Ch. 18 & 19 equilibrium & acid / base 75 ~~80~~ points (~~10~~ 15 ec) honors chem

Academic Honesty: The answers on this test are my own and I am using only the allowed set of notes as described in the syllabus. I have not discussed the test questions with anyone before or during the test nor have I seen the test questions prior to the exam. If you violate any of the preceding items or do not sign, your semester grade is a F.

Signature: _____

1. Write the algebraic expression of Kc for the below (hypothetical ?) reactions. [15 points]

   a. $HCl_{(g)} + NH_{3(g)} \rightleftarrows NH_4Cl_{(s)}$

   5 @ 1.5 ea

   $K_c = \frac{1}{[HCl]\,[NH_3]}$

   b. $Mg_{(s)} + 2HCl_{(aq)} \rightleftarrows MgCl_{2(aq)} + H_{2(g)}$

   $K_c = \frac{[H_2]\,[MgCl_2]}{[HCl]^2}$

   c. $CO_{2(g)} + H_2O_{(g)} \rightleftarrows O_{2(g)} + C_6H_{12}O_{6(aq)}$

   6 6 6 1

   $K_c = \frac{[C_6H_{12}O_6]\,[O_2]^6}{[CO_2]^6\,[H_2O]^6}$

2. In the reaction: $N_{2(g)} + 3\,H_{2(g)} \rightleftarrows 2\,NH_{3(g)}$, the initial partial pressure of N_2, H_2, and NH_3 are 1.0 atm, 2.0 atm, and 3.0 atm, respectively. If the equilibrium partial pressure of H_2 is 1.0 atm, then what is the value of the Kp ? [10 points]

   2 + 3 pts

   i) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

	N_2	H_2	NH_3
I	1	2	3
C	$-\frac{1}{3}$	-1	$+\frac{2}{3}$
E	2/3	1	$3\frac{2}{3}$

   ii) $K_p = \frac{P_{NH_3}^2}{P_{N_2}\,P_{H_2}^3} = \frac{3.67^2}{0.67\,(1^3)} = 20$

3. Kp of the reaction: $H_{2(g)} + F_{2(g)} \rightleftarrows 2\,HF_{(g)}$ has a value of 10 and the initial partial pressure of H_2, F_2, and HF are 1.0, 2.0, and 5.0 atm, respectively. What is the equilibrium partial pressure of HF ? [10 points]

4 pt

i) $H_2 + F_2 \rightleftarrows 2\,HF$

i	1	2	5
c	$-x$	$-x$	$+2x$
E	$1-x$	$2-x$	$5+2x$

(guess)

ii) $K_p = \dfrac{P_{HF}^2}{P_{H_2} P_{F_2}}$

$10 = \dfrac{(5+2x)^2}{(1-x)(2-x)}$

$x = 8.\cancel{43}$; -0.099

(iii)

$P_{HF} = 5 + 2x$

$= 5 + 2(-0.099)$

(1 pt) $= 4.8$ atm

4

4. In the reaction: $PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)}$ is an endothermic reaction. What is the effect on the number of moles of chlorine gas due to disturbing the preceding reaction at equilibrium ? basis /rationale. [15 points]

a. addition of helium, an inert gas, at constant temperature and pressure.

5 pt Q

$Q = \dfrac{n_{Cl_2}\, n_{PCl_3}}{n_{PCl_5}\, V}$

$+n_{He} \rightarrow \uparrow n_{total} \rightarrow \uparrow P_t$ but constant P $\rightarrow \uparrow V \rightarrow \downarrow Q \rightarrow \uparrow Q$ to re-establish equilibrium

$\downarrow$

$\updownarrow n_{Cl_2}$

b. addition of neon, another inert gas, at constant temperature and volume

no effect b/c constant V $\rightarrow \pm Q \rightarrow$ no change n_{Cl_2}

b/c still @ equilibrium

c. cool the reaction container

$\downarrow T$ = "heat" $\uparrow T$ = generate $\rightarrow \uparrow n_{Cl_2}$

$\downarrow T + PCl_5 \rightleftharpoons PCl_3 + Cl_2$ b/c $\Delta H > 0$

5. What is the pH of 275 mL of 5.0 mM of ___ ? [20 points]

a. Nitric acid, a strong acid

$pH = -\log[H^+] = -\log(HNO_3) = -\log(5 \cdot 10^{-3})$

$= 2.30$

2+3 pt

b. Potassium hydroxide, a strong base

3 pt

i) $pOH = -\log[OH^-] = -\log(KOH) = -\log(5 \cdot 10^{-3}) = 2.30$

2

ii) $pH + pOH = 14$

$pH + 2.30 = 14$

$pH = 11.70$

c. Benzoic acid, a weak acid

i) $HBz \rightleftharpoons H^+ + Bz^-$

I	5 mM	0	0
C	$-x$	$+x$	$+x$
E	$5\text{mM} - x$	x	x

4 pt

ii) $K_a = \frac{[H^+][Bz^-]}{[HBz]}$

4

$6.3 \cdot 10^{-5} = \frac{x^2}{0.005 - x}$

$\Rightarrow x = -0.00059, 0.00053$

(iii) $pH = -\log[H^+]$

2pt

$= -\log(0.00053)$

$= 3.276$

6. Write the chemical equation(s) describing the addition of the salt to water, which shows if it's an acidic or basic salt. [10 points]

a. NaC_6H_5COO, sodium benzoate

2+3 pt

$NaC_6H_5COO \rightarrow Na^+ + C_6H_5COO^-$

$C_6H_5COO^- + H_2O \rightleftharpoons OH^- + C_6H_5COOH$

b. Ammonium nitrate, NH_4NO_3

$NH_4NO_3 \rightarrow NH_4^+ + NO_3^-$

$NH_4^+ + H_2O \rightleftharpoons H_3O^+ + NH_3$

7. Write the net ionic equation that describes the addition of ___ to a benzoate buffer. [10 points]

a. Hydrochloric acid

5 pt @

$H^+ + C_6H_5COO^- \rightarrow C_6H_5COOH$

b. Sodium hydroxide

$OH^- + C_6H_5COOH \rightarrow H_2O + C_6H_5COO^-$