***Solubility Rules***

**Soluble Compounds Important Exceptions (thus insoluble)\_\_\_**\_\_\_\_\_

*Compounds containing*

**NO31-** None

**C2H3O21-**None

**Cl1-** Compounds with Ag+, Hg22+, and Pb2+

**Br1-** Compounds with Ag+, Hg22+, and Pb2+

**I1-** Compounds with Ag+, Hg22+, and Pb2+

**SO42-**  Compounds of Sr2+, Ba2+, Hg22+, and Pb2+

**Insoluble compounds**  **Important exceptions (thus soluble)\_\_\_\_\_\_\_\_\_\_**

*Compounds containing*

**S2-** Compounds with NH4+, alkali metals, and Ca2+, Sr2+, and Ba2+

**CO32-** Compounds with NH4+ and alkali metals

**PO43-** Compounds with NH4+and alkali metals

**OH1-** Compounds with NH4+ and alkali metals

**CrO42-** Compounds with NH4+ and alkali metals

**O2-** Compounds with NH4+ and alkali metals.

1) Using the solubility rules, indicate whether the following compounds are soluble in water.

a. K2SO4  \_\_yes\_\_\_ b. CaCl2  \_\_yes\_\_ c. Na2S \_\_yes\_\_ d. Al(OH)3 \_\_no\_\_\_

e. CsOH \_\_\_yes\_\_ f. Mg3(PO4)2  \_\_no\_\_\_\_

**Use state symbols to indicate if the products are either a precipitate or an aqueous solution.**

IF THE COMPOUND IS SOLUTION, THEN THE STATE SYMBOL WILL BE (aq)

2) MgCl2 + Li2CO3  🡪 MgCO3 **( \_s\_)** + 2 LiCl**( \_aq\_)**

3) 2 AgNO3 + BeCl2  🡪 Be(NO3)2 **( \_aq\_\_)** + 2 AgCl **( \_\_s\_)**

4) Na3PO4  + 3 KOH 🡪 3 NaOH **( \_\_\_aq\_\_)** + K3PO4 **( \_\_aq\_\_\_)**

\*RECALL\* (s) = solid (l) = liquid (g) = gas (aq) = aqueous solution

*\* Remember the group of elements that are always written in pairs* ***(Br2, I2, N2, Cl2, H2, O2, F2)*** *with a subscript of two when they are alone (diatomics). They do NOT have to be in pairs when they are in a compound. These diatomics usually exist as gases.\**

***Using state symbols when writing chemical reactions.***

Use the solubility rules to determine any precipitates formed, then write balance chemical equations (with state symbols) for each of the following reactions. Then write net ionic equations for these reactions.

***Example problem:***

*Determine the net ionic equation for the reaction:*

strontium bromide(aq) + potassium sulfate(aq) 🡪 strontium sulfate(s) + potassium bromide(aq)

*a. Balanced chemical equation: SrBr2 (aq) + K2SO4 (aq) 🡪 SrSO4 (s) + 2 KBr (aq)*

*b. Complete Ionic equation: Sr2+ + 2Br - + 2K + + SO42- 🡪 SrSO4 + 2K+ + 2Br –*

*c. Net ionic equation: Sr2+ (aq) + SO42 – (aq) 🡪 SrSO4 (s)*

*Spectator ions watch, but don’t participate in the chemical reaction!*

5.) Write the complete ionic and then the net ionic equation for:

a. BeI2 (aq) + Cu2SO4 (aq) 🡪 BeSO4 (aq) + 2 CuI (s)

Check to make sure that the chemical equation is balanced!

Complete ionic: Be2+ (aq) + 2I- (aq) + 2Cu+ (aq) + SO42- (aq) 🡪 Be2+ (aq) + SO42- (aq + 2 CuI (s)

Net ionic (look for spectators): 2I- (aq) + 2Cu+ (aq) 🡪 2 CuI (s)

b. Ni(NO3)3 (aq) + 3 KBr (aq) 🡪 NiBr3 (aq) + 3 KNO3 (aq)

Complete ionic: Ni3+ (aq) + 3NO3- (aq) + 3K+ (aq) + 3Br- (aq) 🡪 Ni3+ (aq) + 3NO3- (aq) + 3K+ (aq) + 3Br- (aq)

Net ionic: NONE, because everything stays in the water. This means that no chemical reaction has occurred, instead two solutions were mixed together and now everything is dissolved in the water.

6.) An aqueous solution of sodium chloride reacts with a solution of lead (II) nitrate to form lead (II) chloride and sodium nitrate.

1. Balanced chemical equation: USE SOLUBILITY RULES and MAKE SURE TO BALANCE THE REACTION!

Pb(NO3)2 (aq) + 2NaCl (aq) 🡪 PbCl2 (s) + 2NaNO3 (aq)

1. Complete Ionic equation: break apart what you can (i.e. anything that’s (aq)). If the state symbol is (s), (l) or (g), just bring down the compound/element as it’s written in the balanced chemical equation.

Pb2+ (aq) + 2NO3- (aq) + 2Na+ (aq) + 2Cl- (aq) 🡪 PbCl2 (s) + 2Na+ (aq) + 2NO3- (aq)

1. Net Ionic equation: cancel the spectators to find the chemical reaction that has occurred by mixing these two solutions together.

Pb2+ (aq) + 2Cl- (aq) 🡪 PbCl2 (s)

7.) Aqueous solutions of sodium hydrogen carbonate and phosphoric acid (do not ionize) react to form sodium phosphate, carbon dioxide and water

1. Write the BALANCED chemical equation and determine STATE SYMBOLS based on solubility rules:

3NaHCO3 (aq) + H3PO4 (aq) 🡪Na3PO4 (aq) + 3CO2 (g) + 3H2O (l)

2. Break everything into ions that you can.

- Keep polyatomic ions together. For example, write NaHCO3 as Na+ + HCO3-

3Na+ + 3HCO3-  + 3H+ + 3PO43- 🡪3Na+ + 3PO43- + 3CO2 + 3H2O

3. Get rid of spectators to determine the net ionic equation:

**3HCO3-(aq) + 3H+(aq) 🡪 3CO2 (g) + 3H2O(l)**

Notice that the one things left are those elements that changed states of matter symbols from one side of the reaction to the other. This, along with the rearrangement of the atoms into different compounds, indicates a chemical change.

8.) Aqueous solutions of ammonium sulfide and a solution of mercuric bromide (HgBr) form ammonium bromide and mercuric sulfide.

1. Write the BALANCED chemical equation and determine STATE SYMBOLS based on solubility rules:

(NH4)2S (aq) + 2HgBr (aq) 🡪2NH4Br (aq) + Hg2S (s)

2. Break everything into ions that you can.

- Keep polyatomic ions together. For example, write NaHCO3 as Na+ + HCO3-

2NH4 +(aq) + 2S 2-(aq)  + 2Hg +(aq)  + 2Br -(aq) 🡪 2NH4 +(aq) + Hg2S (s)+ 2Br -(aq)

3. Get rid of spectators to determine the net ionic equation:

2S 2-(aq)  + 2Hg +(aq) 🡪 Hg2S (s)

9.) An aqueous solution of hydrobromic acid (ionize) and a solution of calcium hydroxide form calcium bromide and water. **THIS QUESTION NEEDS TO BE REWRITTEN IN ORDER TO MAKE SENSE based on solubility rules!**

*An aqueous solution of* hydrobromic acid *(ionize) and a solution of sodium hydroxide form sodium bromide and water.*

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1. Write the BALANCED chemical equation and determine STATE SYMBOLS based on solubility rules:

HBr (aq) + NaOH (aq) 🡪NaBr (aq) + H2O(l)

2. Break everything into ions that you can.

H+(aq) + Br -(aq) + Na+(aq) + OH-(aq) 🡪 Na+(aq) + Br -(aq) + H2O(l)

3. Get rid of spectators to determine the net ionic equation:

H+(aq) + OH-(aq) 🡪 H2O(l)