Lever Rule: Phase Fractions from a Phase Diagram

Mass fractions and masses of two phases in a two-phase field of a binary phase diagram from the alloy composition and the two tie-line end compositions.

Method: Lever rule (mass balance along a tie line; Callister, Materials Science and Engineering, ch. 9)

Input parameters

Unit system: SI

Parameter	Value	Unit
Overall alloy composition (wt %)	0.40000	%
Composition of phase α, tie-line end (wt %)	0.020000	%
Composition of phase β, tie-line end (wt %)	0.77000	%
Alloy mass	100.00	kg

Calculated results

Parameter	Value	Unit
Mass fraction of α	49.333	%
Mass fraction of β	50.667	%
Mass of α	49.333	kg
Mass of β	50.667	kg

Notes for this case

- Read both tie-line ends at the same temperature from the diagram. For steels just below the eutectoid, α is ferrite (about 0.02 % C) and β is pearlite or cementite depending on the question.

Formula and method

$$W_\alpha = \frac{C_\beta - C_0}{C_\beta - C_\alpha}, \quad W_\beta = \frac{C_0 - C_\alpha}{C_\beta - C_\alpha}$$

Variables

C_0	Overall alloy composition	-
C_α	Composition of phase α (tie-line end)	-
C_β	Composition of phase β (tie-line end)	-
m	Alloy mass	kg
W_α	Mass fraction of α	-
W_β	Mass fraction of β	-
m_α	Mass of α	kg
m_β	Mass of β	kg

Method and standards

Mass balance.

Assumptions and limits

- Equilibrium; binary system.
- Compositions in weight per cent give mass fractions of the phases; compositions in atomic per cent would give mole (atom) fractions instead.

References

- Lever rule (mass balance along a tie line; Callister, Materials Science and Engineering, ch. 9)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/properties/lever-rule-phase-fractions

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.