

Lever Rule Cheat Sheet

Phase fractions from a tie line on a binary diagram

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Tie line compositions	C_0, C_α, C_L	Overall alloy, alpha at solidus, liquid at liquidus
Liquid fraction	$W_L = (C_0 - C_\alpha) / (C_L - C_\alpha)$	Arm on the alpha side of C_0
Alpha fraction	$W_\alpha = (C_L - C_0) / (C_L - C_\alpha)$	Arm on the liquid side of C_0
Check	$W_\alpha + W_L = 1$	Fractions always sum to 100%
Mass balance basis	$C_0 = W_\alpha C_\alpha + W_L C_L$	Solute in all phases equals solute in alloy
Post's example	C_0 30, C_α 10, C_L 70 wt%	$W_\alpha = 40/60 = 66.7\%$, $W_L = 20/60 = 33.3\%$

Key takeaways

- Use it only inside a two-phase region of a binary phase diagram, at a fixed temperature.
- Draw a horizontal tie line across the region. Its ends are the compositions of the two coexisting phases.
- Each phase fraction uses the opposite arm of the tie line, hence 'inverse'. Think of a seesaw with C_0 as the pivot.
- Works between liquidus and solidus on cooling, and for solid-solid regions such as alpha plus beta in a eutectic system.
- Why it matters: the ratio of hard to soft (or brittle to ductile) phases sets strength, ductility and machinability.
- Use it for alloy design, heat treatment planning and cooling-rate decisions.
- Steps: (1) read C_α and C_L on the tie line, (2) subtract along the correct arm, (3) divide by the full tie-line length, (4) confirm the sum is 1.

Post's worked example, step by step

Quantity	Calculation	Result
Tie line length	$70 - 10$	60 wt%
Alpha arm (to liquid side)	$70 - 30$	40 wt%
Liquid arm (to alpha side)	$30 - 10$	20 wt%
W_α and W_L	40/60 and 20/60	66.7% and 33.3%