



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

ALCOHOLS, PHENOLS AND ETHERS

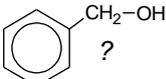
Fermentation

1. Use a book or the internet to find the answers to the following questions:
 - a. How is ethanol produced naturally? Write an equation.
 - b. What can be the sources of sugar and what do we call the products of their fermentation?
 - c. What is the highest possible concentration of ethanol produced by yeast? And why?
 - d. What are spirits and how are they made?
 - e. What is the effect of methanol on human health and what is methanol used for?
 - f. What are the short-term and long-term effects of drinking ethanol?
 - g. What was once the role of ethanol in the chemical industry?

HYDROXYCOMPOUNDS

= compounds with group attached to

- an aliphatic carbon =
 - an aromatic ring =
2. Give examples for both above mentioned groups of compounds.

3. How would you classify  ?

Classification and naming of alcohols

- primary: carbon atom carrying the OH group bonds alkyl group(s) and H atom(s)
- secondary: carbon atom carrying the OH group bonds alkyl group(s) and H atom(s)

- tertiary: carbon atom carrying the OH group bonds alkyl group(s) and H atom(s)

Name: suffix + the position of the OH group in the carbon chain.

4. Write the structures and names for all alcohols with one OH group and with:

- | | |
|------------------------|--------------------------|
| a. one atom of carbon | c. three atoms of carbon |
| b. two atoms of carbon | d. four atoms of carbon |

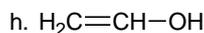
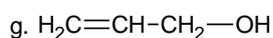
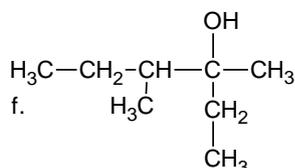
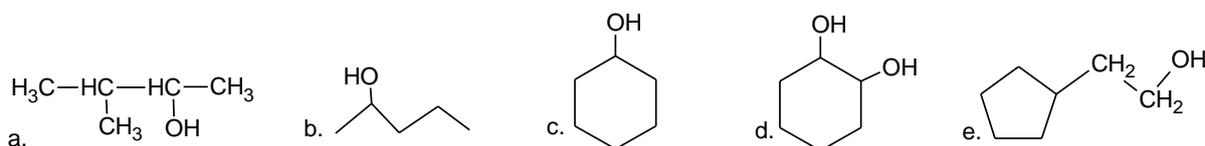
5. Classify the alcohols in the question 4 as primary, secondary or tertiary.

- two OH groups: suffix, three OH groups: suffix

6. Write the structure for ethane-1,2-diol (ethyleneglycol) and name

$$\begin{array}{c} \text{H}_2\text{C}-\text{CH}-\text{CH}_2 \\ | \quad | \quad | \\ \text{OH} \quad \text{OH} \quad \text{OH} \end{array}$$

7. Write the names for:



Notes:

- a.,f.: Carbon atoms are numbered so that OH has number.
- e.: When an alkyl group attached to a cycloalkane carries an OH group the cycloalkane is considered an alkyl group attached to an alcohol.
- g.: An OH group has number than a double bond.
- h.: An enol changes to form

8. Write the formulae for:

a. propane-1,2-diol

d. 4-methylhexane-3-ol

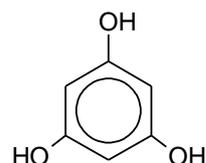
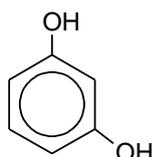
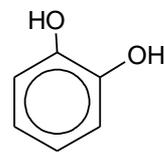
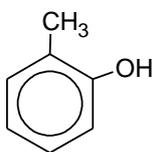
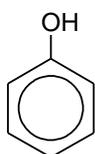
b. pentane-2-ol

e. 4-cyclopentylpentan-2-ol

c. cycloheptane-1,3-diol

f. 2-phenylethanol

Naming of phenols:



9. Write the structures for:

a. 3-methylphenol

b. naphth-1-ol

c. naphth-2-ol

d. p-cresol

Physical properties of alcohols and phenols

The formation of between the molecules of alcohols and between the molecules of alcohols and molecules of water causes high boiling point and in water.

The higher number of OH groups in a molecule of an alcohol the boiling point and viscosity.

The bigger the alkyl (non-polar) group the effect the OH group has on the overall properties, e.g. heptanol is immiscible with water.

Ethanol has a high affinity to water, it is with water in all proportions it also water from the air.

Azeotropic mixture = mixture of 95.6% of ethanol (b.p. 78°C) and 4.4% of water (100°C). Cannot be separated by distillation because of a constant boiling point. Water can be removed from such a mixture using a agent, e.g. CaO.

Phenol: solid with a low melting point, only partially soluble in water because of a large part.

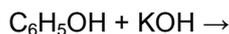
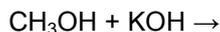
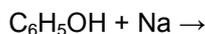
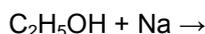
The nature of C–O–H bonds

OH group has an amphoteric character which means that it can act both as

- an : C–O–H →
- or as a: C–O–H + → →

Reactions of alcohols and phenols

1. Reactions of alcohols and phenols with alkali metals and their hydroxides



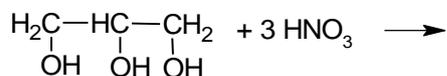
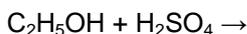
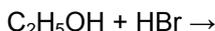
10. Ethanol is a weaker acid than water and phenol is a stronger acid than water. Explain why.

11. Explain why the solubility of phenol in NaOH solution is much higher than that in water

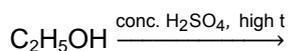
2. Esterification of alcohols

alcohol + carboxylic acid → ester + water (discussed in more detail later on)

3. Reactions of alcohols with inorganic acids



4. Dehydration of alcohols



12. Predict the organic products when:

a. propan-1-ol is heated with an excess of concentrated sulphuric acid

b. *an excess of butan-1-ol is heated with concentrated sulphuric acid*

c. *propan-2-ol vapour passes over heated aluminium oxide catalyst*

5. Oxidation of alcohols

primary: $C_3H_7OH \xrightarrow{\text{acidifiedor } K_2CrO_4}$

secondary: $CH_3CHOHCH_3 \xrightarrow{\text{acidifiedor } K_2CrO_4}$

tertiary: $(CH_3)_3COH \xrightarrow{\text{acidifiedor } K_2CrO_4}$

13. *Predict the organic products (if any) when the following alcohols are heated with acidified manganate(VII) solution:*

a. *butan-1-ol*

b. *butan-2-ol*

c. *2-methylbutan-2-ol*

d. *pentan-3-ol*

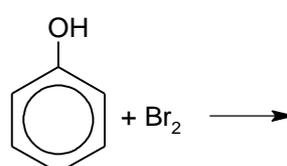
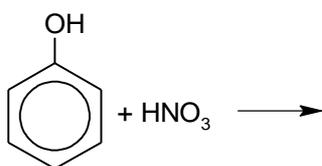
e. *ethanol*

f. *methanol*

14. *What is the reason for the sour taste of a wine that has been stored for some time in an open bottle?*

6. Substitution on the benzene ring of phenol

Phenol contains ring *activating/deactivating* group on the benzene ring so it may undergo S_E even without the presence of a catalyst. The OH group directs the substituents to the position





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Manufacture of alcohols

1. Hydration of alkenes
2. Oxidation of alkenes
3. S_N of haloalkanes

15. Give an example for each of the above reactions

Manufacture of phenol

1. Heating benzenesulphonic acid with NaOH
2. Heating phenyldiazonium hydrogensulphate with water
3. Oxidation of cumene (1-methylethyl)benzene

16. Write the structures for all above mentioned substances and try to predict the byproducts of their reactions.

ETHERS

= substances with two alkyl or aryl groups attached to an oxygen atom.

$R-O-R'$

Symmetrical ethers: $R' \dots R$, unsymmetrical ethers: $R' \dots R$

No possible bonding \Rightarrow volatile, soluble in water.

React with acids = H^+ , protonated ethers may be broken.



Important alcohols, phenols and ethers

Methanol

Ethanol

Ethylene glycol

Glycerol

Phenol

Ethoxyethane