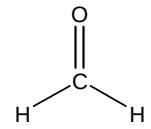
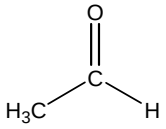
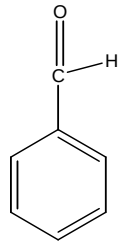
Chapter 16 - Aldehydes & Ketones
Chem 306
Roper

I. Overview

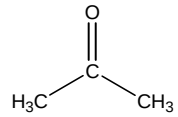
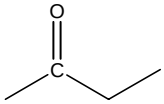
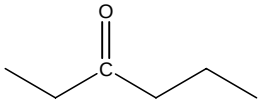
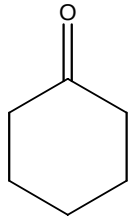
II. Nomenclature

A. Aldehydes

Structure	Common Name	IUPAC Name
	Formaldehyde	Methanal
	Acetaldehyde	Ethanal
	Benzaldehyde	Benzaldehyde

Write the structure for propanal and 3-aminopentanal.

B. Ketones

Structure	Common Name	IUPAC Name
	Acetone	Propanone
	Methyl ethyl ketone (MEK)	Butanone
	Ethyl propyl ketone	3 - Hexanone
	Cyclohexanone	Cyclohexanone

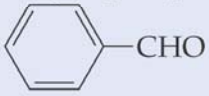
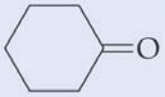
Write the structure for methyl phenyl ketone and 2-methyl - 3 - pentanone.

III. Properties

A. Aldehydes and ketones are called “carbonyl compounds” because they contain a carbonyl group.

B. Physical Properties of Aldehydes and Ketones

Can you explain the trends below? Aldehydes and ketones are soluble in water up to how many carbons?

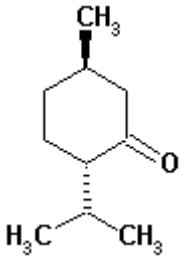
Structure	Name	Boiling Point (°C)	Water Solubility (g/100 mL H_2O)
HCHO	Formaldehyde	−21	55
CH_3CHO	Acetaldehyde	21	Soluble
CH_3CH_2CHO	Propanal	49	16
$CH_3CH_2CH_2CHO$	Butanal	76	7
$CH_3CH_2CH_2CH_2CHO$	Pentanal	103	1
	Benzaldehyde	178	0.3
CH_3COCH_3	Acetone	56	Soluble
$CH_3CH_2COCH_3$	2-Butanone	80	26
$CH_3CH_2CH_2COCH_3$	2-Pentanone	102	6
	Cyclohexanone	156	2

Rank the following compounds (all have a similar molecular weight) in order of increasing boiling temperature: pentane, 1 – butanol, butanal.

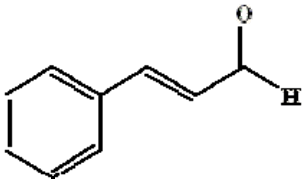
Explain why all aldehydes and ketones are soluble in organic solvents such as hexane or benzene.

C. Smaller ketones (2 – 6) carbons are good solvents because they can dissolve polar and non-polar solutes.

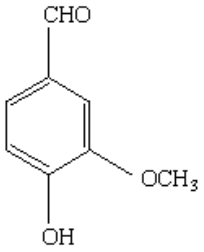
D. Many ketones and aldehydes are fragrant.



menthone



diacetyl (2-butanedione)



benzaldehyde

Cinnamaldehyde

Vanillin

IV. Reactions of Aldehydes & Ketones – Oxidation and Reduction

A. Oxidation

1. ***Aldehydes*** are oxidized to carboxylic acids by a variety of oxidizing agents [O]

Predict the products of the oxidation of the following aldehydes

Acetaldehyde

Benzaldehyde

2. ***Ketones*** resist oxidation by most oxidizing agents.

3. Oxidation is used as a chemical test to distinguish between an aldehyde and a ketone.

B. Reduction

1. Reduction of carbonyl groups involves the addition of hydrogen.

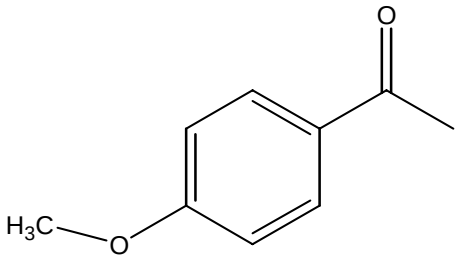
2. Some examples

Aldehyde

Ketone

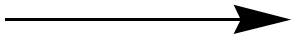
3. Complete the equations for these reductions

a.

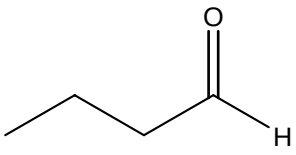


1. Reducing Agent ($:H^-$)

2. H_3O +



b.



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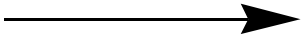
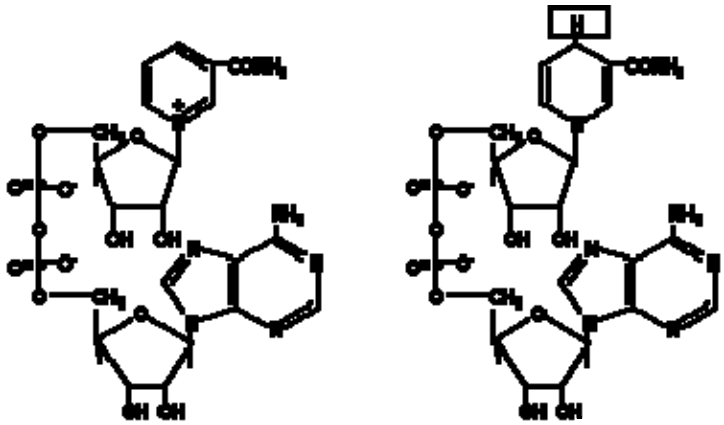


4. In general the reduction of an aldehyde produces

_____ and the reduction of a ketone produces

_____ .

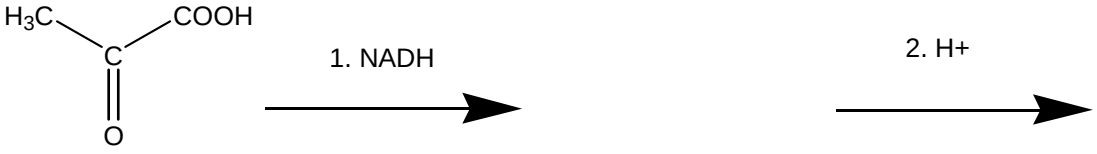
5. NAD+ and NADH are natures oxidizing and reducing agents.



NAD +

NADH

Muscle Chemistry – pyruvate/pyruvic acid is the end product of glycolysis



Pyruvic Acid

V. Reactions of Aldehydes & Ketones – Hemiacetal and Acetal Formation

A. Addition of Alchohols

1. The addition of an alcohol (ROH) to the carbonyl group of an aldehyde or ketone forms a hemi-acetal. If another alcohol is added to the same carbon, an acetal forms.

What could be added to the system above to shift the equilibrium to the left? To the right?

2. Some examples…

a. acetaldehyde + methanol

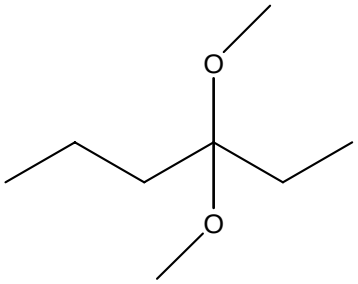
b. acetone + methanol

c. benzaldehyde + ethanol

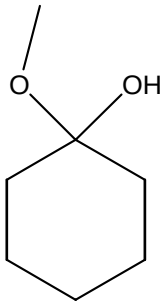
3. Try these.

Which of the following is an acetal? Hemiacetal? Are they formed from aldehydes or ketones?

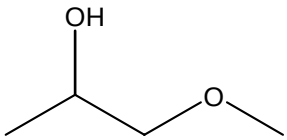
a.



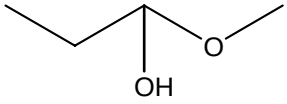
b.



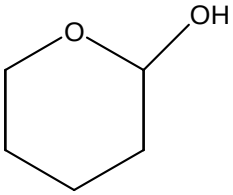
c.



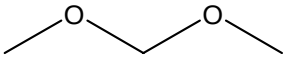
d.



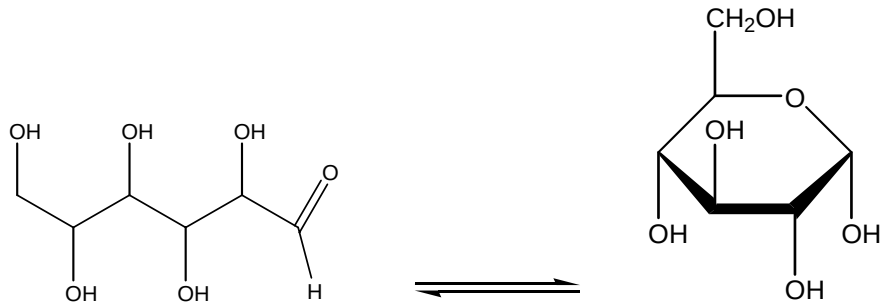
e



f.

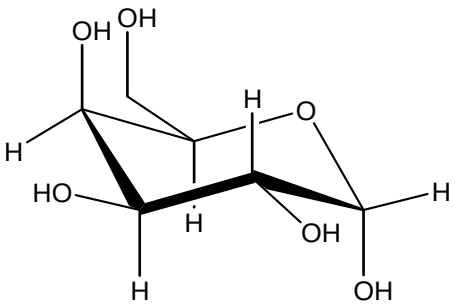


B. Sugar Chemistry – An application of hemiacetal formation.

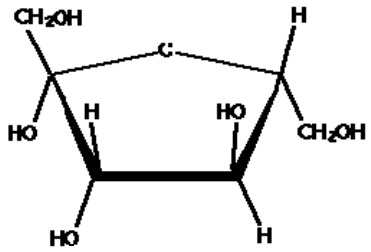


D – glucose

Which carbon in the following sugars is a hemiacetal carbon?



D – galactose



D – fructose