

Solubility Rules and Net Equations

Recall: Ionic compounds are made of an _____ and a _____.

Factors affecting solubility of Ionic Compounds

- **Ion Charge:** The bigger the charge, _____ is the attraction between the ions.
 - **Ion Size:** The bigger the ion, _____ is the attraction between ions.
1. If a compound is _____ in water that means that water cannot break those ions apart.
 2. If a _____ forms, that means that water can not keep those ions apart. Their _____ to each other is too great.
- These relationships have been characterized for a number of compounds and condensed into the solubility chart:
 - Used for making _____ on solubility

Solubility Rules:

Table 1: Solubility of Ionic Compounds at SATP

		Anions							
		Cl ⁻ , Br ⁻ , I ⁻	S ²⁻	OH ⁻	SO ₄ ²⁻	CO ₃ ²⁻ , PO ₄ ³⁻ , SO ₃ ²⁻	C ₂ H ₃ O ₂ ⁻	NO ₃ ⁻	CrO ₄ ²⁻
Cations	High solubility (aq) ≥ 0.1 mol/L (at SATP)	most	Group 1, NH ₄ ⁺ , Group 2	Group 1, NH ₄ ⁺ , Sr ²⁺ , Ba ²⁺ , Tl ⁺	most	Group 1, NH ₄ ⁺	most	all	Na ⁺ , K ⁺ , Mg ²⁺ and NH ₄ ⁺
	All Group 1 compounds, including acids, and all ammonium compounds are assumed to have high solubility in water								
	Low solubility (s) ≤ 0.1 mol/L (at SATP)	Ag ⁺ , Pb ²⁺ , Tl ⁺ , Hg ₂ ²⁺ , (Hg ⁺), Cu ⁺	most	most	Ag ⁺ , Pb ²⁺ , Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , Ra ²⁺	most	Ag ⁺	none	most

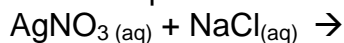
Practice:

1. Is sodium chloride soluble in water?
2. Is chromium(III) hydroxide soluble in water?
3. Is Iron(II) monohydrogen phosphate

In a double displacement reaction, often a precipitate is formed. We use the rules above to make a prediction.

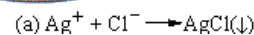
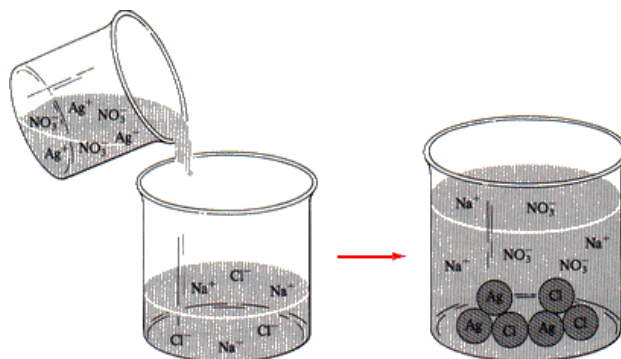
Example:

Balanced Chemical Equation:



To better conceptualize, let's write out all of the ions in solution.

Ionic Equation:



Some ions are not involved in the reaction. They are there at the beginning and there at the end, these ions are called _____.

Eliminate the spectator ions to get the net ionic equation

Net Ionic Equation: a representation of a chemical reaction in a solution that shows only the ions involved in the chemical change

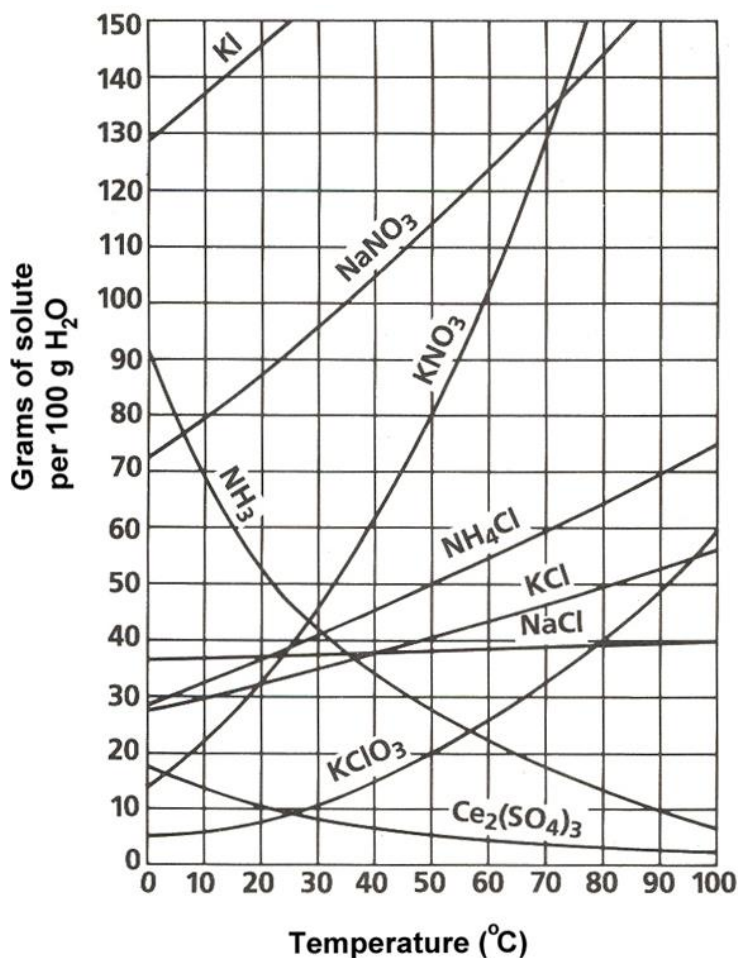
Qualitative Analysis – the process of separating and identifying ions in an aqueous solution i.e., flame test, colour of an aqueous solution

Solubility Curves

Solubility curves, like the one shown here, tell us what mass of solute will dissolve in 100g (100mL) of water over a range of temperatures.

What mass of solute will dissolve in 100mL of water at the following temperatures? Also determine which of the three substances is most soluble in water at 15°C.

- KNO_3 at 70°C
- NaCl at 100°C
- NH_4Cl at 90°C



Solubility Rules and Double Displacement Practice Questions

1. Complete the chart below:

Compound	S/I	Compound	S/I	Compound	S/I
Mercury(II) chloride		Iron(II) hydroxide		Magnesium sulphate	
Zinc sulphide		Copper(I) nitrate		Strontium sulphate	
Uranium(VI) sulphate		Copper (II) nitrate		Lithium carbonate	
Potassium acetate		Lead(II) chromate		Antimony(V)chlorate	
Copper(II) chloride		Lead(II) dichromate		Aluminum phosphate	
Lithium bicarbonate		Cobalt(II) sulphide		Titanium (II) sulphide	
Hydrobromic acid		Barium nitrate		Mercury(I) hydroxide	
Ammonium chromate		Silver acetate		Chloric acid	
Barium sulphate		Silver nitrate		Aluminum hydroxide	

2. Possible Multiple Choice: Pick out the soluble salt:

- AgCl, Ag₂CO₃, AgNO₃, Ag₂S
- NiCO₃, NiBr₂, NiS
- ZnS, ZnSO₄, ZnCO₃
- FeS, FeCO₃, FeSO₄

3. Possible Multiple Choice: Pick out the insoluble salt:

- FeCl₂, FeCrO₄, FeSO₄
- BaCrO₄, (NH₄)₂S, Mg(ClO₃)₄

4. Write the chemical, total and net ionic equations for the reaction between silver nitrate and sodium chloride solutions.

5. Write a dissociation equation for the dissolving of silver nitrate.

Write a dissociation equation for the dissolving of sodium bromide.

Name the precipitate which will form if solutions of sodium bromide and silver nitrate are mixed?

Write the balanced chemical equation for the precipitation reaction

Give the net ionic equation for the precipitation reaction.

Writing Ionic Equations and Net Ionic Equations Worksheet

Using your solubility guidelines, decide which of the following combinations of ionic compounds will produce an insoluble precipitate. Write an ionic equation and net-ionic equation for each. Pick out the spectator ions. If no precipitate forms, write NR.

1. Zinc chloride + sodium phosphate \rightarrow _____

Balanced Chemical Equation:

Ionic equation:

Net ionic equation:

Spectator ions:

2. Lead(II)nitrate + sodium sulfide \rightarrow _____

Balanced Chemical Equation:

Ionic equation:

Net ionic equation:

Spectator ions:

For questions 3-5 write the balanced chemical equation, ionic equation, net ionic equation and spectator ions if there is a chemical reaction

3. Calcium chloride + ammonium hydroxide \rightarrow

4. Magnesium chloride + iron(III) nitrate \rightarrow

5. Iron(III) sulfate + lead(II) chlorate \rightarrow

6. Some natural waters contain iron ions that affect the taste of water and cause rust stains. Aeration converts any iron(II) ions into iron(III) ions. A basic solution (containing hydroxide ions) is added to produce a precipitate.

- Write the net ionic equation for the reaction of aqueous iron(III) ions and aqueous hydroxide ions.
- What separation method is most likely to be used during this water treatment process?