Dissolution & Precipitation

Chem Worksheet 15-2

Name _____

Many ionic compounds dissolve in water to form aqueous solutions. When this occurs the ionic compound dissociates into separate cations and anions. Dissociation describes the process by which an ionic compound is separated into its component ions. For example, when calcium chloride is mixed with water, the resulting solution contains calcium ions and chloride ions.

$$CaCl_2\ (s) \xrightarrow{H_2O} Ca^{2+}\ (aq) + 2Cl^-\ (aq)$$

You can predict which ionic compounds dissolve using a list of solubility rules, such as the table found below. Using this table you can see that the compound sodium phosphate will dissolve (rule #2) and the compound zinc nitrate will dissolve (rule #1). Both of these compounds are described as soluble.

$$Na_3PO_4\ (s) \xrightarrow{H_2O} 3\ Na^+\ (aq) + PO_4^{3-}\ (aq)$$

$$Zn(NO_3)_2\ (s) \xrightarrow{H_2O} Zn^{2+}\ (aq) + 2\ NO_3^-\ (aq)$$

When ions in a solution combine to form a solid this reaction is known as precipitation. For example, if there are magnesium precipitation ions and hydroxide ions in a solution a solid forms (rule #5). A solution containing copper (II) ions and sulfide ions will also form a solid (rule #6).

$$Mg^{2+}\ (aq) + 2OH^-\ (aq) \xrightarrow{H_2O} Mg(OH)_2\ (s)$$

$$Cu^{2+}\ (aq) + S^{2-}\ (aq) \xrightarrow{H_2O} CuS\ (s)$$

Solubility Rules

Rule 1 supercedes rule 2, rule 2 supercedes rule 3, etc.

1. Nitrate (NO_3^-) salts are soluble
2. Salts containing the alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+) are soluble
3. Most chloride, bromide, and iodide salts are soluble. Notable exceptions are salts containing the ions Ag^+, Pb^{2+}, Hg_2^{2+}
4. Most sulfate salts are soluble. Notable exceptions are $BaSO_4$, $PbSO_4$, Hg_2SO_4 and $CaSO_4$.
5. Most hydroxide salts are slightly soluble (insoluble). Exceptions include $Ba(OH)_2$, $Sr(OH)_2$, and $Ca(OH)_2$.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), chromate (CrO_4^{2-}), and phosphate (PO_4^{3-}) salts are insoluble.

Predict which of the following are soluble (s) and which are insoluble (i). List the rule used to predict the solubility for each.

1. potassium chloride, KCl
2. cobalt hydroxide, $Co(OH)_2$
3. silver bromide, AgBr
4. mercury (I) nitrate, $Hg_2(NO_3)_2$
5. iron (II) carbonate, $FeCO_3$
6. lithium phosphate, Li_3PO_4
7. lead (II) sulfate, $PbSO_4$
8. calcium chromate, $CaCrO_4$
9. aluminum hydroxide, $Al(OH)_3$
10. ammonium hydroxide, NH_4OH
11. barium hydroxide, $Ba(OH)_2$
12. chromium (II) nitrate, $Cr(NO_3)_2$

Write balanced equations for the following processes.

13. The dissolution of potassium carbonate, K_2CO_3.
14. The precipitation of silver sulfate, Ag_2SO_4.
15. The dissolution of ammonium phosphate, $(NH_4)_3PO_4$.
16. The precipitation of lead (II) bromide, $PbBr_2$
17. The dissolution of strontium nitrate, $Sr(NO_3)_2$
18. The precipitation of mercury (I) iodide, Hg_2I_2.

Label the following compounds with an (aq) for soluble compounds and an (s) for insoluble compounds.

19. $NaCl\ (\ ) + AgNO_3\ (\ ) \xrightarrow{H_2O} AgCl\ (\ ) + NaNO_3\ (\ )$
20. $2NH_4Cl\ (\ ) + 2Pb(NO_3)_2\ (\ ) \xrightarrow{H_2O} 2NH_4NO_3\ (\ ) + PbCl_2\ (\ )$
21. $Ca(OH)_2\ (\ ) + MgSO_4\ (\ ) \xrightarrow{H_2O} Mg(OH)_2\ (\ ) + CaSO_4\ (\ )$
22. $K_2S\ (\ ) + CoI_2\ (\ ) \xrightarrow{H_2O} CoS\ (\ ) + 2KI\ (\ )$
23. $BaSO_4\ (\ ) + Rb_2CO_3\ (\ ) \xrightarrow{H_2O} Rb_2SO_4\ (\ ) + BaCO_3\ (\ )$
24. $SrBr_2\ (\ ) + Pb(NO_3)_2\ (\ ) \xrightarrow{H_2O} Sr(NO_3)_2\ (\ ) + PbBr_2\ (\ )$