

LABORATORY WORK NO. 27

CARBONYL COMPOUNDS- ALDEHYDES AND KETONES

- **PRINCIPLE:** Carbonyl compounds are ranked among oxygenous derivatives of hydrocarbon and they include carbonyl functional group \rightarrow $[C=O]$ in their molecules. In the aldehyde molecule there is only one bond of a hydrogen atom except alkyl or aryl. The aldehyde functional group is always situated in the beginning of the carbon chain while ketones' functional group is situated inside the carbon chain. Basic substances to prepare aldehydes are primary alcohols. Aldehydes are formed by their mild oxidation. Ketones are formed by oxidation of secondary alcohols.

Properties of carbonyl compounds:

- Formaldehyde is a gas under normal conditions, higher aldehydes and ketones are liquids, the highest are solid substances.
- Their boiling points are much lower than the boiling points of alcohols (carbonyl compounds have not hydrogen bridges).
- Compound with lower molecule weight are soluble in water, the solubility declines with the increasing molecule weight.
- They are well soluble in ethanol and diethyl ether.
- Lower aldehydes have a very strong bad smell but, on the contrary, higher aldehydes and some ketones have a pleasant odour.
- They react well, a characteristic reaction is the nucleophilic addition.

TASK N. 1 PROPERTIES OF ALDEHYDES

- **CHEMICALS:** formaldehyde (methanol), benzaldehyde, Fehling I a II, NaOH (c= 2 mol/l), $AgNO_3$ (c= 0,1 mol/l), NH_3 (1:10), solution of 1-Naphthol in NaOH, 0,5 % solution of sodium nitroprusside, CH_3COOH (c= 1mol/l)
- **AIDS:** test tubes, water bath, burner, test tube holder, watch glass, 1x burette, 2x pipette 1ml

A) Aldehydes as reduction agents

- **PROCEDURE:** We prepare a test tube cleaned by the solution of sodium hydroxide and washed in a great amount of water. In this test tube, we prepare the solution of complex silver ammonium nitrate in the following way: we drop the liquid solution of ammoniac of concentration 1:10 into 2 ml of $AgNO_3$ (0,1 mol/l) until the precipitate dissolves. We add 1 ml of methanol, we stir the mixture and we put the test tube into a hot water bath. After a few minutes, silver will exclude on the walls of the test tube in the form of a mirror.

The redox reaction proceeds according to this equation:





B) Aldehydes reaction with Fehling's solution

- **PROCEDURE:** We put 4 ml of formaldehyde into a test tube using a burette and add the same volume of the solution mixture Fehling I and II (1:1). We heat the test tube very carefully for about 3 – 5 minutes. A red precipitate of copper oxide is created.

Redox reaction proceeds according to this equation:



C) Reaction with sodium nitroprusside – Legalov's test

- **PROCEDURE:** We put 1 ml of formaldehyde and 1 ml of distilled water into a test tube. We add 2 ml of the 0,5 % solution of sodium nitroprusside and a few drops of the solution of sodium hydroxide ($c=2 \text{ mol/l}$). A red or violet colouring will appear in the presence of aldehyde. After adding a few drops of acetic acid, the colouring will change into blue.

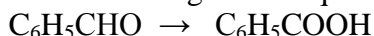
D) Proof of formaldehyde

- **PROCEDURE:** 5 drops of the liquid solution of formaldehyde is added to the solution of 1- naphthol in sodium hydroxide. After heating up, the mixture will change the colouring into light green and later blue.

E) Benzaldehyde oxidation

- **PROCEDURE:** We drop 1 ml of benzaldehyde on a watch glass. We leave everything in rest and after a while white sediment of benzoic acid appears.

Oxidation proceeds according to this equation:



- **CONCLUSIONS:** State your own conclusions for each task, observe the colourings and their changes.
- **SAFETY:** Formaldehyde is toxic when ingested, in contact with skin or during breathing in. Benzaldehyde can cause health problems when ingested. While working with both chemicals, follow safety instructions, use protective means and keep the room ventilated.

TASK N. 2 PROPERTIES OF KETONS

- **CHEMICALS:** acetone, cyklohexanone, NaOH ($c= 2\text{mol/l}$), 10% solution of KOH, solid K_2CO_3 , CH_3COOH ($c= 1\text{mol/l}$), solution of I_2 ($c= 0, 1 \text{ mol/l}$), 0, 5% solution of sodium nitroprusside
- **AIDS:** test tubes, burette, watch glass, table spoon, water bath, burner



A) Iodoform reaction

- **PROCEDURE:** We put 1ml of iodine and 1ml of acetone into a test tube. We drop slowly the 10 % solution of KOH until yellow crystals of iodoform appear. If the crystals do not appear, we add another 1ml of iodine and we warm up the reaction mixture in a water bath.

The reaction proceeds according to this equation:



B) Properties of acetone and cyclohexanone

- **PROCEDURE:** We carry out a burning test with a few drops of acetone on a watch glass. We add distilled water to 2 ml of acetone. We determine the solubility of acetone. We dissolve potassium carbonate in the solution of acetone in water (1:1) until it is saturated. Acetone can be salted out from the water solution. We carry out all the tests also with cyclohexanone and we compare the properties of both ketones.

C) Reaction with sodium nitroprusside - Legalov's test

- **PROCEDURE:** We put 1 ml of acetone into a test tube and we add 2 ml of sodium nitroprusside and 10 drops of sodium hydroxide. A red colouring appears, it will change into red-purple after acidification with acetic acid.
- **CONCLUSION:** Write down the results of reactions and proofs of ketons to all individual tasks.
- **SAFETY:** Acetone is highly combustible and can also cause irritation of eyes. Use protective means (coat, glasses) when working with it. Cyclohexanone is harmful when breathed in, therefore reduce breathing its vapour and work in a well ventilated room.



STUDENT'S SHEET No. 27
CARBONYL COMPOUNDS- ALDEHYDES AND KETONES

1. VOCABULARY

Match the Czech names with their English equivalents:

bond	hydroxid sodný	1....
oxygen	rovnice	2....
chain	vazba	3....
substance	nitropusid sodný	4....
boiling point	sraženina	5....
soluble	kyslík	6....
equation	řetězec	7....
sodium nitroprusside	bod varu	8....
sodium hydroxide	látka	9....
precipitate	rozpustný	10....

2. Choose the correct word or spelling

- a) To combine together to form a whole
- combose
 - compose
 - comfort
- b) A moment when e.g. water reaches 100°C
- heating point
 - warming point
 - boiling point
- c) that can be dissolved in a liquid
- soluble
 - solitude
 - solubility
- d) reaction where a chemical compound with an electron deficient reacts with electron rich reactant...
- neophilic reaction
 - nucleophilic addition
 - nurophilic addition
- e) a glass tube with measurements on it and a tap/faucet at one end
- a pipette
 - a burette
 - a beaker



3. Fill in the missing letters

- α) b-r-t-e
- β) s-diu- h-dr-x-de
- γ) s-tu-a-t-
- δ) -olu-i-n
- ε) b-il-ng p-i-t

4. Complete the crossword. Find following tools or glassware:

Test tube, burette, pipette, watch glass, beaker, holder, burner, mortar, water bath

O	T	J	B	W	R	U	R	G	U	J	P	O
T	G	S	B	A	G	M	G	A	P	I	O	L
B	U	R	E	T	T	E	A					
R	G	L	A	C	X	L	H	U	L	N	K	I
X	U	P	K	H	S	P	H	A	T	E	Z	J
E	I	H	E	G	S	P	M	O	R	T	A	R
Q	L	U	R	L	E	O	T	I	J		T	H
Y	T	R	I	A	T	I	I	C	N	P	V	G
H	N	I	U	S	M	J	N	C	M	I	D	F
N	E	H	Z	S	I	H	M	E	T	P	G	D
I	D	O	F	O	P	B	U	R	N	E	R	S
K	C	L	G	N	L	D	E	L	R	T	N	A
O	V	D	H	T	O	E	D	T	F	T	F	Y
L	R	E	T	E	S	T	T	U	B	E	D	Q
P	T	R	E	M	J	T	X	E	E	U	E	W
Z	W	A	T	E	R	B	A	T	H	U	G	E

5. Translate the words into Czech:

- a) sklíčko
- b) pipeta
- c) kádinka
- d) třecí miska
- e) zkumavka
- f) vodní lázeň
- g) držák
- h) byreta
- i) hořák



6. Find the right word in the mixed letters

- | | |
|---------------------|------------------|
| a) SIUMDO XIHERYDOD | SODIUM HYDROXIDE |
| b) SSIDOLVE | DISSOLVE |
| c) NYCLCOANHEX | CYCLOHEXANON |
| d) CATENO | ACETONE |
| e) SOACLOSH | ALCOHOLS |
| f) EIIDON | IODINE |