ALKANES

Water-insoluble, low density C-C single bonds
Higher MW -> higher BP, higher MP
Branching -> lower BP, higher MP
Forms cycloalkanes which can have ring strain
Cyclohexane: chair vs. boat configuration (chair more stable b/c less ring strain)
-> Chair: equatorial vs. axial hydrogens, can undergo a ring flip exchanging groups
-> Axial substituents can interfere so larger substituents usually on equatorial position

Combustion: react with oxygen to form CO2 + H2O + heat
Combustion is a radical process and exothermic
Higher heat of combustion (enthalpy change) = less stable, more reactive

Halogenation: react with F, Cl, Br to form alkyl halides - radical process, exothermic
1) Initiation: halogen cleaved by heat/light to form free radical
2) Propagation: halogen radical reacts with alkane to form alkyl radical, alkyl radicals can react with other alkanes to form more radicals
3) Termination: two radicals combine to form a stable compound
F is most reactive, so will usually create primary radical + primary product
Br is most selective, so will usually create most stable product
-> Radical stability: 3 > 2 > 1 > methyl
Can have multiple halogenations if there's lots of halogen
**ALKENES**

Water insoluble, as C=C double bond  
Most substituted alkenes are most stable (b/c electrons have room to spread out)  
Higher MW -> higher BP, higher MP  
Branching -> lower BP, higher MP

**Synthesis - E1/E2 reactions**

**E1**: two step reaction, first step is slowest  
(1) Leaving group leaves in presence of weak base, forms carbocation  
(2) Carbocation rearrangement can occur (3 > 2 > 1 > methyl)  
(3) Weak base extracts a hydrogen, creating double bond  
*Saytzeff rule*: major product is most substituted alkene

**Dehydration**: alcohol + hot acid -(E1)-> alkene  
**Dehydrohalogenation**: alkyl halide + weak base -(E1)-> most substituted alkene

**E2**: one step reaction  
-> Strong base extracts hydrogen at same time leaving group leaves, creating double bond  
If base is too bulky then least substituted alkene will be created (violation of Saytzeff's rule)

*Dehydrohalogenation*: alkyl halide + strong/bulky base -(E2)-> least substituted alkene

**Catalytic Hydrogenation** - exothermic  
Alkene + H2 (with heterogeneous Ni, Pd or Pt catalyst) -> alkane  
Hydrogens added to same side of alkene (syn-addition)  
Alkynes -> alkenes by this process

**Oxidation/Ozonolysis**  
Alkene + (1) O2, (2) Zn/H2O -> two carbonyls  
Cleaves double bond, attaches a double bonded O to each side  
Alkynes -> carboxylic acids by this process
**Electrophilic Addition** - b/c alkenes have a huge cloud of electrons
Alkene + hydrogen halide (HF/HCl/HBr/HI) -> alkyl halide
*Markovnikov's rule:* hydrogen attaches to least substituted carbon
Carbocation rearrangement can occur
When there's peroxides (ROOR) with HBr the hydrogen will attach to the most substituted carbon (anti-Markovnikov addition)

**Hydration**
Alkene + H2O -> Alcohol (in cold dilute acid)

**Oxymercuration/Demercuration**
Alkene + Hg(OAc)2 + H2O -> alcohol
Alkene + Hg(OAc)2 + alcohol -> ether
*Markovnikov addition of OH and H* (anti addition)
Carbocation rearrangement doesn't occur

**Hydroboration**
Alkene + BH3 + H2O2 + OH- -> anti Markovnikov addition of OH and H (syn addition)

**Halogenation**
Alkene + Br2 -> vic-dihalide (anti addition of two Br's)

**BENZENE**

Generally undergoes substitution rather than addition
Ortho, meta, para positions
- Electron withdrawing groups direct to meta
  - Includes things containing double bonds with O, triple bonds, (+) charges
  - Halogens are EWG but direct to ortho/para
- Electron donating groups direct to ortho/para
  - Includes things with negative charges, things single bonded with O, alkyl groups
SUBSTITUTION REACTIONS

**SN1:** 2 steps, rate depends on first step
1) Planar carbocation forms when leaving group leaves
2) Nucleophile attacks carbocation, attaches to carbon
Can form both enantiomers b/c carbocation is planar
Only tertiary carbons will undergo SN1

**SN2:** one step
- Nucleophile attacks carbocation at same time as leaving group leaves
Opposite enantiomer will be created (inversion of configuration)

**SN1 vs SN2:**
* Nucleophile: SN2 needs strong nucleophile (lots of electrons)
* Substrate: SN2 needs non sterically hindered substrate
* Solvent: SN2 needs less polar solvent, SN1 likes polar solvents
* Speed: SN2 depends both substrate/nucleophile, SN1 depends on substrate
* Stereochemistry: SN2 inverts configuration, SN1 creates both enantiomers
* Skeleton: SN1 can have carbocation rearrangement

**ALCOHOLS**
Polar, slightly acidic

**Organometallic Synthesis** (Grignard reagents)
Carbonyl + R-MgX -> alcohol with R attached

**Reduction Synthesis**
Carbonyl + NaBH4/LiAlH4 -> alcohol with H attached
Ester + LiAlH4 -> alcohol

**Nucleophilic Addition/Substitution**

**Oxidation:** (reacts with things with a lot of O's)
Primary alcohol -> aldehyde -> carboxylic acid
Secondary alcohol -> ketone
Alkyl Halides
Alcohol + HCl -> Alkyl halide

Mesylates/Tosylates
Alcohol + sulfur compound -> alkyl tosylate/mesylate, which has a great leaving group

Pinacol Rearrangement
Vicinal diol + hot sulfuric acid -> Pinacolone (ketone with tertiary alpha carbon)

ETHERS
Not very reactive, can react with HI/HBr to form alcohols

EPoxyDES
Reacts with water in acid to form diols