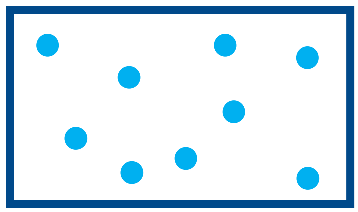
2022A5

GAS LAWS, WIND

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



a) **Increase**. This comes from Charles' Law, volume and temperature are directly proportional; as one increases, so will the other.
b) **Decrease**. This comes from Boyle's Law, volume and pressure are inversely proportional; as one increases, the other decreases, and vice versa.
c) **Decrease**. For this system change, we need to look at the combined relationship:

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

From this, we can see that pressure and temperature are directly proportional; as one decreases, so will the other.
d) **Increase**. Again, we can look at the combined relationship. We can see that moles and pressure are directly proportional; as one increases, so will the other.

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

To answer this problem, we will need to use the Ideal Gas Law!

$$PV = nRT$$

We are given the gas constant (R) and the temperature (T), but we are not given volume or the number of moles of gas… or are we? If we look at the parameter of molar volume, we can see that is has units of moles per liter, which means it has dimensions of an amount of gas over a volume. Molar volume is $\frac{n}{V}$! So, if we rearrange the Ideal Gas Law, we get this:

$$P = \frac{n}{V}RT$$

Now we can plug our numbers into the equation:

$$P = \frac{0.15\,mole}{L} * \frac{0.08206\,L\ \cdot atm}{mole\ \cdot K} * 25\ ℃$$

Oh, but wait! Let's look at this equation closely. Can you find anything wrong with the way we have it laid out above? Our temperature units don't match! The units for temperature are in Kelvin for our gas constant, but in Celsius for our system temperature. To fix this, we need to convert our system temperature to Kelvin by adding 278. The Kelvin temperature is always 278 degrees higher than the Celsius temperature. We can rewrite the equation as:

$$P = \frac{0.15\,mole}{L} * \frac{0.08206\,L\ \cdot atm}{mole\ \cdot K} * 278\,K$$

Plugging this into our calculator gives a system pressure of 3.42 atm. For reference, atmospheric pressure is 1 atm, so this is a slightly pressurized system!