Chapter 4 Exam-Blank

1. **(5 points)** Which compound or compounds in each of the following groups is(are) expected to be insoluble in water? Circle the compounds in each group that are insoluble. **This is NOT a multiple-choice question. You need to answer each part.**
   (a) **FeO,** $FeCl_2$, and **$FeCO_3$**

   (b) **PbI_2**, **$Pb_3(PO_4,)_2$** and $AgNO_3$

   (c) RbOH, $Ba(OH)_2$, **$Co(OH)_2$**

2. **(6 points)** Write the molecular, ionic and net ionic equations for the reaction of an aqueous potassium bromide solution mixing with an aqueous silver nitrate solution. Clearly label states and charges if any.

(a) Molecular: $AgNO_{3(aq)} + KBr_{(aq)} \rightarrow AgBr_{(s)} + KNO_{3(aq)}$
(b) Ionic: $Ag^+_{(aq)} + NO_3^-{}_{(aq)} + K^+_{(aq)} + Br^-{}_{(aq)} \rightarrow AgBr_{(s)} + K^+_{(aq)} + NO_3^-{}_{(aq)}$
(c) Net ion: $Ag^+_{(aq)} + Br^-{}_{(aq)} \rightarrow AgBr_{(s)}$

3. **(6 points)** Write the molecular, ionic and net ionic equations for the reaction of a sodium hydroxide solution mixing with a copper(II) chloride solution. Clearly label states and charges if any.

(a) Molecular: $CuCl_{2(aq)} + 2NaOH_{(aq)} \rightarrow Cu(OH)_{2(aq)} + 2NaCl_{(aq)}$
(b) Ionic: $Cu^{2+}_{(aq)} + 2Cl^-{}_{(aq)} + 2OH^-{}_{(aq)} + 2Na+_{(aq)} \rightarrow Cu(OH)_{2(s)} + 2Cl^-{}_{(aq)} + 2Na+_{(aq)}$
(c) Net ionic: $Cu^{2+}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow CuCl_{2(s)}$

4. **(6 point)** In the laboratory 7.52 g of $Sr(NO_3)_2$ is dissolved in enough water to form 0.75L of $Sr(NO_3)_2$ solution.
   (a) What is the concentration of this solution?
   (b) A 0.100L sample is withdrawn from this stock solution and titrated with a 0.0425 M solution of Na_2CrO_4. What volume of Na_2CrO_4 solution is needed to precipitate the entire amount of strontium ion as $SrCrO_4$? [Hint: Write a balanced equation]

7.52 g $Sr(NO_3)_2$	1 mol $Sr(NO_3)_2$		$=0.04\underline{7}38$ M $Sr(NO_3)_2$
	211.64 g $Sr(NO_3)_2$	0.75 L	

0.100 L sol'n	0.04738 mol $Sr(NO_3)_2$	1 mol Na_2CrO_4	1 L Na_2CrO_4 sol'n	= 0.011L sol'n
	1 L sol'n	1 mol $Sr(NO_3)_2$	0.0425 mol Na_2CrO_4	

5. **(5 points)** A solution is made by mixing 50.0 mL of 6.00 M HCl, 100.0 mL of 1.00 M HCl, 50.0mL of 0.500M $CaCl_2$ and enough water to make 250.0 mL of solution. What is the molarity of the chloride ion (Cl^-) in the final solution?

50.0 mL	6.00 mol HCl	1 mol Cl^-	= 300. mmol Cl^-
	1 L sol'n	1 mol HCl	

100.0 mL	1.00 mol HCl	1mol Cl^-	100. mmol Cl^-
	1 L sol'n	1 mol HCl	

50.0 mL	0.500 mol $CaCl_2$	2 mol Cl^-	50.0 mmol Cl^-
	1 L sol'n	1mol $CaCl_2$	

$$\frac{450.\ \text{mmol } Cl^-}{250.0\ \text{mL sol'n}} = 1.80\ \text{M } Cl^-$$

6. **(4 points)** When ethanol, CH_3CH_2OH, is dissolved in water, a non-conducting solution results. When nitrous acid is dissolved in water, the resulting solution is weakly conducting and acidic in nature. Describe what happens upon dissolution in the two cases and account for the different results.

Ethanol is a non-ionizing substance. This means it does not produce ions in water because it is a molecule that is not an acid. (All acids are molecules) Ions conduct electricity. Water molecules surround the ethanol molecules, but the ethanol does not break up into ions; it stays as a molecule. The attraction for the water molecules is not strong enough to break the bonds that hold the molecule together. It is strong enough to disrupt the solvent-solvent interactions between the water molecules to solvate the ethanol

Nitrous acid is a weak acid. It ionizes in water, but not completely, like a strong acid would in water. The attraction of the water to the acidic hydrogen is strong, but not strong enough to completely dissociate all of the hydrogens from all of the nitrous acid molecules. Since the disassociation of the acid produces some ions, the

solution will conduct electricity because ions are needed for the process of conduction. Nitrous acid is a weak electrolyte; weak electrolytes conduct weakly.

7. **(5 points)** You have 0.954 g of an unknown acid H_2A, which reacts with NaOH according to the reaction below.

$$H_2A_{(aq)} + 2\ NaOH_{(aq)} \rightarrow Na_2A_{(aq)} + H_2O_{(l)}$$

If 36.04 mL of 0.509 M NaOH is required to titrate the acid to the equivalence point, what is the molar mass of the acid?

36.04 mL	0.509 mol NaOH	1 mol H_2A	0.009172 mol H_2A
	1 L sol'n	2 mol NaOH	

$$\frac{0.954\ g\ H_2A}{0.009172\ mol\ H_2A} = 104\ g\ H_2A$$

8. **(6 points)** When iron metal is reacted with potassium permanganate in acid, the following reaction occurs.
In the equation below, determine which reactant is oxidized and which reactant is reduced. How many electrons were gained for the reactant that was reduced?

$$5\mathbf{Fe}_{(s)} + 3\ K\mathbf{Mn}O_{4(aq)} + 24\ HCl_{(aq)} \rightarrow 3\mathbf{Mn}Cl_{2(aq)} + 5\ \mathbf{Fe}Cl_{3(aq)} + 12\ H_2O_{(l)} + 3\ KCl_{(aq)}$$

(a) **(4 points)** Oxidation number of the element in bold :

Fe	K**Mn**O_4	**Mn**Cl_2	**Fe**Cl_3(
0, it is an element	1+X+ —8, X = 7	X + —2 = 2	X + —3 = 3

(b) **(0.5 point)** Compound that contains the oxidized element and identity of that element: **Fe, iron**

(c) **(0.5point)** Compound that contains the reduced element and identity of that element: K**Mn**O_4 Manganese is reduced

(d) **(0.5 point)** Oxidizing agent: K**Mn**O_4

(e) **(0.5 point)** Reducing agent **Fe**

9. **(5 points)** Balance the following equations by putting the correct coefficient in the space provided. If the coefficient is one, put a **1** in the space. **DO NOT LEAVE ANY SPACES BLANK, YOU WILL LOSE POINTS. ALSO MAKE SURE THAT THE EQUATIONS ARE IN THE PROPER FORM.** After you have balanced the equations, indicate which reaction is best described as a redox [R], combination[C], decomposition [D], precipitation [P], acid base [A], or combustion reaction [CO]. could be more than one answer.

1 $C_4H_8N_8O_{8(s)} + 2O_{2(g)} \rightarrow$ 4 $CO_2 + 4H_2O_{(l)} + 4\ N_{2(aq)}$ coefficients: 1,2, 4,4,4 combustion, redox

2 $Na_2S_2O_{3(aq)}$ +1 $I_{2(aq)} \rightarrow$ 2 $NaI_{(aq)}$ + 1 $Na_2S_4O6_{(aq)}$ decomposition redox

1 $(NH_4)_2Cr_2O_{7(aq)} \rightarrow$ 1 $Cr_2O_{3(s)}$ + 4 $H_2O_{(l)}$ + 1$N_{2(g)}$ decomposition redox

2 $C_5H_{10(l)}$ + 13 $O_{2(g)} \rightarrow$ 8 $CO_{2(g)}$ + 10 $H_2O_{(l)}$ combustion , redox

10. **(6 points)** A student has a solution that might contain any or all of the following cations: Cu^{2+}, Pb^{2+}, Ba^{2+}, and Mn^{2+}. Address the following statements about the "mixture" of ions in the solution to determine the identity of ion(s) in the solution. Give a **brief** explanation of each choice based on solubility rules.

(a) Addition of HCl solution to the unknown solution causes a precipitate to form. What is the precipitate that forms?

Addition of chloride causes lead(II) ions to ppt. The other cations would form soluble salts with chloride.

(b) After filtering off the precipitate from (a), a solution of $H_2SO_{4(aq)}$ is added to the remaining (UK) solution of ions and another precipitate forms. What is the precipitate that forms?

Since lead(II) ions were removed from the solution, the ppt must be barium sulfate. The other cations that could be in solution would form soluble salts with sulfate.

(c) This precipitate from (b) is filtered off and a solution of NaOH is added to the resulting solution. No precipitation forms.

Since no ppt formed, the two remaining cations are not present in the solution. Most metal cations except for group 1A, barium and strontium ions, for ppt in the prescience of hydroxide.

(d) What are the cations present in the solution?

the two cations present in the solution are lead(II) and barium ions.

11. **(6 points)** You know that an unlabeled bottle contains one of the following: $Hg_2(NO_3)_2$, $BaCl_2$, or $MnSO_4$. A friend suggests that you test a portion of the bottle with a sodium chloride solution, a sodium sulfate solution, and a sodium hydroxide solution.

    (a) No reaction occurs when sodium chloride solution is added to a sample of the solution from the bottle.

If the solution contained mercury(I) ions, the addition of $NaCl_{(aq)}$ would have created a ppt of Hg_2Cl_2. Since no ppt formed, there is no mercury(I) ions in the solution. Mercury(I) ions would have formed a ppt with sulfate and with hydroxide ions.

(b) No reaction occurs when sodium sulfate solution is added to a sample of the solution from the bottle.

Barium ions form a ppt with sulfate; no ppt formed with the addition of sodium sulfate, so barium ions are not present in the solution. Barium does not form a ppt with chloride or with hydroxide ions.

(c) A precipitate forms with the sodium hydroxide solution is added to a sample of the solution from the bottle.

Manganese ions, as does most metal cations, forms a solid with hydroxide ions. Most metal sulfates and chlorides are soluble.

(d) What cation(s) are present in the bottle? Explain your choice(s).

Manganese is the only ion in the solution.

12. (**6 points)** Consider solutions in which 0.10 mol of each of the following compounds is dissolved in 1 L of water: $Ca(NO_3)_2$, $C_6H_{12}OH$, $NaC_2H_3O_2$, HF, $Al_2(SO_4)_3$. Rank the solutions in order of increasing electrical conductivity (which ones will be the worst conductors of electricity to the best conductors of electricity), based on the number of ions in solution. Explain your choices BRIEFLY.

Conductivity is related to the number of ions a compound produces upon dissolving in water. From worst to best, the order is: $C_6H_{12}OH$, HF, $NaC_2H_3O_2$, $Ca(NO_3)_2$, $Al_2(SO_4)_3$. Molecules, such as $C_6H_{12}OH$, do not ionize when dissolved in water. The bonds between the atoms are stronger than the attraction of the atoms to water. This is a non-electrolyte and does not conduct electricity. $HF_{(aq)}$ is a weak acid. Weak acids ionize, but not 100 and are considered weak electrolytes because they don't put as many ions into the solution as a stronger ionizing species like the $NaC_2H_3O_2$. The last three compounds are strong electrolytes. They ionize completely. $NaC_2H_3O_2$ ionizes completely to form two ions for each unit, $Ca(NO_3)_2$ **forms three ions per unit, and** $Al_2(SO_4)_3$**.forms five ions per unit. The more ions, the better the conductor.**

13. **(12 points)** A precipitate forms when aqueous sodium sulfide is mixed with aqueous copper(II) chloride.

(a) **(2 points)** Write the molecular and ionic equation.

$$Na_2S_{(aq)} + CuCl_{2(aq)} \rightarrow 2NaCl_{(aq)} + CuS_{(aq)}$$

$$2Na^+_{(aq)} + S^+_{(aq)} + Cu^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow 2Na^+_{(aq)} + CuS_{(s)} + 2Cl^-_{(aq)}$$

(b) **(1 points)** Identify the spectator ions.

The spectator ions are sodium ions and chloride ions.

(c) **(2 points)** Calculate the mass of the precipitate that forms when 75.0 mL of 1.50 M sodium sulfide is mixed with 100.0 mL 0.500 M copper(II) chloride.

75.0 mL $Na_2S_{(aq)}$ sol'n	**1.50 mol $Na_2S_{(aq)}$**	**112.5 mmol $Na_2S_{(aq)}$**
	1 L $Na_2S_{(aq)}$ sol'n	

100 mL $CuCl_{2(aq)}$ sol'n	**$CuCl_{2(aq)}$**	**50.0mmol $CuCl_{2(aq)}$**
	$CuCl_{2(aq)}$ sol'n	

50.0mmol $CuCl_{2(aq)}$	**10^{-3}mol**	**1 mol $CuS_{(s)}$**	**95.95 g $CuS_{(s)}$**	**4.80 g $CuS_{(s)}$**
	1mmol	**1 mol $CuCl_{2(aq)}$**		

Since it is 1:1 ration, $CuCl_{2(aq)}$ and therefore, $Cu^{2+}_{(aq)}$ is the limiting reagent.

(d) **(3 points)** Calculate the moles of all the dissolved ions at the end of the reaction (this includes spectator and excess ions)

112.3 mmol $Na_2S_{(aq)}$	**$2Na^+_{(aq)}$**	**225 mmol $Na^+_{(aq)}$+**
	$Na_2S_{(aq)}$	

50.0mmol $CuCl_{2(aq)}$	**$2Cl^-_{(aq)}$**	**100.0 mmol $Cl^-_{(aq)}$**
	$CuCl_{2(aq)}$	

(e) **(1 point)** What is the final volume of the solution?

the final volume is 175.0 mL

(f) **(3 points)** Calculate the individual concentrations of all dissolved ions at the end of the reaction.

$$\frac{\text{100.0 mmol } Cl^-}{\text{175.0 mL}} = 0.571 \text{ M } Cl^- \qquad [Na^+] \quad \frac{\text{225 mmol } Na^+}{\text{175.0 mL}} = 1.29 \text{ M } Na^+$$

$$112.5 \text{ mmol } S^{2-} - 50.0 \text{mmol } S^{2-} = 62.5 \text{ mmol } S^{2-} \quad \frac{\text{62.5 mmol } S^{2-}}{\text{175.0 mL}} \quad 0.357 \text{ M } S^{2-}$$

14. **(5 points)** A solution is prepared by dissolving 1.5842 g of acetic acid ($HC_2H_3O_2$, 60.05 g/mol) in enough water to make 100.00 mL of solution. A 10.00 mL portion of the newly made solution is then diluted to a final volume of 350. mL. What is the final molarity of the acetic acid solution

1.5842 g $HC_2H_3O_2$	**1 mol** $HC_2H_3O_2$ / 60.052 g $HC_2H_3O_2$	0.0263805 mol $HC_2H_3O_2$

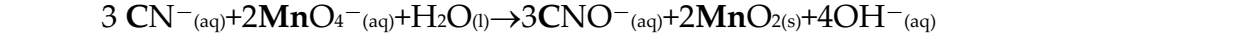
M stock $HC_2H_3O_2$	0.0263805 mol $HC_2H_3O_2$ / 0.10000L	0.263805 M $HC_2H_3O_2$

0.263805 M $HC_2H_3O_2$	10.0 mL / 350.mL	**0.00754 M**$HC_2H_3O_2$

15. **(3 points)** Classify each of the following aqueous solutions as non-electrolyte (NE), weak electrolyte (WE) or strong electrolyte(SE).

$HClO_2$	$HBr_{(aq)}$	KOH	$CoSO_4$	$C_6H_{12}O_6$	O_2
WE	SE	SE	SE	NE	NE

16. **(5 points)** In the equation below, determine which reactant is oxidized and which reactant is reduced. How many electrons were gained for the reactant that was reduced? [hint: the nitrogen in CNO^- has a -3 oxidation state]



$$3\,\mathbf{C}N^-_{(aq)} + 2\mathbf{Mn}O_4^-{}_{(aq)} + H_2O_{(l)} \rightarrow 3\mathbf{C}NO^-_{(aq)} + 2\mathbf{Mn}O_{2(s)} + 4OH^-_{(aq)}$$

(a) (2 points) Determine the oxidation numbers of the elements in bold: CN^-, Carbon is 2+; $\mathbf{Mn}O_4^-$, Mn is 7+; $\mathbf{C}NO^-$, C is 1+; $\mathbf{Mn}O_{2(s)}$, Mn is 4+

(b) (1 point) Compound that contains the oxidized element and identity of that element: CN^-, Carbon

(c) (1 point) Compound that contains the reduced element and identity of that element: $\mathbf{Mn}O_4^-$,Mn

(d) (0.5 point) What is the oxidizing agent: permangante

(e) (0.5 point) What is the reducing agent:cyanide

17. (5 points) Propionic acid, $HC_3H_5O_2$, is less than 5% ionized in dilute solution. One of its salts, calcium propionate, is used as a food preservative.
    (a) Is propionic acid a strong, weak, or non-electrolyte? Explain. **Propionic acid is a weak acid. It ionizes less than 5% and is not one of the strong acids.**
    (b) Is it a strong or weak acid? **It is not HCl, HBr, HI, H_2SO_4, HNO_3, $HClO_3$, or $HClO_4$, therefore it is a weak acid.**
    (c) c) Should it be represented in reaction side of the net ionic equations as $HC_3H_5O_2$ (aq) or as H^+ (aq) and $C_3H_5O_2^-$ (aq)? **Since it doesn't ionize completely, it must be shown as a molecule on the reactant side of the equation.**

18. (4 points) In the equation below, determine which **reactant** is oxidized and which reactant is reduced by determining the oxidation number for the element in bold. [Notes, $Cr_2O_4^{2-}$(aq) has a 2- charge; NO_3^-(aq) and NO_2^-(aq) have a -1 charge.] Show your work and clearly identify the oxidized and reduced species.

    3 $\mathbf{N}O_2^{-}$(aq) + $\mathbf{Cr}_2O_7^{2-}$(aq) → 2 $\mathbf{Cr}^{3+}$(aq) + 3 $\mathbf{N}O_3^-$(aq)

X + 2(-2)= -1, N = +3 charge, 2X + 7(-2) = -2, Cr = -6;, $\mathbf{Cr}^{3+}$=+3; X + 3(-2) = -1, N = +5
Since nitrogen changes from +3 to +5, it is oxidized; the Cr must be reduced, since its oxidation number becomes less positive.

19. (8 points) The distinctive odor of vinegar is due to acetic acid, $HC_2H_3O_2$. Acetic acid reacts with sodium hydroxide to make sodium acetate, $NaC_2H_3O_2$ and water.
    a. If 25.0 mL of vinegar requires 34.9 mL of 0.0960 M NaOH to completely neutralize the acid in the solution (this is the equivalence or stoichiometric end point), how many grams of acetic acid are in a 3.00 gal sample of this vinegar. (4 qt = 1 gal; 1 qt = 0.94635 L) [MM acetic acid = 60.05 amu]

$NaOH_{(aq)} + HC_2H_3O_{2(aq)} \rightarrow NaC_2H_3O_{2(aq)} + H_2O_{(l)}$

3.00 gal	**4 qt**	**0.94635L sol'n**	**0.134 mol** $HC_2H_3O_2$	**60.05 g** $HC_2H_3O_2$	**91.4 g** $HC_2H_3O_2$
	1 gal	**1 qt**	**1 L**	**1 mol** $HC_2H_3O_2$	

20. (5 points) Oxalic acid ($H_2C_2O_4$) reacts with rust [iron(III) oxide] using the following reaction:

$Fe_2O_{3(s)} + 6\ H_2C_2O_{4(aq)} \rightarrow 2\ Fe(C_2O_4)_3^{3-}{}_{(aq)} + 3\ H_2O_{(l)} + 6\ H^+{}_{(aq)}$

Calculate the grams of rust that can be removed by 300. mL of 0.250 M solution of oxalic acid.[MM rust = 159.7 g/mol].

300. mL	**1L**	**0.250 mol** $H_2C_2O_4$	Fe_2O_3	159.7g Fe_2O_3	**2.00 g** Fe_2O_3
	1000 mL	**1L**	6 $H_2C_2O_4$	**1 mol** Fe_2O_3	