2022 0.1

Logistics: 8-9 problem sets; 1st half (Chp 6+) due after 2 weeks

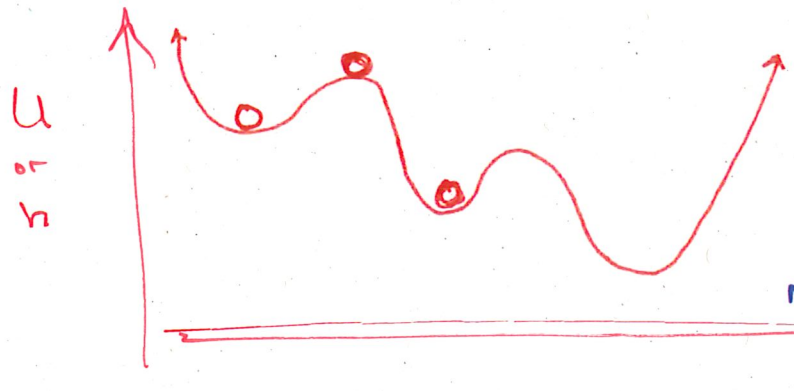
Groups ⇒ 1 group = 1 problem set ⇒ Possible surprise quiz

Maple: Unavoidable, get it over with! Tutorial, Java

*.mws vs *.mw

Goal?: To understand how thermodynamics can be used to predict mineralogy and physical properties in the earth's interior ⇒ Phase diagrams

1) Stability vs Equilibrium



stationary points → Eq → $\frac{\partial U}{\partial x} = 0$

Unstable → $\frac{\partial^2 U}{\partial x^2} < 0$

Metastable, Stable → $\frac{\partial^2 U}{\partial x^2} > 0$

mineral physics vs thermodynamics

2) Variables:

metrical

$\sum_j \alpha^j = 1$

$X^{sys} = \sum \alpha^j X^j$

External – environmental – field → same within all phases (eg. P, T). → states of matter

Internal – compositional – different among the phases → conservative for the system.

Given the possible states of matter (phases) → $\alpha \geq 0$ existence

No interactions!

$\alpha^{Fo} + \alpha^{En} = 1$ → continuity

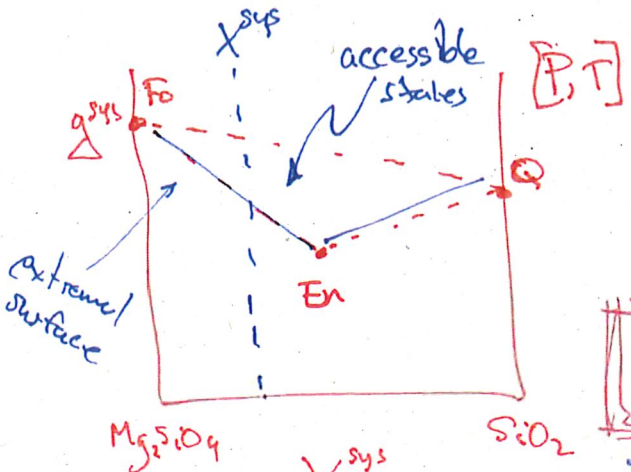
$X^{sys} = \alpha^{Fo} X^{Fo} + \alpha^{En} X^{En}$

$\alpha^{En} = 1 - \alpha^{Fo}$

$\Rightarrow \alpha^{Fo} = \frac{X^{sys} - X^{En}}{X^{Fo} - X^{En}}$

⇒ "The Lever Rule"

2022. 02



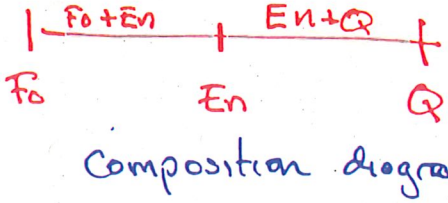
$[P,T]$

$X \rightarrow$ amounts ≥ 0 !

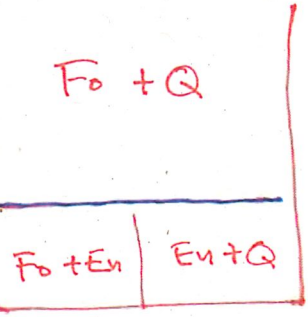
now what? $\Rightarrow$ Thermodynamics

$\min_X(g^{sys})$ at cst $P, T, X \Rightarrow$

$\frac{\partial g}{\partial X} \neq 0 \quad \frac{\partial^2 g}{\partial X^2} \geq 0 \Rightarrow$ An extremal principle



Composition diagram



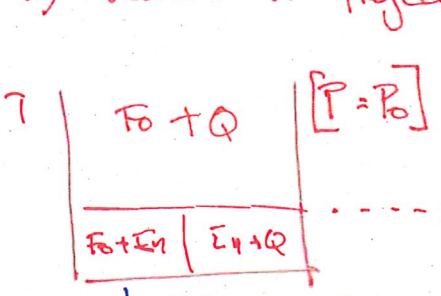
singularity

X

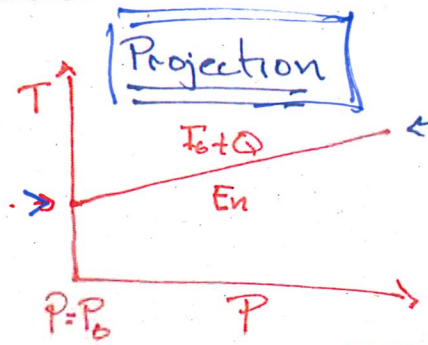
mixed-variable diagram (section)

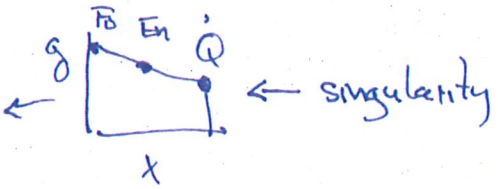
discontinuous reaction/transformation - phases do not change composition $\rightarrow$ heterogeneous reactions

4) Sections vs Projections

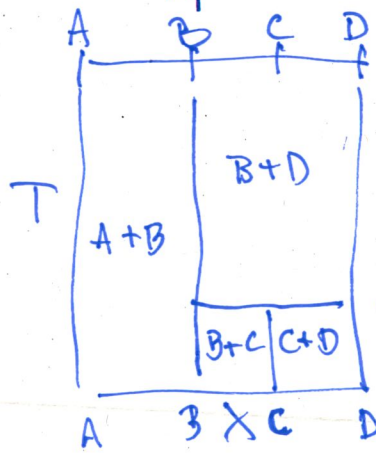


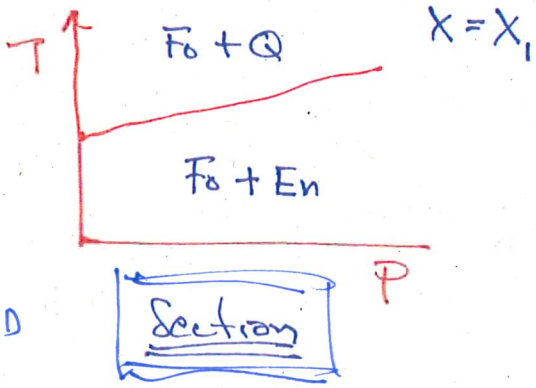
$[P = P_0]$





X_1



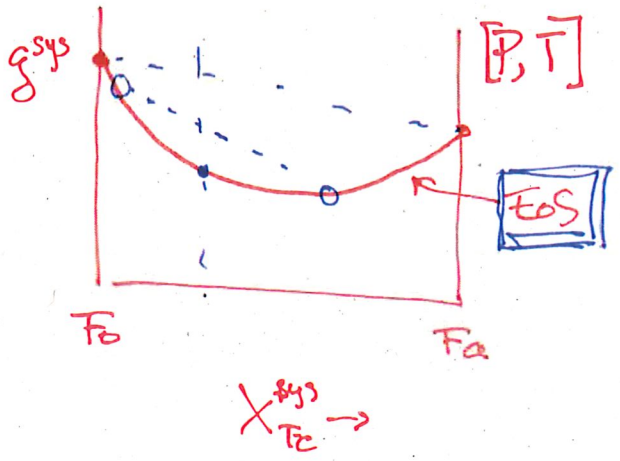


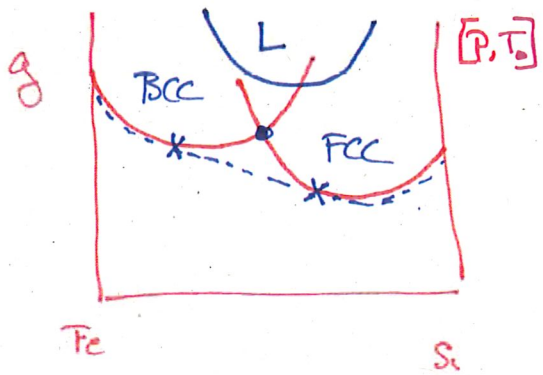
$X^{En} = \alpha^{Fo} X^{Fo} + \alpha^{Q} X^{Q}$

amounts = reaction coefficients

5) Solutions $(Mg,Fe)_2SiO_4$ — Olivine

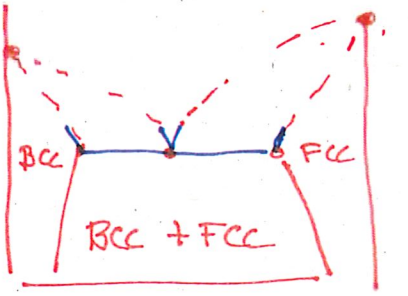
Fo — Fa

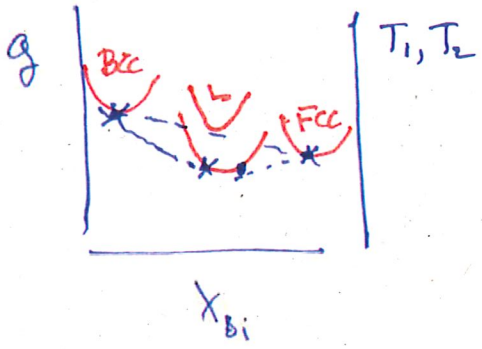


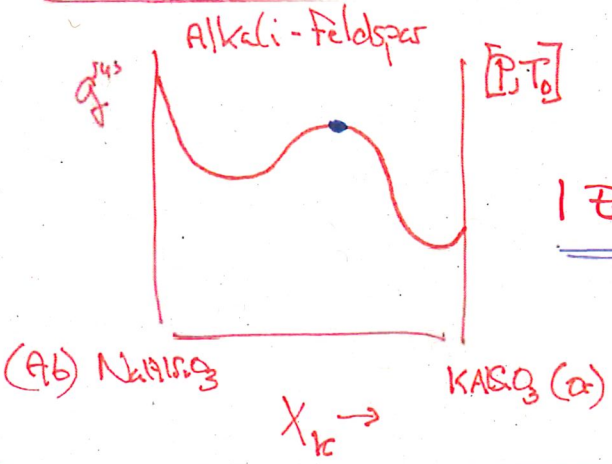


phases change composition continuously as a $F(P,T)$

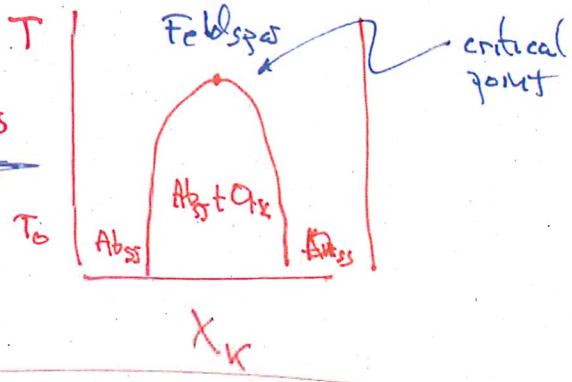
continuous (homogeneous) reactions







1 EoS => 2 phases



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a) If g is some kind of energy why isn't it conserved?

b) Why minimize g at cst P,T,X?

c) What do we minimize at cst $V-T-X$ - isochore

$P-Q-X$ - adiabatic

Problems

problem 9.1 2022 04

$f := ax^2 + bx + c = 0;$

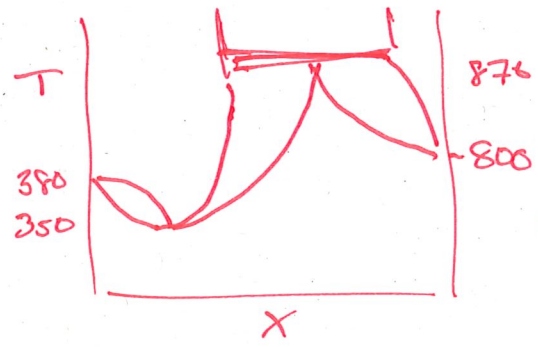
$g := int(f, x)$

$h = dif(f, x)$

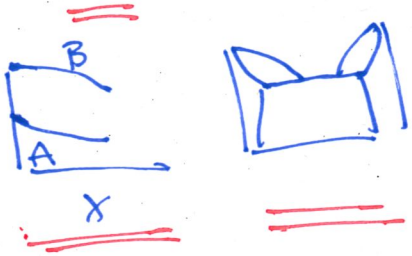
plot (subs (a=1, b=2, c=3, (f, g, h)), x = -10..10, -20..20)

color = ["Red", ...])

example peritectic

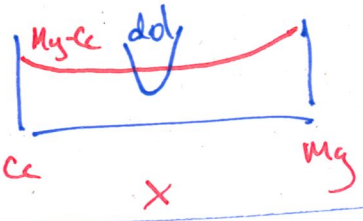


SKETCH !! but not:

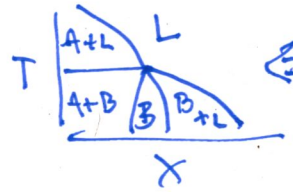


0.1 → solvus

0.2 → order-disorder

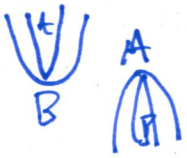


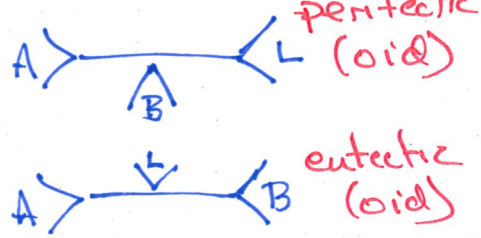
0.3



⇐ possible but improbable

probable:





0.4