

Test #9 Review

Moles and Stoichiometry

- How many significant figures are in the following numbers?
 - 7400 2 sig figs
 - 0.00090100 5 sig figs
 - 5.61×10^{24} 3 sig figs
 - 160.00 5 sig figs

- When dividing $\frac{12.1}{3}$ by 3.5, how many significant figures should be in the final answer?
 $\frac{12.1}{3} = 4$ 2 sig figs in answer

- Define a mole

SI unit for the amount of a substance

- What is Avogadro's number?

6.02×10^{23} (the amount of particles in 1 mole)

- What are the 3 types of particles, and what type of substance do they represent?

atom - elements

molecule - covalent compounds

formula unit - ionic compounds

- How many atoms are in 1.25 moles Sulfur?

$$\frac{1.25 \text{ mol S}}{1 \text{ mol S}} \times 6.02 \times 10^{23} \text{ atoms S} = 7.53 \times 10^{23} \text{ atoms S}$$

- How many moles of SO_3 are in 2.4×10^{24} molecules of SO_3 ?

$$\frac{2.4 \times 10^{24} \text{ molec. SO}_3}{6.02 \times 10^{23} \text{ molec. SO}_3} \times 1 \text{ mol SO}_3 = 4.0 \text{ mol SO}_3$$

- The molar mass of an element is the mass of one mole of the element.

- Where do you find the molar mass of any element?

Periodic Table

- Calculate the molar mass of $\text{Al}_2(\text{SO}_4)_3$

$$\text{Al} = 26.982 \times 2 = 53.964$$

$$\text{S} = 32.066 \times 3 = 96.198$$

$$\text{O} = 15.999 \times 12 = 191.988$$

$$\left. \begin{array}{l} \text{Al} = 53.964 \\ \text{S} = 96.198 \\ \text{O} = 191.988 \end{array} \right\} \text{Add together} = 342.15 \text{ g/mol}$$

- What is the mass of 5.4 moles of aluminum? from P.T.

$$\frac{5.4 \text{ mol Al}}{1 \text{ mol Al}} \times 26.982 \text{ g Al} = 145.70 = 150 \text{ g Al}$$

- How many moles are present in 87.2 grams of SO_2 ?

$$\frac{87.2 \text{ g SO}_2}{64.064 \text{ g SO}_2} \times 1 \text{ mol SO}_2 = 1.36 \text{ mol SO}_2$$

$\text{S} = 32.066 \times 1 = 32.066$
 $\text{O} = 15.999 \times 2 = 31.998$
 64.064

- At STP, what is the volume of 1 mole of a gas?

$$1 \text{ mole} = 22.4 \text{ L}$$

- What is STP an abbreviation for?

Standard temperature and pressure

- How much space would 3.8 moles of CO_2 occupy at STP?

$$\frac{3.8 \text{ mol CO}_2}{1 \text{ mol CO}_2} \times 22.4 \text{ L CO}_2 = 85.12 = 85 \text{ L CO}_2$$

- How many moles of water vapor would occupy 35.4 L at STP?

$$\frac{35.4 \text{ L H}_2\text{O}}{22.4 \text{ L H}_2\text{O}} \times 1 \text{ mol H}_2\text{O} = 1.58 \text{ mol H}_2\text{O}$$

- List the 3 things that are equal to 1 mole.

$$1 \text{ mol} = 22.4 \text{ L}$$

$$1 \text{ mol} = \text{grams from Periodic Table}$$

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ particles (atoms, molecules, formula units)}$$

18. How many atoms are in 2.5 grams of sulfur?

$$\begin{array}{c|c|c} 2.5 \text{ g S} & 1 \text{ mol S} & 6.02 \times 10^{23} \text{ atoms S} \\ \hline & 32.07 \text{ g S} & 1 \text{ mol S} \end{array} = 4.7 \times 10^{22} \text{ atoms S}$$

from P.T.

19. What is the mass of 1.58 L of nitrogen gas at STP? $N = 14.007 \times 2 = 28.014$

$$\begin{array}{c|c|c} 1.58 \text{ L N}_2 & 1 \text{ mol N}_2 & 28.01 \text{ g N}_2 \\ \hline & 22.4 \text{ L N}_2 & 1 \text{ mol N}_2 \end{array} = 1.9 \text{ g N}_2$$

20. Define the following terms

- Limiting Reactant - Reactant that limits the amount of product that can be made (ingredient that runs out first)
- Excess Reactant - Reactant(s) that will have an extra amount left over (once the limiting reactant runs out)
- Theoretical Yield - amount of product that is possible to make from a given amount of reactant (calculated)
- Actual Yield - amount of product that is actually made



- Identify the molar ratios in the equation above (coefficients)
 $\text{Fe} : \text{O}_2 = 4:3$ $\text{Fe}_2\text{O}_3 : \text{O}_2 = 2:3$ $\text{Fe} : \text{Fe}_2\text{O}_3 = 4:2 = 2:1$ OR

- If you have 2.14 moles of oxygen, how many moles of ~~aluminum~~ ^{iron} do you need for a complete reaction?

$$\begin{array}{c|c} 2.14 \text{ mol O}_2 & 4 \text{ mol Fe} \\ \hline & 3 \text{ mol O}_2 \end{array} = 2.85 \text{ mol Fe}$$

← coefficients

- How many moles of Fe_2O_3 can I make with 4.29×10^{23} atoms of iron?

$$\begin{array}{c|c|c} 4.29 \times 10^{23} \text{ atoms Fe} & 1 \text{ mol Fe} & 2 \text{ mol Fe}_2\text{O}_3 \\ \hline & 6.02 \times 10^{23} \text{ atoms Fe} & 4 \text{ mol Fe} \end{array} = 0.356 \text{ mol Fe}_2\text{O}_3$$

- If I have 5.17 mol Fe and 3.82 mol O_2 , how many moles of Fe_2O_3 can I make? Identify the limiting reactant.

$$\begin{array}{c|c} 5.17 \text{ mol Fe} & 2 \text{ mol Fe}_2\text{O}_3 \\ \hline & 4 \text{ mol Fe} \end{array} = 2.59 \text{ mol Fe}_2\text{O}_3$$

$$\begin{array}{c|c} 3.82 \text{ mol O}_2 & 2 \text{ mol Fe}_2\text{O}_3 \\ \hline & 3 \text{ mol O}_2 \end{array} = 2.55 \text{ mol Fe}_2\text{O}_3$$

Limiting Reactant = O_2



- Identify the molar ratios in the equation above

$$\text{Al} : \text{Ag} = 2:6 \text{ OR } 1:3 \quad \text{Ag} : \text{Ag}_2\text{S} = 6:3 \text{ OR } 2:1 \quad \text{Ag}_2\text{S} : \text{Al}_2\text{S}_3 = 3:1$$

- How many moles of aluminum sulfide can be produced if you start with 3.76 moles of aluminum?

$$\begin{array}{c|c} 3.76 \text{ mol Al} & 1 \text{ mol Al}_2\text{S}_3 \\ \hline & 2 \text{ mol Al} \end{array} = 1.88 \text{ mol Al}_2\text{S}_3$$

- What mass of aluminum is needed to produce 36.5 g Ag? from P.T.

$$\begin{array}{c|c|c|c} 36.5 \text{ g Ag} & 1 \text{ mol Ag} & 2 \text{ mol Al} & 26.98 \text{ g Al} \\ \hline & 107.87 \text{ g Ag} & 6 \text{ mol Ag} & 1 \text{ mol Al} \end{array} = 3.04 \text{ g Al}$$

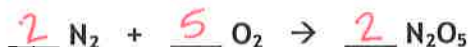
from P.T.

- How many atoms of silver can be produced from 75.2 g Ag_2S ?

$$\begin{array}{c|c|c|c} 75.2 \text{ g Ag}_2\text{S} & 1 \text{ mol Ag}_2\text{S} & 6 \text{ mol Ag} & 6.02 \times 10^{23} \text{ atoms Ag} \\ \hline & 247.80 \text{ g Ag}_2\text{S} & 3 \text{ mol Ag}_2\text{S} & 1 \text{ mol Ag} \end{array} = 3.65 \times 10^{23} \text{ atoms Ag}$$

$$\begin{aligned} \text{Ag} &= 107.868 \times 2 = 215.736 \\ \text{S} &= 32.066 \times 1 = 32.066 \\ \hline & 247.802 \end{aligned}$$

23.



- a) How many molecules of dinitrogen pentoxide can be produced from 14.56 L of oxygen at STP?

$$\begin{array}{c|c|c|c} 14.56 \text{ L O}_2 & 1 \text{ mol O}_2 & 2 \text{ mol N}_2\text{O}_5 & 6.02 \times 10^{23} \text{ molec. N}_2\text{O}_5 \\ \hline & 22.4 \text{ L O}_2 & 5 \text{ mol O}_2 & 1 \text{ mol N}_2\text{O}_5 \end{array} = 1.57 \times 10^{23} \text{ molec. N}_2\text{O}_5$$

- b) What volume of nitrogen gas is needed to produce 101.4 g N₂O₅ at STP?

$$\begin{array}{c|c|c|c} 101.4 \text{ g N}_2\text{O}_5 & 1 \text{ mol N}_2\text{O}_5 & 2 \text{ mol N}_2 & 22.4 \text{ L N}_2 \\ \hline & 108.01 \text{ g N}_2\text{O}_5 & 2 \text{ mol N}_2\text{O}_5 & 1 \text{ mol N}_2 \end{array} = 21.0 \text{ L N}_2$$

$N = 14.007 \times 2 = 28.014$
 $O = 15.999 \times 5 = 79.995$
 108.009

- c) If I start with 0.338 moles of oxygen, and produce 0.126 mol N₂O₅,

- i. What is my actual yield?

$$0.126 \text{ mol N}_2\text{O}_5$$

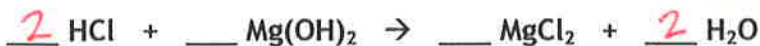
- ii. What is my theoretical yield?

$$\begin{array}{c|c} 0.338 \text{ mol O}_2 & 2 \text{ mol N}_2\text{O}_5 \\ \hline & 5 \text{ mol O}_2 \end{array} = 0.135 \text{ mol N}_2\text{O}_5$$

- iii. What is my percent yield?

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{0.126 \text{ mol}}{0.135 \text{ mol}} \times 100 = 93.3 \%$$

24.



- a) If I have 4.13 mol HCl and 2.76 mol Mg(OH)₂, how many moles of MgCl₂ can I make?

Identify the limiting reagent.

$$\begin{array}{c|c} 4.13 \text{ mol HCl} & 1 \text{ mol MgCl}_2 \\ \hline & 2 \text{ mol HCl} \end{array} = 2.07 \text{ mol MgCl}_2$$

limiting reactant = HCl

$$\begin{array}{c|c} 2.76 \text{ mol Mg(OH)}_2 & 1 \text{ mol MgCl}_2 \\ \hline & 1 \text{ mol Mg(OH)}_2 \end{array} = 2.76 \text{ mol MgCl}_2$$

- b) I actually do the experiment (listed in part a) in the lab, and produce 1.87 mol MgCl₂. What is my percent yield?

theoretical
Yield

actual Yield

$$\% \text{ Yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$= \frac{1.87 \text{ mol MgCl}_2}{2.07 \text{ mol MgCl}_2} \times 100 = 90.3 \%$$