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 PbI_2 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 PbI_2.

$$Pb(NO_3)_{2(aq)} + 2\ KI_{(aq)} \longrightarrow PbI_{2(s)} + 2\ KNO_{3(aq)}$$

According to the equation, 2 moles of KI are required to react with 1 mole of $Pb(NO_3)_2$.
If only 1.5 moles of KI are available, there would not be enough KI to react with 1 mole of $Pb(NO_3)_2$, and we would say that KI is the limiting reactant and $Pb(NO_3)_2$ is the excess reactant. If, on the other hand 2 moles of KI and only 0.75 moles of $Pb(NO_3)_2$ are available, then the $Pb(NO_3)_2$ would be the limiting reactant. The amount of PbI_2 that can be produced is determined by how much PbI_2 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 ($Pb(NO_3)_2$), 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 $Pb(NO_3)_2$ 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 PbI_2 have formed, pour the mixture through a funnel lined with the pre-weighed filter paper in order to collect the PbI_2.

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 PbI_2 obtained.

13. Calculate the theoretical yield of PbI_2, based on the masses of the starting materials, KI and $Pb(NO_3)_2$, which you obtained.

14. Determine the % yield of your PbI_2 crystals.

15. Dispose of the PbI_2 crystals as instructed.

Data and Results:

Mass of KI (g) _____

Mass of $Pb(NO_3)_2$ (g) _____

Moles of KI _____

Moles of $Pb(NO_3)_2$ _____

Mass of filter paper (g) _____

Mass of filter paper + PbI_2 crystals (g) _____

Mass of dry PbI_2 obtained (g) _____

Limiting Reactant _____

Mass of Excess Reactant Remaining (g) _____

Theoretical Yield of PbI_2 _____

% Yield of PbI_2 _____

Write-Up for PbI_2 Synthesis

Title Page

I. Purpose

II. Procedure

III. Results

(a) Table of Data and Values

(b) Calculations for:

- Moles of KI and $Pb(NO_3)_2$ obtained
- Theoretical Yield (Should include calculations for both limiting and excess reactants)
- Amount (in grams) of excess reactant remaining
- Dry weight of PbI_2
- Percent yield of PbI_2

IV. Discussion

What was the limiting reactant in the experiment? What are some possible reasons for your actual yield of PbI_2 being lower than your theoretical yield?