

Final Exam Review - Answers to Written Response

Monday, June 01, 2015
1:30 PM

PART B: WRITTEN RESPONSE

Suggested Time: 40 minutes

INSTRUCTIONS: Answer the following questions in the space provided in this **Response Booklet**. You are expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in this **Response Booklet**. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculations, full marks will NOT be given for providing only an answer.**

1. Consider the reaction: $2\text{Zn(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{ZnO(s)}$

State two different methods that would increase the rate of this reaction.
Explain each in terms of collision theory.

(4 marks)

Method 1: crush Zn to a powder

Explanation: increase surface area

Method 2: increase Temperature

Explanation: increase # of collisions

2. Consider the equilibrium: $\text{CO}_2\text{(g)} + \text{H}_2\text{(g)} \rightleftharpoons \text{CO(g)} + \text{H}_2\text{O(g)}$ $K_{eq} = 1.60$

Initially, 8.2 mol of CO_2 and 8.2 mol of H_2O are placed in a 2.0L container and allowed to react.
Calculate the equilibrium concentrations of CO_2 and CO .

(4 marks)

$$\text{Conc}_I = \frac{8.2 \text{ mole}}{2.0\text{L}} = 4.1\text{M of } [\text{CO}_2] + [\text{H}_2\text{O}] \text{ initial}$$

	CO_2	H_2	\rightleftharpoons	CO	H_2O
I	0	0		4.1M	4.1M
Δ	+x	+x		-x	-x
E	x	x		4.1M-x	4.1M-x

$$K_{eq} = \frac{[\text{CO}][\text{H}_2\text{O}]}{[\text{CO}_2][\text{H}_2]}$$

$$1.6 = \frac{(4.1-x)(4.1-x)}{x \cdot x}$$

$$\begin{aligned} \Rightarrow \therefore x^2 \times 1.6 &= (4.1-x)^2 \\ \sqrt{1.6} \times x &= 4.1-x \\ 1.2649x &= 4.1-x \\ 2.2649x &= 4.1 \\ x &= \frac{4.1}{2.2649} = 1.81 \\ \therefore [\text{CO}_2] &= 1.81\text{M at equil.} \\ [\text{CO}] &= 4.1 - 1.81 = 2.29\text{M} \end{aligned}$$

3. What is the maximum $[Pb^{2+}]$ that can exist in a saturated solution of $BaSO_4$ without causing precipitate formation? (4 marks)



$$K_{sp} = [Ba^{2+}][SO_4^{2-}]$$

$$1.1 \times 10^{-10} = x^2$$

$$\sqrt{1.1 \times 10^{-10}} = x$$

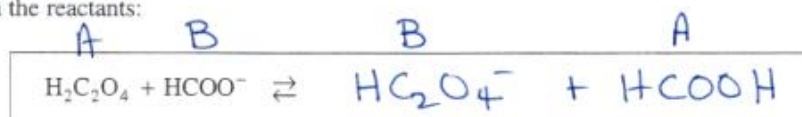
$$1.048 \times 10^{-5} M = x = [SO_4^{2-}]$$

$$\therefore K_{sp} = [Pb^{2+}][SO_4^{2-}]$$

$$[Pb^{2+}] = \frac{1.8 \times 10^{-8}}{1.048 \times 10^{-5} M}$$

$$[Pb^{2+}] = 1.7 \times 10^{-3} M$$

4. Given the reactants:



Complete the acid-base equilibrium equation in the box above.

Determine whether reactants or products will be favoured and explain why.

(3 marks)

since $H_2C_2O_4$ is a stronger weak acid than $HCOOH$ the product side will be favoured.

5. Calculate the pH of a 0.30M H_2S solution. Begin by writing the equation for the predominant reaction.

(5 marks)



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HS}^-]}{[\text{H}_2\text{S}]}$$

$$6 + x = [\text{H}_3\text{O}^+]_{\text{EQU.}}$$

$$\text{Assume } [\text{H}_2\text{S}]_{\text{eq}} = [\text{H}_2\text{S}]_i - x$$

$$9.1 \times 10^{-8} = \frac{x \cdot x}{0.30}$$

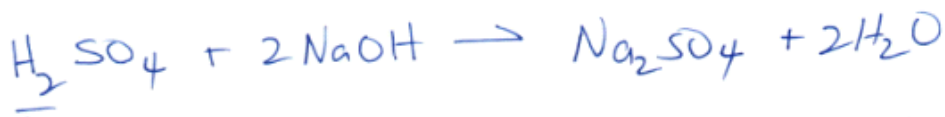
$$x = \sqrt{0.30 \times 9.1 \times 10^{-8}}$$

$$x = 1.652 \times 10^{-4} \text{ M}$$

$$\begin{aligned} \therefore \text{pH} &= -\log[\text{H}_3\text{O}^+] \\ \text{pH} &= -\log(1.652 \times 10^{-4}) \\ \text{pH} &= 3.78 \end{aligned}$$

6. What mass of NaOH(s) is required to just neutralize 50.0 mL of 2.0M H_2SO_4 ? Begin by writing the balanced equation for the neutralization reaction.

(3 marks)



$$\text{moles } \text{H}_2\text{SO}_4 = 2.0 \text{ M} \times 0.050 \text{ L} = 0.100 \text{ moles}$$

$$\therefore 2 \times 0.100 \text{ moles of } \text{H}^+ \text{ will be produced}$$

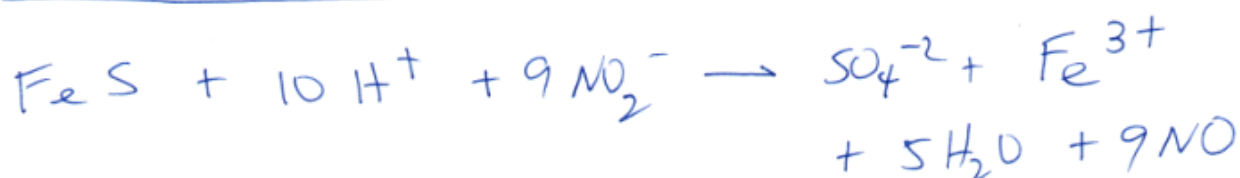
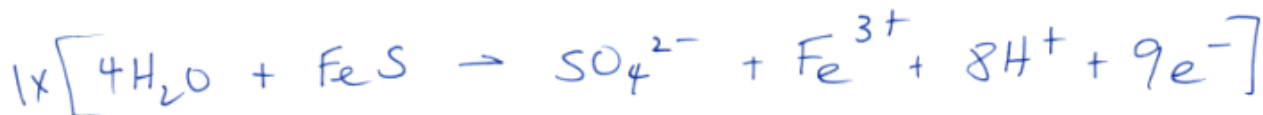
$$\therefore \text{need } 0.200 \text{ moles of } \text{NaOH}$$

$$\begin{aligned} \text{mass } \text{NaOH} &= 0.200 \text{ moles} \times 40.0 \text{ g/mole} \\ &= 8.0 \text{ g.} \end{aligned}$$

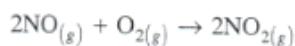
7. Balance the following in acidic solution.



(4 marks)



8. Consider the following overall reaction which is exothermic:



a) Complete the proposed two-step reaction mechanism.

(2 marks)

Step 1	$\text{NO} + \text{NO} \rightarrow \text{N}_2\text{O}_2$
Step 2	$\text{N}_2\text{O}_2 + \text{O}_2 \rightarrow 2\text{NO}_2$



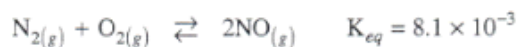
b) Describe how adding a catalyst would affect the activation energy and ΔH for the overall reaction?

(2 marks)

- lower activation energy

- would not change ΔH

9 Consider the following equilibrium:



A 2.0L container is filled with 0.15 mol N_2 , 0.15 mol O_2 and 0.050 mol NO .

Does the $[\text{NO}]$ increase or decrease as equilibrium is established? Support your answer with appropriate calculations.

(4 marks)

$$\text{conc} = \frac{0.15}{2.0\text{L}} = 0.075\text{M} \quad \text{N}_2 + \text{O}_2$$

$$\text{conc} = \frac{0.050}{2.0\text{L}} = 0.025\text{M} \quad \text{NO}$$

$$Q = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} = \frac{(0.025)^2}{(0.075)^2}$$

$$Q = 0.111$$

$$\text{since } Q > K_{eq} \\ 0.111 > 8.1 \times 10^{-3}$$

$[\text{NO}]$ will decrease
as reaction shifts back
towards reactants.

10 Calculate the iodate ion concentration in a saturated copper (II) iodate solution at 25°C .

(3 marks)

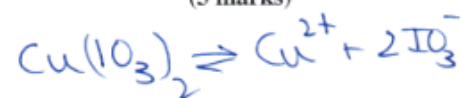
$$K_{sp} = [\text{Cu}^{2+}][\text{IO}_3^-]^2$$

$$6.9 \times 10^{-8} = x(2x)^2 \\ = 4x^3$$

$$4 \times \frac{6.9 \times 10^{-8}}{4} = x^3$$

$$\sqrt[3]{1.725 \times 10^{-8}} = x$$

$$2.58 \times 10^{-3} = x$$



$$6+x = [\text{Cu}^{2+}]$$

$$2x = [\text{IO}_3^-]$$

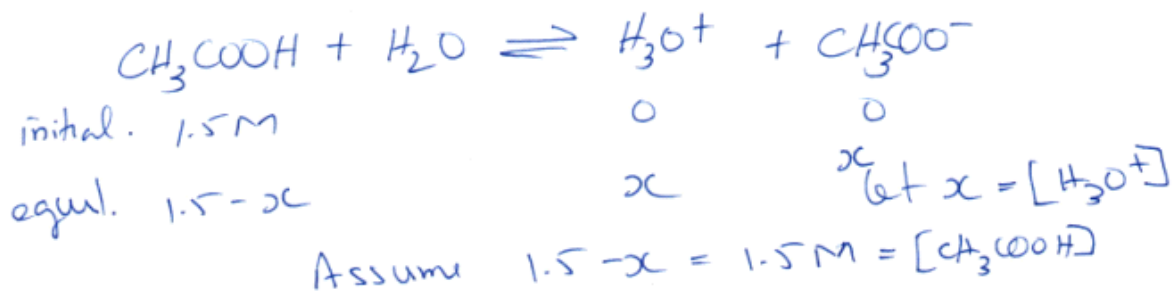
$$\therefore [\text{IO}_3^-] = 2x$$

$$= 2 \times 2.58 \times 10^{-3}$$

$$[\text{IO}_3^-] = 5.2 \times 10^{-3}\text{M}$$

OVER

1. Calculate the pH of a sample of 1.5 M CH_3COOH . Begin by writing the equation for the predominant equilibrium reaction. (5 marks)



$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$$

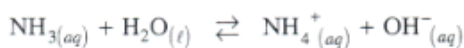
$$1.8 \times 10^{-5} = \frac{2x \cdot 2x}{1.5}$$

$$x = \sqrt{1.5 \times 1.8 \times 10^{-5}}$$

$$x = 0.005196 = [H_3O^+]$$

$$\therefore pH = -\log(0.005196)$$
$$pH = 2.28$$

- 12 State the sequence of events that occur when a small amount of $\text{HCl}_{(aq)}$ is added to a buffer such as:



omit

Be sure to describe the stress, the shift and the effect on pH that occur.

(3 marks)

H^+ react with OH^- to form H_2O
removing the extra H^+ from sol.
the reaction will shift to the right
producing more OH^- keeping the
pH relatively the same

OVER

13. (4 marks)

Balance the following redox equation in acidic solution:

