Chemical Arrows:

When should I use what kind of arrow?!

This is a pressing question for many chemists. Arrows seem like such a straightforward symbol, but chemists use arrows to represent movement, processes and important chemical functions. Each arrow has a distinctive purpose and meaning; using one improperly changes the meaning of your conclusions, confuses your fellow chemists, and may make your work incorrect.

There are several types of arrows, however the ones covered here are the arrows you are most likely to come across, if you haven’t already, in your chemistry career.

1. **The chemical reaction arrow**
   
The reaction arrow is used most frequently and indicates a reaction occurring from the reactants to the products. The arrow’s head points in the direction the reaction proceeds in.

2. **The equilibrium arrow**
   
The equilibrium arrow is a combination of two, half headed arrows facing in the opposite direction to reflect the chemical reaction is a reversible reaction. It symbolizes equilibrium. *Sometimes, but rarely, equilibrium arrows are two full-headed arrows as this was how they were originally drawn.*

   Often, one of the two half headed arrows is drawn longer than the other. If the arrow pointing towards the reactants is longer than the arrow pointing to the products, it reflects that the reaction will reach equilibrium when there are more reactants than products present in the reaction. If the arrow pointing to the products is longer, it shows the reaction reaches equilibrium when there are more products present.

3. **The clockwise and anti-clockwise arrows**
   
These arrows are used to describe a molecule, as either R or S is stereochemistry. The R means *rectus* and represents the arrow traveling in a clockwise direction; the S stands for *sinister* and represents the arrow traveling in the anti-clockwise direction. The tail of the arrow starts at the atom in the molecule with the highest assigned priority (refer to stereochemistry for assigning priority) and travels in the circular direction based on
descending priority groups. The full-head points back to the molecule with the highest priority.

4. **The wavy arrow**

The wavy arrow is used to symbolize the presence of a photon, or a type of energy transfer or emission. The arrow has a full head, the tail is obviously wavy, and it is pointing in the direction the energy is traveling. When the curvy arrow is pointing down, it often depicts the decline of a molecule’s energy as it moves from a higher energy level to a lower one, such as if the molecule was decaying.

5. **The curved electron arrangement arrow**

The curved arrow represents the movement of electrons in a molecule. The tail of the arrow starts where the electron pair begins or is originally stationed in the drawing. The head of the arrow points to the location, or destination, of where the electrons are being moved to. A full-headed arrow means the transfer of an electron pair; a half-headed arrow represents the transfer of one single electron. The half-headed curved arrow is sometimes referred to as a ‘fishhook’ arrow. As we have seen, electron curved arrows are important for understanding resonance, how radicals are created, and electron movement in a reaction.

*Look below for what other arrow this example uses!*
6. **The resonance arrow**

The resonance arrow is useful for showing relation between two resonance contributors of a molecule that differ by electron arrangement. The arrow is a single, straight, double headed arrow, with one full head on each side.

![Resonance Arrow](image)

7. **The dipole moment arrow**

The dipole moment arrow illustrates the direction of a dipole moment a molecule. It is a straight, full-headed arrow; however, at the end of the tail there is a “+” sign. The head points to the more electronegative atom in the molecule (the atom with the stronger dipole moment), and the “+” sign is placed near the less electronegative, or electron deficient, atom.

![Dipole Moment Arrow](image)

8. **Orbital occupying electrons**

When drawing electrons that occupy energy orbitals (i.e. to show hybridization), the electrons are represented with half-headed arrows. The arrows’ heads point straight up and down. When indicating that two electrons occupy the orbital, one of the arrows points up and the other points down. To indicate only one electron occupies the orbital, only one arrow pointing up is drawn.

![Orbital Occupying Electrons](image)

Credits: Google for images, and http://www.ias.ac.in/resonance/January2010/p51-63.pdf for information