Hydrochemistry, HSE **23.02.2015**
WiSe 14/15

1. Calculate the following pH-values:
   a) Sodiumhydroxide; c(NaOH) = 0,034 mol/L
   b) Acetic acid, c(CH_3COOH) = 1,75 mol/L, pK_a(acetic acid) = 4,7
   c) Ammoniumchloride-Solution c_0 = 0,1 mol/L; pK_b (Ammonium-Ion) = 9,25

2. Calculate the solubility of oxygen in Water at a temperature of 10°C!
   O_2-content of air: 20,9 Vol.-%; ambient pressure: 1,03 bar; $H(O_2)$ = 1,674 $mol \cdot m^{-3} \cdot bar^{-1}$ (10°C); M(O) = 16 g/mol

3. Calculate the concentrations of Hg^+ and CO_3^{2-} in a saturated mercurycarbonate solution in mol/L!
   pK_{SP} (Hg_2CO_3)=16,04 , pK_{SP}= - lg K_{SP}

4. The solubility of Cd^{2+} in a water is determined by the solubility of $Cd(OH)_2$. At what pH is the cadmium concentration equal to 0,04 mmol/L? How does the cadmium concentration change at pH-values that are lower than the calculated one?
   $pK_{SP}(Cd(OH)_2)$=13,8

5. Pure water should be produced from a 0,5 molar NaCl-solution at 25°C by reverse osmosis. What pressure has to be applied?
   Gas constant R = 0,083145 $bar \cdot L \cdot mol^{-1} \cdot K^{-1}$

6. The redox intensity of a water is pε = 9 at pH = 5. In equilibrium, what is the ratio of $c(NO_3^-)/c(NH_4^+)$ in this water? The redox system NO_3^-/NH_4^+ is defined as:
   $NO_3^- + 10\ H^+ + 8\ e^- \rightleftharpoons NH_4^+ + 3\ H_2O$ lg K = 121,12

7. a) Regarding the chemical deacidification process what is the difference between the two different kinds of filter materials used in the practical?
   b) Explain the pH-value of the untreated raw water with the help of reaction equation(s)!
   c) Explain how the total hardness of the samples was measured!

Hydrochemistry Retake 07.08.2015

1. Calculate the following pH values
a) Nitric acid; w(HNO_3)= 0,2; M(HNO_3)=63 g/mol; ρ(H_2O)=1 g/cm^3
b) Acetic acid, c_0 = 0,5 mol/L, pK_A(Acetic acid) = 4.7 [1,5P]
c) Sodium carbonate (Na_2CO_3) solution, c_0 = 0,5 mol/L, $pK_B(CO_3^{2-})$ = 3.7,
only the reaction of carbonate to hydrogen carbonate is relevant

2. Calculate the equilibrium concentration of CO_2 in mg/L for percolating water that is in contact with soil-air at 10 °C. The partial pressure of CO_2 in soil air is 50 times higher than in the atmosphere.
CO_2 in the atmosphere: 0,035 Vol.-%, total pressure: 1 bar
$H(CO_2)$ = 52,47 $mol \cdot m^{-3} \cdot bar^{-1}$ (10 °C), M(CO_2) = 44 g/mol

3. A surface water has a total hardness of 4.5 mmol/L. The total equivalent concentration of anions is 11.8 mmol/L. Calculate the sum of the molar concentrations of sodium and potassium.

4. A lake has a sediment containing $PbCO_3$ which is in dissolution equilibrium at pH 10. How does the lead concentration change when the pH changes to 9? Discuss with the help of a reaction equation!

5. The dissolution exponent pK_L (pK_L =-lgK_L) of $Fe(OH)_3$ is 37,4. Calculate the molar solubility of $Fe(OH)_3$ and the molar concentrations of Fe^{3+} and OH^- in the saturated solution.

6. The redox intensity of a waster is pε = -3 at pH = 8. What is the ratio of $c(SO_4^{2-})/c(HS^-)$ (in equilibrium) in this water?
For the redox system $c(SO_4^{2-})/c(HS^-)$ is:
$SO_4^{2-} + 9\ H^+ + 8\ e^- \rightleftharpoons HS^- + 4\ H_2O$; lgK = 34

7. A groundwater has an Saturation index of -1.7. After the filtration over marble the index increases to 0.1. Give a short explanation of these values and formulate the overall equation of calco-carbonic equilibrium. What is the general name of this process step in drinking water treatment?

8. Draw a diagram with the relative concentration (fraction of 100%, y-axis) of Ammonium (NH_4^+) und Ammoniac (NH_3) relative to pH (x-Axis).

$NH_4^+ \rightleftharpoons NH_3 + H^+$; pK_S = 9,25