Savage - KEY

Test #9 Review

Moles and Stoichiometry

1. How many significant figures are in the following numbers?
   a. 7400 2 sig figs
   b. 0.00090100 5 sig figs
   c. 5.61×10^{24} 3 sig figs
   d. 160.00 5 sig figs
2. When dividing 12.1 by 3.5, how many significant figures should be in the final answer?
   3 (2) 2 sig figs in answer
3. Define a mole
   SI unit for the amount of a substance
4. What is Avogadro's number?
   6.02×10^{23} (the amount of particles in 1 mole)
5. What are the 3 types of particles, and what type of substance do they represent?
   atom - elements
   molecule - covalent compounds
   formula unit - ionic compounds
6. How many atoms are in 1.25 moles Sulfur?
   $1.25 \text{ mol S} \left| \frac{6.02 \times 10^{23} \text{ atoms S}}{1 \text{ mol S}} \right. = 7.53 \times 10^{23} \text{ atoms S}$
7. How many moles of SO_3 are in 2.4×10^{24} molecules of SO_3?
   $2.4 \times 10^{24} \text{ molec. } SO_3 \left| \frac{1 \text{ mol } SO_3}{6.02 \times 10^{23} \text{ molec. } SO_3} \right. = 4.0 \text{ mol } SO_3$
8. The molar mass of an element is the mass of one mole of the element.
9. Where do you find the molar mass of any element?
   Periodic Table
10. Calculate the molar mass of $Al_2(SO_4)_3$
    Al = 26.982 x 2 = 53.964
    S = 32.066 x 3 = 96.198
    O = 15.999 x 12 = 191.988
    } Add together = 342.15 g/mol
11. What is the mass of 5.4 moles of aluminum?
    $5.4 \text{ mol Al} \left| \frac{26.982 \text{ g Al}}{1 \text{ mol Al}} \right. = 145.70 = 150 \text{ g Al}$ (from P.T.; 2 sig figs)
12. How many moles are present in 87.2 grams of SO_2?
    S = 32.066 x 1 = 32.066
    O = 15.999 x 2 = 31.998 +
    64.064
    $87.2 \text{ g } SO_2 \left| \frac{1 \text{ mol } SO_2}{64.06 \text{ g } SO_2} \right. = 1.36 \text{ mol } SO_2$
13. At STP, what is the volume of 1 mole of a gas?
    1 mole = 22.4 L
14. What is STP an abbreviation for?
    Standard temperature and pressure
15. How much space would 3.8 moles of CO_2 occupy at STP?
    $3.8 \text{ mol } CO_2 \left| \frac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} \right. = 85.12 = 85 \text{ L } CO_2$
16. How many moles of water vapor would occupy 35.4 L at STP?
    $35.4 \text{ L } H_2O \left| \frac{1 \text{ mol } H_2O}{22.4 \text{ L } H_2O} \right. = 1.58 \text{ mol } H_2O$
17. List the 3 things that are equal to 1 mole.
    1 mol = 22.4 L
    1 mol = grams from Periodic Table
    1 mol = 6.02×10^{23} particles (atoms, molecules, formula units)

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

$$2.5\text{ g S} \left| \frac{1\text{ mol S}}{32.07\text{ g S}} \right. \left| \frac{6.02\times10^{23}\text{ atoms S}}{1\text{ mol S}} \right. = 4.7\times10^{22}\text{ atoms S}$$

from P.T.

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

$$1.5\text{ L } N_2 \left| \frac{1\text{ mol } N_2}{22.4\text{ L } N_2} \right. \left| \frac{28.01\text{ g } N_2}{1\text{ mol } N_2} \right. = 1.9\text{ g } N_2$$

20. Define the following terms

a) Limiting Reactant - Reactant that limits the amount of product that can be made (ingredient that runs out first)

b) Excess Reactant - Reactant(s) that will have an extra amount left over (once the limiting reactant runs out)

c) Theoretical Yield - amount of product that is possible to make from a given amount of reactant (calculated)

d) Actual Yield - amount of product that is actually made

21. $\underline{4}\ Fe + \underline{3}\ O_2 \rightarrow \underline{2}\ Fe_2O_3$

a) Identify the molar ratios in the equation above (coefficients)

$Fe : O_2 = 4:3$ $\quad Fe_2O_3 : O_2 = 2:3$ $\quad Fe : Fe_2O_3 = 4:2$ OR $= 2:1$

b) If you have 2.14 moles of oxygen, how many moles of ~~aluminum~~ iron do you need for a complete reaction?

coefficients

$$2.14\text{ mol } O_2 \left| \frac{4\text{ mol Fe}}{3\text{ mol } O_2} \right. = 2.85\text{ mol Fe}$$

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

$$4.29\times10^{23}\text{ atoms Fe} \left| \frac{1\text{ mol Fe}}{6.02\times10^{23}\text{ atoms Fe}} \right. \left| \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \right. = 0.356\text{ mol } Fe_2O_3$$

d) 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.

$$5.17\text{ mol Fe} \left| \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \right. = 2.59\text{ mol } Fe_2O_3$$

$$3.82\text{ mol } O_2 \left| \frac{2\text{ mol } Fe_2O_3}{3\text{ mol } O_2} \right. = 2.55\text{ mol } Fe_2O_3$$

Limiting Reactant = O_2

22. $\underline{2}\ Al + \underline{3}\ Ag_2S \rightarrow \underline{6}\ Ag + \underline{\quad}\ Al_2S_3$

a) Identify the molar ratios in the equation above

$Al : Ag = 2:6$ OR $1:3$ $\quad Ag : Ag_2S = 6:3$ OR $2:1$ $\quad Ag_2S : Al_2S_3 = 3:1$

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

$$3.76\text{ mol Al} \left| \frac{1\text{ mol } Al_2S_3}{2\text{ mol Al}} \right. = 1.88\text{ mol } Al_2S_3$$

c) What mass of aluminum is needed to produce 36.5 g Ag?

from P.T.

$$36.5\text{ g Ag} \left| \frac{1\text{ mol Ag}}{107.87\text{ g Ag}} \right. \left| \frac{2\text{ mol Al}}{6\text{ mol Ag}} \right. \left| \frac{26.98\text{ g Al}}{1\text{ mol Al}} \right. = 3.04\text{ g Al}$$

from P.T.

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

$Ag = 107.868 \times 2 = 215.736$

$S = 32.066 \times 1 = 32.066$

247.802

$$75.2\text{ g } Ag_2S \left| \frac{1\text{ mol } Ag_2S}{247.80\text{ g } Ag_2S} \right. \left| \frac{6\text{ mol Ag}}{3\text{ mol } Ag_2S} \right. \left| \frac{6.02\times10^{23}\text{ atoms Ag}}{1\text{ mol Ag}} \right. = 3.65\times10^{23}\text{ atoms Ag}$$

23. $\underline{2}\ N_2 + \underline{5}\ O_2 \rightarrow \underline{2}\ N_2O_5$

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

$$14.56\ L\ O_2 \left| \frac{1\ mol\ O_2}{22.4\ L\ O_2} \right| \frac{2\ mol\ N_2O_5}{5\ mol\ O_2} \left| \frac{6.02 \times 10^{23}\ molec.\ N_2O_5}{1\ mol\ N_2O_5} \right| = 1.57 \times 10^{23}\ molec.\ N_2O_5$$

b) What volume of nitrogen gas is needed to produce 101.4 g N_2O_5 at STP?

N = 14.007 × 2 = 28.014
O = 15.999 × 5 = 79.995
108.009

$$101.4\ g\ N_2O_5 \left| \frac{1\ mol\ N_2O_5}{108.01\ g\ N_2O_5} \right| \frac{2\ mol\ N_2}{2\ mol\ N_2O_5} \left| \frac{22.4\ L\ N_2}{1\ mol\ N_2} \right| = 21.0\ L\ N_2$$

c) If I start with 0.338 moles of oxygen, and produce 0.126 mol N_2O_5,

i. What is my actual yield?

0.126 mol N_2O_5

ii. What is my theoretical yield?

$$0.338\ mol\ O_2 \left| \frac{2\ mol\ N_2O_5}{5\ mol\ O_2} \right| = 0.135\ mol\ N_2O_5$$

iii. What is my percent yield?

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

24. $\underline{2}\ HCl + \underline{\quad}\ Mg(OH)_2 \rightarrow \underline{\quad}\ MgCl_2 + \underline{2}\ H_2O$

a) If I have 4.13 mol HCl and 2.76 mol $Mg(OH)_2$, how many moles of $MgCl_2$ can I make? Identify the limiting reagent.

$$4.13\ mol\ HCl \left| \frac{1\ mol\ MgCl_2}{2\ mol\ HCl} \right| = 2.07\ mol\ MgCl_2$$

$$2.76\ mol\ Mg(OH)_2 \left| \frac{1\ mol\ MgCl_2}{1\ mol\ Mg(OH)_2} \right| = 2.76\ mol\ MgCl_2$$

limiting reactant = HCl

b) I actually do the experiment (listed in part a) in the lab, and produce 1.87 mol $MgCl_2$. What is my percent yield?

theoretical yield

actual yield

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

$$= \frac{1.87\ mol\ MgCl_2}{2.07\ mol\ MgCl_2} \times 100 = 90.3\ \%$$