CHE 2060: Summary of key concepts for Module 5, Acid-base reactions

- Know the **Brønsted-Lowry definition** of acidity and basicity: a Brønsted acid is a proton donor, a Brønsted base is a proton acceptor.
- Know the **Lewis definition** of acidity and basicity: a Lewis acid is an electron acceptor; a Lewis base is an electron donor.
- Understand that the **Lewis definition is broader**: all Bronsted acids are also Lewis acids, but not all Lewis acids are also Brønsted acids.
- Be able to draw a **curved arrow mechanism** for both Brønsted and Lewis acid-base reactions.
- Know the **expressions for Ka and pKa** and how to change one to the other mathematically.
- Commit to memory the approximate pKa values for the following functional groups:

Functional group	pka
Hydronium ion, protonated alcohol, protonated carbonyl	0
Carboxylic acids	5
Imines	7
Protonated amines, phenols, thiols	10
Water, alcohols	15
α-carbon acids	20

- Be able to use **pKa values** to compare acidity: a lower pKa corresponds to a stronger acid.
- Know that:
  - For a given pair of acids, the **stronger acid will have the weaker conjugate base**.
  - For a given pair of basic compounds, the stronger base will have the weaker conjugate acid.
- Be able to **identify** the most acidic/basic groups on a polyfunctional molecule.
- Be able to **calculate the equilibrium constant** of an acid base equation from the pKa values of the acids on either side of the equation.
- Be able to use the **Henderson-Hasselbalch equation** to determine the protonation state/charge of an organic compound in an aqueous buffer of a given pH.
- Understand the idea that the best way to compare the strength of two acids is to **compare the stability of their conjugate bases**: the more stable (weaker) the conjugate base, the stronger the acid.
- Be able to compare the acidity or basicity of compounds based on **periodic trends**: acidity increases left to right on the table, so alcohols are more acidic than amines acidity increases top to bottom on the table, so a thiol is more acidic than an alcohol.
- Be able to compare the acidity or basicity of compounds based on **protonation state**: H_3O^{+1} is more acidic than H_2O, NH_4^{+1} is more acidic than NH_3.

- Understand how the **inductive effect** exerted by electronegative groups influences acidity.
- Understand how **resonance delocalization** of electron density influences acidity.
- Be able to explain/predict how **orbital hybridization** affects the relative acidity of terminal alkynes, alkenes, and alkanes.
- Be able to explain why **phenols are more acidic** than alcohols, and **how electron withdrawing** or **donating groups** influence the acidity of phenols.
- Be able to identify the relative basicity of a **nitrogen-containing group** in a compound, based on whether it is an amine, amide, imine, aniline, or 'pyrrole-like'.
- Be able to identify **α-carbon**(s) on a carbonyl compound and explain why **α-protons** are weakly acidic. You should be able to draw the **enolate conjugate base** of a carbonyl compound.
- Be able to identify **tautomeric relationships**, specifically keto-enol and imine-enamine tautomers.
- Understand what a **polyprotic acid** is, what is meant by multiple pKa values, and why these values get progressively higher.