

EXAM I – Chapters 13 & 15

1. (4 pts) What is the correct K_C expression for the following reaction? $2 \text{C}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{CO}(\text{g})$
- $K_C = [2 \text{C}] [\text{O}_2] / [2 \text{CO}]$
 - $K_C = [\text{C}]^2 [\text{O}_2] / [\text{CO}]^2$
 - $K_C = [\text{CO}]^2 / [\text{O}_2]$**
 - $K_C = [\text{CO}]^2 / [\text{O}_2] [\text{C}]^2$
 - $K_C = [2 \text{CO}]^2 / [2 \text{O}_2]$
2. (4 pts) Which statement about the equilibrium constant is **true**? The value of K_C
- changes as product concentration changes.
 - changes as reactant concentration changes.
 - changes as temperature changes.**
 - never changes.
3. (5 pts) At 25°C , $K_C = 2.25 \times 10^4$ for the reaction $\text{C}_3\text{H}_8(\text{g}) + 5 \text{O}_2(\text{g}) \rightleftharpoons 3 \text{CO}_2(\text{g}) + 4 \text{H}_2\text{O}(\text{l})$. If $\Delta H^\circ_{\text{rxn}} = -2216 \text{ kJ}$, determine how the equilibrium position shifts as a result of each of the following disturbances:
- | | | | |
|--|-------------------|--------------------|------------------|
| a. 0.20 atm argon gas is added | Shift Left | Shift Right | No Affect |
| b. Dry ice is added at constant T | Shift Left | Shift Right | No Affect |
| c. The volume is decreased | Shift Left | Shift Right | No Affect |
| d. The temperature is increased | Shift Left | Shift Right | No Affect |
| e. $\text{Mg}(\text{ClO}_4)_2(\text{s})$ is added as a drying agent to remove H_2O | Shift Left | Shift Right | No Affect |
4. (6 pts) At 45°C , $K_C = 4.44 \times 10^{-5}$ for the reaction $3 \text{CO}_2 + 4 \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_3\text{H}_8(\text{g}) + 5 \text{O}_2(\text{g})$. Calculate K_P .
 $K_P = K_C(\text{RT})^{\Delta n} = (4.44 \times 10^{-5}) ((0.08206 \times 318)^3) = 0.789$
5. (4 pts) For the reaction $2 \text{CH}_3\text{CHO}(\text{g}) \rightleftharpoons 2 \text{C}_2\text{H}_4(\text{g}) + \text{O}_2(\text{g})$ there is more oxygen gas at higher temperatures than at lower temperatures. Is the forward reaction exothermic **or endothermic**?
6. (6 pts) As an acid gets stronger, the pH _____(increases/**decreases**), the hydronium ion concentration _____(increases/decrease), and the percent ionization _____(increases/decreases).
7. (4 pts) Which is more basic: **KCN** or NH_4CN ? _____
8. (5 pts) What is the pH of a solution of 0.0550 M nitric acid?
 $\text{pH} = -\log(0.0550) = 1.260$

9. (5 pts) For the reaction $4 \text{NH}_3(\text{g}) + 3 \text{O}_2(\text{g}) \rightleftharpoons 2 \text{N}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$, which of the following statements are true if the partial pressure of $\text{NH}_3 = 0.128 \text{ atm}$, the partial pressure of $\text{O}_2 = 0.080 \text{ atm}$, the partial pressure of $\text{N}_2 = 0.195 \text{ atm}$, and the partial pressure of $\text{H}_2\text{O} = 0.165 \text{ atm}$? $K_p = 1.23 \times 10^{-3}$.
- We are at equilibrium.
 - We must shift towards the reactants to reach equilibrium.
 - We must shift towards the products to reach equilibrium.
 - We need the temperature to find K_c first before we can solve the problem.
 - We can never reach equilibrium.

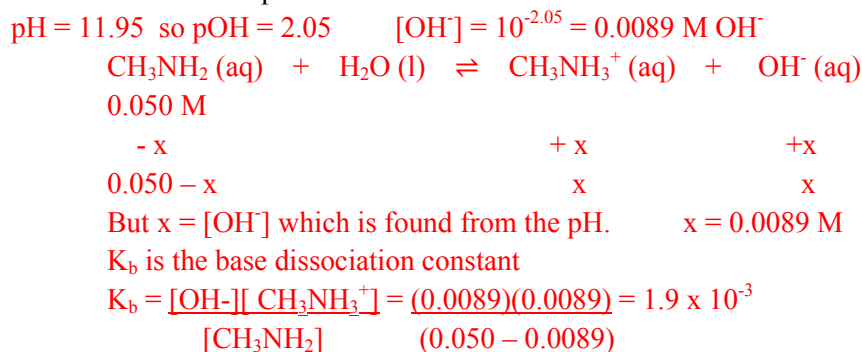
10. (5 pts) Arsenic acid has the formula H_3AsO_4 . It is considered to be a polyprotic acid since it has 3 H^+ ions it can donate. Which one of the following equilibrium expressions is correct for the donation of the **second** H^+ to water?

- $K_{a2} = [\text{H}_2\text{AsO}_4^-][\text{H}_3\text{O}^+] / [\text{H}_3\text{AsO}_4]$
- $K_{a2} = [\text{HAsO}_4^{2-}][\text{H}_3\text{O}^+] / [\text{H}_2\text{AsO}_4^-]$
- $K_{a2} = [\text{AsO}_4^{3-}][\text{H}_3\text{O}^+]^3 / [\text{H}_3\text{AsO}_4]$
- $K_{a2} = [\text{AsO}_4^{3-}][\text{H}_3\text{O}^+] / [\text{HAsO}_4^{2-}]$

11. (4 pts) Which one of the following can behave either as a Bronsted-Lowry acid or a Bronsted-Lowry base in an aqueous solution reaction?

- HSO_3^-
- NH_3
- HI
- H_3PO_4

12. (6 pts) Determine the **base** dissociation constant for a methylamine (CH_3NH_2) solution if the initial concentration is 0.050 M and has a pH of 11.95.



13. (4 pts) Identify the conjugate acid/base pairs present in an aqueous solution of hydrogen sulfate ion, HSO_4^- .

- $\text{HSO}_4^-/\text{H}_2\text{O}$ and $\text{H}_2\text{SO}_4/\text{OH}^-$
- $\text{HSO}_4^-/\text{H}_2\text{O}$ and $\text{H}_3\text{O}^+/\text{SO}_4^{2-}$
- $\text{H}_2\text{SO}_4/\text{HSO}_4^-$ and $\text{H}_2\text{O}/\text{OH}^-$
- $\text{HSO}_4^-/\text{SO}_4^{2-}$ and $\text{H}_3\text{O}^+/\text{H}_2\text{O}$

14. (6 pts) What is the pH of a 0.250 M acetic acid (CH_3COOH) solution that has a $K_a = 1.8 \times 10^{-5}$?

