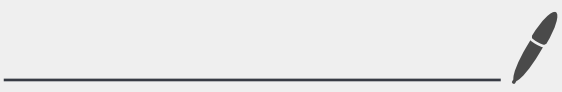
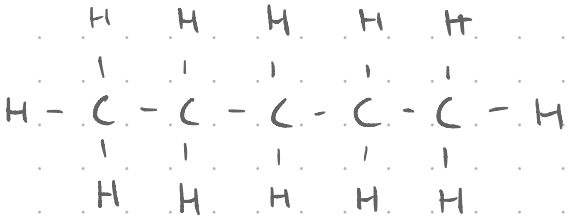


Organic Chemistry

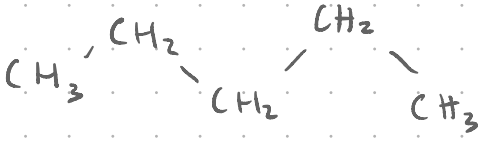
- Carbon-containing compounds
- Usually contains C, H, O, N, P, S
- elements are involved in covalent bonds - shared electrons.

Bond-line / Complete Structural



- Shows all atoms + bonds
- familiar
- long to draw
- 2D only

Condensed



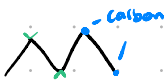
- Shows atoms but not bonds.
- Sometimes shows 109.5° (rather than 180°).

Condensed Formula

$CH_3(CH_2)_3CH_3$

- Faster
- All atoms seen
- Sometimes, 3D shape apparent
- Details of hydrogens lost

Line Drawings



- Very fast
- shows simplified bond angles
- Requires orgo-chem knowledge to interpret.

Hydrocarbon Properties

- Hydrophobic
- Liquid @ room temperature
- Combustible

Saturation

- How many double / triple bonds there are
  ↳ How many hyorogens compared to carbon
- More saturated is less reactive + more stable than less saturated hydrocarbon

Alkanes

- Fully - Saturated hydrocarbons
- Only single bonds
- Follow $C_n H_{2n+2}$
- Simple hydrocarbons all end with -ane

# of C	Root	
1	meth	monkeys
2	eth	eat
3	prop	peeled
4	but	bananas
5	pent	
6	hex	
7	hept	
8	oct	
9	non	
10	dec	

Cyclo -____: Parent chain drawn in circular chain
- $C_n H_{2n}$

cyclopropane

cyclohexane

Alkenes

- Hydrocarbons with one or more double bonds (no triple)
- Unsaturated (less saturated than alkanes)
- General chemical formula $C_n H_{2n}$ with one double bond
- Suffix -ene in naming.

Alkynes

- Hydrocarbon with one or more triple bonds.
- Least saturated
- General chemical formula $C_n H_{2n-2}$ with one triple bond.
- Suffix -yne in naming

Cis-Trans Isomerism

- Stereoisomers have the same chemical formula, bonded the same, different arrangement in space.
- Cis-isomer has largest alkyl groups on the same side (shaped like C) of double bond.
- Trans-isomer has largest alkyl groups on the opposite side of double bond

Trans

Cis

Aromatics

- Benzene is a specific, ring-structured, unsaturated hydrocarbon.
- Bonds between double and single but may shown as rapidly alternating double bonds.
- Shown as:

Reactions with Hydrocarbons

- Functional groups are the most reactive sites.
- Double + triple bonds are reactive. So, reactivity: alkynes > alkenes > alkanes
- Alkanes can react but often need "catalyst"
  - ↳ enzyme which speeds up reaction by lowering activation energy (E_a).

Combustion Reactions

- Alkane + O_2 → CO_2 + H_2O + heat

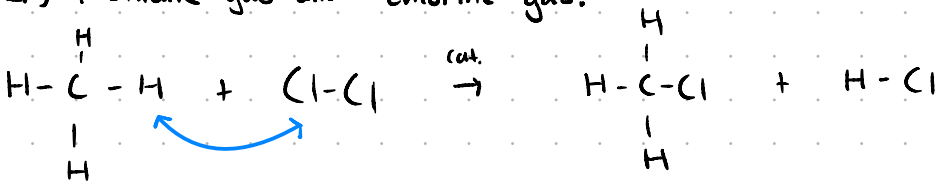
Ex) Butane Combustion:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) + \text{heat}$$

Substitution Reactions

- One part of alkane (usually hydrogen) is swapped for part of other reactant.
- AB + C → AC + B

Ex) Methane gas and chlorine gas:



Addition Reactions

- 2 reactants combine to form one product
- Double + triple bonds get saturated making them good sites for rxns.
- Can be: hydrogenation, halogenation, hydration

Hydrogenation

- Hydrogen atoms (H_2) are added to a molecule.
- When adding H_2 to alkene or alkyne can produce saturated alkane
- Adding halides (Cl_2, Br_2, F_2, I_2) to an alkene or alkyne can make "alkyl halides."

Halogenation

- Halogens are added to a molecule.

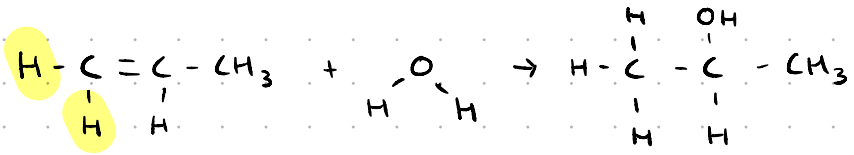
Hydration

- Water is added to a molecule.
- Water + alkene or alkyne can produce an alcohol.

Markovnikov's Rule

- When a hydrogen halide or water is added to an asymmetrical alkene, the hydrogen atom generally bonds to the carbon that already has more hydrogens attached.

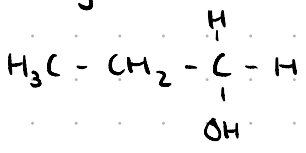
ex).



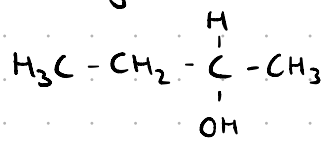
Alcohols (hydroxl functional group)

- Alcohols are molecules that contain at least one hydroxl group (OH)
- Aconols are polar dve to oxygen + hydrogen e^- sharing being uneven.
- IMF's occur more strongly in alcohols.

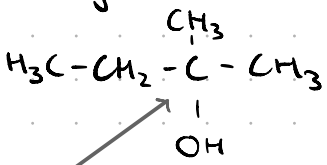
<u>Primary alcohols</u>



<u>Secondary alcohols</u>



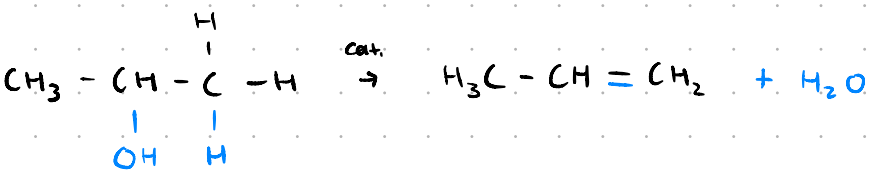
<u>tertiary alcohols</u>



- Can tell which by # of alkyl groups the ~~central~~ C atom is attached to.
  - the one attached to OH hydrox
  - not "central"

Reactions with Alcohols

<u>Dehydration</u>

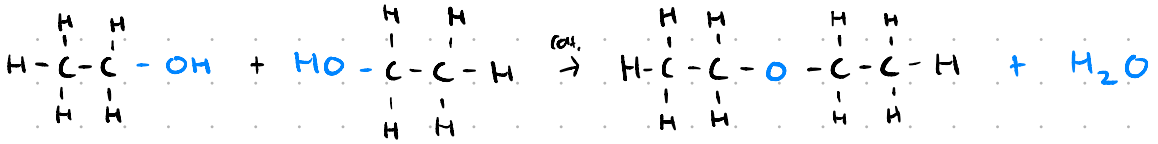


Ethers

- Molecules where oxygen bonded between 2 carbon atoms
- R-C-O-C-R'
- Higher boiling point than alkanes b/c they are polar (oxygen). Alkanes only LDF.
- Lower boiling point than alcohols b/c they don't have H-bonding. Alcohols have all 3 IMFs.

Reactions with Ethers

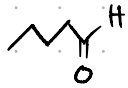
<u>Condensation reactions</u>



ex) pentanol + butanol → butoxypentane

Carbonyl Groups: Aldehydes, Ketones

- Carbonyl functional group includes $R-\overset{\overset{O}{\|}}{C}-R'$.
- Molecules containing a carbonyl group are polar b/c the $C=O$ is polar.

Aldehydes: 

- Forces that act on aldehydes / ketones are:
  - Dipole-dipole
  - LDF
  - not H-bonding (C between O and H)

Ketones: $R-\overset{\overset{O}{\|}}{C}-R'$

Reactions with Aldehydes and Ketones

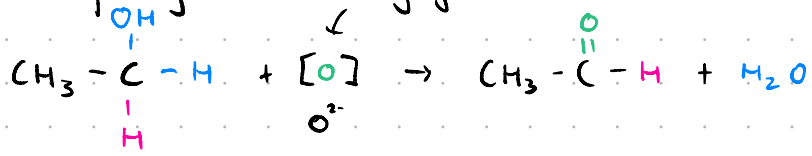
Oxidation

- Oxidation is losing an electron
- Often looks like losing a H atom

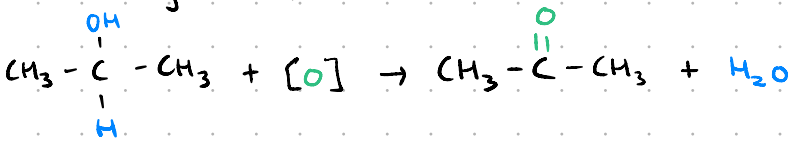
OIL-RIG:

	Oxidation	Reduction
Is	Loss of e^-	Gain of e^-

↳ With primary alcohol: oxidizing agent



↳ With secondary alcohol:

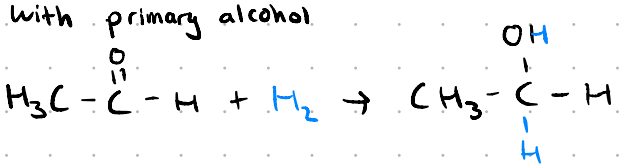


↳ With tertiary alcohol → no reaction (NR)
- because no 2nd H to take

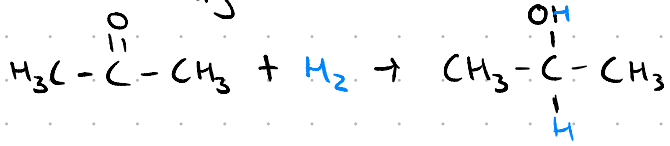
Hydrogenation / reduction

- Adding hydrogen across a double bond

↳ With primary alcohol



↳ With secondary alcohol



Carboxylic Acids

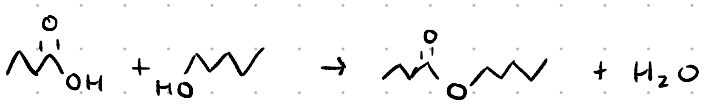
- An acid is a molecule that can donate protons (H^+)
- Carboxylic acid contains the following group: $R-\overset{\overset{O}{\|}}{C}-OH$
- Polar due to oxygen
- All 3 IMFs affect it.

Esters

- Esters have the following functional group: $R-\overset{\overset{O}{\|}}{C}-O-R'$
- They often have a nice smell
- Formed in condensation reactions between carboxylic acids and alcohols.
- Polar and soluble in water.

Reactions with Esters

Condensation ("esterification")



- pentanol + octanoic acid → pentyl octanoate
- butanol + pentanoic acid → butyl pentanoate

Hydrolysis

- Original carboxylic acid and alcohol are produced by adding a water molecule.
- Ethyl pentanoate → ethanol pentanoic acid +
- Heptyl heptanoate → heptanol + pentanoic acid

Summary - Naming / Drawing

Hydrocarbons:

Single bonds - ane - $C_n H_{2n+2}$
double - ene - $C_n H_{2n}$
triple - yne - $C_2 H_{2n-2}$

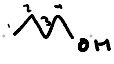
Only LDF


- isopropyl / propan-2-yl


- sec-butyl / butan-2-yl

Alcohols:

-ol


- propanol


- butan-2-ol

All IMFs

- can be diol - triol
- number so OH has lowest #

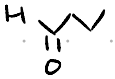
Ethers:


- propoxy_propane

2/3 IMFs
↳ NO H-bonding

- oxy on smaller one
- oxy arm can have #

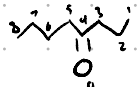
Aldehydes:

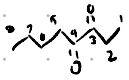

- butanal

2/3 IMFs
↳ no H-bonding

- Carbonyl always on carbon #1

Ketones


- oct-4-one

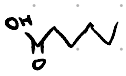

- oct-3,4-dione

2/3 IMFs
↳ no H bonding

- double O bond anywhere
- treated like side chain where

x-_one
↳ prefix
ie: di

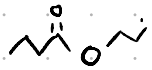
Carboxylic acid


- hexanoic acid

All IMFs

- Carbonyl always on carbon #1

Esters


- propyl butanoate

2/3 IMFs
↳ no H bonding

- double bond have -oate
- other one goes before with -yl

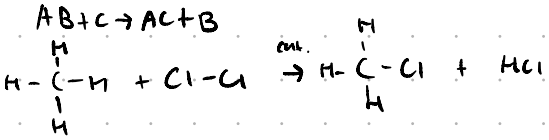
Summary - Rxns

Combustion

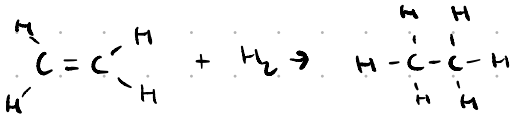
Alkane + O_2 → CO_2 + H_2O + heat

Substitution

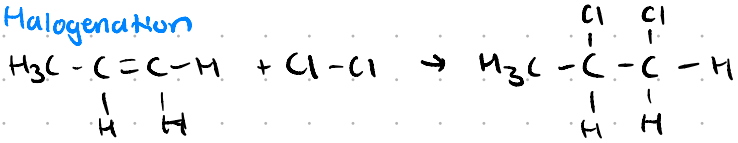
AB + C → AC + B



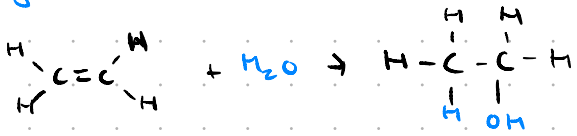
Hydrogenation



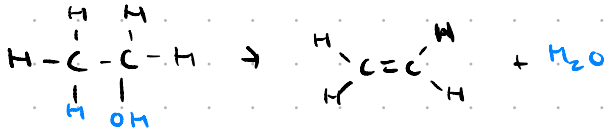
Halogenation



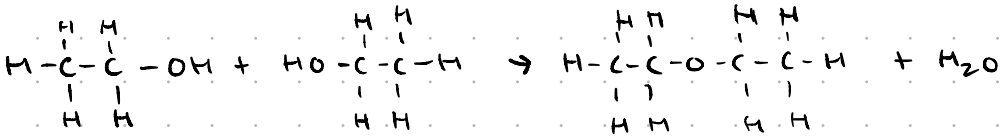
Hydration



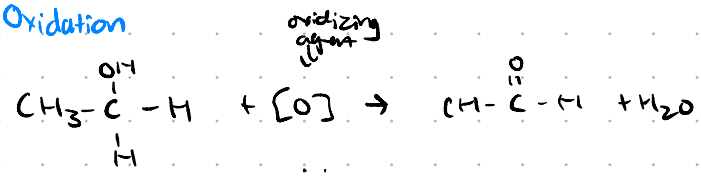
Dehydration

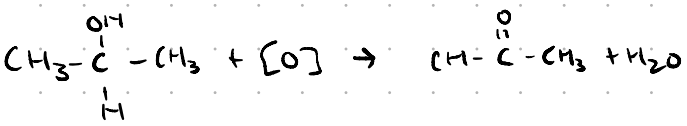


Condensation



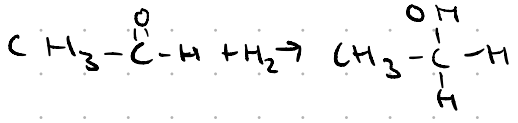
Oxidation

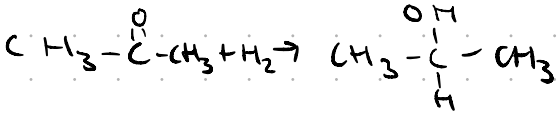




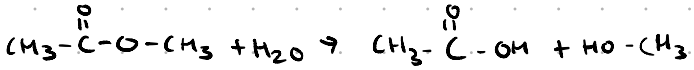
3° alcohol + [O] → NR (no 2 H)

Hydrogenation / reduction

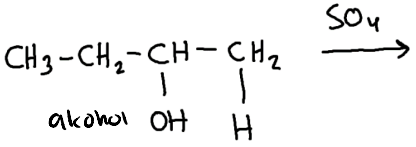




Hydrolysis



dehydration



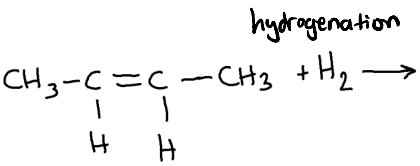
alkene

alkene

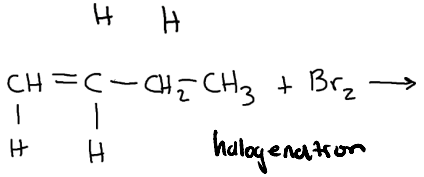
prop-1-ene

butene

hydrogenation

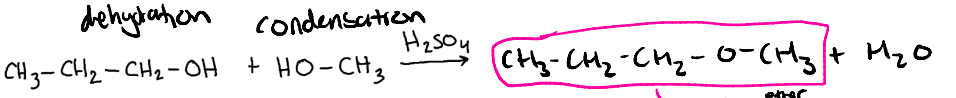


alkane



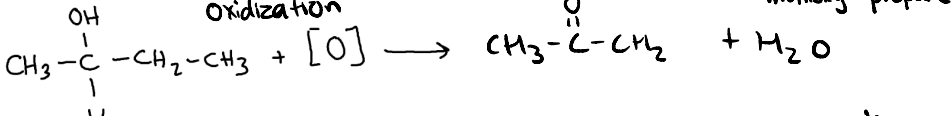
halogenation

dehydration condensation

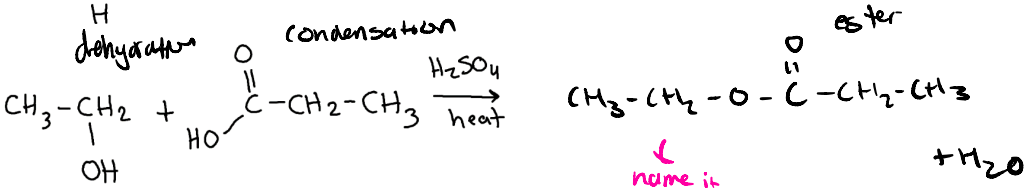


name it: ether methoxy propane

oxidization



dehydration condensation

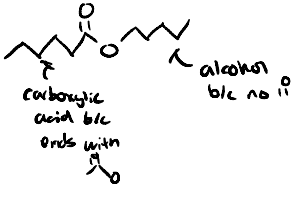


name it

ethyl propanoate

What carboxylic acid and what alcohol produce pentyl hexanoate?

hexanoic acid + pentanol



What carboxylic acid and what alcohol produce ethyl butanoate?

butanoic acid

ethanol