What Does pK_a Tell You?

	What?	How?
1.	In comparing two acids, it tells you which is stronger	The lower the pK_a, the stronger the acid
2.	In comparing two bases, it tells which is stronger	The base whose conjugate acid is the weaker acid (has the higher pKa) is the stronger base
3.	The <u>sign</u> and <u>magnitude</u> of the pK_a for an acid ionization in water is directly related to the <u>sign</u> and <u>magnitude</u> of $\Delta G°$ for that ionization	Large positive values of pK_a indicate a large positive $\Delta G°$. Small positive values of pK_a indicate a small positive $\Delta G°$ (situation for weak acids). Large negative values of pK_a indicate a large negative $\Delta G°$. Small negative values of pK_a indicate a small negative $\Delta G°$ (situation for strong acids).
4.	In an acid-base reaction, it predicts if the forward reaction will proceed	A reaction will always proceed in the direction of the side with the stronger acid (lower pK_a) to the side with the weaker acid (higher pK_a)
5.	In an acid-base reaction, the pK_a of the acid species on both sides of the equation can be used to calculate the K_{eq} (equilibrium constant) for that reaction	The K_{eq} for an acid-base react can be calculated from the following relationship: $K_{eq} = 10^{[pKa(product\ acid) - pKa(reactant\ acid)]}$
6.	In an acid-base reaction, it predicts the side with the stronger acid and base, and the side with the weaker acid and base	The side with the stronger acid (lower pK_a) will be the same side containing the stronger base. The side with the weaker acid (higher pK_a) will be the side with the weaker base
7.	Predict the magnitude/extent of ΔG^o in an S_N2 reaction	When the pK_a of the conjugate acid of the nucleophile is >> than the pK_a of the conjugate acid of the leaving group, the reaction will be very exergonic with a large negative ΔG^o. When the pK_a of the conjugate acid of the nucleophile is only slightly greater than the pK_a of the conjugate acid of the leaving group, the reaction will be only slightly exergonic only a small negative ΔG^o.
8.	In the choice of a leaving group in a nucleophilic substitution (S_N) reaction, it predicts which would be the better leaving group	The leaving group whose conjugate acid has the lower pK_a (stronger conjugate acid), will be the better leaving group (weaker conjugate base)
9.	Predict the relative strength of a nucleophile in a nucleophilic substitution reaction	<u>In polar protic solvents</u>: generally the stronger the base (conjugate acid with the higher pK_a) the stronger the nucleophile, with the exception of going down a periodic group, where the base gets weaker but the nucleophile gets stronger. <u>In polar aprotic solvents</u>: the stronger the base (conjugate acid with the higher pK_a) the stronger the nucleophile, at least for the case of small, anionically charged base species

	What?	How?
10.	Predict the reactivity of a carboxylic acid derivative in nucleophilic acyl substitution reactions (addition-elimination reactions)	The lower the pK_a of the conjugate acid of the leaving group on the carboxylic acid derivative, the more reactive the carboxylic acid derivative in nucleophilic acyl substitution reactions (addition-elimination reactions).
11.	Predict the relative nature of a group attached to a benzene ring as being activating (electron donating group, EDG), or deactivating (electron withdrawing group, EWG) toward electrophilic aromatic substitution reaction	By comparing the pK_a of a benzoic acid substituted with that group vs. unsubstituted benzoic acid. The pK_a of the benzoic acid is 4.20. If the pK_a of the substituted benzoic acid is smaller, that group is an electron withdrawing group and most likely a deactivating group. If the pK_a of the substituted benzoic acid is larger, that group is an electron donating group and most likely an activating group.