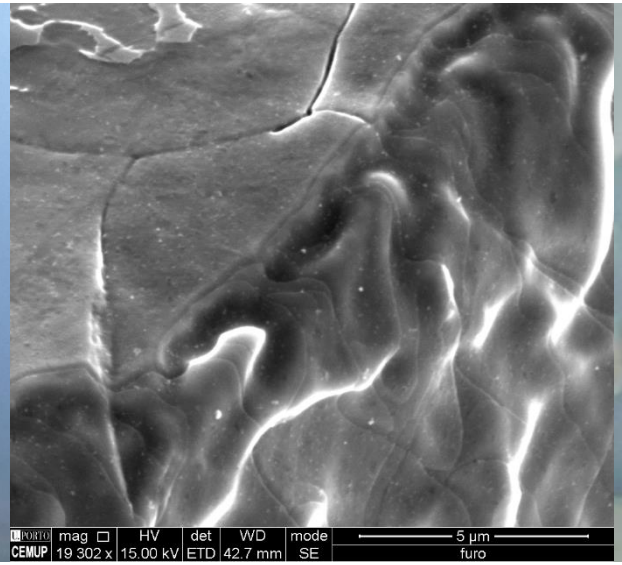
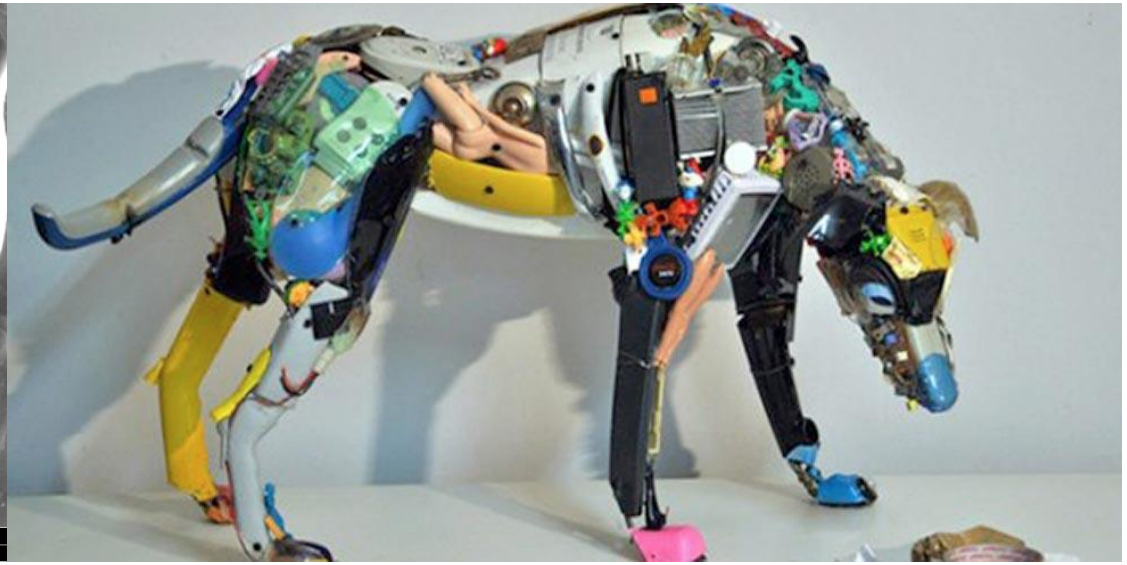
Physical Chemistry

... iremos explorar, refletir, aprender ?..

Area of chemistry concerned with the **application of the techniques and theories of physics** to the study of chemical systems.

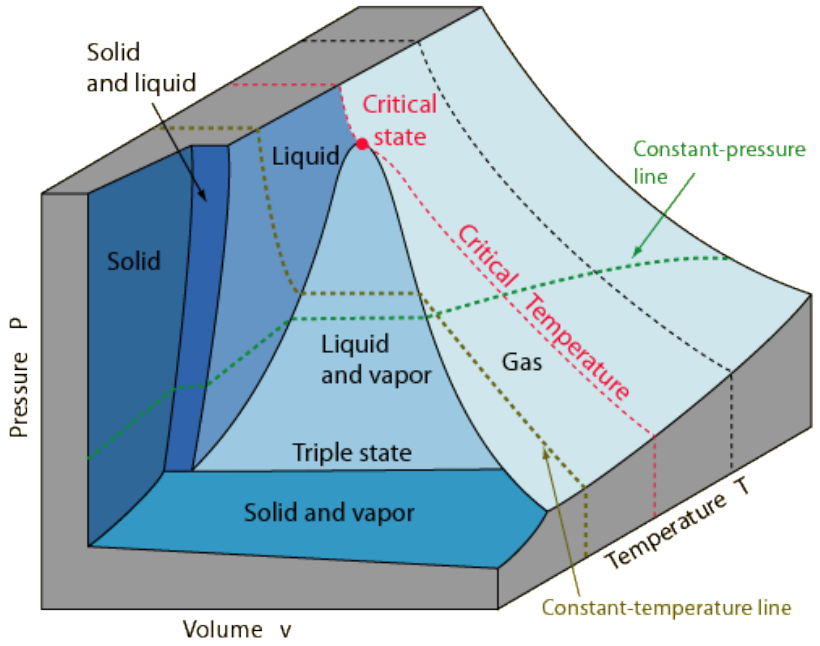


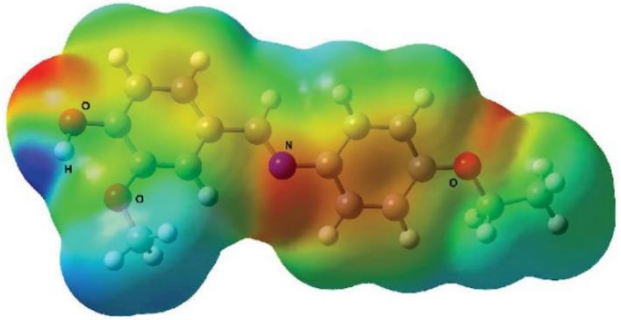


Phase diagrams

Pure substances & Mixtures

PVT diagram

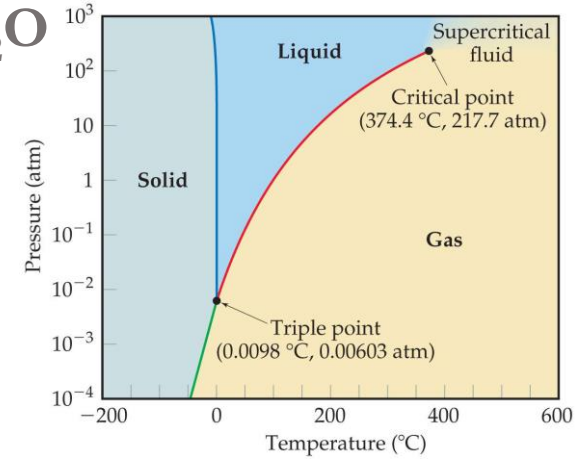




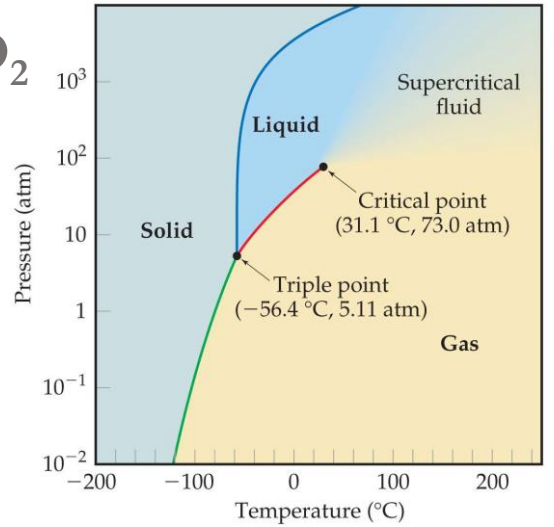
Why each compound have a different PVT surface profile?

- C-H-π and π-π .. interactions
- H-bond
- Electrostatic .. interactions
- Molecular shape
- ...???

H_2O



CO_2



Phase diagrams

One-component systems

$C = 1$

J.W. Gibbs deduced the **phase rule**

$$F = C - P + 2$$

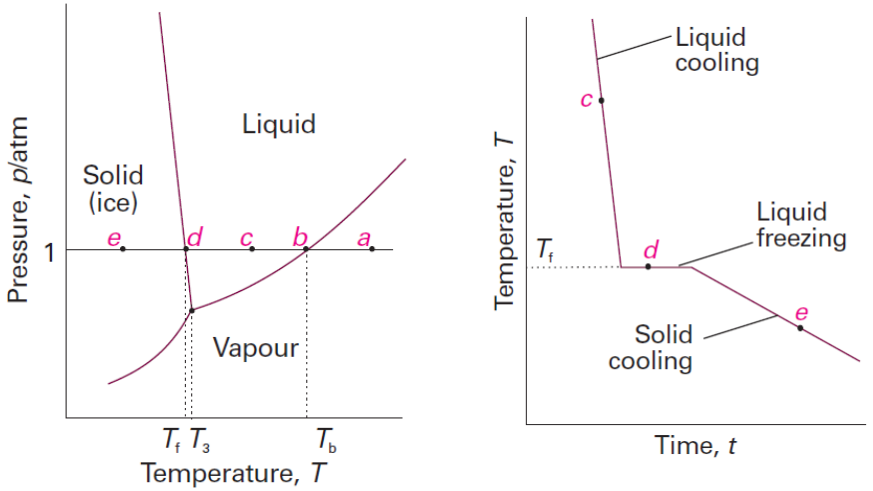
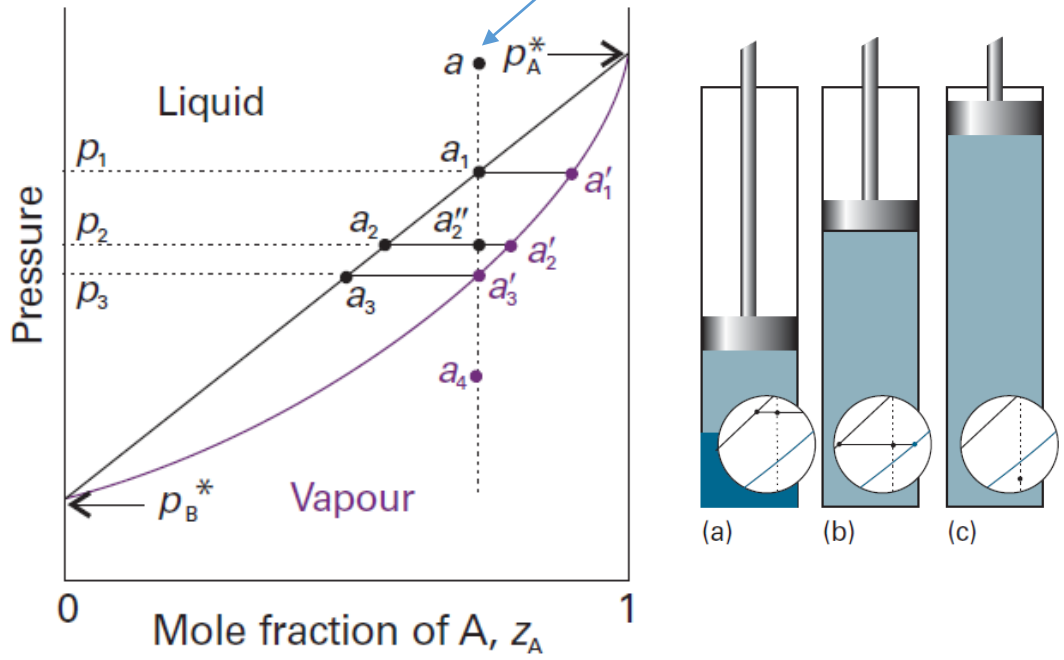


Fig. 6.3 The phase diagram for water, a simplified version of Fig. 4.5. The label T_3 marks the temperature of the triple point, T_b the normal boiling point, and T_f the normal freezing point.

Fig. 6.10 The points of the pressure–composition diagram discussed in the text. The vertical line through *a* is an *isopleth*, a line of constant composition of the entire system.

isopleth,



Phase diagrams

Two-component systems $C = 2$

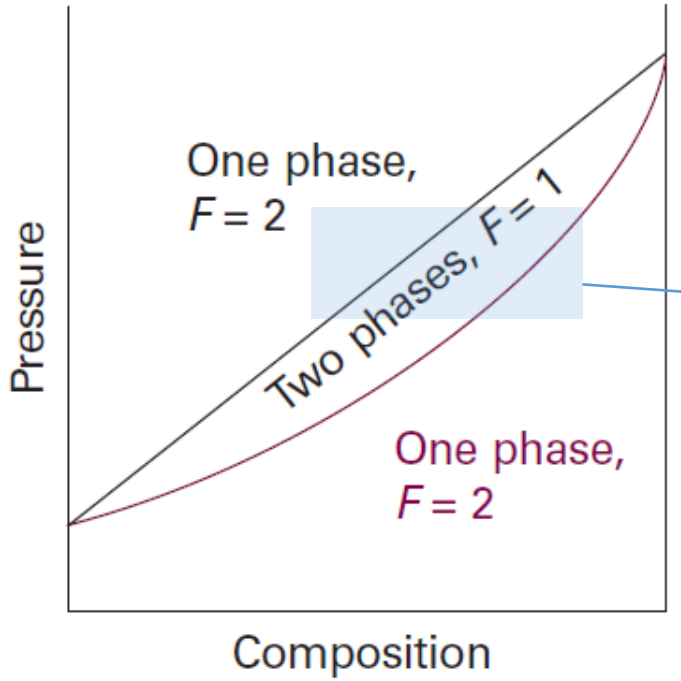
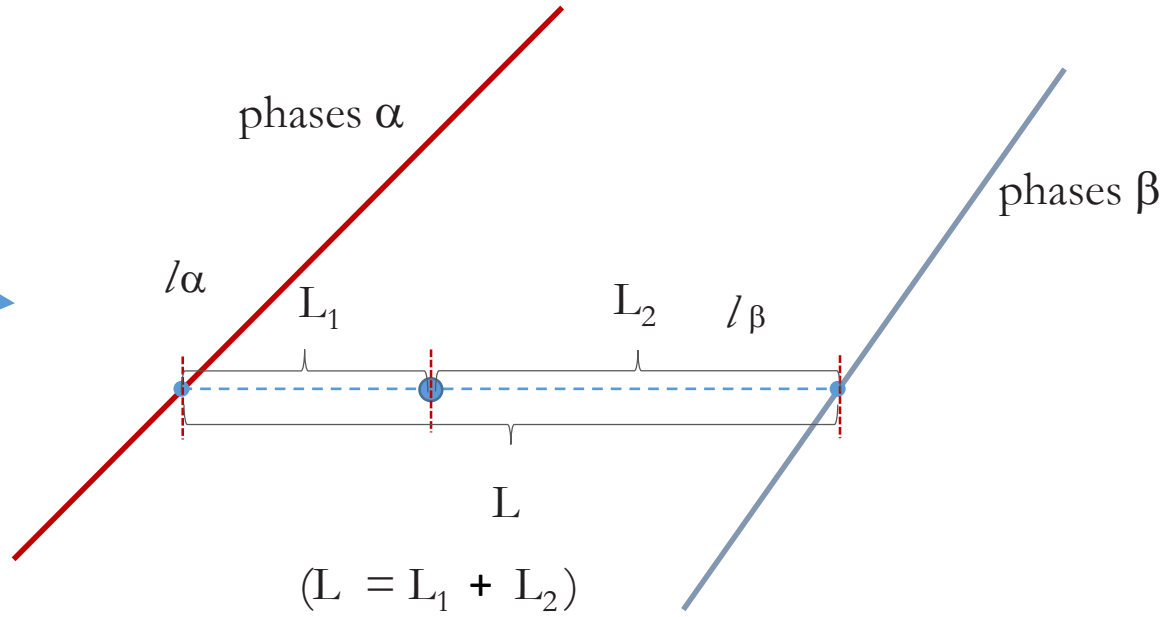


Fig. 6.12 The general scheme of interpretation of a pressure–composition diagram (a vapour pressure diagram).

Lever rule



Proportions of the amounts

phase α = L_2 / L
phase β = L_1 / L

e.g. L=0.50 ; L_1 = 0.20 ; L_2 = 0.30;

phase α = 0.3/0.5 = 0.60 ... 60%
phase β = 0.2/0.5=0.40 ... 40%

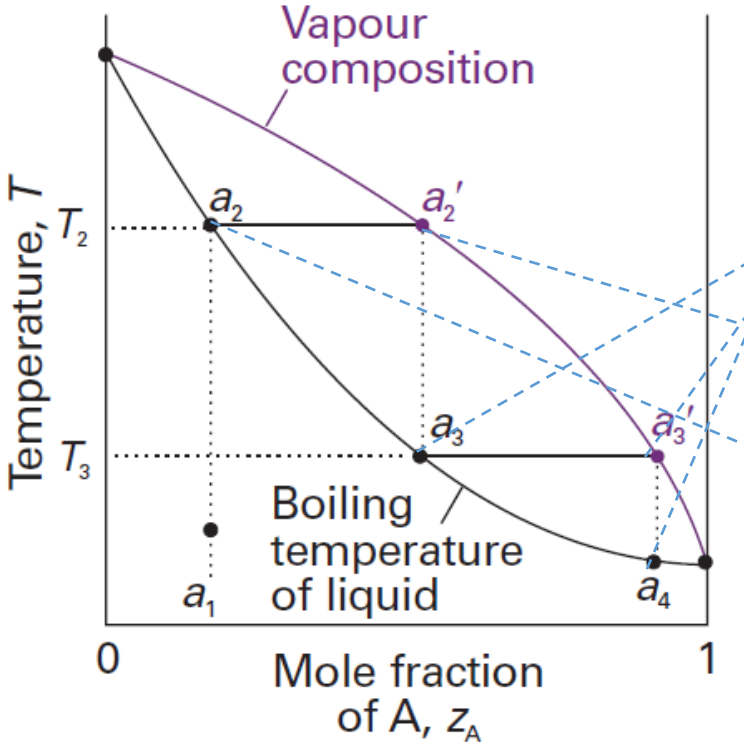
Phase diagrams

Two-component systems

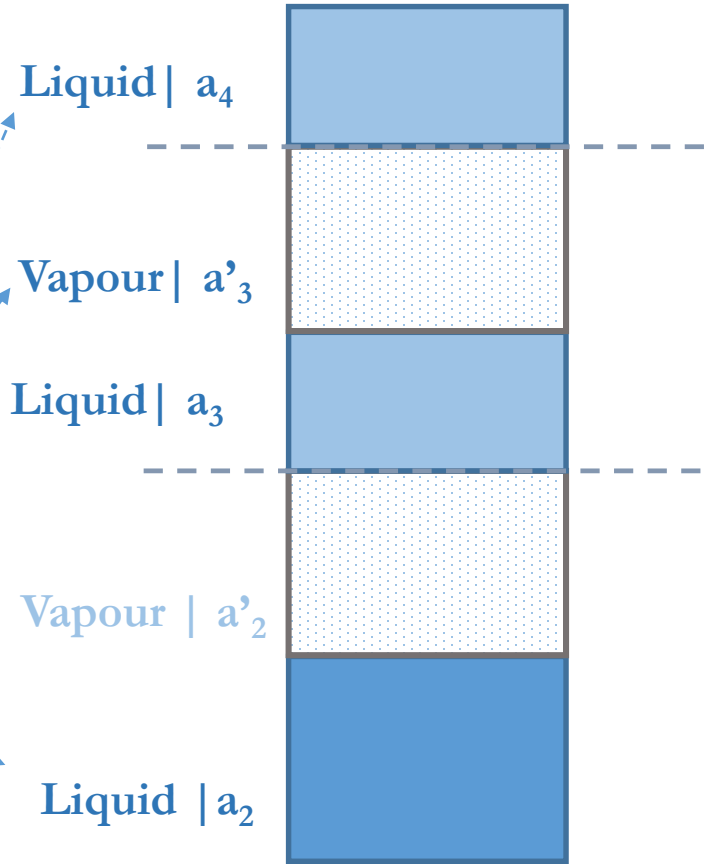
$C = 2$

Temperature–Composition diagram

T - x diagram

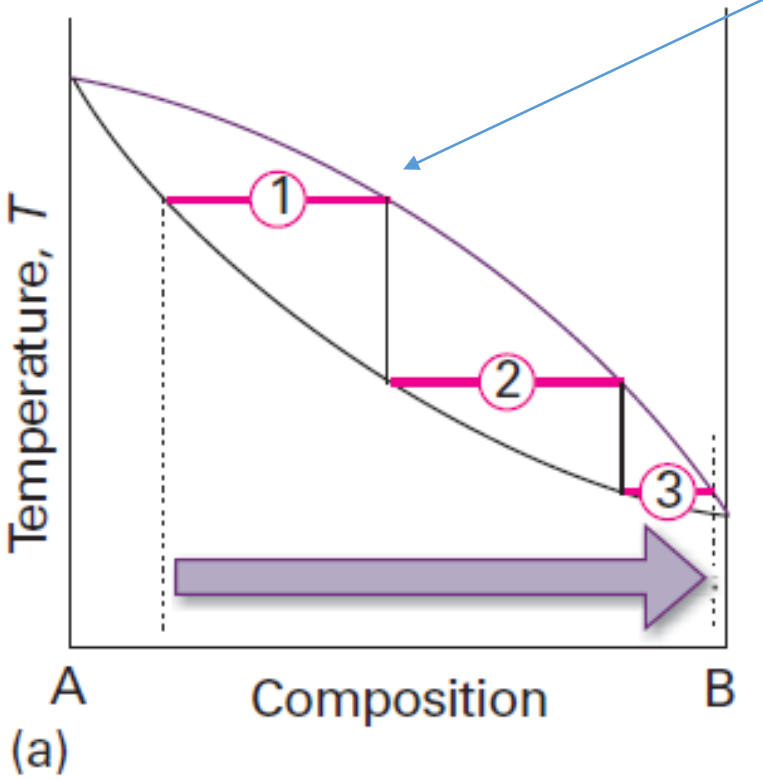


Distillation of a mixture



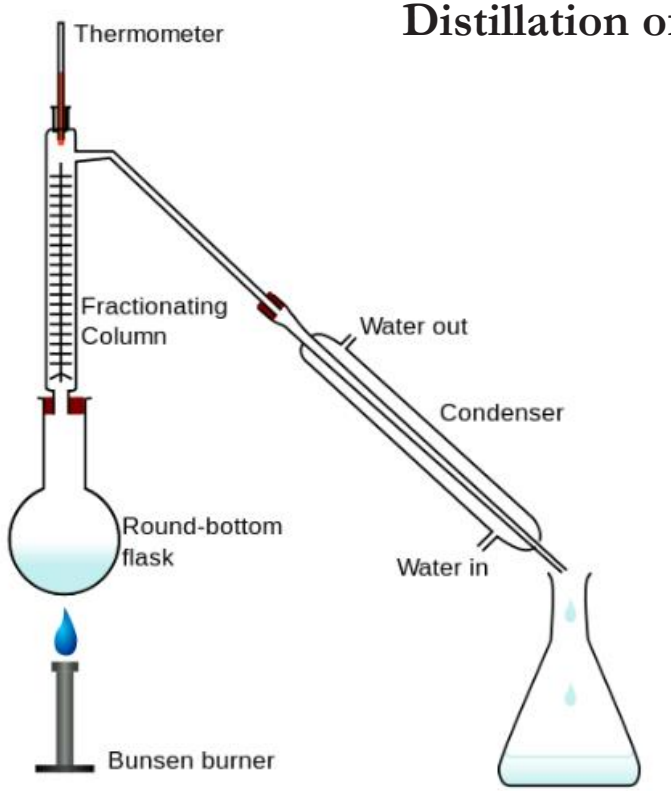
Temperature–Composition diagram

T – x | diagram



Theoretical plates,

Distillation of a mixture,



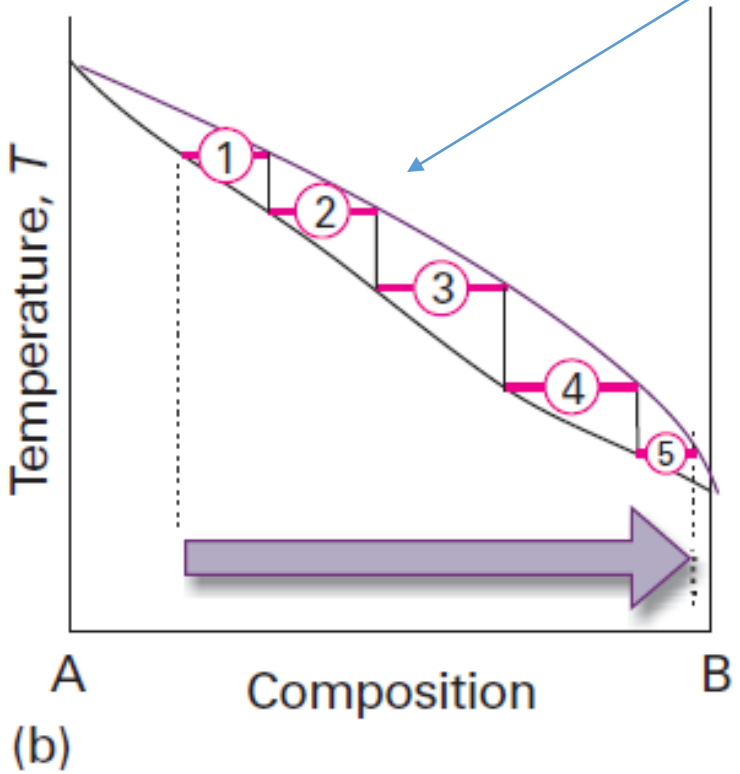
Phase diagrams

Two-component systems $C = 2$

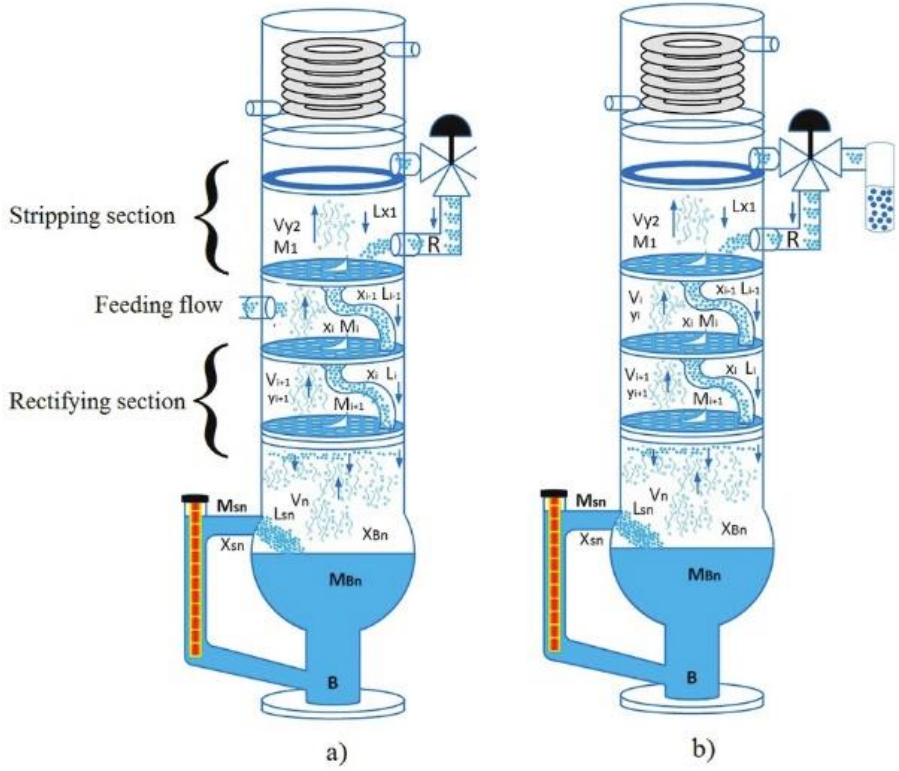
Temperature–Composition diagram

T – x | diagram

Theoretical plates,



Distillation of a mixture,



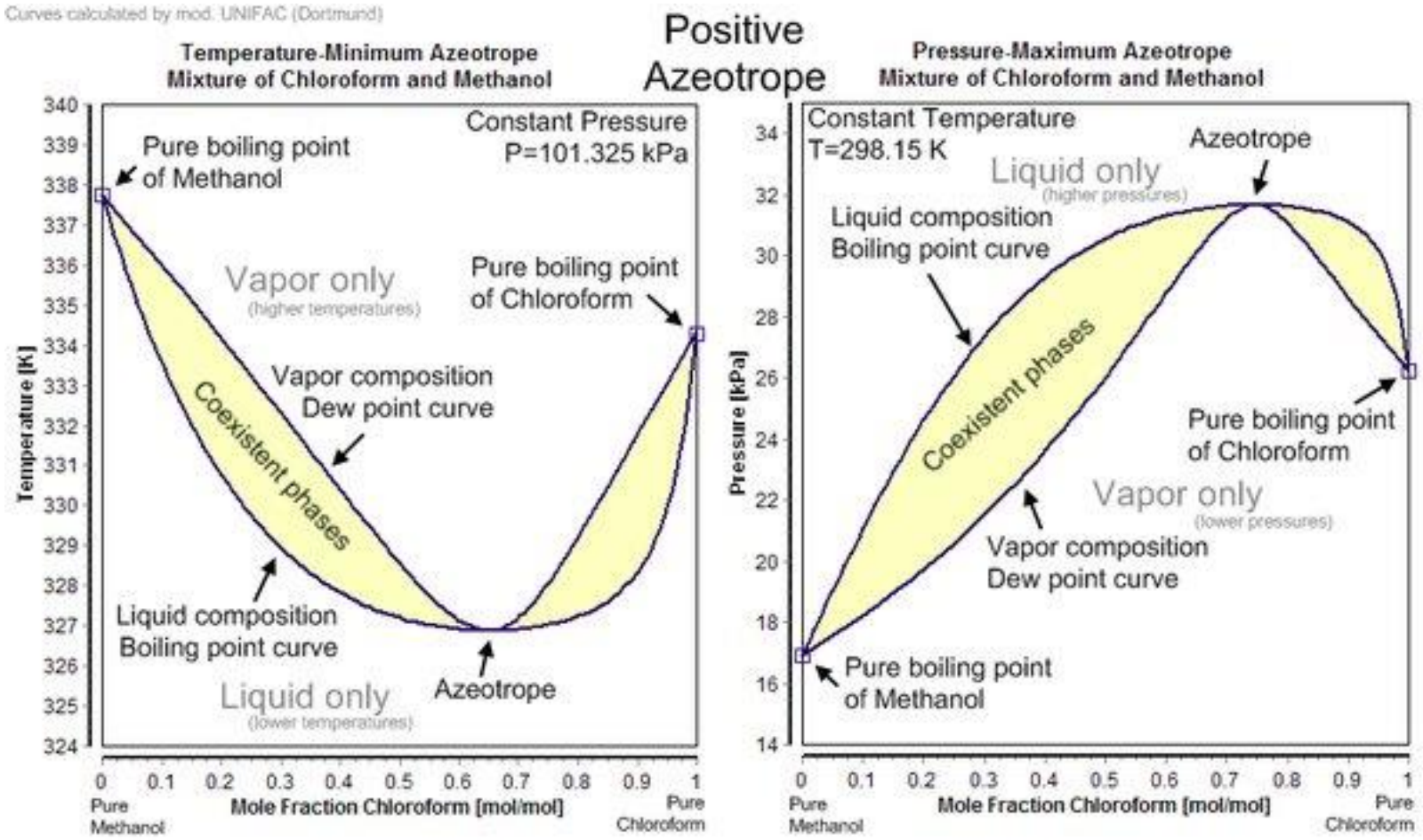
Phase diagrams

Two-component systems $C = 2$

Temperature–Composition diagram

Pressure–Composition diagram

Methanol
Chloroform



Temperature–Composition diagram

Azeotropes

maximum in the phase

favourable interactions

A and B

A–B interactions stabilize the liquid

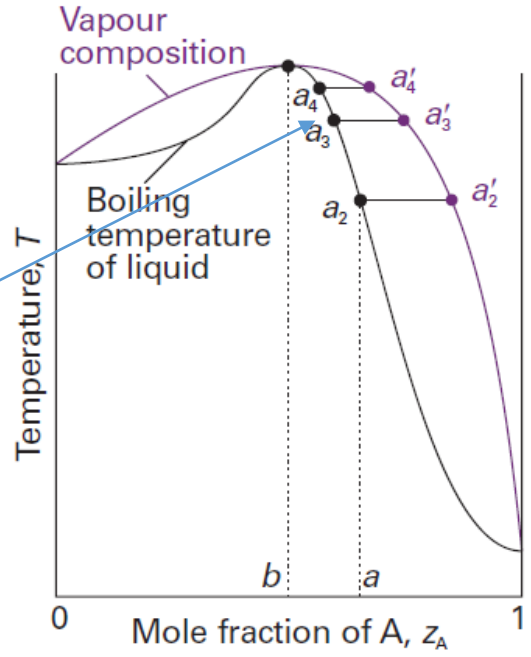


Fig. 6.16 A high-boiling azeotrope. When the liquid of composition *a* is distilled, the composition of the remaining liquid changes towards *b* but no further.

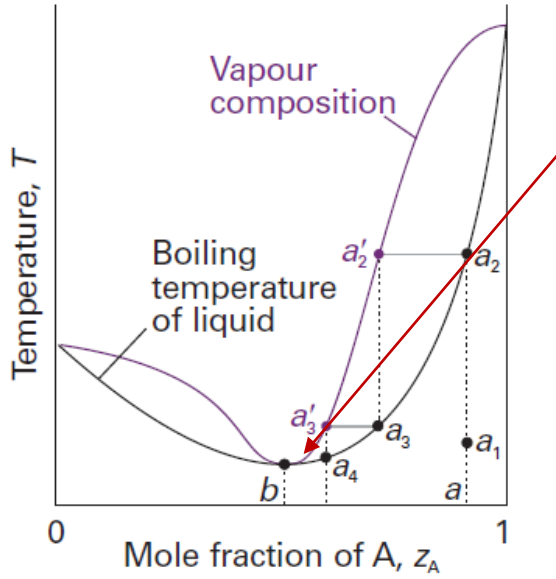


Fig. 6.17 A low-boiling azeotrope. When the mixture at *a* is fractionally distilled, the vapour in equilibrium in the fractionating column moves towards *b* and then remains unchanged.

Minimum in the phase

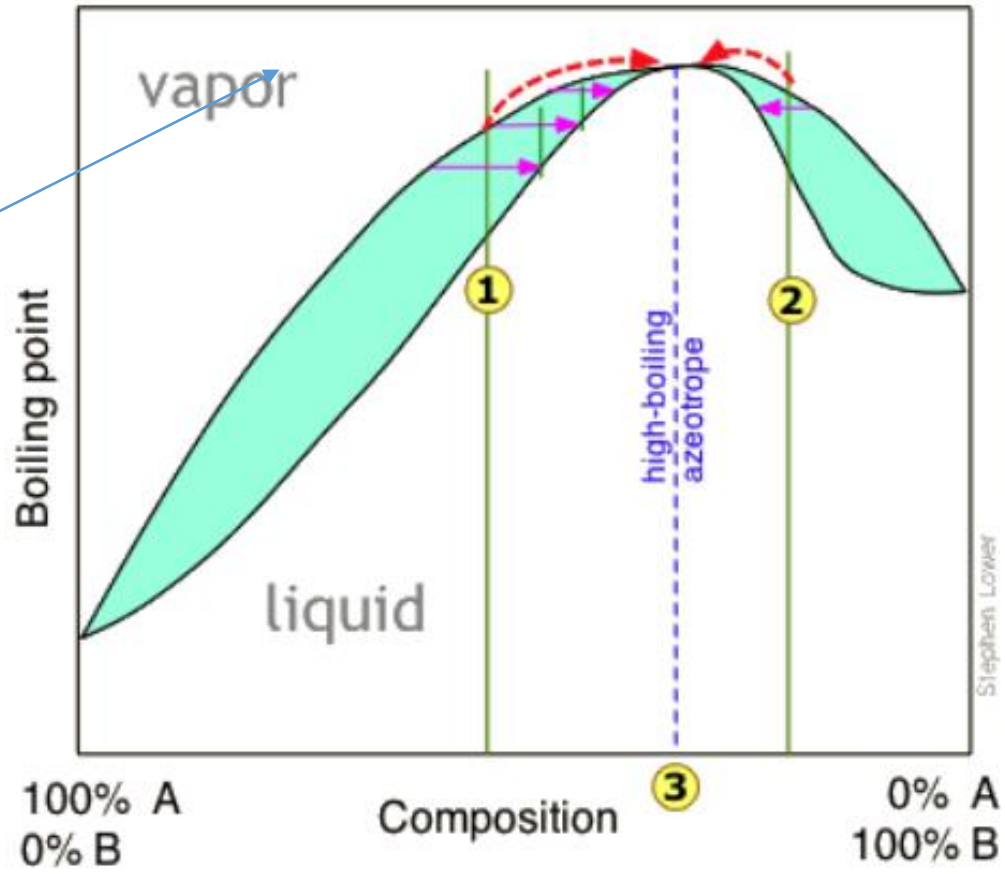
A–B interactions then being unfavourable

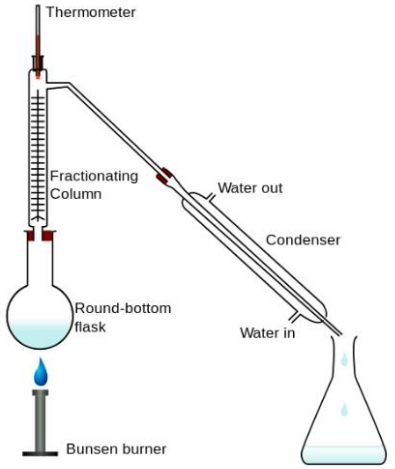
Temperature–Composition diagram

Azeotropes

maximum in the phase
favourable interactions
A and B

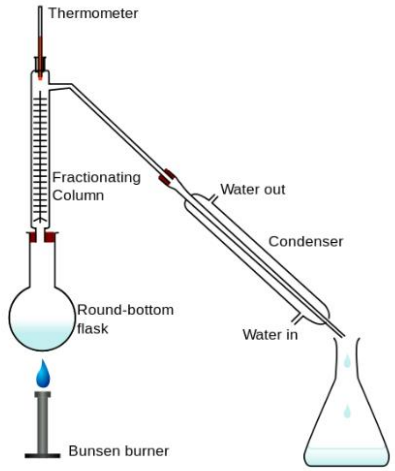
A–B interactions
stabilize the liquid

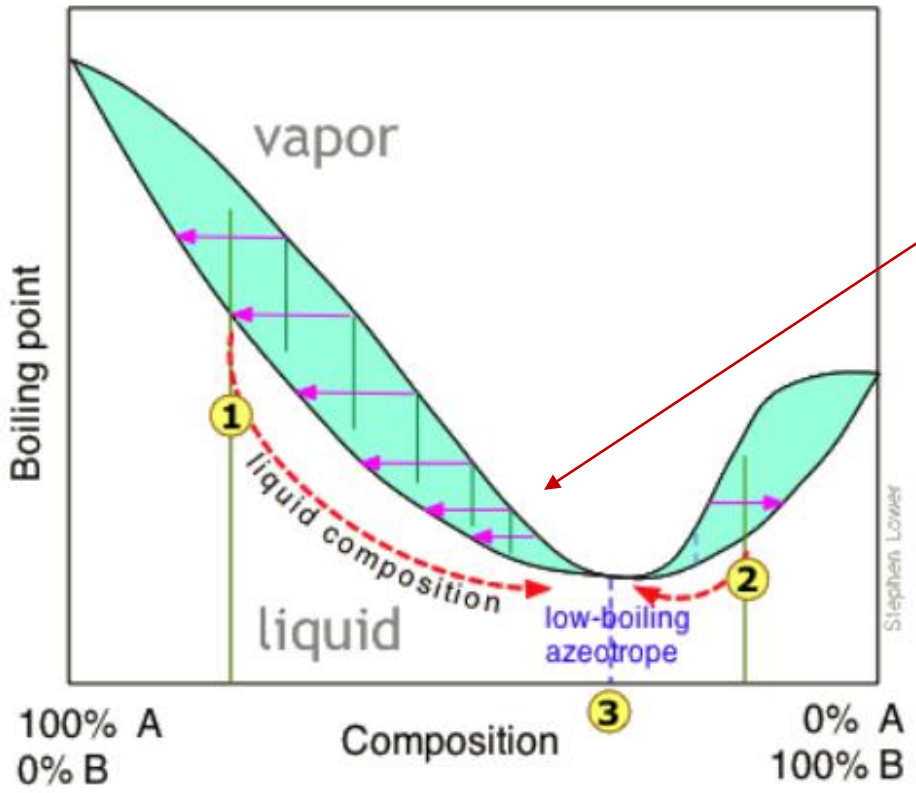




Temperature–Composition diagram

Azeotropes





- Minimum in the phase
- A–B interactions then being unfavourable

Imiscible Liquids

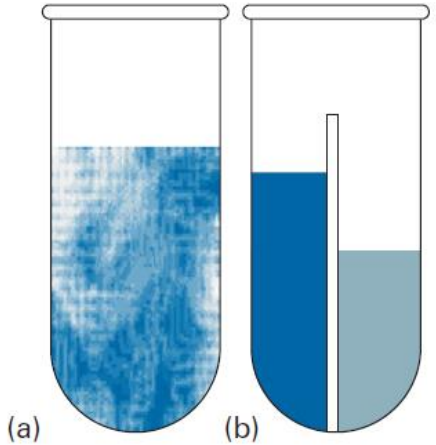


Fig. 6.18 The distillation of (a) two immiscible liquids can be regarded as (b) the joint distillation of the separated components, and boiling occurs when the sum of the partial pressures equals the external pressure.

Distillation of two immiscible liquids, such as **octane** and **water.**

$$p = p_A^* + p_B^*.$$

basis of **steam distillation**

each component is kept saturated in the other component