Name of the project:	**Digitization of chemistry experiments to improve the quality and support chemistry teaching in secondary schools**
Acronym:	**ChemIQSoc**
Project number:	**2021-1-SK01-KA220-VET-000027995**

Co-funded by the Erasmus+ Programme of the European Union

Tittle: Preparation of copper(II) chloride

Work instructions

Task: React 3 g of copper with hydrochloric and nitric acids to prepare $CuCl_2 \cdot 2H_2O$.

Theory

Copper(II) chloride is the second most abundant copper compound after $CuSO_4$. Anhydrous is yellow brown, slowly absorbing moisture to form a green dihydrate.

It is commercially prepared by chlorination of copper:

$$\mathbf{Cu + Cl_2 + H_2O \rightarrow CuCl_2 \cdot 2H_2O} \quad (1)$$

It can also be prepared from CuO, $Cu(OH)_2$ or $Cu(CO_3)_2$ by the action of hydrochloric acid.

$CuCl_2$ is used e.g. in organic syntheses or for pyrotechnical effects (it colours the flame blue green).

Equipment: graduated cylinder, glass rod, separating funnel, funnel, burner, ribbed funnel, Büchner funnel, suction flask, filter paper, watch glass, scales, porcelain bowl

Chemicals: hydrochloric acid (36%), nitric acid (63%), copper powder

Procedures:

1. To the weighed amount of Cu in the porcelain bowl, add the calculated amount (1.2 times the theory) of 24% HCl.
2. Cover the mixture with an inverted funnel and carefully add the calculated amount of 33% HNO_3 from the separating funnel, one part at a time, through the funnel stem.
3. When steam of NO_x stops forming, remove the funnel, rinse in a bowl, and heat the mixture gently until it dissolves.
4. Filter the solution obtained into a clean dish and evaporate with stirring. When a brown band of anhydrous $CuCl_2$ begins to form on the edge of the dish, wipe it off with a stick to prevent it from decomposing with heat. When the solution thickens, allow it to stand and aspirate the excluded crystals on a Büchner funnel.

Management of chemical substances

Chemicals	Form	H-statements	P-statements
HCl	Liquid, 36%	H290, H314, H335	P280, P303 + P361 + P353, P304 + P340, P305 + P351 + P338, P312
HNO_3	Liquid, 65%	H290, H314	P260, P280, P303 + P361 + P353, P305 + P351 + P338, P310
Cu	Solid, powdery	H228, H315, H319, H335	P210, P273, P370 + P378
$CuCl_2 \cdot 2H_2O$	Solid	H290, H302 + H312, H315, H318	P302 + P352, P305 + P351 + P338, P321, P390, P501

Sources of risk and assessment of risk severity

Hydrochloric and nitric acids are strong inorganic acids whose fumes irritate the respiratory system. At the same time, reactions in which nitric acid acts as an oxidising agent often release NO_x. Therefore, always work with them in a fume hood or a well-ventilated area. Copper chloride is toxic to aquatic life, so avoid leaching it into sinks.

Waste management method

After weighing, transfer the product into the prepared container.

Risk reduction measures

Wear tight-fitting safety glasses or face shield, rubber gloves protective clothing and footwear. Wash hands thoroughly after handling. If skin contact occurs, wash with plenty of warm water and soap. In the event of an accident or if you feel unwell, inform the teacher immediately. Work in well-ventilated areas. Do not eat, drink, or smoke while working. Follow the safety instructions given by the teacher. If eyes are hit, rinse gently with water for a few minutes. Remove contact lenses, if fitted, and if they can be removed easily. Continue rinsing.

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Worksheet

Calculations

1. React 3 g of copper with hydrochloric and nitric acid to prepare copper chloride. Calculate:
    a. theoretical yield of copper chloride
    b. the volume of 36% hydrochloric acid required to prepare a 24% solution
    c. the volume of 63% nitric acid required to prepare a 33% solution

    Response: $3\ Cu + 6\ HCl + 2\ HNO_3 + 2\ H_2O \rightarrow 3\ CuCl_2 \cdot 2H_2O + 2\ NO$

    M(Cu) = ... $g.mol^{-1}$, $M(CuCl_2)$ = ... $g.mol^{-1}$, M(HCl) = ... $g.mol^{-1}$

    $M(HNO_3)$ = ... $g.mol^{-1}$

    ρ(HCl, 36%) = ... $g.cm^{-3}$, ρ(HCl, 24%) = ... $g.cm^{-3}$

    ρ (HNO_3, 65%) = ... $g.cm^{-3}$, ρ (HNO_3, 33%) = ... $g.cm^{-3}$

    ρ (H_2O, 20°C) = ... $g.cm^{-3}$

    Mass of copper chloride (II)

    Volume of 36% hydrochloric acid

    Volume of water required for the preparation of 24% hydrochloric acid solution

    Volume of 65% nitric acid

Volume of water required for the preparation of 33% nitric acid solution

2. Calculate the practical yield of copper chloride (II) in %.
   PV = ... g, TV = ... g

   PV(%) = ... %

Observation

1. Describe the appearance of anhydrous copper chloride (II) and copper chloride (II) dihydrate.

2. Search for the basic physicochemical properties of copper chloride (II).

Feature	**Value**
Solubility in water	
Solubility in other solvents	
Melting point	

Yield

1. Record the mass of the prepared copper chloride (II) dihydrate.

   m($CuCl_2 \cdot 2H_2O$) = ... g

Questions

1. Write the equation of the reaction for the preparation of copper chloride from a) copper, b) copper oxide.

2. Explain why it is necessary to cover the mixture with an inverted funnel before adding nitric acid.

3. 3How do you distinguish formed nitric oxide from nitrogen dioxide?

4. Indicate how copper chloride (II) colors the flame.

5. Describe the use of copper chloride (II).

Conclusion

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

Disclaimer