A Study of Limiting/Excess Reactants: Synthesis of Lead (II) Iodide

Objective:

The purpose of this experiment is to study the concept of limiting and excess reactants, using the synthesis of lead (II) iodide from potassium iodide and lead (II) nitrate and to determine the yield of PbI₂ from this reaction.

Concept:

A chemical equation represents the stoichiometric proportions in which chemical substances react with one another and new products are formed. Consider the equation below for the synthesis of PbI₂.

\[
Pb(NO₃)₂(aq) + 2 KI(aq) \rightarrow PbI₂(s) + 2 KNO₃(aq)
\]

According to the equation, 2 moles of KI are required to react with 1 mole of Pb(NO₃)₂. If only 1.5 moles of KI are available, there would not be enough KI to react with 1 mole of Pb(NO₃)₂, and we would say that KI is the limiting reactant and Pb(NO₃)₂ is the excess reactant. If, on the other hand 2 moles of KI and only 0.75 moles of Pb(NO₃)₂ are available, then the Pb(NO₃)₂ would be the limiting reactant. The amount of PbI₂ that can be produced is determined by how much PbI₂ can be produced from the limiting reactant.
**Procedure:**

1. Obtain between 0.50 and 0.60 grams of potassium iodide (KI) and between 0.20 and 0.30 grams of lead (II) nitrate (Pb(NO₃)₂), and record the masses to the nearest 0.0001 gram.

2. In a clean beaker dissolve the KI in approximately 75 mL of deionized water.

3. In a separate beaker dissolve the Pb(NO₃)₂ in approximately 75 mL of deionized water.

4. Bring the two solutions to a near boiling state.

5. Mix the two solutions. Remove the mixture from the heat and allow to cool.

6. Weigh a piece of filter paper and record to the nearest 0.0001 gram.

7. When all crystals of PbI₂ have formed, pour the mixture through a funnel lined with the pre-weighed filter paper in order to collect the PbI₂.

8. Rinse any crystals that remain in the beaker with deionized water and pour through the funnel. Continue to rinse until all of the crystals are collected on the filter paper.

9. Rinse the crystals with 2 – 3 mL of acetone to evaporate the water more readily.

10. Place the wet filter paper with the crystals on a watch glass (labeled with your name) and place the watch glass in the oven for about 15 minutes.

11. When the crystals are completely dry, weigh them (still on the pre-weighed filter paper).

12. Calculate the mass of the dry PbI₂ obtained.

13. Calculate the theoretical yield of PbI₂, based on the masses of the starting materials, KI and Pb(NO₃)₂, which you obtained.

14. Determine the % yield of your PbI₂ crystals.

15. Dispose of the PbI₂ crystals as instructed.
**Data and Results:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of KI (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Mass of Pb(NO₃)₂ (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Moles of KI</td>
<td>_____________</td>
</tr>
<tr>
<td>Moles of Pb(NO₃)₂</td>
<td>_____________</td>
</tr>
<tr>
<td>Mass of filter paper (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Mass of filter paper + PbI₂ crystals (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Mass of dry PbI₂ obtained (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Limiting Reactant</td>
<td>_____________</td>
</tr>
<tr>
<td>Mass of Excess Reactant Remaining (g)</td>
<td>_____________</td>
</tr>
<tr>
<td>Theoretical Yield of PbI₂</td>
<td>_____________</td>
</tr>
<tr>
<td>% Yield of PbI₂</td>
<td>_____________</td>
</tr>
</tbody>
</table>
Write-Up for PbI₂ Synthesis

Title Page

I. Purpose

II. Procedure

III. Results

(a) Table of Data and Values

(b) Calculations for:

• Moles of KI and Pb(NO₃)₂ obtained
• Theoretical Yield (Should include calculations for both limiting and excess reactants)
• Amount (in grams) of excess reactant remaining
• Dry weight of PbI₂
• Percent yield of PbI₂

IV. Discussion

What was the limiting reactant in the experiment? What are some possible reasons for your actual yield of PbI₂ being lower than your theoretical yield?