Seminar 1 – Calculation problems

1. What is the mass of
a) 0.25 mol of methane molecules?
b) 4.5 mol of hydrogen chloride molecules?
c) 1.5 mmol of sulfuric acid molecules?
d) 3.2 kmol of chloride ions?

2. What is the amount of substance of
a) 1.00 kg sulfuric acid?
b) 500 g carbon?
c) 500 g methane?
d) 48 mg calcium ion?

3. What is the number of molecules or atoms in
a) 6.0 g methane?
b) 6.0 g carbon?
c) 15.5 mg phosphoric acid?

4. What is the mass of a single chlorine molecule? What is the mass of a single bromine molecule? What is the ratio of the mass of a bromine and a chlorine molecule?

5. a) Calculate the mass of 3 mol of sodium chloride. Calculate the number of ions in 3 mol of sodium chloride.
b) Calculate the mass of 0.2 mol of aluminium fluoride. Calculate the number of Al^{3+} and F^- ions in 0.2 mol of aluminium fluoride.
c) Calculate the amount of substance for 5 g magnesium oxide. Calculate the number and mass of magnesium and oxide ions in 5 g magnesium oxide.
d) Calculate the mass of 2.5 mol of calcium fluoride. Calculate the number of calcium and fluoride ions in this sample. Calculate the mass of F^- ion that neutralizes 1 g Ca^{2+} ion.
e) Calculate the mass of zinc that contains the same number of atoms as 1 g iron.

6. Naturally occurring thallium is the mixture of two isotopes. The relative atomic mass of the 203 thallium isotope is 202.972320, its frequency is 29.5 %. The relative atomic mass of the 205 thallium isotope is 204.974401, its frequency is 70.5 %. What is the average relative atomic mass of thallium?

7. Calculate the formula corresponding to the following mass percent compositions:
a) 35.0 % N, 5.0 % H, 60.0 % O
b) 89.7 % Bi, 10.3 % O
c) 21.21 % N, 6.06 % H, 48.48 % O, 24.24 % S

8. Calculate the empirical formula of the compound that is composed of 20.2 % magnesium, 26.6 % sulfur, and 53.2 % oxygen.

9. Calculate the molecular formula of the compound that is composed of 65.0 % carbon, 13.5 % hydrogen, 21.5 % oxygen and its molecular formula is the same as its empirical formula.

10. Calculate the molecular formula from the following data:
a) M = 74.0 g/mol, 48. 65 % C, 43.24 % O, 8.11 % H
b) ρ_{rel} (CO_2) = 1.00; 18.18 % H, 81.82 % C
c) ρ_{rel} (O_2) = 0.8125; 7.7 % H, 92.3 % C

11. Calculate the empirical and molecular formula of the compound that is composed of 40 % carbon, 53.33 % oxygen, 6.67 % hydrogen, and the relative density of its vapour is 2.143 referenced to nitrogen.

12. Calculate the empirical formula of the compound that is composed of 9.8 % magnesium, 13.0 % sulfur, 26.0 % oxygen and 51.2 % water of crystallization.

Seminar 2 – Calculation problems

1.) a) What is the molarity of a solution made when water is added to 12 g NaCl to make 100 cm^3 of solution?

b) 40 cm^3 of $AgNO_3$ solution is prepared. The concentration of the prepared solution is 0.245 M. What is the mass of $AgNO_3$ that is necessary for the preparation of this solution?

2.) How many grams of solute are there in 6.00 dm^3 of a 0.8 M $AgNO_3$ solution?

3.) Calculate the mass percent compositions of the following solutions:

a) 15 g of NaCl is dissolved in 100 g of water.

b) 15 g of $Na_2CO_3 \times 12\ H_2O$ is dissolved in 100 g of water.

c) 1 g of iodine is dissolved in 15 g of CCl_4.

4.) Calculate the molar amount and the mass of hydrogen chloride in 200.0 cm^3 of 0.500 mol/dm^3 solution!

5.) How many grams of 36.0 m/m% solution can be prepared from 60.00 g of potassium chloride?

6.) 3.20 g of sodium chloride is dissolved in 250.0 cm^3 solution. The density of the solution is 1.010 g/cm^3.

Calculate the: a) mass concentration; b) molarity; c) mass percent composition; d) molar percent composition and e) Raoult concentration of the solution!

7.) Calculate the: a) molality; b) mass concentration; c) Raoult concentration and the d) molar percent composition of a hydrogen chloride solution the density of which is 1.05 g/cm^3 and its mass percent composition is 10.0.

8.) 30.0 g of sodium hydroxide is dissolved in 170.0 g of water. The density of the solution is 1.33 g/cm^3. Calculate the mass percent composition and the molarity of the solution!

9.) What is the mass percent composition of a solution that was prepared by dissolving 50 g $CuSO_4 \times 5\ H_2O$ in 450 g water?

10.) 30 g of $CuSO_4 \times 5\ H_2O$ is dissolved in 170 g of water. Calculate the mass percent composition and the molarity of the solution! (The density of the prepared solution: $\rho = 1.025\ g/cm^3$)

11.) A solution of 600.0 cm^3 is prepared from 15.3 g of NaCl. The density of the solution is 1.008 g/cm^3. Calculate the: a) mass percent composition; b) molar percent composition; c) molarity and d) mass concentration of the solution!

12.) Calculate the mass and the molar amount of hydrogen chloride in 158.0 cm^3 hydrogen chloride solution. (The mass percent composition of the solution is: 37.0 m/m%, $\rho = 1.180\ g/cm^3$)

Seminar 3 – Calculation problems

1. a) A chemist wants to prepare 100 cm^3 of 0.120 M potassium aluminium sulphate solution. What is the mass of the $KAl(SO_4)_2 \cdot 12\ H_2O$ crystals needed?
b) A chemist wants to prepare 100 cm^3 of 0.150 M disodium hydrogen phosphate solution. What is the mass of the $Na_2HPO_4 \cdot 2\ H_2O$ crystals needed?
c) A chemist wants to prepare 250 cm^3 of 0.130 M ferrous sulphate solution. What is the mass of the $FeSO_4 \cdot 7\ H_2O$ crystals needed?

2. 10.0 cm^3 of a 0.0432 mol/dm^3 HCl solution is diluted to 50 cm^3. What will be the molarity of the diluted solution?

3. 80.0 cm^3 of a potassium hydroxide solution (ρ=1.344 g/cm^3) the mass percent composition of which is 18.0 % is diluted to 400 cm^3. What is the molarity of the diluted solution?

4. a) You have to prepare 1500 cm^3 of 1.20 mol/dm^3 sulphuric acid solution from a concentrated (m/m% = 96.0) sulphuric acid solution, the density of which is 1.839 g/cm^3. Calculate the volume of concentrated acid and the volume of water that are necessary for the preparation of this solution if the density of the prepared solution is 1.118 g/cm^3.

b) You have to prepare 500 cm^3 of 0.20 mol/dm^3 nitric acid solution from a concentrated (m/m% = 68.0) nitric acid solution, the density of which is 1.419 g/cm^3. Calculate the volume of concentrated acid that is necessary for the preparation of this solution.

c) You have to prepare 500 cm^3 of 2.00 mol/dm^3 hydrochloric acid solution from a concentrated (m/m% = 36.0) hydrochloric acid solution the density of which is 1.18 g/cm^3. Calculate the volume of concentrated acid and the volume of water that are necessary for the preparation of this solution if the density of the prepared solution is 1.034 g/cm^3.

5. We add 7 dm^3 of water to 1 dm^3 of $ZnCl_2$ solution the mass percent composition of which is 69 %. The density of the original solution is 1.933 g/cm^3. Calculate the density and the volume of the diluted solution! c= 1.25 M

6. 10.0 cm^3 of a sulphuric acid solution (ρ=1.83 g/cm^3) the mass percent composition of which is 98.0 m/m% is diluted to 1 dm^3. Calculate the molarity of the diluted solution!

7. We mix 20.0g of a 20.0 m/m% sodium hydroxide and 30.0 g of a 8 m/m% sodium hydroxide solution. What will be the mass percent composition of the prepared solution?

8. 300.0 g of water is added to 200.0 g of NaCl solution the mass percent composition of which is 10.0. What will be the mass percent composition of the diluted solution?

9. 10.0 g of NaCl is dissolved in 200.0 g of NaCl solution the mass percent composition of which is 10.0. What will be the mass percent composition of the final solution?

Seminar 4 - Calculation problems

1. 10.0 g of crystalline copper(II) sulphate (formula: $CuSO_4$ X 5 H_2O) is added to 200.0 g of $CuSO_4$ solution the mass percent composition of which is 10.0. What will be the mass percent composition of the final solution?

2. How many grams of crystalline copper(II) sulphate (formula: $CuSO_4$ X 5 H_2O) are needed for the preparation of 250.0 g of solution the mass percent composition of which is 7.00?

3. 2.50 g of crytalline sodium-sulphate ($Na_2SO_4 \cdot 10\ H_2O$) is dissolved in 247.5 g of water. The density of the solution in 1.01 g/cm^3. Calculate the molar concentration of the solution.

4. How many grams of $Na_2SO_4 \cdot 10\ H_2O$ are needed for the preparation of 200.0 g of solution of 5.00 m/m%. What is the mass of water needed?

5. a) 3.20 g of potassium chloride can be dissolved in 100.0 g of water. What is the mass percent composition of the solution?

b) In the case of 8.00 m/m% solution how many grams of potassium chloride are dissolved in 100 g of water?

6. 500.0 g of saturated KNO_3 solution is cooled down from 60ºC to 20ºC. How many grams of KNO_3 will be precipitated?

Solubilities: at 60ºC 111.0 g salt / 100 g H_2O
at 20ºC 31.2 g salt / 100 g H_2O

7. 250.0 g of saturated KNO_3 solution is cooled down from 60ºC to 20ºC. How many grams of KNO_3 will be precipitated?

Solubilities: at 60ºC 111.0 g salt / 100 g H_2O
at 20ºC 31.2 g salt / 100 g H_2O

8. 200.0 g of K_2SO_4 is cooled down from 85 ºC to 15 ºC. How many grams of K_2SO_4 will be precipitated?

Solubilities: at 85ºC 22 g salt (without water) / 100 g H_2O
at 15ºC 10 g salt (without water) / 100 g H_2O

9. 250 g of saturated $MgSO_4$ solution is cooled down from 80 °C to 0 °C. What is the mass of
$MgSO_4 \cdot 7\ H_2O$ precipitated? Saturated solution is of 38.6 m/m% at 80 °C and 29,0 m/m% at 0 °C.

10. Saturated solution of sodium-carbonate is of 17.7 m/m% at 20 °C and 31.4 m/m% at 80 °C. What is the mass of saturated solution at 80 °C needed to get 100 g of $Na_2CO_3 \cdot 10\ H_2O$ precipitated upon cooling down to 20 °C?

Seminar 5 – Calculation problems

1. Saturated solution of sodium-carbonate is of 17.7 m/m% at 20 °C and 31.4 m/m% at 80 °C. What is the mass of saturated solution at 80 °C needed to get 100 g of $Na_2CO_3 \cdot 10\ H_2O$ precipitated upon cooling down to 20 °C?

2. 2.50 g of crytalline sodium-sulphate ($Na_2SO_4 \cdot 10\ H_2O$) is dissolved in 247.5 g of water. The density of the solution in 1.01 g/cm^3. Calculate the molar concentration of the solution.

3. Balance the following equations:

a) $CaCO_3 + HCl = CaCl_2 + H_2O + CO_2$

b) $CuCl_2 + NaOH = Cu(OH)_2 + NaCl$

c) $Fe_2(SO_4)_3 + NaOH = Na_2SO_4 + Fe(OH)_3$

4. How many grams of propane (C_3H_8) are burnt when 500 g of carbon dioxide is formed in the reaction?

The chemical equation that you should balance: $C_3H_8 + O_2 = CO_2 + H_2O$

5. How many grams of 10 m/m% lead(II) nitrate solution are reacting with 25 cm^3 of 2 mol/dm^3 sulphuric acid solution? How many grams of lead(II) sulphate are formed?

The chemical equation that you should balance: $Pb(NO_3)_2 + H_2SO_4 = PbSO_4 + HNO_3$

6. For preparing ammonium zinc sulphate ($[(NH_4)_2Zn(SO_4)_2 \times 6\ H_2O]$) in the laboratory, you measure out 7.19 g of $ZnSO_4$ x 7 H_2O. Calculate the theoretical yield of ammonium zinc sulphate and the percent yield if 5.67 g of ammonium zinc sulphate was obtained at the end of the reaction!

The chemical equation that you need: $(NH_4)_2SO_4 + ZnSO_4 \times 7\ H_2O = [(NH_4)_2Zn(SO_4)_2 \times 6\ H_2O] + H_2O$

7. You are preparing common alum ($[AlK(SO_4)_2 \times 12\ H_2O]$) in the laboratory. You dissolve 16.6 g of $Al_2(SO_4)_3 \times 18H_2O$ in hot water and add 4.4 g of K_2SO_4. Calculate the theoretical yield of common alum!

The chemical equation that you should balance: $Al_2(SO_4)_3 \times 18H_2O + K_2SO_4 + H_2O = [AlK(SO_4)_2 \times 12H_2O]$

8. For preparing chromium potassium sulphate ($[CrK(SO_4)_2 \times 12\ H_2O]$) in the laboratory, you measure out 7.4 g of $K_2Cr_2O_7$. Calculate the theoretical yield of chromium potassium sulphate and the percent yield if 12.52 g of ammonium zinc sulphate was obtained at the end of the reaction!

The chemical equation that you need: $K_2Cr_2O_7 + 3\ C_2H_5OH + 4\ H_2SO_4 + 17\ H_2O = 2\ [CrK(SO_4)_2 \times 12\ H_2O] + 3\ CH_3CHO$

9. 13.02 g $(NH_4)_2SO_4$ is dissolved in water. 27.22 g $Al_2(SO_4)_3 \times 18H_2O$ is added to the hot solution. At the end of the procedure 28.72 g $AlNH_4(SO_4)_2 \times 12H_2O$ is obtained. Calculate the percent yield. (lab manual page 35.)

The chemical equation that you need: $(NH_4)_2SO_4 + Al_2(SO_4)_3 \times 18H_2O + 6\ H_2O = 2\ [AlNH_4(SO_4)_2 \times 12H_2O]$

Seminar 6 – Calculation problems

1. A 2.85 g sample of a mixture containing $KClO_3$ and an inert substance is heated to 300ºC and held there until its weight does not change any more. After cooling, the sample weighs 2.41 g. What is the mass percentage of $KClO_3$ in the mixture? (the same as in lab manual page 32. but with different numbers)

2. We dissolve 5.30 g of Na_2CO_3 in 500 cm^3 of a 4.00 mol/dm^3 hydrochloric acid solution. If the volume of the reaction mixture remains unchanged after the reaction, what will be the molarity of the solution with respect to the substances that are still dissolved (we assume that all the carbon dioxide that is generated during the reaction passes away)?

3. 5.00 g of a copper-zinc alloy is ground and hydrochloric acid is poured over it. During the reaction 563 cm^3 gas is generated under standard conditions. Calculate the mass percent composition of this alloy!

4. 2.00 g of a copper-zinc alloy is ground and hydrochloric acid is poured over it. During the reaction 450 cm^3 gas is generated under standard conditions. Calculate the mass percent composition of this alloy!

5. 2.00 g of a magnesium-aluminium alloy is ground and hydrochloric acid is poured over it. During the reaction 2.104 dm^3 gas is generated under standard conditions. Calculate the mass percent composition of this alloy!

6. 12.00 g of a mixture of iron and copper metals is reacted with chlorine gas. 6.12 dm^3 of chlorine gas is used under standard conditions. Calculate the mass percent composition of the mixture!
The chemical equations: $Fe + 1.5\ Cl_2 = FeCl_3$
$Cu + Cl_2 = CuCl_2$

7. A 2.53 g sample of a mixture of sodium chloride and potassium chloride is dissolved in water then silver nitrate ($AgNO_3$) is added to the solution. The mass of the white precipitate that is formed as a result of the reaction is 5.74 g. Calculate the mass percent and the molar percent composition of the mixture!

8. A gaseous mixture contains 3 mols of carbon dioxide and 15 mols of propane. Calculate the average molar mass of the mixture!

9. Air contains 78 V/V% of nitrogen, 21 V/V% of oxygen and 1 V/V% of carbon dioxide. Calculate the average molar mass of air!

10. A gaseous mixture contains 5.0 mols of methane and 10.0 mols of hydrogen gas. Calculate the average molar mass of the mixture!

Seminar 7 – Calculation problems

1. A 2.00 g sample of a mixture containing $KClO_3$ and an inert substance is heated to 300ºC and held there until its weight does not change any more. After cooling, the sample weighs 1.65 g. What is the mass percentage of $KClO_3$ in the mixture?

2. How much 0.200 mol/dm^3 NaOH solution reacts exactly with 66.00 cm^3 0.134 mol/dm^3 HCl solution?

3. 50.00 cm^3 of an unknown HNO_3 solution reacts exactly with 19.85 cm^3 0.100 mol/dm^3 KOH solution. What is the molarity of the HNO_3 solution?

4. a) How much 90 m/m% 1.82 g/cm^3 sulphuric acid solution is needed for preparing 250 cm^3 2.00 mol/dm^3 sulphuric acid solution?
b) How much 5 m/m% 1.055 g/cm^3 sodium hydroxide solution is needed to neutralize the sulphuric acid solution?

5. Will the solution be basic or acidic when 200 g of a 10 m/m% sulphuric acid solution and 150 g of 16.0 m/m% sodium hydroxide solution are mixed?

6. 10.00 cm^3 0.173 mol/dm^3 HCl solution is exactly neutralized by 7.85 cm^3 unknown NaOH solution. What is the concentration of the NaOH solution? Give the result to a reasonable precision. (lab manual: page 43.)

7. We titrate a sample of $HClO_4$ with NaOH solution. The sample contains 10.00 cm^3 0.205 mol/dm^3 $HClO_4$. Three titrations were performed and the volume of the NaOH that was consumed was measured. The following results were received: 8.57 cm^3; 8.46 cm^3 and 8.44 cm^3. Calculate the concentration of the NaOH solution!

8. Lactic acid (2-hydroxy propanoic acid) is a simple monobasic weak acid. Its molar weight is determined in an experiment through acid-base titration.
0.1025 g lactic acid is weighed into a titration flask and dissolved completely in 20-25 cm^3 of distilled water. This sample is titrated with 0.0980 mol/dm^3 NaOH solution. The equivalent volume is 11.65 cm^3. Determine the molar weight of lactic acid based on the titration result. What is the difference between the experimentally determined and actual molar weight? (lab manual: page 45.)

9. The molar weight of benzoic acid is determined in an experiment through acid-base titration.
0.0503 g benzoic acid is weighed into a titration flask and dissolved completely in 30 cm^3 of acetone-water mixture. This sample is titrated with 0.05305 mol/dm^3 NaOH solution. The equivalent volume is 8.51 cm^3. Determine the molar weight of benzoic acid based on the titration result. What is the difference between the experimentally determined and actual molar weight?

10. We titrate a sample of HCl with NaOH solution. The sample contains 10.00 cm^3 0.215 mol/dm^3 HCl. Three titrations were performed and the volume of the NaOH that was consumed was measured. The following results were received: 9.15 cm^3; 9.20 cm^3 and 9.38 cm^3. Calculate the concentration of the NaOH solution!

11. The molar weight of benzoic acid is determined in an experiment through acid-base titration.
0.0515 g benzoic acid is weighed into a titration flask and dissolved completely in 30 cm^3 of acetone-water mixture. This sample is titrated with 0.05279 mol/dm^3 NaOH solution. The equivalent volume is 8.75 cm^3. Determine the molar weight of benzoic acid based on the titration result. What is the difference between the experimentally determined and actual molar weight?

Seminar 8 – Calculation problems

1. How many molecules are there in 20.0 cm^3 of a gas at -10ºC and 1.333 × 10^4 Pa?

2. 0.210 g of the vapor of an unknown volatile liquid takes up a volume of 0.8 dm^3 at 18 ºC and 99991 Pa. What is the molar mass of this substance?

3. 0.777 g of the vapor of an unknown volatile liquid takes up a volume of 314 cm^3 at 98.7 ºC and 98660 Pa. What is the molar weight of this substance? (lab manual: page 56.)

4. How many grams of zinc are needed for generating 0.625 dm^3 of hydrogen gas under standard conditions?

5. How many grams of calcium carbonate are needed for generating 0.325 dm^3 of carbon dioxide gas under normal conditions?

6. 10.00 dm^3 of chlorine gas should be generated at 22ºC and at 98659 Pa. How many grams of $KMnO_4$ are needed for this reaction?
The equation for the chemical reaction is the following:
$2\ KMnO_4 + 16\ HCl = 2\ KCl + 2\ MnCl_2 + 5\ Cl_2 + 8\ H_2O$

7. We add 10.0 cm^3 of 30.0 m/m% H_2O_2 (d = 1.15 g/cm^3) to 2.00 g $K_2Cr_2O_7$. How many dm^3 of oxygen gas is generated at 22 ºC and at 95000 Pa?
The equation for the chemical reaction is the following:
$Cr_2O_7^{2-} + 8\ H^+ + 3\ H_2O_2 = 2\ Cr^{3+} + 7\ H_2O + 3\ O_2$

8. 0.630 g of the vapor of an unknown volatile liquid takes up a volume of 0.5 dm^3 at 20 ºC and 99999 Pa. What is the molar mass of this substance?

Seminar 9 – 10. – Calculation problems

1. Balance the following reactions:
a) $Ag + HNO_3 = AgNO_3 + NO + H_2O$
b) $SnCl_2 + KBrO_3 + HCl = SnCl_4 + KBr + H_2O$
c) $H^+ + SO_3^{2-} + MnO_4^- = SO_4^{2-} + Mn^{2+} + H_2O$
d) $Fe^{2+} + Cr_2O_7^{2-} + H^+ = Fe^{3+} + Cr^{3+} + H_2O$

2. Calculate the mol/dm^3 concentration of the $NaNO_2$ solution 15.0 cm^3 of which reacts with 37.5 cm^3 of a 0.020 mol/dm^3 $KMnO_4$ solution under acidic conditions!
The unbalanced chemical equation: $MnO_4^- + NO_2^- + H^+ = Mn^{2+} + NO_3^- + H_2O$

3. How many grams of copper can be dissolved in 500 g of sulphuric acid (m/m% = 98.0)? What is the volume of SO_2 that is generated in the reaction under standard conditions?
The unbalanced chemical equation: $Cu + H_2SO_4 = CuSO_4 + SO_2 + H_2O$

4. Calculate the volume of chlorine gas that is generated under standard conditions from 7.90 g of $KMnO_4$ if the loss is 15%!
The unbalanced chemical equation: $KMnO_4 + HCl = KCl + MnCl_2 + Cl_2 + H_2O$

5. 10.0 g lead(II) chloride needs to be prepared (see description in section 18.1). Calculate the weight of metallic lead (A_{Pb} = 207.9), sodium chloride, and the volume of nitric acid (20 m/m%, ρ = 1.115 g/cm^3) needed if the percent yield is 65 % and the acid is used in 15 % stoichiometric excess. (lab manual page 59.)
Balance the chemical reactions: …. Pb + …. HNO_3 = ….. $Pb(NO_3)_2$ + ….. H_2O + ….. NO
…. $Pb(NO_3)_2$ + ….. NaCl = ….. $PbCl_2$ +….. $NaNO_3$

6. Calculate the theoretical yield if you prepare zinc(II) sulphate ($ZnSO_4 \times 7\ H_2O$) from 6.50 g of zinc. (lab manual page 60.)
The chemical reaction: $Zn + H_2SO_4 + 7\ H_2O = ZnSO_4 \cdot 7H_2O + H_2$

7. Calculate the volume of the 0.100 mol/dm^3 sodium sulphite solution that reacts with 250.0 cm^3 of 0.120 mol/dm^3 $KMnO_4$ solution under basic conditions!
The unbalanced chemical reaction: $OH^- + MnO_4^- + SO_3^{2-} = MnO_4^{2-} + SO_4^{2-} + H_2O$

8. What is the volume of the hydrogen gas that is generated from 12.0 g of sodium at 23°C and at 95000 Pa?
The unbalanced chemical reaction: $Al + NaOH + H_2O = Na[Al(OH)_4] + H_2$

9. We put a piece of aluminium the mass of which is 3.40 g into 200.0 cm^3 2.00 mol/dm^3 hydrochloric acid solution the density of which is 1.03 g/cm^3.
Calculate the volume of the hydrogen gas that is generated in the reaction at 18 °C and at 102.0 kPa pressure!
The unbalanced chemical reaction: $Al + HCl = AlCl_3 + H_2$

10. How many grams of iron(II) sulphide are needed (purity of which is 80%) for the generation of 3 dm^3 of hydrogen sulphide at 20ºC and at 1.218×10^5 Pa pressure?
The unbalanced chemical reaction: $FeS + HCl = H_2S + FeCl_2$

Seminar 11 – Calculation problems

1. Calculate the pH of the solutions:

a) $[H_3O^+] = 0.01$ mol/dm^3

b) $[H_3O^+] = 5\times10^{-9}$ mol/dm^3

c) $[H_3O^+] = 4.1\times10^{-3}$ mol/dm^3

d) $[H_3O^+] = 2.65\times10^{-5}$ mol/dm^3

2. Calculate the $[H_3O^+]$ and the $[OH^-]$ concentrations in the following solutions:

a. pH = 3.25
b. pH = 6.83
c. pH = 11.72

3. Calculate the pH of the following solutions!

a) 250 cm^3 of a 0.0100 M HCl solution

b) 2.00 dm^3 of a 0.250 M HNO_3 solution

c) 0.720 g NaOH is dissolved and 500 cm^3 of solution is prepared

d) 2.00 cm^3 of a 50.0 m/m% NaOH solution (ρ= 1.53 g/cm^3) is diluted to 2.00 dm^3.

4. How much HCl solution (pH = 2.17) is neutralized by 25.00 cm^3 of NaOH solution (pH = 10.95)?

5. What is the pH of the solution that was prepared by mixing 1.00 dm^3 of a 5.00 m/m% NaOH solution (ρ = 1.054 g/cm^3) and 1.00 dm^3 of 4.00 m/m% HCl solution (ρ = 1.020 g/cm^3) and diluted to 5.00 dm^3?

6. 0.300 g of $Al(OH)_3$ is dissolved in 30.00 cm^3 of 1.000 mol/dm^3 HCl-solution and then the solution is completed to 100.00 cm^3. What will be the pH of the solution?

7. How many cm^3 of 0.100 mol/dm^3 NaOH-solution should be added to 30.0 cm^3 of distilled water to prepare a solution the pH of which will be 12.40?

8. How much 0.0457 mol/dm^3 sodium hydroxide solution is needed to neutralize 15.36 cm^3 0.0356 mol/dm^3 HCl solution?

9. How much 1.469 mol/dm^3 nitric acid solution is needed to neutralize 10.00 cm^3 2.16 mol/dm^3 NaOH solution?

Seminar 12 – Calculation problems

1. Calculate the pH of a 0.100 mol/dm^3 acetic acid solution! ($K_a = 1.86 \times 10^{-5}$)

2. Calculate the pH of a 0.001 mol/dm^3 acetic acid solution! ($K_a = 1.86 \times 10^{-5}$)

3. Calculate the pH of a 0.100 mol/dm^3 HNO_2 acid solution! ($K_a = 4.94 \times 10^{-4}$)

4. Calculate the acid ionization constant for monochloro acetic acid in a 0.02 mol/dm^3 solution at pH = 2.34!

5. Calculate the pH of a 0.8 mol/dm^3 ammonia solution! ($K_b = 1.75 \times 10^{-5}$)

6. What is the pH of the buffer solution in which the concentration of acetic acid is 0.200 M and that of sodium acetate is 0.100 M? ($K_a = 1.86 \times 10^{-5}$)

7. Calculate the pH of the buffer solution that contains 0.500 mol/dm^3 ammonia and 0.400 mol/dm^3 ammonium chloride! ($K_b = 1.75 \times 10^{-5}$)

8. We mix 10.0 cm^3 of a 0.5 mol/dm^3 acetic acid solution and 8 cm^3 of 0.400 mol/dm^3 sodium acetate solution. What will be the pH of the mixture?

9. Calculate the pH of the acetic acid / sodium acetate buffer in which $c_{CH3COOH} = c_{CH3COONa} = 1.0$ mol/dm. K_a(acetic acid) = 1.86×10^{-5} M? (lab manual: page 77.)

10. Calculate the pH of the buffer solution that contains 0.200 mol/dm^3 ammonia and 0.200 mol/dm^3 ammonium chloride! ($K_b = 1.75 \times 10^{-5}$)

Practice exercises:

11. Calculate the pH for the following acid solutions!

a, 0.01 mol/dm^3 HCl
b, 0.53 mol/dm^3 HNO_3
c, 0.45 mol/dm^3 HCl
d) 0.15 mol/dm^3 weak acid ($K_a = 1.5 \times 10^{-5}$)
e) 0.26 mol/dm^3 formic acid ($K_a = 1.77 \times 10^{-4}$)

12. Calculate the pH for the following base solutions!

a, 0.01 mol/dm^3 NaOH
b, 0.34 mol/dm^3 KOH
c, 0.005 mol/dm^3 NaOH
d) 0.15 mol/dm^3 ammonia ($K_b = 1.75 \times 10^{-5}$)
e) 0.25 mol/dm^3 methylamine ($K_b = 4.38 \times 10^{-4}$)

Seminar 13 – Calculation problems

1. Calculate the electromotive force (EMF) of the Daniell cell when the Cu plate is immersed into a 1.00 mol/dm^3 $CuSO_4$-solution and the Zn plate is immersed into a 1.00 mol/dm^3 $ZnSO_4$-solution!

2. Decide if a spontaneous chemical reaction is expected in the following two experiments.
- a copper plate is immersed into a solution of lead(II) nitrate
- a lead plate is immersed into a solution of copper(II) nitrate

3. Decide if a spontaneous chemical reaction is expected in the following two experiments.
- a zinc plate is immersed into a solution of lead(II) nitrate
- a lead plate is immersed into a solution of zinc(II) nitrate (lab manual: page 86.)

4. Which of these metals dissolve in dilute (0.2 mol/dm^3) hydrochloric acid based on the standard electrode potentials? Write the chemical equations of the processes.

$\varepsilon^0_{Pb^{2+}/Pb} = -0.130$ V; $\varepsilon^0_{Fe^{2+}/Fe} = -0.440$ V; $\varepsilon^0_{Ag^{+}/Ag} = +0.800$ V;

$\varepsilon^0_{Mg^{2+}/Mg} = -2.380$ V $\varepsilon^0_{Al^{3+}/Al} = -1.660$ V; $\varepsilon^0_{Na^{+}/Na} = -2.710$ V

$\varepsilon^0_{Cu^{2+}/Cu} = +0.337$ V; $\varepsilon^0_{Zn^{2+}/Zn} = -0.760$ V; $\varepsilon^0_{\frac{1}{2}Br_2/Br^-} = +1.07$ V

$\varepsilon^0_{\frac{1}{2}Cl_2/Cl^-} = +1.36$ V; $\varepsilon^0_{\frac{1}{2}I_2/I^-} = +0.54$ V

5. Decide if a spontaneous chemical reaction is expected in the following two experiments:
- a copper plate is immersed into a solution of silver(I) nitrate
- a silver plate is immersed into a solution of copper(II) nitrate

In one of the experiments, the mass of the metal plate used is changed by 3.05 g. Decide if this was a decrease or increase. Determine the number of moles reacted by this time. (lab manual: page 87.)

6. Decide if a spontaneous chemical reaction is expected in the following two experiments.
- copper plate is immersed into a solution of iron(II) nitrate
- an iron plate is immersed into a solution of copper(II) nitrate

In one of the experiments, the mass of the metal plate used is changed by 770 mg. Decide if this was a decrease or increase. Determine the number of moles reacted by this time.