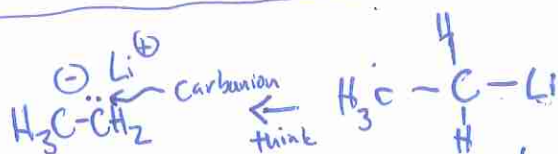


Names for Molecules that Make Bonds

Nucleophiles → e^- rich → lone pairs, π -bonds (organometallic)
 ↳ think \ominus / δ^-

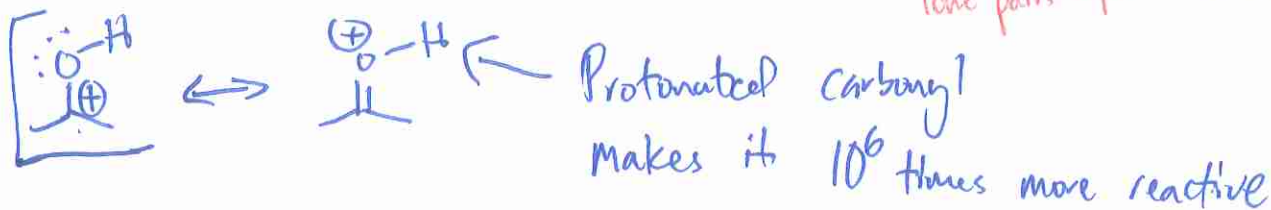
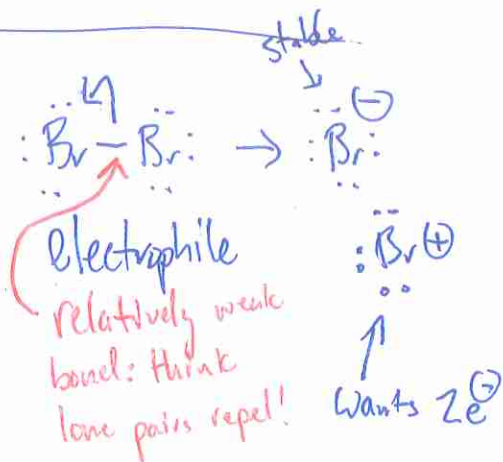
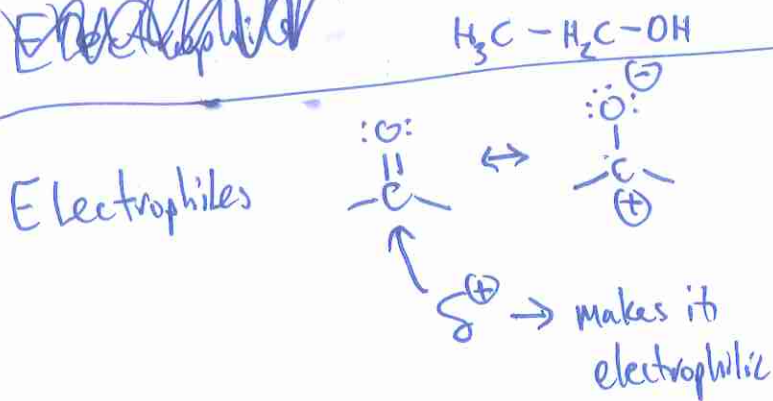
Electrophiles → e^- poor → like to make bonds w/ nucleophiles
 ↳ think \oplus / δ^+
 can accept e^-

Examples

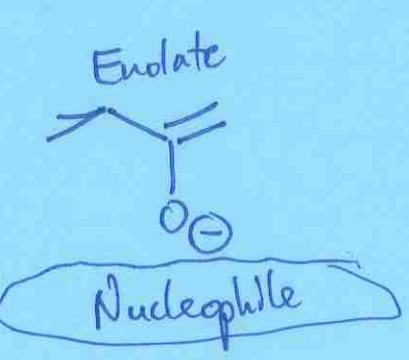
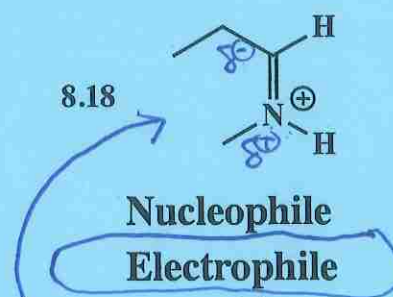
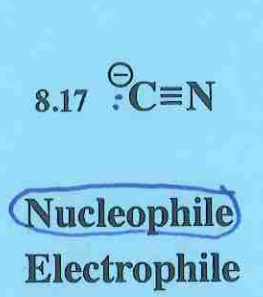
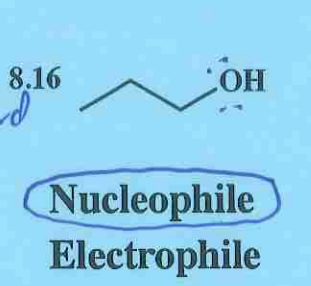
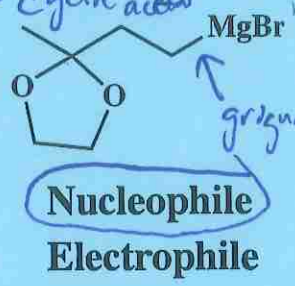
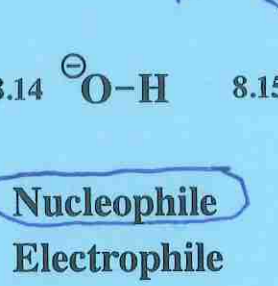
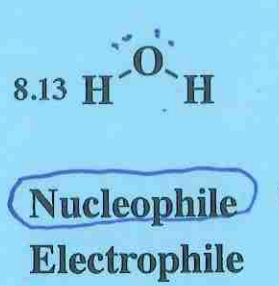
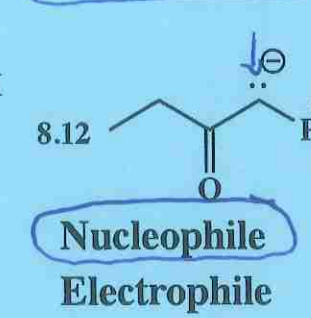
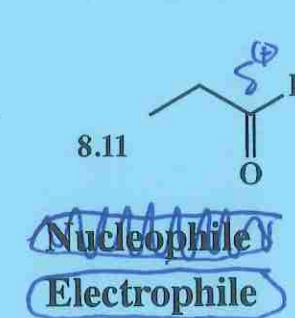
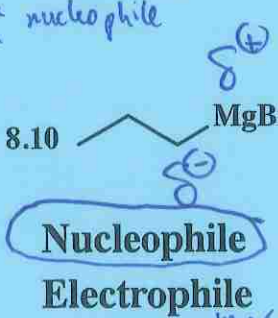
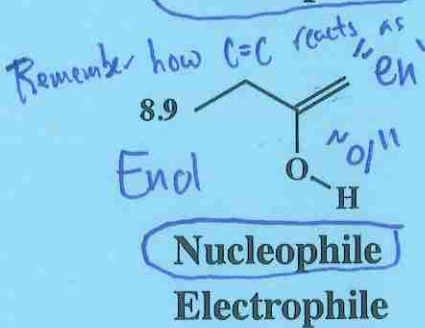
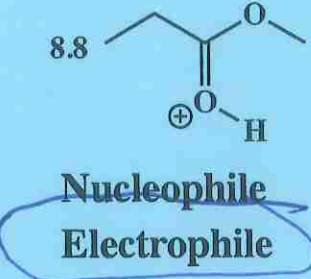
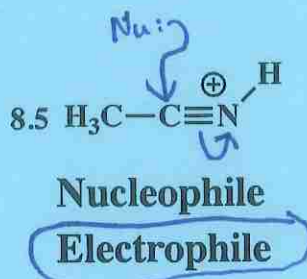
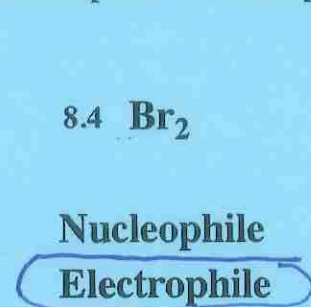
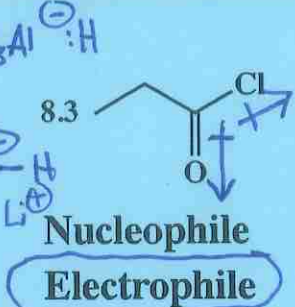
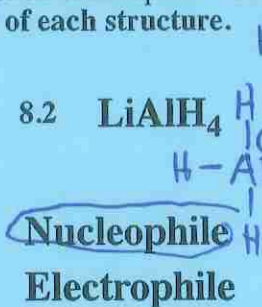
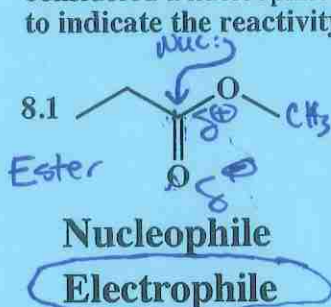


Nucleophile $H_2O:$, ROH (alcohol), NH_3 , RNH_2 , $H_2C=CH_2$, $MgBr$, $CuLi$
 $R = -CH_2CH_3$ for ethanol

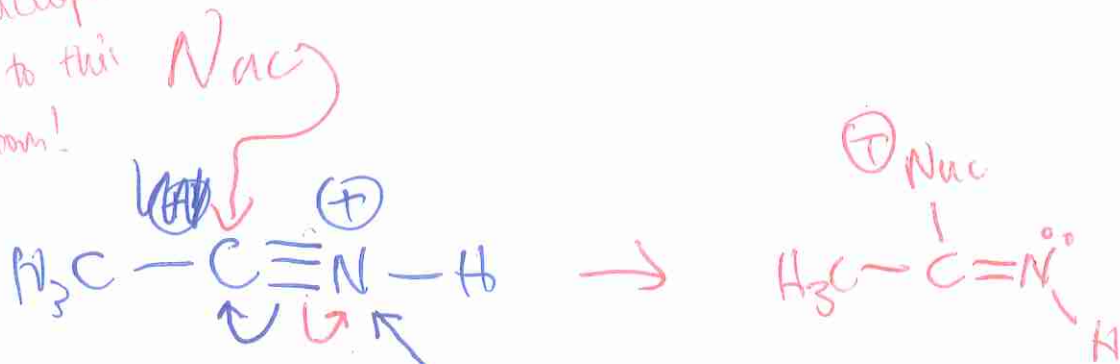
~~Electrophiles~~



8. (18 pts) In a bond-making step of a reaction, a nucleophile donates the electron pair that will make the new bond, and an electrophile accepts the electron pair in the process. The following species are either nucleophiles or electrophiles in reaction mechanisms we have learned. Note for this problem we are ignoring any proton transfer steps, we are just interested in whether the following can best be considered a nucleophile or an electrophile. **ON THIS PAGE CIRCLE "nucleophile" or "electrophile" to indicate the reactivity of each structure.**



Nucleophiles
will add to this
C atom!

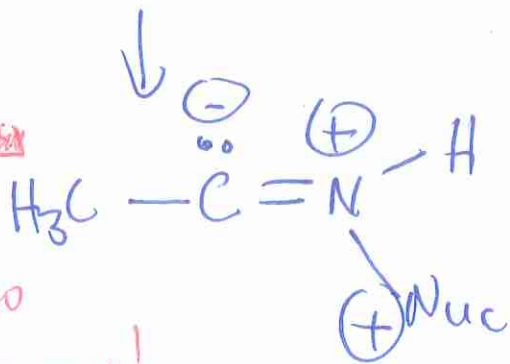


Nuc:

Nucleophiles won't
add to the N atom

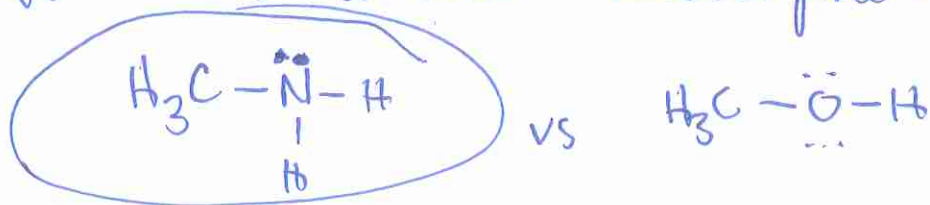
Very
unstable \rightarrow so

this won't happen!



Carbocation,
two \oplus !

Which is a better nucleophile?

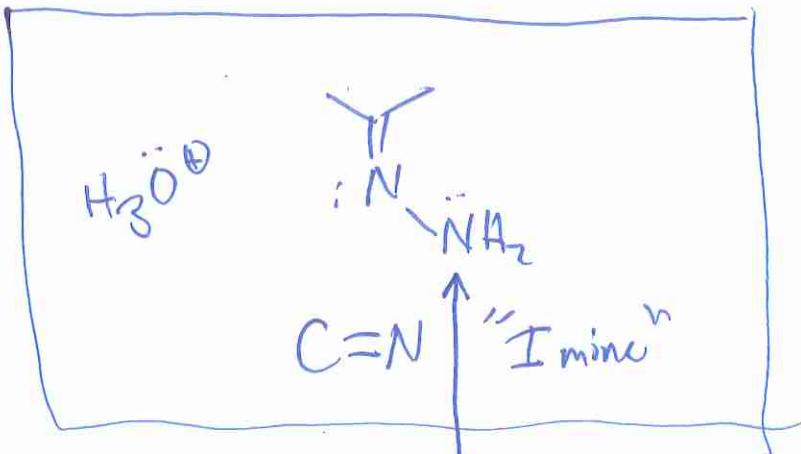
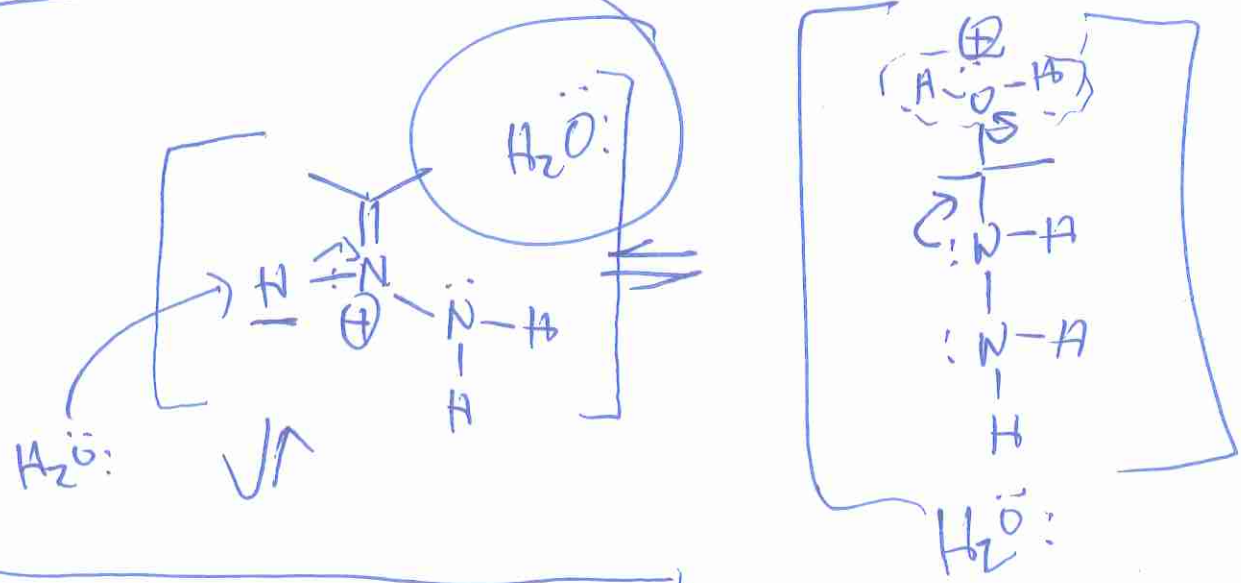
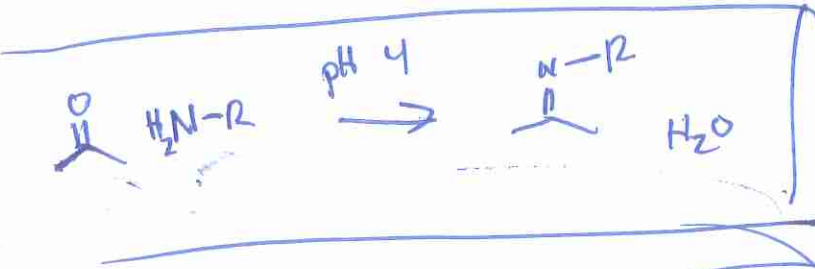
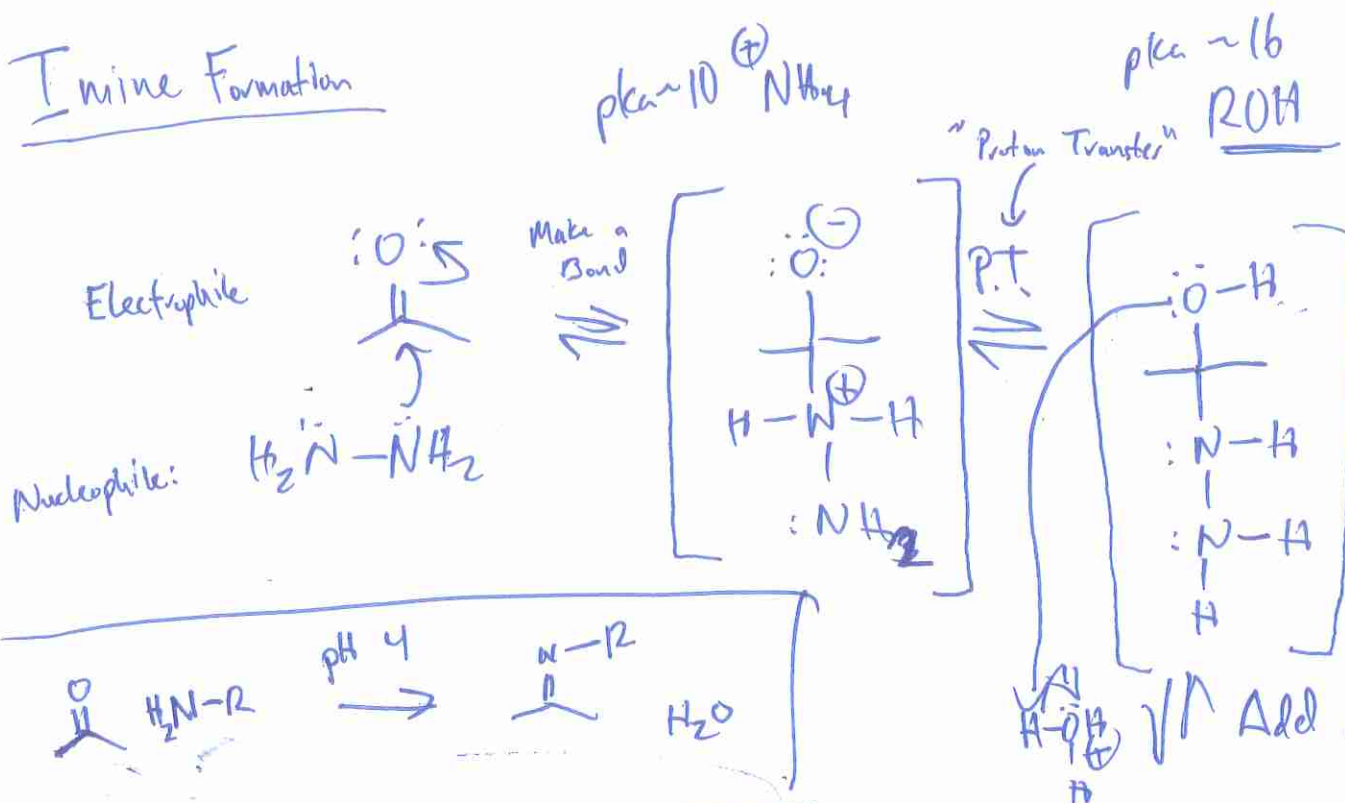


Both neutral? Yes.

O atom is more electronegative

\downarrow
doesn't "want" to give away
 e^- s as much as "less greedy"
(less electronegative) N atom

Imine Formation



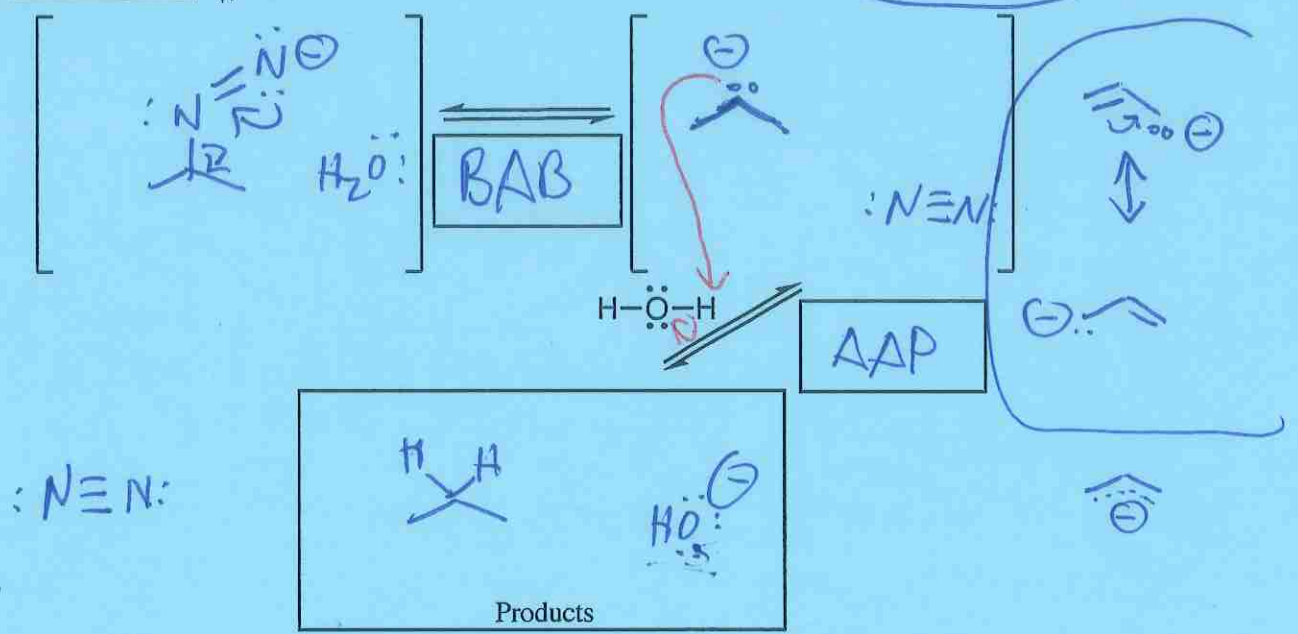
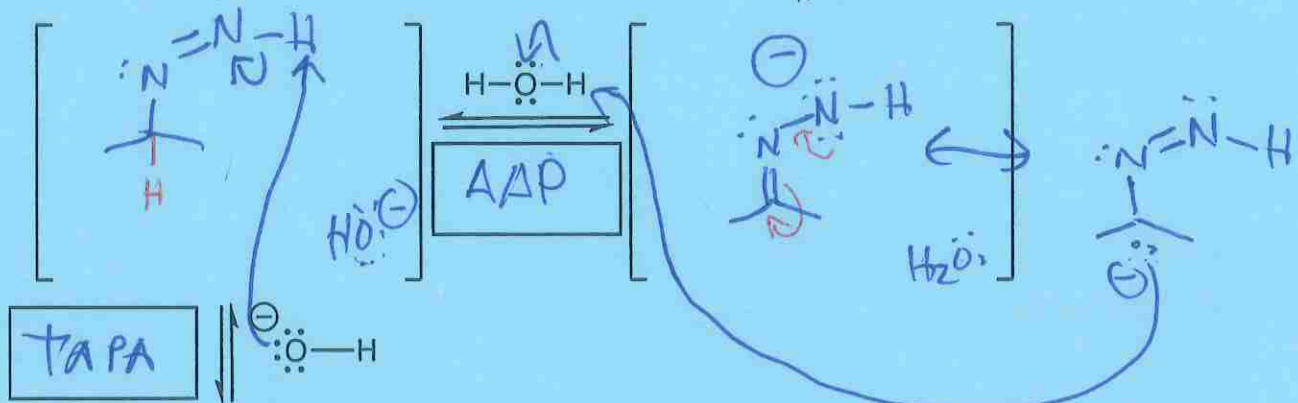
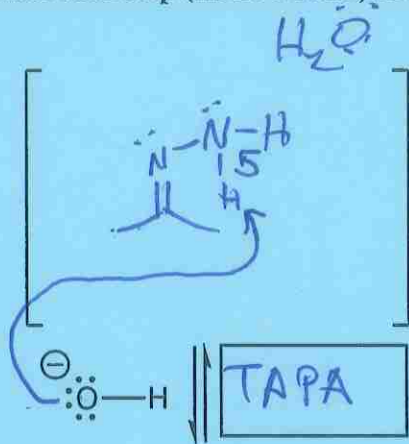
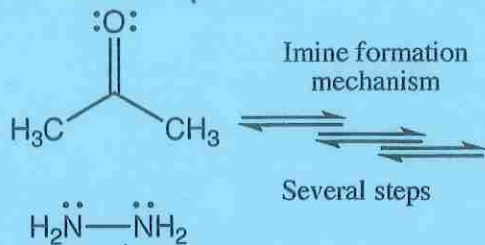
Special name for Imines when this group is an "-NH₂"
↳ "Hydrazone"

Note I drew the last "Step" as happening in two steps (departure of LG then deprotonation) - this is a reasonable mechanism but different than what we did in class - see your packet and ask questions!

16. (34 pts) Complete the mechanism for the following Wolff-Kishner reaction. **Be sure to show arrows to indicate movement of all electrons, write all lone pairs, all formal charges, and all the products for each step.** Remember, I said all the products for each step. **IF A NEW CHIRAL CENTER IS CREATED IN AN INTERMEDIATE OR PRODUCT, MARK IT WITH AN ASTERISK AND LABEL THE MOLECULE AS RACEMIC IF APPROPRIATE.** In the boxes provided, write which of the 4 mechanistic elements describes each step (make a bond, break a bond, etc.).

4

No need to draw arrows on these two structures



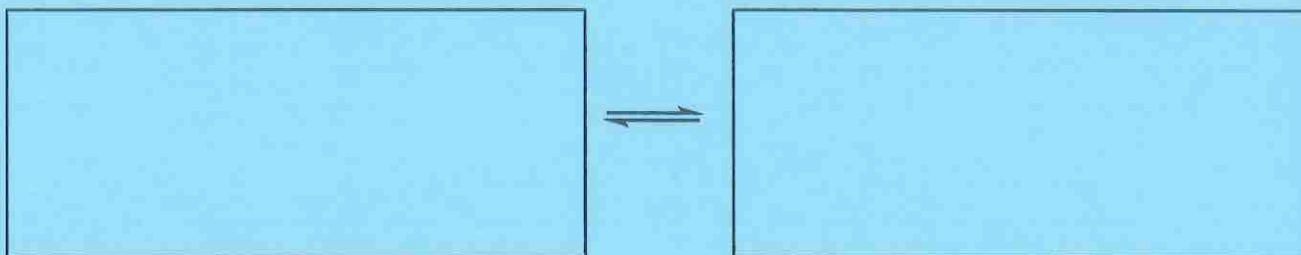
Note you will have to write a balanced equation for the above mechanism on PAGE 11

Signature _____

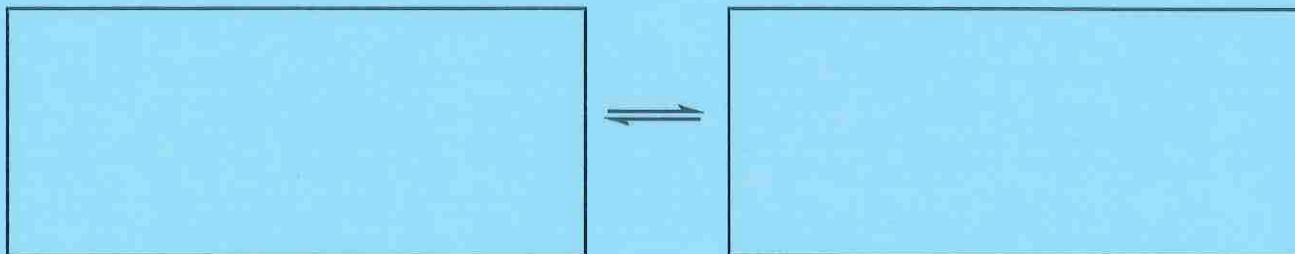
Pg 11 _____ (14)

17. (14 pts) Write BALANCED equations for the three mechanisms, 1-3, that you drew on the last three pages. Only include molecules consumed or created during the reactions. In other words, DO NOT SHOW CATALYSTS IN EITHER BOX!

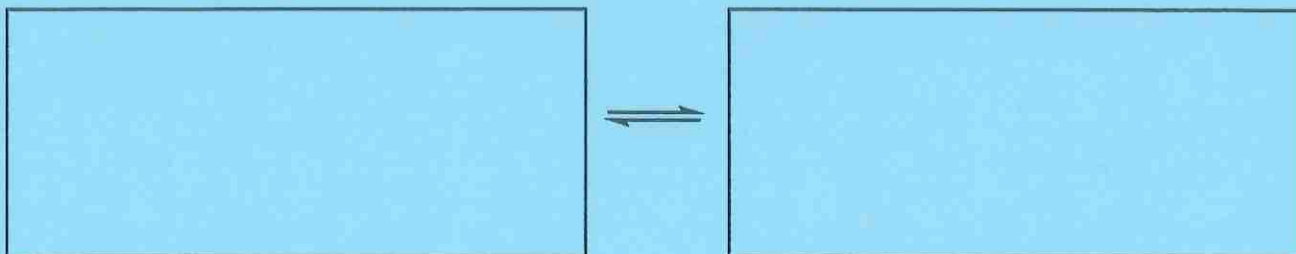
Write a balanced equation for the overall process described by mechanism 1 from page 8



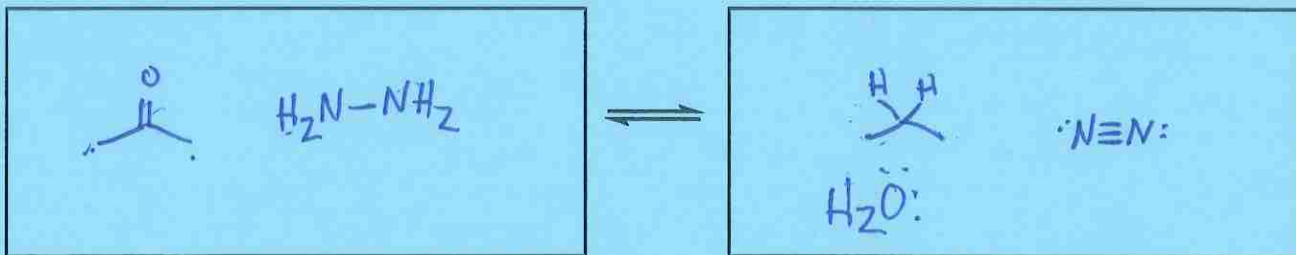
Write a balanced equation for the overall process described by mechanism 2 from page 8



Write a balanced equation for the overall process described by mechanism 3 from page 9



Write a balanced equation for the overall process described by mechanism 4 from page 10



3C
 2N
 10H
 1O

3C
 2N
 8H
 0O

Missing $2\text{H} \cdot 10 \rightarrow \text{H}_2\text{O}$ lost from imine formation

Neutral Charge Neutral

Check out this handout → Website under "Things you need to know" ↓

Lewis Bases, Lewis Acids, Brønsted-Lowry Bases, Brønsted-Lowry Acids, Nucleophiles and Electrophiles

Electron-Rich Molecules

Quick summary An electron-rich molecule is called:

A **Lewis base** when the bond being made is a dative or coordinate bond (in other words relatively weak so that it repeatedly forms and dissociates at or near room temperature).

A **Brønsted-Lowry base** when the bond being made is to a proton.

A **nucleophile** when the bond being made is a covalent bond in the product.

Nucleophiles, Bases, Electrophiles, Acids

Let us take a closer look at related concepts and terminology. One of the key principles of organic chemistry is that molecules with electron-rich areas (partial or full negative charge), generally lone pairs of electrons or in some cases specific bonds such as the pi bonds of alkenes, have important and characteristic patterns of reactivity. Such electron-rich species are described by three different but related terms depending on the type of bond being made and this can be confusing at first.

1. The most general description of an electron-rich species is as a **Lewis base** (Section 4.7 of the book). Being electron-rich, **Lewis bases** will react with electron-deficient atoms of various types, and the ions or molecules containing such electron-deficient atoms are referred to as **Lewis acids**. Although some chemists still refer to virtually all electron-rich species as **Lewis bases**, we will restrict use of the term to situations in which the bond being made is a so-called dative or coordinate bond, in other words, a relatively weak type of bond that repeatedly forms and dissociates at or near room temperature. It might be a good idea to review **Lewis acids** and **Lewis bases** in Section 4.7 of the book before proceeding. The new species held together by the coordinate bond is commonly referred to as a **Lewis acid-Lewis base** complex.
2. When the reaction is with a proton source (a **Brønsted-Lowry acid** such as HCl) so that the new bond is being made to a proton, the electron-rich molecule should be referred to as a **Brønsted-Lowry base** (Section 4.2 of the book) to indicate the reaction being discussed is a proton-transfer reaction.
3. A third important context involves the discussion of reaction mechanisms in which an electron-rich species such as an atom with a lone pair or the pi bond of an alkene reacts with a variety of reagents to make a new covalent bond. Covalent bonds are so stable that once formed in the final product they are considered "fixed", in other words, they do *not* repeatedly form and dissociate at or near room temperature. For example, it will be a covalent bond if it forms between C, N, O and H atoms among others. There is an emphasis on "final" in final product. A nuance here is that some of these bonds may *reversibly* form during a reaction mechanism in the context of a high-energy reaction intermediate, but in the *final* product they will become "fixed" covalent bonds. When discussing reaction mechanisms and a new covalent bond is formed between an electron-rich atom or bond and an electron-deficient atom, we refer to the electron-rich species as the "**nucleophile**" and the electron-deficient species as the "**electrophile**". *The source of the arrow that*