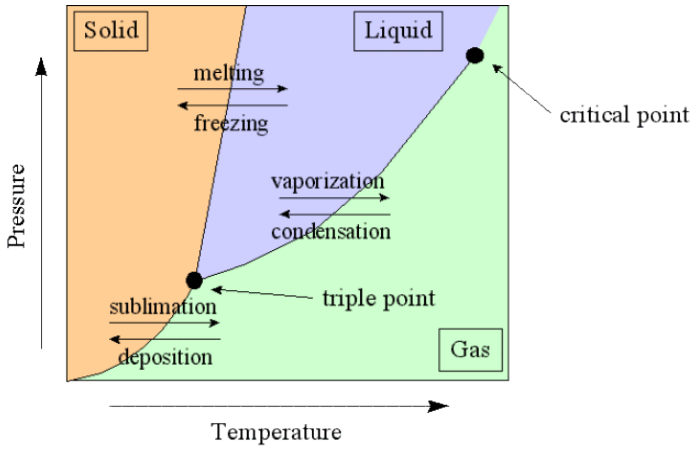
Allotropes are different arrangements of the same type of elements. For example, graphite and diamond are all made of carbon but have very different properties.

Sublimation occurs when a solid changes to a gas without passing though a liquid state. Examples are air fresheners, dry ice, iodine, and ice cubes in the freezer (they'll sublime if you leave them in too long).

Plasma is a gaseous mixture of electrons and positive ions. Examples are the aurora borealis, fluorescent lights, lightening, and stars.

Plasma is often called the *fourth state of matter*.

Phase diagrams allow us to graphically see how temperature, pressure, and state are related.



Each shaded region represents a phase.

Two phases are at **equilibrium** at the line between phases.

The **triple point** is where all three curves meet and all three phases exist at one time.