



INTRODUCTION TO CURLY ARROW DIAGRAMS

Mechanisms for organic reactions, often called curly arrow diagrams, show step-by-step the movement of electrons as the reactants turn into the products.

Mechanisms have been deduced from much careful research including many carefully controlled experiments.

A double headed curly arrow represents the movement of a pair of electrons. These electrons may be from

- from a covalent bond (a bonding pair of electrons) or
- from a lone pair (a non bonding pair of electrons)

ARROW STARTING POINT

The arrow starts where the electrons come from, either

- from the middle of the covalent bond, or
- from a lone pair

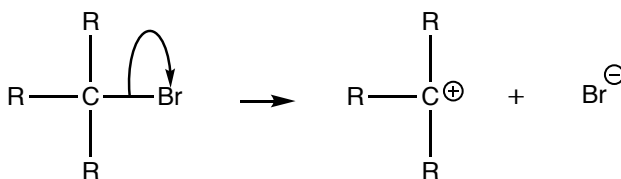


ARROW FINISHING POINT

The arrow points to where the electrons are going:

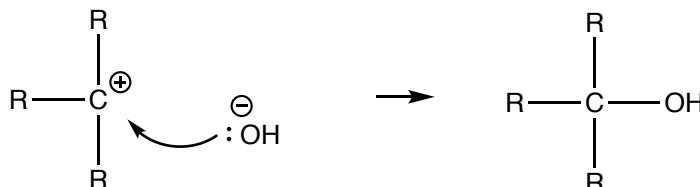
- to an atom if they are going to become an extra lone pair
- to the area between the two atoms they are going to become a bond between those two atoms
- to a single bond that will then become a double bond

Example 1

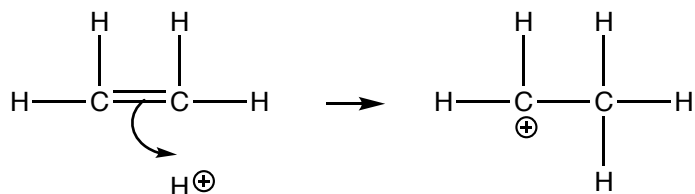


- The curly arrow goes from the middle of the C–Br bond to the Br atom.
- The two electrons in the C–Br bond are moving from the bond to the Br atom.
- This means that the bond is broken and the Br is no longer attached to the C.
- The Br atom gets both the electrons from the bond. This means it has its own electron from the covalent bond, but now also has the other electron that was originally from the C atom. This means that the Br atom has one extra electron and so has a – charge. This means the C atom has one fewer electron and has a + charge

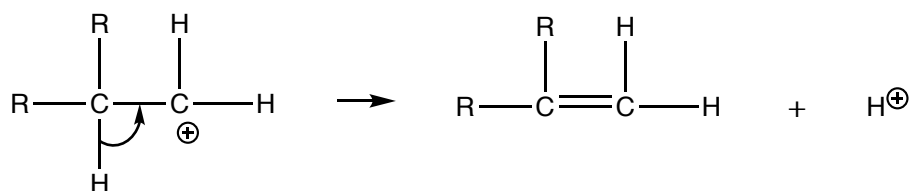
Example 2



- The two electrons in the O lone pair are going to become a covalent bond between the O atom and the C atom.
- The curly arrow goes from the lone pair on the O to the space between the C and O atoms (note 1 – we usually put the arrow head slightly closer to the atom the electrons are going towards; note 2 – the curly arrow does not start or end on any charges – they never do).
- Once the bond forms, the two electrons that were on the O are now shared between the C and the O. This means that the C effectively has one extra electron so is now neutral (was +) and the O effectively has one fewer electron so is now neutral (was –)

Example 3

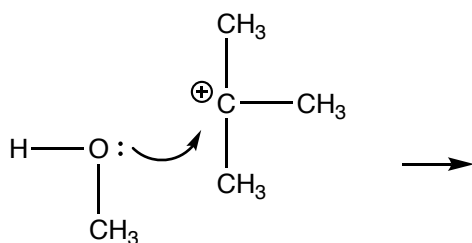
- The curly arrow goes from the middle of the C=C bond to the area between the C atom and H⁺ ion.
- The two electrons from the C=C double bond are moving from being a bond between the two C atoms to become a bond between a C atom and the H⁺ ion.
- This means that one of the two covalent bonds in C=C is broken and so that becomes a single C-C.
- The new bond is formed between one of the C atoms and the H⁺. Once the bond forms, the C atom in this new bond has not changed its number of electrons so remains neutral (was neutral). The H⁺ ion has an extra electron so is now neutral (was +). The other C atom in the double bond now has one fewer electron and so is + (was neutral).

Example 4

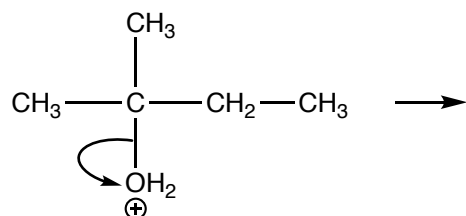
- The curly arrow goes from the middle of the C-H bond to the middle of the C-C bond.
- The two electrons from the C-H bond are moving from being a bond between the C and H atom to become a bond between the two C atoms.
- This means that the covalent bond in between the C and H is broken. Both electrons are moving to become a bond between the two C atoms and so the H atom has lost the one electron that it had originally. As it is one electron short of what it would have as an atom, it is now an H⁺ ion.
- The new bond is formed between the two C atoms. As there was already a single C-C bond, there is now a double C=C bond. The left hand C atom still has the same number of electrons and so it is still neutral. The right hand C has gained an electron and so is now neutral (was +).

Draw the products of each of the following.

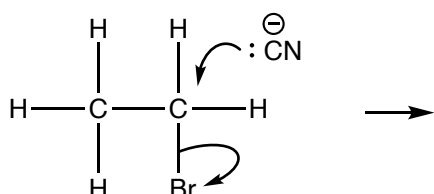
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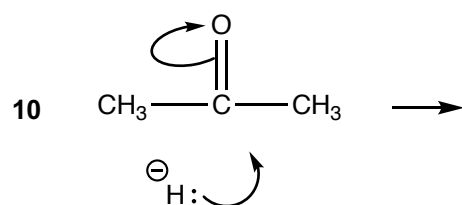
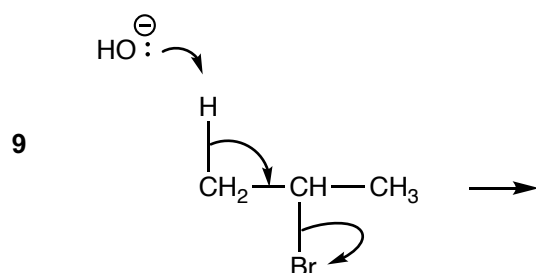
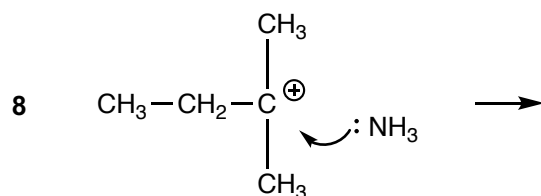
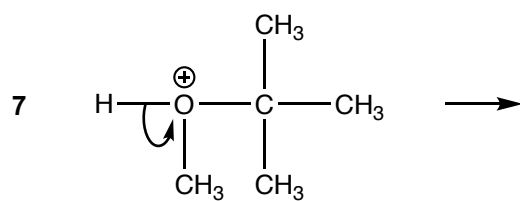
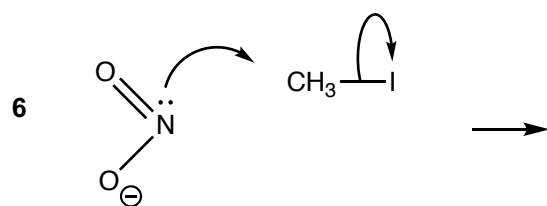
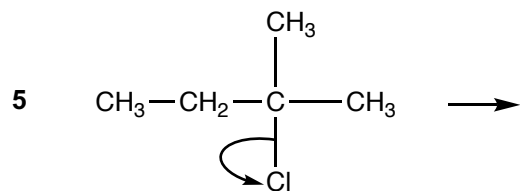
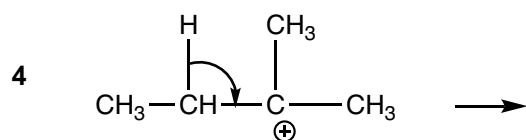


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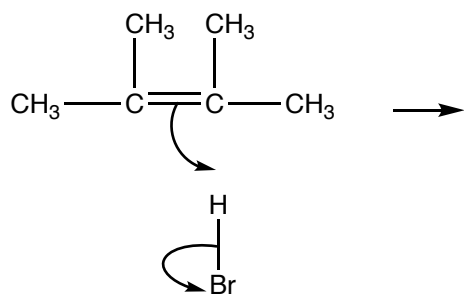


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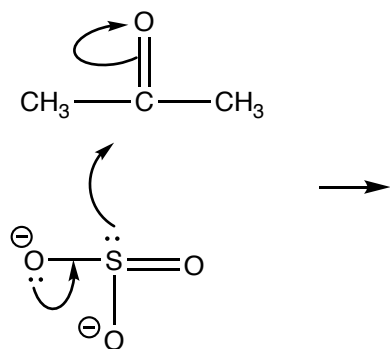




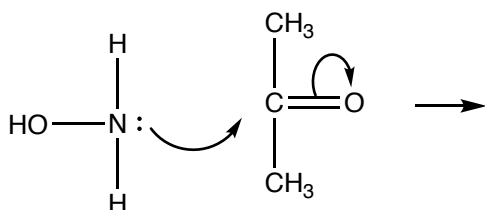
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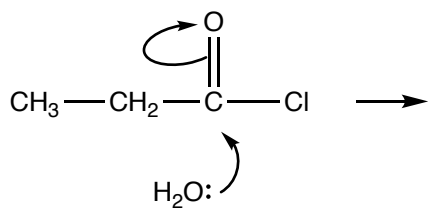
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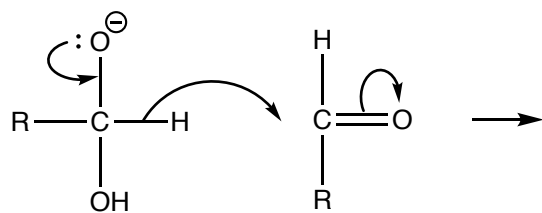
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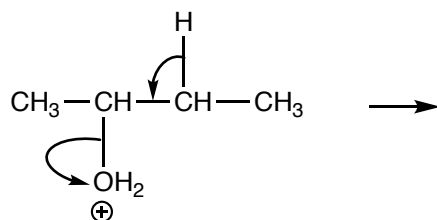
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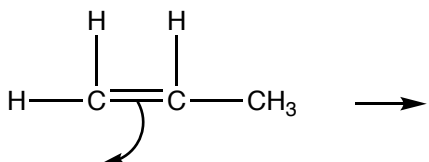


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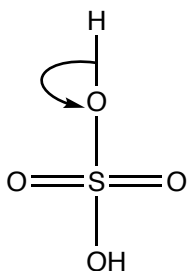


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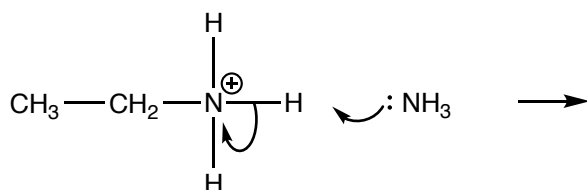




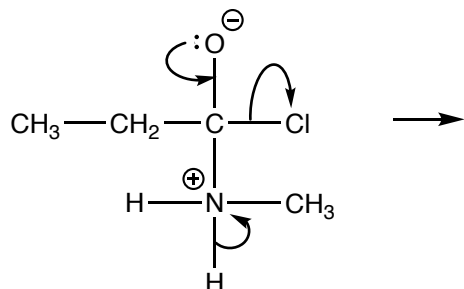
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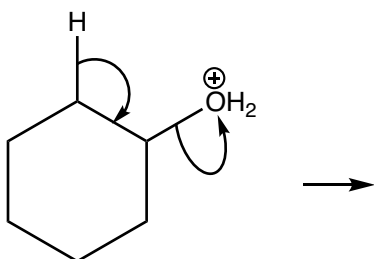
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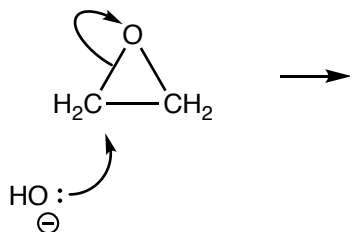
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