Problem Set #2

CHEM101A: General College Chemistry

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1 Topic A Problem 12

What mass of Fe_2O_3 would react with 20.00 g of Zn? The chemical equation for this reaction is:

$$3\,Zn + Fe_2O_3 \longrightarrow 2\,Fe + 3\,ZnO \tag{1}$$

1.1 Solution

The simple stoichiometry is the way to go here.

$$20.00\text{g} \times \frac{1\,\text{mol}\,Zn}{65.38\text{g}} \times \frac{1\,Fe_2O_3}{3\,Zn} \times \frac{159.7\,\text{g}\,Fe_2O_3}{1\,\text{mol}\,Fe_2O_3} = \boxed{16.28\,\text{g}\,Fe_2O_3} \tag{2}$$

2 Topic A Problem 13

x moles of C_4H_{10} reacts with oxygen according to the following equation:

$$2\,C_4H_{10} + 13\,O_2 \longrightarrow 8\,CO_2 + 10\,H_2O \tag{3}$$

a) How many moles of water are formed?
b) How many moles of oxygen are consumed?

2.1 Solution (a)

2.2 Solution (b)

3 Topic A Problem 14

10.00 g of N_2 is mixed with 33.61 g of F_2, and the elements react according to the following equation:

$$N_2 + 3\,F_2 \longrightarrow 2\,NF_3 \tag{4}$$

a) Which element is the limiting reactant?
b) What is the theoretical yield of NF_3?
c) If the reaction goes to completion, how many grams of the excess reactant will remain?
d) Set up an ICE table for this reaction.

3.1 Solution

4 Topic A Problem 15

a) If 58.26 g of iodine reacts with excess aluminum, what is the theoretical yield of aluminum iodide? The reaction is $2\,\mathrm{Al} + 3\,\mathrm{I_2} \longrightarrow 2\,\mathrm{AlI_3}$.
b) If 56.11 g of aluminum iodide is actually formed in the reaction in part a, what is the percent yield of aluminum iodide?

4.1 Solution

5 Topic A Problem 16

A chemist mixes 16.00 g of HCl with 10.00 g of Mg and obtains an 81.3% yield of $MgCl_2$. What mass of $MgCl_2$ did the chemist obtain? The chemical reaction is:

$$Mg + 2\,HCl \longrightarrow MgCl_2 + H_2 \tag{5}$$

5.1 Solution

6 Topic A Problem 17

How many milliliters of liquid Br_2 (density = 3.1 g/mL) will react with 6.143 g of Cr, if the product of this reaction is $CrBr_3$?

6.1 Solution

7 Topic A Problem 18

Ethane (C_2H_6) reacts with oxygen according to the following chemical equation:

$$2\,C_2H_6 + 7\,O_2 \longrightarrow 4\,CO_2 + 6\,H_2O \tag{6}$$

a) If you mix 5 moles of C_2H_6 with 13 moles of O_2, how many moles of each substance will you end up with, assuming the reaction goes to completion? Include an ICE table in your answer.
b) If you mix 81.43 g of C_2H_6 with 194.60 g of O_2, how many grams of each substance will you end up with, assuming the reaction goes to completion? Include an ICE table in your answer. (Note: your ICE table should be in terms of moles.)
c) A chemist mixes 3.414 moles of O_2 with an unknown number of moles of C_2H_6. The chemist obtains 1.657 moles of O_2. How many moles of C_2H_6 must have been present originally, assuming the reaction went to completion? Include an ICE table in your answer.

7.1 Solution

8 Topic A Problem 19

Ammonia reacts with oxygen according to the following chemical equation:

$$4\,NH_3 + 3\,O_2 \longrightarrow 2\,N_2 + 6\,H_2O \tag{7}$$

Suppose you mix x moles of NH_3 with y moles of O_2.
a) If NH_3 is the limiting reactant, how many moles of each substance will you end up with, assuming the reaction goes to completion? Include an ICE table in your answer.
b) If O_2 is the limiting reactant, how many moles of each substance will you end up with, assuming the reaction goes to completion? Include an ICE table in your answer.
c) If you end up with 0.4y moles of O_2, what must the relationship be between x and y, assuming the reaction goes to completion?

8.1 Solution

9 Topic A Problem 20

You have x grams of $Na_2Cr_2O_7$. How many grams of CrCl3 will be formed if the $Na_2Cr_2O_7$ undergoes the reaction below? Express your answer in terms of x.

$$Na_2Cr_2O_7 + 3\,Zn + 14\,HCl \longrightarrow 2\,CrCl_3 + 3\,ZnCl_2 + 2\,NaCl + 7\,H_2O \qquad (8)$$

9.1 Solution

10 Topic A Problem 21

A metal sample weighing 1.410 g contains a mixture of copper and aluminum. When excess HCl is added to this sample, the aluminum reacts as follows:

$$2\,\mathrm{Al} + 6\,\mathrm{HCl} \longrightarrow 2\,\mathrm{AlCl_3} + 3\,\mathrm{H_2} \tag{9}$$

849 mL of H_2 (density 0.08264 g/L) is produced. Calculate the mass percentage of each element in the original sample. Note that copper does not react with HCl.

10.1 Solution

11 Topic A Problem 22

A chemist has a mixture of $AgNO_3$ and KNO_3 that weighs a total of 4.177 g. The chemist dissolves the mixture in water and then adds a solution of NaOH. The AgNO3 reacts with the NaOH as follows:

$$2\,AgNO_3(aq) + 2\,NaOH\,(aq) \longrightarrow Ag_2O\,(s) + 2\,NaNO_3(aq) + H_2O\,(l) \qquad (10)$$

The chemist finds that 1.080 grams of Ag_2O were formed. Calculate the mass percentages of $AgNO_3$ and KNO_3 in the original mixture. (Note that KNO_3 does not react with NaOH.)

11.1 Solution

12 Topic A Problem 23

A 25.000 g sample of sulfur is burned. Some of the sulfur reacts to form SO_2:

$$S + O_2 \longrightarrow SO_2 \tag{11}$$

The rest of the sulfur reacts to form SO_3:

$$2\,S + 3\,O_2 \longrightarrow 2\,SO_3 \tag{12}$$

The total mass of products (SO_2 and SO_3) is 58.723 g. Calculate the masses of SO_2 and SO_3 in this mixture.

12.1 Solution

13 Topic B Problem 1

Answer each of the following questions about making solutions.
a) If you dissolve 4.18 g of solid $Mg(NO_3)_2$ in enough water to make 150 mL of solution, what will be the molarity of the resulting solution?
b) If you need to make 100 mL of 1.08 M $CaCl_2$, what mass of solid CaCl2 will you need?
c) You have 25.0 g of solid KCl, and you use all of it to make a 0.500 M KCl solution. What volume of solution did you make?

13.1 Solution

14 Topic B Problem 2

Answer the following questions about dilutions.
a) If you add 100 mL of water to 10 mL of 0.605 M HCl, what will be the molarity of the resulting solution?
b) You have 200 mL of 1.50 M HNO_3. If you wish to dilute this solution to a final concentration of 0.300 M, what volume of water should you add?
c) You need to make 1.50 liters of 0.400 M NaOH by diluting a 2.00 M NaOH solution. What volume of the 2.00 M NaOH should you use, and what volume of water should you add to it?

14.1 Solution

15 Topic B Problem 3

All of the compounds below dissolve in water. Which of them are strong electrolytes, which are weak electrolytes, and which are nonelectrolytes?

a) $NaCl$
b) $Mg(NO_3)_2$
c) $HClO_2$
d) $MgCrO_4$
e) H_3PO_4
f) AgF
g) C_2H_5OH
h) $HC_3H_5O_3$
i) CH_3CN
j) H_2SO_4
k) NH_4Br
l) $(CH_3)_2CO$

15.1 Solution

16 Topic B Problem 4

What ions (if any) are present in each of the following solutions, and what is the molar concentration of each ion?

a) 0.1 M NaBr

b) 0.04 M KNO_3

c) 0.2 M $FeCl_3$

d) 1.5 M $(NH_4)_2SO_4$

16.1 Solution

17 Topic B Problem 5

How many moles of each ion are present in 175 mL of 0.147 M $Fe_2(SO_4)_3$?

17.1 Solution

18 Topic B Problem 6

Which of the following are acceptable ways to make one liter of 1 M NaCl?
a) Put 1 liter of water into a container, then add 1 mole of NaCl and stir until the NaCl dissolves.
b) Put 1 mole of NaCl into a container, then add 1 liter of water and stir until the NaCl dissolves. c) Put 1 mole of NaCl into a container, then add water with stirring until the total volume reaches 1 liter.

18.1 Solution

19 Topic B Problem 7

Janet dissolves 6.50 g of solid potassium phosphate in enough water to make 100.0 mL of solution. Farid then adds enough water to the solution to reduce the concentration of potassium ions to 0.250 M. How much water did Farid add?

19.1 Solution

20 Topic B Problem 8

Gerardo dissolves 8.213 g of solid $Mg(NO_3)_2$ in enough water to make 200.0 mL of solution. Marciela then adds enough solid $Al(NO_3)_3$ to increase the concentration of nitrate ions to 0.900 M. Assuming that the solution volume does not change significantly, what mass of $Al(NO_3)_3$ did Marciela add?

20.1 Solution

21 Topic B Problem 9

Chantelle dissolves 2.35 g of NaCl, 3.12 g of $CaCl_2$, and 1.88 g of $FeCl_3$ in enough water to make 175 mL of solution. What is the molarity of chloride ions in this solution?

21.1 Solution

22 Topic B Problem 10

Wenzhou prepares 200 mL of a solution of $SnCl_4$ in which the concentration of chloride ions is 0.240 M.
a) What is the molarity of the $SnCl_4$ solution (i.e. what should the bottle be labeled)?
b) What mass of $SnCl_4$ did Wenzhou use?

22.1 Solution

23 Topic B Problem 11

A beaker holds x liters of 0.2 M $AlBr_3$. Give answers to each part below in terms of x.
a) How many moles of aluminum ions are in this solution?
b) How many moles of bromide ions are in this solution?
c) How much water must you add if want to dilute the original solution to a concentration of 0.02 M?

23.1 Solution

24 Topic B Problem 12

Using the solubility rules, determine which of the following compounds are insoluble in water. There is a solubility rules handout available in Canvas.

a) $K_2Cr_2O_7$

b) $Mn(NO_3)_2$

c) FeS

d) $ZnBr_2$

e) $MgSO_4$

f) $NaHCO_3$

g) $Ba_3(PO_4)_2$

24.1 Solution

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