

## Solubility Rules

- Rule 1: *Binary Acids*: HCl, HBr, and HI are strong, all other binary acids and HCN are weak. Strong acids are written in ionic form, weak acids are written in undissociated form
- Rule 2: *Ternary Acids*: If the number of oxygen atoms in the inorganic acid molecule exceeds the number of hydrogen atoms by two or more, the acid is strong. All organic acids (contain carbon) will be considered weak.
- Rule 3: *Polyprotic Acids*: In the second and subsequent ionizations the acids are always weak, whether or not the original acid is strong or weak.
- Rule 4: *Bases*: Hydroxides of the Groups 1 and 2 elements except beryllium are strong bases. All others are weak.
- Rule 5: *Salts*: Salts are written in ionic form if soluble and in undissociated form (solid) if insoluble. (Use rules for salts below)
- Rule 6: *Oxides*: Oxides are always written in undissociated form
- Rule 7: *Gases, liquids, and solids*: Gases, liquids, and solids are always written in undissociated form.

### Solubility Rules for Salts (Ionic Compounds)

Soluble Compounds	Insoluble Compounds
<ul style="list-style-type: none"> <li>□ Compounds of Group 1 elements</li> <li>□ Ammonium (NH<sub>4</sub><sup>+</sup>) compounds</li> <li>□ Chlorides (Cl<sup>-</sup>), bromides (Br<sup>-</sup>), and iodides (I<sup>-</sup>), except those of Ag<sup>+</sup>, Hg<sub>2</sub><sup>+2</sup>, and Pb<sup>+2</sup></li> <li>□ Nitrates (NO<sub>3</sub><sup>-</sup>), nitrites (NO<sub>2</sub><sup>-1</sup>), acetates (CH<sub>3</sub>CO<sub>2</sub><sup>-</sup>), chlorates (ClO<sub>3</sub><sup>-</sup>), and perchlorates (ClO<sub>4</sub><sup>-</sup>)</li> <li>□ Sulfates (SO<sub>4</sub><sup>-2</sup>), except those of Sr<sup>+2</sup>, Ba<sup>+2</sup>, Pb<sup>+2</sup>, and Hg<sub>2</sub><sup>+2</sup></li> </ul>	<ul style="list-style-type: none"> <li>□ Carbonates (CO<sub>3</sub><sup>-2</sup>), chromates (CrO<sub>4</sub><sup>-2</sup>), oxalates (C<sub>2</sub>O<sub>4</sub><sup>-2</sup>), and phosphates (PO<sub>4</sub><sup>-3</sup>), except those of the Group 1 elements and NH<sub>4</sub><sup>+</sup></li> <li>□ Sulfides (S<sup>-2</sup>), except those of the Group 1 and 2 elements and NH<sub>4</sub><sup>+</sup></li> <li>□ Hydroxides (OH<sup>-</sup>) and oxides (O<sup>-2</sup>), except those of the Group 1 and 2 elements, and NH<sub>4</sub><sup>+</sup></li> </ul>

#### Background:

Solubility is not as “black and white” as the above chart makes it look. The chosen dividing line between soluble and insoluble is 0.1M at 25 °C. Any substance that can form 0.1 M or greater is considered SOLUBLE. Any substance cannot reach a concentration of 0.1 M is considered INSOLUBLE. This dividing line was chosen because most substances form solutions either much greater than or much less than 0.1M. If you find any discrepancies with the above table and a solubility table from another source it is likely those substances are “slightly soluble” and the authors had differing opinions of how to define those substances. Wondering what the “M” stands for? M stands for molarity, which is a way to describe concentration – it means moles/liter.

#### References:

- <http://dbhs.wvusd.k12.ca.us/webdocs/Solutions/Solubility-Rules.html>
- <http://dbhs.wvusd.k12.ca.us/webdocs/Equations/Solubility-Table.html>
- Brown, Lemay, Bursten, **Chemistry: the Central Science**, Pearson/Prentice Hall, Tenth Edition, 2006.
- Smith, Hines, Smoot, Solving Problems in Chemistry, Glencoe.

# Net Ionic Equation Decision Making Tree

