Chem 20 Unit D - Qualitative Changes in Chemical Systems

Stoich Wrap-up and Limiting and Excess Reagents

Dec 7-9:26 PM

Dr. Martyn Poliakoff
Proudly Presents:

The Periodic Table Movie of the Day!!

Dec 7-9:27 PM

Recall: in a stoich problem:

The reactant that gets used up first is called the limiting reagent.

The reactant that is left over after reaction is called the excess reagent.

Let's go over a few more complicated examples using limiting reagents.

Dec 7-9:27 PM

ex) 10.0 g of copper metal is placed in a solution of 20.0 g of silver nitrate.

a) Which reagent is the limiting reagent?

b) What mass of the excess reagent is left remaining after the reaction?

c) What mass of each product is produced?

Dec 7-9:31 PM

a) Which reagent is the limiting reagent?

Step 1: Write out the eqn, list your info.

$$Cu_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$$

m = 10.0 g
M = 63.55 g/mol

m = 20.0 g
M = 169.88 g/mol

Step 2: Determine the amount of each reactant present.

n_{Cu} = 10.0 g / 63.55 g/mol = 0.157 mol

n_{AgNO_3} = 20.0 g / 169.88 g/mol = 0.118 mol

Dec 7-9:35 PM

Step 3: Assume one reactant is the limiting reagent. It doesn't matter which. We'll call this reactant A.

Determine the amount of the other reactant (B) that would be used up using stoich.

If there is more of B left over, it really is the excess reagent.

If there is less of B left over, it is actually the limiting reagent.

Dec 7-9:39 PM

$1\ Cu_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$

*I'll assume $Cu_{(s)}$ is the limiting reagent. I'll call it A. How much of B would be used up?

$$\frac{AgNO_3}{Cu}\ \frac{\text{unknown}}{\text{known}} = \frac{n}{0.157\ mol} = \frac{2}{1}$$

$n = 0.315$ mol of $AgNO_{3(aq)}$

As this is more $AgNO_{3(aq)}$ than we actually have, our initial assumption was incorrect. $Cu_{(s)}$ must be the excess reagent and $AgNO_{3(aq)}$ would be the limiting reagent.

Dec 8-7:20 AM

Important Hint:

Know that we know our limiting reagent, we must use this amount of moles when doing our other calculations!

Dec 8-7:28 AM

b) What mass of excess reagent is left over?

Step 1: Determine the amount of excess used up using the number of moles of the limiting.

$$1\ Cu_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$$

n = 0.157 mol (excess) n = 0.118 mol (limiting)

$$\frac{\text{unknown}}{\text{known}} = \frac{n_{Cu}}{0.118\ mol} = \frac{1}{2}$$

$n_{Cu} = 0.0589$ mol

Dec 8-7:26 AM

Step 2: Convert this to a number of grams, then subtract from the initial mass.

$n_{Cu} = 0.0589\ mol \times 63.55\ g/mol = 3.74\ g$

$10.0\ g - 3.74\ g = \underline{\underline{6.3\ g}}$

Dec 8-7:32 AM

c) What is the mass of each product produced?

Again, do the stoich steps using the number of moles of the limiting reagent.

$$1\ Cu_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$$

n = 0.118 mol (limiting)

$$\frac{\text{unknown}}{\text{known}} = \frac{n_{Ag}}{0.118\ mol} = \frac{2}{2} \qquad \frac{\text{unknown}}{\text{known}} = \frac{n_{Cu(NO3)2}}{0.118\ mol} = \frac{1}{2}$$

$n_{Ag} = 0.118$ mol
$m_{Ag} = 12.7$ g

$n_{Cu(NO3)2} = 0.059$ mol
$m_{Cu(NO3)2} = 10.0$ g

Dec 8-7:27 AM

Practice: Page 324 #3

Dec 8-7:36 AM

HW: Page 324 #4 and 5*

*2% Bonus Question

Dec 8-7:40 AM