

Chem 151 Drilling Question Set #3
Solubility of Inorganic Compounds (Answer Key)

1. Based on the solubility guidelines to predict whether each of the following compounds is likely to be classified as water soluble or insoluble. Circle your responses)

MgCO ₃	(Soluble / Insoluble)	<i>Most carbonates are insoluble</i>
NiBr ₂	(Soluble / Insoluble)	<i>Most bromides are soluble and nickel is not a heavy metal</i>
ZnSO ₄	(Soluble / Insoluble)	<i>Most sulfates are soluble w/ a few exceptions; but zinc sulfate is not among the exceptions</i>
Al ₂ O ₃	(Soluble / Insoluble)	<i>Most oxides are insoluble</i>
Pd(NO ₃) ₂	(Soluble / Insoluble)	<i>All nitrates are soluble</i>
CoI ₂	(Soluble / Insoluble)	<i>Most iodides are soluble and cobalt is not a heavy metal</i>
CaSO ₃	(Soluble / Insoluble)	<i>Most sulfites are insoluble</i>
Rb ₃ PO ₄	(Soluble / Insoluble)	<i>Most phosphates are insoluble, but Rb is an alkali metal</i>

2. List the formula(s) of the major species (cations, anions, or molecules) in water when each of the following substances dissolves in water.

Potassium sulfide	<i>K⁺, S²⁻</i>
Ferrous sulfate	<i>Fe²⁺, SO₄²⁻</i>
Hydrofluoric acid (a weak electrolyte)	<i>HF molecules because it is a weak electrolyte</i>
Copper(II) chlorate	<i>Cu²⁺, ClO₃⁻</i>
Lead(II) acetate	<i>Pb²⁺, CH₃COO⁻</i>
Cesium oxalate	<i>Cs⁺, C₂O₄²⁻</i>
Oxygen gas	<i>O₂ molecules because O₂ is a covalent compound</i>

3. When solutions in each of the following mix with each other, predict if precipitate is likely to form. If your prediction is YES, give the chemical formula of the precipitate.

Sodium chloride solution is added to lead(II) nitrate solution	(YES / NO)	<i>PbCl₂</i>
Nickel sulfate solution is added to barium chloride solution	(YES / NO)	<i>BaSO₄</i>
Potassium phosphate solution is added to manganese(II) chloride solution	(YES / NO)	<i>Mn₃(PO₄)₂</i>
Copper(II) chloride solution is added to cobalt(II) sulfate solution	(YES / NO)	
Lithium sulfate solution is added to sodium hydroxide solution	(YES / NO)	
Hydrobromic acid is added to lead(II) nitrate solution	(YES / NO)	<i>PbBr₂</i>
Phosphoric acid is added to rubidium chloride solution	(YES / NO)	

4. Listed below are solubilities of some lead compounds in grams per liter of water. Calculate the molarity of Pb^{2+} ions in a solution that is saturated with each of the compounds. Solubility of a substance is the quantity of this substance that can dissolve in a given amount of solvent. For the sake of simplicity, you may assume the volume of solvent and volume of solution are the same in the below calculations. This in general, is a good assumption for very dilute solutions, but not true when the concentration becomes high.

a) PbS : 0.00086 g/L

$$\text{Molar mass of PbS} = 239.9 \text{ g/mol}$$

$$\text{Moles of PbS in saturated solution} = \frac{0.00086 \text{ g}}{239.3 \text{ g/mol}} = 3.6 \times 10^{-6} \text{ mol} = \text{moles of Pb}^{2+}$$

$$[\text{Pb}^{2+}] = \frac{3.6 \times 10^{-6} \text{ mol}}{1 \text{ L}} = 3.6 \times 10^{-6} \text{ M}$$

b) PbCl_2 : 33.4 g/L in hot water

$$\text{Molar mass of PbCl}_2 = 278.1 \text{ g/mol}$$

$$\text{Moles PbCl}_2 \text{ in saturated solution} = \frac{33.4 \text{ g}}{278.1 \text{ g/mol}} = 0.120 \text{ mole PbCl}_2 = 0.120 \text{ mole Pb}^{2+}$$

$$[\text{Pb}^{2+}] = 0.120 \text{ M}$$

c) $\text{Pb}(\text{NO}_3)_2$: 376 g/L

$$\text{Molar mass of Pb}(\text{NO}_3)_2 = 331.2 \text{ g/mol}$$

$$\text{Moles of Pb}(\text{NO}_3)_2 \text{ in saturated solution} = \frac{376 \text{ g}}{331.2 \text{ g/mol}} = 1.14 \text{ mol}$$

$$[\text{Pb}^{2+}] = 1.14 \text{ M}$$

Please note that $\text{Pb}(\text{NO}_3)_2$ is classified as a soluble compound, PbCl_2 is moderately soluble, and PbS is insoluble. The above example gives you the amount of solid that can dissolve in water for substances classified in different categories as well as the concentrations of solutes in a saturated solution of each category.