LESSON PLAN

School: ''Constantin Noica'' Theoretical High-School, Sibiu
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SUBJECT MATTER/TOPIC: Water Analysis. Water purification in the laboratory.

Grade: 10, specialization Natural Science.

Type of activity: Laboratory work

Goals: To assess the water pollution and to develop understanding of water contaminants.

Learning objectives: by the end of this lesson, students will be able to:

- Determine the acidity and alkalinity of a water sample and compare the results with the standard quality figures.
- Measure the water sample pH by means of a litmus paper and indicate if it is acid or basic.
- Build and test a water filtration system.
- Understand and test the role of plants in filtering waste water.
- Create a Power Point presentation of main aspects of water pollution.
- Exemplify the impact of water contaminants in case studies.

Methods and procedures: heuristic conversation**,** case study, laboratory experiment, investigation, brainstorming, problematisation.

Resurces: 2 hours; handouts, substances, utensils and materials for the experiment, A4sheets of paper, glue, Chemistry lab, videoprojector, PC.

Organisation: 5 groups of students, whole class work.

Stages of the lesson:

- **Introduction and lead-in**: organize class in 5 groups; Power Point presentation of water pollution; state objectives, share handouts
- **Development**:
- Determination of the acid and basic/alkaline character of water.
- Measuring the water pH.
- Mechanical and biological filtering of waste water
- **Closure :** Your role ! Your responsibility! (Conclusions)

Instructions:

- Use the laboratory data refering to acidity and alkalinity of water and apply them on 3 different water samples;
- Use pH- paper to measure the pH of the water samples; indicate by color the acid and basic/alkaline character of water
- Build and test a simple water filtration system, using a coffee filter, medical coal, sand, pebble gravel in order to filter waste water

- Test the absorbing power of Eichhornia crassipes, commonly known as water hyacinth and its role in decontamination of waste/polluted water.
- Complete the charts for each practical work.
- Create your own message against pollution on a sheet of paper, to be included in the group poster (Conclusion).

Laboratory work

I.A. Determination of water alkalinity

Generalities

The alkalinity of the water is given by the presence of bicarbonates, alkaline carbonates, alkaline-earths and hydroxides.

Purpose: to determine the alkalinity of a water sample.

The principle of the method: the neutralizing of a water sample with a diluted acid in the presence of an acid-base indicator.

The alkalinity determined in presence of phenolphthalein (pH=8.2) is **the permanent alkalinity** and is given by the free bases and by the alkaline carbonates**:**

$$NaOH + HCI \rightarrow NaCI + H_2O$$

$$K_2CO_3 + HCI \rightarrow KHCO_3 + KCI$$

The alkalinity determined in presence of methyl orange (pH= 4,4) is **the total alkalinity** and is given by the free bases, carbonates and alkaline bicarbonates.

$$NaOH + HCI \rightarrow NaCI + H_2O$$

$$K_2CO_3 + HCI \rightarrow KHCO_3 + KCI$$

$$Ca(HCO_3)_2 + 2HCI \rightarrow CaCI_2 + 2H_2CO_3$$

Reagents and needed tools:

- solution of HCI 0,1 N with known factor;
- Berzelius glasses
- solution of phenolphthalein 0.1%;
- Burette, Erlenmeyer flasks, filtering funnel.
- watery solution of methyl orange 0,1%;

Procedure:

1) Determination of permanent alkalinity

- in an Erlenmeyer flask pour 100ml of sample water for analysis
- add 2-3 drops of phenolphthalein and:
  - if the water remains colorless, the alkalinity as against to phenolphthalein is zero;

- if it becomes reddish, titrate with HCI 0,1N until the solution becomes completely colorless (permanent alkalinity P).

$$\mathbf{Alc_P} = \frac{V \cdot f}{V_p} \cdot 1000 \text{ , } \qquad \textbf{ml HCI 0,1 N/dm}^3$$

where: V_p – the volume of the water for analysis, ml;

V – the volume of HCI 0,1N used for titration, ml;

f – the correction factor of HCI 0,1N solution.

2) Determination of total alkalinity

- in the same solution, add 2-3 drops of methyl orange and continue the titration with HCI 0,1N until the color indicator shows yellow-orange (total alkalinity T)

$$\mathbf{Alc_T} = \frac{V \cdot f}{V_p} \cdot 1000 \textbf{ , } \qquad \textbf{ml HCl 0,1 N/dm}^3$$

where: V_p – the volume of water for analysis, ml;

V – the volume of HCI 0,1N used for titration, ml;

f – the correction factor of the HCI 0,1N solution

Tasks:

- perform the laboratory work;
- observe the work safety regulations;
- calculate the total and the permanent alkalinity of the water sample;
- note the results in the chart;
- compare the obtained results with the standard quality values .

Sample No.	**Water sample provenience**	**The determination of alkalinity** ml sol. HCl 0,1 N	
		total (T)	**permanent (P)**
1			
2			

3			

Laboratory work

B. Determination of water acidity

General facts: Water acidity is given by the presence of free carbon dioxide, mineral acids, salts of strong acids with weak bases.

Purpose: to determine the acidity of water samples.

Principle of the method: neutralization of the water samples to be analyzed with a base in the presence of an indicator.

Reagents and tools:

• 0.1 N NaOH solution with known factor;
• alcoholic phenolphthalein solution 0.1%;
• 0.1% aqueous methyl orange solution;
• 250 ml Erlenmeyer flaskss; Berzelius glasses; burette.

Procedure:

1) Determination of total acidity

1. in an Erlenmeyer flask introduce 100 ml of water to be tested;
2. titrate with 0.1 N NaOH in the presence of phenolphthalein until we get a persistent pink color.

$$\mathbf{Ac_t = ,\ \ ml\ NaOH\ 0{,}1\ N/dm^3}$$

where: Vp - volume of water for analysis, ml;

V - volume of 0.1N NaOH used for titration, ml;

f - correction factor of 0.1 N NaOH solution

3. If the water sample has a higher than 4.5 pH, the acidity caused by mineral acids is 0.

4. If the water sample has a lower than 4.5 pH, the acidity is due to mineral acids. It is called real acidity and can be determined as follows:

2) **Determination of real or permanent acidity**

- in an Erlenmeyer flask introduce 100 ml of water to be tested;
- titrate with 0.1 N NaOH solution in the presence of methyl orange until the yellow - orange color turns into lemon yellow

$$\mathbf{Ac_R = , ml\ NaOH\ \ 0,lN/dm^3}$$

where: Vp - volume of water for analysis, ml;
V - volume of 0.1N NaOH used for titration, ml;
f - correction factor of 0.1N NaOH solution

Tasks:

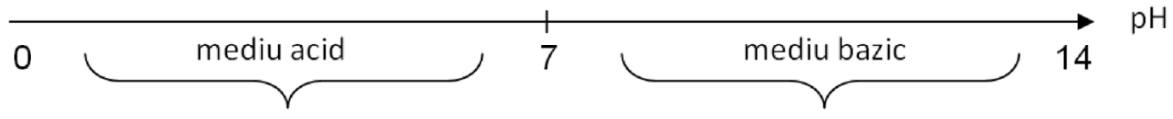
- perform the laboratory work;
- observe the work safety regulations;
- calculate the total and the permanent acidity of the water sample;
- note the results in the chart;
- compare the obtained results with the standard quality values for water .

Sample No.	**Water sample provenience**	**Acidity,** ml sol. NaOH 0,1 N	
		total (T)	**real ®**
1			
2			
3			

II. The pH determination of water

Overview

PH-represents a way to express the concentration of ions H_3O^+ from an aqueous solution. So, the pH of a solution is defined by the relation:
$PH = -\log[H_3O^+]$
Analogous, $pOH = -\log[HO^-]$



The pH of a solution can be measured with pH Paper / universal indicator or witth pH meter.

Purpose: to determine the pH of some water samples

Principle of the method: The pH determination is done by using the colorimetric method with the comparison scale.

The pH value can be read on the scale of pH-meter with a better precision of 0.1 units.

Materials/tools

- Test tube, Berzelius glass, paper pH indicator, glass wands, pH-meter, water samples from each group

Procedure:

- With the help of glass wands put 1-2 drops on the pH indicating paper and compare the resulting color with the standard scale in the box.
- In the water sample for analysis insert the pH-meter electrode and read the pH value.

Task: note the obtained values in this table:

Chart of data

SampleNo. group/	The source	pH	Observations
GR.1			
GR. 2			
GR. 3			

Appendix 1: The values from quality standards of studied indicators

Indicator	Unit of measurement	Surface water					Drinking water
		Order no. 161/16/02/2006					Law 311 / 28/06/2004
		Quality class					
		I	II	III	IV	V	
pH	-	6.5 – 8.5					6,5-9,5
Total hardness, minimum	German degrees	-	-	-	-	-	5
Dissolved oxygen	mg O_2/l	9	7	5	4	<4	<18

Nitrite (-NO_2^-)	mg N/l	0,01	0,03	0,06	0,3	> 0,3	0,50
Nitrate (-NO_3^-)	mg N/l	1	3	5,6	11,2	> 11,2	50

III: Mechanical Wastewater Treatment

General view: The pollutants entered in natural and artificial water sources are numerous.

Conventional water treatment methods are the following: sedimentation, coagulation, physical or biological filtration, and disinfection. Mineralization processes are sometimes used as well.

Goal: Elimination of substances in wastewater.

Principle of the Method

Pass polluted water with household substances (e.g. dishwater), waste water, over different surfaces that are designed to retain some of the pollutants.

Coffee filter → activated charcoal → sand → gravel

Materials and tools required:

• Water samples provided by each group - 100 cm^3

• Separatory funnel, metal ring, rod, support, plugs, clips, glass rod, filter funnel.

• Filter paper (from coffee machine), sand, gravel, activated charcoal.

• Containers, Erlenmeyer flasks, graduated cylinder, pH indicator paper, watch glasses.

Procedure:

If the wastewater contains non-miscible liquids, one must perform a separation using separatory funnel mounted on a support with a metal ring. At the bottom, the water is collected in an Erlenmeyer flask. The sewage treatment mechanism is composed of recycled containers (cups, plastic bottles with a hole for draining etc.) provided by each group. Mount / secure one on top of the other, its waters flowing over the different layers. Finally, measure the pH of the resulting water.

Tasks: Determine the pH of the resulting water in last container and compare it with the initial pH of the sample.

Group nr.	Initial pH	Final pH	Conclusions
Gr. 1			
Gr. 2			
Gr. 3			

Biological treatment of wastewater

General view: Use of the water hyacinth (Eichhornia Crassipes) for wastewater treatment is considered a simple technology that does not require expensive machinery and equipment. They have miraculous properties—they areable to tain 1,200 times more pollutants than waste water could store (assimilation of toxins, pesticides and heavy metals etc.).

Goal: The elimination of substances from sewage / wastewater.

Principle of the Method: The use of biological filters (the water hyacinth) to absorb substances in water and thus cleanse the water.

Method: Prepare four containers with different water samples, equal volumes of 500 cm^3 : tap water, water with pig droppings (diluted 1-2) from Fofeldea village, raw water from Sadu, water from the Cibin etc. (any type of wastewater). Place a stalk of water hyacith in each container. Measure the length of roots and the pH of the water. Note the required values in the chart.

Tasks:

• Measure the pH of the 4 water samples, measure the length of the hyacinth roots and check for nitrite and ammonium ions using appropriate reactives (place 10 ml of each sample in separate containers and add the reactives).

• Repeat the measurement at different time intervals. Note in the chart below:

Water sample No.	Length of the roots cm		pH		Nitrite reactives	Ammonium reactives	Conclusions
	Initial Data	Final Data	Initial Data	Final Data	Colour Data i f	Colour Data i f	
1.							
2.							

3.							
4.							

Consult the chart!

Ions	Colour lack of ions	Colour ions exist
Nitrites	Colourless	Shades of pink (the intensity increases with the concentration)
Ammonium	Yellow/Orange	Green .... → blue (depending on the concentration)

IV. Your role! Your responsibility!

Requirement: each group completes on an A4 sheet of paper their own conclusions regarding the protection of the environment and water protection. They gather these sheets to make a final poster.

Materials: A4 paper, markers, glue, large sheet of paper.

Evaluation: realization of the laboratory essays.

Homework: Create a minidictionary of environmental issues terms.