Limiting Reagent

Handout - Notes – Limiting Reagent

- Chemical reactions are like cooking. You need to mix the correct amount of "ingredients" or your cake won't rise.

- If you add too much of one or more ingredients then the cake tastes poor. In chemistry if you add too much of one of more reactants (ingredients) the product (cake) ends up being wasted.

Activity – pHET – Limiting Reagent

Instructions – go to the address below on a laptop. Figure out which ingredient decides how many sandwiches can be made each time. Test your ideas by completing the game.

http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers

Ex. – building a bike. A bike has 1 frame, 2 tires, 1 handle bar, 1 seat and 2 pedals.

If you have 2 frames, 3 handlebars, 1 seat and 9 petals, 4 tires how many bikes can you build?

Answer – 1 bike! With 2 tires, 1 frame, 2 handlebars and 7 pedals.

- Chemical reactions work the same way. The chemical with the least amount needed for the reaction to work will limit how much product is made.

Ex. 1 - $2\ H_{2\ (g)} + O_{2\ (g)} \rightarrow 2\ H_2O_{(l)}$

Parts = 2 H_2 and 1 O_2 This will only make 2 water!

- If we have $20.0\ g$ of $H_{2\ (g)}$ reacted with $100.0\ g\ O_{2\ (g)}$, which reactant is in excess?

Remember, the coefficients used to balance the reaction above are the mole equivalencies for each molecule. That is, I need twice as many moles of hydrogen gas as the number of moles of oxygen gas.

Answer – change grams to moles and use the mole ratio to see if there is enough oxygen to react all of the oxygen.

$$20.0\ g\ H_2 \times \frac{1\ mol\ H_2}{2.02\ g\ H_2} \times \frac{1\ mol\ O_2}{2\ mol\ H_2} \times \frac{32.00\ g\ O_2}{1\ mol\ O_2} = 158.735\ g\ O_2$$ This means I need 159 g of O_2

I only have $100.0\ g$ of O_2 so oxygen is limiting!!!!

Ex. 2 – If $56.8\ g$ of $FeCl_2$, $14.0\ g$ of KNO_3 and $40.0\ g$ of HCl are reacted according to the equation below, which chemical is the limiting reagent?

___ $FeCl_2$ + ___ KNO_3 + ___ HCl → ___ $FeCl_3$ + ___ NO + ___ H_2O + ___ KCl

Balance First!!!! 3 $FeCl_2$ + KNO_3 + 4 HCl → 3 $FeCl_3$ + NO + 2 H_2O + KCl

Pick one of the products that you will convert each reactant to. (choose NO as its only 1 mole)

$$56.8\ g\ FeCl_2 \times \frac{1\ mol\ FeCl_2}{126.75\ g\ FeCl_2} \times \frac{1\ mol\ NO}{3\ mol\ FeCl_2} \times \frac{30.01\ g\ NO}{1\ mol\ NO} = 4.48\ g\ NO$$

$$14.0\ g\ KNO_3 \times \frac{1\ mol\ KNO_3}{101.11\ g\ KNO_3} \times \frac{1\ mol\ NO}{1\ mol\ KNO_3} \times \frac{30.01\ g\ NO}{1\ mol\ NO} = 4.15\ g\ NO \leftarrow$$

$$40.0\ g\ HCl \times \frac{1\ mol\ HCl}{36.46\ g\ HCl} \times \frac{1\ mol\ NO}{4\ mol\ HCl} \times \frac{30.01\ g\ NO}{1\ mol\ NO} = 8.22\ g\ NO$$

smallest so limiting is KNO_3

as KNO_3 is chemical that made the smallest NO amount

Ex. 3 - How much excess of each of the other reactants was there?

$$14.0\ g\ KNO_3 \times \frac{1\ mol\ KNO_3}{101.11\ g\ KNO_3} \times \frac{3\ mol\ FeCl_2}{1\ mol\ KNO_3} \times \frac{126.75\ g\ FeCl_2}{1\ mol\ FeCl_2} = 52.651\ g\ FeCl_2$$

So . . . $56.8\ g - 52.651 = 4.149\ g$ → $4.1\ g\ of\ excess\ FeCl_2$

$$14.0\ g\ KNO_3 \times \frac{1\ mol\ KNO_3}{101.11\ g\ KNO_3} \times \frac{4\ mol\ HCl}{1\ mol\ KNO_3} \times \frac{36.46\ g\ HCl}{1\ mol\ HCl} = 20.1935\ g\ HCl$$

So . . . $40.0\ g - 20.19\ g = 19.806\ g$ → $19.8\ g\ of\ excess\ HCl$

Practice – Worksheet – Limiting Reagent

Practice – Lab – Law of Definite Composition

Practice – Lab – Double Replacement of Sodium and Calcium

Double Replacement of Sodium and Calcium - KEY

Practice – Quiz – Limiting Reagent Limiting Reagent - KEY