LABORATORY WORK NO. 3

WORK WITH SOLUTIONS AND THEIR CONCENTRATION

PRINCIPLE:

Solutions are homogeneous systems consisting of two or more components. In chemistry, liquid solutions consist of a solvent (usually water) and one or more solutes.
When working with solutions, the most frequent is the accurate measuring of their volume.

According to usage, we can divide the volumetric glassware into **dishes for topping** and **for the outpouring**:
- for topping (flasks, graduated cylinder)
- for the outpouring (pipette, burette)

Principles of volume measurements are as follows:
Dishes are always perfectly clean, free of grease, kept in vertical position; the eye is at the level of liquid surface, it is necessary to read out the lower meniscus level (only for colored solutions the upper meniscus is read).

The solubility of a substance is the amount of substance in grams dissolved in 100 g of a solvent at a certain temperature and it is (for the given substance) listed in tables. It is stated in g / 100 g of the solvent.

The concentration of the solution is the quantity of a substance in grams dissolved in a given volume of the solution. It is stated in g / cm 3, g / ml, kg / m3, etc.

Solutions are diluted, concentrated and saturated.
Saturated solutions contain the maximum amount of a substance dissolved at a given temperature.

The molar concentration in the SI system has the unit mol / m^3, respectively mol / l. It is used for exact analytical solutions which are prepared in volumetric flasks.

Weight (percentage) solution concentration is expressed using the **weight fraction w** which determines how many percent a solute forms in a solution.
Formula:

$$w = \frac{m_{(A)}}{m} \cdot 1\,C$$

w is weigh fraction of agent A in %,
$\mathbf{M_{(A)}}$ – mass of agent A in grams,
m – total mass of solution in grams

TASK NO. 1 MEASURING THE VOLUME OF LIQUIDS AND THEIR DEPENDENCE ON TEMPERATURE

- **CHEMICALS:** water

- **AIDS**:
  graduated cylinders (10 ml, 25 ml), graduated pipette (25 ml), volumetric flask (100ml), thermometer, burner

- **PROCEDURE**

1. Prepare 150ml of water of 20 °C and 150ml of warm water of 80 °C and keep them at this temperature.
2. Using the graduated pipette, pipette 6ml of water and 22 ml of water (20 °C) into a clean graduated cylinder. Compare the differences in the measured volume of the pipette and the cylinder.
3. Using the graduated pipette again, pipette 6 ml of water and 22 ml of 80 °C warm water into the measuring cylinder. Allow it to cool to 20 °C. Write down the differences in the volumes of liquids.
4. Fill in (with the greatest possible accuracy) the volumetric flask with 100 ml water of 80 °C up to the mark. After cooling to 20 ° C, check the water level in the flask and fill it up till the mark.

- **CONCLUSION:** Determine which volumetric glassware is most accurate and compare it with other dishes. Draw conclusions about the thermal expansion of liquids.

TASK NO. 2 PREPARE 50 g OF 5% NaCl AND DILUTE IT IN 1% SOLUTION

- **CHEMICALS:** water, technical NaCl (solid)

- **AIDS**: graduated cylinder (100 ml), weighing boat, lab spoon, beaker (100 ml), scales

- **PROCEDURE:**

1. Determine the amount of NaCl (in g) and water (in ml) for the preparation of the solution using the calculation formula of mass fraction w.
2. Weigh NaCl with accuracy to 3 decimal places and prepare a 5% solution of NaCl.

Using dilution equations or cross-mixing scheme, calculate the required amount of water to dilute the whole quantity of the 1% solution.

3. Prepare 250g of the final NaCl solution.
4. Place the resulting and tagged 1% NaCl solution into a common bottle or (by the teacher's instructions) allow it to thicken and crystallize in a crystallization dish.

- **CALCULATIONS:**
  Use these formulas for calculations:

  Mass fraction: $w = \frac{m_1}{m} \cdot 100$

  Mixing equations: $m_1w_1 + m_2w_2 = m_3w_3$

  Mixing scheme :

  w_1 — $w_2 - w_3$
  w_3
  w_2 — $w_1 - w_3$

  where: index 1 stands for NaCl,
  index 2 stands for water,
  index 3 stands for final solution

- **CONCLUSION:**
  Indicate the amount of each substance you need for preparing the solutions.

TASK NO. 3 PREPARE 100 ml SOLUTION OF NaCl with concentration c = 0,5 mol/l.

- **CHEMICALS:** water, technical NaCl (solid)
- **AIDS:** 100ml volumetric flask, weighing boat, spoon, wash bottle, 100 ml beaker, funnel, scales
- **PROCEDURE:**

1. Weigh the calculated amount of NaCl to three decimal places.
2. Using a beaker, dissolve a sample weight in a small amount of water (about 30 ml).
3. Transfer the solution quantitatively into a volumetric flask.
4. Add water to the solution in the flask up to the mark (on bottom meniscus).

5. Close the flask, stir and label the solution with the name and concentration of chemicals.

- **CALCULATIONS:**

  - $m = c \cdot V \cdot M$ where **m** is mass of agent [g]
    - **c** - concentration in [mol/l],
    - **V**- volume [l],
    - **M** – molar mass of NaCl [g/mol]

- **CONCLUSION:**
  Indicate the amount of NaCl needed for the preparation of the solution (0.5M-NaCl).

TASK NO. 4 PREPARE SOLUTIONS OF FOLLOWING CONCENTRATIONS :

HCl (c = 1 mol.dm^{-3})	NaOH (c = 0,5 mol.dm^{-3})
H_2SO_4 (c = 1 mol.dm^{-3})	NH_4OH (1:1)
H_2SO_4 (c = 2 mol.dm^{-3})	KI 5%
HNO_3 (c = 1 mol.dm^{-3})	$Ca(OH)_2$ saturated solution

- **CHEMICALS:** water, concentrated HCl, conc. H_2SO_4, NH_4OH 25%, NaOH, KI

- **AIDS:** volumetric flasks (2x 100 ml,1x 250 ml), weighing boat, spoon, wash bottle, 3x 100 ml beaker, funnel, scales, 10-20 ml graduated pipettes

- **PROCEDURE:**

- Calculate the amount of neccesary substances for the preparation of 100 ml or 100g solutions wiht indicated concentrations. For acids, go from concentrated acids, find their density on storage bottles or in chemical tables.

- Pipette the acids, do not weigh them on scales. Wear gloves and goggles, work always under the supervision of a teacher (or a teacher himself doses concentrated acid according to your calculations).

- **CALCULATIONS:**
  Use the previously mentioned formula: m = c.V. M

$$w = \frac{m_1}{m} \cdot 10$$

- **CONCLUSION:** Specify the quantities of substances needed for the preparation of solutions and write down the specified volume of prepared solution.

VOLUMETRIC GLASSWARE TEST

Task:

Identify the names of volumetric glassware, number and arrange it from the least precise to the most precise. Indicate which volumetric glassware is for topping and for the outpouring.

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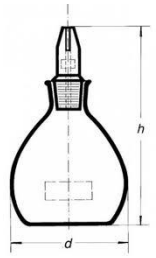

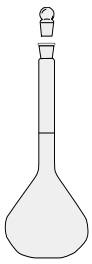

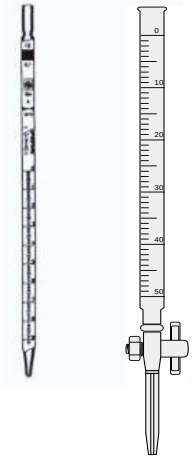

Followed by a list ready for copying tests.

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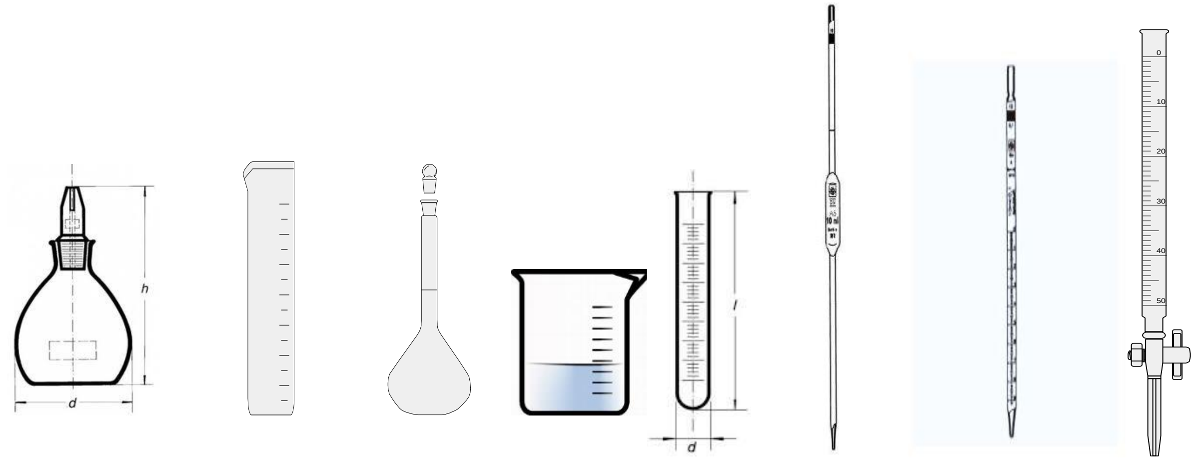

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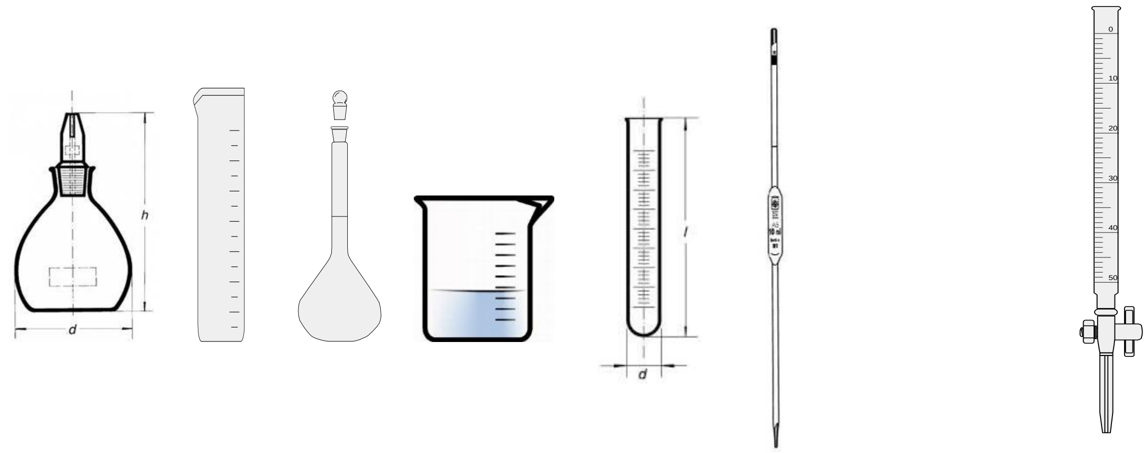

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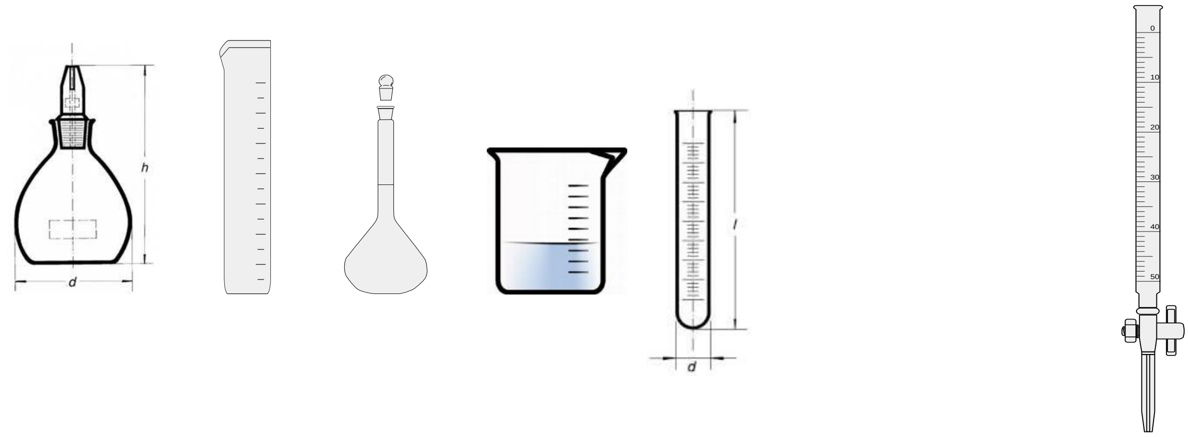

STUDENT´S SHEET No.3

1) **Matching words**
Match correctly the words to their translations:

1. volumetric flask	A. kádinka
2. funnel	B. odměrná baňka
3. beaker	C. baňka
4. flask	D. odměrný válec
5. weighing boat	E. lodička
6. graduated cylinder	F. nálevka

2) **<u>Fill in the missing words:</u>**

1. Solutions are _____ systems consisting of two or more components.

a) hommogen b) humangeneous c) homogeneous d) hommogeneous

2. It is the amount of substance _____ in a solution.

a) dislocated b) dissolved c) disolved d) disconnected

3. Saturated solutions _____ the maximum amount of a substance dissolved at a given temperature.

a) contain b) obtain c) combine d) contrain

3) Word search

1. TEPETPI ……PIPETTE
2. SALGS CAWHT ……
3. RUNREB ……
4. RADGTAUED DERCYLIN ……
5. ETRUBET ……
6. MREMORHTRET……

4) Easy crossword – Fill in the missing verbs:

a) změřit

b) určit

c) obsahovat

d) skládat se z něčeho

e) upřesnit,vymezit

5) **Matching words II .Match correctly words to their translations:**

1. density	G. hladina, povrch
2. acids	H. rozpustnost
3. surface	I. hustota
4. solubility	J. ochranné brýle
5. saturated	K. nasycený
6. goggles	L. kyseliny
7. gloves	M. přesný, vhodný
8. accurate	N. ruka