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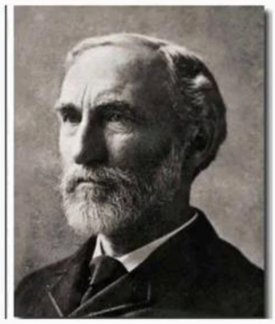
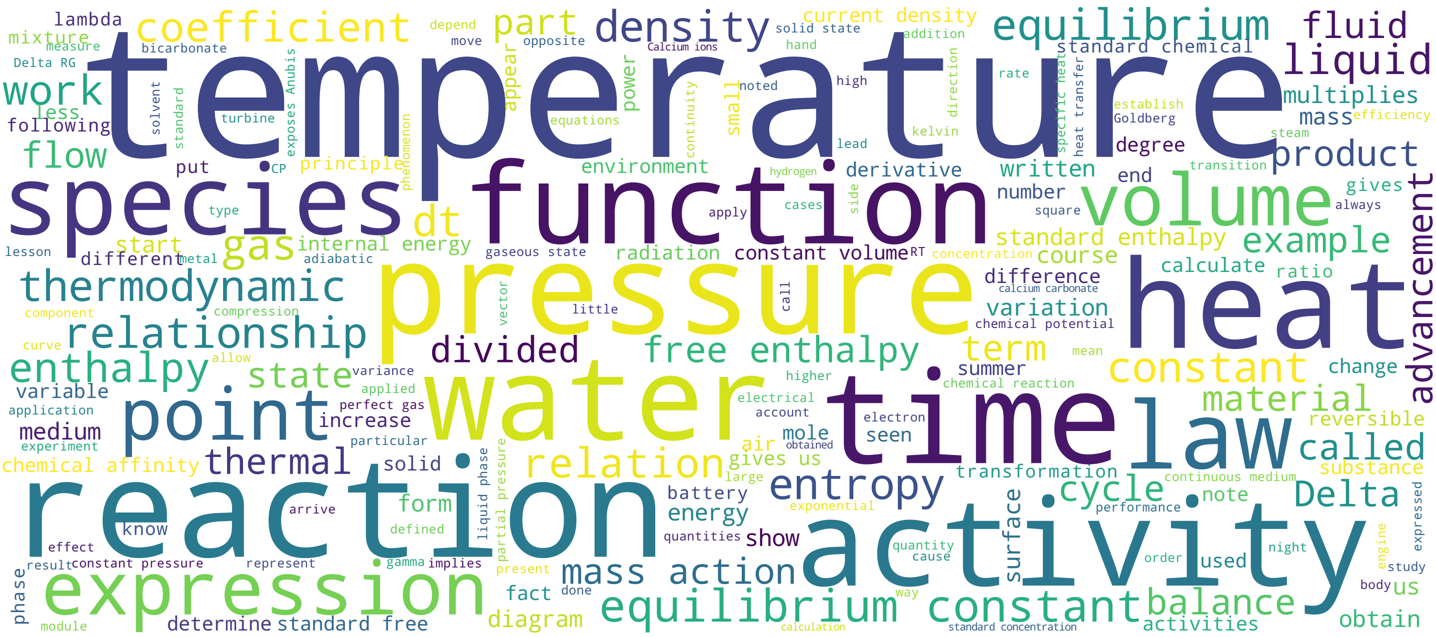


Josiah Willard Gibbs

Thermodynamique

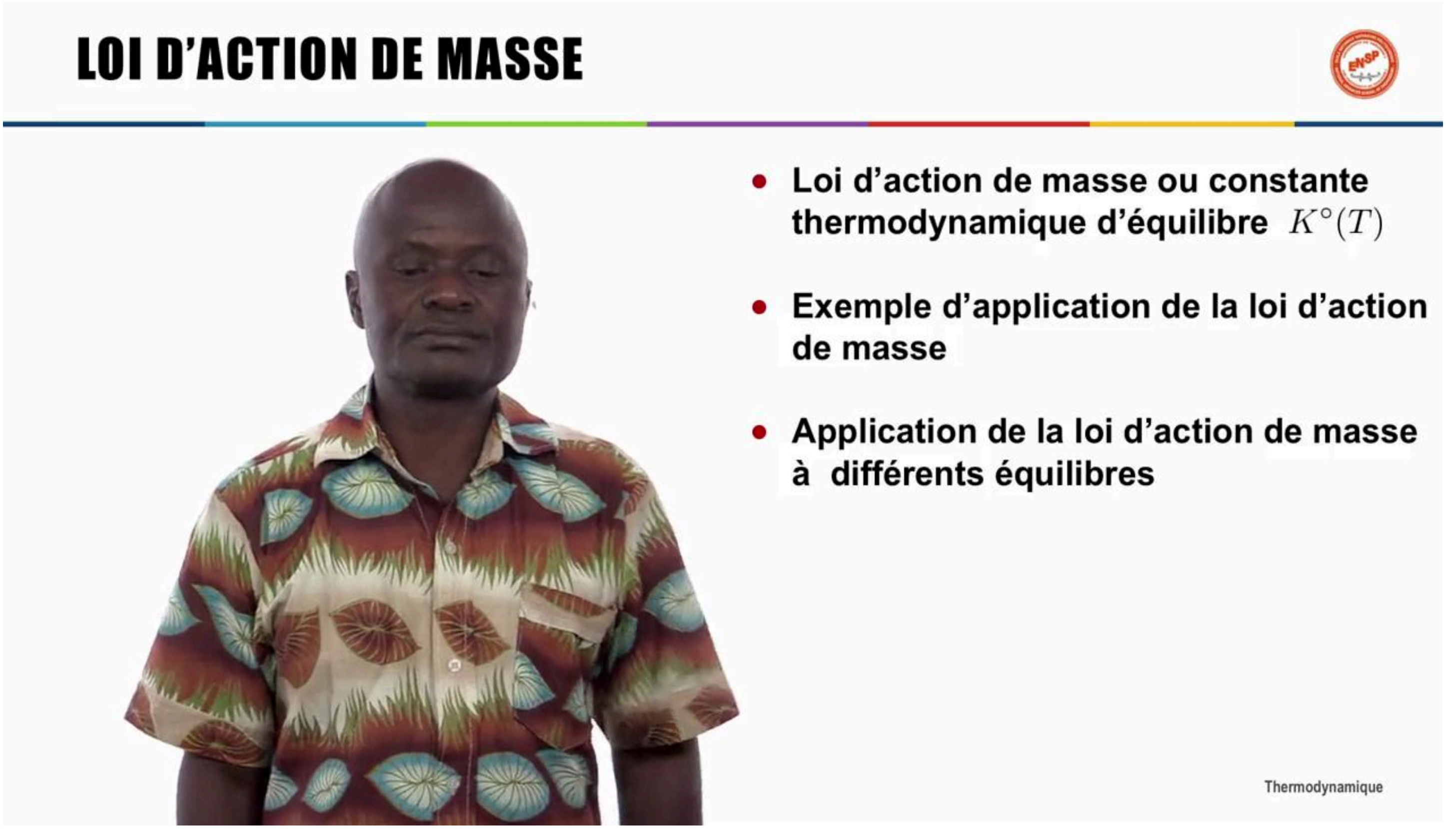
LOI D'ACTION DE MASSE

Dr. Théophile MBANG, ENSP – Yaoundé - Cameroun



Video

EPFL



Hello. It is a great pleasure to contribute to the short story of thermodynamics coordinated by the Ecole Polytechnique Fédérale de Lausanne and BFL in Switzerland. I am a son of a chemistry teacher at the Ecole Nationale Supérieure Polytechnique. Uh, DK in Cameroon. We will continue our course on thermo chemistry. Today. We will study the law of mass action. Establish it. And apply it to different chemical equilibria. And conclude.

Notes

Summary

0m 04s

RELATION DE GULDBERG ET WAAGE

$K°(T)$ est sans dimension.

Si $B =$ Soluble, $a_B = \gamma_B \frac{C_B}{C°}$

γ_B = coefficient d'activité de l'espèce *B*.
$C°$ = concentration standard égale à *1 mol.L*$^{-1}$.
Si $B =$ Solide, $a_B = 1$
Si $B =$ Solvant, $a_B = 1$
Si $B =$ Gaz, $a_B = \gamma_B \frac{P_B}{P°}$; $P° =$ pression standard égale à $1\text{bar} = 1,013.10^5 Pa$

Si l'écriture de l'équation bilan fait apparaître une phase gazeuse, une phase liquide (solution aqueuse) et une phase solide, la constante d'équilibre doit tenir compte des activités de toutes les espèces.

Thermodynamique

What is the expression for the equilibrium constant at zero in summer? Everything is that there is balance of equations homogeneous or heterogeneous chemistry. Probe balance of one night r r gives its nights p p and the product R the reactants is characterized by a thermodynamic constant of equilibrium, because zero is only dependent on temperature and translates the relationship of Goldberg and. A law of mass action. Fifteen zero based on temperatures is equal to the product of the activities. B exposes Anubis. Uber is product positive and asset negative. Fifteen zero in the summer and dimensionless. If the species B. Is soluble, the activity of B is equal to gamma B times the concentration of B divided by the standard concentration which is equal to one mole per liter. Gamma B is the activity coefficient of species B. This is the species B is a solid. Its activity is equal to a and if species B is the solvent, the activity is also equal to one. But if space B is a gas, the activity of these gases B is equal to the activity coefficient of the species B. Gamma B sees the partial pressure of B divided by the standard pressure. Since the standard position is equal to one bar 1.013 ten power and five pascal.

Notes

Summary

0m 47s

Etablissement de la loi d'action de masse

Affinité d'une réaction chimique : $A(T,P,\xi)$

$$A(T,P,\xi) = -\Delta_r G(T,P,\xi) = -\sum \nu_B \mu_B;$$

$$\mu_B(T,P) = \mu_B^{\circ}(T) + R\,T\;\ln(a_B)^{\nu_B}$$

μ_B= potentiel chimique de l'espèce B; a_B= activité de l'espèce B

μ_B° = potentiel chimique standard de l'espèce B; $A^{\circ}(T)$ = affinité chimique standard.

$$A(T,P,\xi) = A^{\circ}(T) - RTln(a_B)^{\nu_B}$$

A l'équilibre:

$$A(T,P,\xi) = 0 \Rightarrow A^{\circ}(T) - RTln(a_B)^{\nu_B} = 0$$

$$\Rightarrow A^{\circ}(T) - RTlnK^{\circ}(T) = 0 \Rightarrow K^{\circ}(T) = \prod_B (a_B)^{\nu_B}, \text{ c.q.f.d };$$

$$\text{Et } lnK^{\circ}(T) = \frac{A^{\circ}(T)}{RT} \text{ or } A^{\circ}(T) = -\Delta_r G^{\circ}(T) \Rightarrow lnK^{\circ}(T) = -\frac{\Delta_r G^{\circ}(T)}{RT}$$

$$\Rightarrow K^{\circ}(T) = \exp(-\frac{\Delta_r G^{\circ}(T)}{RT}), \text{ c.q.f.d.}$$

Thermodynamique

But if the writing of the balance equation shows a gas phase, a liquid phase and a solid phase, the equilibrium constant must take into account the activities of all species. Neither the solvent nor the insoluble species are taken into account, such as solids. We had the activity, the solvents at law. The mass action or Goldberg and wave relations can also be written k zero dt. The equilibrium constant is equal to to the exponential of the standard free enthalpy of reaction diffused by RT. R being the coefficient of perfect gases and the temperature in kelvin. With Delta Air zero dt that is. The standard free enthalpy of reaction is equal to the standard enthalpy of reaction at g0 dt minus the temperature. Times the standard entropy of reaction. Delta RS zero. Let's try to establish the law of mass action here. A condition of the affinity of a chemical reaction that we have in function of temperature, pressure and advancement, what affinity to function of countries and countries and what is equal to the opposite of the free enthalpy of reaction which depends on the temperature T, the pressure P and the advancement of what is equal to -100 Me the number times. Mubi.

Notes

Summary

2m 39s

Etablissement de la loi d'action de masse

Affinité d'une réaction chimique : $A(T,P,\xi)$

$$A(T,P,\xi) = -\Delta_r G(T,P,\xi) = -\sum \nu_B \mu_B;$$

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A l'équilibre:

$$A(T,P,\xi) = 0 \Rightarrow A^{\circ}(T) - RTln(a_B)^{\nu_B} = 0$$

$$\Rightarrow A^{\circ}(T) - RTlnK^{\circ}(T) = 0 \Rightarrow K^{\circ}(T) = \prod_B (a_B)^{\nu_B}, \text{ c.q.f.d ;}$$

$$\text{Et } lnK^{\circ}(T) = \frac{A^{\circ}(T)}{RT} \text{ or } A^{\circ}(T) = -\Delta_r G^{\circ}(T) \Rightarrow lnK^{\circ}(T) = -\frac{\Delta_r G^{\circ}(T)}{RT}$$

$$\Rightarrow K^{\circ}(T) = \exp(-\frac{\Delta_r G^{\circ}(T)}{RT}), \text{ c.q.f.d.}$$

Thermodynamique

Mubi being the chemical potential of the species b but b the chemical potential, the species b. Depending on the temperature, the pressure is equal to the standard chemical potential of the species GRANBY. Depending on the t+ r times. The logarithmic temperature of the activity of B exposes Anubis to B and the activity of B is a function of P which is the temperature, p the pressure and ski. The advancement is equal to the standard chemical affinity a0 dt minus r times logarithm of the activity a b exponent ni b at equilibrium. Chemical affinity a. Function of the T. There is the temperature P, the pressure and the ski advance is 0 to 0. The RT logarithms controls from to. The activity of B. Exponents B is equal to zero. We try to solve. This implies that the standard chemical affinity as a function of t minus r logarithm of zero cases in summer is equal to zero. We solve and it gives us that the equilibrium constant k zero dt is equal to the product of the activities of the species b exponent nu b. Here we have the equilibrium constant. And we can try to express it as we saw at the beginning as a function of the free enthalpy of reaction, and we have the logarithm of the equilibrium constant as zero dt is equal to the standard chemical affinity at zero dt divided by RT.

Notes

Summary

4m 20s

Etablissement de la loi d'action de masse

Affinité d'une réaction chimique : $A(T, P, \xi)$

$$A(T, P, \xi) = -\Delta_r G(T, P, \xi) = -\sum \nu_B \mu_B;$$

$$\mu_B(T, P) = \mu_B^{\circ}(T) + R\,T\ \ln(a_B)^{\nu_B}$$

μ_B= potentiel chimique de l'espèce B; a_B= activité de l'espèce B
μ_B° = potentiel chimique standard de l'espèce B; $A^{\circ}(T)$ = affinité chimique standard.

$$A(T, P, \xi) = A^{\circ}(T) - RTln(a_B)^{\nu_B}$$

A l'équilibre:

$$A(T, P, \xi) = 0 \Rightarrow A^{\circ}(T) - RTln(a_B)^{\nu_B} = 0$$

$$\Rightarrow A^{\circ}(T) - RTlnK^{\circ}(T) = 0 \Rightarrow K^{\circ}(T) = \prod_B (a_B)^{\nu_B}, \text{ c.q.f.d ;}$$

$$\text{Et } lnK^{\circ}(T) = \frac{A^{\circ}(T)}{RT} \text{ or } A^{\circ}(T) = -\Delta_r G^{\circ}(T) \Rightarrow lnK^{\circ}(T) = -\frac{\Delta_r G^{\circ}(T)}{RT}$$

$$\Rightarrow K^{\circ}(T) = \exp\left(-\frac{\Delta_r G^{\circ}(T)}{RT}\right), \text{ c.q.f.d.}$$

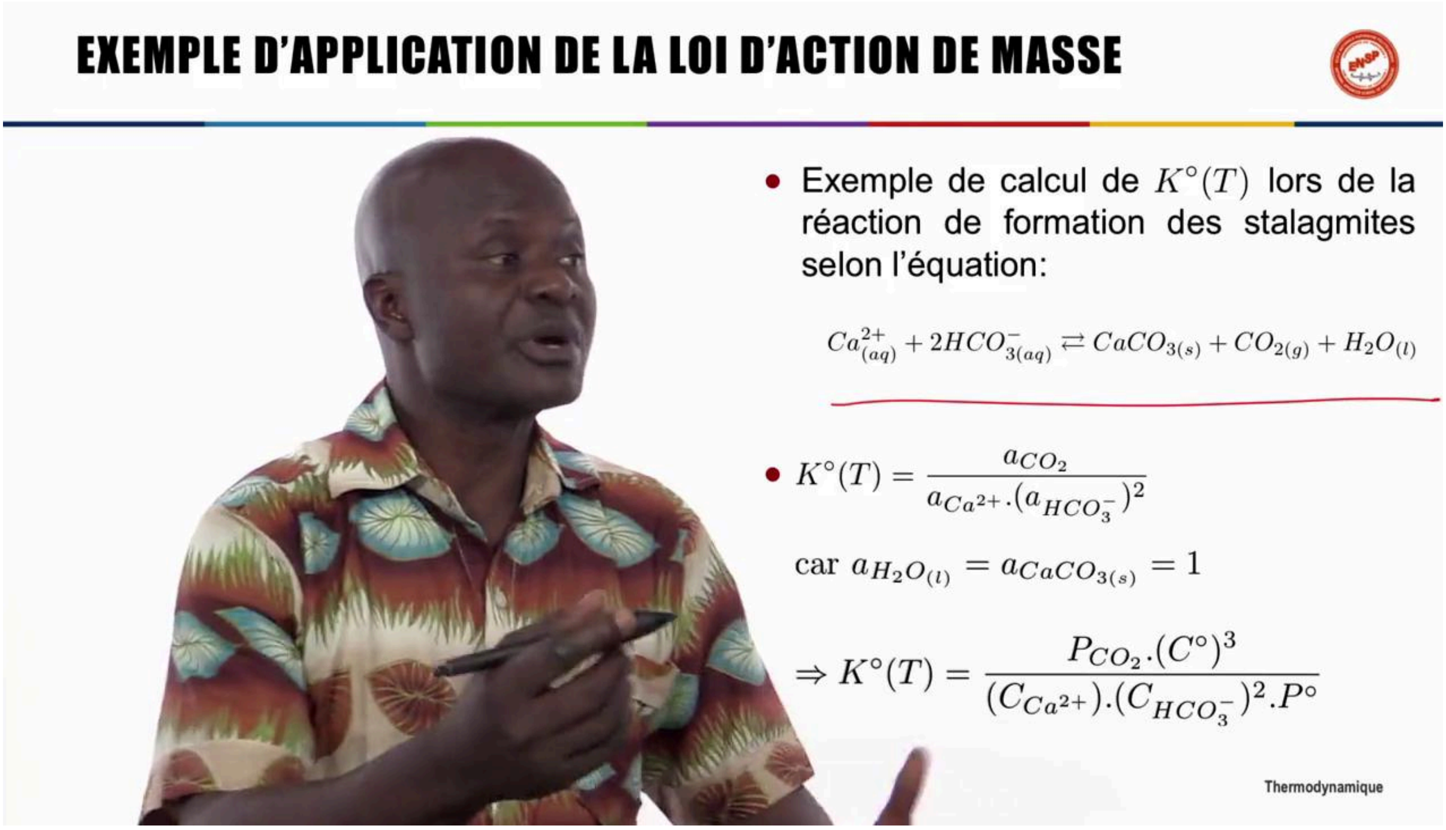
Thermodynamique

Now the standard chemical affinity dt is equal to. Delta RG zero dt is equal to the opposite of d the standard free enthalpy of reaction. This implies that the heavy rhythm one. We are in mathematics, the logarithm of fifteen zero in summer is equal to at least. The standard free enthalpy of reaction Delta RG zero was divided by r p. So from this, we can draw that at zero dt the equilibrium constant zero dt and equal to the exponential. In addition, the standard free enthalpy of the T Delta RG zero was divided by RT. This is how we can establish the law of mass action through the chemical affinity or the free enthalpy of reaction.

Notes

Summary

6m 26s



Let's look at some examples. Let's talk about an example of application to the mass version. Example of calculations of the equilibrium constant. Zero. During. From the reaction of the stalagmite formations according to the equation. Calcium ions react with bicarbonate ions to give the calcium carbonate in the solid state, of carbon dioxide in a gaseous state and water in a liquid state. So we have this reaction. For us, it is now necessary to calculate the equilibrium constant, apply the law of mass action. Fifteen zero. Here.

Notes

Summary

7m 25s

EXEMPLE D'APPLICATION DE LA LOI D'ACTION DE MASSE

$$K^{\circ}(T) = \prod (a_B)^{\nu_B}$$
$$= (a_{Ca^{2+}})^{-1} \cdot (a_{HCO_3^-})^{-2} \cdot (a_{CaCO_3})^{1} \cdot a_{CO_2} \cdot a_{H_2O}$$
$$K^{\circ}(T) = \frac{a_{CO_2}}{a_{Ca^{2+}} \cdot a_{HCO_3^-}^{2}}$$

- Exemple de calcul de $K^{\circ}(T)$ lors de la réaction de formation des stalagmites selon l'équation:

$$Ca^{2+}_{(aq)} + 2HCO^{-}_{3(aq)} \rightleftarrows CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$$

- $K^{\circ}(T) = \dfrac{a_{CO_2}}{a_{Ca^{2+}}.(a_{HCO_3^-})^2}$

car $a_{H_2O_{(l)}} = a_{CaCO_{3(s)}} = 1$

$$\Rightarrow K^{\circ}(T) = \frac{P_{CO_2}.(C^{\circ})^3}{(C_{Ca^{2+}}).(C_{HCO_3^-})^2.P^{\circ}}$$

Thermodynamique

We take here. Establish fifteen zero. DT. And equal to the product of the activities of the species. B. Naked exhibitor b. All the species that participate in the reaction and we know how to calculate the activities of each species. So that gives us if, if it is equal to the activity of. Calcium ions, calcium ions. The product exponent -1 since it is of a reagent that multiplies the activity of the bicarbonate. Here. The closed, exposing -2 that multiplies the activity. From. Calcium carbonate. In a solid state, exposes a man. You can't write a that multiplies the activity of these gas waters that multiplies the activity of the H. Two or. Good. Exhibitor. A I can not put these exhibitors. One. Now we know that calcium carbonate in the solid state. So its activity is left to the water and the team to indicate the activity. One. So if you give us the equilibrium constant zero. DT. Is equal to the activity of the dioxide of carbon in gaseous state divided by the calcium diluent activity. That multiplies the activity. The lions. Bicarbonate. Exhibitors. D But it can be active as it is a gas. The gas activity here and this night here had the pressure.

Notes

Summary

8m 14s

EXEMPLE D'APPLICATION DE LA LOI D'ACTION DE MASSE

$K°(T) = \prod (a_B)^{\nu_B}$

$= (a_{Ca^{2+}})^{-1} \cdot (a_{HCO_3^-})^{-2} \cdot (a_{CaCO_3})^{1} \cdot a_{CO_2} \cdot a_{H_2O}$

$K°(T) = \frac{a_{CO_2}}{a_{Ca^{2+}} \cdot a_{HCO_3^-}^2}$

$a_{CO_2} = \frac{P_{CO_2}}{P°}$; $a_{HCO_3^-}^2 = \frac{C_{HCO_3^-}^2}{C°^2}$

$a_{Ca^{2+}} = \frac{C_{Ca^{2+}}}{C°}$

- Exemple de calcul de $K°(T)$ lors de la réaction de formation des stalagmites selon l'équation:

$$Ca^{2+}_{(aq)} + 2HCO^-_{3(aq)} \rightleftarrows CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$$

- $K°(T) = \frac{a_{CO_2}}{a_{Ca^{2+}}.(a_{HCO_3^-})^2}$

car $a_{H_2O_{(l)}} = a_{CaCO_{3(s)}} = 1$

$$\Rightarrow K°(T) = \frac{P_{CO_2}.(C°)^3}{(C_{Ca^{2+}}).(C_{HCO_3^-})^2.P°}$$

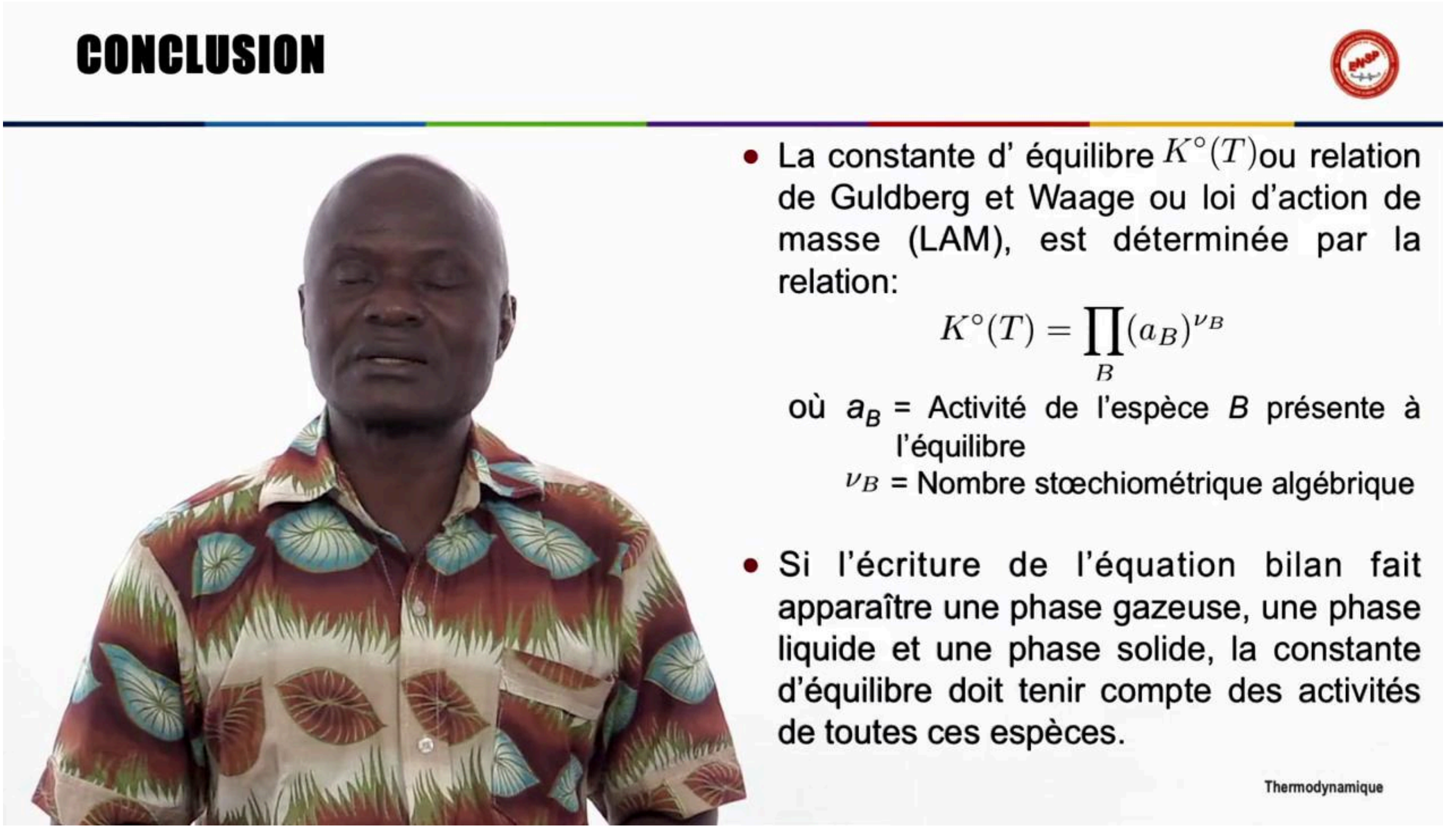
Thermodynamique

So we blocked the activity of the gas syrups is equal to the partial pressure of the. That's or two. Divide by the standard pressure. Activity. Lions. Bicarbonate. Here. Bicarbonate, the bicarbonate ion like bicarbonate. Is equal to the concentration, to the concentration of the lion when bicarbonate. Cube and square divided by. We are broadcasting this here. By what? Through concentration. This is bicarbonates. Semi-colon of the start. The standard concentration, the pot squared putting even squared and the activity of calcium. The same thing is equal to the concentration of calcium lions divided by the standard concentration. And by replacing this one, we give that the equilibrium constant zero and therefore equal to the partial pressure of these two times the standard cube concentration divided by the lion concentration. Calcio that occupies me the finding of the bicarbonate to the square. That banging my head is a lure. Because the equilibrium constant is dimensionless.

Notes

Summary

10m 27s



Application of the law of mass action to different equilibria. The Mondiale establishes this law of masses. The law of mass action applies to all types of homogeneous or heterogeneous equilibrium. For the cause. The acidity constant because of the acid. Bases and basicity. KB for weak acids and bases. The dissociation constant KD and a formation at F of a complex. For equilibrium, dissociation and complex formation. The solubility product of poorly soluble salts. KS. In conclusion. We have just seen what the equilibrium constant does not achieve. And one for it concerns the balance that to zero lity or relationship of Goldberg and VERGES. We see it from mass actions. The soul is determined by the fifteen-zero relationship. The summer also produced activities of a species b exposes Anubis applied to all species. Inversion. If the balance equation is written as appear a gaseous phase, a liquid phase and a solid phase, the equilibrium constant must take into account the activities of all these species. Thank you and goodbye.

Notes

Summary

12m 12s