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# Polyhydric alcohols (Item No.: P7172200)

#### **Curricular Relevance** Subtopic: Area of Expertise: Sauerstoffhaltige **Education Level: Topic:** Experiment Chemie Organische Chemie organische Mehrwertige Alkanole Klasse 7-10 Verbindungen Difficulty **Preparation Time Execution Time Recommended Group Size** RRRRR 00000 $\odot$ 10 Minutes 10 Minutes 2 Students Easy **Additional Requirements: Experiment Variations: Keywords:**

alkanols, polyhydric alcohols, properties of polyhydric alcohols

## Task and equipment

## Information for teachers

#### Learning objectives

- Polyhydric alcohols exhibit similar properties to monohydric alcohols, but have, among others, higher boiling points and viscosities.
- Polyhydric alcohols can be differentiated from monohydric alcohols by the formation of a deep-blue copper complex.

#### Notes on setup and procedure

Preparation:

Prepare 1% copper sulphate solution (0.2 g copper sulphate in 100 ml water) and dilute caustic soda (10 g NaOH to 100 ml water).

The concentrations given are guidelines and can differ a bit.

#### Remarks on the students experiments:

The addition of caustic soda to test tubes 1 and 2 must be stopped as soon as blue copper hydroxide precipitates out. The addition of caustic soda to test tubes 3 and 4 must be stopped as soon as a deep-blue complex forms.



## **Hazard and Precautionary statements**

Ethylene glycol: H302: P501:

Harmful if swallowed. Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.



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#### Teacher's/Lecturer's Sheet

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Copper(II)				
sulphate:				
H302:				
H315:	Causes skin irritation.			
H319:	Causes serious eye irritation.			
H410:	Very toxic to aquatic life with long lasting effects.			
P273:	Avoid release to the environment.			
P302 + P352:	IF ON SKIN: Wash with plenty of soap and water.			
P305 + P351 + P308:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.			
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.			
Sodium hydroxide:				
H314:	Causes severe skin burns and eye damage.			
H290:	May be corrosive to metals.			
H280:	Wear protective gloves/ protective clothing/ eye protection/ face protection.			
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.			
P309 + P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.			
P301 + P330 + P331:	IF SWALLOWED: rinse mouth. Do NOT induce vomiting.			
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.			
Propyl alcohol:				
H225:	Highly flammable liquid and vapour.			
H318:	Causes serious eye damage.			
H336:	May cause drowsiness or dizziness.			
P210:	Keep away from heat/sparks/open flames/hot surfaces No smoking.			
P223:	Keep away from any possible contact with water, because of violent reaction and possible flash.			
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.			
P313:	Get medical advice/ attention.			
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.			
Ethanol:				
H225:	Highly flammable liquid and vapour.			
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.			

#### Hazards

- Alcohols are highly inflammable. Extinguish all open flames! Wear protective glasses!
- Ethylene glycol is harmful to health. Do not let it contact skin, do not swallow it!

#### Notes

The flow times given above are very dependent upon the angle of inclination and the amount of substance, they are therefore only given as examples. Polyhydric alcohols can form soluble complexes with copper hydroxide. They can also form inclusion compounds with other substances.

#### **Remarks on the method**

Point out that by the addition of glycol, the melting point of water can be decreased to -50 °C. The "wine scandal", the addition of diethylene glycol to wine in order to simulate the "oiliness" of high quality wines (mainly caused by glycerol) might also be subject to discussion.

#### Waste disposal

Precipitate out copper ions in the form of sulphides and put the precipitate in the waste container for waste containing heavy metals or put the alcoholic solutions in the waste container for acid/ alkaline solutions.



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### Task and equipment

#### Task

# How do the properties of alcohols change with the presence of more hydroxyl groups?

Examine some properties of polyhydric alcohols.





#### Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, I=370 mm, d=10 mm	02059-00	1
3	Test tube brush w. wool tip,d25mm	38762-00	1
4	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
5	Test tube, 180x18 mm,100pcs	37658-10	(4)
6	Labor pencil, waterproof	38711-00	1
7	Pipette with rubber bulb	64701-00	2
8	Protecting glasses, clear glass 39316-00		1
9	Boss head 02043		1
10	Stop watch 4	03078-00	1
11	Universal clamp	37715-00	1
	Rubber stopper, d=22/17 mm, without hole	39255-00	4
	Ethanol extra pure ab.95% 1000 ml	30008-70	1
	Glycerol, 250 ml	30084-25	1
	Ethylene glycol 250 ml	30085-25	1
	Copper-II sulphate,cryst. 250 g	30126-25	1
	Sodium hydroxide, flakes, 1000 g	30157-70	1
	Water, distilled 5 l	31246-81	1
	Propyl alcohol,normal 250 ml	31754-25	1



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## Set-up and procedure

## Set-up

#### Hazards

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## Setup

Set up the stand as in Fig. 1 to 3. Number the test tubes from 1 to 4.







Fix test tube 1 at an angle of 45° in the universal clamp (Fig. 4).







#### Procedure

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Use the pipette to place a large drop of ethanol on the inner edge of the test tube (Fig. 5). Measure the time which the drop requires to flow down to the bottom of the test tube (Fig. 6). Put the test tube in the test tube rack. Fix test tube 2 similarly with the universal clamp, use the emptied pipette to pick up propanol and transfer a large drop of it to the inner edge of the test tube. Again measure the time the drop needs to reach the bottom of the test tube.



Change the pipette and repeat the procedure above with ethylene glycol and glycerol in test tubes 3 and 4 respectively.

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Fill the test tubes 1 to 4 to a height of about 1 cm with the alcohols which were just used (Fig. 7).





Put the triple amount of copper sulphate solution in test tube 1 (Fig. 8) and mix the liquids by shaking carefully (Fig. 9). Then add approximately 2 ml of caustic soda (Fig. 10).







Repeat this procedure with the alcohols in test tubes 2 to 4.

#### Waste disposal



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Precipitate out copper ions in the form of sulphides and put the precipitate in the waste container for waste containing heavy metals or put the alcoholic solutions in the waste container for acid and alkaline solutions.

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## **Report: Polyhydric alcohols**

#### Result - Table 1

Note the flow times of the alcohols in the table.

Test tube	Content	Flow time in s
1	Ethanol	1
2	Propanol	1
3	Ethylene glckol (ethanediol)	1
4	Glycerol (propanetriol)	1

#### Result - Table 2

Note your observations on the second part of the experiment in the table.

Test tube	Content	Colour	
1	Ethanol	light-blue (precipitate)	1
2	Propanol	light-blue (precipitate)	1
3	Ethylene glycol (ethanediol)	deep-blue	1
4	Glycerol (propanetriol)	deep-blue	1



#### **Student's Sheet**

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#### **Evaluation - Question 1**

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Draw conclusions from the first part of the experiment.

#### **Evaluation - Question 2**

Substantiate which statements can be made on the boiling point of the polyhydric alcohols compared to the boiling points of the monohydric alcohols of the same chain-length.



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#### **Student's Sheet**

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#### **Evaluation - Question 3**

Summarize in a single mnemonic sentence, how polyhydric alcohols differ from monohydric alcohols experimentally.

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#### **Evaluation - Question 4**

Name the most important uses of glycerol and glycol.



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