

Gas volume and limiting reagent

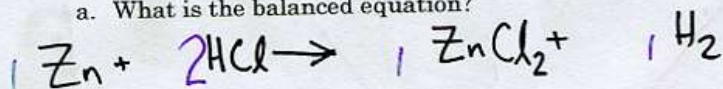
Chemistry: <http://genest.weebly.com>

Stop in for help every day at lunch and Tues & Thurs after school!



Name **KEY**
Period

1. What does STP stand for? Standard temperature and pressure
2. At STP what is the pressure? 1.00 atmospheres
3. At STP what is the temperature? 0° Celsius
4. Suppose 8.61 g of zinc was allowed to react with 8.61 liters of HCl gas to produce zinc chloride and hydrogen gas.
 - a. What is the balanced equation?



- b. Which reactant is limiting? (Show both calculations.)

$$8.61 \text{ liters HCl} \times \left(\frac{1 \text{ mol HCl}}{22.4 \text{ L HCl}} \right) \times \left(\frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \right) = 0.192 \text{ mol H}_2$$

$$8.61 \text{ grams Zn} \times \left(\frac{1 \text{ mol Zn}}{65.38 \text{ g Zn}} \right) \times \left(\frac{1 \text{ mol H}_2}{1 \text{ mol Zn}} \right) = 0.132 \text{ mol H}_2$$

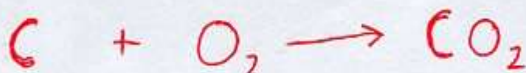
*** Answer: Zinc is limiting**

- c. Using the limiting reactant, solve for how many liters of hydrogen gas will form at Standard Temperature and Pressure.

We just found that the limiting reactant is Zinc. It formed 0.132 moles of H₂ above.

$$0.132 \text{ mol H}_2 \times \left(\frac{22.4 \text{ Liter H}_2}{1 \text{ mol H}_2} \right) = 2.96 \text{ liters}$$

5. Determine the volume in liters of carbon dioxide that should be produced in the reaction between 100. g of carbon and 100. liters of O₂. (Use the same three steps as in the previous problem above).



$$100 \text{ g C} \left(\frac{1 \text{ moles C}}{12.01 \text{ grams C}} \right) \left(\frac{1 \text{ moles CO}_2}{1 \text{ moles C}} \right) = 8.32 \text{ moles CO}_2$$

$$100 \text{ L O}_2 \left(\frac{1 \text{ moles O}_2}{22.4 \text{ liters O}_2} \right) \left(\frac{1 \text{ moles CO}_2}{1 \text{ O}_2} \right) = 4.46 \text{ moles CO}_2$$

then convert the CO₂ from the true result (from the limiting reactant)

$$4.46 \text{ moles CO}_2 \times \left(\frac{22.4 \text{ L CO}_2}{1 \text{ mole CO}_2} \right) = 99.9 \text{ liters}$$

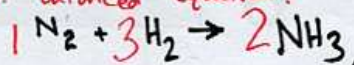
Answer: 99.9 liters CO₂

$$4.46 \text{ mol CO}_2 \times \left(\frac{22.4 \text{ liters CO}_2}{1 \text{ moles CO}_2} \right) = 99.9 \text{ liters}$$

KEY

6. Suppose 2.00 L of nitrogen gas and 5.00 L of hydrogen gas are mixed and reacted to form ammonia (NH₃). Calculate the volume in liters of ammonia produced when this reaction runs to completion.

Step 1: balanced equation:



Step 2: $2.00 \text{ L N}_2 \times \left(\frac{1 \text{ mol N}_2}{22.4 \text{ L N}_2} \right) \times \left(\frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \right) \left(\frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} \right) = 4.00 \text{ L NH}_3$

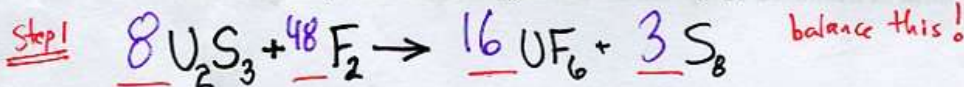
$5.00 \text{ L H}_2 \times \left(\frac{1 \text{ mol H}_2}{22.4 \text{ L H}_2} \right) \times \left(\frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} \right) \left(\frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} \right) = 3.33 \text{ L NH}_3$

there are multiple ways to solve. Since the answer is supposed to be in liters of NH₃ gas, we can save time by putting that as the goal in step 2.

Step 3. We sort of already combined step 3 into step 2. That's why we went into liters instead of stopping at moles.

Answer
3.33 liters
of NH₃ gas

7. Uranium (III) sulfide can react with fluorine to form uranium hexafluoride gas and S₈. Write a balanced reaction and then find how many liters at STP of UF₆ will form if you have 333.3 grams uranium (III) sulfide and 0.9 liters fluorine.



Step 2+3: $333.3 \text{ grams U}_2\text{S}_3 \times \left(\frac{1 \text{ moles U}_2\text{S}_3}{572.24 \text{ grams U}_2\text{S}_3} \right) \times \left(\frac{16 \text{ moles UF}_6}{8 \text{ moles U}_2\text{S}_3} \right) \left(\frac{22.4 \text{ liters UF}_6}{1 \text{ moles UF}_6} \right) = 26.1 \text{ L UF}_6$

$0.9 \text{ liters F}_2 \times \left(\frac{1 \text{ moles F}_2}{22.4 \text{ liters F}_2} \right) \times \left(\frac{16 \text{ moles UF}_6}{48 \text{ moles F}_2} \right) \left(\frac{22.4 \text{ liters UF}_6}{1 \text{ moles UF}_6} \right) = 0.3 \text{ L UF}_6$

↑
use
one mole = 22.4 L

↑
use the coefficients from the balanced equation

↑
use
one = 22.4 L gas at STP

Answer: F₂ is limiting. 0.3 liters of UF₆ will form.

class

notes begin here

PURPOSE WHAT MATH CAN WE
DO WITH CONCENTRATION?

WARMUP
Do the slip by 10:12

Warmup Slip

Directions: Turn the following into balanced equations by filling in the blanks with the correct coefficients, formulas of ions or solids, and names.

Cation	Anion		Formula	Name
A. ___ Cu ⁺	+ ___ SO ₄ ²⁻	→	_____	_____
B. ___ Pb ²⁺	+ ___ Cl ⁻	→	_____	_____
C. _____	+ _____	→	AlCl ₃	_____
D. _____	+ _____	→	Mg(NO ₃) ₂	_____
E. _____	+ _____	→	_____	iron (III) sulfide
F. _____	+ _____	→	_____	copper (II) nitrate
G. ___ Cu ²⁺	+ ___ OH ⁻	→	_____	_____

Warmup Slip

Directions: Turn the following into balanced equations by filling in the blanks with the correct coefficients, formulas of ions or solids, and names.

Cation	Anion	Formula	Name
A. <u>2</u> Cu ⁺	+ <u>1</u> SO ₄ ²⁻	→ <u>Cu₂SO₄</u>	<u>Copper(I) sulfate</u>
B. <u>1</u> Pb ²⁺	+ <u>2</u> Cl ⁻	→ <u>PbCl₂</u>	<u>Lead(II) chloride</u>
C. <u>Al³⁺</u>	+ <u>3Cl⁻</u>	→ <u>AlCl₃</u>	<u>Aluminium chloride</u>
D. <u>Mg²⁺</u>	+ <u>2NO₃⁻</u>	→ <u>Mg(NO₃)₂</u>	<u>magnesium nitrate</u>
E. <u>Fe³⁺</u>	+ <u>S²⁻</u>	→ <u>Fe₂S₃</u>	<u>iron (III) sulfide</u>
F. <u>Cu²⁺</u>	+ <u>NO₃⁻</u>	→ <u>Cu(NO₃)₂</u>	<u>copper (II) nitrate</u>
G. <u>1</u> Cu ²⁺	+ <u>2</u> OH ⁻	→ <u>Cu(OH)₂</u>	<u>Copper(II) hydroxide</u>

Copy this formula. In the second box rearrange the formula to isolate moles. In the third box rearrange to isolate volume:

$$\text{molarity} = \frac{\text{moles}}{\text{volume}}$$

~~moles~~

$$\text{molarity} = \frac{\text{moles}}{\text{volume}}$$
$$\text{molarity} \times \text{volume} = \text{moles}$$

$$\text{volume} = \frac{\text{moles}}{\text{molarity}}$$

Molarity is number of things per volume.

It is also called concentration..)

Units:

molarity is $\frac{\text{mol}}{\text{L}}$ (abbreviated)

$$1\text{cm}^3 = 1\text{ mL for all things}$$

#1

Compute the number of moles needed to make a 900 mL solution that has a concentration of 1.40M.

remember 1.40M is $1.40 \frac{\text{moles}}{\text{liter}}$

~~moles =~~

$$\begin{aligned}\text{Moles} &= \text{volume} \times \text{molarity} \\ \text{moles} &= (0.9\text{L}) \times (1.40 \frac{\text{mol}}{\text{L}}) \\ \text{moles} &= 1.26 \text{ moles}\end{aligned}$$

#2

Compute the molarity of 40.6 g of $\text{Al}_3(\text{NO}_3)_3$ dissolved in enough water to make 400 mL of solution.

take inventory

volume | 0.4 liters

molarity | ??

moles | 0.152

We can get moles, using the grams

$$40.6\text{g} \times \left(\frac{1 \text{ moles } \text{Al}(\text{NO}_3)_3}{266.97 \text{ grams}} \right) = 0.152 \text{ moles } \text{Al}(\text{NO}_3)_3$$

$$\text{molarity} = \frac{\text{moles}}{\text{volume}}$$

$$\text{molarity} = \frac{0.152 \text{ moles}}{0.4 \text{ L}}$$

$$\text{molarity} = 0.38 \frac{\text{moles}}{\text{L}}$$