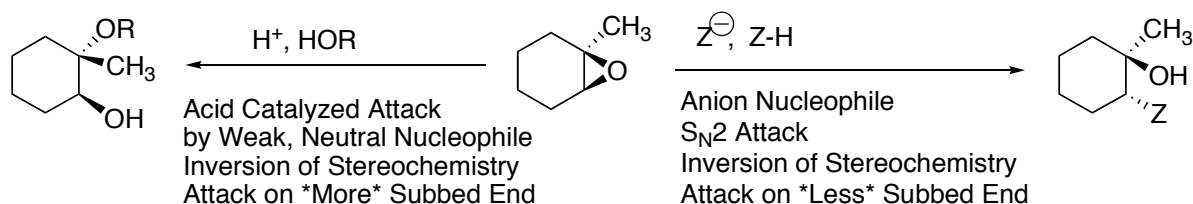
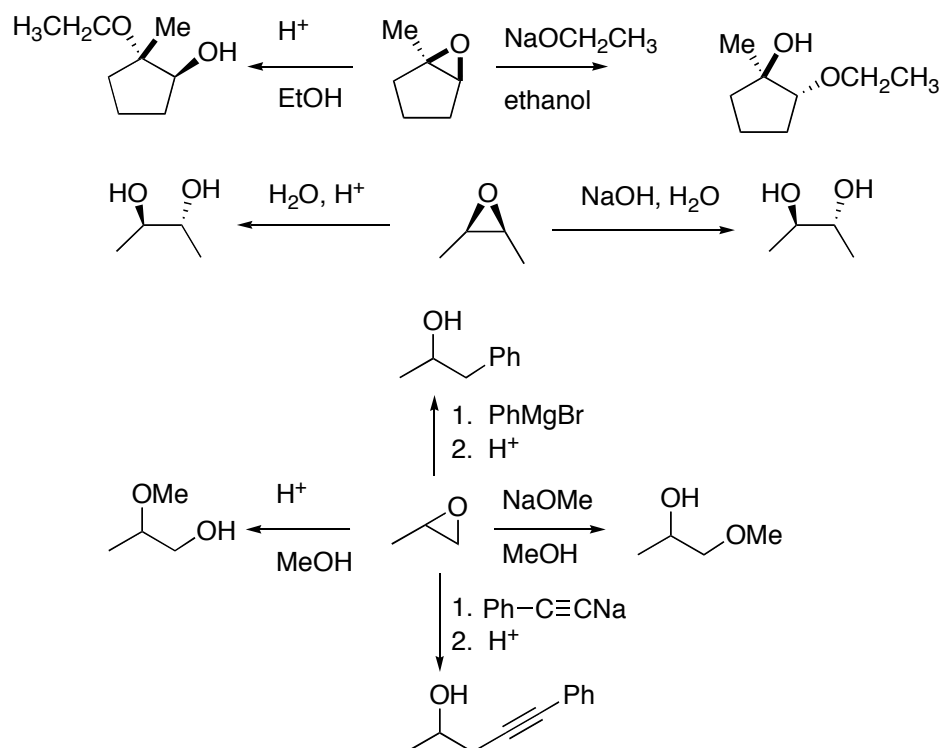


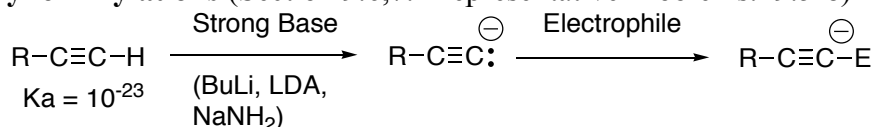
Special Topics for Final Exam: Topics that Frequently Appear on ACS or Standardized Tests, But That I Didn't Cover in Class This Year

1. Epoxides as Electrophiles (Section 14.12-15. Representative Problems: 14.25-28)



- Because of ring strain, epoxides are relatively reactive toward nucleophilic substitution, in which one of the C-O bonds breaks.
- Two different substitution profiles:
 - Strong, anionic nucleophiles
 - $\text{S}_{\text{N}}2$ mechanism, followed by a protonation step
 - Types of nucleophiles:
 - Carbon anions: Grignards, enolates, alkyne anions
 - Oxygen anions
 - Stereochemistry: Inversion (if stereochemistry matters).
 - Site of Attack: If Epoxide is unsymmetric, nucleophile attacks the less hindered end
 - Acid-catalyzed addition of weak, neutral nucleophiles
 - Types of nucleophiles: normally water or alcohol
 - Stereochemistry: Inversion (if stereochemistry matters)
 - Site of Attack: if epoxide is unsymmetric, nucleophile adds to the more hindered end.

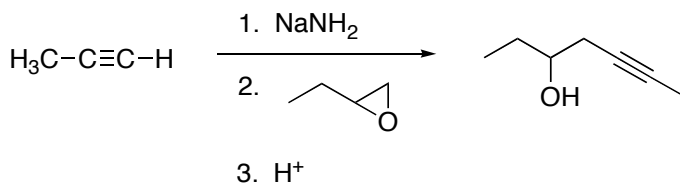
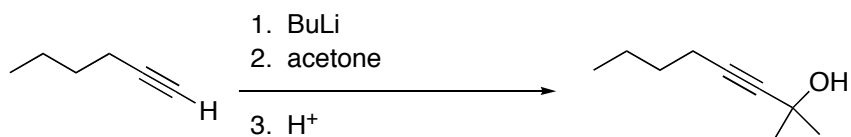
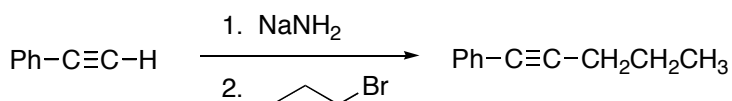


2. **Alkyne Alkylations** (Section 9.6,7. Representative Problems: 9.5-8)Overview

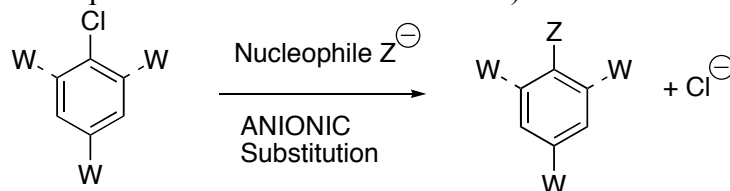
- Alkyne hydrogens are weakly acidic.
- They can be deprotonated by strong bases to generate carbanions.
- Like other carbanions (Grignards, enolates....) the anions are strongly nucleophilic and can react with electrophiles

Details

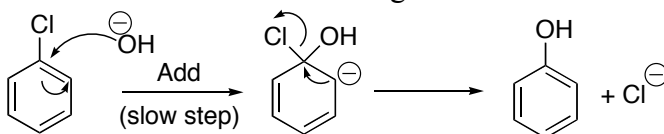
- **Acidity**
 - The K_a value for acetylenes is about 10^{-23} , (comparable to a ketone).
 - Why? Acidity follows hybridization: $sp > sp^2 > sp^3$
 - Why? The more s character, the closer the electrons are gripped by the positive nucleus. (Reverse of amine basicity...)
- **Base Requirements:**
 - Complete deprotonation is required
 - Therefore, strong bases are required.
 - Oxygen anion bases (NaOH, NaOMe...) are too weak.
 - Nitrogen bases are good: NaNH_2 or LDA
 - Carbon bases are good: BuLi
- **3 Electrophiles:**
 - Carbonyls (aldehydes and ketones, just as for Grignard and aldol reactions...)
 - Alkyl halides ($\text{S}_\text{N}2$ reactions)
 - Epoxides



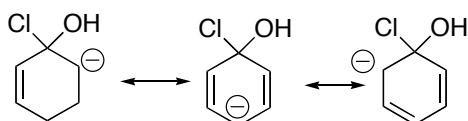
3. Nucleophilic (Anionic) Aromatic Substitution for a Leaving Group: (Section 17.12A. Representative Problems: 17.25a-d)



- Mechanism: Anionic analog to cationic aromatic substitution

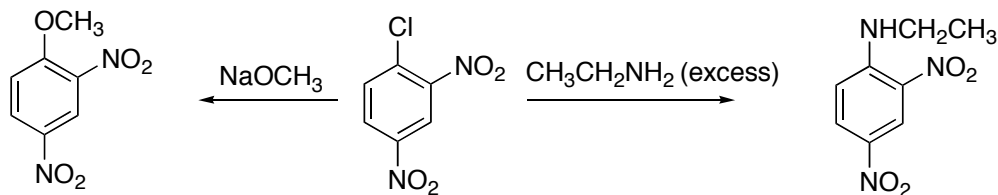


3 Resonance Structures for Delocalized Anion:

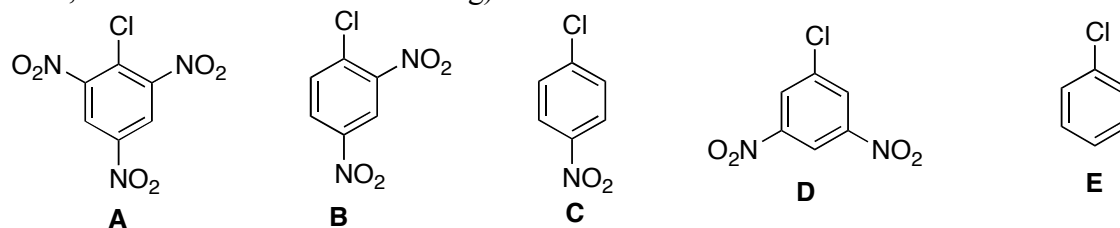


Charge shared at ortho/para positions. Withdrawing substituents will stabilize the charge, and accelerate the reaction.

- Differences:
 - no ortho/para/meta issues. A halide leaving group must be in the starting material, and the nucleophile must attack at that spot.
 - Reactivity depends on anion stabilizers at the ortho and para positions. You must have one or more electron withdrawers present. (Unlike cationic aromatic substitution, which benefit from electron donors...)
 - The withdrawing groups must be ortho and/or para, not meta, otherwise the anionic gets no resonance benefit.
 - Meta withdrawers don't help much.
- Leaving groups: Cl, Br, I, even F (which halogen doesn't matter much, because addition is rate determining step, not the elimination)
- Nucleophiles: NaOH, NaOR, NH_3 , RNH_2 , $NaNHR$ (anion or nucleophilic amines)



Rank the reactivity of the following towards NaOH: A > B > C (more o/p withdrawers) > D (meta withdrawer doesn't do very much good, because anion doesn't delocalize meta) > E (even meta, the EWG is better than nothing)

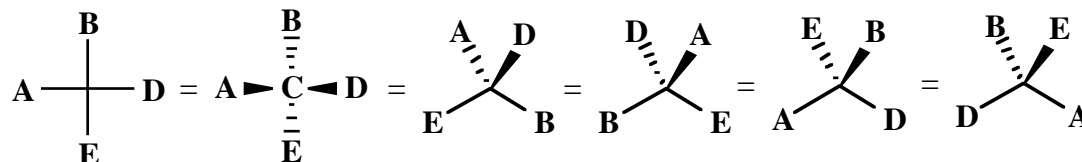


Common Question formats:

- What is product?
- Rank reactivity (or, which is fastest? Or slowest?)
- Which would be an intermediate or the resonance structure of an intermediate in the following reaction?

4. Fischer Projections (Section 5.10. Representative Problems: 5.16-19)

In Fischer projections, atoms attached to horizontal lines are viewed as being in front of the plane (wedged), and atoms attached to vertical lines are viewed as being behind the plane (wedged).



Summary of Fischer Projections and their use:

1. They are most useful for compounds with two or more asymmetric carbon atoms
2. Asymmetric carbons are at the centers of crosses
3. The vertical lines project away from the viewer, the horizontal lines toward the viewer
4. The entire projection can be rotated 180° (but not 90°) in the plane of the paper without changing its stereochemistry
5. Interchanging any two groups on an asymmetric carbon (for example, those on the horizontal line) inverts the R/S configuration of that chiral carbon.

Recognizing Stereochemical Relationships Fischer Projections and their use:

1. One is **achiral** if there is either a vertical or horizontal plane of symmetry. If no plane, the structure is **chiral**
2. **Meso** compounds will have 2 or more chiral centers, but have a horizontal plane of symmetry through a Fischer Projection
3. Two are the **same** if you can superimpose by sliding one over or by doing a 180° rotation
4. Two are **enantiomers** if they are chiral and the verticals are consistent, but **all of the lefts/rights are inverted**.
5. Two are **diastereomers** if they are chiral and the verticals are consistent, but **some but not all of the lefts/rights are inverted**. (In other words, if there is essentially a different cis/trans relationship relative to the Fischer projection)
6. Two are structural isomers if atoms are at different crosses (or “rungs of the ladder”)

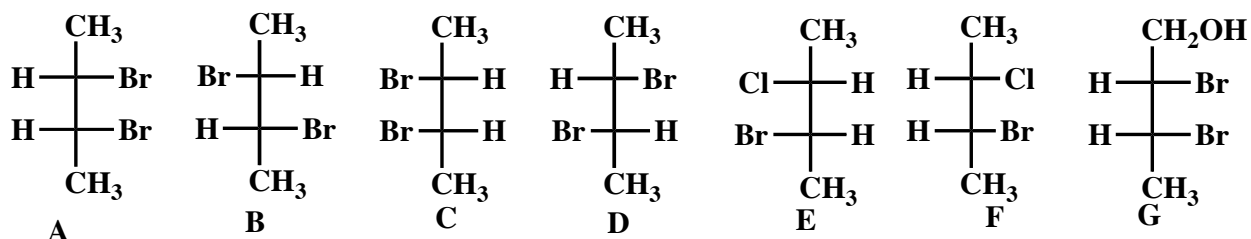
Classifying R/S configuration at a chiral center in a Fischer Projection: Since an H will always be on a horizontal (coming forward....), if you draw an arrow from priority 1 to priority 2 to priority 3 attachment:

Clockwise → S (opposite from the case with normal 3-D drawings)

Counterclockwise → R

Some Fischer Projection skills:

1. Recognize chiral C's
2. Recognize chiral molecules
3. Recognize meso molecules
4. Recognize R/S configuration at chiral C's
5. Recognize relationships between pairs of molecules:
 - a. Same
 - b. Enantiomers
 - c. Diastereomers
 - d. Structural Isomers



1. Which of the above molecules are chiral?

B, D, E, F, G

2. Which of the above molecules are meso compounds?

A and C.

3. Classify the relationship between the following pairs as same, enantiomers, or diastereomers:

- A + B Diastereomers (cis/trans type situation. One but not both stereocenter inverted)
- A + C Same. If you take A and do a 180° rotation, you get C. A is a meso compound, achiral. Therefore it's a given that it's mirror image C is identical to the original A.
- B + D Enantiomers. All of the chiral Centers have their left-rights inverted, so the two are mirrors. But they are not identical. Non-identical mirrors are enantiomers.
- E + F Enantiomers. Both stereocenters are inverted (left/right switch), but they are not the same.

4. Classify the R/S stereochemistry for the chiral centers in A and B.

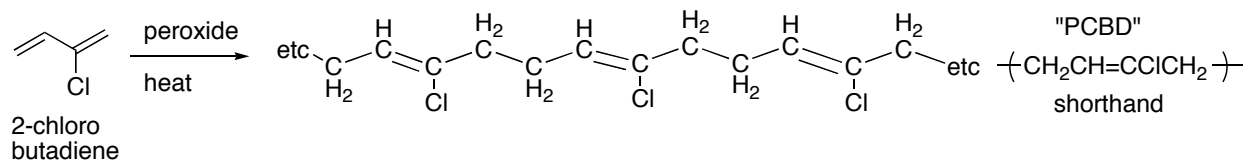
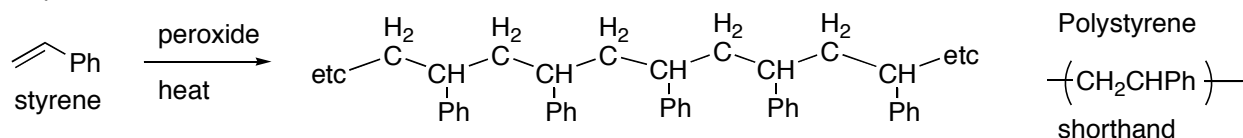
A: top carbon is S, bottom carbon is R. B: both are R.

5. **Polymers:** (Section 8-16, 26-2 [addition polymers], 27-7 [condensation polymers]).
 Representative Problems: 26.22 (isobutylene is 2-methyl-1-propene), 26.23, 26.27)

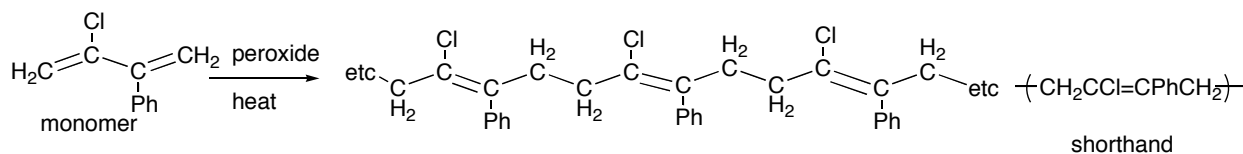
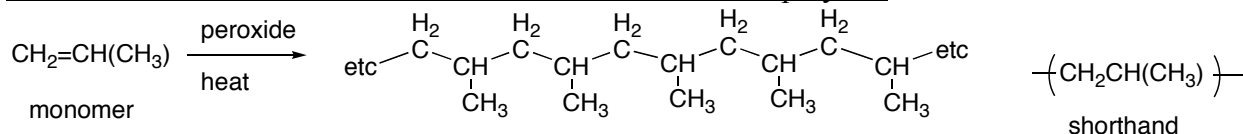
Addition Polymers

- No change in atoms, you simply add all the atoms in the reactants together to make long polymer strings. The repeat unit in the polymer must have the same atoms as the monomer.
- Precursors: Alkenes or Conjugated Dienes
- Polymer has one fewer double bond than monomer: monoalkene \rightarrow none; diene \rightarrow one.
- For a conjugated diene, the two middle carbons end up double-bonded in the polymer
- Initiation/recognition: Usually radical/peroxides. Sometimes acid or Lewis acid catalyzed.
- Skills: Given monomer, draw polymer
- Skills: Given polymer, recognize monomer.
- Skills: Use and understand shorthand

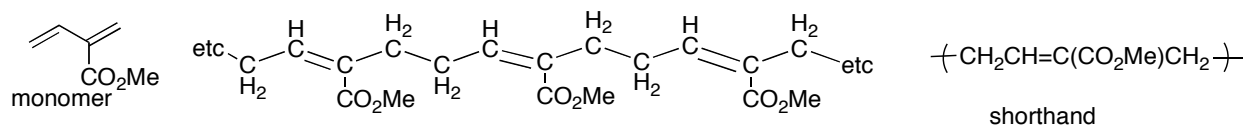
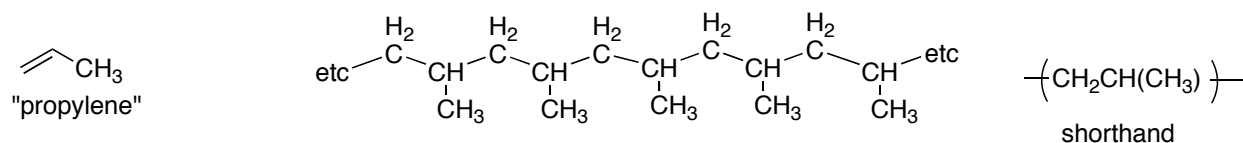
Ex:



Problems: Draw the monomer and the shorthand version of polymer

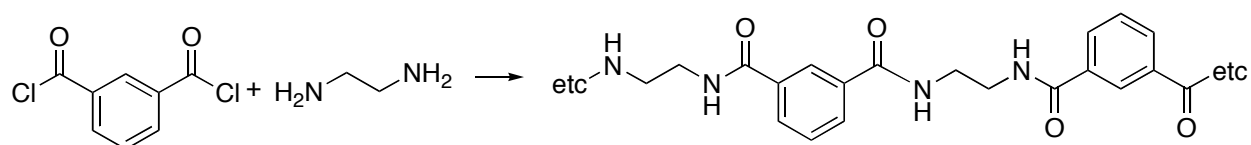
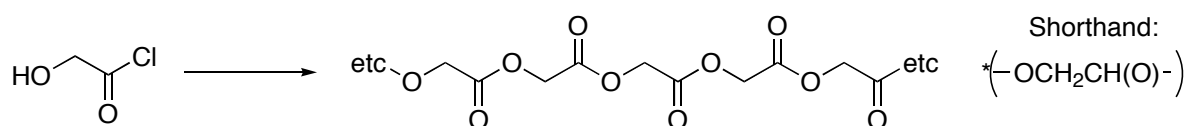
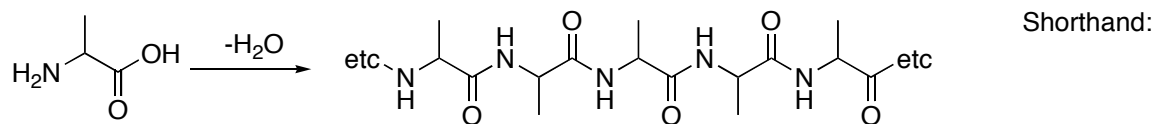


Draw the polymer from the following monomer, both shorthand and longstretch

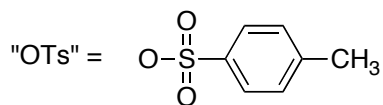
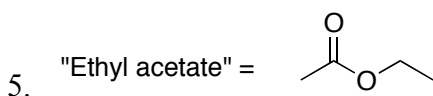
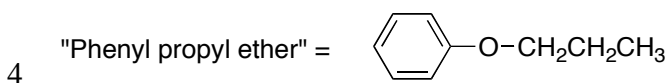


Condensation Polymers: Ester or Amide bonds are created

Usually these involve ClAvENO type condensations, in which HOH or HCl is extruded

**6. Miscellaneous**

1. Be comfortable with condensed formulas! A lot of structures are given by their condensed formula, not by the picture.
2. $\text{H}_2\text{CrO}_4 = \text{H}^+$, $\text{CrO}_3 = \text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$
3. $\text{Br}_2/\text{Fe} = \text{FeBr}_3$



Outstanding leaving group. (Anion is comparable to sulfuric acid anion)

