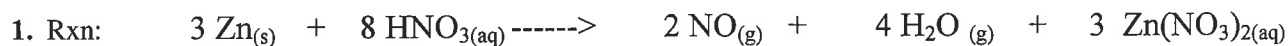


AP Chem In-class practice: Stoichiometry, limiting and excess reactants, percent yield!



a. If 14.4 grams of zinc powder react with excess acid, how many molecules of water should form?

$$(14.4 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{4 \text{ mole H}_2\text{O}}{3 \text{ mole Zn}} \right) \left(\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole}} \right) = \boxed{1.77 \times 10^{23} \text{ molecules}}$$

b. What mass of nitric acid will be consumed, when the 14.4 grams of zinc react?

$$(14.4 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{8 \text{ mole HNO}_3}{3 \text{ mole Zn}} \right) \left(\frac{63.0128 \text{ g}}{1 \text{ mole}} \right) = \boxed{37.0 \text{ g}}$$

c. If 18.0 grams of zinc are allowed to react with 0.658 moles of nitric acid, how many liters of NO gas should be collected, if measured at STP?

$$(18.0 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{2 \text{ mole NO}}{3 \text{ mole Zn}} \right) \left(\frac{22.4 \text{ L}}{1 \text{ mole}} \right) = 4.1113 \rightarrow 4.11 \text{ L}$$

$$(0.658 \text{ mole HNO}_3) \left(\frac{2 \text{ mole NO}}{8 \text{ mole HNO}_3} \right) \left(\frac{22.4 \text{ L}}{1 \text{ mole}} \right) = 3.6848 \rightarrow 3.68 \text{ L}$$

$\boxed{3.68 \text{ L can form}}$ (Zn is excess, HNO₃ is limiting)

d. If these amounts (in part c) are allowed to react, but only 3.27 liters of NO are collected, what was the percent yield?

$$\% \text{ yield} = \frac{\text{actual}}{\text{expected}} \times 100 = \frac{3.27 \text{ L}}{3.6848 \text{ L}} \times 100 = 88.743 \rightarrow \boxed{88.7\%}$$

e. If these amounts (in part c) are allowed to react, what mass of excess reactant will remain, once the limiting reactant has been consumed?

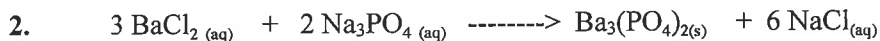
HNO₃ was limiting (is all consumed)

$$(0.658 \text{ mole HNO}_3) \left(\frac{3 \text{ mole Zn}}{8 \text{ mole HNO}_3} \right) \left(\frac{65.38 \text{ g}}{1 \text{ mole}} \right) = 16.1325 \rightarrow 16.1 \text{ g}$$

16.1 g Zn will be consumed in the rxn.

we started w/ 18.0 g Zn.

$$18.0 \text{ g} - 16.1 \text{ g} = \boxed{1.9 \text{ g Zn remaining after rxn}}$$



If 0.432 moles of barium chloride react are allowed to react with 0.383 moles of sodium phosphate,

a. What mass of barium phosphate should be produced? $\text{Ba}_3(\text{PO}_4)_2$ has a formula mass of 601.93 amu.

$$(0.432 \text{ moles BaCl}_2) \left(\frac{1 \text{ mole Ba}_3(\text{PO}_4)_2}{3 \text{ mole BaCl}_2} \right) \left(\frac{601.93 \text{ g}}{1 \text{ mole}} \right) = 86.68 \rightarrow \underline{86.7 \text{ g}}$$

$$(0.383 \text{ moles Na}_3\text{PO}_4) \left(\frac{1 \text{ mole Ba}_3(\text{PO}_4)_2}{2 \text{ mole Na}_3\text{PO}_4} \right) \left(\frac{601.93 \text{ g}}{1 \text{ mole}} \right) = 115.3 \rightarrow \cancel{115 \text{ g}}$$

so, 86.7 g can form.

or: $\frac{0.432}{0.383} = 1.13 \quad 1.13 < \frac{3}{2} \quad \text{so BaCl}_2 \text{ is limiting}$

$$(0.432 \text{ moles BaCl}_2) \left(\frac{1 \text{ mole Ba}_3(\text{PO}_4)_2}{3 \text{ mole BaCl}_2} \right) \left(\frac{601.93 \text{ g}}{1 \text{ mole}} \right) = 86.7 \text{ g Ba}_3(\text{PO}_4)_2$$

b. Which reactant is the limiting reactant?

Which reactant is the excess reactant?

BaCl₂

Na₃PO₄

c. How many moles of excess reactant should remain after the reaction is complete?

$$(0.432 \text{ moles BaCl}_2) \left(\frac{2 \text{ mole Na}_3\text{PO}_4}{3 \text{ mole BaCl}_2} \right) = \underline{0.288 \text{ moles Na}_3\text{PO}_4 \text{ Consumed}}$$

0.383 moles Na₃PO₄ @ start

- 0.288 moles Na₃PO₄ consumed

0.095 moles

Na₃PO₄ remain

3. $\text{Zn}_{(s)} + 2 \text{HCl}_{(aq)} \rightarrow \text{H}_{2(g)} + \text{ZnCl}_{2(aq)}$
 If a 5.68 gram chunk of zinc is dropped into a solution containing 8.22×10^{23} HCl molecules,
 a. What mass of hydrogen gas should be collected?

$$(5.68 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{1 \text{ mole H}_2}{1 \text{ mole Zn}} \right) \left(\frac{2.0158 \text{ g}}{1 \text{ mole}} \right) = 0.17513 \rightarrow \underline{0.175 \text{ g}}$$

$$(8.22 \times 10^{23} \text{ molecules}) \left(\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molec}} \right) \left(\frac{1 \text{ mole H}_2}{2 \text{ mole HCl}} \right) \left(\frac{2.0158 \text{ g}}{1 \text{ mole}} \right) = 1.38 \text{ g}$$

so 0.175 g can be collected

OR: $(5.68 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) = 0.08688 \text{ moles Zn}$

$$\frac{1.37}{0.08688} > \frac{2}{1}$$

$$(8.22 \times 10^{23} \text{ molecules}) \left(\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molecules}} \right) = 1.37 \text{ mole HCl}$$

so HCl is xs
 Zn is limiting.

so only use Zn to
 calculate H₂

- b. What volume of hydrogen gas should be collected, if measured at STP?

$$(5.68 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{1 \text{ mole H}_2}{1 \text{ mole Zn}} \right) \left(\frac{22.4 \text{ L}}{1 \text{ mole}} \right) = \underline{1.95 \text{ L H}_2 \text{ gas}}$$

- c. How much excess reactant remains?
 (if Zinc is excess, report your answer in grams. Otherwise, report it in molecules.)

(Zn is limiting, HCl is xs)

$$(5.68 \text{ g Zn}) \left(\frac{1 \text{ mole}}{65.38 \text{ g}} \right) \left(\frac{2 \text{ mole HCl}}{1 \text{ mole Zn}} \right) \left(\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole}} \right) = 1.046 \times 10^{23} \text{ molec. consumed}$$

$$8.22 \times 10^{23} \text{ @ start} - 1.046 \times 10^{23} \text{ consumed} = \underline{7.17 \times 10^{23} \text{ molecules remain}}$$