Questions
for the first general test

Section I
Theoretical background

1. Laboratory equipments. Sorting of glass and ceramic tools by their heating properties.
2. Volumetric measurement in laboratory. Tools for measuring volumes, and usage of them.
3. Weighing in laboratory. Properties of the two types of laboratory balances.
4. Different modes of filtration.
5. Principle of the purification of contaminated benzoic acid.
6. Definitions: theoretical yield, percent yield.
7. Most important safety rules.

Section II
Calculation of amount of substance, number of molecule, number of atoms, using of molar weight

1. Fill in the missing data in the table! (The data written by red ink are considered the missing data)

Name	Formulae	Molar weight	Mass	Number of substance	Number of „molecules”	Number of atoms
methane	*CH_4*	*16.05 g/mol*	32.16 g	*2.004 mol*	*$1.202 \cdot 10^{24}$*	*$6.01 \cdot 10^{24}$*
potassium phosphate	K_3PO_4	*212.28 g/mol*	*307.8 g*	1.45 mol	*$8.7 \cdot 10^{23}$*	*$6.96 \cdot 10^{24}$*
crystalline iron alum	$FeNH_4(SO_4)_2 \cdot 12H_2O$	*483.27 g/mol*	*139.4 g*	*0.2885 mol*	*$1.731 \cdot 10^{23}$*	$9 \cdot 10^{24}$
dichlormethane	CH_2Cl_2	*84.93 g/mol*	*1.699 g*	*0.02 mol*	$1.2 \cdot 10^{22}$	*$6 \cdot 10^{22}$*
acetone	*CH_3COCH_3*	*58.09 g/mol*	*4.357 g*	*0.075 mol*	*$4.5 \cdot 10^{22}$*	$4.5 \cdot 10^{23}$
acetaldehyde	CH_3COH	*44.06 g/mol*	*2.203 g*	*0.05 mol*	*$3 \cdot 10^{22}$*	$2.1 \cdot 10^{23}$
sodium hydrogencarbonate	*$NaHCO_3$*	*84.01 g/mol*	*138.6 g*	1.65 mol	*$9.9 \cdot 10^{23}$*	*$5.94 \cdot 10^{24}$*
sodium thiosulfate	*$Na_2S_2O_3$*	*158.1 g/mol*	13.87 g	*0.088 mol*	*$5.28 \cdot 10^{22}$*	*$3.696 \cdot 10^{23}$*
lead iodide	PbI_2	*461 g/mol*	*26892 g*	*58.33 mol*	$3.5 \cdot 10^{25}$	*$1.05 \cdot 10^{26}$*
benzoic acid	*C_6H_5COOH*	*122.13 g/mol*	356.2 g	*2.917 mol*	*$1.75 \cdot 10^{24}$*	*$2.635 \cdot 10^{25}$*
aluminum hydroxide	*$Al(OH)_3$*	*78.01 g/mol*	*78.01 g*	*1 mol*	*$6 \cdot 10^{23}$*	$4.2 \cdot 10^{24}$
crystalline zinc sulfate	$ZnSO_4 \cdot 7H_2O$	*287.58 g/mol*	45.98 g	*0.1599 mol*	*$9.594 \cdot 10^{22}$*	*$2.59 \cdot 10^{24}$*
crystalline copper sulfate	*$CuSO_4 \cdot 5H_2O$*	*249.71 g/mol*	*1308 g*	5.24 mol	*$3.144 \cdot 10^{24}$*	*$6.602 \cdot 10^{25}$*
crystalline alum	$AlK(SO_4)_2 \cdot 12H_2O$	*474.44 g/mol*	0.12 g	*0.00025 mol*	*$1.5 \cdot 10^{20}$*	*$7.2 \cdot 10^{21}$*

2. Which compound has higher amount of substance?

a, 57.36 g *barium chromate* or 64.32 g led acetate
b, 17.46 kg sodium hydroxide or 104 kg *sulfuric acid*
c, 434.67 g *nitric acid* or 84 g ammonia
d, 710 mg *chlorine* or 1600 mg crystalline copper sulfate
e, 130 g phosphoric acid or 120.2 g *manganese dioxide*

Section III
Concentration units. Making solutions. Interconversation of conversation units.

1. Calculate the weight percent compositions of the following solutions!

a, 67.54 g NaOH were dissolved in 600 g water *10.12%*
b, 17.43 g potassium nitrate were dissolved, and 250.0 g solution was made. *6.97%*
c, 125.6 g crystalline copper sulfate ($CuSO_4 \cdot 5H_2O$) were dissolved in 340 g water *17.24%*
d, 0.22 mol crystalline iron alum were dissolved and 300 g solution was made *19.51%*
e, 1.34 g crystalline aluminum sulfate were dissolved in 50 ml water *1.34%*
f, 60 g water added to 3.4 ml 37 w/w% hydrochloric acid ($d=1.185\ g/cm^3$) *2.33%*
g, 9.7 ml 50 w/w% sodium hydroxide was diluted with 70 ml water ($d=1.53\ g/cm^3$) *8.75%*

2. Calculate the molarity of the following solutions!

a, 56.15 g sodium chloride used to make 250 cm^3 solution — *3.843 mol/dm^3*

b, 64.16 g potassium sulfate were dissolved, and 200 cm^3 solution was made — *1.841 mol/dm^3*

c, 73.35 g crystalline chromium alum weighed to make 1 liter solution — *0.147 mol/dm^3*

d, 0.653 g crystalline copper sulfate were used to prepare 5 ml solution — *0.523 mol/dm^3*

e, 3.4 cm^3 5.6 mol/dm^3 hydrochloric acid were diluted to 100.00 cm^3 — *0.190 mol/dm^3*

f, 19.28 cm^3 1.53 mol/dm^3 sulfuric acid were diluted to 250.00 cm^3 — *0.118 mol/dm^3*

3. How much solute is needed to prepare the following solutions?

a, 360 g 18.76 w/w% sodium sulfate — *67.54 g*

b, 0.9087 of 6.81 w/w% barium chloride — *1.75 g*

c, 250 cm^3 0.15 mol/dm^3 zinc sulfate — *6.05 g $ZnSO_4$ or 10.78 g $ZnSO_4 \cdot 7H_2O$*

d, 25 cm^3 0.165 mol/dm^3 potassium carbonate — *0.57 g*

e, 150 cm^3 16.54 w/w% sodium acetate (d=1.54 g/cm^3) — *38.21 g*

f, 1 litre 1 w/w% boric acid (H_3BO_3) (d=1.002 g/cm^3) — *10.02 g*

4. How much concentrated solution should be diluted to prepare the following solutions?

a, 200 cm^3 0.54 mol/dm^3 NaOH solution (from 50 w/w%, d=1.53 g/cm^3) — *5.6 cm^3*

b, 1000 ml 0.2 mol/dm^3 HCl solution (from 37 w/w%, d=1.195 g/cm^3) — *16.5 cm^3*

c, 5 litre 1 mol/dm^3 sulfuric acid solution (from 98 w/w%, d=1.87 g/cm^3) — *268 cm^3*

5. Convert the concentration units of the solution from molarity to w/w% or back!

a, 17.5 w/w% $CaCl_2$, d=1.198 g/cm^3 — *1.889 mol/dm^3*

b, 10.0 w/w% HCl, d=1.05 g/cm^3 — *2.877 mol/dm^3*

c, 1.023 mol/dm^3 H_2SO_4, d=1.157 g/cm^3 — *8.67%*

d, 0.056 mol/dm^3 $ZnSO_4$, d=1.055 g/cm^3 — *0.86%*

Section IV

Calculations based on chemical equations (The chemical equation is required in all case. <u>You can find it in the lab manual</u>)

1. 5.63 g K_2SO_4 is dissolved in water. 22.11 g $Al_2(SO_4)_3 \cdot 18H_2O$ is added to the hot solution. At the end of the procedure 13.18 g $KAl(SO_4)_2 \cdot 12H_2O$ is obtained. Calculate the percent yield! *43.00%*

2. 13.02 g $(NH_4)_2SO_4$ is dissolved in water. 27.22 g $Al_2(SO_4)_3 \cdot 18H_2O$ is added to the hot solution. At the end of the procedure 28.72 g $AlNH_4(SO_4)_2 \cdot 12H_2O$ is obtained. Calculate the percent yield! *77.56%*

3. Chromium alum is being prepared from 23.45 g $K_2Cr_2O_7$. Calculate the theoretical yield for this reaction! *79.61 g*

4. Iron alum is going to be prepared from 12.76 g $FeSO_4$. How much ammonium sulfate is required for the preparation? Calculate the theoretical yield! *5.55 g $(NH_4)_2SO_4$, t.y.=40.59 g*

Section V

Calculations based on empirical formula

1. Calculate the empirical formula of the compound which is composed of 20.2% magnesium, 26.6% sulfur, and 53.2% oxygen. *($MgSO_4$)*

2. Calculate the molecular formula of the compound which is composed of 65.0% carbon, 13.5% hydrogen, 21.5% oxygen and its molecular formula is the same as its empirical formula. *($C_4H_{10}O$)*

3. Calculate the empirical formula of the compound which is composed of 9.8% magnesium, 13.0% sulfur, 26.0% oxygen, and 51.2% water of crystallization. *($MgSO_4 \cdot 7H_2O$)*