10/27 (Day 16) Intro to Stoichiometry

Friday, October 23, 2020 11:16 AM

Daily Agenda:
- Check In/Attendance
- Warm-up
- Intro to Stoichiometry
  - Balanced equations
  - Mole relationships
  - Limiting Reagent

Announcements:
- HW: Mole relationship practice
- QA7: Mole relationships DUE Friday by 5 pm

Warm-Up:

A) Find the molar mass of:

1a) ammonium phosphate ~~NH_4P~~ (phosphide) NH_4^{+1} PO_4^{3-}

$(NH_4)_3PO_4$ = 149.089 g/mol

2a) Ammonia, NH_3 17.034 g/mol

B) Convert 1.47 moles of each substance above to grams:

1b) $1.47 \text{ moles} \times \frac{149.089 \text{ g}}{1 \text{ mol}} = 219 \text{ g}$

2b) $1.47 \text{ mole} \times \frac{17.034 \text{ g}}{1 \text{ mol}} = 25.03 \text{ g}$

C) Convert 75 g of each substance above to moles:

1c) $75 \text{ g} \times \frac{1 \text{ mol}}{149.089 \text{ g}} = 0.503 \text{ mol}$

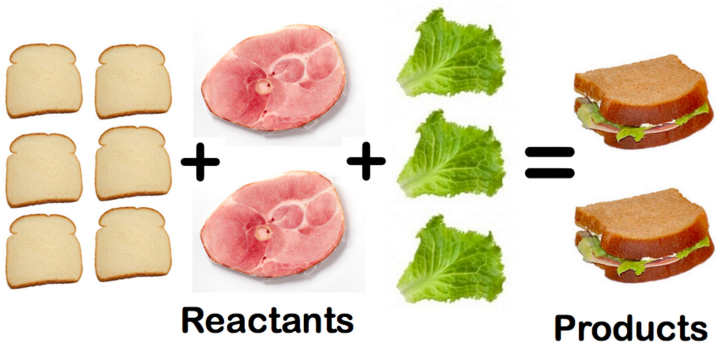
2c) $75 \text{ g} \times \frac{1 \text{ mol}}{17.034 \text{ g}} = 4.40 \text{ mol}$

If you have time: Convert the moles in part C to particles of each substance:

1d) $0.503 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}} = 3.03 \times 10^{23} \text{ particles}$

2d) $4.40 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}} = 2.65 \times 10^{24} \text{ particles}$

Intro to Stoichiometry:

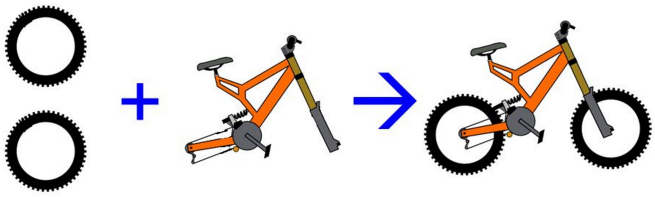


6 B + 2 H + 3 L → 2 Sandwiches

−4 B −2 H −2 L

2 B 0 1 L

0 ← limiting reagent



2wheels + 1frame → 1bike

How many frames would be needed to 'react' completely with 20 wheels?

20W + ? 10F → 10B

How many bikes could be produced from 4 wheels and 560 frames? What is the limiting reactant here?

Setting this up using something called ICE chart notation:

	2W + 1F → 1Bike			
Initial	4	560	Ø	
Change	−4	−2	+2	
End	Ø	558	2	

Limiting reagent (LR)

① Ratio in change must match balanced equation

② Subtract reactants Add products in change row

Putting this all into the context of chemistry: * ALWAYS BALANCE THE EQUATION FIRST

	3 Mg (s) + 1 N_2 (g) → 1 Mg_3N_2 (s)		
Initial	15	15	Ø
Change	−15	−5	+5
End	Ø	10	5

LR

Example 1: How much magnesium nitride can we make if we start with 15 moles of Mg and 15 moles of N_2?

THINGS TO NOTE:

1) Numbers in ICE charts are always in moles so one of the few times that we can write numbers without units.
2) For 10th grade chem, the initial amounts of products will always be zero.
3) ALWAYS check that the ratio in the change row matches the ratios in the balanced chemical equation.
4) In a problem that states that one reactant is in excess, you can use the abbreviation X.S. for both the initial and end rows but MUST still complete the mole relationships in the change row based on the information given about the other reactant. (See next example)

Example 2: How much magnesium nitride can we make if we start with 30 moles of Mg and excess nitrogen?

	3 Mg (s) + 1 N_2 (g) → 1 Mg_3N_2 (s)		
Initial	30	X.S.	Ø
Change	−30	−10	+10
End	Ø	X.S.	10

LR

Example 3: How much magnesium nitride can we make if we start with 21 moles of Mg and 12 moles of N_2?

*There is often a temptation to use that you will use up the reactant with the fewer number of moles. While that can be a good place to start, the mole relationship from the balanced equation drives which reactant will be consumed first/

Scenario 1: Using up ALL 12 moles of N_2

	3 Mg (s) + 1 N_2 (g) → 1 Mg_3N_2 (s)		
Initial	21	12	Ø
Change	−36	−12	+12
End			

Given or calculate

given or calculate

Initial	21	12	Ø	
Change	−36	−12	+12	
End	−15 < 0	Ø	12	

* Doesn't work

Scenario 2: Using up ALL 21 moles of Mg

	3 Mg (s) + 1 N_2 (g) → 1 Mg_3N_2 (s)			
Initial	21	12	Ø	
Change	−21	−7	+7	
End	Ø (LR)	5	7	

Example 4: How much silver can we make if we react 25 moles of Cu with 35 moles of $AgNO_3$?

	1 Cu (s) + 2 $AgNO_3$ (aq) → 2 Ag (s) + 1 $Cu(NO_3)_2$ (aq)			
Initial	25 *	35 *	Ø	Ø
Change	−17.5	−35	+35	+17.5
End	7.5	Ø (LR)	35	17.5

How much copper did I consume if I made 24 moles of Ag knowing there was excess silver nitrate? 12 mol Cu

	1 Cu (s) + 2 $AgNO_3$ (aq) → 2 Ag (s) + 1 $Cu(NO_3)_2$ (aq)			
Initial	12	X.S.	Ø	Ø
Change	−12	−24	+24	+12
End	Ø (LR)	X.S.	24 *	12

implied by saying in X.S.

Example 5: How much calcium phosphate can we produce from 15 moles of $Ca(OH)_2$ and 12 moles of H_3PO_4?

	3 $Ca(OH)_2$ (s) + 2 H_3PO_4 (aq) → 1 $Ca_3(PO_4)_2$ (s) + 6 H_2O (l)			
Initial	15 *	12 *	Ø	Ø
Change	−15	−10	+5	+30
End	Ø (LR)	2	5	30

$\left(\frac{12\text{ mol}}{2\text{ (column it's in)}}\right) \cdot 3\text{ (column it's going to)} = 18$

$\left(\frac{15}{3\text{ (column it's in)}}\right) \cdot 2\text{ (column it's going to)} = 10$

Example 6: How much hydrogen gas can we make if we start with 57 moles of Al and 100 moles of HCl?

	2 Al (s) + 6 HCl (aq) → 2 $AlCl_3$ (aq) + 3 H_2 (g)			
Initial	57	100	Ø	Ø
Change	−33.3	−100	+33.3	+50
End	23.7	Ø	33.3	50

How much Al will I need to make 150 moles of H_2 assuming excess HCl? 100 mol

	2 Al (s) + 6 HCl (aq) → 2 $AlCl_3$ (aq) + 3 H_2 (g)			
Initial	100	X.S.	Ø	Ø
Change	−100	−300	+100	+150
End	Ø (LR)	X.S.	100	150 *

$\left(\frac{100}{6}\right) \cdot 2 = 33.\overline{3}$

6: column it's in; 2: column it's going toward

(*) $100\text{ mol HCl} \times \frac{2\text{ mol Al}}{6\text{ mol HCl}} = 33.\overline{3}\text{ mol Al}$

mol ratio = from balanced equation