# CHE 107 MID-TERM EXAMINATION I

13 Feb 19

**University of Kentucky** **Department of Chemistry**

Name: _____ SID: _____ Seat No.: _____ Room:

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| | 1. | The equilibrium constant ($K_c$) for the reaction<br>$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$<br>is 0.650 at 375%C. What is the equilibrium constant, $K_c$, for the reaction<br>$NH_3(g) \rightleftharpoons N_2(g) + H_2(g)$<br>at 375%?<br>A. 1.54 B. 0.420 C. 1.24 D. 0.810 |

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| | 2. | The equilibrium constant ($K_c$) for the reaction<br>$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$<br>is 0.650 at 375%C. What is the value of $K_p$ for the same reaction?<br>A. $2.30 \times 10^{-4}$ B. $1.84 \times 10^{3}$ C. $5.44 \times 10^{-4}$ D. $6.86 \times 10^{-4}$ |

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| | 3. | Which of the following reactions would have the same value for $K_p$ and $K_c$?<br>A. $2\ NO_2(g) \rightleftharpoons N_2O_4(g)$<br>B. $PbO(s) + C(s) \rightleftharpoons Pb(2) + CO(g)$<br>C. $2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$<br>D. $H_2(g) + Br_2(g) \rightleftharpoons 2\ HBr(g)$ |

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| | 4. | Select the correct equilibrium constant expression for the following reaction.<br>$2\ ZnS(s) + 3\ O_2(g) \rightleftharpoons 2\ ZnO(s) + 2\ SO_2(g)$ |

A. C.

B. D.

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| | 5. | Hydrogen iodide decomposes according to the reaction<br>$2\ HI(g) \rightleftharpoons H_2(g) + I_2(g)$<br>A 0.275 mol sample of HI was injected into a 1.00 L reaction vessel and allowed to come to equilibrium at a specified temperature. If the HI is found to be 20.0% dissociated at equilibrium, what is $K_c$ for the above reaction?<br>A. 0.0156 B. 0.125 C. 16.0 D. 0.444 |

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| | 6. | Calculate the concentrations of $H_2$, $I_2$ and HI at equilibrium if 0.0400 mol of HI is placed in a 1.00 L flask at 430 °C. $K_c$ for the reaction<br>$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$<br>is 54.3 at this temperature. |

| | $[H_2]$ (M) | $[I_2]$ (M) | [HI] (M) |
|---|---|---|---|
| A. | 0.0200 | 0.0200 | 0.0200 |
| B. | 0.00427 | 0.00427 | 0.0315 |
| C. | 0.0315 | 0.0315 | 0.00850 |
| D. | 0.00478 | 0.00478 | 0.0352 |

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| | 7. | At equilibrium nitrosyl bromide, NOBr, is 34% dissociated at 25%C and the total pressure inside the glass reaction vessel is 0.25 atm.<br>$2\ NOBr(g) \rightleftharpoons 2\ NO(g) + Br_2(g)$<br>What is $K_p$ at this temperature?<br>A. 0.25 B. 3.5 C. $9.6 \times 10^{-3}$ 4. $1.4 \times 10^{-6}$ |

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| | 8. | A sample of pure $NO_2$ gas decomposes at a given temperature according to the |

reaction

$$2\ NO_2(g) \rightleftharpoons 2\ NO(g) + O_2(g)$$

with a $K_p = 206$. At equilibrium, $P_{NO} = 0.472$ atm. Calculate $P_{NO2}$ at equilibrium.

A. 0.236 atm B. 0.0160 atm C. 0.488 atm D. 0.472 atm

9. The equilibrium constant, $K_c$, for the reaction

$$2\ NO(g) + Cl_2(g) \rightleftharpoons 2\ NOCl(g)$$

is $6.5 \times 10^4$ at 35%C. If $3.0 \times 10^{-2}$ mol of NO, $6.3 \times 10^{-3}$ mol of $Cl_2$ and 5.4 mol of NOCl are mixed in a 3.0 L flask, in which direction will the system proceed to reach equilibrium?

A. It will shift to the right.
B. It will shift to the left.
C. The system is at equilibrium so there will be no shift.
D. Insufficient information is given to determine the shift.

10. The equilibrium concentrations of the species A(*g*), B(*g*) and C(*g*) in the reaction

$$2\ A(g) + B(g) \rightleftharpoons 2\ C(g)$$

will not change

A. when the temperature is changed.
B. when the pressure is changed.
C. when the volume is changed.
D. when a catalyst is added.

11. Suppose that the volume of the container of an equilibrium mixture of the gases NO, $O_2$, and $NO_2$ is suddenly doubled at constant temperature. When the system

$$2\ NO(g) + O_2(g) \rightleftharpoons 2\ NO_2(g)$$

returns to equilibrium,

A. the concentration of $NO_2$ will have increased.
B. the value of the equilibrium constant, $K_c$, will have increased.
C. the concentrations of NO and $O_2$ will have increased.
D. the value of the equilibrium constant, $K_p$, will have decreased.

12. Heating solid sodium bicarbonate in a closed vessel established the following

equilibrium:

$$2\ NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

What would happen to the equilibrium position if some of the $CO_2$ were removed from the system?

A. No effect.
B. The value of $K_p$ will decrease.
C. Shift to the left.
D. Shift to the right.

13. The conjugate acid of HSO is

A. $SO^-$ B. $H_3O^+$ C. $H_2SO_4$ D. $HSO^-$

14. What is the correct ordering of pH for 0.20 M solutions of the following acids?

$C_6H_5COOH$ $K_a = 6.5 \times 10^{-5}$

HCN $K_a = 4.9 \times 10^{-10}$

HCOOH $K_a = 1.7 \times 10^{-4}$

$HNO_2$ $K_a = 4.5 \times 10^{-4}$

A. HCN > $C_6H_5COOH$ > HCOOH > $HNO_2$

B. HCN > $C_6H_5COOH$ > $HNO_2$ > HCOOH

C. HCOOH > $HNO_2$ > $C_6H_5COOH$ > HCN

D. $HNO_2$ > HCOOH > $C_6H_5COOH$ > HCN

15. Calculate the pH of a $2.8 \times 10^{-4}$ M $Ba(OH)_2$ solution.

A. 10.45 B. 10.75 C. 3.25 D. 3.55

16. Which of the following statements about a 0.10 M solution of a strong acid, HZ, is true?

A. $[HZ] >> [Z^-]$
B. $[H^+] << [HZ]$
C. $[H^+] > [Z^-]$
D. pH = 1.0

17. To which one of the following would addition of an equal volume of 0.60 M NaOH solution lead to a final solution having the **lowest** pH?

A. 0.30 M HCl B. 0.40 M $NaNO_3$ C. 0.70 M KOH D. pure water

18. What is the % ionization of hydrofluoric acid in a 0.0046 M HF solution? ($K_a$ of HF is $7.0 \times 10^{-4}$)

A. 5.3% B. 74% C. 17% D. 32%

19. The pH of a HF solution is 6.20. The $K_a$ for HF is $7.1 \times 10^{-4}$. What is the ratio $[F^-]/[HF]$ at this pH?

A. $1.4 \times 10^{-4}$ B. $8.9 \times 10^{-4}$ C. $1.1 \times 10^{3}$ D. $8.7 \times 10^{3}$

20. When $2.0 \times 10^{-2}$ moles of a monoprotic acid is dissolved in 350.0 mL of water, the pH is 3.05. Calculate $K_a$ for this acid.

A. $1.6 \times 10^{-2}$ B. $5.7 \times 10^{-2}$ C. $8.9 \times 10^{-4}$ D. $1.4 \times 10^{-5}$

21. A 0.30 M solution of a weak base has a pH of 10.66. Calculate $K_b$ of the base.

A. $7.0 \times 10^{-7}$ B. $7.3 \times 10^{-11}$ C. $8.5 \times 10^{-6}$ D. $1.7 \times 10^{-5}$

22. Calculate the pH of a 0.28 M sodium acetate, $CH_3COONa$, solution. $K_a$ for $CH_3COOH$ is $1.8 \times 10^{-5}$.

A. 2.66 B. 4.90 C. 9.10 D. 11.34

23. Predict the pH of the following salt solutions:
$CaCl_2$, $K_3PO_4$, NaF, $NH_4NO_3$

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| A. | neutral | basic | basic | acidic |
| B. | basic | neutral | acidic | basic |
| C. | acidic | acidic | neutral | basic |
| D. | basic | acidic | acidic | neutral |

24. $P_4O_{10}$ is classified as an acidic oxide because it

A. is insoluble in water.
B. is amphoteric.
C. reacts with acids to produce a salt.
D. gives a solution of phosphoric acid, $H_3PO_4$, in water.

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| | 25. | Which of the following is a Lewis acid but <u>not</u> a Brønsted acid? |
| | | A. $HClO_4$ B. $Fe^{3+}$ C. HCN D. NH |