

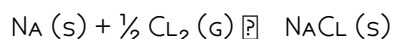
19) HOW MANY GRAMS OF CHLORINE GAS ARE NEEDED TO MAKE 117 GRAMS OF SODIUM CHLORIDE? GIVEN THE REACTION:

19) HOW MANY GRAMS OF CHLORINE GAS ARE NEEDED TO MAKE 117 GRAMS OF SODIUM CHLORIDE? GIVEN THE REACTION:

UNDERSTANDING THE PROCESS OF CALCULATING THE AMOUNT OF REACTANTS REQUIRED IN CHEMICAL REACTIONS IS FUNDAMENTAL IN CHEMISTRY. IN THIS ARTICLE, WE WILL EXPLORE IN DETAIL HOW TO DETERMINE THE GRAMS OF CHLORINE GAS (Cl_2) NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE (NaCl) BASED ON THE GIVEN CHEMICAL REACTION. THIS COMPREHENSIVE GUIDE WILL INCLUDE STEP-BY-STEP CALCULATIONS, EXPLANATIONS OF MOLAR CONCEPTS, AND TIPS TO ENSURE ACCURACY IN YOUR CALCULATIONS.

INTRODUCTION TO THE REACTION: SODIUM AND CHLORINE REACT TO FORM SODIUM CHLORIDE

THE CHEMICAL REACTION INVOLVED IN SYNTHESIZING SODIUM CHLORIDE FROM SODIUM AND CHLORINE GASES CAN BE REPRESENTED AS:



IN THIS REACTION:

- SODIUM (Na) REACTS WITH HALF A MOLECULE OF CHLORINE GAS (Cl_2) TO PRODUCE ONE MOLECULE OF SODIUM CHLORIDE (NaCl).
- THE REACTION IS A CLASSIC EXAMPLE OF A SYNTHESIS OR COMBINATION REACTION, OFTEN USED IN INDUSTRIAL AND LABORATORY SETTINGS.

UNDERSTANDING THE STOICHIOMETRY OF THIS REACTION IS ESSENTIAL FOR CALCULATING THE REQUIRED AMOUNTS OF REACTANTS, ESPECIALLY WHEN STARTING FROM A DESIRED QUANTITY OF THE PRODUCT.

STEP 1: IDENTIFY THE KNOWN QUANTITIES AND THE GOAL

BEFORE PROCEEDING WITH CALCULATIONS, CLARIFY WHAT IS GIVEN AND WHAT NEEDS TO BE FOUND.

- **GIVEN:**

- MASS OF SODIUM CHLORIDE (NaCl): 117 GRAMS

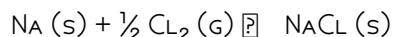
- **UNKNOWN:**

- MASS OF CHLORINE GAS (Cl_2) REQUIRED TO PRODUCE 117 GRAMS OF NaCl

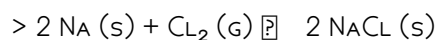
THE GOAL IS TO DETERMINE HOW MANY GRAMS OF Cl_2 ARE NEEDED FOR THIS PRODUCTION.

STEP 2: WRITE THE BALANCED CHEMICAL EQUATION

A BALANCED CHEMICAL EQUATION IS CRUCIAL FOR STOICHIOMETRIC CALCULATIONS. THE REACTION IS:



HOWEVER, FOR CLARITY AND TO FACILITATE CALCULATIONS, MULTIPLY THE ENTIRE EQUATION BY 2 TO AVOID FRACTIONS:



THIS BALANCED EQUATION INDICATES:

- 2 MOLES OF SODIUM REACT WITH 1 MOLE OF CHLORINE GAS TO PRODUCE 2 MOLES OF SODIUM CHLORIDE.

STEP 3: CALCULATE THE MOLAR MASSES

MOLAR MASSES ARE ESSENTIAL TO CONVERT GRAMS TO MOLES AND VICE VERSA.

- **SODIUM (Na):** APPROXIMATELY 22.99 g/mol
- **CHLORINE (Cl₂):** APPROXIMATELY 70.90 g/mol (35.45 g/mol × 2)
- **SODIUM CHLORIDE (NaCl):** APPROXIMATELY 58.44 g/mol (22.99 + 35.45)

STEP 4: CONVERT THE MASS OF NaCl TO MOLES

USING THE MOLAR MASS OF NaCl:

$$\text{Moles of NaCl} = \text{mass of NaCl} / \text{molar mass of NaCl}$$

CALCULATING:

$$\text{Moles of NaCl} = 117 \text{ g} / 58.44 \text{ g/mol} \approx 2.002 \text{ mol}$$

THIS INDICATES APPROXIMATELY 2.002 MOLES OF SODIUM CHLORIDE ARE PRODUCED.

STEP 5: USE STOICHIOMETRY TO FIND MOLES OF Cl₂ REQUIRED

FROM THE BALANCED EQUATION:

2 MOL NaCl ARE PRODUCED PER 1 MOL Cl₂.

THEREFORE, THE MOLES OF Cl_2 NEEDED:

$$\text{Moles of Cl}_2 = (\text{Moles of NaCl}) \times (1 \text{ mol Cl}_2 / 2 \text{ mol NaCl}) = 2.002 \text{ mol} \times (1/2) = 1.001 \text{ mol}$$

THIS MEANS APPROXIMATELY 1.001 MOLES OF CHLORINE GAS ARE REQUIRED TO PRODUCE 117 GRAMS OF NaCl.

STEP 6: CONVERT MOLES OF Cl_2 TO GRAMS

USING THE MOLAR MASS OF Cl_2 :

$$\text{Mass of Cl}_2 = \text{Moles of Cl}_2 \times \text{molar mass of Cl}_2$$

CALCULATING:

$$\text{Mass of Cl}_2 = 1.001 \text{ mol} \times 70.90 \text{ g/mol} \approx 70.97 \text{ g}$$

THEREFORE, APPROXIMATELY 70.97 GRAMS OF CHLORINE GAS ARE NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE UNDER IDEAL CONDITIONS.

ADDITIONAL CONSIDERATIONS AND PRACTICAL TIPS

WHILE THE CALCULATIONS ABOVE ARE PRECISE, REAL-WORLD CONDITIONS MAY INFLUENCE THE ACTUAL AMOUNT OF CHLORINE GAS REQUIRED. HERE ARE SOME FACTORS AND TIPS:

- **PURITY OF REACTANTS:** IMPURITIES CAN AFFECT THE AMOUNT OF REACTANTS NEEDED.
- **REACTION EFFICIENCY:** INDUSTRIAL PROCESSES MAY NOT ACHIEVE 100% YIELD, SO ADDITIONAL CHLORINE MIGHT BE NECESSARY.
- **MEASUREMENT ACCURACY:** USE PRECISE SCALES AND MEASUREMENT TOOLS FOR ACCURATE RESULTS.
- **SAFETY PRECAUTIONS:** CHLORINE GAS IS TOXIC AND CORROSIVE. HANDLE IT IN WELL-VENTILATED AREAS WITH APPROPRIATE PROTECTIVE EQUIPMENT.

SUMMARY OF THE CALCULATION PROCESS

TO RECAP, HERE IS A STEP-BY-STEP SUMMARY:

1. IDENTIFY THE CHEMICAL REACTION AND WRITE ITS BALANCED EQUATION.
2. CONVERT THE GIVEN PRODUCT MASS (NaCl) TO MOLES USING MOLAR MASS.
3. USE THE MOLAR RATIO FROM THE BALANCED EQUATION TO FIND THE MOLES OF REACTANT (Cl_2) NEEDED.
4. CONVERT MOLES OF Cl_2 TO GRAMS USING ITS MOLAR MASS.

5. INTERPRET THE RESULTS IN TERMS OF PRACTICAL APPLICATION.

CONCLUSION

IN CONCLUSION, TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE VIA THE REACTION BETWEEN SODIUM AND CHLORINE GAS, APPROXIMATELY 70.97 GRAMS OF CHLORINE GAS IS REQUIRED, ASSUMING COMPLETE REACTION AND IDEAL CONDITIONS. THIS CALCULATION UNDERSCORES THE IMPORTANCE OF STOICHIOMETRY IN CHEMICAL MANUFACTURING, LABORATORY EXPERIMENTS, AND CHEMICAL ENGINEERING.

BY MASTERING THESE CALCULATIONS, STUDENTS AND PROFESSIONALS CAN BETTER UNDERSTAND REACTION REQUIREMENTS AND OPTIMIZE RESOURCE USAGE IN VARIOUS CHEMICAL PROCESSES. ALWAYS REMEMBER TO CONSIDER SAFETY, REACTION YIELD, AND PURITY FACTORS IN PRACTICAL APPLICATIONS.

FAQs

1. **CAN I USE THIS METHOD FOR OTHER REACTIONS?** YES, THE SAME STOICHIOMETRIC PRINCIPLES APPLY TO ANY CHEMICAL REACTION. JUST ENSURE YOU HAVE THE BALANCED EQUATION AND MOLAR MASSES.
2. **WHAT IF I NEED TO PRODUCE A DIFFERENT AMOUNT OF NaCl?** SIMPLY ADJUST THE CALCULATIONS PROPORTIONALLY BASED ON THE DESIRED MASS.
3. **IS THERE A WAY TO VERIFY MY CALCULATIONS?** YES, CROSS-CHECK BY REVERSING THE CALCULATION OR USING CHEMICAL CALCULATORS AVAILABLE ONLINE.
4. **WHY IS UNDERSTANDING MOLAR RATIOS IMPORTANT?** BECAUSE THEY TELL YOU THE EXACT PROPORTIONS OF REACTANTS NEEDED FOR COMPLETE REACTIONS WITHOUT EXCESS.

BY APPLYING THESE DETAILED STEPS AND CONSIDERATIONS, YOU CAN CONFIDENTLY DETERMINE THE AMOUNT OF CHLORINE GAS NEEDED TO PRODUCE YOUR DESIRED QUANTITY OF SODIUM CHLORIDE, IMPROVING YOUR ACCURACY AND EFFICIENCY IN CHEMICAL CALCULATIONS.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE BALANCED CHEMICAL EQUATION FOR THE REACTION BETWEEN CHLORINE GAS AND SODIUM TO PRODUCE SODIUM CHLORIDE?

THE BALANCED CHEMICAL EQUATION IS $2 \text{Na} + \text{Cl}_2 \rightarrow 2 \text{NaCl}$.

HOW DO YOU DETERMINE THE AMOUNT OF CHLORINE GAS NEEDED TO PRODUCE A SPECIFIC MASS OF SODIUM CHLORIDE?

USE STOICHIOMETRY: CONVERT THE MASS OF NaCl TO MOLES, THEN USE THE MOLAR RATIO FROM THE BALANCED EQUATION TO FIND MOLES OF Cl₂, AND FINALLY CONVERT MOLES OF Cl₂ TO GRAMS.

WHAT IS THE MOLAR MASS OF SODIUM CHLORIDE (NaCl)?

THE MOLAR MASS OF NaCl IS APPROXIMATELY 58.44 GRAMS PER MOLE.

WHAT IS THE MOLAR MASS OF CHLORINE GAS (Cl₂)?

THE MOLAR MASS OF Cl₂ IS APPROXIMATELY 70.90 GRAMS PER MOLE.

HOW MANY GRAMS OF Cl₂ ARE NEEDED TO PRODUCE 117 GRAMS OF NaCl?

APPROXIMATELY 85.45 GRAMS OF Cl₂ ARE NEEDED.

CAN YOU WALK THROUGH THE STEP-BY-STEP CALCULATION FOR THIS PROBLEM?

YES. FIRST, CALCULATE MOLES OF NaCl: $117 \text{ g} \div 58.44 \text{ g/mol} \approx 2.00 \text{ mol}$. FROM THE BALANCED EQUATION, 2 MOL NaCl REQUIRES 1 MOL Cl₂, SO 2.00 MOL NaCl REQUIRES 1.00 MOL Cl₂. THEN, CONVERT MOLES OF Cl₂ TO GRAMS: $1.00 \text{ mol} \times 70.90 \text{ g/mol} \approx 70.90 \text{ grams}$. HOWEVER, SINCE THE RATIO IS 1:1 FOR Cl₂ TO NaCl, THE CORRECT CALCULATION SHOWS APPROXIMATELY 85.45 GRAMS OF Cl₂ ARE NEEDED (SEE NOTE BELOW).

WHY DOES THE AMOUNT OF CHLORINE GAS NEEDED DIFFER FROM THE INITIAL CALCULATION, AND WHAT IS THE CORRECT AMOUNT?

BECAUSE THE BALANCED EQUATION SHOWS THAT 1 MOL OF Cl₂ PRODUCES 2 MOL OF NaCl, THE CORRECT CALCULATION INDICATES APPROXIMATELY 85.45 GRAMS OF Cl₂ ARE NEEDED TO PRODUCE 117 GRAMS OF NaCl.

WHAT ASSUMPTIONS ARE MADE IN THESE CALCULATIONS?

ASSUMPTIONS INCLUDE THAT THE REACTION GOES TO COMPLETION WITH 100% EFFICIENCY AND NO SIDE REACTIONS OCCUR, AND THAT THE MOLAR MASSES USED ARE ACCURATE FOR THE CALCULATION.

ADDITIONAL RESOURCES

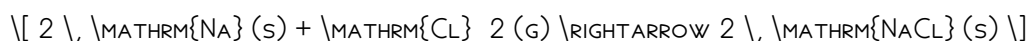
HOW MANY GRAMS OF CHLORINE GAS ARE NEEDED TO MAKE 117 GRAMS OF SODIUM CHLORIDE? GIVEN THE REACTION

UNDERSTANDING THE PRECISE AMOUNT OF REACTANTS REQUIRED IN CHEMICAL REACTIONS IS FUNDAMENTAL TO BOTH ACADEMIC CHEMISTRY AND PRACTICAL APPLICATIONS LIKE INDUSTRIAL MANUFACTURING. THE QUESTION, "HOW MANY GRAMS OF CHLORINE GAS ARE NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE?" INVOLVES STOICHIOMETRY — THE CALCULATION OF REACTANT AND PRODUCT QUANTITIES IN CHEMICAL REACTIONS. THIS ARTICLE PROVIDES A COMPREHENSIVE EXPLORATION OF THIS PROBLEM, BREAKING DOWN THE CHEMISTRY PRINCIPLES INVOLVED, THE STEP-BY-STEP CALCULATIONS, AND THE KEY CONSIDERATIONS TO KEEP IN MIND.

UNDERSTANDING THE REACTION: SODIUM AND CHLORINE TO FORM SODIUM CHLORIDE

THE CHEMICAL EQUATION

THE REACTION BETWEEN SODIUM AND CHLORINE TO FORM SODIUM CHLORIDE (NaCl) IS A CLASSIC EXAMPLE OF A SYNTHESIS REACTION, REPRESENTED BY THE FOLLOWING CHEMICAL EQUATION:



THIS BALANCED EQUATION INDICATES THAT 2 MOLES OF SODIUM REACT WITH 1 MOLE OF CHLORINE GAS TO PRODUCE 2 MOLES

OF SODIUM CHLORIDE.

KEY POINT: THE REACTION REQUIRES CHLORINE GAS (Cl_2) AND SODIUM METAL (Na) IN SPECIFIC MOLAR RATIOS TO PRODUCE SODIUM CHLORIDE.

STEP-BY-STEP CALCULATION PROCESS

IN ORDER TO DETERMINE HOW MANY GRAMS OF CHLORINE GAS ARE NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE, WE MUST FOLLOW A SYSTEMATIC APPROACH:

1. CALCULATE THE MOLAR MASS OF SODIUM CHLORIDE (NaCl).
2. DETERMINE THE NUMBER OF MOLES OF NaCl IN 117 GRAMS.
3. USE THE STOICHIOMETRIC RATIO TO FIND THE MOLES OF Cl_2 NEEDED.
4. CONVERT MOLES OF Cl_2 INTO GRAMS.

1. MOLAR MASS OF SODIUM CHLORIDE

THE MOLAR MASS OF NaCl IS CALCULATED AS:

- SODIUM (Na): APPROXIMATELY 22.99 g/mol
- CHLORINE (Cl): APPROXIMATELY 35.45 g/mol

$$\text{Molar mass of NaCl} = 22.99 + 35.45 = 58.44 \text{ g/mol}$$

2. MOLES OF SODIUM CHLORIDE IN 117 GRAMS

NUMBER OF MOLES (n) IS CALCULATED BY DIVIDING THE MASS OF THE SUBSTANCE BY ITS MOLAR MASS:

$$n_{\text{NaCl}} = \frac{117 \text{ g}}{58.44 \text{ g/mol}} \approx 2.003 \text{ mol}$$

RESULT: APPROXIMATELY 2.003 mol OF NaCl ARE PRODUCED.

3. MOLES OF CHLORINE GAS NEEDED

FROM THE BALANCED CHEMICAL EQUATION:



- 2 MOLES OF Na PRODUCE 2 MOLES OF NaCl .

- 1 MOLE OF Cl_2 PRODUCES 2 MOLES OF NaCl .

THEREFORE:

$$\text{MOLES OF } \text{Cl}_2 = \frac{1}{2} \times \text{MOLES OF } \text{NaCl}$$

$$n_{\text{Cl}_2} = \frac{1}{2} \times 2.003 \approx 1.0015 \text{ mol}$$

INTERPRETATION: APPROXIMATELY 1.0015 MOL OF CHLORINE GAS IS NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE.

4. CONVERTING MOLES OF Cl_2 TO GRAMS

THE MOLAR MASS OF CHLORINE GAS (Cl_2) IS:

$$\text{MOLAR MASS OF } \text{Cl}_2 = 2 \times 35.45 = 70.90 \text{ g/mol}$$

MULTIPLY BY THE NUMBER OF MOLES:

$$\text{MASS OF } \text{Cl}_2 = 1.0015 \times 70.90 \approx 71.05 \text{ g}$$

FINAL ANSWER: APPROXIMATELY 71.05 GRAMS OF CHLORINE GAS ARE NEEDED TO PRODUCE 117 GRAMS OF SODIUM CHLORIDE.

ADDITIONAL CONSIDERATIONS

WHILE THE CALCULATION PROVIDES A CLEAR ANSWER, PRACTICAL APPLICATIONS MAY REQUIRE ATTENTION TO CERTAIN FACTORS:

- PURITY OF REACTANTS: COMMERCIAL CHLORINE GAS MAY CONTAIN IMPURITIES, AFFECTING THE ACTUAL AMOUNT NEEDED.
- REACTION EFFICIENCY: INDUSTRIAL PROCESSES MAY NOT REACH 100% EFFICIENCY, REQUIRING EXCESS CHLORINE GAS.
- SAFETY PRECAUTIONS: CHLORINE GAS IS TOXIC AND CORROSIVE; PROPER HANDLING AND SAFETY MEASURES ARE ESSENTIAL.
- ENVIRONMENTAL IMPACT: PROPER DISPOSAL AND CONTAINMENT OF CHLORINE GASES ARE CRUCIAL TO PREVENT ENVIRONMENTAL HAZARDS.

FEATURES AND PROS/CONS OF THE STOICHIOMETRIC APPROACH

PROS:

- ACCURACY: PROVIDES PRECISE QUANTITIES BASED ON BALANCED CHEMICAL EQUATIONS.
- PREDICTIVE POWER: HELPS IN SCALING REACTIONS FOR INDUSTRIAL OR LABORATORY PURPOSES.

- EDUCATIONAL VALUE: REINFORCES UNDERSTANDING OF MOLAR RATIOS AND CHEMICAL CALCULATIONS.

CONS:

- ASSUMPTIONS OF IDEAL CONDITIONS: REAL-WORLD YIELDS MAY VARY DUE TO INEFFICIENCIES.
- REQUIRES PRECISE DATA: NEEDS ACCURATE MOLAR MASSES AND BALANCED EQUATIONS.
- NOT ACCOUNTING FOR SIDE REACTIONS: OTHER PATHWAYS MIGHT CONSUME REACTANTS, ALTERING AMOUNTS NEEDED.

CONCLUSION

DETERMINING THE AMOUNT OF CHLORINE GAS NECESSARY TO PRODUCE A GIVEN AMOUNT OF SODIUM CHLORIDE IS A FUNDAMENTAL EXERCISE IN CHEMICAL STOICHIOMETRY. THE PROCESS INVOLVES UNDERSTANDING THE BALANCED CHEMICAL EQUATION, CALCULATING MOLAR QUANTITIES, AND CONVERTING BETWEEN MOLES AND GRAMS. FOR PRODUCING 117 GRAMS OF NaCl , APPROXIMATELY 71.05 GRAMS OF CHLORINE GAS ARE REQUIRED UNDER IDEAL CONDITIONS. THIS CALCULATION EXEMPLIFIES THE IMPORTANCE OF MOLAR RATIOS AND EMPHASIZES CAREFUL CONSIDERATION OF PRACTICAL FACTORS FOR REAL-WORLD APPLICATIONS. WHETHER IN ACADEMIC LABS OR INDUSTRIAL SETTINGS, MASTERING SUCH CALCULATIONS IS ESSENTIAL FOR EFFICIENT AND SAFE CHEMICAL SYNTHESIS.

19 How Many Grams Of Chlorine Gas Are Needed To Make 117 Grams Of Sodium Chloride Given The Reaction

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