Chemistry 112-2014, Vining NAME: _____

Exam #3 **Take Home Version**

1. When the reversible reaction, $N_2 + O_2 \rightleftarrows 2\ NO$, has reached a state of dynamic equilibrium, which statement below is true?

(a) Both the forward and reverse reactions stop completely and no more NO, N_2 or O_2 are produced.

(b) The rate of the forward reaction equals the rate of the reverse reaction.

(c) The rate constant of the forward reaction equals the rate constant of the reverse reaction.

2. For the reaction $2\ SO_2Cl_2(g) \rightleftarrows 2\ SO_2(g) + Cl_2(g)$, the expression for K_{eq} is

(a) $K_{eq} = \dfrac{[SO_2]^2[Cl_2]^2}{[SO_2Cl_2]^2}$

(b) $K_{eq} = \dfrac{[SO_2]^2[Cl_2]}{[SO_2Cl_2]^2}$

(c) $K_{eq} = \dfrac{2[SO_2]^2[Cl_2]}{2[SO_2Cl_2]^2}$

(d) $K_{eq} = \dfrac{[SO_2]^2[Cl_2]}{[SO_2Cl_2]}$

(e) $K_{eq} = \dfrac{[SO_2Cl_2]^2}{[SO_2]^2[Cl_2]}$

3. The equilibrium $2\ SO_2Cl_2(g) \rightleftarrows 2\ SO_2(g) + Cl_2(g)$ has an equilibrium constant of K = 22.6. What is the value of K for the equilibrium written as: $SO_2(g) + ½\ Cl_2(g) \rightleftarrows SO_2Cl_2(g)$?

(a) 22.6 (b) 0.0442 (c) 511 (d) 0.00196 (e) 0.210

4. Consider the system, $2\ CH_2Cl_2(g) \rightleftarrows CH_4(g) + CCl_4(g)$, which has an equilibrium constant of K = 2.4. If a system has:

$[CH_2Cl_2] = 0.22$ M
$[CH_4] = 1.64$ M
$[CCl_4] = 0.58$ M

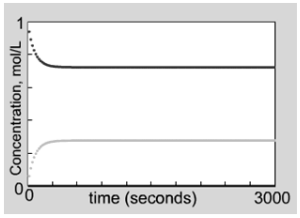
then, (a) the system is at equilibrium
(b) the system is not at equilibrium and will react to form more CH_2Cl_2
(c) the system is not at equilibrium and will react to form more CH_4 and CCl_4

5. The following system is at equilibrium $CH_4(g) + CCl_4(g) \rightleftarrows 2\ CH_2Cl_2(g)$.

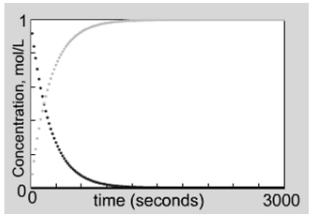
If CCl_4 is added to the sample, what will then happen to the concentrations of CH_4 and of CH_2Cl_2?

(a) both $[CH_4]$ and $[CH_2Cl_2]$ will increase
(b) both $[CH_4]$ and $[CH_2Cl_2]$ will decrease
(c) $[CH_4]$ will decrease and $[CH_2Cl_2]$ will increase
(d) $[CH_4]$ will increase and $[CH_2Cl_2]$ will decrease
(e) $[CH_4]$ will remain constant and $[CH_2Cl_2]$ will increase

Questions 6-7 use the following concentration-time plots. The black line represents reactants and the light gray line represents products. Answer with the correct letter.



a.



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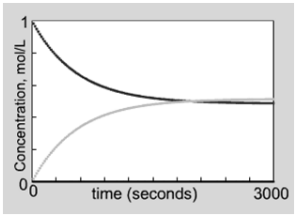

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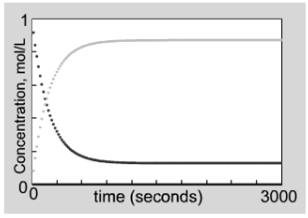
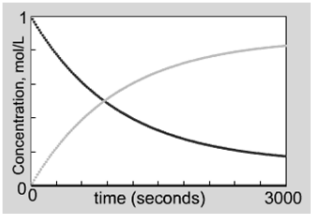


d.



e.

6. Which reaction goes to completion? Choose the letter

7. Which reaction has the smallest equilibrium constant? Choose the letter

8. What is the conjugate base of $HC_2O_4^-$?

(a) $H_2C_2O_4$ (b) $H_3C_2O_4^+$ (c) $2\ CO_2$ (d) $C_2O_4^{2-}$

9. What is the pH of a 0.000483 M solution of NaOH?

(a) 4.83×10^{-4} (b) 2.07×10^{-11} (c) 3.31 (d) 10.68 (e) 7.00

10. What are $[H_3O^+]$ and $[OH^-]$ for a solution that has a pH of 9.0?

(a) $[H_3O^+] = 9$ M and $[OH^-] = 5$ M

(b) $[H_3O^+] = 5$ M and $[OH^-] = 9$ M

(c) $[H_3O^+] = 1 \times 10^9$ M and $[OH^-] = 1 \times 10^5$ M

(d) $[H_3O^+] = 1 \times 10^{-5}$ M and $[OH^-] = 1 \times 10^{-9}$ M

(e) $[H_3O^+] = 1 \times 10^{-9}$ M and $[OH^-] = 1 \times 10^{-5}$ M

11. Which of the following are the pH ranges expected for solutions of NH_4NO_3 and KCN?

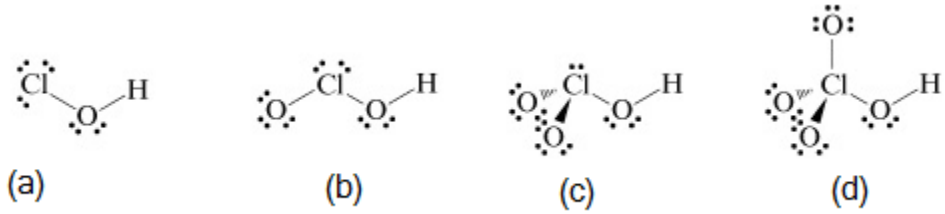
a) NH_4NO_3 is acidic and KCN is basic

b) NH_4NO_3 is acidic and KCN is neutral

c) NH_4NO_3 is basic and KCN is basic

d) NH_4NO_3 is neutral and KCN is acidic

12. Which of the following acids has the largest K_a value?



13. Consult the table of K_a values provided. Is it possible for a solution of hydrofluoric acid to have a higher pH than a solution of formic acid? That's all the information you are given- don't ask for more.

(a) yes (b) no (c) it is impossible to answer

14. A chemical system has an equilibrium constant of 1.4×10^{-6}. This means:

(a) ΔG^o is positive and the system is reactant-favored

(b) ΔG^o is negative and the system is product-favored

(c) ΔG is positive and the system is not spontaneous

(d) ΔG is negative and the system is spontaneous

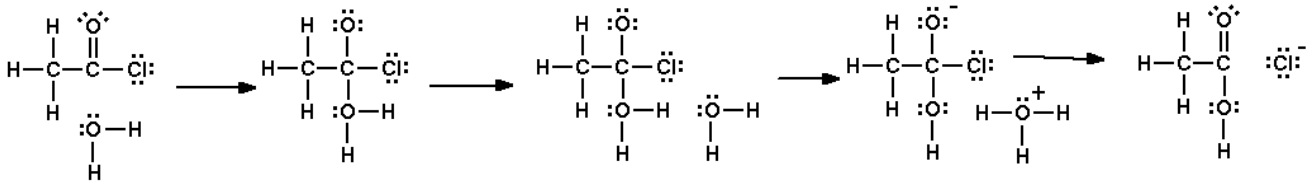
Exam **#3B:** ANSWER SHEET Name: _____

1.	a	b	c	d	e	8.	a	b	c	d	e
2.	a	b	c	d	e	9.	a	b	c	d	e
3.	a	b	c	d	e	10.	a	b	c	d	e
4.	a	b	c	d	e	11.	a	b	c	d	e
5.	a	b	c	d	e	12.	a	b	c	d	e
6.	a	b	c	d	e	13.	a	b	c	d	e
7.	a	b	c	d	e	14.	a	b	c	d	e

15. Write the net-ionic equation for the acid-base reaction occurring between HClO and KOH.

16. Consider the following set of reaction steps. Add the following labels to the species they represent. Point to the species and add the label. You label four things in total. If something is both Lewis and Bronsted, label it Bronsted. For example, find something that is acting as a Lewis Acid and draw and arrow to it labeled with "LA."

BA = Bronsted Acid LA = Lewis Acid
BB = Bronsted Base LB = Lewis Base



17. For each of the following, circle the one that will have the higher pH (or circle they are the same):

a. 0.1 M CH_3CO_2H or 0.1 M $NaCH_3CO_2$ or same

b. 0.1 M HCl or 0.1 NaOH or same

c. 0.1 M HCl or 0.1 M HNO_3 or same

18. A student ran the following reaction in the laboratory at **450** K: $\mathbf{PCl_5}(g) \rightleftarrows \mathbf{PCl_3}(g) + \mathbf{Cl_2}(g)$
When she introduced **0.789** moles of $\mathbf{PCl_5}(g)$ into a 1.00 liter container, she found the equilibrium concentration of $\mathbf{Cl_2}(g)$ to be **0.0312** M. Calculate the equilibrium constant, K_c.

K_c = _____

19. Butene isomerizes to form cyclobutane.

butene $\rightleftarrows$ cyclobutane K = 6.0

If a sample of 1.00 M butene is placed in a flask and allowed to react, what will [cyclobutane] be once equilibrium is established?

20. What is the pH of a 0.0030 M solution of HF?

pH = _____

21. A 0.100 M solution of a weak acid, HA, has pH = 3.88 at 25 ^oC and pH = 3.10 at 55 ^oC. What are ΔH^o and ΔS^o for the weak acid ionization reaction?

Useful Information

$pH = -\log[H_3O^+]$ $pOH = -\log[OH^-]$ $K_w = 1.0 \times 10^{-14}$ at 25 °C

$[H_3O^+] = 10^{-pH}$ $[OH^-] = 10^{-pOH}$ $\Delta G^o = -RT \ln K$ $\Delta G = \Delta G^o + RT \ln Q$

K_a and K_b Values

Name of Acid	Acid	K_a	Name of Base	Base	K_b
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	sulfate ion	SO_4^{2-}	8.3×10^{-13}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	dihydrogen phosphate ion	$H_2PO_4^-$	1.3×10^{-12}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	pentaaquahydroxoiron(III) ion	$Fe(H_2O)_5OH^{2+}$	1.6×10^{-12}
Hydrofluoric acid	HF	7.4×10^{-4}	fluoride ion	F^-	1.4×10^{-11}
Formic acid	HCO_2H	1.8×10^{-4}	formate ion	HCO_2^-	5.6×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	benzoate ion	$C_6H_5CO_2^-$	1.6×10^{-10}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	acetate ion	$CH_3CO_2^-$	5.6×10^{-10}
Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}	pentaaquahydroxoaluminum ion	$Al(H_2O)_5OH^{2+}$	1.3×10^{-9}
Carbonic acid	H_2CO_3	4.2×10^{-7}	hydrogen carbonate ion	HCO_3^-	2.4×10^{-8}
Hydrogen sulfide	H_2S	1×10^{-7}	hydrogen sulfide ion	HS^-	1×10^{-7}
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	hydrogen phosphate ion	HPO_4^{2-}	1.6×10^{-7}
Hypochlorous acid	HClO	3.5×10^{-8}	hypochlorite ion	ClO^-	2.9×10^{-7}
Ammonium ion	NH_4^+	5.6×10^{-10}	ammonia	NH_3	1.8×10^{-5}
Hydrocyanic acid	HCN	4.0×10^{-10}	cyanide ion	CN^-	2.5×10^{-5}
Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}	pentaaquahydroxoiron(II) ion	$Fe(H_2O)_5OH^+$	3.1×10^{-5}
Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}	carbonate ion	CO_3^{2-}	2.1×10^{-4}
Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}	phosphate ion	PO_4^{3-}	2.8×10^{-2}