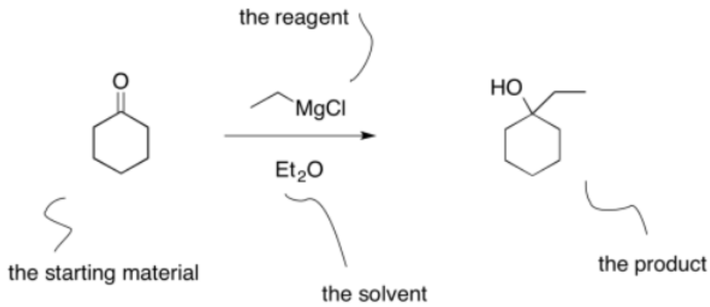
3.1: What is a Solvent?

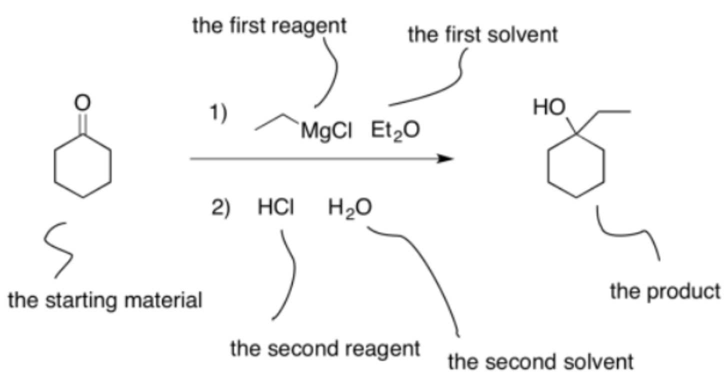
From the student's point of view, the information presented in an equation of a reaction can be confusing. The starting material and the product are linked by a straight reaction arrow. The starting material is the compound at the beginning of the reaction; the product is the compound at the end. The reagent is usually shown above the arrow. The reagent is the compound needed to turn the starting material into the product.

However, something else is often listed along with the reagent: the solvent. That can make students wonder: what does this thing do? Is it a second reaction I should be worrying about?



Students sometimes make the assumption that the reagent is written above the arrow and the solvent written below the arrow. That's a good observation, because reactions are often written that way, although there is no rule that says they have to be. However, there are exceptions in which that typical way of writing things is abandoned. Some reactions require lots of different reagents, additives, and promoters, or else there is a need to report the temperature or the pressure. In these cases, additional items are written below the arrow, just because there isn't enough room on top.

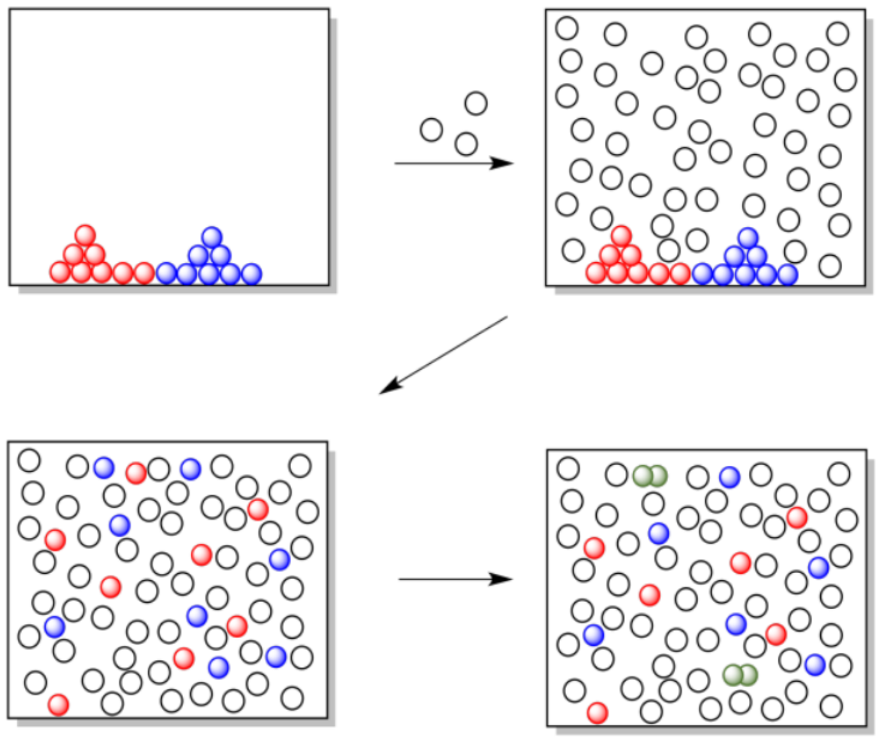
In other cases, a series of reactions are run. For example, in the above reaction it is assumed that there was an aqueous workup to neutralise the product. We might write that reaction out explicitly. In that case, the two different steps are numbered, so that we know that they were done one step at a time, rather than throwing everything in all at once.



Chemists often list the solvent in the reaction because the solvent is, practically speaking, tremendously important. Performing a reaction without solvent is a little like washing your hands without water. You could take a bar of soap and run it between your fingers, but not much will happen without the power of the water. The water dissolves up the soap (or at least suspends it in micelles), moves it around, gets it into contact with the dirt and carries it away.

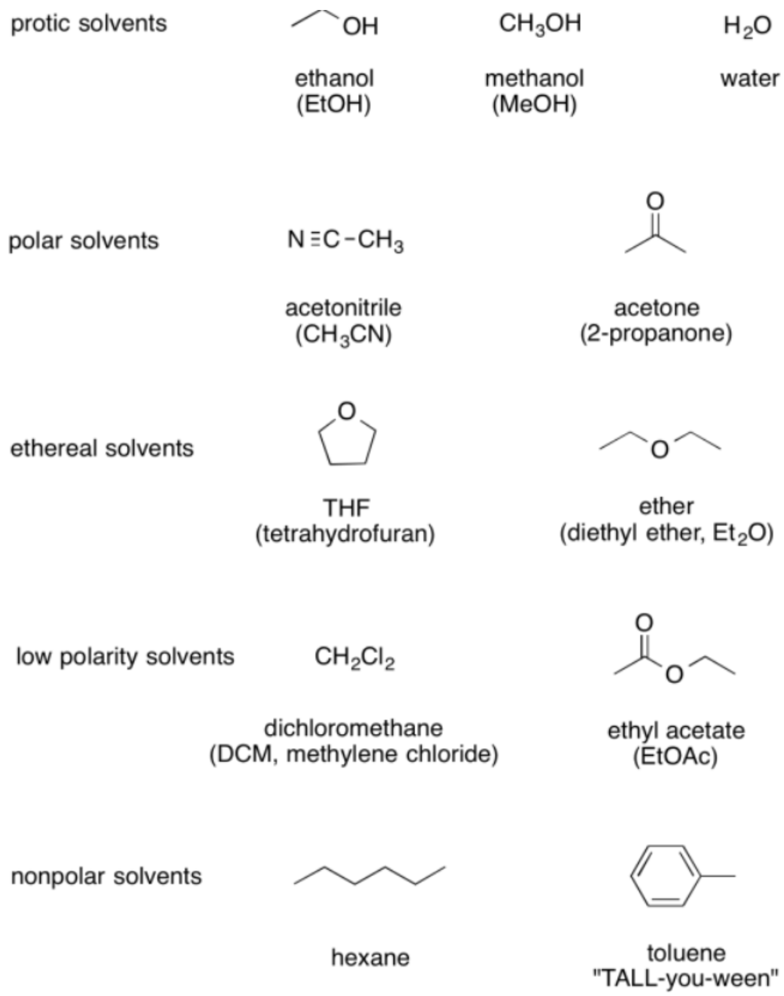
In fact, water is literally the solvent in the physical process of washing. It can be a solvent in many chemical reactions as well. The solvent has many roles to play in a reaction. Foremost, it dissolves the reactants. In that state, the reactants are very mobile. Without the solvent, the reactants may be solids, or if liquids, they may be too thick for molecules to move around very quickly; they may be more like oils. Depending on the nature of the solvent, intermediates may be stabilised, allowing them to form more easily and aiding the course of the reaction. Solvents also act like baths, moderating heat flow into or out of the reaction as needed.

In the cartoon below, nothing happens when the two reagents are dumped together. When a solvent is added, the two reagents start to dissolve, and as they move around in the solution the two reagents encounter each other and start to react.



At the beginning, you may not want to worry too much about the role of the solvent. However, you may still want to know what sorts of things are likely to be solvents, if only so that you can safely ignore them when trying to sort out how the reactant gets to the product.

The following table sums up a number of the most common solvents, displayed from most polar at the top to least polar at the bottom.



Note that, just because something acts as a solvent in one reaction does not mean it must be one in another. For example, acetone is a pretty common solvent, but it also happens to be a ketone. It's likely to undergo carbonyl addition reactions if presented with good nucleophiles. For that reason, carbonyl addition reactions wouldn't be carried out with acetone, because the nucleophile would just react with the solvent instead of the intended electrophile.
