

Stoichiometry

Mole ratios, mass-to-mass, limiting reactant, excess, and percent yield.

01 Balance first

CORE RULE

Balance the equation before any calculation. The coefficients are the source of every mole ratio you will use.

02 Mole ratio (stoichiometric factor)

CORE RULE

Coefficients give the conversion factor between substances. The factor from A to B is (coefficient of B) / (coefficient of A).

03 Convert to moles first

CORE RULE

Anything not in moles must become moles before the ratio: mass $\div$ molar mass; gas at STP $\div$ 22.4 L/mol; particle count $\div$ N_a .

04 Mass-to-mass (four steps)

METHOD

mass A $\rightarrow$ mol A ($\div$ MM_A) $\rightarrow$ mol B ($\times$ stoichiometric factor) $\rightarrow$ mass B ($\times$ MM_B). Carry units so they cancel.

05 Find the limiting reactant

METHOD

When both reactant amounts are given: convert each to moles, divide each by its coefficient; the smaller quotient is the limiting reactant. (Or compute product from each; the smaller wins.)

06 Use the limiting reactant

CORE RULE

Compute product from the limiting reactant's moles only (never the excess): $\times$ stoichiometric factor $\times$ product molar mass.

07 Excess reactant remaining

CORE RULE

Consumed excess = mol LR $\times$ (excess coeff / LR coeff) $\times$ MM_excess. Remaining = initial excess – consumed. A negative result means the LR was misidentified.

08 Percent yield

CORE RULE

Percent yield = (actual / theoretical) $\times$ 100. Theoretical comes from the limiting reactant at 100% conversion.

09 Theoretical from a known yield

CORE RULE

Given actual amount and percent yield: theoretical = (actual $\times$ 100) / percent yield.

10 Reverse-yield (work backwards)

METHOD

Given actual product + percent yield, find reactant needed: actual $\rightarrow$ theoretical (via % yield) $\rightarrow$ mol product $\rightarrow$ mol reactant (ratio) $\rightarrow$ mass reactant ($\times$ MM).

11 Gas at STP

CORE RULE

At STP (273.15 K, 1 atm) one mole of any ideal gas occupies 22.4 L. Use 22.4 L/mol to convert moles $\leftrightarrow$ volume for gas-phase species only (not liquids/solids).

12 Mass-balance check

WATCH OUT

Conservation of mass: total mass of reactants consumed = total mass of products formed. Use it as an independent check on the answer.