Effect of structure on Acid Strength

Strong acid means gives H\(^+\) easily. What factors in the structure decide the ability to donate H\(^+\)?

- **Polarity of the bond**

  more electronegative the atom X, more polar the H-X bond, stronger the acid. (but wait, F is the most electronegative atom, HF is a weak acid. Why? There is a second factor-

- **Strength of the bond H-X**

  The smaller the atom X attached to H, stronger the H-X bond, weaker the acid like in HF.

So which factor dominates over the other? - Depends on the type of acid

**SUMMARY of DOMINANT FACTOR**

<table>
<thead>
<tr>
<th>Top to Bottom in periodic chart</th>
<th>ACIDS with NO OXYGEN (acid HX)</th>
<th>OXYACID (acid HOX)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength of the bond</strong></td>
<td>size of X increases, bond strength decreases, <em>acid strength increases</em>. Example: HF is weakest, HI is strongest. HF &lt; HCl &lt; HBr &lt; HI</td>
<td>Polarity of the bond The same atom O is attached to H in all acids. Electronegativity of atom X attached to O decreases down a group, polarity of OH bond decreases, <em>acid strength decreases</em>. Example: HOF is strongest, HOI is weakest. HOF &gt; HOCl &gt; HOBr &gt; HOI</td>
</tr>
</tbody>
</table>

| Left to Right | Polarity of the bond Electronegativity of atom X increases, polarity of HX increases, *acid strength increases*. Example: \( \text{H}_2\text{S} \) is weaker than HCl | Polarity of the bond The same atom O is attached to H in all acids. Electronegativity of atom X attached to O increases across a period/row, polarity of OH bond increases, *acid strength increases*. Example: \( \text{H}_3\text{PO}_4 \) is weaker than \( \text{H}_2\text{SO}_4 \) |

Other important concepts:

1. As the number of O atoms attached to atom X increases, acid strength increases.

   \[
   \text{H-O-Cl} < \text{H-O-Cl-O} < \text{H-O-ClO}_2 < \text{H-O-ClO}_3
   \]

2. The first H in a poly proctic acid is more acidic than the 2\(^{nd}\) H, which in turn is more acidic than the 3\(^{rd}\) H and so on:

   \[
   \text{H}_3\text{PO}_4 > \text{H}_2\text{PO}_4^- > \text{HPO}_4^{2-}
   \]