4U Chemistry:
Notes, Drawings, Examples

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Units

1 Organic Chemistry

1.1 Reactions of Hydrocarbons

There are serveral reactions of hydrocarbons ($\tilde{2}0$ I think?) and this is too low of a level to logic it out, so it will all be memorization, get ready.

1.2 Alkane Reactions

In general, alkanes are fairly unreactive, however, the burn very easily in combustion reactions, releasing a lot of energy.

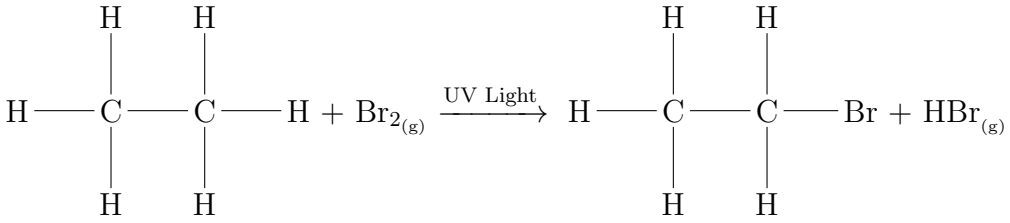
Reactants of the reaction will be the hydrocarbon and $O_{2(g)}$ with the products of a complete combustion being $CO_{2(g)} + H_2O_{(g)}$

1.2.1 Substitution Reaction

During a substitution replaced a H atom with a halogen to make an alkyl halide. This reaction only occurs with three halogen gases F_2, Cl_2, and Br_2.

This reaction can create a mixture of different isomers and can occur in multiple phases, making multiple substituions if needed.

NOTE: This reaction required UV light to occur



1.3 Alcohols

An alcohol group is an organic compound that contains the hydroxyl $-OH$ functional group the "alcohol" in beer and wine is really "ethanol"

CH_3OH	CH_3CH_2OH	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_2CH_2OH$
methanol	ethanol	propan-1-ol	butan-1-ol

Some Important Alcohols:

- Methanl - prodiced from wood, often used a solvent but is toxic
- Isopropanol (propan-2-yl) - Rubbing alcohol, used as an antiseptic
- Glycerol - Used to make fats in the body. (propan-1,2,3-ol)

1.3.1 Naming Alcohols

When naming alcohol, the following rules need to be followed in this exact order:

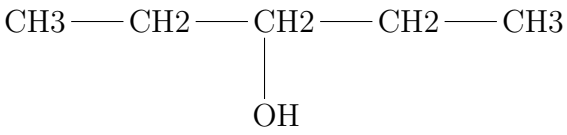
1. Identify the longest chain of C that contains the $-OH$ (hydroxyl) group
2. Number the C atoms with the #1 closest to the $-OH$. It has prority over the alkyl groups and halogens
3. Drop the -e ending (if two vowels are present) on alkane and add -ol. Use a number if needed before the -ol
4. Name any side branches

Examples:

- pentan-1-ol

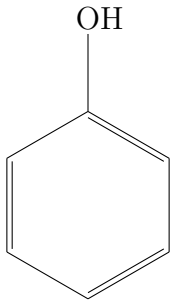
$$CH_3-CH_2-CH_2-CH_2-CH_2-OH$$

- pentan-3-ol

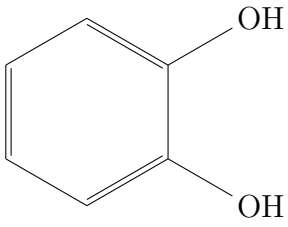


1.3.2 Aromatic Alcohols

The simples aromatic alcohol is a benzene ring with one hydroxyl group group bondede to it. Its IUPAC name is phenol



If the benzene ring has two $-$OH groups attached, the name is based on benzene and inlcudes numbers for the $-$OH groups



1.4 Primary, Secondary, and Tertiary Alchols

Alcohols are classified acording to where the $-$OH is attached. They are classified as primary, secondary, and tertiary alchols as stated below:

- 1° (Primary Alcohol) - Hydroxyl group attached to the end

- 2° (Secondary Alcohol) - Hydroxyl group attached to a C that is attached to two other C
- 3° (Tertiary Alchol) - Hydroxyl group attached to a C that is attached to three other C

1.5 Polyalcohols

Polyalcohols are just alcohols with more than one hydroxyl. For Nomencalture, use suffixes (di, tri, etc.) and numbers. The -e is kept if it followed by a consonant but is dropped if followed by a vowel

1.6 Properties of Alcohols

The presence of $-OH$ group makes the molecule polar that can form hydrogen bonds. The longer the Carbon (C) the less polar it is. Small alcohols are completely soluble in water, but the solubility decreases as the length of the carbon chain increases.

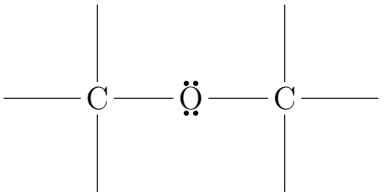
1.6.1 BP and MP

Alcohols can hydrogen bond and have higer MP and BP than hydrocarbons of similar sizes

Molecule	Molar Mass	Boiling Point
Propane	44 g/mol	$-42.1°C$
Ethanol	46 g/mol	78.3°C

1.7 Ethers

In an ether, the functional group consists of two C atoms connected to a single O atom. The $C-O$ bond is polar and the shape is bent, making it a polar molecule. Ethers are also known to be good solvents



An **ether**

Some Important Ethers

- Ethylene Oxide - Used in Epoxy
- MBTE - A gasoline aditive that helps gasoline burn better
- 18-crown-6 - Built by Pedersen and Cram (Nobel Prize 1987, capable of building metal ions)

1.7.1 Naming Ethers

When naming ethers you need to follow a set or rules are you do alcohols and other substances, although, keep in mind that ethers are made up of two parts. The rules are as follows:

1. Name the smallest alkyl group first, drop -yl and add oxy. This will be named as a side chain
2. End the longest alkyl group last named as an alkane. This is the parent chain

1. Name the smallest alkyl group 1st, drop the -yl, and add oxy. The will be named as a side chain

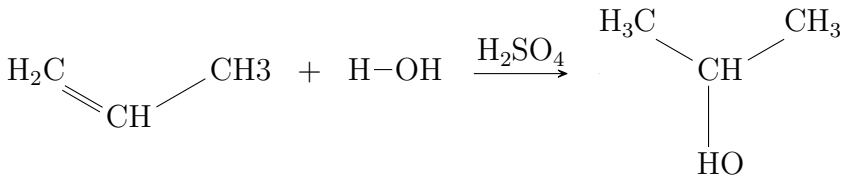
2. End with the longest alkyl group last named as an alkane. This is the parent chain

1.8 Alcohol and Ether Reactions

1.8.1 Hydration Reaction

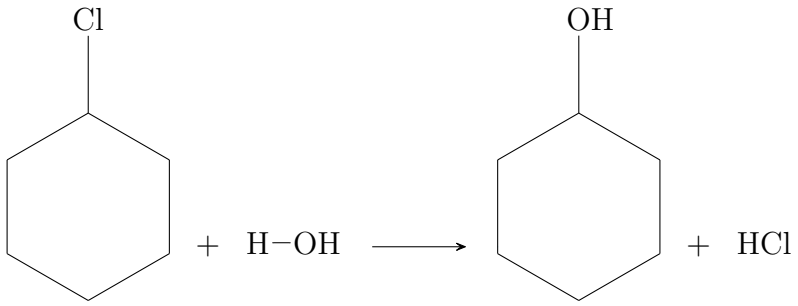
We can prepare alcohols with an addition reaction, specifically, a hydration reaction. In this reaction Alkenes with a double bond will accept/react with H_2O. One will take the H^+ and the other the OH^-.

This reaction requires a strong acid catalyst, for which we will be using H_2SO_4. Below is an example of the reaction.



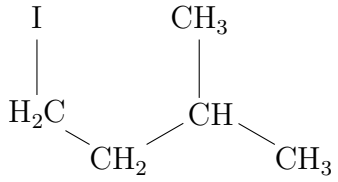
1.8.2 Subsitution Reaction

Another way an alcohol can be prepared is by susbstituting an alkyl halide with water to form an alcohol. There are no reaction conditions required in this reaction, below is an example with cholocyclohexane and water



We can also perform a substituion between an alcohol and a hydrogen halide to produce an alkyl halide and water. Below is an example of 3-methylbutan-1-ol and

hydrogen iodide.



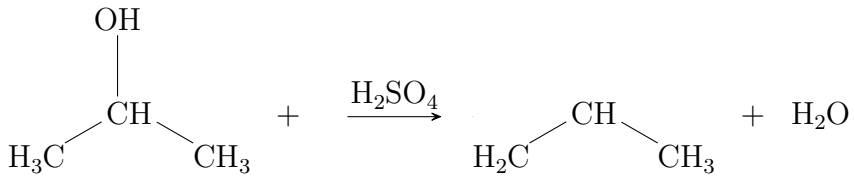
1.8.3 Combustion of Alcohols

A combustion required O_2 and produces CO_2 and H_2O. With these reactions, though, it is important to be careful when balancing as they can get tricky! (fractions are ok)

$$C_2H_5OH_{(l)} + 3\,O_{2(g)} \longrightarrow 2\,CO_{2(g)} + 3\,H_2O_{(g)}$$

1.8.4 Dehydration Reaction

In dehydration reaction results in the removal of a water form of alkene, it can be described as a reverse hydration reaction. Similarly to its counterpart, it also required a strong acid which yet again will be H_2SO_4. An example is shown below:



1.8.5 Condensation Reaction

A condensation reaction is a way of preparing an ether from an alcohol. With this reaction, the H_2O is condensed out with one alcohol donating a H^+ and the other donating a OH^-. This reaction also required both a strong acid (H_2SO_4) as well as extreme heat.

$$CH_3CH_3CH_2 \;+\; CH_3CH_3CH_2 \xrightarrow{H_2SO_4}$$

1.9 Carbonyl Group

Aldehydes and ketones both contain the carbonyl group. A carbonyl group is a carbon atom double-bonded to an oxygen atom.

1.10 Aldehydes

In an aldehyde the carbonyl group is bonded to at least 1 hydrogen atom (it is at the end of a C chain). The simplest two aldehydes are methanal (commonly refferd to as formaldehyde) and ethanal.

1.10.1 Nomenclature of Aldehydes

Below is how tou name aldehydes:

1. Find the longest chain with the carbonyl group
2. Drop the -e ending and add -al
3. When numbering the carbons on the parent chain, the carbonyl group has priority

1.11 Properties of Aldehydes and Ketones

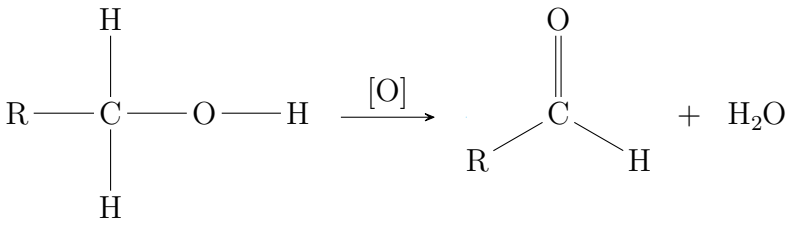
The carbonyl group is polar. The molecules will have dipole-dipole attraction but there will be no hydrigen bonding. Their boiling points are higher than similar alkanes due to alkanes only having LDFs compared to the aldehydes and ketones DP-DP. Although, they have lower boiling points than similar alcohols due to alcohols having hydrogen bonding.

Small aldehydes and ketones are also soluble in water, but the solubility decreases as additional carbons are added to the chain. This is because as the chain

grows larger is becomes less and less polar.

1.12 Reaction of Aldehydes and Ketones

These reactions are prepared y the controlled oxidation of an alcohol. It involves the gaining of an oxygen. The reaction needs an oxidizing agent like $K_2Cr_2)_7$, H_2O_2, or $KMnO_4$. The symbol for an oxidization reaction is [O] with the product of said reaction being and aldehyde/ketone + water.



1.12.1 1° vs 2° vs 3° alcohol

A primary alcohol in an oxidization reaction results in an aldehyde with water while a secondary alcohol results in a ketone with water. Tertiary alcohols on the other hand don't oxidize

The reason that tertiary alcohols do not oxidize because for this reaction to occur a hydrogen need to be removed to make space for the new oxygen double bond. The tertiary alcohol can't do this as its bonded to other carbons and there are no hydrogen to remove.

1.12.2 Hydrogenation of Aledhydes and Ketones

This reaction occurs under conditions of high temperature and pressure, and a Pt catalyst. The reactants are hydrogen + ketone/aldehyde with its product being an alcohol. Is a reverse-oxidization of alcohols where aldehydes become primary alcohols and ketones become secondary alcohols.