Equivalent

A stoichiometric term based on the particular reaction under consideration. An amount sufficient to completely react with the amount of starting material used; how much that is depends not only on the starting material but the stoichiometry of the particular reaction.

Example 1. A compound C\(_7\)H\(_{10}\) absorbs two *equivalents* of hydrogen; how many rings are present in the compound?

*Answer.* The formula C\(_7\)H\(_{10}\) has three points of unsaturation, each corresponding to either a ring or a multiple bond. The compound absorbs two equivalents of hydrogen; this means that in the reaction

\[
\begin{align*}
\text{C} &= \text{C} + \text{H}_2 \quad \text{catalyst} \\
\text{C} &= \text{C}
\end{align*}
\]

it consumes twice the stoichiometric amount of hydrogen required for one double bond (which in this case is one mole H\(_2\) per mole of double bonds). This means, of course, that there are two double bonds (or one triple bond) in the compound; in other words, two of the three points of unsaturation are carbon-carbon multiple bonds. The third must be a ring; therefore the compound has one ring.

Example 2. In the conversion of acid chlorides to amides, how many *equivalents* of amine are required?

*Answer.* The question is asking, what is the stoichiometry of the reaction with respect to the amine, or more simply, how many moles of amine are required per mole of acid chloride? In this case the answer is two: the reaction itself has a 1:1 stoichiometry with respect to the amine, but the by-product of the reaction is HCl in a 1:1 mole ratio with product, and an additional mole of amine (per mole of acid chloride) is needed to consume the HCl. We conventionally write this reaction as

\[
\begin{align*}
\text{R} &= \text{C} - \text{Cl} + \text{HNR}_2 \quad \text{2 equiv.} \\
\text{R} &= \text{C} - \text{NR}_2
\end{align*}
\]