Pretest 3.3 Solutions– Dissociation of Acids and Bases

1. True or False?

a) Only acidic solutions conduct electricity.

False. All electrolytes conduct electricity. An electrolyte is any aqueous solution containing a salt, base or acid.

b) Acid and base react together to produce an ionic compound and water.

True. For any acid of the form HX and for any base of the form WOH,

HX+ WOH --> HOH + WX

Acid + base = water + salt (ionic compound)

c) The sum of pH and pOH of any aqueous solution is always 14.0. TRUE

d) The pH is a scale used to represent the concentration of hydrogen ion in a solution. TRUE

e) The $K_{b(x)}$ of solution X is 3.5×10^{-5} and $K_{b(y)}$ of solution Y is 8.3×10^{-8}. Then, solution Y is more basic than solution X.

FALSE. X has a higher K_b. The higher the K_b (K_b is just the equilibrium constant for a base), the stronger the base. Why?

$K_b = \frac{[X^{-1}][OH^{-1}]}{[XOH]}$, so the more OH^{-1} (stronger base) you have, the greater the K value.

f) If dissociation of an acidic solution is endothermic, the K_a will decrease with increasing temperature.

FALSE. If HX + heat = H^{+1} + X^{-1}, then with increasing heat, you will disturb equilibrium and shift it to the right (more products).More products means more H^{+1} and more X^{-1} which ***increases*** the value of Ka.

2. Fill in the blanks.

$[H^{+1}]$ mol/L	$[OH^{-1}]$ (mol/L)	pH	pOH	Acidic or basic?
4.5×10^{-8}	$[OH^{-1}] =$ $10^{-14}/4.5 \times 10^{-8} =$ 2.22×10^{-7}	pH = $-\log[H^{+1}] =$ 7.35	pOH = 14-pH = 14 - 7.35 = 6.65	pH>7, so it is basic
$[H^{+1}] =$ $10^{-14}/4.5 \times 10^{-8} =$ 2.47×10^{-7}	4.05×10^{-8}	pH = $-\log[2.47 \times 10^{-7}] =$ 6.60	pOH = 14- pH = 14 - 6.60 = 7.40	pH<7, so it is acidic
2.00×10^{-5}	5.01×10^{-10}	4.7	9.3	acidic
6.31×10^{-6}	1.58×10^{-9}	5.2	8.8	acidic

3. The acid dissociation constant for formic acid, HCO_2H is 1.8×10^{-4}.

a) Write the equilibrium equation of formic acid dissociation.

$HCO_2H_{(aq)} = H^{+1}_{(aq)} + CO_2^{-1}{}_{(aq)}$

b) Calculate the pH of 0.050 M formic acid.

0.050 M formic acid. = initial concentration

moles/L	HCO_2H	H^{+1}	CO_2^{-1}
inital	0.050	0	0
R/f	x	x	x
equilibrium	0.050 - x	x	x

$$K_a = \frac{x(x)}{0.050 - x} = 1.8 \times 10^{-4}$$

Solve using the quadratic formula:

x = 0.00291 = $[H^{+1}]$

pH = 2.5

4. The pH of hypobromous acid, $HOBr_{(aq)}$ is 4.85. What concentration of $HOBr_{(aq)}$ was used? (K_a=2.0x10^{-9})

What concentration of $HOBr_{(aq)}$ was used? = they want the initial concentration.

moles/L	HOBr	H^{+1}	OBr^{-1}
inital	?	0	0
R/f	$10^{-4.85}$	$10^{-4.85}$	$10^{-4.85}$
equilibrium	x	$10^{-4.85}$	$10^{-4.85}$

$$K_a = \frac{10^{-4.85}(10^{-4.85})}{x} = 2.0 \times 10^{-9}$$

x = 0.09976 M

initial - $10^{-4.85}$ = 0.09976 M

initial = 0.0978 M

5. A solution of carbonic acid, H_2CO_3 dissociates into $H^{+1}_{(aq)}$ and $HCO_3^{-1}{}_{(aq)}$.

a) Write the equilibrium equation of carbonic acid dissociation.

$H_2CO_{3\,(aq)}$ = $H^{+1}_{(aq)}$ + $HCO_3^{-1}{}_{(aq)}$.

b) Calculate the K_a for 0.070 M solution(initial) of carbonic acid with pH of 3.76.

moles/L	$H_2CO_{3\,(}$	H^{+1}	HCO_3^{-1}
inital	0.070	0	0
R/f	$10^{-3.76}$	$10^{-3.76}$	$10^{-3.76}$
equilibrium	$0.070-10^{-3.76} = 0.0698$	$10^{-3.76}$	$10^{-3.76}$

$$K_a = \frac{10^{-3.76}(10^{-3.76})}{0.0698} = 4.33\ X\ 10^{-7}$$

6. A 0.450 M solution of ethylamine, $C_2H_5NH_2$ has pH of 12.2. Given:

$$C_2H_5NH_{2(aq)} + H_2O_{(l)} = C_2H_5NH_3^{+1}{}_{(aq)} + OH^{-1}{}_{(aq)}$$

a) What is the concentration of hydroxide ion?

pOH = 14 - pH = 14 - 12.2 = 1.8

$[OH^{-1}] = 10^{-pOH} = 10^{-1.8} = 0.0158$ M

b) Calculate the K_b of the solution.

0.450 M solution of ethylamine = initial concentration

$$K_b = \frac{0.0158\ (0.0158\ )}{0.450\ -0.0158} = 5.75\ X\ 10^{-4}$$

7. The base dissociation constant for hydrazine, H_2NNH_2 is $3.0x10^{-6}$.

a) Write the equilibrium equation when hydrazine dissociates in water.

This should have been given to you:

$H_2NNH_{2(aq)} + H_2O_{(l)} = H_2NNH_3^{+1}{}_{(aq)} + OH^{-1}{}_{(aq)}$

b) Calculate the pH for a 1.50 M hydrazine solution (initial concentration).

moles/L	$H_2NNH_{2(aq}$	$H_2NNH_3^{+1}{}_{(aq)}$	$OH^{-1}{}_{(aq)}$
inital	1.50	0	0
R/f	x	x	x
equilibrium	1.50 - x	x	x

$$K_b = \frac{x(x)}{1.50 - x} = 3.0 \times 10^{-6}$$

Cross multiply, bring all terms to one side and use the quadratic formula:

$X = 0.0021 = [OH^{-1}{}_{(aq)}]$

pOH = -log(0.0021) = 2.67

pH = 14 - 2.67 = 11.33

8. A 100.0 mL solution of ammonia, NH_3 dissociates in water and the resulting pH is 11.48.

a) Write the equilibrium equation for ammonia.

This should have been given to you:

$NH_{3(aq)} + H_2O_{(l)} = NH_4^{+1}{}_{(aq)} + OH^{-1}{}_{(aq)}$

b) If the K_b of $NH_{3(aq)}$ is 1.8×10^{-5}, what mass (in grams) of ammonia was present in the 100.0 mL solution?

pOH = 14 - 11.48 = 2.52

$[OH^{-1}] = 10^{-pOH} = 10^{-2.52} = 0.0030$ M

moles/L	$NH_{3(aq}$	$NH_4^{+1}{}_{(aq)}$	$OH^{-1}{}_{(aq)}$
inital	?	0	0
R/f	0.0030	0.0030	0.0030
equilibrium	x	0.0030	0.0030

$$K_b = \frac{0.0030\ (0.0030\ )}{x} = 1.8 \times 10^{-5}$$

x = 0.51 M = 0.51 mole/L

$[NH_3]$ initial = 0.51 + 0.003 = 0.513 moles/L

$$grams = \left[\frac{0.513\ moles}{L}\right][0.100\ L]\left[\frac{17\ g}{mole}\right] = 0.86\ g$$

9. When 2.40 g of $NH_4NO_{3\,(s)}$ is dissolved in 25.0 mL of water at 25^0C, the temperature decreases to 19.27^0C. What is the molar enthalpy of NH_4NO_3?

25 mL of water = 25 g

Q = mc T = 25(4.19)(19.27 - 25) = - 600 J

H = - Q = 600 J = 0.600 kJ

H/n = 0.600 / (2.40 g/80 [g/mole]) = 20 kJ/mole

10. a) At 30^0C and 101.3 KPa, what volume does 20.0 g of freon gas, $CCl_2F_{2,}$ occupy?

V = nRT/P = (20/121)(8.31)(30 + 273)/101.3 = 4.1 L

b) What volume will 3.0 moles of freon gas occupy at STP ?

V = 3 moles * 22.4L/mole = 67.2 L