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Time: 10min | **Chemistry 203** Quiz 4 | **Mon., Dec. 12, 2011**

Name: Bilal Hammoud

Section: _____

1. In today's experiment you are going to use the Henderson Hasselbalch equation to determine the pKa of the indicator. Derive this equation and state how you can determine the pka of bromthymol blue using this equation.

(7)

$pH = pka + \log \frac{[In^-]}{[HIn]}$

$HIN \rightleftharpoons H^+ + In^-$

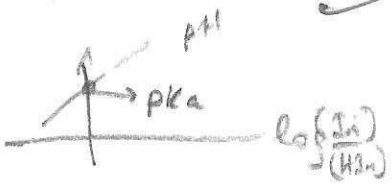
$pH = -\log[H^+] \Rightarrow [H^+] = 10^{-pH}$

$Ka = \frac{[In^-][H^+]}{[HIN]} = \frac{[In^-]}{[HIn]} \cdot 10^{-pH}$

Log both sides $pka = \log \frac{[In^-]}{[HIn]} + \log 10^{pH} = \log \frac{[In^-]}{[HIn]} + pH$

$\Rightarrow pH = pka + \log \frac{[In^-]}{[HIn]}$

plot of pH versus $\log \frac{[In^-]}{[HIn]}$ and see intercept



2. a. Calculate the pH of a solution (A) containing 0.100M $HC_3H_5O_2$ ($Ka=1.3\times10^{-5}$) and 0.100M $NaC_3H_5O_2$.
   b. Calculate the pH after adding 0.020mol NaOH to 1.00L of (A).
   c. What can you say about solution (A)?

(7)

$HC_3H_5O_2 \rightleftharpoons C_3H_5O_2^- + H^+$

a) 0.1

c) A is a (buffer solution) pH has slight change when adding OH^- (7)

a) $pH = pka + \log \frac{[C_3H_5O_2^-]}{[HC_3H_5O_2]} = pka + \log \frac{0.1}{0.1} = pka + \log 1 = pka$

$pKa = -\log(1.3\times10^{-5}) = 4.89$

b) $[OH^-] = \frac{n}{V} = \frac{0.02}{1} = 0.02$ mol/L

	OH^-	+ $HC_3H_5O_2$	→ $C_3H_5O_2^-$	+ H_2O
	0.02	0.1	0.1	
	$-x$	$-x$	x	
	$0.02-x$	$0.1-x$	$0.1+x$	

$Ka = \frac{[C_3H_5O_2^-]}{[OH^-][HC_3H_5O_2]} \cdot kw = \frac{(0.1+x)\,10^{-14}}{(0.02-x)(0.1-x)} = 1.3\times10^{-5}$ ⇒ solve the equation

consider $x = 0.02$ mol/L ⇒ $pH = pka + \log \left(\frac{0.1+x}{0.1-x}\right) = 4.89 + \log \frac{0.1+0.02}{0.1-0.02} = 4.89 + 0.2 = 5.09$

version 2

Time: 10min **Chemistry 203** **Fri., Dec. 16, 2011**
Quiz 4

15

Name: Mahmoud Tohmaz

Section: 6

1. In today's experiment you are going to determine the thermodynamic functions of the dissolution of borax by a graphical method. What are going to plot and how can you determine the needed quantities from the plot?

$\Delta G_o = -RT\ln K$ & $\Delta G_o = \Delta H_o - T\Delta S_o$ $\Rightarrow \ln K = \frac{\Delta H_o - T\Delta S_o}{-RT} = \frac{\Delta S_o}{R} - \frac{\Delta H_o}{R}\frac{1}{T}$

we are going to plot $\ln K$ versus $\frac{1}{T}$

The slope of the curve is $-\frac{\Delta H_o}{R}$, & from it we determine ΔH_o

They y-intercept is $\frac{\Delta S_o}{R}$, & from it we determine ΔS_o

(The eqn. of the curve is $\ln K = -\frac{\Delta H_o}{R}\cdot\frac{1}{T} + \frac{\Delta S_o}{R}$)

2. Consider the following reaction $Br_2(l) \rightarrow Br_2(g)$
   a. What is the sign of $\Delta G°$ for the reaction to be spontaneous?
   b. At what temperatures is the above reaction spontaneous at 1 atm?
   $\Delta H° = 31.0$ kJ/mol $\Delta S° = 93.0$ J/K.mol

a) $\Delta G° < 0$ for a spontaneous reaction.

b) $\Delta G_o = \Delta H_o - T\Delta S_o$

$\Rightarrow 31\times10^3 - T(93.0) < 0$

$93\,T > 31\times10^3$

$T > \frac{31\times10^3}{93} \Rightarrow T > 333.33\,K$

3. Assuming standard conditions, can the following reaction take place at room temperature, 25°C? $3Cl_2(g) + 2CH_4(g) \rightarrow CH_3Cl(g) + CH_2Cl_2(g) + 3HCl(g)$
Given the standard free energy of formation for $CH_4(g) = -50.72$ kJ/mol
$CH_2Cl_2(g) = -68.85$ kJ/mol
$CH_3Cl(g) = -57.37$ kJ/mol
$HCl(g) = -95.30$ kJ/mol

$\Delta G°_{rxn} = \sum \Delta G°_{products} \times \text{stoichiometric coeff.} - \sum \Delta G°_{reactants} \times \text{stoich. coeff.}$

$= \left[\Delta G°(CH_3Cl) + \Delta G°(CH_2Cl_2) + 3\Delta G°(HCl)\right] - \left[3\Delta G°(Cl_2) + 2\Delta G°(CH_4)\right]$

$= \left[-57.37 - 68.85 + 3(-95.3)\right] - \left[0 + 2(-50.72)\right]$

$= -310.68$ kJ/mol

$\Delta G°_{rxn} < 0 \Rightarrow$ Reaction is spontaneous $\Rightarrow$ yes it can take place at 25