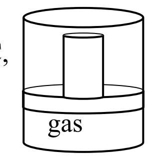
P D.1 **(pg** 1 of 3) Combined Gas Law **("Before & After" Problems)**

Name________________Per___

1. Imagine you have a sealed 20.0 L balloon filled with helium gas at 750 mmHg in the house at 25ºC.
   a. If you brought it outside on a winter day and its temperature dropped to -10ºC. Determine the volume of the balloon. Assume that the pressure in the balloon will stay constant.
   b. Then if you bring the same balloon into a sauna at 35ºC, what would the volume of the balloon become?

2. If you have a sealed piston set up like the picture on the right and you have 5 ml of gas that weighs 0.0034 g inside at 45ºC and 1 atm pressure. When you draw the piston back to a volume of 20 ml and cool the gas to 30ºC,
   a. What will be the mass of the gas?
   b. What will be the pressure of the gas inside the syringe?



3. If you had a closed 10 L container of gas at 2 atm pressure and 20ºC, and you reduced the volume to 4 L what would the temperature of the gas need to be, to be sure that the pressure increased to 5 atm?

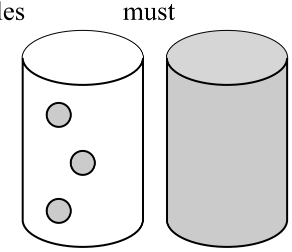
4. If you had the same 10 L container of gas at 2 atm pressure and 20ºC, and you reduced the volume to only 8 L what would the temperature of the gas need to be, to be sure that the pressure increased to 5 atm?

5. A sample of air in a sealed rigid container is at 30ºC to what temp in celsius do you have to heat it to double the pressure?

6. If you had 3 moles of gas in a rigid container at 20ºC and 5 atm pressure and you wanted to double the pressure while maintaining a constant temperature, how many moles of gas should you squirt in?

7. If you have 18.0 g of gas in a 5.0 L glass flask at 10ºC and 3 atm pressure what mass of gas do you need to release so that the pressure will drop to 1 atm

8. The two sealed containers shown at the right are at the same temp and pressure, how many molecules must be in the gray container?



9. The same containers as shown to the right, but this time the pressure in the right container is twice that of the left container, how many molecules must be in the gray container?

For all of these problems you should use the combined gas law equation. $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

If any of the variables stays constant, it can cancel out of the equation.

All of these problems MUST be done in the Kelvin temperature scale. Refer to your text (pg 16) to remind you how to convert Celsius to Kelvin.

1. Since a balloon is flexible, you can assume that it's internal pressure stays more or less constant, and since the balloon is sealed, the number of moles stays constant. So the equation reduces to $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ and solve for $V_2 = \frac{V_1T_2}{T_1}$

   a. $V_2 = \frac{(20L)(263K)}{(298K)}$ Solve V_2 = 17.7 L

   b. $V_2 = \frac{(20L)(308K)}{(298K)}$ Solve V_2 = 20.7 L

2. Assume the piston is sealed
   a. Thus the mass will stay the same = 0.0034 g.
   b. Since the mass stays constant throughout the problem, the moles will remain constant, so the equation reduces to $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ and solve for $P_2 = \frac{P_1V_1T_2}{V_2T_1}$

   $P_2 = \frac{(1atm)(5ml)(303K)}{(20ml)(318K)}$ P_2 = 0.24 atm

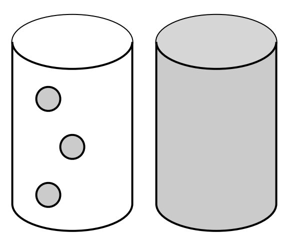
3. Again the container is sealed, so the n remains constant throughout the problem. You might notice that the volume is reduced by a factor of 2.5 while the pressure in creased by the same factor. This means that these factor changes will cancel each out, meaning that the temp will need to stay the same, 20ºC

   Alternatively, you can use the equation which reduces to $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ then solve for $T_2 = \frac{P_2V_2T_1}{P_1V_1}$

   so $T_2 = \frac{(4L)(5atm)(293K)}{(10L)(2atm)}$ solve and T_2 = 293 K which equals 20ºC, the same starting temp.

4. This time the volume is not reduced as much as the pressure is increased. So you will find it easiest to use the equation. which reduces to $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ then solve for $T_2 = \frac{P_2V_2T_1}{P_1V_1}$

   so $T_2 = \frac{(8L)(5atm)(293K)}{(10L)(2atm)}$ then solve and T_2 = 586 K which = 313ºC (586 K – 273K)



5. The temperature must be doubled. But that is a doubling of the Kelvin temp. So 30ºC = 303K which would double to 606 K which is 333ºC.
   Alternatively you can use the equation. The container is rigid, so the volume will stay constant, and it is sealed so the number of moles is also constant so the equation reduces to $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ and

   then you can solve for $T_2 = \frac{P_2T_1}{P_1}$ since you are not given a pressure, you can just pick any value, and then double it. I'll pick a value of 1 and double it to 2.

   so $T_2 = \frac{(2L)(303K)}{(1L)}$ then solve and T_2 = 606 K which is 333ºC

6. To double the pressure while holding the volume and temperature constant, you would need to double the number of moles of gas.
Alternatively you can use the equation. The volume is constant because the container is rigid, and the temperature is held constant.
so the equation reduces to $\frac{P_1}{n_1} = \frac{P_2}{n_2}$ and then you can solve for $n_2 = \frac{P_2 n_1}{P_1}$ $n_2 = \frac{(10atm)(3mol)}{5atm}$ so n_2 = 6 moles,
thus you would need to squirt in 3 more moles.

7. It is important to realize that mass of gas is directly proportional to its number of moles. So even though we don't know the number of moles, we can assume that the mass will change by the same proportion as moles would. In this problem, the volume is constant because it is a glass container, and it says the temp is held at 10ºC. Thus if the pressure is reduced by one third, the amount of moles must be reduced by the same one third. Thus the new mass must be 6 g (one third of 18g) meaning that 12 g must be released.

8. We can assume the volumes are the same, so it the pressure and temp are the same, the number of moles, therefore number of molecules must be the same = 3

9. If the pressure is doubled and the temp and volume are constant, it can only be caused by more gas molecules. They must be doubled. Thus there must be 6 molecules in the gray container.