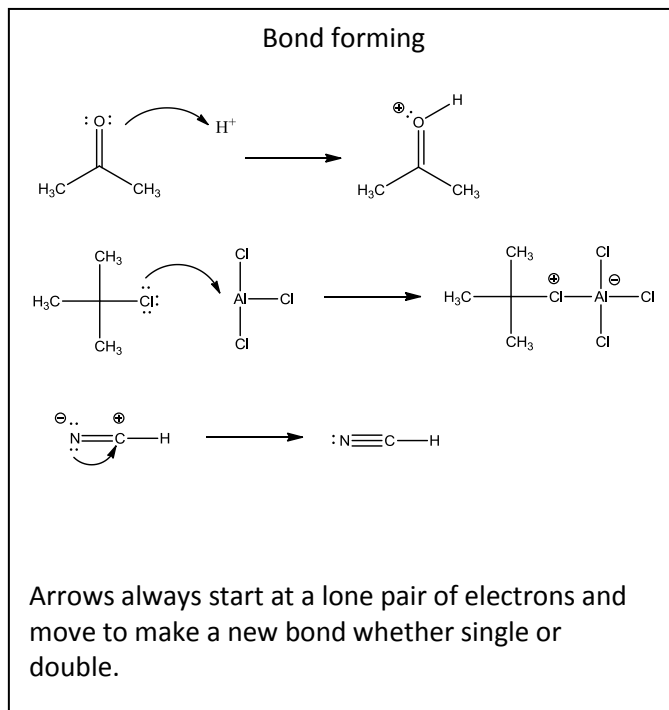
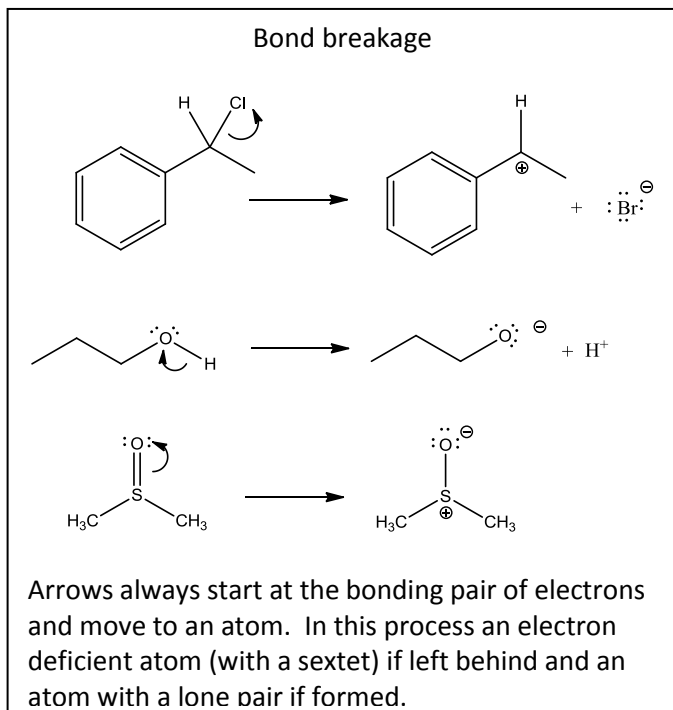


## Use of Electron Pushing Arrows in Organic Chemistry

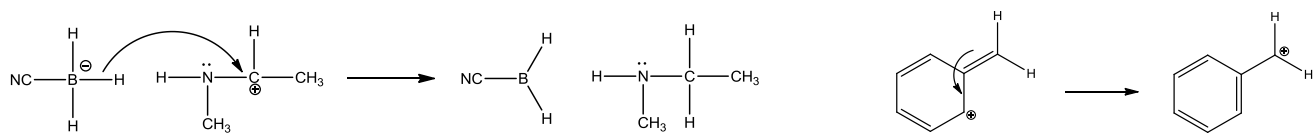
The use of electron pushing arrows in organic chemistry is vital for understanding chemical reactions. When used in resonance structures electron pushing arrows help us keep track of formal charges and bonding. In chemical reactions we are able to understand bond breaking and bond forming.

Let us consider bond breaking and bond formation and how electron pushing arrows are used:

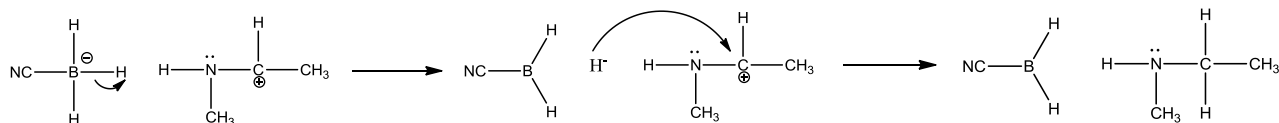


In each of the cases just seen electron movement makes the starting atom increase one formal charge unit and the terminal atom increase in one negative charge.

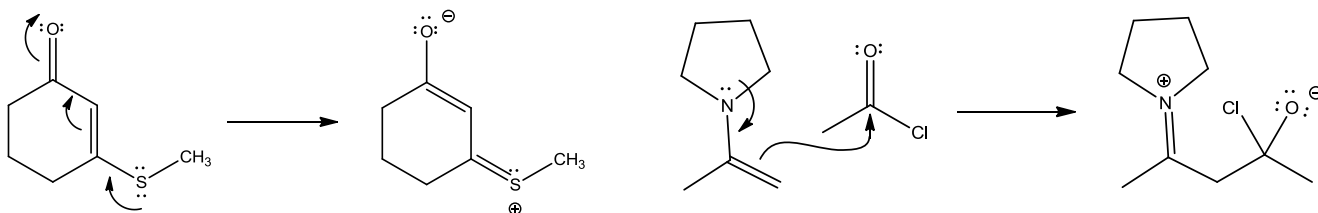
Sometimes we shorten a reaction process by showing one bond formation.



When in reality it may be the reaction occurs as a two stage process of bond breakage and bonding forming.

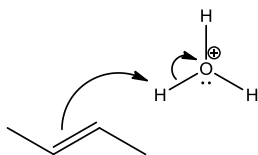


It is important to keep track of the bond breakage and bond forming process because a pair of electrons may end up on an atom that already has a complete octet. If the process cannot rearrange electrons to regain their full octet then the process is not logical. On the other hand, if a series of electron movements can be strung together then only the first and last atoms of the series will change their number of bonds (see below).

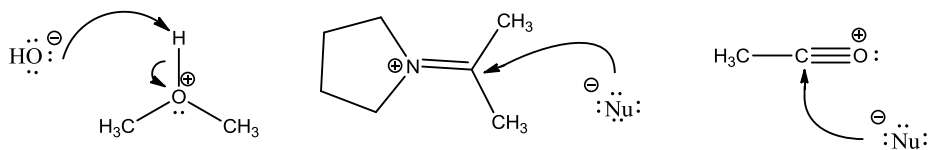


### Things to watch for when writing electron pushing

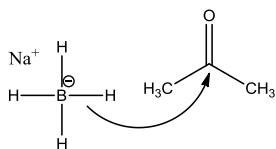
- Draw all the atoms attached to an atom undergoing a transformation. (Check for any violations of the Octet Rule.)
- Always draw arrows in the right direction, that is, from electron donor to electron recipient. Therefore in this scenario double bonds attack hydrogen ions (or better H attached to solvent, etc).



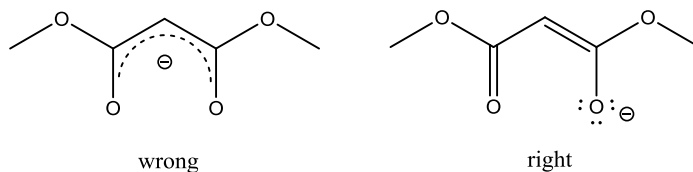
- Electron deficiency and positive charge should be clearly distinguished. Example, an ammonium ion which has a positive charge is not electrophilic at the nitrogen atom. In each of the ions shown below the positively charged oxygen and nitrogen atoms are not the electrophilic species. The neighboring atoms to these charged ions are the ones being attached by nucleophiles/bases.



- Conversely, check for formal negative charges and lone pairs of electrons. The pair of electrons to make a bond comes from the sigma bond,  $\sigma$ , attached to the atom that has the formal negative charge.

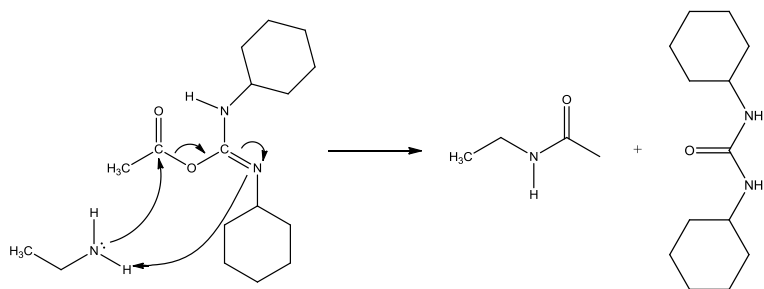


- For structures that exhibit resonance do not use the “hybrid” form. Usually these do not show electron pairs or bonds.



- Mechanisms written with a continuous series of arrows is discouraged. It is often that a mechanism of a chemical reaction contains an intermediate. You should be able to include the intermediate in your mechanism.

Incorrect:



The actual mechanism involves several steps:  
 a) Nucleophilic attack on the carbonyl.  
 b) Collapse of the alkoxide to an  $sp^2$ -carbon and release of DCC.  
 c) Acid-base reaction.

Correct:

