

Name Solution

**CH1020**

**EXAM 2 (70 points)**

***November 14<sup>th</sup>, 2018***

**A**

**There is a total of 10 pages in the exam (including this page).**

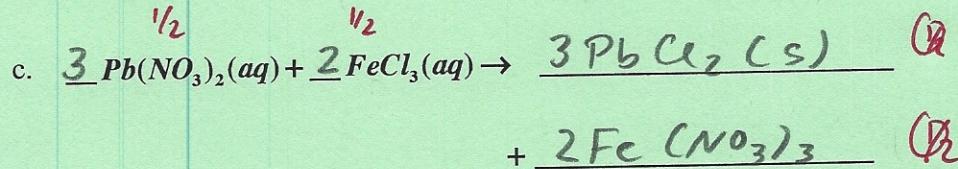
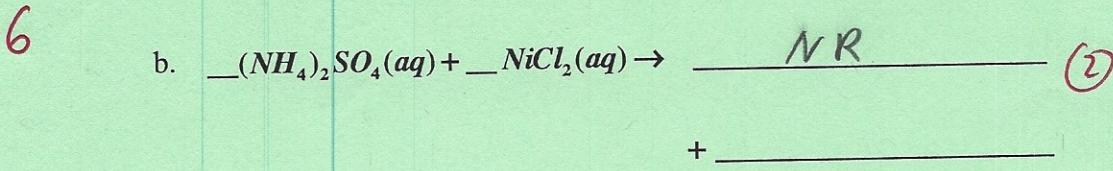
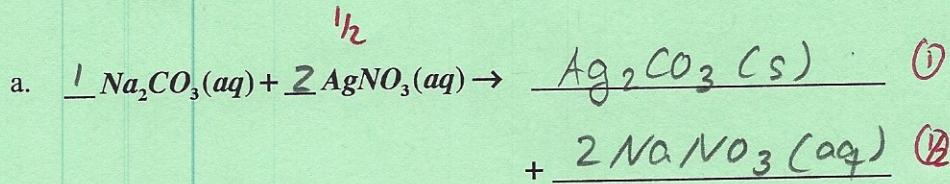
**There is a total of 13 questions.**

**Show your work to get full credit.**

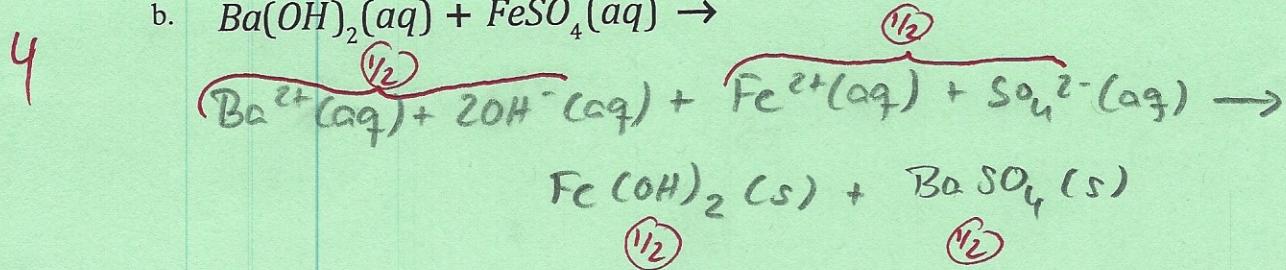
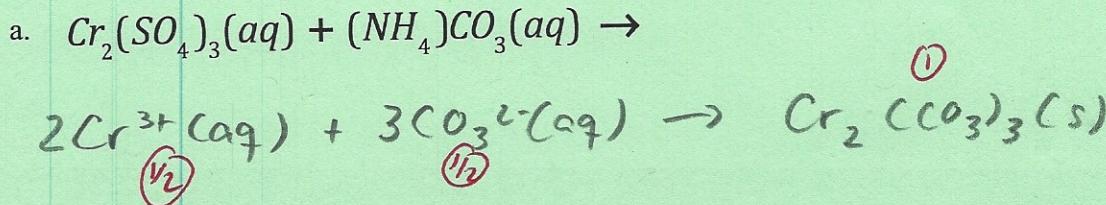
**The activity series table, the precipitation rules, and the periodic table are on the last 3 pages**

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1. (6 Points) Complete and balance each equation. If no precipitation reaction occurs, write "NR".



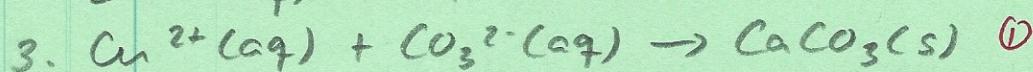
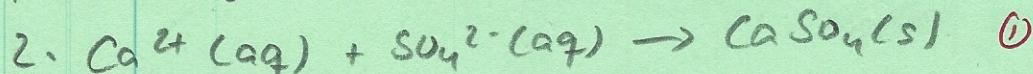
2. (4 Points) Write balanced net ionic equations for each reaction:



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3. (4 Points) A solution contains one or more of the following ions:  $\text{Ag}^+$ ,  $\text{Ca}^{2+}$  and  $\text{Cu}^{2+}$ . When you add sodium chloride to the solution, no precipitate forms. When you add sodium sulfate to the solution, a white precipitate forms. You filter off the precipitate and add sodium carbonate to the remaining solution, producing another precipitate. Which ions were present in the original solution? Write net ionic equations for the formation of each of the precipitates observed.

1.  $\text{no } \text{Ag}^{2+} \text{ b/c no AgCl precipitate}$



(1) (1)

$\text{Ca}^{2+}$  and  $\text{Cu}^{2+}$  are present

4. (6 Points) A solution contains  $\text{Ag}^+$  and  $\text{Hg}^{2+}$  ions. The addition of 0.100 L of 1.22 M NaI solution is just enough to precipitate all the ions as  $\text{AgI}$  and  $\text{HgI}_2$ . The total mass of the precipitate is 28.1 g. Find the moles of  $\text{AgI}$  that precipitate.

$$M_w(\text{AgI}) = 234.8 \text{ g/mol}; M_w(\text{HgI}_2) = 454.4 \text{ g/mol}$$

$$\text{moles (I)} = 0.100\text{L} \cdot 1.22\text{M} = 0.122\text{mol} \quad (1)$$

$$\text{AgI} = x \quad \text{HgI}_2 = y$$

$$x + 2y = 0.122\text{mol} \Rightarrow y = 0.061\text{mol} - \frac{1}{2}x \quad (1)$$

$$x \cdot 234.8 \text{ g/mol} + y \cdot 454.4 \text{ g/mol} = 28.1 \text{ g} \quad (1)$$

$$234.8 \text{ g/mol} \cdot x + (0.061\text{mol} - \frac{1}{2}x)454.4 \text{ g/mol} = 28.1 \text{ g}$$

$$234.8 \text{ g/mol} \cdot x + 27.72\text{g} - 227.2\text{g} \cdot x = 28.1\text{g} \quad (1)$$

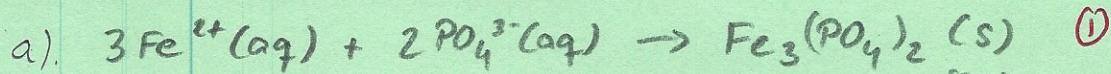
$$7.6\text{g} \cdot x = 28.1\text{g} - 27.72\text{g} = 0.4\text{g}$$

$$x = 5.26 \cdot 10^{-2} \text{ mol} \quad (2)$$

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5. (9 Points) A sample of  $3.44 \times 10^{-4}$  mol  $K_3PO_4$  is added to 18.0 mL of 0.050 M  $FeCl_2$  solution, resulting in the formation of a precipitate. (a) Write the net ionic equation for the reaction. (b) What is the mass of the precipitate that forms? (c) What is the remaining concentration of the ion in solution that is in excess?  $M_w(K_3PO_4) = 212.27$  g/mol ;  $M_w(FeCl_2) = 126.75$  g/mol; (you need to determine the  $M_w$  of the precipitate yourself once you have identified its formula)



$$b). \text{moles } (PO_4^{3-}) = 73 \text{ mg} \cdot \frac{1g}{1000 \text{ mg}} \cdot \frac{1 \text{ mole}}{212.27} \cdot \frac{1 \text{ mole } (PO_4)}{1 \text{ mole } (K_3PO_4)} = 3.44 \cdot 10^{-4} \text{ mol}$$

$$\text{moles } (Fe_3(PO_4)_2) = 3.44 \cdot 10^{-4} \text{ mol} \cdot \frac{1 \text{ mol}}{2 \text{ mol}} = 1.72 \cdot 10^{-4} \text{ mol}$$

$$\text{moles } (Fe^{2+}) = 0.050 \text{ M} \cdot 0.018 \text{ L} = 9.00 \cdot 10^{-4} \text{ mol}$$

$$\text{moles } (Fe_3(PO_4)_2) = 9.00 \cdot 10^{-4} \text{ mol} \cdot \frac{1 \text{ mol}}{\frac{3 \text{ mol}}{1 \text{ mol}}} = 3.00 \cdot 10^{-4} \text{ mol}$$

$\Rightarrow PO_4^{3-}$  is limiting (1)

$$\text{mass } (Fe_3(PO_4)_2) = 1.72 \cdot 10^{-4} \text{ mol} \cdot 352.5 \text{ g/mol} = 0.061 \text{ g}$$

$$c). Fe^{2+}(\text{used}) = 1.72 \cdot 10^{-4} \text{ mol} \cdot \frac{3 \text{ mole } Fe^{2+}}{1 \text{ mole } Fe_3(PO_4)_2} = 5.13 \cdot 10^{-4} \text{ mol}$$

$$Fe^{2+}(\text{remaining}) = 9.00 \cdot 10^{-4} \text{ mol} - 5.13 \cdot 10^{-4} \text{ mol} = 3.87 \cdot 10^{-4} \text{ mol}$$

$$[Fe^{2+}] = \frac{3.87 \cdot 10^{-4} \text{ mol}}{0.018 \text{ L}} = 0.022 \text{ M}$$

6. (5 Points) What is the definition of an Arrhenius acid and base? What is the definition of a Brønsted-Lowry acid and base? Give an example of a Brønsted-Lowry acid that is not an Arrhenius acid.

Arrhenius acid : produces  $H_3O^+$  (1)

base : produces  $OH^-$  (1)

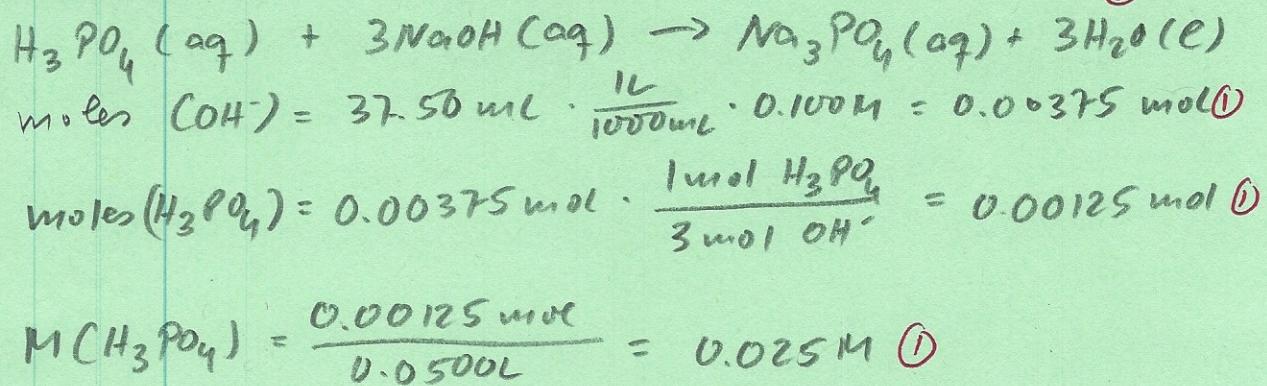
Brønstedt acid: donates  $H^+$  (1)

base accepts  $H^+$  (1)

e.g.  $HCl(g)$  (1)

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7. (5 points) A 50.00 mL sample of an unknown phosphoric acid solution is titrated with a 0.100 M sodium hydroxide solution. The equivalence point is reached when 37.50 mL sodium hydroxide solution is added. Provide the balanced equation and calculate the concentration of the unknown phosphoric acid solution.

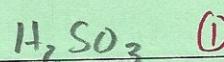


8. (3 points) Provide the chemical formulas for each of the following acids:

a. hydrocyanic acid



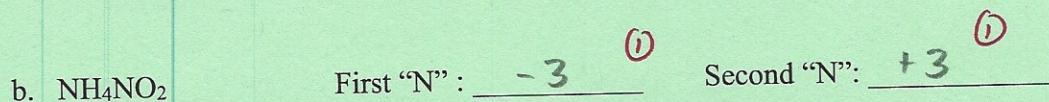
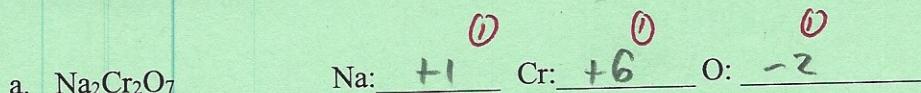
b. sulfurous acid



c. hydrofluoric acid



9. (5 points) Determine the oxidation numbers for the indicated elements in the following substances:



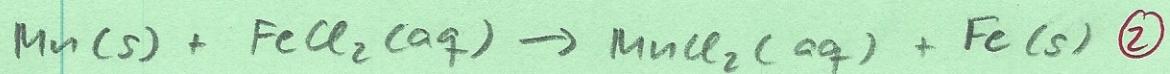
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10. (6 points) Write balanced chemical equations for the following redox reactions. If no reaction occurs, write NR.

- a. Fe is added to a solution of Nickel(II)sulfate



- b. Manganese is added to a solution of iron(II)chloride



- c. Silver is added to a solution of Mercury(II)nitrate

NR (2)

11. (5 points) A mixture contains only  $\text{SrCl}_2$  and  $\text{NH}_4\text{NO}_3$ . A 0.715 g of this mixture is dissolved in water, and an excess of  $\text{AgNO}_3$  is added, producing a precipitate of  $\text{AgCl}$ . The precipitate is filtered, dried, and weighed. Its mass is 0.236 g. Calculate the mass percent of  $\text{SrCl}_2$  in the mixture.

$$\# \text{ moles}(\text{AgCl}) = 0.236 \text{ g} \cdot \frac{1 \text{ mol}}{143.3 \text{ g}} = 1.65 \cdot 10^{-3} \text{ mol} \quad (1)$$

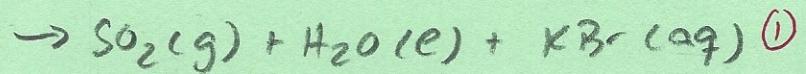
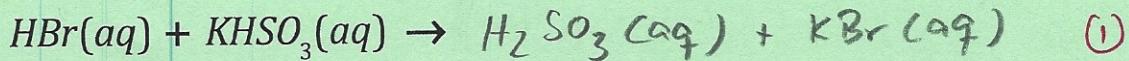
$$\# \text{ moles}(\text{SrCl}_2) = 1.65 \cdot 10^{-3} \text{ mol} \cdot \frac{1 \text{ mol}}{2 \text{ mol}} = 8.23 \cdot 10^{-4} \text{ mol} \quad (1)$$

$$\text{mass}(\text{SrCl}_2) = 8.23 \cdot 10^{-4} \text{ mol} \cdot \frac{158.5 \text{ g}}{1 \text{ mol}} = 0.130 \text{ g} \quad (1)$$

$$\% = \frac{0.130 \text{ g}}{0.715 \text{ g}} \cdot 100\% = 18.2\% \quad (2)$$

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12. (2 points) Complete and balance the following gas evolution reaction:



13. (10 points) Complete and balance the following redox reaction in acidic solution

