1.) The position of equilibrium for the reaction

\[ \text{ZnO(s) + H}_2\text{(g)} \rightleftharpoons \text{Zn(s) + H}_2\text{O(g)} \]

does not depend upon which of the following: (1) concentration of ZnO(s); (2) concentration of H\(_2\)(g); (3) concentration of Zn(s); (4) concentration of H\(_2\)O(g); (5) the value of K\(_e\)?

a.) (1), (2), (3)  
b.) (2), (3), (4)  
c.) (5)  
d.) (2), (3)  
e.) (1), (3)

2.) Which way will the following reactions, initially at equilibrium, shift when the temperature is decreased at constant pressure?

1.) \( 2\text{C}_2\text{H}_4\text{(g)} + \text{SO}_3\text{(g)} \rightleftharpoons 4\text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)} \quad \Delta H = -1297 \text{ kJ} \) right

2.) \( \text{CO}_2\text{(g)} + \text{O}_2\text{(g)} \rightleftharpoons \text{C}(s) \quad \Delta H = +393 \text{ kJ} \) left

3.) \( 4\text{Fe}(s) + 3\text{O}_2\text{(g)} \rightleftharpoons 2\text{Fe}_2\text{O}_3\text{(s)} \quad \Delta H = -1644 \text{ kJ} \) right

3.) A substance that donates a proton in a chemical reaction can be described as:

a.) Bronsted-Lowry acid  
b.) Bronsted-Lowry base  
c.) Conjugate base  
d.) Arrhenius acid  
e.) Arrhenius base

4.) A solution with a [OH\(^-\)] = 5.5 \times 10^{-7} \text{ M} at 25 \text{ °C} is

a.) Acidic  
b.) Basic  
c.) Neutral

5.) What is the value of K\(_e\) for the following reaction if the equilibrium concentrations are \([A] = 0.60 \text{ M} [B] = 0.35 \text{ M} [C] = 0.55 \text{ M}\)?

\[ 2 \text{A (aq)} + \text{B (aq)} \rightleftharpoons 2 \text{C (aq)} \]

\[ K_c = \frac{[\text{C}]^2}{[\text{A}]^2[\text{B}]} = \frac{(0.55)^2}{(0.60)(0.35)} = 2.10 \]

6.) Initially 0.035 moles of SO\(_2\), 0.5 moles of SO\(_2\)Cl\(_2\), and 0.08 moles of Cl\(_2\) are combined in a 5 liter flask. What is the value of Q and which direction will the reaction proceed to establish equilibrium?

\[ \text{SO}_2\text{Cl}_2\text{(g)} \rightleftharpoons \text{SO}_2\text{(g)} + \text{Cl}_2\text{(g)} \quad K_c = 0.078 \]

\[ \begin{array}{c|c|c|c}
\text{SO}_2\text{Cl}_2 & \text{SO}_2 & \text{Cl}_2 \\
0.035 \text{ mol} & 0.5 \text{ mol} & 0.08 \text{ mol} \\
0.07 \text{ M} & 0.07 \text{ M} & 0.07 \text{ M} \\
\end{array} \]

\[ Q = \frac{[\text{C}] \times [\text{SO}_2\text{Cl}_2]}{[\text{SO}_2] \times [\text{Cl}_2]} = \frac{(0.07)(0.07)}{(0.07)(0.07)} = 1 \]

\[ Q = 1.12 \times 10^{-3} \]

Q < K moves forward
7.) What is the Keq expression for the following reaction?

\[2 \text{NO}(g) + 2 \text{H}_2(g) \rightleftharpoons \text{N}_2(g) + 2 \text{H}_2\text{O}(g)\]

\[K_{eq} = \frac{[\text{N}_2][\text{H}_2\text{O}]}{[\text{NO}]^2[\text{H}_2]^2}\]

8.) Which of these conjugate acid-base pairs will NOT function as a buffer?
   a. CH₃COOH and CH₃COO⁻
   b. HCl and Cl⁻ - strong acid & its CB
   c. HCO₃⁻ and CO₃²⁻
   d. All of the above will function as a buffer

9.) Which one of the following binary compounds would you expect to be the most acidic?
   a. NaH
   b. CH₃
   c. SnH₄
   d. H₂O
   e. H₃S
   has weakest H-X bond

10.) TRUE or FALSE: NH₄OH is an oxoacid. not acidic

11.) The aqueous solution of KClO₃ is
   a. Acidic
   b. Basic
   c. Neutral
   \[K^+ + \text{ClO}_3^-\]
   \[\text{HClO}_3 = \text{SH}\]

12.) Which of the following 0.1 M solutions has the smallest pH?
   a. NH₄Cl
   b. NaNO₃
   c. BaCl₂
   d. NH₃ + base
   e. Na₂CO₃

13.) The pH of a 0.15 M weak base B is 9.25. What is K_b for B?
\[\text{B} + \text{H}_2\text{O} \rightleftharpoons \text{BH}^+ + \text{OH}^-\]
\[\text{pH} + 14 = \text{pK}_b = 4.75\]
\[E = \text{K}_w = 10^{-14} = 1.78 \times 10^{-5}\]
\[K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]} = \frac{(1.78 \times 10^{-5})^2}{1.15} \approx 2.11 \times 10^{-9}\]

14.) Label the following as a SA, WA, or negligible and write its conjugate base.
   a. HCOOH WA / HCOO⁻ / WB
   b. H₂ negligible, H⁻ SB
   c. CH₄ negligible, CH₃⁻ SB
   d. HF WA / F⁻ WB
   e. NH₃ WB / NH₂WB
15.) Given the $K_a$ for ammonia is $1.8 \times 10^{-5}$ and for hydrazine is $1.1 \times 10^{-8}$, which is the stronger base?
   a. weaker
   b. stronger
   c. $K_a = 1.8 \times 10^{-5}$

\[
K_a = \frac{[\text{H}^+][\text{NH}_2]}{[\text{NH}_3]} = 1.8 \times 10^{-5}
\]

16.) If a solution of HF ($K_a = 6.8 \times 10^{-4}$) has a pH of 3.65 calculate the concentration of hydrofluoric acid.

\[
[H^+] = 10^{-3.65} = 2.23 \times 10^{-4}
\]

\[
K_a = 6.8 \times 10^{-4} = \frac{[H^+][F^-]}{[HF]}
\]

\[
6.8 \times 10^{-4} = \frac{2.23 \times 10^{-4}}{y}
\]

\[
y = 2.23 \times 10^{-4}
\]

17.) Determine the pH of an initial 0.95 M solution of HOCl ($K_a = 3.0 \times 10^{-8}$)

\[
K_a = \frac{(10^{-7})(x)}{0.95} = 3.0 \times 10^{-8}
\]

\[
pH = -\log(1.7 \times 10^{-4}) = 3.76
\]

18.) Explain why a mixture formed by mixing 100 mL of 0.100 M CH$_3$COOH and 50 mL of 0.100 M NaOH will act as a buffer.

\[
\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}
\]

As long as CH$_3$COOH has excess, the solution will contain both buffer components.
CH3

Change in: concentration, temp., volume, pressure

ICE: find x or K

Q = k_eq, k but at any point in the reaction?

- Q=k_eq forms reactants
- Q=k forms products

B: Acid - proton (H+) donors (lose H+)

HF + H2O = H3O+ + F-

Ka 71 = SA, how much H+ dissociate to make H3O+

Kp 71 = SB

HCl, HI, HBr, HNO3, H2SO3, HClO4

SA ≈ CB negligible (weak weak-base)

SB ≈ CA negligible (weak weak-acid)

pH, Ka, Kp, pK_a, pK_b, [H+]

pH = -log[H+]^1, [H+] = 10^(-pH), pOH = -log[OH+], [OH+] = 10^-pOH

H2O + H2O = H3O+ + OH-

Kw = 10^(-14) at 25°C

at 25°C, pH = 7, neutral, pH > 7, basic, pH < 7, acidic

[OH-] more, [H+] more

ICE

Ka(HA) = Kw/Kb(H-)

Kb(B) = Kw/Ka(HB+)

H-X more acidic in this direction

HOCl, more O:H more acidic

more than one acidic H: K_a1 > K_a2 > K_a3

= 1: Acid + its conjugate base

- Usually weak acids & bases

HA + CB, 1/2SA + WB, 1/2SB + WH