Determining the Empirical Formula of Zinc Iodide v.8.17
MCTC Chemistry

Objective: To conduct a zinc/iodine reaction and use reactant mass measurements to determine an empirical formula for the product that is made.

Prelab Questions: Read through this lab handout and answer the following questions before coming to lab. There will be a quiz at the beginning of lab over this handout and its contents.

1. What are several precautions you should take when using the analytical balance?
2. In today's experiment, which reactant is in excess?
3. Why is it necessary to dissolve the I_2 in methanol?
4. How do we prevent I_2 gas from leaving the 125 mL Erlenmeyer flask?
5. What do you do to keep the reaction mixture from boiling dry when heating?
6. What does it mean to "decant"?
7. Where is the product located at the time it is weighed?
8. What does it mean to be hygroscopic?
9. Convert 14.5 grams of Zn into moles with excess significant figures.

Chemistry Overview

In this experiment, you will react solid zinc with solid iodine (I_2) and then determine the empirical formula of the zinc iodide product that forms. However, simply placing Zn metal in contact with solid I_2, won't produce a significant reaction since the materials are not in close enough contact with one another.

For this reason, we will be reacting Zn metal with I_2 that is dissolved in hot methanol. The dissolved I_2 molecules are now able to make much better contact with the Zn metal and the reaction proceeds much faster. Heating increases the energy and frequency of atomic collisions that result in product formation.

Experiment: Balances

Top Loading Balance

The first and least expensive balance is the "Top Loading Balance." It costs about $250, has a maximum capacity of 400 grams and has 2 decimal place accuracy.

When using a top loading balance, be sure to place a weighing paper on the balance pan. Then "Tare" or "Zero" the balance before making your measurement.

Always use the same balance for multiple mass measurements.

Report and clean up all spills. Your instructor will give you cleanup instructions.

Analytical Balance

Analytical balances cost about $3500 and have 4 decimal place accuracy. The additional two decimal places (compared to a top loading balance) are what make the analytical balances so expensive. Generally, in science, more accurate measurements cost more.

Analytical balances have sliding doors to keep dust out and to keep air movement from affecting the measurement. Close the doors while making the measurement and close them when you finish to keep dust out.

When using an analytical balance, be sure to place a weighing paper on the balance pan.

Also, remember to "Tare" or "Zero" the balance before making your measurement.

Never move an analytical balance and don't lean on the benchtop while making a measurement.

Experiment: Procedure

1. Label and pre-weigh a clean/dry 125 mL Erlenmeyer flask and a clean/dry 150 mL beaker on an analytical balance. Record their masses in the data table.

   Record the balance number (or model) on your data sheet.

2. Use a spatula and the top loading balance to weigh out *between 0.9 and 1* grams of metallic Zn granules in a clean/dry 50 mL beaker.

3. Transfer the zinc granules from the 50 mL beaker to 125 mL Erlenmeyer flask

   Reweigh the 125 mL Erlenmeyer flask and its contents on the analytical balance and record the value in your data table.

   Calculate the mass of the zinc in the flask and record this value with 4 decimals in the data table.

4. Obtain I_2 from your instructor. Shake the capped vial vigorously to loosen the I_2 crystals.

   Transfer all the solid I_2 to the 125mL Erlenmeyer flask.

   Reweigh the flask (analytical balance) and record the mass in your data table. Calculate the mass of the solid I_2 to 4 decimal digits and record this value in your data table.

5. Cover the 125 mL flask with a small watch glass to keep gaseous I_2 from escaping into the atmosphere.

6. While working in the fume hood, add *approximately* 15 mL of methanol to the 125 mL flask using the graduated cylinder provided.

   Replace the watch glass.

   Note the color change. What is responsible for the color of the solution?

7. While working in the fume hood, *gently heat* the flask (heat setting 200 ^{o}C on dial) until it boils.

   Continue heating the flask. Adjust as necessary to maintain a gentle boil.

   Hot plates are hot in the center and cooler at the edges. You can move the flask away from the hotplate's center for less heat.

8. Continue heating until the reaction mixture is colorless. (You decide.)

   Don't allow the solution to boil dry!!! If the solution level drops significantly, add small amounts of methanol to bring the level up.

   Don't leave your experiment unattended!!! If you must leave your station, have someone else watch things until you return.

9. Remove the flask from the hotplate and allow it to cool for several minutes.

10. Decant (pour off) the liquid in the flask into the pre-weighed 150 mL beaker.

    Leave the un-reacted Zn in the flask.

11. Rinse the un-reacted Zn by adding approximately 5 mL of methanol to the reaction flask and then re-heating for 15 seconds.

    Decant the rinse solution from the 125mL flask into the 150 mL beaker.

    Repeat this rinsing procedure two more times.

12. Place the 125mL Erlenmeyer flask (containing the un-reacted Zn) on the hot plate and allow the Zn granules to dry.

    Agitate or gently shake the flask to accelerate the drying process.

13. When the Zn in the reaction flask is dry, cover it with the small watch glass and let it cool.

    Reweigh the flask on the analytical balance.

14. Place the 150 mL beaker containing the methanol solution on the hot plate and boil to dryness.

    This MUST be done gradually at **low heat (<200^{o}C) and in the fume hood** to protect us from methanol vapors.

    A glass stirring rod should be left in the beaker as it will improve the boiling behavior of the solution and reduce bumping. Remove the glass stirring rod before the liquid has completely been boiled off.

15. Cover the beaker and let it cool. Re-weigh the beaker on an analytical balance and record this measurement in your data table

    The dry, solid product that now coats the inside of the 150 mL beaker is hygroscopic. What does <u>hygroscopic</u> mean?

16. Use your measurements to determine the masses of zinc and iodine that have *actually* reacted.

    Convert these mass quantities into moles and determine the empirical formula of the product.

<u>Prelab Questions:</u> Answers!

1. Keep doors closed, don't lean on countertop, use weighing paper, Tare or Zero before weighing.
2. Zinc is in excess.
3. To improve the contact/interaction between I2 and Zn.
4. Cover the mouth of the flask with a small watch glass.
5. Add methanol as needed.
6. To pour off liquid and leave the solid behind.
7. In the pre-weighed 150 mL beaker
8. Hygroscopic materials quickly absorb water from the air.
   For this reason, we keep them covered until it is time to weigh them.
9. 0.2216820 $moles_{Zn}$

C1151 Data Sheet
Empirical Formula
Instructor Initials_____

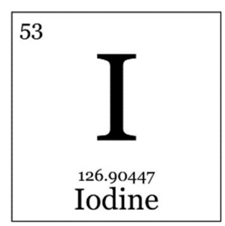
Name_________________________
Date of Exp. ________________
Lab Section ________________

Your *<u>individual</u>* *experimental report (Data table and answers to questions) is due at the beginning of the next lab.*

Data Table: *(All entries must be in written in ink before you leave the lab).*

NOTE: Do not round until you get to the "Empirical Formula" entries.

	Balance # __________	**Mass (g)**
Before Heating	**125 mL Flask**	
	150 mL Beaker	
	125 mL Flask & Zn	
	125 mL Flask & Zn & I_2	
	Initial Zn mass	
	Initial I_2 mass	
After Heating	**125 mL Flask & Zn**	
	150 mL Beaker + product	
	Product mass	
	Excess Zn mass	
	Consumed Zn mass	
Calculated Product Values	**moles$_{Zn}$** ***(Use Consumed Zn)***	
	moles$_{I}$ ***(Use Initial I_2 mass)***	
	Empirical Formula (4 significant figures *)	
	Empirical Formula (single digit subscripts **)	



* Each subscript has 4 significant figures inherited from the analytical balance measurements. Example: $Cu_{1045}Cl_{2100}$

** Subscripts are rounded to single digits. Example Cu_1Cl_2

Answer the following questions:

- Answers must be readable and make sense for credit.
- Copied/duplicate answers will result in all involved students receiving a zero score

1. Why is the exact amount of methanol used in this experiment not important?
(i.e. why was only *approximately* 15 mL used?)

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2. What is responsible for the color of the solution before you begin heating?

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3. What is the purpose of rinsing the $Zn_{(s)}$ with methanol several times once the reaction is complete?

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4. I_2 is the limiting reactant in this experiment. Give two experimental observations that support this fact.

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5. Use Zn consumed and the Initial I_2 Mass to calculate the total mass of the reactants.
Compare this to the mass of the product and state clearly which is greater? (Show all calculations).

The product mass should *ideally* be equal to the total reactant mass. Explain why your product mass is higher or lower than the combined reactant masses.

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6. A compound is known to be 52% carbon, 13% hydrogen and the remainder oxygen. What is the compound's empirical formula? (Show calculations)