

Equations and Constants

$$\text{pH} = -\log[\text{H}^+] \quad \text{pOH} = -\log[\text{OH}^-] \quad \text{pH} + \text{pOH} = 14 \quad \text{K}_a \cdot \text{K}_b = \text{K}_w$$

$$\text{K}_w = 1.0 \times 10^{-14} \text{ (at } 25^\circ\text{C)} \quad \text{M}_1\text{V}_1 = \text{M}_2\text{V}_2$$

$$\text{N}_A = 6.0221367 \times 10^{23}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

CHEMISTRY 1100 Fall 07

Exam 1

USE PEN ONLY

ANSWER KEY (PRINT)
LAST NAME, FIRST NAME

SECTION

1. _____ (25pts)

2. _____ (25pts)

3. _____ (25pts)

4. _____ (25pts)

_____ (Total)

SHOW ALL WORK!

All essay questions must be answered with complete sentences. All calculations must be clearly shown with units and their cancellations in at least one step of the problem. Answers must have the proper number of significant figures. Only exams written in ink are eligible for a re-grade. Academic Integrity is expected of everyone and anyone caught cheating will receive an F in the course.

1. _____ (25pts)

_____ **Print Initials**

(5pts for each question, all or nothing, place the letter answer on the line provided before the question)

___ **D** ___ (i) What is the oxidation state of chlorine in KClO_2 ?

- (A) -1 (B) +1 (C) +2 (D) +3 (E) +4

___ **C** ___ (ii) A solution is prepared by combining 52.0 mL of 0.120M HCl and 75.0 mL of 0.081M HCl. What is the concentration of H^+ in the final solution?

- (A) 0.0123M (B) 0.201M (C) 0.0970M (D) 0.0491M (E) 0.101M

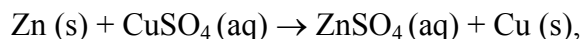
___ **A** ___ (iii) A compound has the composition of C 75% and H 25%. What is the empirical formula of the compound? (The compound only contains C and H.)

- (A) CH_4 (B) C_3H_8 (C) CH_3 (D) C_2H_6 (E) C_2H_8

___ **A** ___ (iv) A 25.0-mL sample of HNO_3 (Molar Mass: 63.0 g/mol) was titrated with a standard 0.100 M NaOH solution. The end-point was reached when 20.0 mL of the NaOH solution was added. How many grams of HNO_3 did the sample contain?

- (A) 0.126 g (B) 0.155 g (C) 0.197 g (D) 0.252 g (E) 0.312 g

___ **B** ___ (v) In the chemical reaction,



- (A) metallic zinc is reduced
(B) metallic zinc is the reducing agent.
(C) copper ion is oxidized.
(D) sulfate ion is the oxidizing agent.
(E) there is no oxidation or reduction.

2. _____ (25pts)

_____ **Print Initials**

(5pts for each question, all or nothing, place the letter answer on the line provided before the question)

___ **D** ___ (i) When the reversible reaction



- (A) no further reaction occurs.
- (B) the total moles of products must equal the remaining moles of reactant.
- (C) all of the reactants have been consumed.
- (D) the concentration of each substance in the system will be constant.
- (E) the product $[\text{N}_2] \times [\text{O}_2]$ equals $[\text{NO}]^2$.

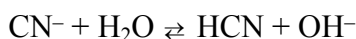
___ **C** ___ (ii) What volume of 0.230 M NaCl should be added to water to make 125. mL of a 0.130 M NaCl solution?

- (A) 221. mL (B) 3.73 mL (C) 70.7 mL (D) 100. mL (E) 16.3 mL

___ **B** ___ (iii) What is the pH of a 0.345 M solution of $\text{Ba}(\text{OH})_2$?

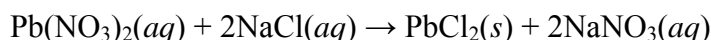
- (A) 13.53 (B) 13.84 (C) 0.46 (D) 0.16 (E) 13.00

___ **B** ___ (iv) Identify an acid-base conjugate pair in the reaction below:



- (A) H_2O and HCN (B) H_2O and OH^- (C) CN^- and H_2O (D) HCN and OH^-

___ **B** ___ (v) In the following reaction, what ions, if any, are spectator ions?



- (A) $\text{Pb}^{2+}(\text{aq})$, $\text{NO}_3^-(\text{aq})$
- (B) $\text{Na}^+(\text{aq})$, $\text{NO}_3^-(\text{aq})$
- (C) $\text{Pb}^{2+}(\text{aq})$, $\text{Cl}^-(\text{aq})$
- (D) $\text{Na}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$
- (E) There are no spectator ions

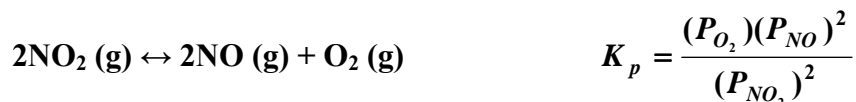
3. _____ (25pts)

Print Initials

(15 points) At a certain temperature, K_p for the following reaction is 4.48×10^{-13} :



0.75 atm of NO_2 are introduced into a container and allowed to come to equilibrium. What are the equilibrium partial pressures of NO and O_2 ?



I	0.75	0	0
C	-2x	+2x	+x
E	0.75-2x	2x	x

$$4.48 \times 10^{-13} = \frac{(x)(2x)^2}{(0.75 - 2x)^2}$$

You can neglect $2x$ with respect to 0.75 because K_p is very small.

$$4.48 \times 10^{-13} = \frac{(x)(2x)^2}{(0.75)^2} = \frac{4x^3}{0.5625}$$

$$x = 4.0 \times 10^{-5}$$

$$P_{\text{NO}} = 2x = 2(4.0 \times 10^{-5}) = 8.0 \times 10^{-5} \text{ atm}$$
$$P_{\text{O}_2} = x = 4.0 \times 10^{-5} \text{ atm}$$

(10 points) A solution of methanol (CH_3OH) in water has a concentration of 0.200 M . What mass of methanol, in grams, is present in 0.150 liters of this solution?

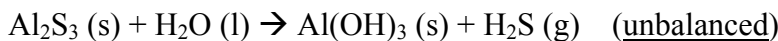
Molar Mass of Methanol: 32.045 g/mol

$$0.150 \text{ L} \times \frac{0.200 \text{ mol}}{\text{L}} \times \frac{32.045 \text{ g}}{\text{mol}} = 0.961 \text{ g Methanol}$$

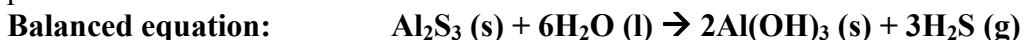
4. _____ (25pts)

Print Initials

(12 points) Aluminum sulfide reacts with water to form aluminum hydroxide and hydrogen sulfide gas according to the following equation:



If 15.28 grams of aluminum sulfide react with 8.51 grams of water, (A) what is the limiting reagent and (B) what is the maximum number of grams of H₂S that can be produced?



$$15.28 \text{ g Al}_2\text{S}_3 \times \frac{1 \text{ mol}}{150.17 \text{ g}} = 0.102 \text{ mol Al}_2\text{S}_3 \quad 8.51 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.016 \text{ g}} = 0.473 \text{ mol H}_2\text{O}$$

$$0.102 \text{ mol Al}_2\text{S}_3 \times \frac{6 \text{ mol H}_2\text{O}}{1 \text{ mol Al}_2\text{S}_3} = 0.612 \text{ moles of water needed to completely react}$$

with all the aluminum sulfide present

$$0.473 \text{ mol H}_2\text{O} \times \frac{1 \text{ mol Al}_2\text{S}_3}{6 \text{ mol H}_2\text{O}} = 0.0788 \text{ moles of aluminum sulfide needed to}$$

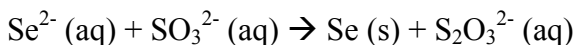
completely react with all the water present

Because there is not enough water to react with the entire amount of aluminum sulfide present water is the limiting reagent.

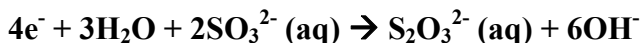
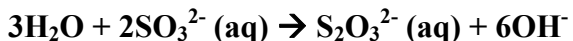
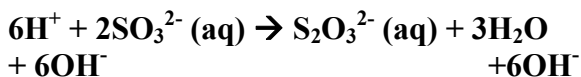
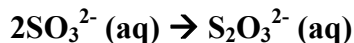
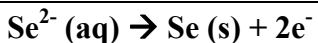
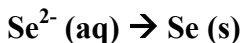
$$0.473 \text{ mol H}_2\text{O} \times \frac{3 \text{ mol H}_2\text{S}}{6 \text{ mol H}_2\text{O}} = 0.237 \text{ mol H}_2\text{S} \times \frac{34.086 \text{ g}}{1 \text{ mol}} = 8.08 \text{ g H}_2\text{S}$$

The Redox problem is on the next page ...

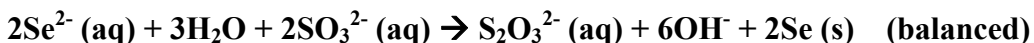
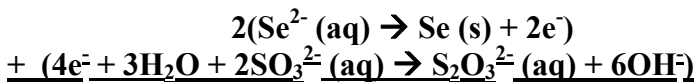
(10 points) Balance the following redox reaction in basic solution:



Split into half reactions:



Combine the two balanced half reactions to obtain the overall balanced redox reaction: (Multiply the oxidation half reaction by 2 so that the electrons cancel)



(3 points) Which species is the oxidizing agent? SO₃²⁻