Unit 10 Group Work – Intermolecular Forces and the Ideal Gas Law

Group members:

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1. Please describe the relationship between the strength of intermolecular forces for a given substance and the T_m and T_b.

2. For each of the following compounds, please determine which intermolecular force is the most important in stabilizing the liquid and solid phases. You may wish to start by drawing a Lewis structure.

NH_3	CH_4	H_2O	CH_3CO_2H	$CH_3CH_2CH_2CH_3$	HCl	CH_3Cl	NCl_3
H-bond	**London**	**H-bond**	**Dipole-dipole**	**London**	**Dipole-Dipole**	**Dipole-Dipole**	**London**

3. For each pair, predict which vaporizes at a higher temperature. **You must justify your answer.**

   NH_3 and NCl_3

   CH_4 and **CH_3Cl**

   $CH_3CH_2CH_3$ and **$CH_3CH_2CH_2CH_3$**

   HCl and **HF**

4. Justify this data based on intermolecular forces:

Molecule	**ΔH_{vap} (kJ/mol)**
F_2	6.62
Cl_2	20.41
Br_2	29.96
I_2	41.57

5. Starting with the ideal gas law, determine a formula that can be used to calculate the density of a gas ($density = \frac{mass}{volume}$).

$$\frac{\boldsymbol{m}}{\boldsymbol{V}} = \frac{\boldsymbol{P \cdot MW}}{\boldsymbol{RT}}$$

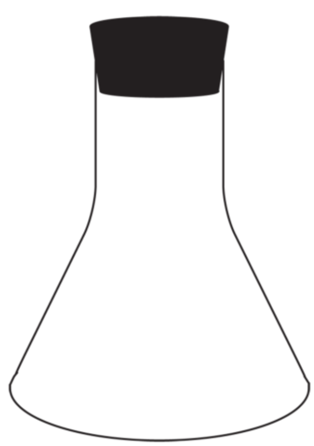
6. Calculate the **Molarity and Density** for each of the gases at STP. Do you notice any trends in these numbers?

CH_4	N_2	Ar	CO_2	Xe

Molarity of all is the same (**0.0446 mol L^{-1}**)

0.716 g/L	**1.25 g/L**	**1.78 g/L**	**1.96 g/L**	**5.86 g/L**

7. NO_2 (g) and Xe (g) are combined in the flask below. NO_2 has a characteristic yellow color while Xe (g) is colorless. These gases do not react with each other. Please sketch what you expect the flask to look like after the gases are allowed to completely settle.



8. A 1.98 L sample of a gas exerts a pressure of 2.00 atm at 30˚C and has a mass of 12.44 g. If this gas has an empirical formula of CH, determine the molecular formula.

C_6H_6

9. Under standard temperature and pressure conditions, what volume would 1 mole of Kr occupy?

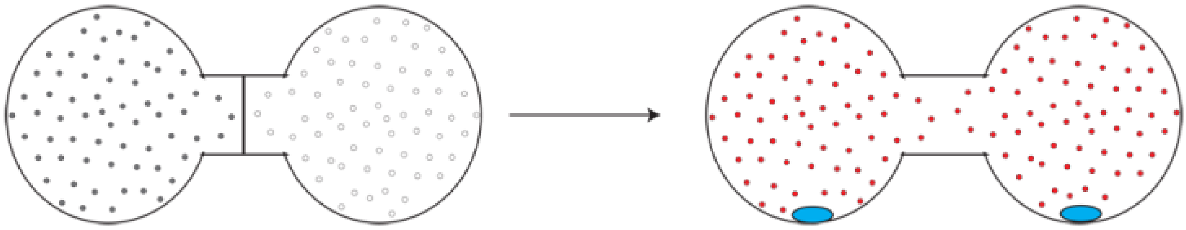
22.4 L

10. Methane (CH_4) reacts with H_2O (g) to produce H_2 (g) and either carbon monoxide **OR** carbon dioxide.

*If 5 L of CH_4 (g)is found to react completely with 10 L of H_2O (g) at **constant temperature and pressure**, which of these processes has occurred?*

CO_2 was produced

11. Consider the reaction container below. Each chamber is exactly 1 L. One chamber contains 0.5 moles of O_2 (g) and the other chamber contains 0.1 moles of C_6H_6 (g). When these gases are allowed to mix, a combustion reaction occurs. CO_2 (g) and H_2O (l) are produced. Pay close attention to the change in volume when the gases are mixed.



a. Calculate the pressure of each chamber if the temperature is held at 25 ºC.

P_{O2} = 12.23 atm. **P_{C6H6} = 2.45 atm**

b. Write a balanced equation for the combustion reaction that would occur between these two molecules.

c. What is the pressure of CO_2 (g) after the reaction if the temperature did not change.

7.34 atm.

d. What is the mass of water that is produced?

5.41 g H_2O

12. For each of the following blank graphs, determine what the graph would look like if all other variables in the ideal gas law are held constant. For example:

V vs. T → n and P are constant $PV = nRT$ $V = \frac{nRT}{P}$ $V = (Constant)T$

So in a graph of V vs. T, we would see a straight line with a slope of $\frac{nR}{P}$