3.8 LIQUID AND GAS MATTER AND PRESSURE

We'll use this section to transition from liquids to gases, since liquids and gases are more affected by pressure and temperature than solids. Further, note that gases are affected more than liquids by "normal" variations in pressure and temperature, such as we see with changing seasons and changes in barometric pressure. However, in experimental situations, liquids and gases can be quite affected by temperature and pressure changes.

At STP, the boiling point of water is 100°C. If the water matter in liquid form is at 70°C and is raised to 102°C, we understand that the liquid water is going to boil when it hits 100 and will turn into a gas. But, if the water matter is already at 102°C, then it will be in the form of gas matter. Now, if we start to take the gas water (called **water vapor**) to its "boiling point"—100°C, that means it is going to get cooler. And, as it does, when it hits 100°C, then the water vapor will change into a liquid. But, when that happens, we don't say that the gas "boiled" into a liquid, because boiling is when a liquid turns into a gas. 100°C is a "magic number" for water, but it isn't just the temperature at which liquid water turns into a gas. It is also the temperature at which water vapor turns into a liquid. When gas matter turns into a liquid, it is called **condensation**. So we say that gas matter condenses into a liquid. Therefore, 100°C is the boiling point for water that is below 100°C and the condensation point for water that is over 100°C.

There is also a correlate for the melting point of a solid. When a solid is heated and hits a high enough temperature, it melts into a liquid. When that same type of matter is already a liquid and hits the "melting point," that means its temperature is going down, so it turns into a solid. But we don't say that the liquid "melted" into a solid; instead, the term we use for that is "**freeze**." Liquids freeze into solids when the freezing point is reached, and the freezing point is the same temperature as the melting point. Using our water example, 0°C is both the melting point of solid water and the freezing point of liquid water, so liquid water freezes into solid water ("ice") when the liquid reaches 0° C.

Figure 3.8.1

Effect of Pressure on Liquids and Gases

The relationship between pressure and temperature on gas density, liquid density, gas condensation point and liquid boiling point holds fairly well across liquids and gases of all types, so that is what this table focuses on (however, note that water interestingly doesn't follow ALL the rules in this area). If we have a flask filled with a gas and increase the pressure inside it, the density of the gas increases because the increased pressure squishes the gas molecules closer together. The opposite occurs to the gas particles when we decrease the pressure in the container (we'll see an example of this in a few pages). Pressure also affects a gas' condensation point, where increasing the pressure increases the condensation point and decreasing the pressure decreases the condensation point. Normally, nitrogen boils/condenses at -195.8°C, but if we took a flask filled with nitrogen gas, we could make it condense at room temperature (20°C) simply by increasing the pressure inside the flask. Conversely, if we decrease the pressure in the flask, then the condensation point of the nitrogen decreases, which means that by decreasing the pressure inside the flask, we'd have to cool the nitrogen to well below -195.8°C to make it condense. The density of liquids are not affected too much by changes in pressure, but the boiling point is. If we have a flask filled with liquid nitrogen, increase the pressure inside the flask and then start to heat it, we would find that we need to heat the nitrogen well above -195.8°C to get it to boil. Conversely, if we reduce the pressure inside the flask, we can make the nitrogen boil at temperatures well below -195.8°C.

	Pressure Increase	**Pressure Decrease**
Gas density	Increases	Decreases
Liquid density	Negligible increase	Negligible decrease
Gas Condensing Point	Temperature required increases	Temperature required decreases
Liquid Boiling Point	Temperature required increases	Temperature required decreases