Solubility rules lab answers

Redirection to Download Precipitation Reaction and Solubility Rules Lab Answers PDF by Second Laboratory Activity: Student Version Laboratory Activity: Teacher Notes Laboratory Activity: Teacher Notes Activity 1: What Dissolves and What Doesn't: Creating Some Rules Level This activity can be used with basic, general, and honors students. Safety These solutions include some heavy metal ions that are toxic in the environment. Although they are safe to use when handled correctly, you should dispose of these ions carefully. A smaller approach is proposed to reduce the amount of the necessary solutions. Materials Set II Set III Set IV Set V Solution 1: $Ba(NO_3)_2$ Na_2SO_4 $FeCl_3$ $CoCl_2$ $BaCl_2$ Solution 2: $BaCl_2$ $Al_2(SO_4)_3$ $Co(NO_3)_2$ $MgCl_2$ $Sr(NO_3)_2$ Solution 3: NaI S 2 $CoCl_2$ K_2SO_4 Na_2Co_3 Solution 4: $AgNO_3$ $BaCl_2$ NaOH NaOH $Al_2(SO_4)_3$ Solution 5: $NaNO_3$ $Ba(NO_3)_2$ KOH $Ba(OH)_2$ $K(CH_3COO)$ Solution 6 : KCl $AlCl_3$ $NaNO_3$ $MgSO_4$ $AgNO_3$ Preparation in advance Prepare 10% solutions of the reagents by dissolving 10 g of each in 90 ml of water. If the whole sample does not dissolve, it must sit down and use the clear solution. Place the solutions in dropper bottles and arrange in sets. Prepare at least five complete setups. These solutions are stable and can be used many times. Assign only one set to each student pair. (Beral™ pipettes in an audio cassette is also a convenient arrangement.) Acetate plates, or small glass plates work well. Acetate sheets are cheap and eliminate the risk of glass cuts. You may want to photocopy the web and give more to each student, or make transparencies of the web. Small cell good plates work nicely. Students can rinse them and dry with Q-tips Grid sheets on colored paper increase the visibility of white precipitate. You may find it convenient to provide a large chart on the board and have students record their data as they complete each part of the lab\pair activity. The following chart is suggested as a possible format. Cl^- CH_3COO^- CO_3^{2-} OH^- NO_3^- I^- SO_4^{2-} Ag^+ Al^{3+} Ba^{2+} Co^{2+} Fe^{3+} K^+ Mg^{2+} Na^+ Sr^{2+} Place an (I) for Insoluble in the room where a precipitate was formed. Count one (S) in spaces where there was no sediment. In general, we consider everything insoluble if it has a solubility of less than 0.1 g per 100 ml. You may find it necessary to declare some compounds as slightly soluble (ss). Silver sulphate fits this category. Pre-Laboratory Discussion When students gather their data and compare their observations, it will be found that certain combinations of solutions produce precipitatees. Furthermore, it can be established that only certain pairs of ions react to producing precipitatees. When the class collected, some generalisations regarding the solubility of ionic compounds may be drawn. It is important that the general rules of solubility are developed as a result of students' observations and are not presented as something to be remembered. This activity gives students experience in (1) developing laboratory skills, (2) making and recording observations, (3) drawing conclusions and making generalizations from data and (4) work as part of a team. Students should be introduced to dissociation, separation of ions in aqueous solution. They should identify all ions present in a resolution and write correct ionic symbols. They must understand that precipitate only when an insoluble product is produced by recombination of ions in solution. They should also be able to write net ionic equations for precipitation reactions, eliminating spectator ions. For example, you can select the combination of silver nitrate and sodium chloride solutions. Do this as a demonstration – just add one to the other. a dense white precipitate of silver chloride will form. Invite students to list all the ions present in the combined solutions and eliminate those that would not precipitate. Show students that the precipitate could not sodium nitrate by dissolving a mall amount of this substance in water to show that it is highly soluble. It is stressed that the elimination process to determine that the precipitate must be silver chloride is based on all four potential salts in each reaction plus the registration of all six solution salts as soluble at the beginning of the activity. Teacher-student interaction While students collect and compare their data, it provides an opportunity to discuss experimental errors and the need to collect a large amount of data before finding conclusions. Students should be prepared to support their conclusions with careful observations and data collection. They should also realise that the rules, theories and hypotheses used by chemists are the direct or indirect result of laboratory experiments. This laboratory activity allows all students to help form the rules that chemists try to describe and understand their surroundings. Expected student results Students' results will be encouragingly consistent. If a question arises about whether a precipitate is formed, you can mix several milliliters of the solutions in front of the class and ask for their observations. Responses to data analysis and concept development The patterns match those found in general rules for water sol sol solubles of ionic substances. A. No precipitating d. No precipitate b. Precipitate e. Precipitate c. No precipitation f. No precipitating post-laboratory activities After discussing student data and creating a set of generalizations regarding the solubility of certain compounds, draw attention to in the textbook or distribute a copy. Compare these two sets of rules. Spot check students' understanding by providing possible combinations of solutions. (What would happen if solutions of lead nitrate and potassium carbonate were mixed? What would the precipitate be?) You may find that barium hydroxide and sodium hydroxide (Set 4) produce a precipitate due to dissolved carbon dioxide in sodium hydroxide, forming barium carbonate. If this happens, the students explain that it is not due to the combination of ions from the original connections. Assessment of laboratory learning It is important that students understand what their laboratory activity has produced in terms of knowledge of solubility, rather than just getting students to remember the rules of solubility. Allow students to refer to the class-generated solubility diagram and predict the solubility of different ionic compounds or the precipitate that is formed when different ionic solutions are mixed. Invite students to design sets of solutions to control the solubility of connections not included on their charts. Have students write net ionic equations, remove all spectators. (page 6,7,8) To develop a set of soluciability rules. • To observe trends in solubility and exceptions to these trends. • To write chemical formulas based on cation/anion charges. • Learning to write net ionic equations. Chemical reactions can be divided into five main classes: 1 Combination or synthesis actions (formation): Two substances together form a compound. The generic expression is: Examples of such reactions include: 2 Degradation reactions: The opposite of a combination reaction, a compound breaks apart and forms two or more products. The generic expression is: Examples of such reactions include: 3 Single displacement reactions: One element, ion or functional group displaces another element, ion or functional group from a substance. The generic term is: Some examples include: (8) $Cu + 2\,HNO_3 \rightarrow Cu(NO_3)_2 + H_2$ (9) 4 Double displacement or metathesis reactions: Atoms or ions in two or more different substances change locations to form new compounds. The generic term is: Some examples include: (11) $HC_2H_3O_2(aq) + NaOH(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O$ (12) $Pb(NO_3)_2(aq) + 2\,KI(aq) \rightarrow PbI_2(aq) + 2\,KNO_3(aq)$ Double displacement reactions fall into at least two major subclasses. Equation 11 shows one of them, a neutralizing reaction between an acid and a base. Equation 12 shows another, a precipitation reaction. Soluble species (generally ions) react to form insoluble solid compounds called precipitate. 5 Electron transfer or Redox reactions: Electrons are transferred from one substance to another. These will be treated separately in this laboratory course. In this experiment we will work with rainfall involving ions. Ionic solids are dissolved in water by a process known as solution. If a the amount of the solid is dissolved, it is said to be soluble. The ions are slyed by water, and free to move independently of each other in the solution. When two aqueous solutions of ionic substances are mixed, the mobile ions in each solution interact with each other. Coulomb's law describes the interaction between the ions (charged particles). where: F is the force × 8.9875 × 10^9 N·m2/C2 q1 and q2 is the distance separating them ε (epsilon) is the dielectric constant of the solvent* * Water has a large dielectric constant, which constantly reduces electrostatic interaction between particles. When the signs on fees q1 and q2 are the same, F> 0 and charges repel each other. When ions of opposite charge encounter each other, F< 0, and ions are attracted to each other. When the attractive force between opposite charged ions is large enough to overcome the energetically favorable interaction between ions and water, the ions combine to form a substance that is not soluble in water. We say that the connection falls out of resolution, or precipitate (verb). The fixed connection that has formed is called a precipitate (noun). As an initial hypothesis, we can indicate that precipitate will form when the attractive force between ions is large. This will be the case when their charges (q1 and q2) are opposite in signs and large. As mentioned earlier, soluble ionic species are mobile and free to move independently of each other. Freedom is not absolute; the positive ions will not all be assembled into part of the solution. Nevertheless, the ions are not bound to a position or to a particular counterweight (ion of the opposite charge). To express this, one can write a reaction in the form of a total ionic equation, as shown below: (14) $Pb^{2+}(aq) + 2\,NO_3^-(aq) + 2\,K^+(aq) + 2\,I^-(aq) \rightarrow PbI_2(s) + 2\,K^+(aq) + 2\,NO_3^{-}{}^-(aq)$ This rather cumbersome equation contains several ions that appear in identical form on both sides of the equation. These ions are not directly involved in the chemical reaction and are called bystanders. It is often convenient to write a reaction with a net ionic equation, which only shows the species participating in the chemical reaction. The net equation for the reaction shown in equation 14 is shown below. (15) $Pb^{2+}(aq) + 2\,I^-(aq) \rightarrow PbI_2(s)$ Netionic equations are much simpler to write and interpret than total ionic equations. They are often used in inorganic chemistry. The spectators must, of course, be present. One does not find a bottle of lead (II) cations or iodidions on a lab shelf! However, the reaction will work well regardless of whether the lead ion is introduced as lead nitrate, $Pb(NO_3)_2$ or as lead acetate, $Pb(C_2H_3O_2)_2$. Similarly, the iodide compound may be potassium iodide, KI or sodium iodide, All these compounds are soluble in water, and stable. In this laboratory, you will perform a number of microscale chemical reactions to determine which anions form insoluble compounds with different cations. The results will be used to formulate a table of solubility rules. As the reactions will be with ions in solution, the solutions must be made from compounds that are soluble. All nitrate salts are soluble. Therefore, the cations you want to use will be solutions of their nitrate salts. In accordance with the use of net ionic equations, only cation, e.g. Ca^{2+}, will be listed in your data table. For anions, you will formulate a solubility rule that will allow you to guess what a suitable spectator cation might be. 1 250 ml beaker (for waste) 1 plastic 8 × 12 well plate 1 test tube rack 2+ small test tubes ~ 3 drops 0.20 M NaCl ~ 3 drops 0.20 M $NaClO_4$ ~ 3 drops 0.20 M NaOH ~ 3 drops 0.20 M Na_2CO_3 ~ 3 drops 0.0.2 0 20 M Na_2SO_4 ~ 3 drops 0.20 M Na_3PO_4 ~ 3 drops 0.20 M NH_4NO_3 ~ 3 drops 0.20 M KNO_3 ~ 3 drop 0.20 M Ca (NO3) 2 ~ 3 drops 0.20 M Sr (NO3) 2 ~ 3 drops 0.20 M Mg (NO3) 2 ~ 3 drops 0.20 M Al (NO3) 3 ~3 drops 0.20 M Fe (NO3) 3 ~3 drops 0.20 M Zn (NO3) 2~3 drops 0.20 M Pb (NO3) 2~3 drops 0.20 M $AgNO_3$ Some of cation solutions are toxic. Do not ingest them. If you waste something on yourself, wash well with soap and water. Do not put anything in your mouth while you are in the lab, such as a computer. Silver solution will form dark spots on the skin if spilled. The stains do not appear for about 24 hours as the ions are slowly reduced to the metal. They are not dangerous and will fade in a few days. All solutions produced in this experiment must be discarded in the waste container on the side shelf. You may want to have a beaker in the work area to collect waste while performing the experiment. Make sure it's marked. Use a squeeze bottle of deionized water to flush the solutions into the beaker; Use the minimum amount of water you can, to avoid creating large amounts of waste solution. The plates and test tubes can then be washed normally. Print the worksheet for this lab. You will need this sheet to record your data. Part A: Study trends in solubility 1 Get an 8 × 12 plastic good plate. You want to mix ions in the well plate. The combinations of ions are listed in the grid in Table A. 2 To keep track of what you are doing, put your solutions in the well plate in the same order as they are listed in Table A. 3 Add three drops of each solution specified for the well. (More is not better!) Be careful to release the solution into the well without touching the net or any solution that is already in the well. If the pipette touches another solution, the reagent in the dropper bottle will be contaminated. Place your cations (nitrate solutions) in Place dine anioner (natriumopl-sninger) (natriumopl-sninger) Rows. 4 Record your observations in Table A. If a precipitate forms, put a Y in the space corresponding to the two solutions that were mixed. If there is no reaction (no sediment forms), place an N in the appropriate room in the table. If you do not see a clear result in the well plate, repeat the test in a small clean test tube. 5 Note any observations other than precipitation below the table. If a precipitate e.g. Part B: Examination of some exceptions to the solubility rules 1 In two of the unused wells on your well plate, mix the solutions listed in Table B, as you did in Part A. 2 Record your observations in Table B. If a sediment forms, put Y in the space corresponding to the two solutions that were mixed. If there is no reaction (no sediment forms), place an N in the appropriate room in the table. If you do not see a clear result in the well plate, repeat the test in a small clean test tube. 3 When you are finished, collect all your waste and deposit it in the waste container on the side shelf. Use a minimum amount of water to flush residual solutions into the waste container. Then clean and dry all your equipment and return it to the setup area where you found it. 4 Before you leave, go to a computer in the lab and enter your results in the In-Lab task. If all results are scored as correct, log out. If not all results are correct, try to find the error or consult with your lab instructor. When all results are correct, note them and sign out of WebAssign. The In-Lab task must be completed at the end of the laboratory period. If extra time is needed, consult your laboratory instructor. Instructor.