Ap Chem Summer Assignment #3

Shaurya Singh

September 6, 2021

1 The following reaction was performed, Identify element X.

$$
\begin{aligned}
&\mathrm{Fe_2O_3(s) + 2\,X(s) = 2\,Fe(s) + X_2O_3(s)} \\
&79.847g + 2x = 55.847g + 50.982g \\
&\Rightarrow\ 2x = 106.829g - 79.847g \\
&\Rightarrow\ 2x = 26.982g
\end{aligned}
$$

Since the atomic weight of Fe is proportional to the given weight ($55.847g$), the atomic weight of X is equally proportional to the derived weight ($26.982g$). **Therefore, the element is Aluminium (Al).**

2 Fill in the blanks to balance the following chemical equations:

a. $\mathrm{2\,AgI + Na_2S \rightarrow Ag_2S + 2\,NaI}$

b. $\mathrm{(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4\,H_2O}$

c. $\mathrm{Na_3PO_4 + 3\,HCl \rightarrow 3\,NaCl + H_3PO_4}$

d. $\mathrm{TiCl_4 + 2\,H_2O \rightarrow TiO_2 + 4\,HCl}$

e. $\mathrm{Ba_3N_2 + 6\,H_2O \rightarrow 3\,Ba(OH)_2 + 2\,NH_3}$

f. $\mathrm{3\,HNO_2 \rightarrow HNO_3 + 2\,NO + H_2O}$

3 Balance the following equation:

We can multiple NH_4OH by 4, and increase NH4 and H2O on the product side to compensate

Balanced equation:

$4\,NH_4OH\,(aq) + KAl(SO_4)_2 \cdot 12\,H_2O\,(s) = Al(OH)_3(s) + 2\,(NH_4)_2Cr_2O_7 + KOH\,(aq) + 12\,H_2O\,(l)$

4 Balance the following equation

We need to increase the number of acetate ions on the right side to match the ones on the left. We also need to increase the right hand side to match the number of hydrogen atoms on the left.

Balanced equation: $2\,Fe\,(s) + 6\,HC_2H_3O_2(aq) = 2\,Fe(C_2H_3O_2)_3(aq) + 3\,H_2(g)$

5 How many grams of water vapor can be generated from the combustion of 18.74 g of ethanol (C 2 H 6 O)?

Balanced reaction: $C_2H_6O\,(g) + 3\,O_2(g) \rightarrow C_2O_2(g) + 3\,H_2O\,(g)$

Given: ethanol (C_2H_6O) = 18.74 g

To be calculated : gms of water vapour (H2O) generated after combustion

Calculating how many mol of ethanol we have:

Molar mass of ethanol = 46.07 g/mol

Mass(g) of ethanol = 18.74g

Mol = Mass in grams(g) / molar mass (g/mol)

$$\begin{aligned} mol &= 18.74/46.07 \\ &= .4068 \end{aligned}$$

Multiply this by the ratio of H2O produced from the combustion of ethanol 3 H2O molecules were produced from 1 C2H6O molecule

$$\begin{aligned} \text{mol of H2O} &= \text{mol of C2H6O} * (\text{molecules produced of H2O}/\text{molecules of reactant of C2H6O}) \\ &= 0.4068mol \times (3/1) \\ &= 1.22mol \end{aligned}$$

Convert mol back to grams

Mass(g) / molar mass(g/mol) = # of mol

Mass(g) = # of mol * molar mass(g/mol)

$$\begin{aligned} \text{Mass of H2O(g)} &= 1.22mol * 18.015(g/mol) \\ &= 21.99g \end{aligned}$$

Therefore, we will get 21.99g of water vapor

6 How many grams of potassium iodide are necessary to completely react with 20.61g of Mercury (II) chloride

Balance the equation: $HgCl_2 + 2\,KI\,(aq) \rightarrow HgI_2(s) + 2\,KCl\,(aq)$

Find the molar mass of HgCl and 2KI (g/mol)

$HgCl_2 = 200.59 + 2(35.45)$

$= 271.49$

$2\,KI = 2(39.10 + 126.90)$

$= 332$

We calculate the ratio of KI to HgCl2

Ratio = 2KI/HgCl2

$= 332/271.49$

$= 1.22$

Multiply this by the amount of HgCl2 used to get the amount of Potassium Iodide needed

$20.61 \cdot 1.22 = 25.20g$

Therefore, 25.20g of Potassium Iodide is needed

7 A reaction combines 113.484 g of lead (II) nitrate with 45.010 g of sodium hydroxide (NaOH[aq]).

The equation for the reaction is $Pb(NO_3)_2 + 2\,NaOH \rightarrow Pb(OH)_2 + 2\,NaNO_3$

The molecules molar mass's are

$Pb(OH)_2 = 241.196amu$

$Pb(NO_3)_2 = 331.207amu$

$2\,NaOH = 79.94amu$

$2\,NaNO_3 = 169.99amu$

a. We know that 331.207 amu of lead nitrate can react with 79.94 amu of sodium hydroxide. Therefore, $113.484g$ of lead nitrate will react with $\frac{113.484*79.94}{331.207}g$, or $27.41g$ of sodium hydroxide

   Similarly, we know that 331.207 amu of lead nitrate can produce 241.196 amu of lead hydroxide. Therefore, $113.484g$ of lead nitrate will produce $\frac{113.484*241.196}{331.207}g$, or $82.643g$ of lead hydroxide

b. From the above we can see the limiting reactant is lead (II) nitrate and the excess reactant left over is sodium hydroxide.

c. There is $45.010 - 27.408 = 17.602$ grams of the excess reactant left over.

d. From the above we get an experimental yield of 80.02 percent. We know the limiting reactant gives us a theoretical yield of 82.463 percent. Therefore, the percent yield is $(\frac{80.02}{82.463} \times 100 = 97.04)$, or 97.04%

8 A reaction combines 64.81 grams of silver nitrate with 92.67 grams of potassium bromide

The equation for the reaction is already balanced: $AgNO_3 + KBr \rightarrow AgBr + KNO_3$

a. Calculate the atomic weight of the reactants and AgBr:

   $AgNO_3 = 169.872g$

   $\text{Kbr} = 119.002g$

   $\text{AgBr} = 187.772g$

   Now we can calculate how much AgBr each reactant made

   $AgNO_3$: $\frac{64.81 \times 187.772g}{169.872} = 71.64g$

   KBr: $\frac{92.67 \times 187.772g}{119.002} = 146.2g$

b. $AgNO_3$ is the limiting reactant since it produces the least amount of AgBr. Therefore the excessive reactant is Kbr since it produced the most amount of AgBr

c. To calculate how much excessive reactant is left over, we can use the theoretical yield and find the mass of the excessive reactant used:

   $\frac{71.64 \times 119.002g}{187.772} = 45.40$, or $45.40g$ of KBr

d. In order to find the percent yeild, divide the actual yield by the theoretical yield, then multiply by 100:

   $\frac{14.77g}{71.64g} \times 100 = 20.62$, or 20.62 percent.

9 The moleculer weight of an insecticide, dibromoethane, is 187.9. Its molecular formula is $C_2H_4Br_2$, What percent by mass of bromine does dibromoethane contain?

We must calculate the atomic weight for each element

$$\begin{aligned} \mathrm{C} &= 12.011 \\ \mathrm{H} &= 1.008 \\ \mathrm{Br} &= 79.90 \end{aligned}$$

Since the formula is $C_2H_4Br_2$, we can substitute the atomic weights in place of the elements

$$\begin{aligned} &= 2(\mathrm{C}) + 4(\mathrm{H}) + 2(\mathrm{Br}) \\ &= 2(12.011) + 4(1.008) + 2(79.90) \\ &= 24.022 + 4.032 + 159.8 \\ &= 187.9 \end{aligned}$$

Finally, we need to divide the amount of bromine by the total amount in order to find the percent by mass of bromine in $C_2H_4Br_2$

$$\begin{aligned} &= \frac{159.8}{187.9} \\ &= .8505 \end{aligned}$$

Therefore, dibromoethane contains 85.05% by mass of bromine.

10 A given sample of xenon fluoride contains molecules of a single type of XeFn, where n is some whole number.

First, we need to calculate how many moles of xenon fluoride there are, and calculate its weight

$$\begin{aligned} moles &= 9.03 * 10^{20} / 6.022 * 10^{23} \\ &= 1.5 * 10^{-}3 \\ &= 0.31g \end{aligned}$$

Now, we can calculate for n

$$
\begin{aligned}
&= 0.31/131 + 19n \\
&= 186.5 + 23.5n = 310 \\
n &= 4
\end{aligned}
$$

Therefore its formula is $\mathrm{XeF_4}$

11 A 6.32 g sample of potassium chlorate was decomposed according to the following equation, how many moles were formed?

We have the following values:

$$
\begin{aligned}
k &= 39.0983g \\
Cl &= 35.45g \\
O &= 16.00g
\end{aligned}
$$

From there we can calculate the total molar mass

$$39.0983 + 35.45 + 3 * 16 = 122.55g$$

Now, by performing dimensional analysis we get the following equation to convert grams of potassium chlorate to moles of oxygen

$$
\begin{aligned}
\text{mol} &= \frac{6.32g}{1} \times \frac{1mol}{122.548g} \times \frac{3}{2} \\
&= \frac{6.32g * 3}{(122.648 * 2)} \\
&= 7.74 * 10^{-2}
\end{aligned}
$$

Therefore, $7.74 * 10^{-2}$ **moles of** $\mathrm{O_2}$ **is formed**

12 What is the coefficient in front of water, when it is produced from the reaction of hydrochloric acid with calcium hydroxide? Calcium chloride is the other product.

The balanced equation is $Ca(OH)_2{}^+{}_2HCl = CaCl_2 + 2\,H_2O$

Therefore the coeffecient of water (H_2O is 2

13 What is the subscript of aluminum in the formula of aluminum phosphate?

Aluminum has a subscript of 1 in $AlPO_4$

14 The reaction of 11.9 g of CHCl 3 with excess chlorine produced 12.6 g of CCl 4 , carbon tetrachloride, what is the percent yield?

The equation for the reaction is $2\,CHCl_3 + 2\,Cl_2 = 2\,CCl_4 + 2\,HCl$

We need to calculate the theoretical yield of this reaction. To do that, we need to calculate the atomic weight of $CHCl_3$ and CCl_4.

$ChCl_3$: $119.378g$

CCL_4: $153.823g$

Now we can find the theoretical yield:

$$\begin{aligned}
&= \frac{11.9g}{1} \times \frac{1mol}{119.378g} \times \frac{2}{2} \times \frac{153.823g}{1} \\
&= \frac{11.9 * 2 * 153.823g}{(119.378 * 2)} \\
&= 15.3g
\end{aligned}$$

To find the percent yield, divide the experimental yield by the theoretical yield, then multiply by

100

$$\begin{aligned} &= \frac{12.6g}{15.3g} \times 100 \\ &= 82.4 \end{aligned}$$

Therefore the percent yield is 82.4%

15 What mass of CCl 4 is formed by the reaction of 8.00 g of methane with an excess of chlorine? Ch4 is the limiting reactant

The given equation is already balanced. The question is asking us to calculate the theoretical yield

We need to calculate the atomic weight of CCl_4 and CH_4

CCl_4: $153.823g$

CH_4: $16.043g$

Using dimensional analysis, we can calculate the theoretical yield

$$\begin{aligned} &= \frac{8.00g}{1} \times \frac{1}{16.043g} \times \frac{1}{1} \times \frac{153.823g}{1} \\ &= \frac{8 \times 153.823g}{16.043} \\ &= 76.7g \end{aligned}$$

Therefore, $76.72g$ **of** CCl_4 **is formed by the reaction.**

16 A reaction occurs between sodium carbonate and hydrochloric acid producing sodium chloride, carbon dioxide, and water. Write the balanced chemical equation for the reaction.

The equation will be sodium carbonate + hydrohloric acid = sodium chloride + carbon doxide + water. In correct notation this is written as:

$$Na_2CO_3 + HCl + NaCl + CO_2 + H_2O$$

Balanced, this equation is

$$Na_2CO_3 + 2\,HCl + 2\,NaCl + 2\,CO_2 + H_2O$$

17 Classify the type of reaction from the five major type of reactions you learned in your first year chemistry course and write word equations. If necessary, balance.

a. This equation is already balanced, and is a double replacement reaction since the two positive ions switched the negative ions they are bonded with.

b. $CH_4 + 2\,O_2 = CO_2 + 2\,H_2O$ is a combustion reaction. since CH_4 reacted with oxygen gas.

c. $Fe + 3\,NaBr = FaBr_2 + 3\,Na$ is a single replacement reaction since the negative ion in the reactants switches the positive ion its bonded with.

d. This equation is already balanced, and is a double replacement reaction since the two positive ions switched the negative ions they are bonded with. The equation was already balanced out

e. This equation is already balanced, and is a double replacement reaction since the two positive ions switched the negative ions they are bonded with. The equation was already balanced out

f. This equation is already balanced, and is a synthesis reaction since the two reactants combined to form one product.

g. This equation is already balanced, and is a decomposition reaction since a compound (in this case the reactant) breaks down

18 Now try these recation types, Rewrite as a balanced equation with the products predicted

a. $Ba(OH)_2 \rightarrow BaO + H_2O$

b. $Na_2CO_3 \rightarrow Na_2O + CO_2$

c. $2\,LiClO_3 \rightarrow 2\,LiCl + 3\,O_2$

d. $2\,Al_2O_3 \rightarrow 4\,Al_2 + 3\,O_2$

e. $H_2SO_4 \rightarrow H_2O + SO_3$

19 Now try these recation types, Rewrite as a balanced equation with the products predicted

a. $2\,Mg + O_2 \rightarrow 2\,MgO$

b. $N_2 + 3\,H_2 \rightarrow 2\,NH_3$

c. $S + O_2 \rightarrow SO_2$

d. $CaO + H_2O \rightarrow Ca(OH)_2$

20 Attempt to write and predict products the following chemical reactions:

a. $2\,H_2O_2 \rightarrow 2\,H_2O + O_2$

b. $Ba(OH)_2 + CuSO_4 \rightarrow Cu(OH)_2 + BaSO_4$

c. $Al + 3\,AgNO_3 \rightarrow Al(NO_3)_3 + \ + 3\,Ag$

d. $Cl_2 + 2\,NaBr \rightarrow Br_2 + 2\,NaCl$

e. $2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$

21 Using the solubility rules table, classify each of the substances as being soluble or insoluble in water. Then, Identify the two new compounds that form if the solutions, as suggested by the following table, were mixed via a double displacement reaction.

21.1 Part A

a. KBr = Soluble

   Based on the soluble salt rules, bromine anions are soluble when bonded with a cation that isn't Pb, Ag, or $Hg_2{}^+$. This means that Kbr is soluble.

b. $PbCO_3$ = Insoluble

   Since Pb isn't from group 1 and there aren't any rules for CO_3, $PBCO_3$ is insoluble.

c. $BaSO_4$ = Insoluble

   Based on the soluble salt rules, when SO_4 is bonded with Ba, it makes it insoluble

d. zinc hydroxide = Insoluble

   $Zn(OH)_2$ is amphateric but it isn't a strong acid or a strong base, so its insoluble

e. sodium acetate = Soluble

   $NaCH_3COO$ is soluble since the cation is from the first group of the periodic table and the anion is the polyatomic ion acetate, both of whitch are always soluble in a compound

f. silver iodide = Insoluble

   AgI is insoluble since the rules of soluble salts state that when the anion I is in a compound with Ag, then it is insoluble

g. cadmium (II) sulfide = Insoluble

   CdS is insoluble since there is no rule written about sulfur anions nor cadmium. Cadmium also isn't a group 1 element, making the compound insoluble

h. zinc carbonate = Insoluble

$ZNCO_3$ is insoluble since there is no rule written about carbonate polyatomic anions. Zinc also isn't a group 1 element

i. silver acetate = Soluble

   $AgC_2H_3O_2$ is soluble since the compound countains an acetate polyatomic anion. The soluble salt rule states that any compound with acetate should be soluble

j. copper (II) sulfide = Insoluble

   CuS is insoluble since neither or copper nor sulfur is included in the soluble salt rules. Copper also isn't a group 1 element, so the compound is insoluble

k. $Mg_3(PO_4)_2$ = Insoluble

   Phosphate is not mentioned in the soluble salt rules, and magnesium isn't a group one element, so this compound is insoluble

l. KOH = Soluble

   It is in the list of the 8 strong bases

m. $NiCl_2$ = Soluble

   The soluble salt rule states that when a compound contains chlorine as anion, as long as the cation it is bonded to isn't Pb, Ag, or ${Hg_2}^{2+}$ it will be a soluble compound.

n. NH_4OH = Soluble

   NH_4OH contains NH_4, and based on the soluble salt rules, the compound containing it is soluble.

o. Hg_2SO_4 = Insoluble

   The soluble salt rules state when sulfate is bonded with Hg_2 in a compound, it renders it insoluble

p. PbI_2 = Insoluble

   The soluble salt rule states that when the anion iodine is bonded to the cation lead, it will be insoluble

21.2 Part B

Underlined compounds are precipitates of the reaction

$\underline{AgBr(s)}$, $KNO_3(aq)$	$\underline{Ag_2CO_3(s)}$, $NaNO_3(aq)$	$\underline{Ag_2S(s)}$, $Ca(NO_3)_2(aq)$	$\underline{AgOH(s)}$, $NH_4NO_3(aq)$
$BaBr_2(aq)$, $KCl(aq)$	$NaCl(aq)$, $\underline{BaCO_3(s)}$	$CaCl(aq)$, $BaS(aq)$	$Ba(OH)_2(aq)$, $NH_4Cl(aq)$
$AlBr_3(aq)$, $KNO_3(aq)$	$\underline{Al_2(CO_3)_3(s)}$, $NaNO_3(aq)$	$AlBr_3(aq)$, $\underline{Al_2S_3(s)}$	$\underline{Al(OH)_3(aq)}$, $NH_4NO_3(aq)$
$K_2SO_4(aq)$, $CuBr_2(aq)$	$\underline{CuCO_3(s)}$, $NaSO_4(aq)$	$K_2SO_4(aq)$, $\underline{CuS(s)}$	$NH_4(SO_4)_2(aq)$, $\underline{Cu(OH)_2(s)}$

22 Name the following, then draw the Lewis Structure for the following hydrocarbons from their full names.

a. CH_4 - methane

Since the compound contains one carbon atom (meth) and there are sigma bonds (ane), the name of this compound is methane. From the diagram we can see the molecular formula is CH_4

b. C_3H_8 - propane

Since the compound has three carbon atoms (prop) and there are sigma bonds (ane), the name of the compound is propane. With the help of the diagram, we can see the molecular formula is C_3H_8

c. C_4H_8 - 1-butene

Since the compound contains four carbon atoms (but) and central double bond (ene), the name of the compound is 1-butene. With the help of the lewis diagram the molecular formula is C_4H_8

d. C_4H_8 - 2-butene

Since the compound contains four carbon atoms (but) and a central double bond (ene), the name of this compound is 2-butene. The arrangement is different than 1-butene, hence the $2-$ at the start of the name

22.1 Draw Lewis Structures for the following

a. Ethane C_2H

Based on the name, there are two carbon atoms and sigma bonds are present. The lewis diagram would be

b. Methane CH_4

Based on the name, there should be one carbon atom and sigma bonds are present. The lewis diagram would be

c. Propyne C_3H_4

Based on the name, there shold be three carbon atoms and a triple bond. The lewis diagram woudl be

d. 2 Butene 2 C_4H_8

Based on the name, there shuold be four carbon atoms and a double bond. The 2 in front signifies this is an isomer of butene. It's lewis diagram would be