**Limiting Reagent Experiment – Precipitate Reaction of Lead Nitrate and Sodium Iodide**

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| **General Discussion** |
| Solutes in solutions react in the same mole and mass ratios as they do in any other state.  The ratios in which they react may be determined from a balanced equation.  |
| In the first part of the experiment you will allow measured volumes with known mass of two solutions to react.   You will vary the quantity of one reagent by using different volumes in each trials The quantity of the other reagent will be held constant. One of the products formed in the reaction is an insoluble substance, a precipitate (this substance is Lead Iodide, PbI2). The quantity of precipitate formed will indicate how much of the reactants have reacted. Once the amount of the fixed reagent is consumed, no more significant amount of precipitate will form, regardless of how much of the other reactant is added.  At this point the ratio of the moles of each reactant in the reaction is equal to the mole ratio expressed by the coefficients in the balanced equation.  |
| Finally, you will filter, dry, and weigh the precipitate obtained from one trial. This experimentally determined yield may then be compared with the theoretical (calculated) yield from the balanced equation. |
| **Objectives:** |
|  To verify that chemical substances react in definite mole ratios and determine the limiting reagent in different reaction ratios. |
| **Materials:** Solutions of 0.5M Lead(II) nitrate, sodium iodide.  |
| **Equipment:** Burette, test tubes, electronic balance, filter, filter funnel, wash bottle, alcohol. |

**Procedure:**

**1.** Obtain six clean, dry test tubes and number them 1 through 6.  Add 6 mL of 0.5M NaI solution to each of these tubes.
**2.** To test tube 1, add 1.0 mL of the 0.5M lead(II) nitrate solution. Then add 2.0 mL, 3.0 mL, 4.0 mL, 5.0 mL and 6.0 mL respectively to test tubes 2, 3, 4, 5 and 6.

**3.** Mix the solutions well and allow the precipitate of PbI2 to settle for 10 -15 minutes.

**4.** Measure the height of the precipitate in each test tube in cm and record these data in Table I.
**5.** Weigh several pieces of filter paper and determine the average mass of a single piece.
**6.** Filter the precipitate from test tube 1.  Rinse any remaining PbI2 from the test tube into the filter paper using a wash bottle.  Avoid using excess amounts of water.
**7.** Wash the PbI2 precipitate with 4 to 5 mL of alcohol.
**8.** Place the filter paper containing the precipitate on the counter, labeled with your name & test tube number, to dry overnight.

**9.** Repeat for each test tube.
**10.** Weigh the dry precipitate of PbI2.  Subtract the mass of the filter paper and record the mass of precipitate in Table II.

**Data Table I   Mole Relationships in a Chemical Reaction**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** **Tube** **No.** | **Volume of** **0.50 M** **NaI (mL)** | **Volume of** **0.50 M** **Pb(NO3)2** **(mL)** | **Moles** **of** **NaI** | **Moles** **of** **Pb(NO3)2** | **Moles** **of PbI2** **(calc.)** | **Mass in grams of** **PbI2** **(calc.)** | **Mass of** **PbI2** **(exp.)** | **Height of** **PbI2** **ppt.** **(cm)** |
| **1** | 6.0 | 1.0 | 3x10-3 | 5x10-4 |  |  |  |  |
| **2** | 6.0 | 2.0 | 3x10-3 | 1x10-3 |  |  |  |  |
| **3** | 6.0 | 3.0 | 3x10-3 | 1.5x10-3 |  |  |  |  |
| **4** | 6.0 | 4.0 | 3x10-3 | 2x10-3 |  |  |  |  |
| **5** | 6.0 | 5.0 | 3x10-3 | 2.5x10-3 |  |  |  |  |
| **6** | 6.0 | 6.0 | 3x10-3 | 3x10-3 |  |  |  |  |

**Data Table II   Mass of PbI2 Precipitate**

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| --- | --- | --- | --- |
| **Trial #** | **Mass of filter paper + PbI2** | **Mass of filter paper** | **Mass of PbI2 precipitate** |
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| **Graph the relationship between number of moles of I-(aq) and the number of moles of Pb+2(aq).** |
| The molecular equation for the reaction in this experiment is:  |
|  Pb(NO3)2(aq)   +   2 NaI(aq)   ----->  2 NaNO3(aq)  +   PbI2(s)The ionic equation for this reaction is Pb+2(aq)   +   2 I-1(aq)   ----->  PbI2(s) |
| **Follow up Questions** |
| 1. Describe the pattern in the heights of the precipitate in the 6 test tubes?
2. Explain the pattern in the heights of the precipitate in the 6 test tubes? Your answer should include correct and accurate use of the term limiting reagent.
3. List the reactant in excess in each test tube.
4. Calculate the moles of reactant in excess in each test tube
5. Write a general statement of 2 sentences or less explaining which reactant in a reaction will determine the quantity of product formed. Your answer should not be specific to the equation studied in this experiment.
6. From the mass of precipate weighted, calculate the moles of  lead(II) iodide precipitated.
7. Calcualte the theoretical yield of Lead Iodide in this test tube.
8. Was there significant error in this experiment? Justify your decision.
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