AVOGADRO'S HYPOTHESIS – SAMPLE PROBLEMS

KEY

PLEASE NOTE THAT N_a = Avogadro's number = 6.02×10^{23} molecules

1. There are 3.67×10^{32} molecules of nitrogen gas in a flask at STP. How many molecules of oxygen gas would be present in the same flask?
   3.67×10^{32} molecules of oxygen gas.
   From Avogadro's Hypothesis, we have learned that the number of moles (or molecules) of the gas in a sample at a given volume, temperature, and pressure does NOT depend on the identity of the gas.

2. 312 L of chlorine gas at STP. What mass of fluorine gas would be present at the same volume, temperature and pressure.

312 L x 1 mole / 22.4 L x 38.0 g / mole = 529 g

2b. How many molecules would this be?

13.9 mole x N_a = 8.37×10^{24} molecules

3. What mass do 4.37×10^{32} molecules of ammonia gas possess?

4.37×10^{32} molecules x N_a x 17.0 g / mole = 1.23×10^{10} g

4. 156 g of ammonia gas in a flask at STP. What mass of chlorine gas would fit in the same flask?

156 g x 1 mole / 17.0 g = 9.18 moles

AVOGADRO'S HYPOTHESIS:

(V, T, P) NH_3 = (V, T, P) Cl_2

# of molecules of NH_3 = # of molecules of Cl_2

moles of NH_3 = moles of Cl_2

9.18 moles x 71.0 g / mole = 651 g

5. 211.5 g of fluorine gas at RTP. 178 g of oxygen gas in the same container at RTP. How many litres of each gas are present at RTP?

211.5 g x 1 mole/38.0 g x 24.5 L / mole = 136 L F_2

178 g x 1 mole/32.0 g x 24.5 L / mole = 136 L O_2

Due to Avogadro's hypothesis, the volume that both gases occupy will be equal, since the temperature and pressure conditions are the same, and the # of moles is the same. (Check it! The number of moles of both gases is 5.57 moles)

6. A balloon holds 4678 g of He gas. What mass of hydrogen gas would it hold at identical conditions?

4678 g x 1 mole/4.00 g He x 2.02 g H_2 / mole = 2.36×10^3 g

(V, T, P) He = (V, T, P) H_2

moles of He = moles of H_2

7. What mass of Neon gas would the balloon in #6 hold (at identical conditions)?

1169.5 moles (from question 6) x 20.2 g Ne / mole = 2.36×10^4 g

7b. How do the molecules of hydrogen gas and Neon gas compare in mass?

$\frac{2.36 \times 10^4 \text{ g Ne}}{2.36 \times 10^3 \text{ g } H_2} = 10.0$

mass of Ne: mass of H_2 = 10: 1 ratio

i.e. Neon gas' mass is 10 times the hydrogen gas' mass

8. How many molecules of carbon monoxide gas are present in 176 L of the gas at STP?

176 L x1 mol / 22.4 L x N_a = 4.73×10^{24} CO molecules

9. A container holds 6.93 moles of ammonia gas at 42°C and 176 kPa. What mass of chlorine gas would the container hold at identical conditions?

6.93 moles x 71.0 g / mole = 491 g Cl_2

10. A container holds **302 g** of gas "X". The same container holds 75 g of oxygen gas under identical conditions. What is the molar mass of gas "X"?

75 g x 1 mole / 32.0 g O_2 = 2.3 moles

$\frac{302 \text{ g of gas "X"}}{2.3 \text{ moles}} = 131.3$ g / mole must be Xe

11. Argon has a density of 1.784 g/L.

How many atoms are present in 220. mL of Argon gas?

0.22 L x 1.784 g / L x 1 mole / 39.9 g Ar x N_a = 5.91×10^{21} Ar atoms

12. 361 L of C_3H_8 gas at STP. How many moles would exist at RTP?

361 L X 1 mole / 22.4 L X 24.5 L / mole = 395 L

We know to divide by STP and multiply by RTP

Since the temperature is going up, we expect the volume of the gas to get BIGGER.