

Solubility and Qualitative Analysis Review

- Four white, crystalline compounds, labeled A, B, C, and D, will be tested and identified. The possible identities of the four compounds are oxalic acid, sodium chloride, magnesium oxide, and sucrose. The tests and their subsequent outcomes will be decided by you.
 - What tests should be performed on the solids to determine their identity?
 - Create an observation table based on the tests to be performed. [Remember to label as A, B, C, and D.]
 - Complete the observation table illustrating some possible results for your experiments.
 - Based on the results that you presented, what is the identity of A, B, C, and D?
- Pairs of compounds are listed and for each case determine whether they will be soluble with one another. Explain what type(s) of intermolecular force enable solubility in each case where a solution forms. Be specific.
 - water ($\text{H}_2\text{O}_{(l)}$) and isopropyl alcohol ($\text{C}_3\text{H}_7\text{OH}_{(l)}$)
 - benzene ($\text{C}_6\text{H}_{6(l)}$) and carbon tetrachloride ($\text{CCl}_{4(l)}$)
 - glucose ($\text{C}_6\text{H}_{12}\text{O}_6(s)$) and methyl alcohol ($\text{CH}_3\text{OH}_{(l)}$)
 - ammonia ($\text{NH}_{3(g)}$) and water ($\text{H}_2\text{O}_{(l)}$)

- Calcium chloride, $\text{CaCl}_{2(s)}$, is a compound composed of ions that form a crystal lattice structure (see **Fig. 1**). Since covalent bonds are not present, ionic compounds are not considered polar or nonpolar as those terms are reserved for molecular compounds. However, ionic compounds are soluble in polar solvents such as water.
 - Write the balanced chemical equation showing the process that calcium chloride undergoes as it dissolves in a polar solvent such as water.
 - What is the term used for this process?
 - Draw a diagram to represent one unit of calcium chloride dissolving in water.
 - What is the name for the intermolecular force formed in this solution?
 - Explain how this process reinforces an important empirical property of ionic compounds.

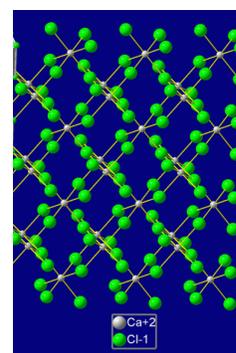


Figure 1. Crystal lattice

- Create an experiment that would distinguish between a test tube containing ethanol, $\text{C}_2\text{H}_5\text{OH}_{(l)}$, a colourless liquid, and a test tube containing cyclohexane, $\text{C}_6\text{H}_{12(l)}$, a colourless liquid.
 - Provide an abstract, a list of materials required, and the steps in the procedure.
 - Explain the observational difference(s) that will distinguish between these two colourless liquids.
- Using a solubility curve (see **Fig. 1**), answer the following questions.
 - What is the solubility of ammonium chloride (in g/100 mL) at 50°C ?
 - How much sodium nitrate can dissolve in 500-mL of water at 40°C ?

A mixture of two solids contains 5.7 g of potassium chloride and 1.2 g of sodium nitrate. However, to purify the potassium chloride, the sodium nitrate will be selectively dissolved from the mixture.

- How much water is needed to completely dissolve the sodium nitrate at 20°C ?
- What mass of potassium chloride will be dissolved under these conditions?
- Describe a technique to separate the remaining potassium chloride from the solution.

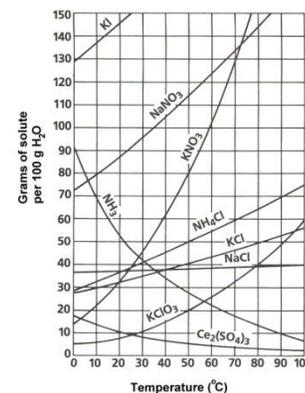


Figure 1. Solubility curves

6. An aqueous solution of calcium chloride is added to an aqueous solution of potassium carbonate.
- Write the balanced chemical equation for this reaction.
 - Write the total ionic equation for this reaction.
 - Write the net ionic equation for this reaction.
7. Through qualitative analyses, an aqueous solution has been shown to contain both calcium ions, $\text{Ca}^{2+}_{(\text{aq})}$, and iron(III) ions, $\text{Fe}^{3+}_{(\text{aq})}$, in solution with nitrate ions, $\text{NO}_3^{-}_{(\text{aq})}$.
- What solution colour would be observed? Indicate why.
 - What colour would arise from a flame test of the solution? Indicate why.
 - What test(s) could be performed to indicate the anion is nitrate, $\text{NO}_3^{-}_{(\text{aq})}$, and not chloride or bromide?
 - Explain what the ratio between the concentration of nitrate ions, $\text{NO}_3^{-}_{(\text{aq})}$, to calcium ions, $\text{Ca}^{2+}_{(\text{aq})}$, in the whole solution would need to be (remember $\text{Fe}^{3+}_{(\text{aq})}$ is also present).
 - Describe a procedure that would separate the calcium ions, $\text{Ca}^{2+}_{(\text{aq})}$, from the iron(III) ions, $\text{Fe}^{3+}_{(\text{aq})}$.