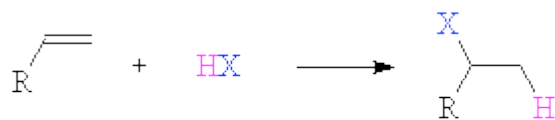


**Reaction 1. Electrophilic addition of hydrogen halides (HX) to alkenes.**

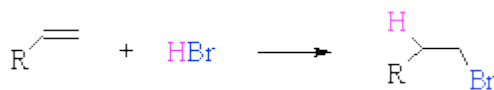


X = Cl, Br, I

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• HCl, HBr in ether</li><li>• KI + H<sub>3</sub>PO<sub>4</sub></li><li>• room temperature</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition</li><li>• carbocation intermediates</li><li>• Markovnikov's rule apply</li><li>• carbocation rearrangements possible</li><li>• both anti and syn addition</li></ul>

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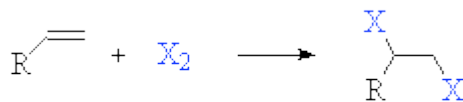
**Reaction 2. Radical addition of hydrogen bromide (HBr) to alkenes. (NOT COVERED THIS TIME)**



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• radical initiators (usually peroxides)</li><li>• heat or light</li></ul>	<ul style="list-style-type: none"><li>• chain reaction</li><li>• radical intermediates</li><li>• anti-Markovnikov's products</li><li>• both syn and anti addition</li></ul>

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**Reaction 3. Electrophilic addition of halogens (X<sub>2</sub>) to alkenes.**

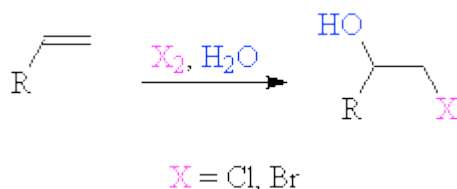


X = Br, Cl

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• Br<sub>2</sub>, Cl<sub>2</sub> in CCl<sub>4</sub> (or AcOH)</li><li>• room temperature</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition</li><li>• bromonium or chloronium ion intermediates</li><li>• anti addition</li></ul>

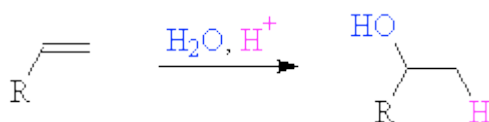
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#### Reaction 4. Electrophilic addition of halogens to alkenes in the presence of water.



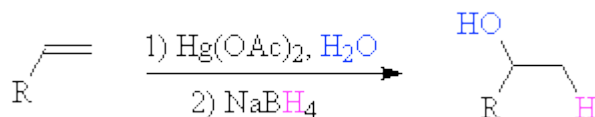
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{Br}_2</math> (<math>\text{Cl}_2</math>) in <math>\text{H}_2\text{O}</math> or NBS in <math>\text{H}_2\text{O}/\text{DMSO}</math></li><li>• room temperature</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition of <math>\text{X}_2</math></li><li>• bromonium or chloronium ion intercepted by <math>\text{H}_2\text{O}</math></li><li>• Markovnikov's rule apply (with respect to <math>\text{H}_2\text{O}</math>)</li><li>• anti addition</li></ul>

#### Reaction 5. Electrophilic addition of water to alkenes.



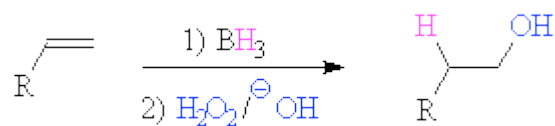
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• acid catalyst needed with non-nucleophilic counter ion (<math>\text{H}_2\text{SO}_4</math>, <math>\text{HClO}_4</math>)</li><li>• high temperature required</li><li>• often reversible (rather used to make olefins from alcohols)</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition</li><li>• carbocations intermediates</li><li>• Markovnikov's rule applies</li><li>• syn and anti addition</li></ul>

#### Reaction 6. Oxymercuration of alkenes (formal addition of water).



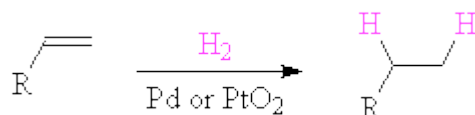
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{Hg}(\text{OAc})_2</math> in <math>\text{H}_2\text{O}</math> (or <math>\text{THF}/\text{H}_2\text{O}</math>)</li><li>• reduction step required to replace mercury with hydrogen (<math>\text{NaBH}_4</math>)</li><li>• room temperature</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition of mercury compound</li><li>• mercurinium ion as the intermediate intercepted by <math>\text{H}_2\text{O}</math></li><li>• Markovnikov's rule applies with respect to <math>\text{H}_2\text{O}</math></li><li>• reduction step with a complicated mechanism</li><li>• the addition of <math>\text{H}_2\text{O}</math> is anti, but reduction complicates matters</li></ul>

### Reaction 7. Hydroboration of alkenes (formal addition of water).



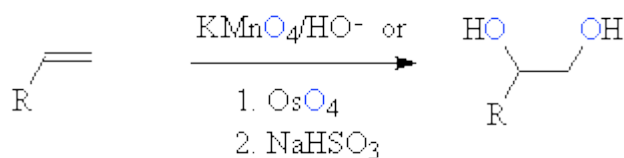
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{BH}_3</math>-THF complex in THF</li><li>• oxidation step necessary (<math>\text{H}_2\text{O}_2/\ominus\text{OH}</math>)</li><li>• room temperature or heat</li><li>• tri-fold addition (to borane) is common</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition of <math>\text{BH}_3</math></li><li>• cyclic transition state, putting boron at the least substituted carbon of the double bond</li><li>• syn addition, preserved in the oxidation step</li><li>• anti-Markovnikov products</li></ul>

### Reaction 8. Hydrogenation of alkenes.



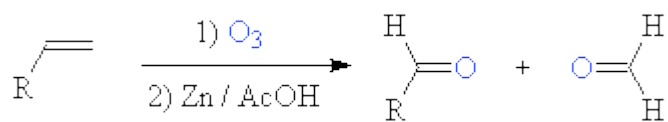
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{H}_2</math> gas over heterogeneous catalysts</li><li>• room temperature or heat</li><li>• facile reaction (many other functional groups remain untouched)</li></ul>	<ul style="list-style-type: none"><li>• surface reaction</li><li>• syn addition from the less crowded face</li><li>• mechanism is complicated</li><li>• redox reaction</li></ul>

### Reaction 9. Hydroxylation of alkenes.



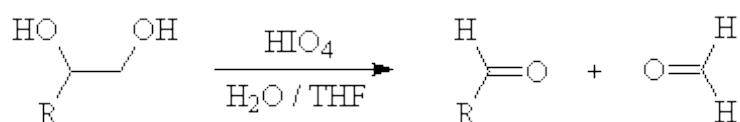
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{KMnO}_4/\ominus\text{OH}</math> (lower yield)</li><li>• <math>\text{OsO}_4</math>/pyridine (higher yield but toxic and expensive)</li></ul>	<ul style="list-style-type: none"><li>• cyclic transition state and intermediate resulting in syn addition</li><li>• redox reaction</li></ul>

### Reaction 10. Ozonolysis of alkenes.



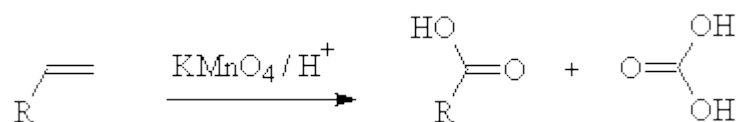
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>ozone at low temperature followed by reduction with Zn/AcOH</li></ul>	<ul style="list-style-type: none"><li>complicated mechanism with O<sub>3</sub></li><li>oxidation followed by reduction</li></ul>

### Reaction 11. Oxidation of diols.



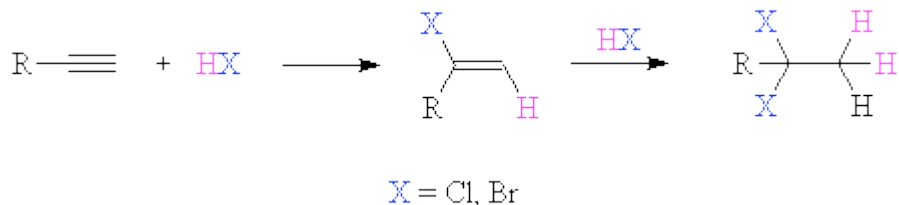
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>1,2-diol (formed in reaction 9) treated by HIO<sub>4</sub> in H<sub>2</sub>O/THF</li><li>equivalent to ozonolysis of the corresponding olefins (reaction 10)</li></ul>	<ul style="list-style-type: none"><li>cyclic intermediate with HIO<sub>4</sub></li></ul>

### Reaction 12. Oxidation of alkenes with permanganate under acidic conditions.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>potassium permanganate under acidic or neutral conditions</li></ul>	<ul style="list-style-type: none"><li>redox reaction</li><li>oxygen inserts into all C-H bonds of the former double bond</li></ul>

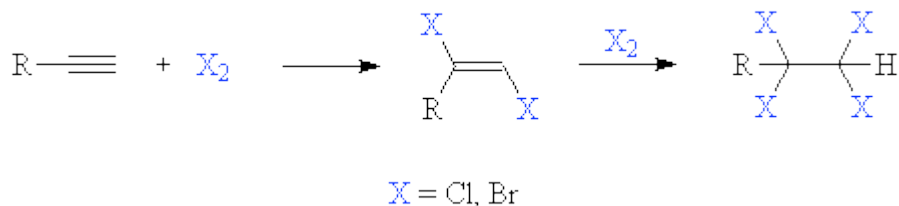
**Reaction 13. Electrophilic addition of hydrogen halides (HX) to alkynes.**



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>HCl, HBr in acetic acid</li></ul>	<ul style="list-style-type: none"><li>electrophilic addition</li><li>vinyl carbocation as an intermediate</li><li>Markovnikov's rule apply</li><li>first addition usually trans</li><li>second addition often follows</li><li>less reactive than alkenes</li></ul>

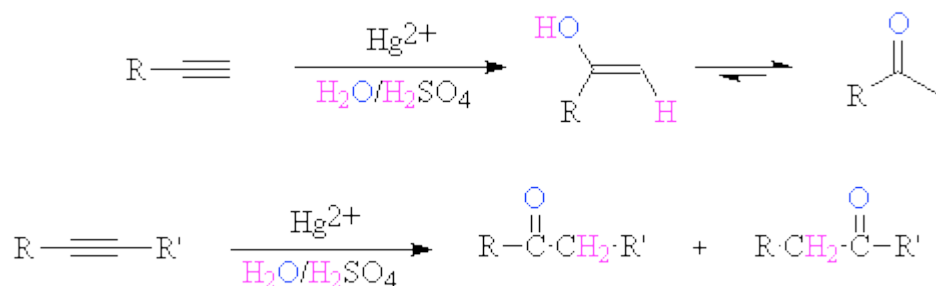
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**Reaction 14. Electrophilic addition of halogens (X<sub>2</sub>) to alkynes.**

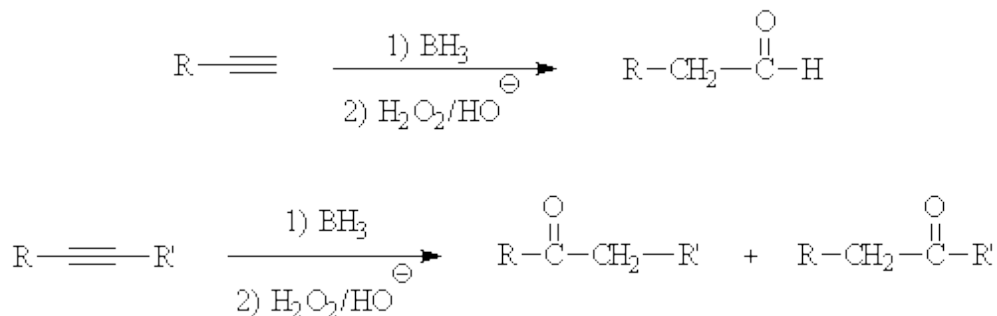


Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>Cl<sub>2</sub>, Br<sub>2</sub> in CCl<sub>4</sub></li></ul>	<ul style="list-style-type: none"><li>electrophilic addition</li><li>vinyl carbocations or halonium (bromonium) ion as intermediates</li><li>Markovnikov's rule apply</li><li>first addition usually trans (anti)</li><li>second addition often follows</li><li>less reactive than alkenes</li></ul>

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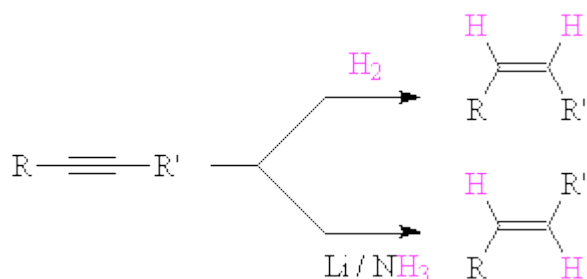
**Reaction 15. Electrophilic addition of water to alkynes.**

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{H}_2\text{SO}_4 + \text{HgSO}_4 + \text{H}_2\text{O}</math></li><li>• no <math>\text{NaBH}_4</math> necessary to replace mercury (Hg) with hydrogen</li></ul>	<ul style="list-style-type: none"><li>• electrophilic addition catalyzed by <math>\text{Hg}^{2+}</math> (mercurinium ion not involved)</li><li>• Markovnikov's rule apply</li><li>• the primary product is an enol, a less stable tautomer of a ketone</li></ul>

**Reaction 16. Hydroboration of alkynes (formal addition of water).**

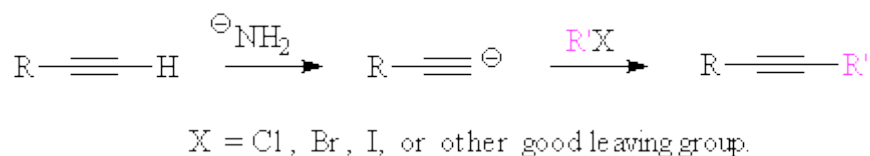
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{BH}_3/\text{THF}</math> gives mixture of regioisomers for disubstituted alkynes, double addition with terminal alkynes</li><li>• <math>\text{R}'_2\text{BH}</math> (<math>\text{R}' = 1,2\text{-dimethylpropyl}</math>) is used for monoaddition to terminal alkynes</li></ul>	<ul style="list-style-type: none"><li>• four - membered cyclic transition state for addition</li><li>• syn addition</li></ul>

### Reaction 17. Hydrogenation of alkynes.



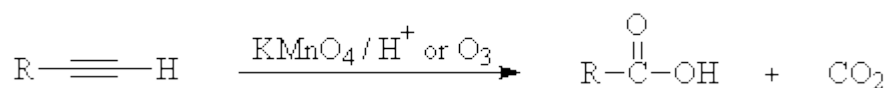
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>Lindlar catalyst used for cis product (Pd, CaCO<sub>3</sub>, Pb(OAc)<sub>2</sub>, quinoline)</li> <li>lithium metal in ammonia for trans product</li> </ul>	<ul style="list-style-type: none"> <li>hydrogenation is a heterogeneous reaction</li> <li>hydrogenation catalyst is poisoned (deactivated) to prevent further reduction of the double bond</li> <li>Li reduction involves electron-transfer process and proceeds via an intermediate vinylic carbanion</li> </ul>

### Reaction 18. Alkylation of acetylide anion.



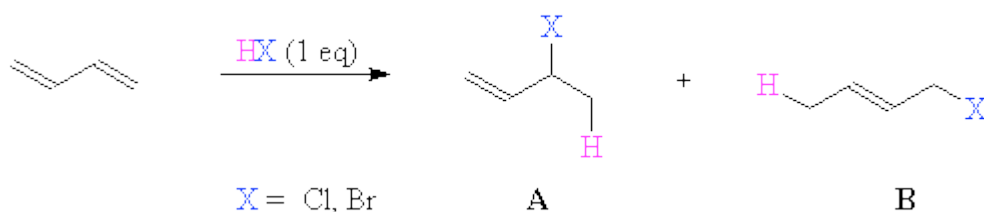
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>KNH<sub>2</sub> used as a base (in NH<sub>3</sub> or THF)</li> <li>primary electrophiles (alkylating agents) work well</li> </ul>	<ul style="list-style-type: none"> <li>the increased acidity of the <i>sp</i> hybridized carbon makes carbanion accessible (the lone electron pair in the conjugate base, acetylide anion, has large <i>s</i> character)</li> <li>S<sub>N</sub>2 substitution mechanism followed (back-side attack on the electrophilic carbon)</li> </ul>

### Reaction 19. Oxidative cleavage of alkynes.



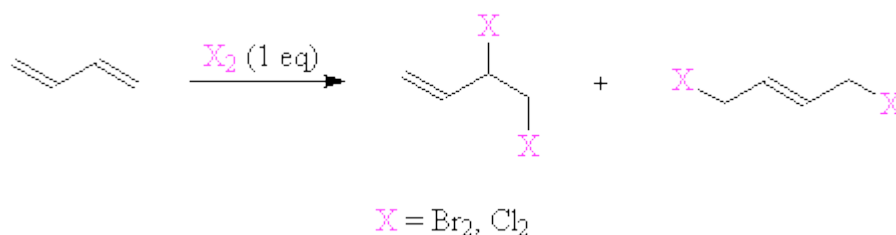
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>KMnO<sub>4</sub> or ozone</li> <li>often low yields</li> </ul>	<ul style="list-style-type: none"> <li>complicated oxidation mechanisms</li> <li>more difficult to oxidize than alkenes</li> <li>substituted "ends" yield the corresponding carboxylic acids, unsubstituted ones give CO<sub>2</sub></li> </ul>

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**Reaction 20. Electrophilic addition of HX to conjugated dienes.**

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>HCl or HBr in ether</li></ul>	<ul style="list-style-type: none"><li>electrophilic addition leading to allyl (resonance stabilized) carbocations</li><li>the allyl cation can be attacked by the bromide anion at two positions</li><li>the 1,2-adduct (<b>A</b>) is kinetically favored (predominates at low temperatures)</li><li>the 1,4-adduct (<b>B</b>) is thermodynamically more stable and it predominates at higher temperatures</li></ul>

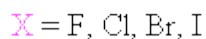
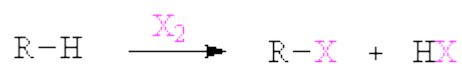
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**Reaction 21. Electrophilic addition of halogens to conjugated dienes.**

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li><math>\text{Br}_2</math> or <math>\text{Cl}_2</math> in <math>\text{CCl}_4</math></li></ul>	<ul style="list-style-type: none"><li>electrophilic addition leading to allyl (resonance stabilized) carbocations</li><li>the allyl cation can be attacked by the bromide anion at two positions</li><li>the 1,2-adduct is kinetically favored (predominates at low temperatures)</li><li>the 1,4-adduct is thermodynamically more stable and predominates at higher temperatures</li></ul>

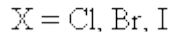
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**Reaction 22. Radical (chain) halogenation of alkanes.**

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{X}_2</math>; the reaction is explosive for <math>\text{F}_2</math> and very sluggish for <math>\text{I}_2</math> (thermodynamic reasons)</li><li>• heat or light used to generate radicals in the initiation steps</li><li>• mixtures of products are obtained (mono- and poly-halogenated compounds, and different regioisomers)</li><li>• NBS in <math>\text{CCl}_4</math> (with light or initiators) used for allylic or benzylic brominations</li></ul>	<ul style="list-style-type: none"><li>• radical chain reactions</li><li>• the initiation step generates <math>\text{X}^\bullet</math> radical</li><li>• selectivity is established in the hydrogen-abstraction step by <math>\text{X}^\bullet</math></li><li>• the more reactive <math>\text{X}^\bullet</math>, the less selective it is</li></ul>

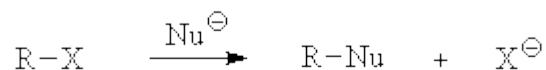
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**Reaction 23. Conversion of alcohols into alkyl halides.**

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• <math>\text{HX}</math> in ether (works best for tertiary alcohols)</li><li>• <math>\text{PBr}_3</math> in ether or <math>\text{CH}_2\text{Cl}_2</math></li><li>• <math>\text{SOCl}_2</math> in pyridine</li><li>• <math>\text{TosCl}</math>/pyridine followed by <math>\text{X}^-</math></li></ul>	<ul style="list-style-type: none"><li>• <math>\text{S}_\text{N}1</math> mechanism for tertiary alcohols</li><li>• <math>\text{S}_\text{N}2</math> mechanism for primary alcohols</li><li>• hydroxyl group is converted to a better leaving group by reaction with the reagent of choice</li></ul>

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**Reaction 24. Nucleophilic substitution reaction on  $sp^3$  hybridized carbons.**



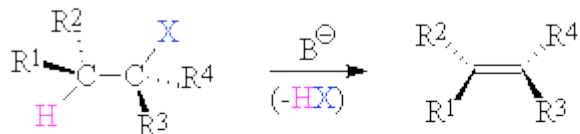
$X$  = leaving group (for example: Cl, Br, I, Tos)

$Nu^{\ominus}$  = nucleophile (for example:  $HS^{\ominus}$ ,  $HO^{\ominus}$ ,  $RO^{\ominus}$ ,  $^{\ominus}CN$ ,  $I^{\ominus}$ ,  $RNH_2$ ,  $H_2O$ )

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• variety of conditions and solvents usually polar and protic solvents for <math>S_N1</math> reactions</li><li>• usually polar aprotic solvents for <math>S_N2</math> reactions</li></ul>	<ul style="list-style-type: none"><li>• <math>S_N1</math> mechanism for tertiary substrates: the leaving group departs in a unimolecular rate-limiting step, generating the carbocation, which in the second step reacts with the nucleophile; ion pairs may be involved and carbocation rearrangements may compete</li><li>• <math>S_N2</math> mechanism for primary substrates: the nucleophile displaces the leaving group in one-step bimolecular back-side attack leading to inversion of configuration on stereogenic centers</li><li>• secondary, allylic or benzylic substrates may react by both mechanisms</li><li>• competition with elimination reactions (<math>E1</math> and <math>E2</math>) often observed</li></ul>

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## Reaction 25. Elimination reaction to form carbon-carbon double bonds.



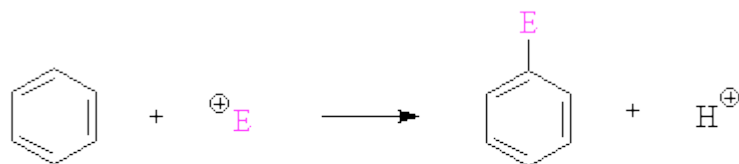
$X$  = leaving group (for example:  $Cl$ ,  $Br$ ,  $I$ ,  $Tos$ )

$B^{\ominus}$  = base (for example:  $HO^{\ominus}$ ,  $H_2N^{\ominus}$ ,  $t-BuO^{\ominus}$ ,  $Cl^{\ominus}$ ,  $H_2O$ ,  $RNH_2$ )

Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• variety of conditions and solvents</li><li>• usually strong bases favor E2 mechanism</li></ul>	<ul style="list-style-type: none"><li>• E1 mechanism for tertiary or secondary allylic or benzylic substrates: the leaving group departs in a unimolecular rate-limiting step, generating the carbocation, which in the second step is deprotonated (with base) on the carbon adjacent to the cationic center, yielding the olefin; carbocation rearrangements may compete</li><li>• E2 mechanism favored by strong bases: the base removes a proton from the carbon adjacent to one bearing the leaving group in a one-step bimolecular reaction that requires periplanar orientation of the hydrogen and the leaving group (anti-periplanar preferred)</li><li>• competition with substitution reactions (<math>S_N1</math> and <math>S_N2</math>) often observed</li><li>• Usually the most substituted olefin is the major product (Zaitsev's rule)</li></ul>

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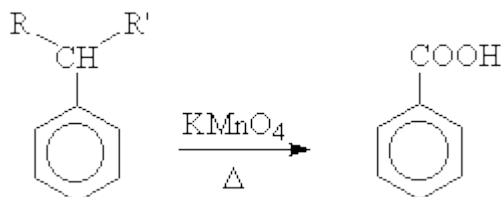
### Reaction 26. Aromatic electrophilic substitution.



$E^{\oplus}$  = electrophile (for example:  $^{\oplus}\text{NO}_2$ ,  $\text{HSO}_3^{\oplus}$ ,  $\text{R}-\text{C}\equiv\text{O}^{\oplus}$ ,  $\text{R}^{\oplus}$ ,  $\text{Br}^{\oplus}$ )

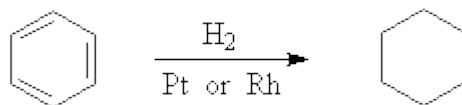
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>• <math>\text{Br}_2</math> and <math>\text{FeBr}_3</math> (or <math>\text{AlBr}_3</math>) for bromination</li> <li>• <math>\text{Cl}_2</math> and <math>\text{FeCl}_3</math> (or <math>\text{AlCl}_3</math>) for chlorination</li> <li>• <math>\text{I}_2</math> and <math>\text{H}_2\text{O}_2</math> (or <math>\text{CuCl}_2</math>) for iodination</li> <li>• <math>\text{HNO}_3/\text{H}_2\text{SO}_4</math> for nitration</li> <li>• <math>\text{SO}_3/\text{H}_2\text{SO}_4</math> for sulfonation</li> <li>• <math>\text{RX}</math> and <math>\text{AlCl}_3</math> for alkylation</li> <li>• <math>\text{RCOX}</math> and <math>\text{AlCl}_3</math> for acylation</li> </ul>	<ul style="list-style-type: none"> <li>• positively charged electrophile adds to the aromatic ring in the rate-limiting step; the resulting carbocation reverts to aromaticity by the loss of proton</li> <li>• the relative reactivity and regiochemistry of the reaction on substituted benzene derivatives is governed by the nature of the substituent: the substituents that are electron withdrawing by inductive and resonance effects are deactivating and <i>meta</i>-directing; the substituents that are electron withdrawing by inductive effects and electron donating by resonance are <i>ortho</i>- and <i>para</i>-directing and depending on the electron-density balance are deactivating (halides) or activating (O in ethers, N in amines or amides); the substituents that are electron donating by inductive and resonance (hyperconjugation) effects are activating and <i>ortho</i>- and <i>para</i>-directing</li> </ul>

### Reaction 27. Oxidation of side chains in aromatic compounds.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>• <math>\text{KMnO}_4</math> or <math>\text{Na}_2\text{Cr}_2\text{O}_7</math></li> </ul>	<ul style="list-style-type: none"> <li>• complex oxidation mechanism</li> <li>• requires at least one benzylic hydrogen</li> </ul>

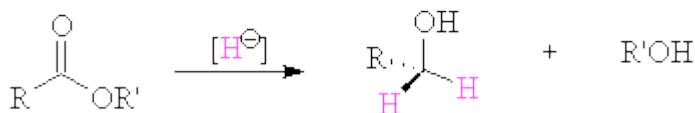
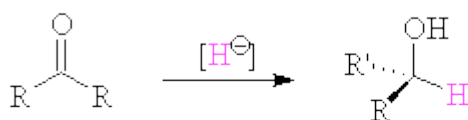
**Reaction 28. Hydrogenation of aromatic compounds.**



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• H<sub>2</sub> (several hundred atm) over Pd</li><li>• H<sub>2</sub> (1 atm) over Rh</li></ul>	<ul style="list-style-type: none"><li>• heterogeneous catalysis with a complex mechanism</li><li>• no partial reduction possible</li></ul>

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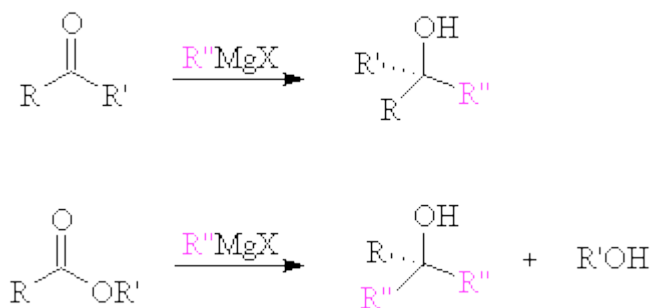
**Reaction 29. Reduction of carbonyl compounds to alcohols.**



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>• NaBH<sub>4</sub> (or LiAlH<sub>4</sub>) for aldehydes and ketones</li><li>• LiAlH<sub>4</sub> for carboxylic acids and esters</li><li>• BH<sub>3</sub>-THF for carboxylic acids</li></ul>	<ul style="list-style-type: none"><li>• the hydrides deliver H<sup>-</sup> to the carbonyl-group carbon (nucleophilic addition to C-O double bond)</li><li>• for carboxylic acids and their derivatives, the tetrahedral intermediate formed loses R'O<sup>-</sup> group, and the newly formed carbonyl group is reduced again</li></ul>

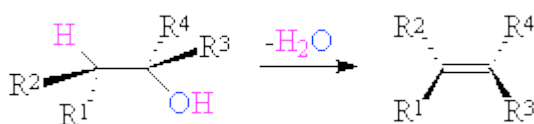
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**Reaction 30. Addition of Grignard reagents to carbonyl compounds to yield alcohols.**



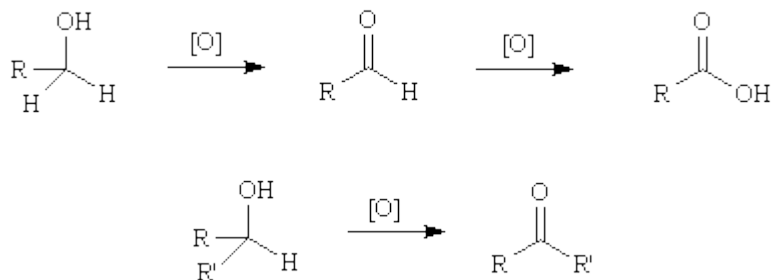
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>Grignard reagents are prepared by reacting organic halides with metallic magnesium in ether solvents</li> <li>usually carried out in ether solvents (ether, THF)</li> <li>organolithium compounds (RLi) can be used instead of Grignard reagents</li> </ul>	<ul style="list-style-type: none"> <li>nucleophilic addition of electron-rich (carbanion-like) carbon from the organometallic reagent to the electrophilic carbon of the carbonyl group</li> <li>the addition to esters takes place twice; the initially formed tetrahedral intermediate expels <math>\text{RO}^-</math>, regenerating the carbonyl group which reacts with the second molecule of the organometallic reagent</li> </ul>

**Reaction 31. Dehydration of alcohols.**



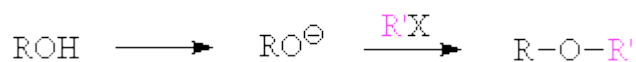
Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"> <li>acid with a non-nucleophilic counterion (<math>\text{H}_2\text{SO}_4</math>) for tertiary substrates</li> <li><math>\text{POCl}_3</math>/pyridine for <math>2^\circ</math> and <math>1^\circ</math> alcohols</li> </ul>	<ul style="list-style-type: none"> <li>E1 mechanism for tertiary alcohols</li> <li>E2 mechanism for <math>\text{POCl}_3</math>/pyridine (<math>\text{POCl}_3</math> converts <math>-\text{OH}</math> into a good leaving group: <math>-\text{OPOCl}_2</math>)</li> <li>usually Zaitsev's rule followed (see Reaction 25)</li> </ul>

### Reaction 32. Oxidation of alcohols.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>PCC (pyridinium chlorochromate) for oxidation of 1° alcohols to aldehydes (2° alcohols are oxidized to ketones with PCC)</li><li>Jones' reagent (<math>\text{CrO}_3/\text{H}_2\text{SO}_4/\text{H}_2\text{O}/\text{acetone}</math>) or dichromate (<math>\text{Na}_2\text{Cr}_2\text{O}_7</math>) for oxidation of 1° alcohols to carboxylic acids and 2° alcohols to ketones</li></ul>	<ul style="list-style-type: none"><li>E2-like elimination on chromate intermediate</li></ul>

### Reaction 33. The Williamson ether synthesis.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>alkoxides are prepared by reaction of alcohols with bases or alkali metals</li><li>reaction of alkoxides with primary alkyl halides</li><li>intramolecular reaction yields cyclic ethers</li></ul>	<ul style="list-style-type: none"><li><math>\text{S}_{\text{N}}2</math> substitution reaction with oxygen serving as nucleophile</li></ul>

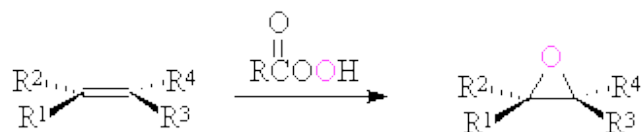
### Reaction 34. Acidic cleavage of ethers.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>HI or HBr for 1° and 2° ethers</li><li>HI, HBr and HCl for 3° ethers</li></ul>	<ul style="list-style-type: none"><li><math>\text{S}_{\text{N}}2</math> for primary ethers (after protonation on oxygen, attack by <math>\text{X}^-</math> on the least substituted of the two carbons)</li><li><math>\text{S}_{\text{N}}1</math> for tertiary, benzylic or allylic ethers (after</li></ul>

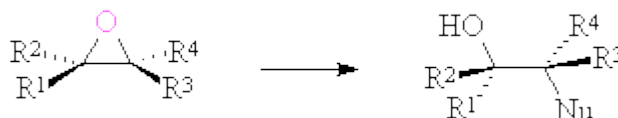
protonation on oxygen)

### Reaction 35. Synthesis of epoxides with peroxyacids.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>peroxyacids (RCOOH, for example <i>m</i>-chloroperoxybenzoic acid)</li></ul>	<ul style="list-style-type: none"><li>direct oxygen transfer from the peroxyacid to the alkene (syn stereochemistry)</li></ul>

### Reaction 36. Ring-opening reactions of epoxides.



Reagents and conditions	Mechanistic details
<ul style="list-style-type: none"><li>acid catalysis (H<sub>2</sub>O, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup> as nucleophiles)</li><li>direct nucleophile addition (HO<sup>-</sup>, RO<sup>-</sup>, RNH<sub>2</sub>, R<sub>2</sub>N<sup>-</sup>, RMgX)</li></ul>	<ul style="list-style-type: none"><li>under acid catalyzed conditions the protonated epoxide can be attacked by the nucleophile at the more (usually the major site of attack), or the less substituted site, depending on substitution patterns (anti stereochemistry results)</li><li>direct nucleophilic attack (S<sub>N</sub>2) takes place at the least substituted carbon (anti stereochemistry results)</li></ul>