SCH3U Solution Review Questions

1. Calculate the number of mL of 2.00 M HNO_3 solution required to react with 216 grams of Ag according to the equation.

   $\_Ag(s) + \_HNO_3(aq) \text{ ---------> } \_AgNO_3(aq) + \_NO(g) + \_H_2O(l)$

2. Barium nitrate and potassium sulphate solutions react and form a precipitate. What is the precipitate? How many mL of 0.40 M $Ba(NO_3)_2$ solution are required to precipitate completely the sulphate ions in 25 mL of 0.80 M K_2SO_4 solution?

3. By the additions of water, 75.0 mL of 6.0 M H_2SO_4 is diluted to 150.0 mL. What is the concentration of H_2SO_4 after dilution?

4. What volume of 6.00 mol/L nitric acid, $HNO_3(aq)$, solution is needed to make 4.2 L of 0.15 mol/L HNO_3 solution?

5. Write ionic and net ionic equations for these reactions.

   (a) $(NH_4)_2CO_{3(aq)} + MgCl_{2(aq)} \text{ ----> } 2\ NH_4Cl_{(aq)} + MgCO_{3(s)}$

   (b) (b) $2\ AgC_2H_3O_{2(aq)} + NiCl_{2(aq)} \text{ ----> } 2\ AgCl_{(s)} + Ni(C_2H_3O_2)_{2(aq)}$

6. Trisodium phosphate (TSP), Na_3PO_4, is a useful cleaning agent, but it must be handled with care because its solutions are quite caustic. If a solution of Na_3PO_4 is added to one containing a calcium salt such as $CaCl_2$, a precipitate of calcium phosphate is formed. Write the balanced equation, then the total ionic and net ionic equations for this reaction.

7. How can we prepare 250 mL of 0.200 M $NaHCO_3$?

8. How can 500 mL of 0.150 M Na_2CO_3 solution be prepared?

9. What volume of 0.556 M HCl has enough hydrochloric acid to combine exactly with 24.5 mL of aqueous sodium hydroxide with a concentration of 0.458 M?

10. How many millilitres of 0.114 M H_2SO_4 solution provide the sulphuric acid required to react with the sodium hydroxide 32.2 mL of 0.122 M NaOH?

11. What volume of 0.337 M KOH provides enough solute to combine with the sulphuric acid in 18.6 mL of 0.156 M H_2SO_4?

12. How can we prepare 10.0 L of 0.040 M $K_2Cr_2O_7$ from 0.200 M $K_2Cr_2O_7$? $C_1V_1 = C_2V_2$

13. How many millilitres of water would have to be added to 100 mL of 0.40 M HCl to give a solution with a concentration of 0.10 M? $C_1V_1 = C_2V_2$

14. In a titration involving phosphoric acid, H_3PO_4, solution having a molarity of 0.345 M and a volume of 20.00 mL is titrated against a sample of $Ca(OH)_2$. If the reaction requires 22.25 mL of base to reach the final endpoint, what is the molarity of the calcium hydroxide?

15. What is the pH of a 0.0010 M HCl solution? $pH = -\log(0.001) = 3$

    $HCl \rightarrow H^+ + Cl^-$

16. What hydrogen ion concentration corresponds to a pH of 8.64? $10^{-pH} = 10^{-8.64} = 2.29 \times 10^{-9}$

17. Explain the meaning of the terms "strong" and "weak" when applied to acids and bases.

    ↳ ionizes a little (< 50%)

    ↳ ionizes a lot (> 99%)

18. For the following reactions identify the conjugate acid-base pairs

    C.A. = conjugate acid

    C.B = conjugate base

    $CO_3^{2-} + HF \leftrightarrow HCO_3^- + F^-$

    BASE ACID C.acid conjugate base

    $N_2H_5^+ + SO_4^{2-} \leftrightarrow N_2H_4 + HSO_4^-$

    ACID BASE C.B C.A.

    $NH_4^+ + H_2O \leftrightarrow NH_3 + H_3O^+$

    ACID BASE C.B. C.A.

19. Give directions for preparing 2.0 L of 0.250 mol/L HCl using 11.7 M HCl.

    $C_1V_1 = C_2V_2$

    $11.7(V_1) = 0.25(2)$

    $V_1 = 0.0427\ L = 42.7\ mL$

    Measure 42.7 mL of 11.7 mol/L HCl and add water to make 2 L.

Solution Review Questions Answers

3. $C_1V_1 = C_2V_2$

$6(75) = C_2(150)$

$C_2 = 3 \text{ mol/L}$

4. $C_1V_1 = C_2V_2$

$6(V_1) = 0.15(4.2)$

$V_1 = 0.105 \text{ L}$

$= 105 \text{ mL}$

5. a) $(NH_4)_2CO_{3(aq)} + MgCl_{2(aq)} \rightarrow 2NH_4Cl_{(aq)} + MgCO_{3(s)}$

$2NH_4^+_{(aq)} + CO_3^{-2}_{(aq)} + Mg^{+2}_{(aq)} + 2Cl^-_{(aq)} \rightarrow 2NH_4^+_{(aq)} + 2Cl^-_{(aq)} + MgCO_{3(s)}$

$CO_3^{-2}_{(aq)} + Mg^{+2}_{(aq)} \rightarrow MgCO_{3(s)}$

b) $2AgC_2H_3O_{2(aq)} + NiCl_{2(aq)} \rightarrow 2AgCl_{(s)} + Ni(C_2H_3O_2)_{2(aq)}$

$2Ag^+_{(aq)} + 2C_2H_3O_2^-_{(aq)} + Ni^{+2}_{(aq)} + 2Cl^-_{(aq)} \rightarrow 2AgCl_{(s)} + Ni^{+2}_{(aq)} + 2C_2H_3O_2^-_{(aq)}$

$2Ag^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow 2AgCl_{(s)}$

6. $2Na_3PO_{4(aq)} + 3CaCl_{2(aq)} \rightarrow 6NaCl_{(aq)} + Ca_3(PO_4)_{2(s)}$

$6Na^+_{(aq)} + 2PO_4^{-3}_{(aq)} + 3Ca^{+2}_{(aq)} + 6Cl^-_{(aq)} \rightarrow 6Na^+_{(aq)} + 6Cl^-_{(aq)} + Ca_3(PO_4)_{2(s)}$

$2PO_4^{-3}_{(aq)} + 3Ca^{+2}_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)}$

7. $n = C \times V$

$= 0.2 \times 0.250$

$= 0.05 \text{ mol}$

$m = n \times M$

$= 0.05 \times 84.008$

$= 4.2 \text{ g}$

Na	22.99
H	1.008
C	12.01
O_3	48.00
	84.008

8. $n = C \times V$
$= 0.15 \times 0.5$
$= 0.075\ mol$

$m = n \times M$
$= 0.075 \times 105.99$
$= 7.95g$

$Na_2 = 45.98$
$C = 12.01$
$O_3 = 48.00$
105.99

9. $HCl + NaOH \rightarrow H_2O + NaCl$

$V = ?$ $V = 0.0245L$
$C = 0.556$ $C = 0.458\ mol/L$
$n = 0.011221$ $n = C \times V$
$V = \frac{n}{C} = 0.0202L$ $= 0.011221$

$\div 1 \times 1$

10. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$V = ?$ $V = 32.2mL$
$C = 0.114$ $= 0.0322L$
$V = \frac{n}{C} = 0.01723L$ $C = 0.122$
$n = 1.9642 \times 10^{-3}$ $n = C \times V$
$= 3.9284 \times 10^{-3}$

$\div 2 \times 1$

11. $2KOH + H_2SO_4 \rightarrow 2H_2O + K_2SO_4$

$C = 0.337$ $V = 18.6mL$
$V = ?$ $= 0.0186L$
$n = 5.8 \times 10^{-3}$ $C = 0.156$
$V = \frac{n}{C}$ $n = C \times V$
$= \frac{5.8 \times 10^{-3}}{0.337}$ $= 0.0186 \times 0.156$
$= 0.0172L$ $= 2.9 \times 10^{-3}$

$\div 1 \times 2$

12. $C_1V_1 = C_2V_2$

$(0.2)(V_1) = 0.04(10)$

$V_1 = 2\ L$

Take 2 L of 0.2 $K_2Cr_2O_7$ and add distilled H_2O until 10 L is attained.

13. $C_1V_1 = C_2V_2$

$0.4(100mL) = 0.1(V_2)$

$V_2 = 4000\ mL$

$4000 - 100 = 3900\ mL$ to add

14. $2H_3PO_4 + 3Ca(OH)_2 \rightarrow 3H_2O + Ca_3(PO_4)_2$

$V = 20\ mL = 0.02\ L$

$C = 0.345$

$n = C \times V$

$= 0.02 \times 0.345$

$= 6.9 \times 10^{-3}\ mol$

$V = 22.25\ mL = 0.02225\ L$

$C = \frac{n}{V} = \frac{0.01035}{0.02225}$

$= 0.465\ mol/L$

$n = 0.01035\ mol$

$\div 2 \times 3$

15.

-also Solution Review Question Answers *1 + 2.

Molarity and Dilutions Worksheet - EXTRA PRACTICE

1. Calculate the final concentration of a solution that is made by dissolving 14.8 g of solid sodium hydroxide in 600.0 mL of solution.

C = n/V, we need to find n to do this calculation.
n = m/MM → n = 14.8 /40.0 = 0.370 mol
C = 0.370 mol/ 0.600 L = 0.617 M

2. If I add water to 100 mL of a 0.15 M NaOH solution until the final volume is 150 mL, what will the molarity of the diluted solution be?

$C_1V_1 = C_2V_2$
$M_1V_1 = M_2V_2$
(0.15 M)(100 mL) = x (150 mL)
x = 0.100 M

3. If I add 25 mL of water to 125 mL of a 0.15 M NaOH solution, what will the molarity of the diluted solution be?

$C_1V_1 = C_2V_2$
$M_1V_1 = M_2V_2$
(0.15 M)(125 mL) = x (150 mL)
x = 0.125 M

4. I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?

$C_1V_1 = C_2V_2$
$M_1V_1 = M_2V_2$
(1.5 M)(345 mL) = x (250 mL)
x = 2.07 M

5. How much water would I need to add to 500 mL of a 2.4 M KCl solution to make a 1.0 M solution?

$C_1V_1 = C_2V_2$
$M_1V_1 = M_2V_2$
(2.4 M)(500 mL) = (1.0 M) x
x = 1200 mL

1200 mL will be the final volume of the solution. However, since there's already 500 mL of solution present, you only need to add 700 mL of water to get 1200 mL as your final volume. The answer: 700 mL.

*1. 6. Calculate the number of mL of 2.00 M HNO_3 solution required to react with 216 grams of Ag according to the equation:

$3\ Ag(s) + 4\ HNO_3(aq) \rightarrow 3\ AgNO_3(aq) + NO(g) + 2\ H_2O(l)$ **1.34×10^3 ml HNO_3**

7. Calculate in mL the volume of 0.500 M NaOH required to react with 3.0 grams of acetic acid. The equation is: $NaOH(aq) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l)$ **0.0999L or 100ml NaOH**

8. Calculate the number of grams of AgCl formed when 0.200 L of 0.200 M $AgNO_3$ reacts with an excess of $CaCl_2$. The equation is:

$2\ AgNO_3(aq) + CaCl_2(aq) \rightarrow 2\ AgCl(s) + Ca(NO_3)_2(aq)$ **5.73 g AgCl**

9. Calculate the mass of AgCl formed when an excess of 0.100 M solution of NaCl is added to 0.100 L of 0.200 M $AgNO_3$. **2.87 g AgCl**

10. Calculate: a) the mass of $BaSO_4$ formed when excess 0.200 M Na_2SO_4 solution is added to 0.500 L of 0.500 M $BaCl_2$ solution, and **58.3 g $BaSO_4$**

b) the minimum volume of the Na_2SO_4 solution needed to precipitate the Ba^{2+} ions from the $BaCl_2$ solution. **1.25 L Na_2SO_4**

11. A sample of impure sodium chloride weighing 1.00 grams is dissolved in water and completely reacted with silver nitrate solution. The dried precipitate of AgCl has a mass of 1.48 grams . Calculate the percentage of NaCl in the original impure sample.

(0.603 g pure NaCl/1.00 g impure NaCl) x 100% = 60%

12. To neutralize the acid in 10.0 mL of 18.0 M H_2SO_4 that was accidentally spilled on a laboratory bench top, solid sodium bicarbonate was used. The container of sodium bicarbonate was known to weigh 155.0 g before this use and out of curiosity its mass was measured as 144.5 g afterwards. The reaction that neutralizes sulphuric acid this way is as follows: $H_2SO_4 + 2\ NaHCO_3 \rightarrow Na_2SO_4 + 2\ CO_2 + 2\ H_2O$

Was sufficient sodium bicarbonate used? Calculate the limiting reactant and the maximum yield in grams of sodium sulphate.

Sufficient $NaHCO_3$ was used because all the H_2SO_4 was used up in this reaction. H_2SO_4 is the limiting reagent (L.R.) and 0.18 mol was used up. The maximum yield of $NaSO_4$ is 25.6 g.

*2. **13.** Barium nitrate and potassium sulphate solutions react and form a precipitate. What is the precipitate? How many mL of 0.40 M $Ba(NO_3)_2$ solution are required to precipitate completely the sulphate ions in 25 mL of 0.80 M K_2SO_4 solution?

$Ba(NO_3)_2 + K_2SO_4 \rightarrow BaSO_4 = 2KNO_3$ **50 ml $Ba(NO_3)_2$**

14. What mass of silver chloride can be precipitated from a silver nitrate solution by 200 mL of a solution of 0.50 M $CaCl_2$?

$2\ AgNO_3 = CaCl_2 \rightarrow 2AgCl = Ca(NO_3)_2$ **28.7 g AgCl**

SCH3U Solution Stoichiometry Name:

Stoichiometry Involving Solutions Worksheet

*1.

1. Calculate the number of mL of 2.00 M HNO_3 solution required to react with 216 grams of Ag according to the equation.**[1.33L]**

$3\ Ag_{(s)} + 4\ HNO_{3(aq)} \text{ ---------> } 3\ AgNO_{3(aq)} + NO_{(g)} + 2\ H_2O_{(l)}$

Mass of Ag= 216_g C=2.00M V=?
Molar Mass= 107.18g/mol
n=m/MM
n=2.002 mols
Mass of HNO_3= 2.002 mols of Ag x $\frac{4 \text{ mol } HNO_3}{3 \text{ mol Ag}}$ = 2.66 mols
V= n/c V=2.66mol/2.00M
V= 1.33x1000 V=1330 mL

2. Calculate in mL the volume of 0.500 M NaOH required to react with 3.0 grams of acetic acid. **[0.10L]**
The equation is:

$NaOH_{(aq)} + HC_2H_3O_{2(aq)} \text{ -------> } NaC_2H_3O_{2(aq)} + H_2O_{(l)}$

Mass of $HC_2H_3O_2$ = 3.0g C=0.500M
Molar Mass=48.00 g/mol V=?
n= m/ MM
n= 0.049 mols
moles of NaOH= 0.049 mols of $HC_2H_3O_2$ x 1 mol NaOH/ 1 mol $HC_2H_3O_2$ = 0.049 mols
V= n/c
V=0.049mol/0.500M= 0.10L

3. Calculate the number of grams of AgCl formed when 0.200 L of 0.200 M $AgNO_3$ reacts with an excess of $CaCl_2$. The equation is: **[5.73g]**

$2\ AgNO_{3(aq)} + CaCl_{2(aq)} \text{ -------> } 2\ AgCl_{(s)} + Ca(NO_3)_{2(aq)}$

V=0.200 L
C= 0.200M
n=0.200 Lx0.200 M= 0.04 mols
Mass of AgCl= 0.04 mols of $AgNO_3$ x 2 mol AgCl/ 2 mol $AgNO_3$ = 0.04 mol
m= MM x n = 0.04 mol x (107.87 + 35.45)g/mol = 5.73g

4. Calculate the mass of AgCl formed when an excess of 0.100 M solution of NaCl is added to 0.100 L of 0.200 M $AgNO_3$.**[2.87g]**

$NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

V=0.100L
C=0.200M
n=C xV
n = 0.200Mx0.100L= 0.02 mols
moles of AgCl = 0.02 mols of $AgNO_3$ x 1 mol AgCl/ 1 mol$AgNO_3$ = 0.02 mols x 143.32g/1 mol AgCl = 2.87g
mass of AgCl= 0.02 mols x 143.32g/1 mol AgCl = 2.87g

5. Calculate:

a) the mass of $BaSO_4$ formed when excess 0.200 M Na_2SO_4 solution is added to 0.500 L of 0.500 M $BaCl_2$ solution, and **[58.3 g]**

$Na_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

V=0.500L

C= 0.500M

n= 0.500Mx0.500L = 0.25 mol

moles of $BaSO_4$ = 0.25 mol of $BaCl_2$ x 1mol $BaSO_4$ / 1 mol $BaCl_2$ = 0.25mol

Mass= 0.25 mol x 233. 27g/mol= 58.3 g

b) the minimum volume of the Na_2SO_4 solution needed to precipitate the Ba^{2+} ions from the $BaCl_2$ solution. **[1.25L]**

n=0.250 mol

C= 0.200M

V=n/c

V=0.250mol/0.200M = 1.25L

6. To neutralize the acid in 10.0 mL of 18.0 M H_2SO_4 that was accidentally spilled on a laboratory bench top, solid sodium bicarbonate was used. The container of sodium bicarbonate was known to weigh 155.0 g before this use and out of curiosity its mass was measured as 144.5 g afterwards. The reaction that neutralizes sulphuric acid this way is as follows.

$H_2SO_{4(aq)} + 2\ NaHCO_{3(s)} \text{--------} > Na_2SO_{4(aq)} + 2\ CO_{2(g)} + 2\ H_2O_{(l)}$

Was sufficient sodium bicarbonate used? Calculate the limiting reactant and the maximum yield in grams of sodium sulphate. **[$NaHCO_3$- LF, m= 8.85g]**

H_2SO_4 [n=0.01L x18M **= 0.18 mol**], $NaHCO_3$ [155.0-144.5= 10.5g, n= 10.5g/84.01g/mol = **0.125mol**]

Limiting Reagent TEST : H_2SO_4 **- 0.18 mol/1= 0.18 mol** ; $NaHCO_3$. **0.125mol/2= 0.062mol ← LF**

Moles of Na_2SO_4 =0.125 mols x 1 mol Na_2SO_4/ 2 mol $NaHCO_3$ =0.0625 mols

m= nxMM

mass of Na_2SO_4 = 0.0625mols x 141.67g/mol = 8.85g

7. Barium nitrate and potassium sulphate solutions react and form a precipitate. What is the precipitate? How many mL of 0.40 M $Ba(NO_3)_2$ solution are required to precipitate completely the sulphate ions in 25 mL of 0.80 M K_2SO_4 solution? **[0.05 L]**

$Ba(NO_3)_{2(aq)} + K_2SO_{4\ (aq)} \rightarrow 2KNO_{3\ (aq)} + BaSO_{4(s)}$

$Ba(NO_3)_2$: V=? K_2SO_4: V= 0.025

C= 0.40M C=0.50M

n= 0.02mols ⟷ n= 0.02 mols

1 : 1

V=n/c , V= 0.02mol / 0.40M,

V=0.05 L

8. What mass of silver chloride can be precipitated from a silver nitrate solution by 200.0 mL of a solution of 0.50 M $CaCl_2$? **[29 g]**

$2AgNO_{3(aq)} + CaCl_{2(aq)} \text{->} 2AgCl_{(s)} + Ca(NO_3)_{2(aq)}$

$CaCl_2$: V= 0.2 L

C=0.50M

n= 0.1 mols

moles of AgCl = 0.1 mol of $CaCl_2$ x 2 mol AgCl/ 1mol $CaCl_2$ = 0.2 mol

Mass of AgCl= nXMM

m= 0.2mol x 143.32g/mol = 29 g