TOPIC B PROBLEMS

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 $CaCl_2$ 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?

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?

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) $(CH_3)_2CO$

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 $(NH_4)_2SO_4$

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

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.

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?

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?

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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?

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?

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?

12) Using the solubility rules, determine which of the following compounds are <u>insoluble</u> 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) $Ba_3(PO_4)_2$

13) For each of the mixtures below, do the following:
   1) Identify the actual species that are present in the mixture (before any reaction occurs).
   2) Write the formula of any product that forms. If no product will form, write "no reaction" and skip Step 3.
   3) Write the net ionic equation for the reaction that occurs, including the state of each substance (*s*, *l*, *g*, or *aq*).

   Example: Mixing 0.1 M NaCl and 0.1 M $Pb(NO_3)_2$
   (a) The actual species are Na^+, Cl^-, Pb^{2+}, and NO_3^-
   (b) $PbCl_2$ will form (because it is insoluble in water)
   (c) The net ionic equation is $Pb^{2+}(aq) + 2\ Cl^-(aq) \rightarrow PbCl_2(s)$

   a) Mixing 0.1 M $MgCl_2$ and 0.1 M Na_3PO_4
   b) Mixing 0.1 M HNO_3 and 0.1 M NaOH
   c) Mixing 0.1 M $Fe(NO_3)_3$ and 0.1 M KOH
   d) Mixing 0.1 M $ZnBr_2$ and 0.1 M $CuSO_4$
   e) Mixing 0.1 M HCl and 0.1 M $NaHCO_3$
   f) Mixing 0.1 M $AgNO_3$ and 0.1 M K_2CO_3
   g) Mixing 0.1 M $Ba(OH)_2$ and 0.1 M Na_2SO_4
   h) Mixing 0.1 M $HC_2H_3O_2$ and 0.1 M $Ba(OH)_2$
   i) Mixing 0.1 M HC_6H_5O and 0.1 M NaOH
   j) Mixing 0.1 M $H_2C_4H_4O_4$ (succinic acid) and excess 0.1 M NaOH. (Hint: You should write two equations for this.)

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14) Write balanced net ionic equations that explain the following observations.
   a) When solutions of $BaCl_2$ and K_2CrO_4 are mixed, a bright yellow precipitate forms.
   b) When solutions of $NaC_{12}H_{22}O_2$ and $Ca(NO_3)_2$ are mixed, a white precipitate forms.

15) Write the net ionic equation for the reaction that occurs when each of the following insoluble compounds is mixed with excess 6 M HCl. Be sure to include the state of each substance.
   a) $Mg(OH)_2$ b) CuO c) $Al(OH)_3$ d) Cr_2O_3

16) If you put some solid $CaCO_3$ into a beaker of water and slowly add HCl solution, stirring vigorously the whole time, the $CaCO_3$ gradually dissolves. As the last of the $CaCO_3$ dissolves, bubbles begin to form, and if you continue to add HCl, you observe steady bubble formation.
   a) Write a net ionic equation that shows why the $CaCO_3$ dissolves.
   b) Write a net ionic equation that shows why the mixture bubbles.

17) Both MgO and PbO are insoluble in water. When solid MgO is added to 3 M H_2SO_4, the solid dissolves completely. When solid PbO is added to 3 M H_2SO_4, the solid changes color slightly, but does not dissolve. Explain this difference.

18) A solution contains <u>one or more</u> of the following anions: I^-, PO_4^{3-}, and NO_3^-. A chemist carries out the following experiments on this solution:
   - <u>Experiment 1</u>: The chemist adds 0.1 M $Ba(NO_3)_2$ to a small portion of this solution, and no precipitate forms.
   - <u>Experiment 2</u>: The chemist adds 0.1 M $AgNO_3$ to the solution from Experiment 1, and a precipitate forms.

   Based on these results, tell which anions are definitely present in the original solution, which anions are definitely absent from the original solution, and which anions cannot be determined from the information given here. Explain your answer.

19) Complete the following ICE table:

	$3\ Ca^{2+}$	+	$2\ PO_4^{3-}$	→	$Ca_3(PO_4)_2$
Initial moles:	0.0685		0.0505		0
Change:					
Ending moles:					

20) Complete the following ICE table, assuming that Ca^{2+} is the limiting reactant.

	$3\ Ca^{2+}$	+	$2\ PO_4^{3-}$	→	$Ca_3(PO_4)_2$
Initial moles:	***x***		***y***		0
Change:					
Ending moles:					

21) Repeat Problem 20, but now assume that PO_4^{3-} is the limiting reactant.

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22) A chemist prepares a mixture that contains 0.0200 mol of $CuCl_2$ and 0.0300 mol of KOH dissolved in water.
   a) Write the balanced net ionic equation for the reaction that occurs.
   b) What are the spectator ions in this reaction?
   c) What is the limiting reactant in this reaction? *(Hint: it's an ion.)*
   d) Construct an ICE table for this reaction, using the net ionic equation.

23) A chemist mixes 5.00 mL of 0.240 M KI with 4.00 mL of 0.200 M $Pb(NO_3)_2$.
   a) Write the balanced net ionic equation for the reaction that occurs.
   b) Construct an ICE table for this reaction, using the net ionic equation.
   c) What mass of solid product is formed?
   d) What is the concentration of the excess reactant in the final mixture?
   e) What is the concentration of nitrate ions in the final mixture?

24) A chemist adds 1.35 g of solid Ag_2O to 25.0 mL of 2.00 M HBr, causing this reaction:

$$Ag_2O(s) + 2\ H^+(aq) + 2\ Br^-(aq) \rightarrow 2\ AgBr(s) + H_2O(l)$$

   a) What mass of solid AgBr is formed?
   b) What is the concentration of H^+ ions in the final mixture? (You may assume that the final solution volume is 25.0 mL.)

25) You have 50.0 mL of a 0.138 M $Ba(NO_3)_2$ solution. What is the minimum volume of 0.131 M Na_3PO_4 solution that you must add in order to remove all of the barium ions from the solution?

26) A solution contains an unknown concentration of sulfate ions. When 20.00 mL of this solution is mixed with excess aqueous $Ba(NO_3)_2$, 0.877 g of $BaSO_4$ is formed. Calculate the molarity of sulfate ions in the original solution.

27) A solution contains an unknown concentration of citric acid, $H_3C_6H_5O_7$. A 15.73 mL portion of this solution is placed in a flask and titrated with 0.321 M NaOH. The endpoint is reached when 23.44 mL of the NaOH solution has been added. Calculate the molarity of the original citric acid solution. The net ionic equation for the reaction that occurs is:

$$3\ OH^-(aq) + H_3C_6H_5O_7(aq) \rightarrow 3\ H_2O(l) + C_6H_5O_7^{3-}(aq)$$