

A Twelve-Step Program for Arrow Pushers

Adapted from Prof. K. A. Woerpel and C. J. Douglas

1. Electrons flow from sites of high electron density to sites of low electron density.
2. Balance the Equation: it really helps.
3. Don't violate the basic rules of physics.
 - a. Conservation of mass and energy (a corollary to step 2)
 - b. Conservation of charge (a more common error than you might think)
4. Three Arrow Rule: Don't push more than 3 arrows at one time.
 - a. Some Rules were made to be broken – this one gets broken a fair amount, but do follow it as you are starting out.
5. Draw out all intermediates.
 - a. Take your time here: a common mistake is to improperly draw an intermediate.
 - b. A 3-D depiction can be useful. Use models if necessary.
6. Use your lone pairs.
7. All steps are, in principle, reversible.
8. Contemplate your options and carry each to its conclusion before discarding.
9. The correct mechanism gives the observed product.
10. Use connectivity to tell you how the puzzle fits together.
 - a. A logical numbering system works wonders.
 - b. "Principle of least action."
11. Always identify the nucleophiles and electrophiles at every step.
 - a. At times it may be useful to substitute oxidants & reductants above.
12. Work backwards from the product to likely precursors.

Learning how to push arrows will help develop your 'chemical intuition'. These "12-steps" have been very helpful to me.

For more details, see Appendix 5 of Anselyn & Dougherty.