CEN 207 Physical Chemistry

Text book:

Atkins' Physical Chemistry, Peter Atkins, Julio de Paula, James Keeler, 11th Edition, Oxford University Press.

Reference books

. Physical Chemistry, Robert J. Silbey, Robert A. Alberty, Moungi G. Bawendi

. Physical Chemistry, Ira N. Levine

Content

The properties of gases
The perfect gas
Variables of state
Equations of states
The kinetic model:
The model: i) Pressure and molecular speeds; ii) The Maxwell-Boltzmann distribution of speeds; iii. Mean values
Collisions: i) The collision frequency; ii) The mean free path
Real gases: i) Deviations from perfect behaviour; ii) The van der Waals equation
The First Law: Internal Energy, Enthalpy, Thermochemistry, State functions and exact differentials, Adiabatic changes
The Second and Third Laws: Entropy, Gibbs energy etc.
Simple mixtures: The thermodynamic description of mixtures, The properties of solutions, Activities.
Chemical equilibrium: The equilibrium constant, The response of equilibria to conditions, Electrochemical cells, Electrode potentials
Processes at solid surfaces: An introduction to solid surfaces, Adsorption and desorption, Processes at electrodes.

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The properties of gases

A gas is a form of matter that fills whatever container it occupies.

The perfect gas (an idealised version of gas = a perfect gas)

Perfect gas → basis for the development of many relations in thermodynamic, and a good approximation for the properties of real gases

Variables of state: a) Pressure; b) Temperature

The physical state of a sample of a substance is defined by its physical properties.

The variables needed to specify the state of a system:

i. The amount,

ii. The volume,

iii. The pressure,

iv. The temperature.

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The properties of gases

a) Pressure: The origin of the force exerted (applied) by a gas is the incessant battering of the molecules on the wall of its container. The collisions are so numerous that they exert an effectively steady force, which is experienced as a steady pressure. The pressure exerted by the atmosphere is measured with a barometer

The SI unit of pressure: the pascal (Pa, 1 Pa = 1 N m^{-2}) ; 1 bar: standard pressure

b) Temperature: Related in length of a column of liquid: Melting point of ice shows 0 (zero) and boiling point of water shows 100. 0-100 is divided into 100 steps called "degree". This procedure led to the Celsius scale of temperature. The Celsius scale is denoted theta (Θ) and expressed in degree Celsius (°C).

On the thermodynamic temperature scale temperatures are denoted T and are normally reported in kelvins (K). Thermodynamic and Celsius temperatures are related by the exact expression

T/K= Θ/°C+273.15

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The properties of gases

Equations of state:

The general form of an equation of state (experimental fact) is

$P=f(T,V,n)$ (General form of an equation of state)

T,V,n → if known → p has fixed value

$p=nRT/V$

R: constant (independent of the identity of the gas)

The properties of gases

a) The empirical basis: Following individual gas laws should be familiar:

Boyle's law: **pV=constant, at constant n, T**

Charles's law: **V=constant x T, at constant n, p**

p=constant x T, at constant n, V

} examples of a limiting law ($p \rightarrow 0$)

the volume of a substance (found empirically) $\mathbf{V = aT+bp+cp^2}$. In the limit of $p \rightarrow 0$

V = aT (many relations that are strictly true only at p=0)

Avogadro's principle: V = constant x n, at constant p, T

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