

CHEMISTRY 1B – Fall, 2015
EXAM 1 – VERSION A

Use Scantron Form SC982-E and select the letter corresponding to the correct answer. Make sure to put **your full name, lab section number, and exam version** (under test no.) on the Scantron Form.

Equations and constants that you could need: $0^{\circ}\text{C} = 273\text{ K}$; $K_w = 1.0 \times 10^{-14}$

The quadratic equation for $ax^2 + bx + c = 0$ is $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

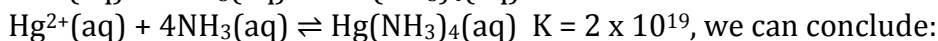
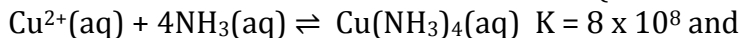
A periodic table is provided on the last page along with a blank page to be used as scratch paper.

Part I. Multiple Choice Section. All Questions have only one correct answer. Each Question is worth 4 points.

1. The reaction $2\text{NO}_2(\text{g}) \leftrightarrow \text{N}_2\text{O}_4(\text{g})$ is at equilibrium. This means that:

- a) No molecules of reactant or product are being converted any longer
- b) For every 2 molecules of NO_2 that react to form N_2O_4 , one of ~~NO_2~~ N_2O_4 reacts backwards.
- c) The rate constants for the forward reaction and backwards reaction are equal
- d) The forward and backwards rates have decreased to zero

2. Given the K values for the two reactions (with the right side called a “complex”):



- a) Cu^{2+} complexes weakly with NH_3
- b) Hg^{2+} complexes more strongly with NH_3 than Cu^{2+}
- c) NH_3 is a poor Lewis base
- d) Cu^{2+} and Hg^{2+} would remain mostly uncomplexed even with NH_3 present

3. Which of the following concentration based equilibrium equations correctly corresponds to the following chemical equation: $2\text{CO}(\text{g}) + 4\text{H}_2(\text{g}) \rightleftharpoons \text{C}_2\text{H}_5\text{OH}(\text{g}) + \text{H}_2\text{O}(\text{g})$?

a) $K_C = \frac{[\text{CO}][\text{H}_2]}{[\text{C}_2\text{H}_5\text{OH}][\text{H}_2\text{O}]}$

b) $K_C = \frac{[\text{CO}]^2[\text{H}_2]^4}{[\text{C}_2\text{H}_5\text{OH}][\text{H}_2\text{O}]}$

c) $K_C = \frac{[\text{C}_2\text{H}_5\text{OH}][\text{H}_2\text{O}]}{[\text{CO}][\text{H}_2]}$

d) $K_C = \frac{[\text{C}_2\text{H}_5\text{OH}][\text{H}_2\text{O}]}{[\text{CO}]^2[\text{H}_2]^4}$

4. In the reaction: $\text{CO}_3^{2-}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons 2\text{HCO}_3^-(\text{aq})$, all of the species except _____ will be included in the equilibrium equation.

- a) $\text{CO}_3^{2-}(\text{aq})$
- b) $\text{CO}_2(\text{g})$
- c) $\text{H}_2\text{O}(\text{l})$
- d) $\text{HCO}_3^-(\text{aq})$

5. For the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, If the initial partial pressure of N_2 , H_2 , and NH_3 are 10.0, 10.0 and 0 atm and the equilibrium partial pressure of NH_3 is 6.0 atm, $K_P =$

- a) 3.6×10^{-3}
- b) 0.06
- c) 0.14
- d) 5.1

6. Sulfur gases leaving a power plant exhaust stack have P_{SO_2} and P_{SO_3} equal to 1.0×10^{-2} atm and 5.0×10^{-4} atm, respectively and enter the air. If K_p for the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{SO}_3(\text{g})$ is 320, in which direction with the reaction proceed if $P_{\text{O}_2} = 0.20$ atm?

- a) to the products
b) to the reactants
c) it is at equilibrium
d) depends on ΔH

7. If K_c for the reaction $2\text{Na}_2\text{O}_2(\text{s}) + 2\text{CO}_2(\text{g}) \rightleftharpoons 2\text{Na}_2\text{CO}_3(\text{s}) + \text{O}_2(\text{g})$ is 6.3×10^4 , what is the equilibrium concentration of CO_2 in M if the equilibrium concentration of O_2 is 0.0100 M?

- a) 1.6×10^{-7} b) 4.0×10^{-4} c) 2.0×10^{-4} d) 0.020 M

8. The reaction $2\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{N}_2\text{O}(\text{g})$ starts with $P_{\text{N}_2} = 0.79$ atm, $P_{\text{O}_2} = 0.20$ atm (and no N_2O) and proceeds to an equilibrium. The ICE table **equilibrium** partial pressures of N_2 , O_2 and N_2O (bottom row of table) will be:

- a) $0.79 - x$ and $0.20 - x$, and $+x$, respectively
b) $0.79 - 2x$ and $0.20 - x$, and $+2x$, respectively
c) $0.79 + x$ and $0.20 + x$, and $-x$, respectively
d) 0.79^2 , 0.2, and $2x^2$, respectively

9. If at 1000°C , $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$ has $K = 2.0 \times 10^{-9}$ and $\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ has $K = 38$, then $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ has $K =$

- a) 5.3×10^{-11} b) 7.6×10^{-8} c) 38 d) 1.9×10^{10}

10. The reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ reaches an equilibrium in a sealed 1.0 L flask. This reaction is endothermic. Which of the following changes will result in a shift toward the products?

- a) decreasing the flask temperature b) increasing the flask volume
c) adding a catalyst d) removing through N_2O_4 condensation

11. In the reaction: $\text{Al}(\text{H}_2\text{O})_6^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{Al}(\text{H}_2\text{O})_5\text{OH}^{2+}(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$, the Bronsted-Lowry acid (in the direction shown) is:

- a) $\text{Al}(\text{H}_2\text{O})_6^{3+}(\text{aq})$ b) $\text{H}_2\text{O}(\text{l})$ c) $\text{Al}(\text{H}_2\text{O})_5\text{OH}^{2+}(\text{aq})$ d) $\text{H}_3\text{O}^+(\text{aq})$

12. A Lewis acid is defined as a:

- a) a compound that produces H^+ in water b) a proton donor
c) an electron pair acceptor d) a positively charged acid

13. Which of the following salt solutions is neutral?

- a) KOH b) NH_4Cl c) Na_2CO_3 d) KNO_3

14. Which of the following acids has the strongest conjugate base (conjugate base with the greatest K_b)?

- a) HSO_4^- ($\text{p}K_a = 2.00$) b) HF ($\text{p}K_a = 3.17$)
c) N_2H_5^+ ($\text{p}K_a = 7.98$) d) HCN ($\text{p}K_a = 9.24$)

15. What is the pH of a 0.0050 M $\text{Ba}(\text{OH})_2$ solution? (Note: K_w given on p. 1)

- a) 0.01 b) 2.00 c) 11.70 d) 12.00

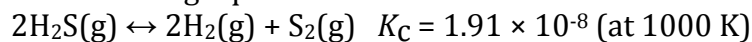
16. A solution has a pH of 4.89. $[H^+]$ is:
 a) 7.8×10^{-10} b) 1.3×10^{-5} c) 7.5×10^{-3} d) 0.69
17. What is the pH of a 0.20 M $HC_2H_3O_2$ acid ($K_a = 1.8 \times 10^{-5}$)?
 a) 0.70 b) 2.72 c) 4.74 d) 7.00
18. An unknown weak acid is prepared to an initial concentration of 0.010 M. The pH is measured to be 3.16. The percent ionization of that weak acid is:
 a) 0.16% b) 3.3% c) 6.9% d) 135%
19. A polyprotic acid is **defined as** an acid which:
 a) releases two or more protons per molecule b) is a polymer that is acidic
 c) has both acid and base functional groups d) all of the above
20. Which of the following combinations makes the best buffer?
 a) HCl + NaCl b) $NH_4Cl + NH_3$ c) $HC_2H_3O_2 + HCl$ d) $KOH + H_2O$
21. Fluorine is the most electronegative element and it stabilizes electron rich anions. Based on this, which of the following acids would be expected to be the strongest?
 a) CH_3CO_2H b) CFH_2CO_2H c) CF_2HCO_2H d) CF_3CO_2H
22. How many moles of sodium acetate should be added to a 1.0 L solution of 0.040 M acetic acid to make a pH = 5.00 buffer? (acetic acid $K_a = 1.8 \times 10^{-5}$)
 a) 0.023 moles b) 0.050 moles c) 0.070 moles d) 1.00 moles

23 - Bonus. Given K_a values below, which anion will make an acidic solution?

- a) HPO_4^{2-} b) HCO_3^- c) $HC_8H_4O_4^-$ d) $C_2H_3O_2^-$

Acid	K_{a1}	K_{a2}	K_{a3}
H_3PO_4	7.1×10^{-3}	6.3×10^{-8}	4.2×10^{-13}
H_2CO_3	4.5×10^{-6}	4.7×10^{-11}	NA
$H_2C_8H_4O_4$	1.1×10^{-3}	3.9×10^{-6}	NA
$HC_2H_3O_2$	1.8×10^{-5}	NA	NA

Work out Problem (12 pts) – Answer on the back of the Scantron and show work
 Consider the following equation:



If the initial concentration of $H_2S(g)$ was 0.060 M and the other species were at zero, what is the equilibrium concentration of the product, $H_2(g)$? You must show your work for full credit. If you make any simplifying assumptions, show and validate them.