**40th Austrian Chemistry Olympiad**

**National Competition**





**Practical Part – June 14th, 2014**

**Solution**

# Task 1 13 points

**Qualitative Analysis**

*Write the result of your analysis into the table:*

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| **sample** | **cation** | **anion** |
| **1** | Li+ | SO42- |
| **2** | Ba2+ | NO3- |
| **3** | K+ | I- |
| **4** | Fe3+ | NO3- |
| **5** | Ni2+ | SO42- |
| **6** | Ba2+ | SO42- |
| **7** | Pb2+ | CO32- |

# Task 2 15 points

**Quantitative Analysis of a Mixture of**

**Potassium dichromate and Potassium permanganate**

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| *2.1. Exact concentrations of the standard solutions* |
| *Volume of titrant Na2S2O3 (average for dichromate): 9.05 mL* |
| *Volume of titrant Na2S2O3 (average for permanganate): 6.10 mL* |
| *Chemical equation MnO4- - I-: MnO4- + 5 I- + 8 H+ ⇄ Mn2+ + 4 H2O + 2,5 I2* |
| *Chemical equation Cr2O72- - I-: Cr2O72- + 6 I- + 14 H+ ⇄ 2 Cr3+ + 3 I2 + 7 H2O* |
| *Chemical equation S2O32- - I2: 2 S2O32- + I2 ⇄ S4O62- + 2 I-* |
| *Calculation of the concentrations of the standard solutions:*$\left(Cr\_{2}O\_{7}^{2-}\right)=\frac{c(S\_{2}O\_{3}^{2-})∙V(S\_{2}O\_{3}^{2-})}{2∙3∙10}=\frac{V(S\_{2}O\_{3}^{2-})}{6000}=1.5083∙10^{-3} mol/L$$c\left(MnO\_{4}^{-}\right)=\frac{c(S\_{2}O\_{3}^{2-})∙V(S\_{2}O\_{3}^{2-})}{2∙2.5∙50}=\frac{V(S\_{2}O\_{3}^{2-})}{25000}=2.44∙10^{-4} mol/L$ |
| *c(Cr2O72-) = 1.51·10-3 mol/L* | *c(MnO4-) = 2.44·10-4 mol/L* |

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| *2.2. Absorption coefficient of dichromate at 427 nm* |
| *K2Cr2O7- solution 1* | *K2Cr2O7- solution 2* |  |
| *c = 1.51·10-3 mol/L* | *c = 0.755·10-3 mol/L* |  |
| *A = 0.690* | *A = 0.344* |  |
| *ε = 458 L/mol·cm* | *ε = 456 L/mol·cm* | *ε427(average) = 457 L/mol·cm* |
| *2.3. Absorption coefficient of Permanganate at 545 nm* |
| *KMnO4- solution 1* | *KMnO4- solution 2* |  |
| *c = 2.38·10-4 mol/L* | *c = 1.19·10-4 mol/L* |  |
| *A = 0.581* | *A = 0.269* |  |
| *ε = 2.44·103 L/mol·cm* | *ε = 2.26·103 L/mol·cm* | *ε545(av.)=2.37·103 L/mol·cm* |
| *2.4. Absorption coefficient of Permanganate at 427 nm* |
| *KMnO4- solution 1* | *KMnO4- solution 2* |  |
| *c = 2.38·10-4 mol/L* | *c = 1.19·10-4 mol/L* |  |
| *A = 0.056* | *A = 0.016* |  |
| *ε = 235 L/mol·cm* | *ε = 135 L/mol·cm* | *ε427(average) = 185 L/mol·cm* |
| *Show the calculations of the concentration and the absorption coefficient using one example:**dilution 5:5 in solution 2: c (2) = c(1)/2* $ε=\frac{A}{c}=\frac{0.581}{2.38∙10^{-4}}$ |

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| *2.5. Concentrations of KMnO4 and K2Cr2O7 in the sample* |
| *A427 (sample) = 0,676* | *A545 (sample) = 0,614* |
| *c(Cr2O72-) = 1.37·10-3 mol/L*  | *c(MnO4-) = 2.58·10-4 mol/L*  |
| *Show your calculations:*$c\left(MnO\_{4}^{-}\right)=\frac{A\_{545}}{ε}=\frac{0.614}{2370}=2.58∙10^{-4}$$A\_{427}\left(MnO\_{4}^{-}\right)=185∙2.58∙10^{-4}=0.048$$A\_{427}\left(Cr\_{2}O\_{7}^{2-}\right)=0.676-0.048=0.628$$c\left(Cr\_{2}O\_{7}^{2-}\right)=\frac{A\_{427}}{ε}=\frac{0.628}{457}=1.37∙10^{-3}$ |

# Task 3 12 points

**Synthesis of 1,4-dihydro-2,6-dimethylpyridine-3,5-dicarboxylic acid diethyl ester**

**(Hantzsch-ester)**

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| *3.1. Hand in the product on the watch glass.*  *The product should be bright yellow crystals.* |

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| *3.2. Calculate the theoretical yield: 1.27 g* |
| *Calculation:*$m=1.30∙\frac{253}{130}∙0.5=1.27$ |

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| *3.3. Calculate your yield in % of the theory.* |
| *Calculation:*$\%=\frac{m\_{own}}{1.27}∙100$ |

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| *3.4. Melting point of your product: 192-193°C* |

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| *3.5. Mark all your spots by circling with a pencil also mark the starting line and the front line. Hand in the TLC plate (with your number on it).* |

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| *3.6. Calculate the Rf-values.* |
|  *Rf of ethyl acetoacetate: 0.47-0.53* *Rf of raw product: 0.34-0.40**Rf‘ of recrystallized product: 0.34-0.40* |