Name of the project:	**Digitization of chemistry experiments to improve the quality and support chemistry teaching in secondary schools**
Acronym:	**ChemIQSoc**
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Tittle: Acidimetry–Standardisation of the HCl volumetric solution

Work instructions

Task: Determine the exact concentration of the volumetric solution of hydrochloric acid.

Theory

Volumetric solutions of strong acids (hydrochloric or sulfuric) are used for the determination of bases. These titration methods are called acidimetry.

A sodium bicarbonate is used to determine the exact concentration of a volumetric solution of HCl. In titration with acid, the following reaction takes place

$$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O \quad (1)$$

For visual indication of the equivalence point, methyl orange is used as an indicator.

Equipment: beakers, pipettes, pipetting balloon, glass rod, stand, volumetric flask (250 ml), burette

Chemicals: deionised water, sodium bicarbonate solution (stock solution with an approximate concentration of 0.2 mol l^{-1} by weighing 4.2 g of $NaHCO_3$, dissolving in deionised water and filling up to 250 ml in a volumetric flask; calculate the exact concentration according to the actual weighted amount), volumetric solution of HCl with approximate concentration of 0.2 mol l^{-1} (prepared by dilution with 36 % HCl), methyl orange indicator

Procedures:

1. Rinse the burette 3 times with demi-water and 3 times with hydrochloric acid solution. Mix thoroughly the hydrochloric acid solution before use.
2. Fix the burette in the laboratory stand and fill with HCl volumetric solution.
3. Rinse the pipette with 3× demi-water.
4. Mix the sodium bicarbonate stock solution and then wash the pipette 3 times.
5. Pipette 25 ml of sodium bicarbonate solution into the titration flask.
6. Add 2-3 drops of the acid-base indicator methyl orange to the solution.
7. Titrate the solution with HCl solution (dropwise) until the colour changes from yellow to weak orange (onion yellow).
8. Repeat the titration 3 times.

Management of chemical substances

Chemicals	Form	H-statements	P-statements
$NaHCO_3$	Solid	---	---
HCl	36% solution	H290, H314, H335	P234, P261, P271, P303 + P361 + P353, P305 + P351 + P338
Methyl orange	Solution, indicator	H301	P264, P270, P301 + P310, P405, P501

Sources of risk and assessment of risk severity

The student works with solutions prepared in advance in stock bottles. Does not come into direct contact with toxic chemicals, pipetting dilute solutions and using protective work equipment (protective clothing, gloves, goggles or shield).

Method of waste management

Pour residual chemicals into prepared containers. Place broken glass in the container provided. Do not return leftover standard solutions to storage bottles.

Risk reduction measures

Wear protective gloves, protective clothing and goggles. Avoid release of chemicals into the environment; if skin contact occurs, wash with plenty of soap and water. Do not expose yourself to prolonged or repeated exposure. In the event of an accident or if you feel unwell, inform the teacher immediately. Do not eat, drink or smoke while working, and wash your hands with warm water and soap or apply a reparative cream after work or when interrupting work.

Worksheet

Experimental data

1. Derive the equation for calculating the exact concentration of the HCl solution when standardizing to $NaHCO_3$.

2. Preparation of the stock solution of sodium bicarbonate sample (differentially 4.2 g in a 250 ml flask)

	Weight [g]
Weighing boat with sample	
Weighing boat after emptying	
Sample weight	

2. Record the volume of the hydrochloric acid solution used in the titration.

Titration	**V(HCl) [ml]**
1	
2	
3	

Calculations

1. Calculate the exact concentration of the volumetric solution of HCl.

Questions

1. Write the equation of the reaction of standardization of volumetric solution of hydrochloric acid.

2. How the acid-base indicator works.

3. What is the base substance and what do we need it for?

4. Indicate the sources of errors in this method. How would you minimise these errors?

Conclusion

Briefly summarize the objective of the experiment, the main results and compare them with the expected values.

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