

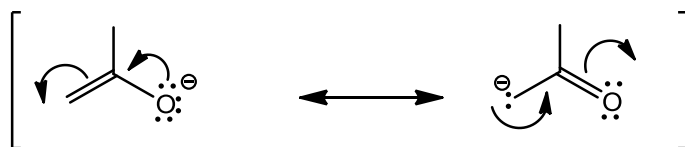
ELECTRON FLOW

- Resonance**

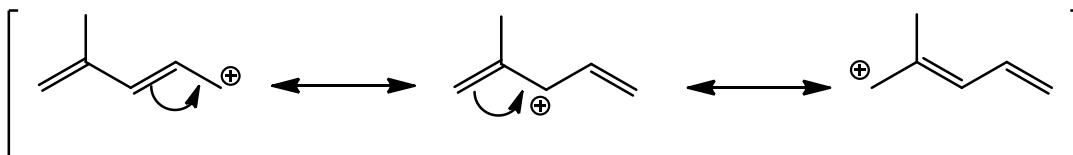
Resonance is possible whenever a Lewis structure has a multiple bond (for example, C=C) and an adjacent atom (Q) where Q has at least one lone pair or is part of a multiple bond or has a charge (positive or negative). We say that the multiple bond (such as a double bond) is conjugated (separated by a single bond) to the atom Q. The properties of such molecules or polyatomic ions show that the multiple bond and the single bond in such a molecule do not behave as a multiple or single bond. The actual structure of such species is the resonance hybrid.

Scientists have developed a model whereby we can interpret these species as if they are able to resonate between two or more different structures.

The following is an example for resonance in a structure with a negatively charged atom that is conjugated to a double bond. The arrows are used to show how one can represent the shifting of the electrons as the one resonance structure changes to another resonance structure. When this takes place, the bonding in the ionic species cannot be shown as a single Lewis structure – the π electrons are not bonded specifically to two atoms but are dispersed over three atoms. The delocalisation of the electrons takes place to give the following resonance or contributing structures:



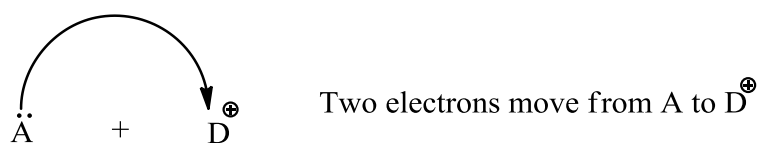
Below is an example of resonance in a structure where a positive charge is conjugated to double bonds. Once again the arrows indicate how the electrons move as one resonance structure changes to another. When this takes place the bonding of the cationic species cannot be shown as a single Lewis structure – the π electrons are not specifically bonded to four atoms but are spread over five atoms. Delocalisation of electrons take place to give resonance or contributing structures as shown:



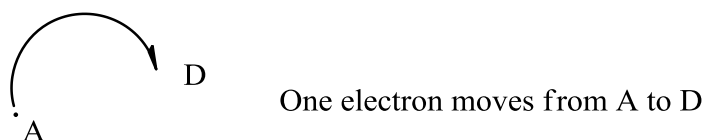
- Reaction Intermediates**

A mechanism is the series of bond-making and bond-breaking processes in a reaction. Bond-making and bond-breaking involve the flow of electrons.

Movement of two electrons: HETEROLYTIC.



The movement of one electron: HOMOLYTIC

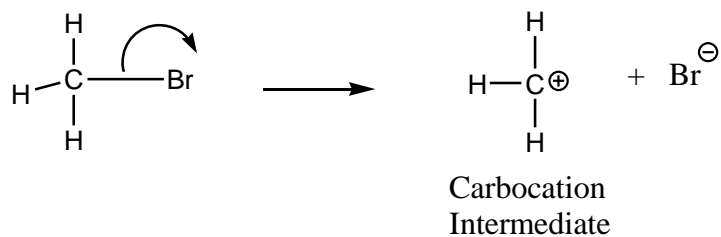


- **BOND-BREAKING:**

- (a) **Heterolytic cleavage**

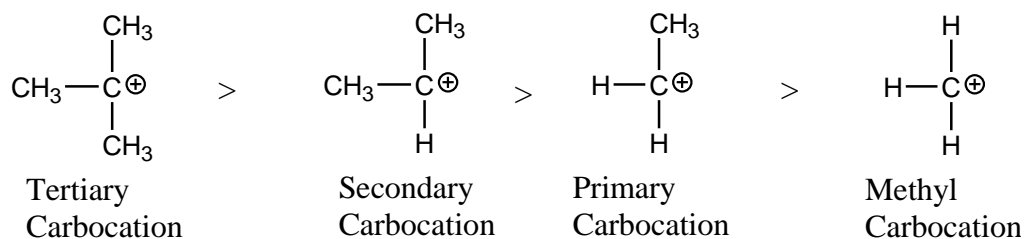
Examples of heterolytic cleavage:

1)

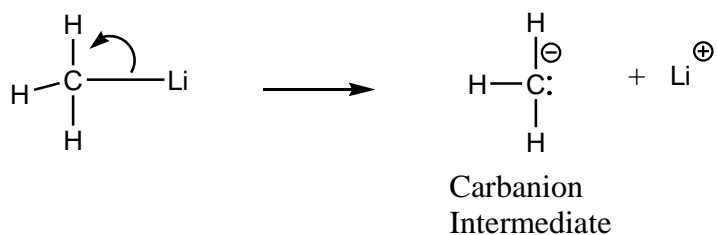


The bromine leaves with the two electrons of the bond and a positively charged carbon species is produced. Note: the charges on each side of the reaction arrow should balance: Left hand side-neutral and on right hand side the positive (+) and negative (-) charges cancel to give overall neutral charge.

Carbocation intermediate vary in stability:



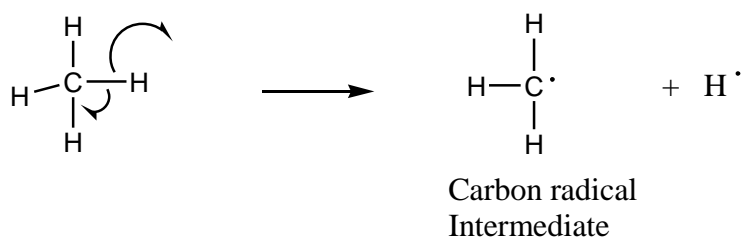
2) The bond breaks in such a manner that the two bonding electrons remain with the carbon atom giving a negatively charged species, a carbanion.



Note: Once again the charges on each side of the reaction arrow should balance.

(b) Homolytic cleavage

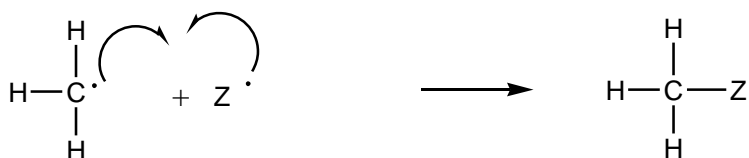
Example of homolytic cleavage:



Similar to the carbocation intermediates, the radical intermediate has different stabilities depending on the nature of the carbon atom bearing the unpaired electron. The tertiary carbon radical is more stable than the secondary carbon radical. The secondary carbon radical is more stable than the primary carbon radical and the methyl radical is the least stable.

BOND-FORMATION:

Combination of two radicals:

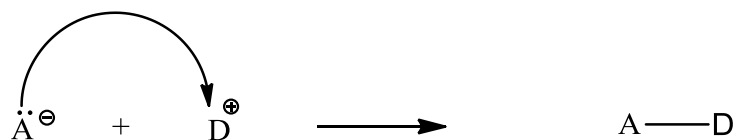


Bond –formation involving the flow of two electrons

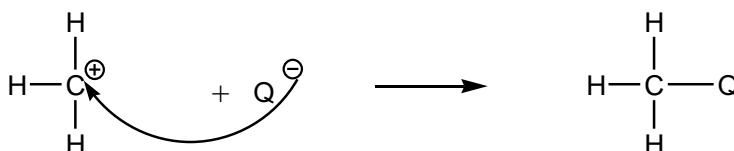
In the above process a bond is formed between the above species:



Another process involving the movement of two electrons:



Combination of a carbocation and a nucleophile:



The combination of a carbanion and an electrophile:

