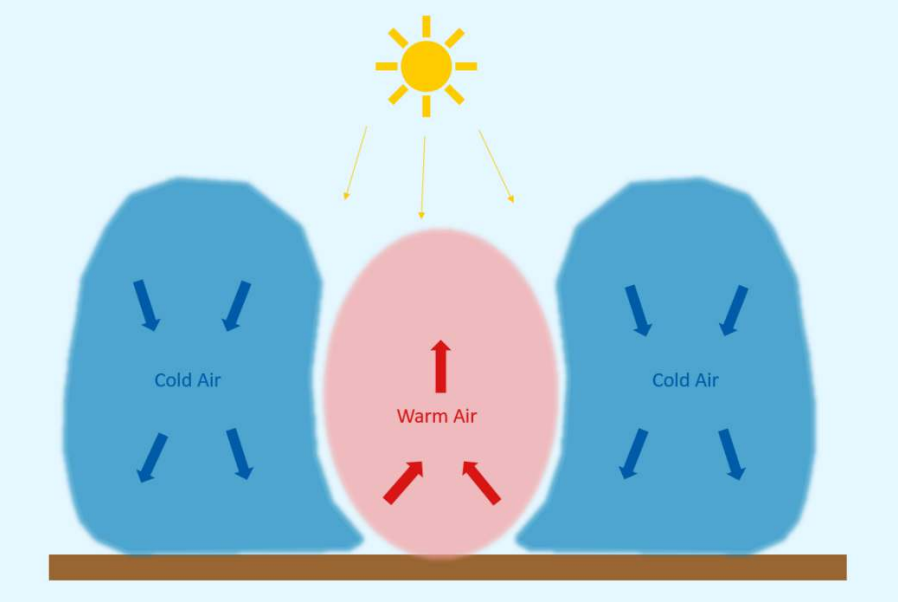
2022Q5 GAS LAWS, WIND

After so many Wind Studies, we feel it's important to discuss the concept for which they are named: WIND! In this Wind Study, we will discuss how wind is formed and some basic principles behind it.

In short, wind is formed due to temperature and pressure differences between layers of the atmosphere. When rays from the sun hit the earth, the air closer to the ground warms faster than the air above. The warmer air rises, displacing the cooler air above; this movement of air is the basis of wind. But what causes air, and the gases that compose it, to behave this way? Why does warm rise above the cold air? Let's find out!



The behavior of gases is governed by the three Gas Laws: Boyle's Law, Charles' Law, and Avogadro's Law. These laws combine to describe the relationships between pressure, temperature, volume, and amount of gas.

The first law we'll look at is Boyle's law, which describes the relationship between pressure and volume. It is the inverse correlation shown below:

$$P \propto \frac{1}{V}$$

That fancy fish looking symbol stands for "proportional to." So, the correlation is saying that pressure is proportional to the inverse of volume. As pressure increases, volume decreases, and vice versa.

The next law, Charles' Law, describes the relationship between temperature and volume. It is the correlation shown below:

$$T \propto V$$

The correlation is saying that temperature is proportional to volume. As temperature increases, volume increases.

The third law, Avogadro's law, describes the relationship between the amount of gas (usually measured in moles) and the volume of said gas. It is the correlation shown below:

$$n \propto V$$

A mole is a measure of atoms, 1 mole is equal to 6.022 x 10^{23} atoms. The correlation is saying that moles of gas, and in turn the number of atoms of gas, is proportional to volume. As the amount of gas increases, the volume increases.

You'll notice that each of the relationships involves volume. By combining the three laws in terms of volume, we get an equation relating the four variables discussed above.

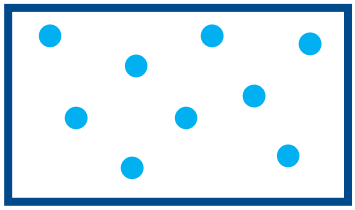
$$V \propto \frac{nT}{P}$$

By adding in a constant (R), which allows us to directly relate volume to the other three variables, we can take this proportional relationship and transform it into a usable equation known as the Ideal Gas Law!

$$PV = nRT$$

The following questions will build on the information provided above!

Level 1: Predict how gases would react to the following system changes. (Imagine molecules in a closed box, as shown below.)



a) If the temperature of this box increased, would the volume taken up by the gases increase or decrease?
b) If the volume of this box increased, would the pressure of the gas inside increase or decrease?
c) If the temperature of this box decreased, would the pressure of the gas inside increase or decrease?
d) If the number of moles of gas in the box increased, would the pressure of the gas increase or decrease?

Level 2: Let's take the system from the first question, a group of molecules enclosed in a box. Determine the pressure (in atmospheric units, "atm") in the system given the following parameters:

Gas Constant (R) = 0.08206 $\frac{L \cdot atm}{mol \cdot K}$

Temperature (T) = 25 °C

Molar Volume = 0.15 moles per liter