CHEM 2.5

Standard 91165 Demonstrate understanding of the properties of selected organic compounds

Click **here** for the NCEA page for this standard.
This standard can be divided into 3 parts
Please read **this document**.

1. **Introduction to organic chemistry**
    a. Functional groups
    b. Naming and drawing organic compounds
    c. Isomers
        i. Structural
        ii. Geometrical
2. **Physical and chemical of functional groups**
    a. Physical properties of organic substances
    b. Type of organic reactions
    c. Alkane
        i. Substitution reactions
    d. Alkene and alkyne
        i. Addition reactions
            1. Markovnikov rule
            2. Addition polymer
        ii. Oxidation reactions
    e. Haloalkanes
        i. Type of haloalkane
        ii. Substitution reactions
        iii. Elimination reactions
            1. Anti-Markovnikov rule
    f. Alcohols
        i. Substitution reactions
        ii. Elimination reactions
        iii. Oxidation reactions
    g. Amines
    h. Carboxylic acids
    i. Identifying unknown organic substances
3. **Overall reaction scheme**

Introduction to organic chemistry

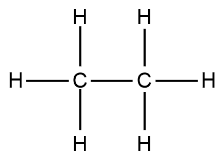
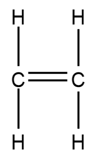
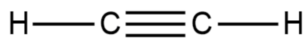
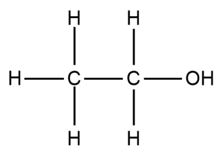
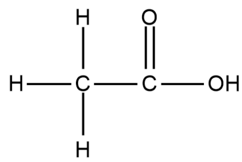
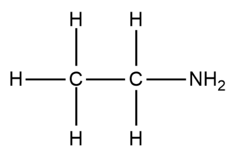
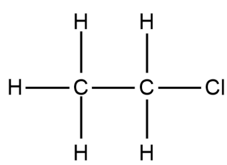
There are three major themes for this part of the standard

1) Functional groups
2) Naming and drawing organic compounds
    a) Naming organic compounds
    b) Drawing organic compounds
3) Isomers
    a) Structural isomers
    b) Geometrical isomers (cis and trans isomers)

- Organic chemistry is the chemistry of carbon based compounds.
- Since living organism on earth are mostly composed of organic substances, therefore it is an important part of chemistry.
- Although the organic chemistry is rather basic in level 2 (and even level 3), it is a VERY important part of chemistry and is part of the first year of biomedical science and health science programme which is the path to medical school as well as pharmacy, food science, and engineering, in University of Auckland (my Alma Mater).
- The most basic form of organic compounds involve **carbon** and **hydrogen** atoms only.
    - They are called **hydrocarbons**.
    - The simplest of them is the alkane.
        - A hydrocarbon with carbon to carbon single bond only.
- The more complicated organic compounds involve other elements such as oxygen and nitrogen.
- One of the very important in organic chemistry is
    - **Carbon 4 bonds**
    - **Nitrogen 3 bonds**
    - **Oxygen 2 bonds**
    - **Hydrogen and halogen 1 bond**

Functional groups

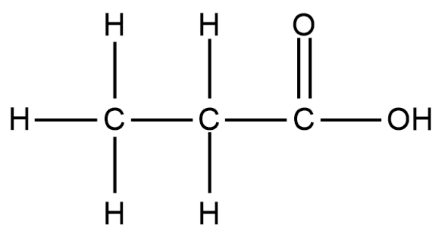
- Most of the chemical reaction in organic chemistry involves the functional group the molecule contains.
- Only functional group part of the molecule changes in a particular chemical reaction and leaving the rest of the molecule unchanged.
- Below are the functional groups for CHEM 2.5

Name of functional group	Example
Alkane Hydrocarbons with **C-C** only	 Ethane
Alkene Hydrocarbons with at least one **C=C**	 Ethene
Alkyne Hydrocarbons with at least one or **C≡C**	 Ethyne
Alcohol It contains **-OH** group	 Ethanol
Carboxylic acid It contains **-COOH** group	 Ethanoic acid
Amine It contains **-NH_2** group	 ethanamine
Haloalkane It contains at least one halogen atom **Halogens** = Group 17 elements **F, Cl, Br or I**	 Chloroethane

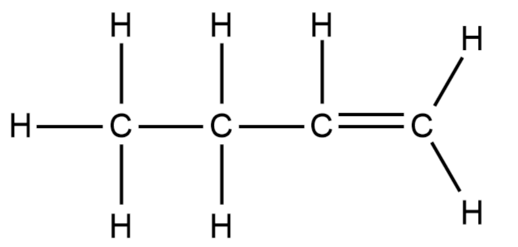
Exercise for functional groups

Circle and name the functional group(s) for the molecules below.

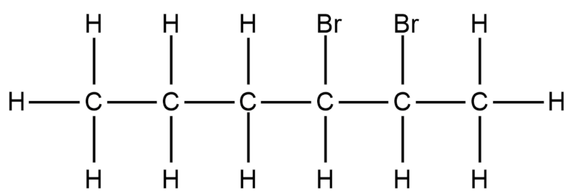
1.



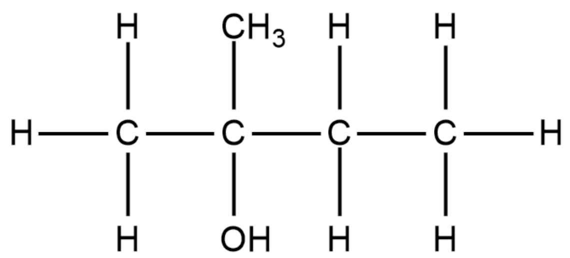
2.



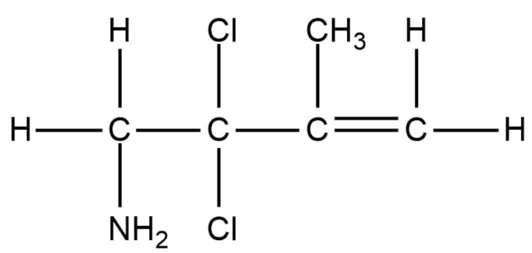
3.



4.



5.



Naming organic compounds

- The system of naming organic compounds commonly used is called IUPAC
    - IUPAC stands for **I**nternational **U**nion of **P**ure and **A**pplied **C**hemistry
- The table below is a summary of the naming system
    - **-#-** is the location of the chain[1]
- Saturation describes the molecules contains **C=C** or **C≡C**
    - Molecules that contains **C-C** bond only are **saturated**
    - Molecules that contains **double** or **triple** bonds are "**unsaturated**"

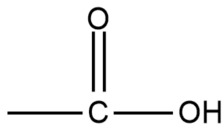
<table>
<tr><th>Branched chain
Or sub-group</th><th>Main chain
(longest continuous chain)</th><th>saturation</th><th>Major
Functional group</th></tr>
<tr><td rowspan="4">Halogens
-F #-floro
-Cl #-chloro
-Br #-bromo
-I #-iodo</td><td>1 × C - meth</td><td>C-C bond only an</td><td rowspan="2">Contains
-OH
-#-ol</td></tr>
<tr><td>2 × C - eth</td><td>C=C -#-en</td></tr>
<tr><td>3 × C - prop</td><td rowspan="7">C≡C -#-yn</td><td rowspan="2">Contains
-NH_2
-#-amine*</td></tr>
<tr><td>4 × C - but</td></tr>
<tr><td rowspan="3">Branched chain
1 × C - #-methyl
2 × C - #-ethyl
3 × C - #-propyl
And so on</td><td>5 × C - pent</td><td rowspan="4">Contains
-COOH

oic acid⋆</td></tr>
<tr><td>6 × C - hex</td></tr>
<tr><td>7 × C - hept</td></tr>
<tr><td rowspan="2">Amine*
#-amino</td><td rowspan="2">8 × C - oct</td></tr>
<tr><td>None of the above e</td></tr>
<tr><td colspan="4">⋇carbon of carboxylic acid is always the 1st carbon
Between # and # use ,
Between # and alphabet use -
If two or more of the same branched chain or functional group add:
di for 2×
tri for 3×
tetra for 4×
eg. 1,2-diol
If two or more branched chains present, they are arranged in alphabetical order
*-NH_2 is treated as branched chain if other major functional group present or it contains multiple C bonds (ene and yne)</td></tr>
</table>

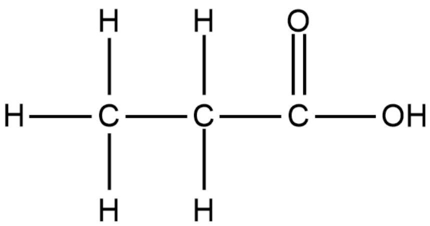
Table 1.1 - Table summary IUPAC naming system for CHEM 2.5

[1] Location should be the smallest number for the major functional group

Naming organic compounds

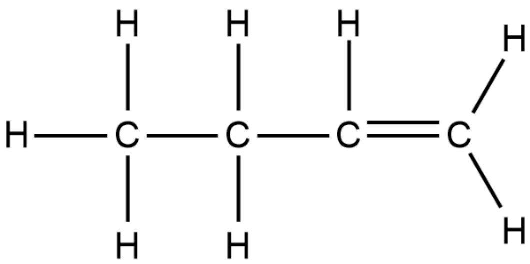
- Naming starts from the **right** to the **left** of the table
    1. Identify major functional group
    2. Saturation
    3. Main chain
    4. Branched chain

- **Example 1**



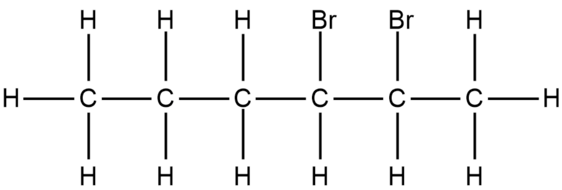
1. It contains -COOH **oic acid**
2. No C=C **anoic acid**
3. Three carbons in the main chain **propanoic acid**
4. No branched chain **propanoic acid**

- **Example 2**



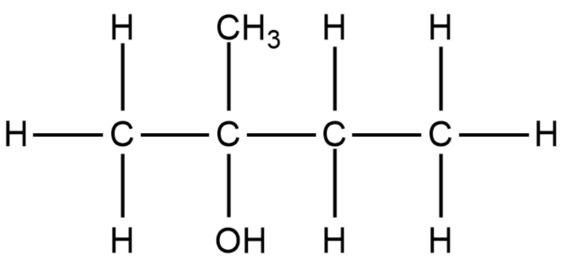
1. No major functional group **e**
2. Contains C=C between 1^{st} carbon and 2^{nd} carbon **-1-ene**
3. Four carbons in the main chain **but-1-ene**
4. No branched chain **but-1-ene**

- **Example 3**



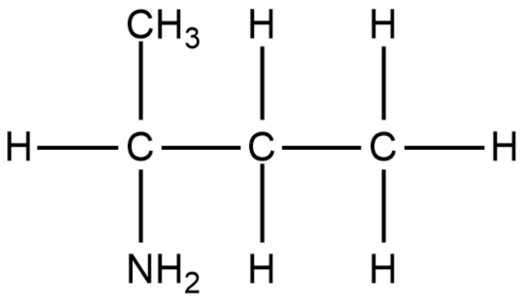
1. No major functional group **e**
2. Contains C-C bond only **ane**
3. Six carbons in the main chain **hexane**
4. Two bromine branched on 2^{nd} and 3^{rd} carbon **2,3-dibromohexane**

- **Example 4**

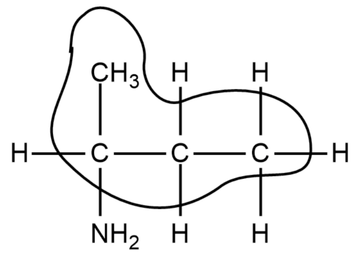


1. Contains -OH on the 2^{nd} carbon **-2-ol**
2. Contains C-C bond only **an-2-ol**
3. Four carbons in the main chain **butan-2-ol**
4. One CH_3 branched chain on the 2^{nd} carbon **2-methylbutan-2-ol**

- **More complicated example 1- identifying longest chain**

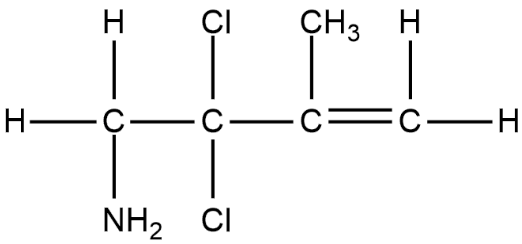


Identify the longest unbranched chain



1. Contains NH_2 on the 2nd carbon **-2-amine**
2. C-C bond only **an-2-amine**
3. Four carbons in the main chain **butan-2-amine**
4. No branched chain **butan-2-amine**

- **More complicated example 2 - multiple branched chain**



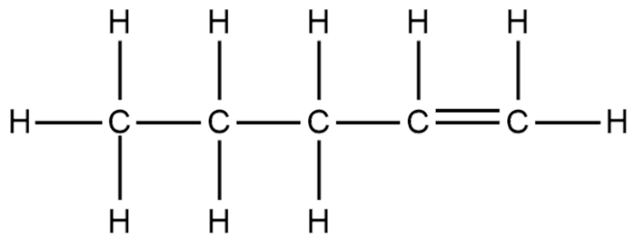
1. Although it contains amine, since molecule contain C=C therefore amine would be treated as branched chain. **e**
2. It contains C=C on the 1st and 2nd carbon **-1-ene**
3. Four carbons in the main chain **but-1-ene**
4. It contains the following branched chains in alphabetical order
   a. amino on the 4th carbon
   b. dichloro both on the 3rd carbon
   c. Methyl on the 2nd carbon

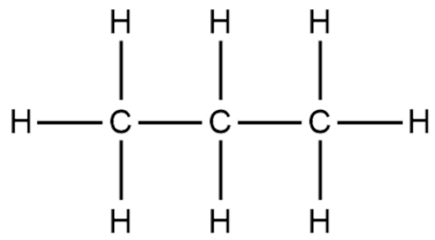
   Therefore the name would be

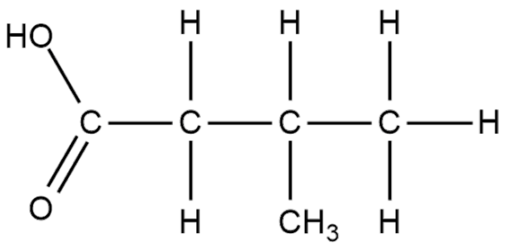
   4-amino-3,3-dichloro-2-methylbut-1-ene

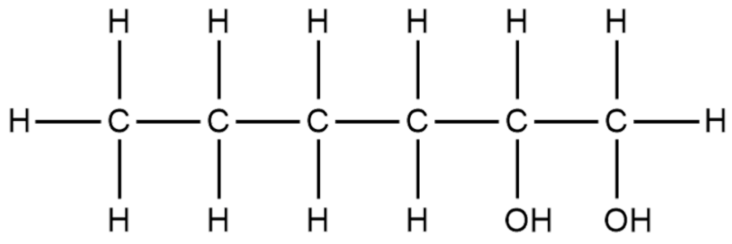
Exercise for naming organic compounds

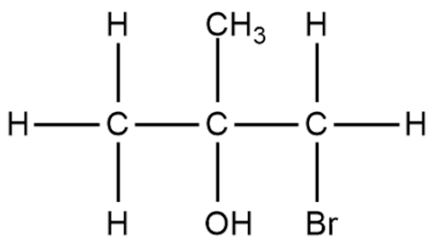
Name the following molecules

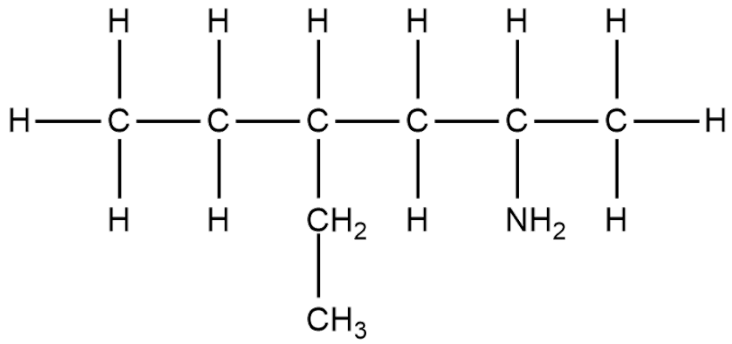








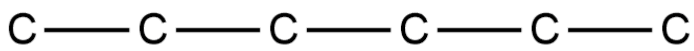




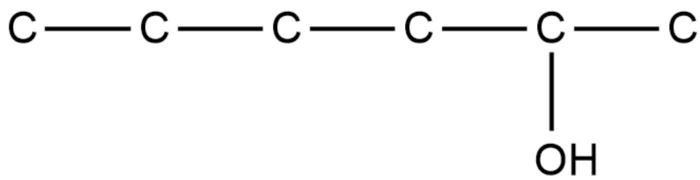
Drawing organic compounds

- Below are the steps for drawing organic compounds
    1. Draw the main chain
    2. Draw the functional group
    3. Draw the branched chain (or sub group)
        a. Starting from the main functional group carbon
    4. Fill the rest of the bonds with hydrogen atoms
        a. MAKE SURE CARBON HAS 4 BONDS ONLY!

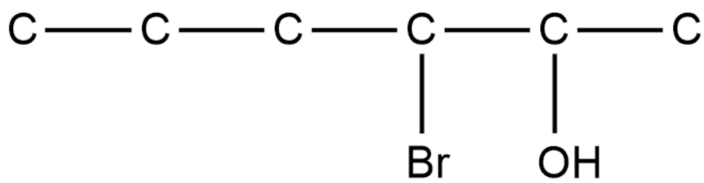
- **Example 1: 3-bromohexan-2-ol**
    1. Draw the main chain
        - **hex** = 6 carbons



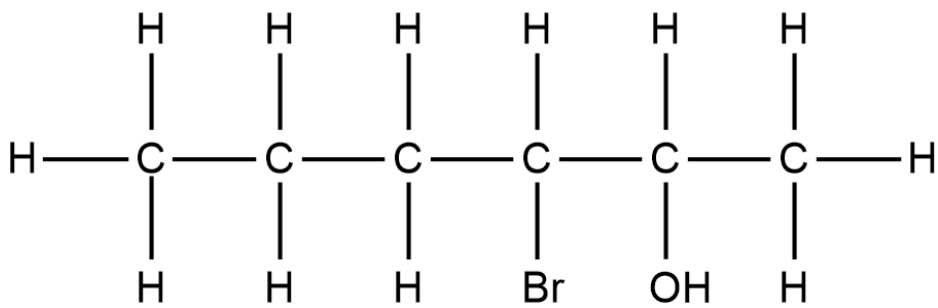
    2. Draw the functional group
        - **-2-ol** = OH on the 2nd carbon



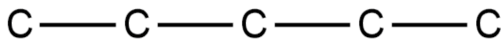
    3. Draw the branched chain
        - **3-bromo** = Br on the 3rd carbon



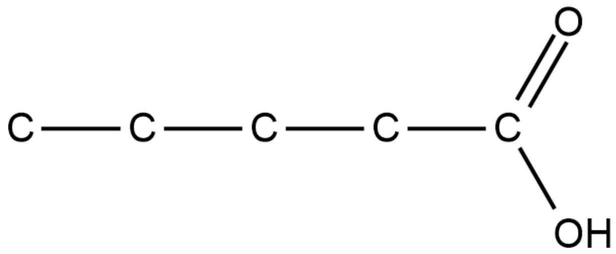
    4. Fill the rest of the bonds with hydrogen atoms



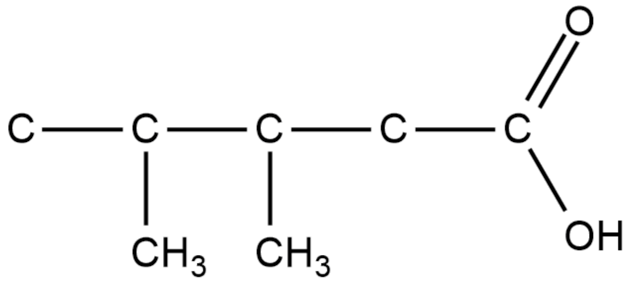
- **Example 2: 3,4-dimethylpentanoic acid**
  1. Draw the main chain
     - **pent** = 5 carbons



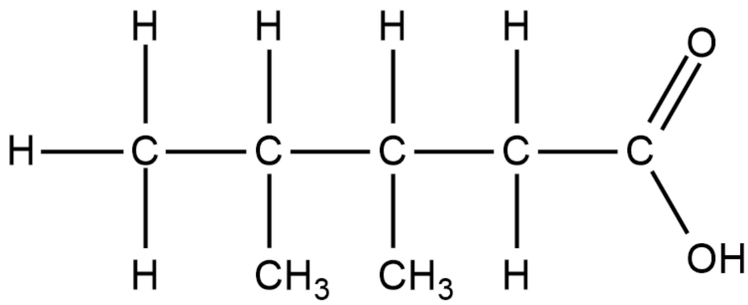
  2. Draw the functional group
     - **anoic acid** = COOH on the 1st carbon



  3. Draw the branched chain
     - **3,4-dimethyl** =CH_3 on the 3rd and 4th carbons (start counting from the COOH group)



  4. Fill the rest of the bonds with hydrogen atoms



Exercise for drawing organic compounds

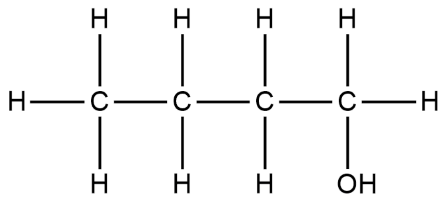
1. Draw the following organic compounds
    a. 4-bromobutan-1-ol
    b. 2,3-dimethylbut-2-ene
    c. 1,1,3-trichloropropane
2. Draw the molecules 2-ethylpropan-2-ol
    a. Explain why the naming is wrong
    b. Give the proper IUPAC name

Isomers

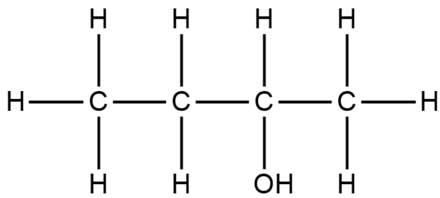
- Isomers are molecules that are similar but different in one way or another
- There are two types of isomers for CHEM 2.5
  - Structural isomers
  - Geometric isomers (*cis* and *trans*)

Structural isomers

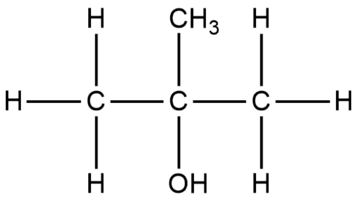
- Structural isomers is also called constitutional isomers.
  - They are compounds with the **same atom composition** (molecular formula) but **arranged in different order** (structural formula)
  - Because of their different structural arrangement, therefore the IUPAC name will be different.
  - Below is an example of structural isomer with a molecular formula $C_4H_{10}O$



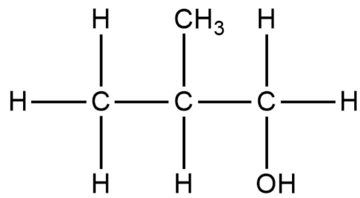
butan-1-ol
Chemical Formula: $C_4H_{10}O$



butan-2-ol
Chemical Formula: $C_4H_{10}O$



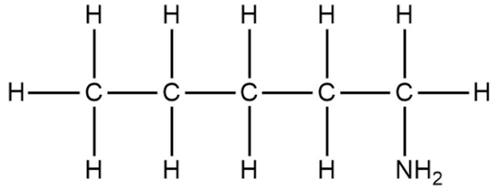
2-methylpropan-2-ol
Chemical Formula: $C_4H_{10}O$



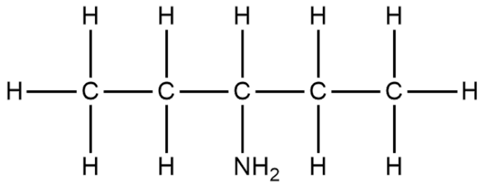
2-methylpropan-1-ol
Chemical Formula: $C_4H_{10}O$

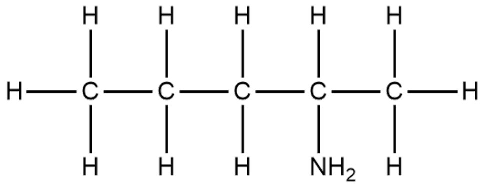
- All of the molecules above has the molecular formula of $C_4H_{10}O$ but they have different structure resulting in a different name.
- Structural isomers can be drawing in an orderly manner
  1. Draw a simple straight chain with functional group on the 1st carbon
  2. Move the functional group along the main chain
  3. Create a branched chain on the 2nd carbon and functional group on the 1st carbon
     a. Then functional on the next etc
     b. Remember there are no 1-methyl
  4. Repeat step 3 but branched chain on the 3rd carbon etc
  5. Name the compounds to ensure that there are no repeats

- **Example #1 - draw all the structural isomers contains amine with the molecular of $C_5H_{13}N$**
    1. Draw a simple straight chain with functional group on the 1st carbon

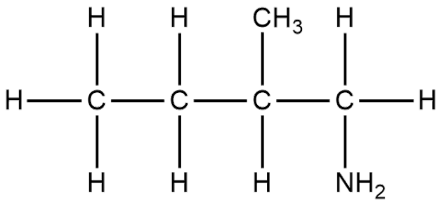


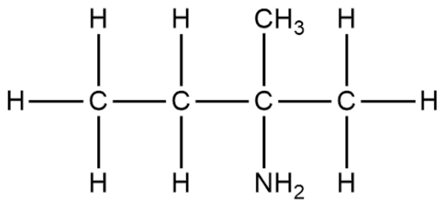
    2. Move the functional group along the main chain



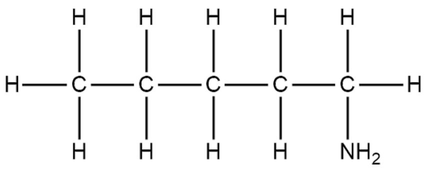


    3. Create a branched chain on the 2nd carbon and functional group on the 1st carbon
        a. Then functional on the next etc

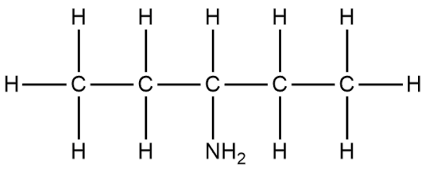




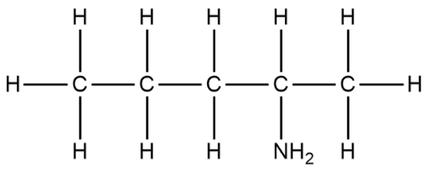
    4. Repeat step 3 but branched chain on the 3rd carbon etc
    5. Name the compounds to ensure that there are no repeats



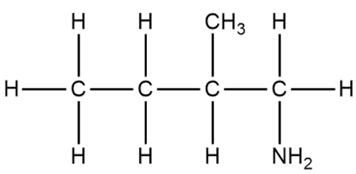
pentan-1-amine



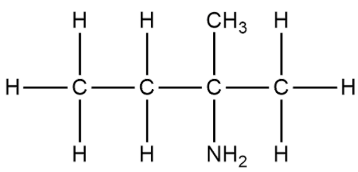
pentan-3-amine



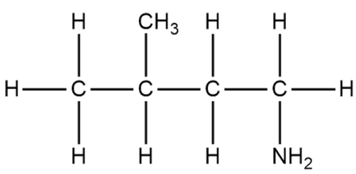
pentan-2-amine



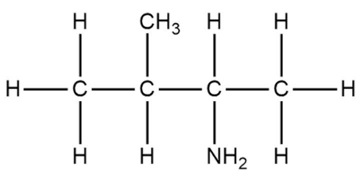
2-methylbutan-1-amine



2-methylbutan-2-amine



3-methylbutan-1-amine



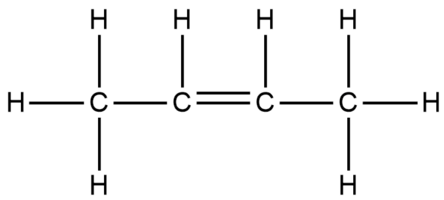
3-methylbutan-2-amine

Exercise for structural isomers

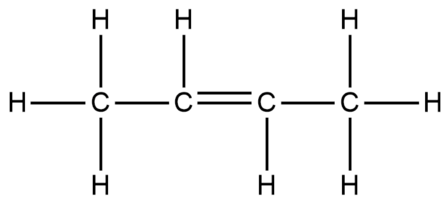
Draw and name all possible isomers that contains a carboxylic acid with molecular formula $C_6H_{12}O_2$

Geometric isomers (cis and trans isomers)

- Geometric isomers is a type of stereoisomers where molecules have the **same composition** and **same arrangement order** but **different position in space**.
- In CHEM 2.5 the **geometric isomers** is the only stereoisomer
    - C = C is **rigid** and is **not able to rotate**.
        - When **both** of the **double bond carbons** contain t**wo different atoms or group of atoms**
            - If one of the carbon contains two of the same atoms or group
                - No geometric isomer
        - There would be two possibilities of arrangement
            - On the same side of the double bond called *cis*
            - On the opposite side of the double bond called *trans*
    - For example but-2-ene

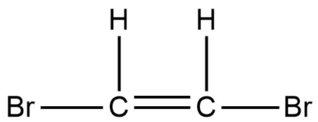


cis but-2-ene

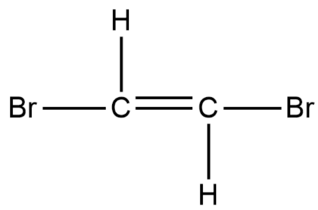


trans but-2-ene

- **Example for geometric isomer for** 1,2-dibromoethene



cis 1,2-dibromoethene



trans 1,2-dibromoethene

Exercise for geometric isomer

1. Draw the two possible geometric isomers for 1-bromobut-1-ene.

2. Explain with diagrams why but-2-ene has geometric isomers whereas but-1-ene and 2-methylprop-1-ene does not have geometric isomer.

Physical and chemical of functional groups

This part of the standards can be divided into

1. Physical properties of organic substances
2. Type of organic reactions
3. Alkane
    a. Substitution with halogen under UV to form haloalkane
4. Alkene and alkyne
    a. Addition reactions
        i. Markovnikov rule (major and minor product)
        ii. Addition polymer
    b. Oxidation
5. Haloalkanes
    a. Type of haloalkane
    b. Substitution reactions
    c. Elimination reactions
        i. Anti-Markovnikov rule
6. Alcohols
    a. Type of alcohol
    b. Substitution reactions
    c. Elimination reactions
    d. Oxidation
7. Amines
    a. Acid and base reaction with
8. Carboxylic acids
    a. Acid and base reaction with
9. Identifying unknown organic substances

Physical properties of organic substances

- For organic compounds the **physical properties** is governed by the
  - Length of the carbon chain
  - Functional group present in the molecule
- **For boiling point and melting point**
  - For the **same functional** group **boiling point increases** as the **chain length increases**
  - With the same chain length, below are the boiling point ranking from highest to lowest.
    - Carboxylic acid
    - Amine
    - Alcohol
    - Haloalkane
    - Alkane and alkene
  - This depends on the **polarity of the functional group**. **Increase** in **polarity** of the functional group, **increase** in **boiling point**.
- **For solubility**
  - Most organic compounds with the exception of
    - Alcohol
    - Carboxylic acid
    - Amine

    That has 5 or less carbons are soluble with water.
  - They forms two layers with water (and aqueous solution) just like mixing oil with water.
  - This is because their they contain a **strongly polar functional group**.

- For organic compounds the **chemical properties** is governed by the **functional group presents**.
  - Hence the word **functional**

Type of organic reactions

- There are
  - **Substitution**
    - An **atom** or **group of atoms** is **replaced** by another **atom** or **group of atoms**.
  - **Addition**
    - **Atoms** and **group of atoms** is **inserted** into the molecules by **breaking of C=C** or **C≡C**.
  - **Elimination**
    - Two neighbour **atoms** or **group of atoms** is **removed** to form a C=C.
  - **Oxidation**
    - Reaction that involves **removal of H atoms** or **addition of O atoms**.
  - **Acids and bases**
    - **Donates** or **accepts hydrogen ions**.

Exercise for physical properties and types of organic reactions
Draw the following substances and identify them as soluble in water or not

1. 2-methylpropan-2-ol

2. Tetrachloromethane

3. Chloroethene

4. 2-methylpropanoic acid

5. 2-amino-2-methylpropanoic acid

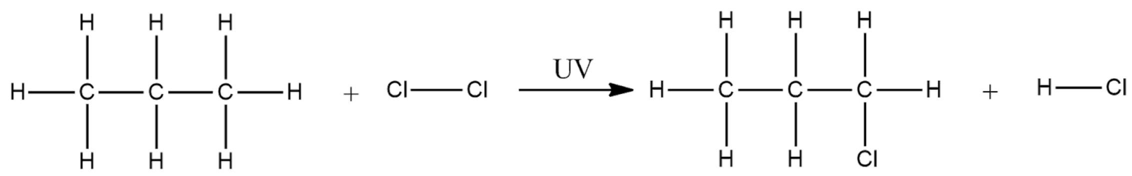
6. tetrafloroethene

Alkane

- As mentioned before, alkanes are **saturated hydrocarbons**.
- It has a general formula of $\mathbf{C_nH_{2n+2}}$.
- Alkane composes the **major component of crude oil**.
- They are generally inert for chemical reaction except for **combustion**.
    - That is why they are commonly used as **organic solvent**.
        - For example, hexane.
    - The only other reaction it involves is **substitution** with **elemental halogen under UV light**.

Substitution

- One of the hydrogen atom is replaced with a **halogen atom** from **halogen** forming a **haloalkane** and **hydrogen halide**.
- For example reaction between **propane** with **chlorine** to form **chloroalkane** and **hydrogen chloride**.
- As mentioned before alkane is unreactive, therefore **UV light** is needed to provide sufficient energy for the reaction to occur.



    - The position for the substitution does not have to be on the 1st carbon.

Exercise for Alkane

1. Write a balanced equation for the following (organic compounds can be drawn)

    a. 2-methylbutane mixed with bromine under sunlight

    b. Hexane mixed with iodine under sunlight

    c. Methane mixed with chlorine under sunlight

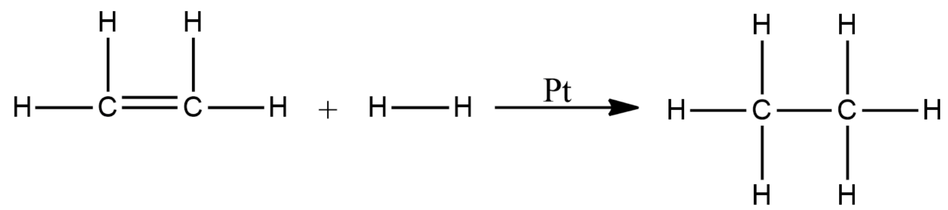
    d. Ethane mixed with fluorine under sunlight

Alkene and alkyne

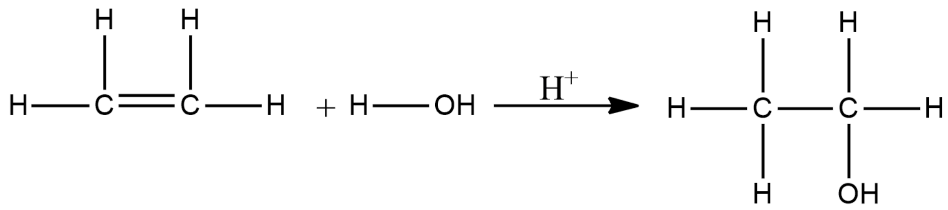
- **Alkene** and **alkyne** are **unsaturated hydrocarbons**
  - **Alkene** has a general formula of $\mathbf{C_nH_{2n}}$
  - **Alkyne** has a general formula of $\mathbf{C_nH_{2n-2}}$
- Their reactions involve in the **C=C** or **C≡C** leaving the rest of the molecule unchanged
- There are **two types of reaction** for alkene
  - **Addition reactions**
  - **Oxidation reactions**

Addition reactions

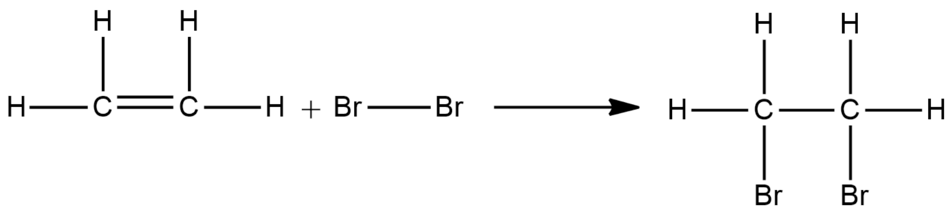
1. Addition of **hydrogen** with platinum catalyst to form **alkane**



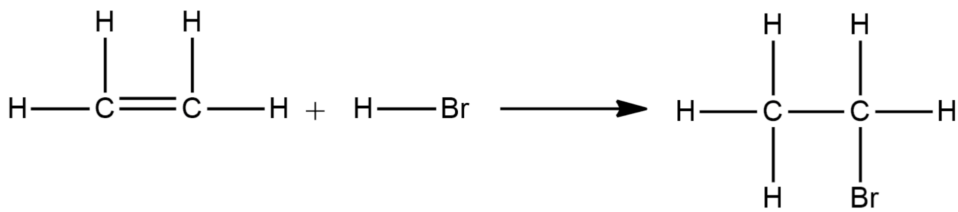
2. Addition of **water** under acidic condition ($H_2SO_{4(aq)}$) to form **alcohol**



3. Addition of **halogen** to form **dihaloalkane**

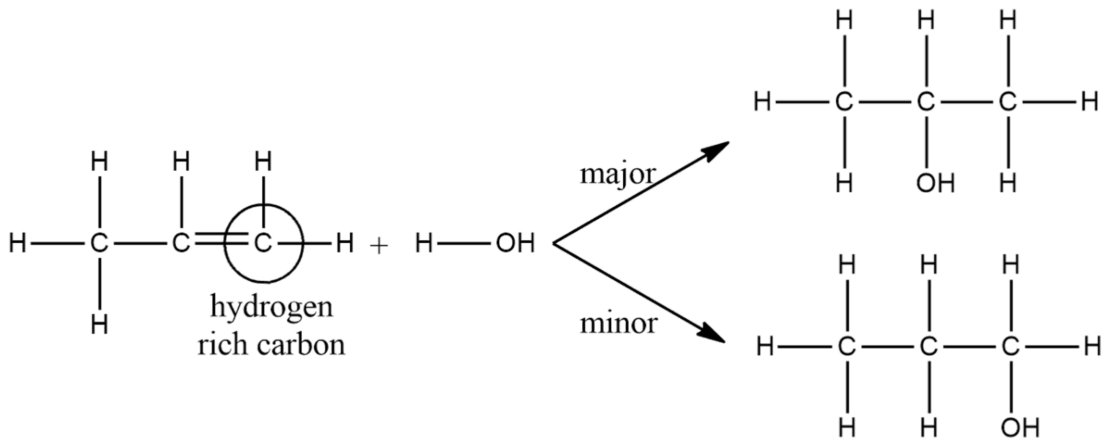


4. Addition of **hydrogen halide** to form **haloalkane**



Markovnikov rule

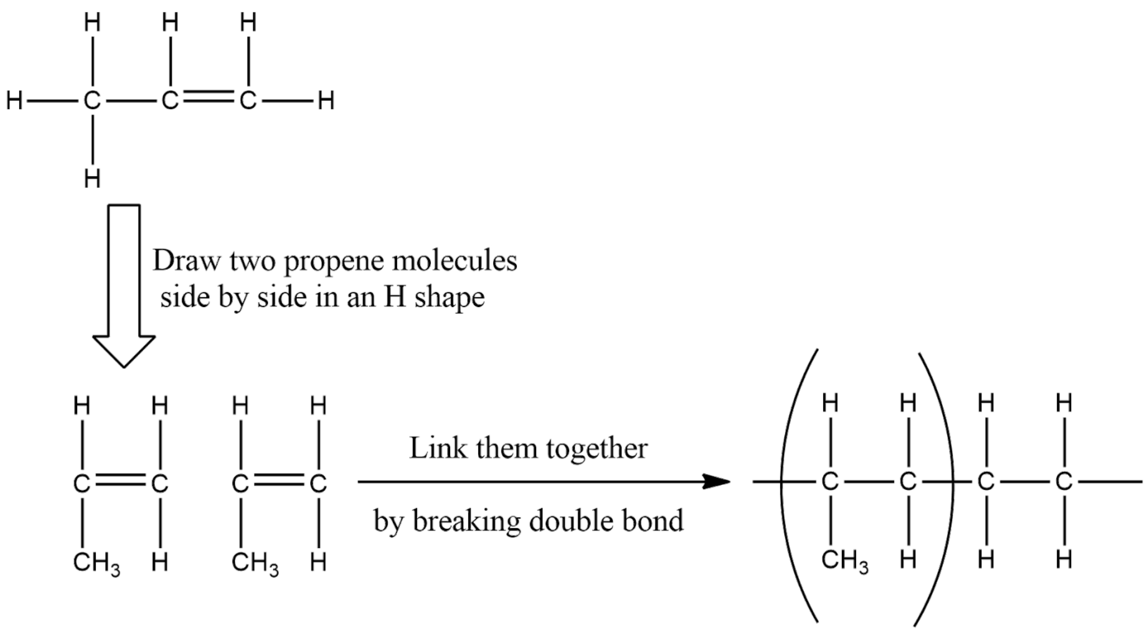
- In an **addition reaction** of **water** or **hydrogen halides** (HF, HCl, HBr, or HI) to an **asymmetrical alkene** or alkyne, the **hydrogen atom** prefer bonded to the **carbon atom that had the greatest number of hydrogen atoms** to form the major product.
- For example addition of water to propene



- A common phrase, **hydrogen rich** gets **richer**.

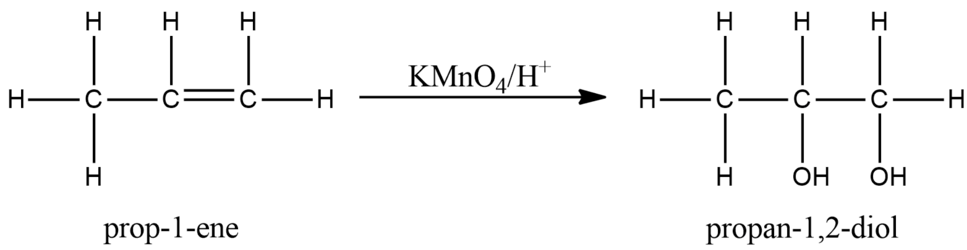
Addition polymers

- Polymers are **long chain molecules** formed by **joining smaller molecules** (monomer) together.
  - They can occur naturally or artificially using fossil fuel based chemicals
  - **Artificial polymers** are commonly known as **plastics**
- **Addition polymers** is when **monomers** joins together to form **polymer** by **breaking of double bonds**.
- **Repeating unit** is the part of the **polymer** which the **monomer** used to be.
- It is important to draw the **alkene** in **H shape** where the **double bond** is the **center of the H**.
- **For example.**
  Polypropylene is an addition polymer made out of the monomer propene.
  - Draw 2 repeating units of the **polymer**.
  - Put a bracket around the **repeating unit**.



Oxidation reactions

- Alkene can be oxidised by
  - Acidified potassium permanganate **$KMnO_4/H^+$.**
    - Observation **Purple to Colourless.**
  - Acidified potassium dichromate **$K_2Cr_2O_7/H^+$.**
    - Observation **Orange to Green.**
- The **double bond is broken** and each of the **carbon of the double bond** is inserted with two **alcohol groups** on each of the carbon forming a **diol**.
- For example oxidation of propene



Exercise for Alkene and alkyne

Draw the **organic product(s)** for the following reactions. Label major and minor when appropriate.

1. But-1-ene reacted with dilute $H_2SO_{4(aq)}$

2. 2-methylpropene reacted with hydrogen chloride gas

3. Pent-2-ene reacted with acidified potassium dichromate

4. cis hex-2-ene reacted with bromine water

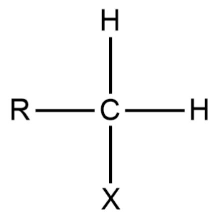
5. 2-methylbut-1-ene reacted with hydrogen chloride gas

Haloalkane

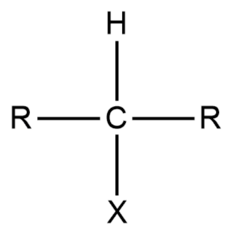
- Haloalkane is a commonly used as a base material for many of the organic synthesis.
  - Halogens are **group XVII elements**
    - Fluorine (**F**)
    - Chlorine (**Cl**)
    - Bromine (**Br**)
    - Iodine (**I**)
- They are often produced in an **industrial scale** by reacting **alkane** with **halogen gas** with **petroleum products** then separated by **fractional distillation**.
- There are **two types of reaction** for haloalkane
  - **Substitution reactions**
  - **Elimination reactions**

Types of haloalkane

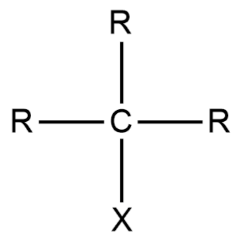
- There are three types of **haloalkane**
  (R = the rest of the chain)
  - **Primary haloalkane**



  - **Secondary haloalkane**

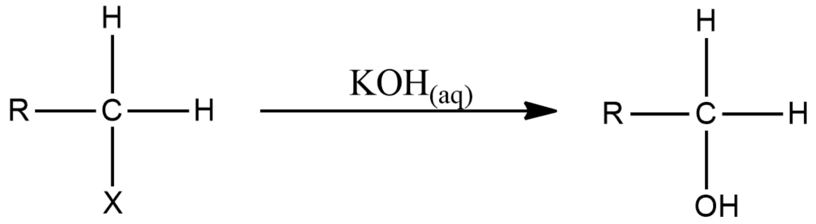


  - **Tertiary haloalkane**

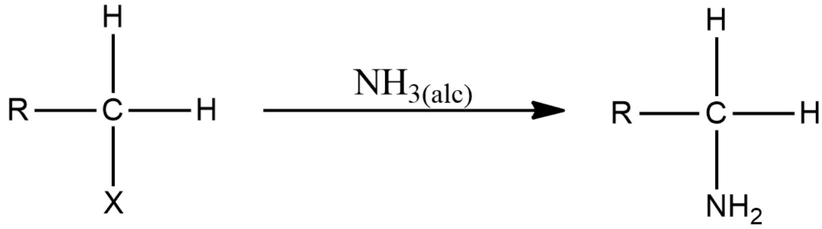


Substitution reactions

- Haloalkane undergoes two **substitution** reactions where the halogen atom is replaced by
  - **-OH** using the reagent **$KOH_{(aq)}$** (or $NaOH_{(aq)}$) to form **alcohol**

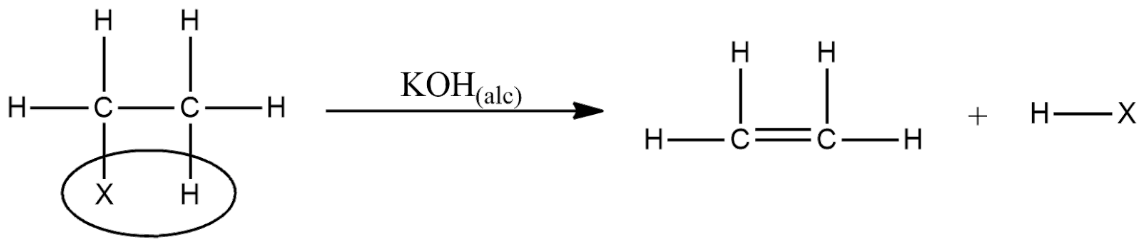


  - **$-NH_2$** using the reagent **$NH_{3(alc)}$** to form **amine**



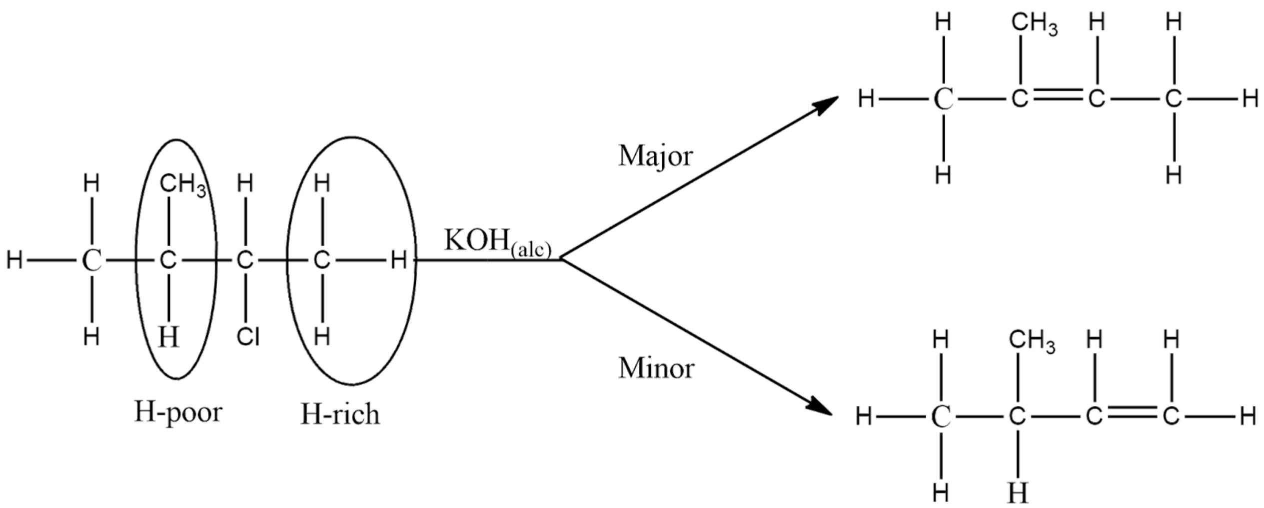
Elimination reactions

- The **halogen atom** and a **neighbouring hydrogen** are **removed** forming a **C=C** using the reagent of **$KOH_{(alc)}$** forming **hydrogen halide** byproduct.



Anti-Markovnikov rule

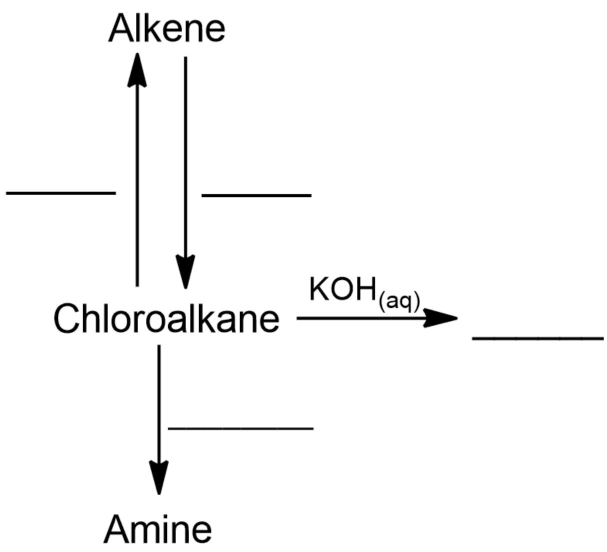
- Similar to addition reaction, there could be **two possible products** (a **major** and a **minor**) if the molecule is **asymmetrical**.
- Opposite to the Markovnikov, If there are two neighboring carbon with hydrogen, the one with the **less hydrogen atom** is favored to form the **major** product.



Exercise for haloalkane

1. Compare and contrast the reactions between the reactions of 2-chlorohexane reacted with potassium hydroxide under different conditions. Identify the types of reactions and provide the structure and name of all organic products and their relationship between them.

2. Complete the diagram below



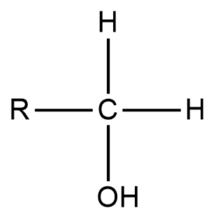
3. Draw the structure of both reactants and organic products of the following reactions.
   a. 1,5-dichlorohexane with alcoholic potassium hydroxide.
   b. 2-bromopentane with alcoholic ammonia.
   c. 2-florobutane with alcoholic potassium hydroxide.
   d. 1-chloropropane with aqueous potassium hydroxide.

Alcohol

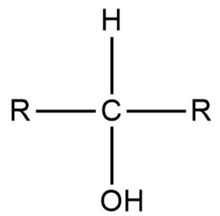
- **Alcohol** in chemistry refers to organic compounds that contain **-OH group**.
- The alcohol in beverages is ethanol which is produced by the fermentation by yeast in an **anaerobic environment**.
- There similar to haloalkane there are **three types of alcohols**
  (R = the rest of the chain)
- There are **three types** of reaction for alcohol
  - **Substitution reactions**
  - **Elimination reactions**
  - **Oxidation reactions**

Types of alcohol

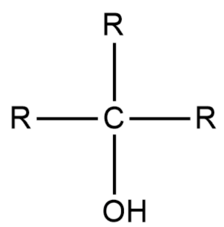
- **Primary alcohol**



- **Secondary alcohol**

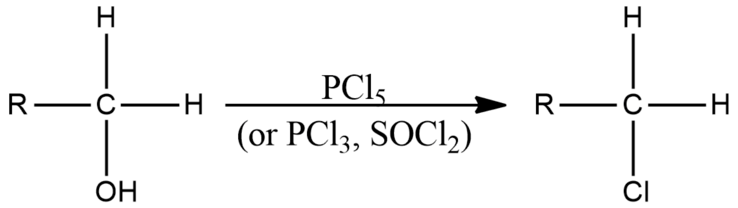


- **Tertiary alcohol**

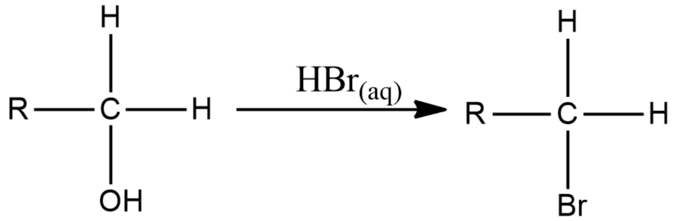


Substitution reactions

- **Alcohol** undergoes **two substitution reactions** where the **-OH** is replaced by
  - **-Cl** using the reagent **PCl_5**, **PCl_3** or **$SOCl_2$**

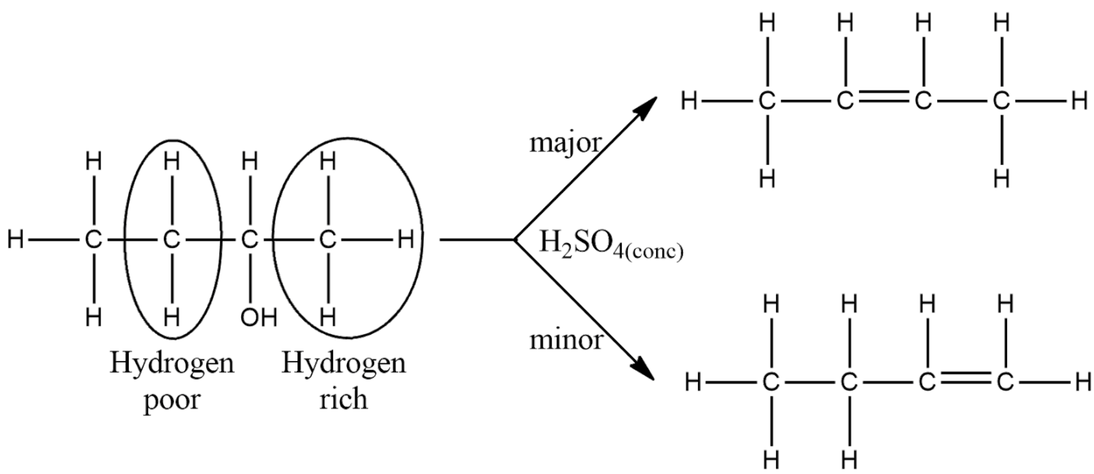


  - **-Br** using the reagent **$HBr_{(conc)}$**



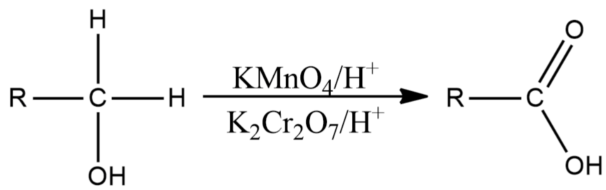
Elimination reactions

- The **-OH group** and a **hydrogen** from a neighbouring carbon is removed to form **C=C** reagent **$H_2SO_{4(conc)}$**.
- Similar to the **elimination of haloalkane**, when there are **two possible positions** to remove the **hydrogen**, it could results in a **major** and **minor product** depending on the **number of hydrogen atom on the carbon**.
  - The **hydrogen poor gets poorer**



Oxidation

- **Primary alcohol** can be **oxidised** to **carboxylic acid** by **$KMnO_4/H^+$** or **$K_2Cr_2O_7/H^+$**



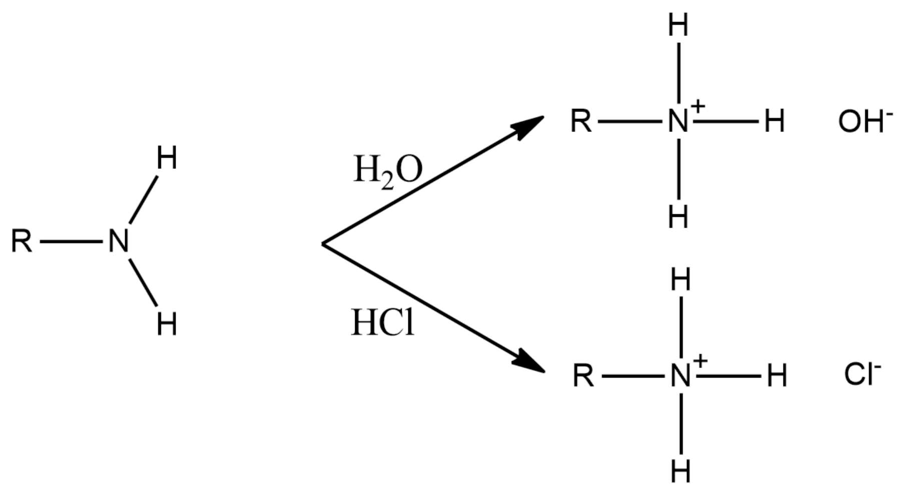
Exercise for alcohol

1. Draw the structure of products for ethanol reactions with
    a. Potassium dichromate
    b. $H_2SO_{4(conc)}$
    c. $SOCl_2$

2. Draw the possible products when 3-methylbutan-2-ol is reacted with $H_2SO_{4(conc)}$

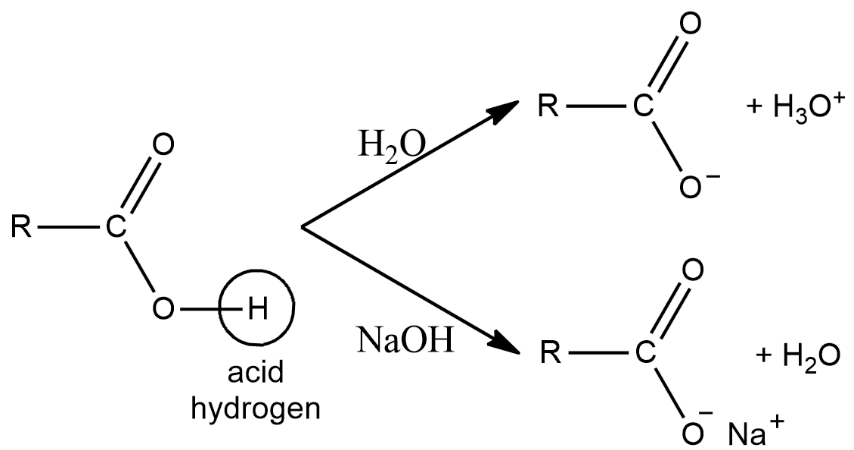
Amine

- **Amine** is a **base**.
  - Repeat this statement 10 times.
- For CHEM 2.5 only reaction is **amine** acting as a **base**.
  - From CHEM 2.6 a **base** is a **H^+ acceptor**.
    - **Amine** is a **weak base**, partially dissociate forming an equilibrium mixture.
    - The **lone pair electrons** of the nitrogen atom **accepts an hydrogen ion**.
  - It will turn **red litmus blue.**
  - **Dissociate** in water forming **OH^-**
  - Reacts with **hydrochloric acid** forming **chloride salt**.



Carboxylic acid

- **Carboxylic acid** is an **acid** (DUH!)
  - From CHEM 2.6 an acid is a **H^+ donor**
    - **Carboxylic acid** is a **weak acid**, partially dissociate forming an equilibrium mixture.
    - The the **hydrogen atom** of the **-OH** in the acid group acts as an **H^+ source**.
  - It will turn **blue litmus red.**
  - **Dissociate** in water forming **H_3O^+.**
  - Reacts with **sodium hydroxide** forming **sodium salt** and **water**.



Exercise for amine and carboxylic acid

1. Draw the organic products for
    a. Propanoic acid with sodium hydroxide

    b. Hexan-3-amine with hydrochloric acid

2. Discuss the follow steps and identify all the reactions below and draw all the organic products.
    - Propan-1-ol is reacted with concentrated sulfuric acid, the mixture is then distilled.
    - The organic product is then reacted with bromine water.
    - The product is then extracted by organic solvent then the organic solvent is then removed by evaporation.
    - The product then mixed with alcoholic ammonia.

Identifying unknown organic substances

- There are many ways to to identify unknown organic substances with a combination of **chemical and physical properties**, I personally find the following steps helpful.
    1. **Acid and base**
        a. Add moist **red litmus** and **blue litmus paper**
            i. **Red** litmus **turns blue**
                1. **Amines**
            ii. **Blue** litmus **turns red**
                1. **Carboxylic acids**
        b. Or use **sodium carbonate solution** (or sodium hydrogencarbonate)
            i. **Bubbles** form
            ii. **acid + carbonate → salt + water + carbon dioxide**
                1. **Carboxylic acids**
    2. **Test alkene**
        a. New sample add **bromine water** to a new sample
            i. Colour change from **brown** to **colourless** quickly
                1. **Alkenes**
            ii. **Single layer** form
                1. **Alcohol, amine or carboxylic acid** with **5 or less carbons**
    3. **Test alcohol or alkene**
        a. New sample add
            i. **Acidified potassium permanganate**
                1. **Purple** to **colourless**
            ii. **Acidified potassium dichromate**
                1. **Organic** to **green**
                2. **Alcohols** or **alkenes**

Exercise for identifying unknown organic substances
Identify three unlabelled bottle containing organic substance of one of the followings:
- Propan-1-ol
- Hex-1-ene
- butanoic acid

Design series of chemical test to determine which of the sample is which.
Provide observations for each test and classify all the chemical reactions to justify your answers.

Overall reaction scheme