

**GENERAL CHEMISTRY 2
SECOND HOUR EXAM
MARCH 18, 2022**

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ (20 points)

Part 2 _____ (42 points)

Part 3 _____ (38 points)

TOTAL _____ (100 points)

Do all of the following problems. Show your work.

Unless otherwise stated, you may assume $T = 25. \text{ }^\circ\text{C}$ in all problems.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

1) For a system at equilibrium which of the following could be true?

- a) $Q_C > K_C$
- b) $Q_C = K_C$
- c) $Q_C < K_C$
- d) Both a and c
- e) Both a and b and c

2) In the gas phase sulfur dioxide (SO_2) and chlorine (Cl_2) will react to form sulfuryl dichloride (SO_2Cl_2).



A system initially at equilibrium contains $\text{SO}_2(\text{g})$, $\text{Cl}_2(\text{g})$, and $\text{SO}_2\text{Cl}_2(\text{g})$. Which of the following changes will cause the number of moles of $\text{SO}_2(\text{g})$ in the system to increase?

- a) Add 0.100 moles of $\text{Cl}_2(\text{g})$ to the system
- b) Add 0.100 moles of $\text{SO}_2\text{Cl}_2(\text{g})$ to the system
- c) Increase the temperature of the system by $40.0 \text{ }^\circ\text{C}$
- d) Both a and c
- e) Both b and c

3) Potassium nitrite (KNO_2) is the salt of a weak acid and a strong soluble base. KNO_2

- a) is a strong acid
- b) is a weak acid
- c) is a strong base
- d) is a weak base
- e) has no acid or base properties

4) Which of the following oxides is expected to form a base when added to liquid water?

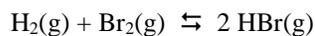
- a) Na_2O
- b) SO_2
- c) N_2O_5
- d) Both b and c
- e) Both a and b and c

5) A Lewis acid

- a) is a proton donor
- b) is an electron pair donor
- c) is a proton acceptor
- d) is an electron pair acceptor
- e) none of the above

Part 2. Short answer.

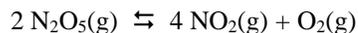
1) The equilibrium constant for the reaction



is $K_C = 2.0 \times 10^9$ at $T = 25. \text{ }^\circ\text{C}$.

For a particular system at equilibrium at $T = 25. \text{ }^\circ\text{C}$ $[\text{Br}_2] = 4.0 \times 10^{-5} \text{ M}$ and $[\text{HBr}] = 0.164 \text{ M}$. Based on this information, what is the value for $[\text{H}_2]$, the concentration of H_2 present in the system? [6 points]

2) The equilibrium constant for the reaction



is $K_C = 8.0 \times 10^{-6}$ at $T = 25. \text{ }^\circ\text{C}$.

a) What is the numerical value for K_p for the above reaction? [4 points]

b) A particular system has the following initial concentrations: $[\text{N}_2\text{O}_5] = 0.0160 \text{ M}$; $[\text{O}_2] = 0.0500 \text{ M}$. There is initially no NO_2 present in the system. Give an ICE table for this system and initial concentrations, but do not use the ICE table to find the equilibrium concentrations that are present. [6 points]

3) Define the following term: amphoteric [5 points]

4) For each of the following, circle the correct answer. There is one and only one correct answer per problem. [3 points each]

a) The conjugate base in the reaction: $\text{HI}(\text{aq}) + \text{C}_5\text{H}_5\text{N}(\text{aq}) \rightarrow \text{C}_5\text{H}_5\text{NH}^+(\text{aq}) + \text{I}^-(\text{aq})$

$\text{C}_5\text{H}_5\text{N}$ $\text{C}_5\text{H}_5\text{NH}^+$ HI I^-

b) The hydroxide compound that is a strong soluble base

AgOH CsOH $\text{Cu}(\text{OH})_2$ $\text{Fe}(\text{OH})_3$

c) The strongest weak acid

NH_3 H_2O H_2S H_2Se

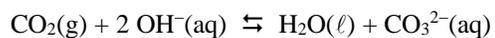
5) The pH of a 0.0270 M solution of a weak monoprotic acid HA is $\text{pH} = 4.17$

a) What are the values for pOH and $[\text{H}_3\text{O}^+]$ for the solution? [6 points]

b) What is the value for the percent dissociation for HA in the above solution? [6 points]

Part 3. Problems.

1) When carbon dioxide (CO_2) is bubbled through an aqueous solution of a strong base, the following reaction will take place



a) Give the expression for K , the thermodynamic equilibrium constant, for the above reaction. [5 points]

b) Using the thermodynamic data below, find the numerical value for K for the above reaction. [12 points]

substance	ΔH°_f (kJ/mol)	ΔG°_f (kJ/mol)	S° (J/mol·K)
$\text{CO}_2(\text{g})$	- 393.5	- 394.4	213.8
$\text{CO}_3^{2-}(\text{aq})$	- 677.1	- 527.8	- 56.9
$\text{H}_2\text{O}(\ell)$	- 285.8	- 237.1	70.0
$\text{OH}^-(\text{aq})$	- 230.0	- 157.2	- 10.8

2) Data for several weak monoprotic acids are given below and may be used in doing the following problem.

CH ₃ COOH	$K_a = 1.8 \times 10^{-5}$	HOCN	$K_a = 3.5 \times 10^{-4}$
HClO	$K_a = 4.0 \times 10^{-8}$	N ₂ H ₄	$K_a = 7.9 \times 10^{-9}$
HN ₃	$K_a = 2.5 \times 10^{-5}$	HIO	$K_a = 3.2 \times 10^{-11}$

a) Give the conjugate base of cyanic acid (HOCN). [3 points]

conjugate base of HOCN = _____

b) The strongest acid from the following list (circle the correct answer). [3 points]

CH₃COOH HClO HN₃ N₂H₄

c) The strongest base from the following list (circle the correct answer). [3 points]

CH₃COO⁻ ClO⁻ N₃⁻ N₂H₃⁻

d) What is the pH of a 0.0600 M aqueous solution of hypoiodous acid (HIO)? [12 points]