



Stoichiometry

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Stoichiometry



Calculate quantities of substances in chemical reactions

For a **Balanced chemical equation**, the coefficients show:

- # formula units that react
- mole ratio of reactants & products
- (with molar mass) # grams of reactants & products

Uses mole concept to calculate chemical quantities



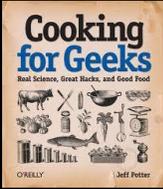
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Process for getting the right ingredients
cause chemical procedure = a recipe







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Thinking Moles Solves Problems



And
yields a better product!

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Generalized Pathway



“Per” Expression” (Molar Ratio)



Entry & Exit Points Depend On
Given Wanted

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Kirk Used Stoichiometry to Defeat the Gorn



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Stoichiometry Lab




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Today's Lab (Work as a Table Unit in the Hood)

Purpose: To investigate reaction of sodium carbonate and hydrochloric acid

$$\text{Na}_2\text{CO}_3 + 2 \text{HCl} \rightarrow 2 \text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$$

Procedure:

Measure the mass of an evaporating dish and a watch glass.
 Remove the watch glass, tare the balance, and add 1.5 – 2 g of Na_2CO_3
 Record the exact mass of Na_2CO_3 in the dish
 Remove the evaporating dish and Na_2CO_3 from the balance
 Slowly add HCl to the Na_2CO_3 until no more gas is evolved



Safety note: HCl is caustic to the skin and eyes! Use caution.

Stoichiometry says you will not need more than 7 mL for 2 g of Na_2CO_3
 xs HCl will be evaporated into the air you might breathe

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Stoichiometry Lab

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When the reaction is complete, use Bunsen Burner to evaporate to dryness
 Use the watch glass as a cover to help prevent spattering.
 Heat the contents very carefully
 Allow the evaporating dish and watch glass to cool completely
 Weigh the evaporating dish, NaCl and watch glass.



The NaCl product is drain disposable
 Wash out the product with water
 Clean the evaporating dish and watch glass with soap and water
 Rinse evaporating dish with tap water & RO water
 Dry the watch glass & evaporating dish and return to their drawers.
 Clean up all other glassware
 Return all pieces of equipment to proper storage drawer or cabinet

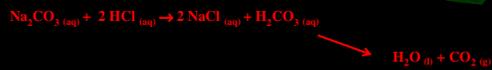



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Some "Numbers"

How many grams CO₂ are formed from 2.00 grams Na₂CO₃?



$$2.00 \text{ g Na}_2\text{CO}_3 \times \frac{1 \text{ mole Na}_2\text{CO}_3}{105.99 \text{ g}} \times \frac{1 \text{ mole CO}_2}{1 \text{ mole Na}_2\text{CO}_3} \times \frac{44.01 \text{ g}}{1 \text{ mole CO}_2} = 0.83 \text{ g}$$

How much CO₂ (mL) is formed from 2.00 grams Na₂CO₃?

(One mole of a substance occupies 22.4 L at STP)

$$0.83 \text{ g CO}_2 \times \frac{1 \text{ mole CO}_2}{44.01 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mole}} = 0.422 \text{ L} \rightarrow 422 \text{ mL}$$



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More "Numbers"



How much 6 M HCL is needed to completely react with 2.00 g Na₂CO₃?

(6 M HCL means 6 moles HCL per liter of solution)

$$2.00 \text{ g} \times \frac{1 \text{ mole Na}_2\text{CO}_3}{105.99 \text{ g}} \times \frac{2 \text{ mole HCl}}{1 \text{ mole Na}_2\text{CO}_3} \times \frac{1 \text{ L}}{6 \text{ moles HCl}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 6.28 \text{ mL}$$

How many grams NaCl are formed from 2.00 grams Na₂CO₃?

$$2.00 \text{ g} \times \frac{1 \text{ mole Na}_2\text{CO}_3}{105.99 \text{ g}} \times \frac{2 \text{ mole NaCl}}{1 \text{ mole Na}_2\text{CO}_3} \times \frac{58.43 \text{ g}}{1 \text{ mole NaCl}} = 2.21 \text{ g}$$



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More "Numbers"

$$\% \text{ Yield} = \frac{\text{Actual (Obtained in Experiment)}}{\text{Theoretical (Calculated Yield based on Stoichiometry)}} \times 100$$

$$\% \text{ Error} = \frac{\text{Actual Yield (g)} - \text{Theoretical Yield (g)}}{\text{Theoretical Yield (g)}} \times 100$$

% Error should be small and negative



For isolation of 2.16 grams:

$$\% \text{ Yield} = \frac{2.16 \text{ g}}{2.21 \text{ g}} \times 100 = 97.7 \quad \% \text{ Error} = \frac{(2.16 \text{ g} - 2.21 \text{ g})}{2.21 \text{ g}} \times 100 = -2.26$$



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Stoichiometry Lab



Results

Table that displays the answers to your calculations.

Be sure to report all results with correct units and proper significant figures

Conclusion

Brief paragraph describing how you met the purpose of today's lab

You should summarize your results - include the balanced chemical equation



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Let's Boldly Go Explore Today's Lab



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