All Things Chemistry (26026)

Only Christian & Helena and some other guy :))*

Good pages

- Solubility rules page 101 (Table 4.2)

- Oxidation numbers: page 114 (figure 4.10)

- Electron configuration: page 255 (table 7.3), 242 (table 8.1)

- Ionization energies page 265 (table 8.2)

- Electron negativity: page 296 (figure 9.5)

- Bond enthalpies: page 314 (table 9.3), 573 (table 16.6)

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- Dipole moments of some polar molecules: page 336 (table 10.3)

- Hybrid orbitals and shapes: page 344 (table 10.4)

- Molal boiling/freezing-point: page 453 (table 13.2)

- Standard Reduction Potential: page 673 (table 19.1)

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- Functional groups: page 391 (table 11.4)

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- Relationships amount E_{cell}, K and ΔG

- Ligands: page 711 (table 20.2)

- Names of common ligands: page 714 (table 20.3)

- Geometry of coordination compounds: page 715

- Coordination geometry of compounds: page 715 (figure 20.6)

- High/- Low sping properties: page 721 (figure 20.17)

- Monomers and their common syntheic polymers: page 766 (table 22.1)

- The 20 amino acids: page 769-770 (table 22.2)

- DNA and RNA: page 776 (figure 22.5 and 22.16)

GitHub

See https://github.com/ElMiho/chemistry-26026 for python and mathematica scripts.

Key Terms

Atoms, molecules and ions

Begreb	Forklaring
Atom	The basic unit of an element that can enter into chemical combinations
Nucleus	The central core within an atom
Atomic number (Z)	The number of protons in the nucleus of each atom of an element
Mass number (A)	The total number of neutrons and protons present in the nucleus of an atom of an element
Isotopes	Atoms with the same atomic number but different mass numbers
Periods	Horizontal rows in the periodic table
Groups	Vertical rows in the periodic table
Alkali metals	Group 1A elements (Li, Na, K, Rb, Cs and Fr)
Alkaline earth metals	Elements in group 2A (Be, Mg, Ca, Sr, Ba and Ra)
Halogens	Elements in group 7A (F, Cl, Br, I and At)
Noble gases	Elements in group 8A (He, Ne, Ar, Kr, Xe and Rn)
Molecule	Aggregate of at least two atoms in a definite arrangement held together by chemical bonds
Compound	Aggregate of two or more elements
Ion	An atom or a group of atom that has a net negative or positive charge.
Cation	An ion with net positive charge
Anion	An ion with net negative charge
Ionic compound	Formed from cations and anions
Chemical formulas	Expreesion of the composition of molecules and ionic compunds in terms of chemical symbols
Molecular formula	Shows the exact number of atoms at each element in the smallest unit of its substance
Empirical formula	Tells which elements are present and the smallest whole number ratio of their atoms

Stock system	The accepted procedure of designating different cations of the same element by using Roman numerals (I for positive charge, II for two positive charges etc)
Acid	Substance that yields hydrogen ions (H^+) when dissolved in water
Bases	Substance that yields hydroxid ions (HO^-) when dissolved in water.

Stoichiometry

Begreb	Forklaring
Atomic mass	The mass of the atom in atomic mass units (amu)
Molar mass (M)	Mass of 1 mole of units of a substance
Molecular mass	Sum of the atomic masses (in amu) in the molecule
Chemical reaction	A process in which a substance is changed into one or more new substances
Chemical equation	Uses chemical symbols to show what happens during a chemical reaction
Reactants	The starting materials in a chemical reaction
Products	The substance formed as a result of a chemical reaction
Stoichiometry	The quantitative study of reactants and products in a chemical reaction
Mole method	The stoichiometric coefficients in a chemical equation can be interpreted as the number of moles of each substance
Stoiciometric amounts	The proportions indiciated by the balanced equation
Limiting reactant	The reactant used up first in the reaction
Excess reactant	Reactants present in quantities greater than necessary to react with the the quantity of the limiting reactant
Theoretical yield	The amount of product that would result if all the limiting reagents reacted
Actual yield	The amount of product actually obtained from a reaction

Reactions in Aqueous Solutions

Begreb	Forklaring
Solution	Homogeneous mixture of two or more substances
Solute	The substance present in a smaller amount
Solvent	The substance present in a larger amount
Aqueous solution	The solute is initially a liquid or a solid and the solvent is water
Electrolyte	A substance that when dissolved in water results in a solution that can conduct electricity
Hydration	The process in which an ion is surrounded by water molecules arranged in a specific manner
Chemical equilibrium	A chemical state in which no net change can be observed
Precipitation reaction	A reaction that occurs in aqueous solutions which results in the formation of an insoluble product, or precipitate
Precipitate	An insoluble solid that separates from the solution
Solubility	The maximum amount of solute that will dissolve in a given quantity of solvent

Ionic equation	An equation which shows dissolved species as free ions
Spectator ions	Ions that are not involved in the overall reaction
Net ionic equation	Shows only the species that actually take part in the reaction
Brønsted acid	A proton donor
Brønsted base	A proton acceptor
Neutralization reaction	A reaction between an acid and a base: acid + base $\rightarrow$ salt + water
Salt	An ionic compound made up of a cation other han H+ and an anion other than OH- or O(2-)
Oxidation-reduction/Redox	Electron transfer reactions
Half-reactions	Steps that explicitly shows the electrons involved in a redox reaction
Oxidation reaction	The half-reaction that involves loss of electrons
Reduction reaction	The half-reaction that involves gain of electrons
Reducing agent	Donator of electrons
Oxidizing agent	Acceptor of electrons
Oxidation number	The number of charges the atom would have in a molecule if electrons were transferred completely.
Combination reaction	A reaction in which two or more substances combine to form a single product
Decomposition reaction	The breakdown of a compound into two or more components
Combustion reaction	A reaction in which a substance reacts with oxygen, usually with the release of heat and light to produce a flame
Displacement reaction	An ion (or atom) in a compound is replaced by an ion (or atom) of another element
Activity series	A convenient summary of the results of many possible displacement reactions
Concentration of a solution	The amount of solute present in a given amount of solvent, or a given amount of solution
Molarity (M)/Molar concentration	The number of moles of solute per liter of solution
Dilution	The procedure for preparing a less concentrated solution from a more concentrated one
Titration	A solution of accurately known concentration is added gradually to another solution of unknown concentration until the chemical reaction between the two solutions is complete
Standard solution	The solution of accurately known concentration

Gasses

Begreb	Forklaring
Pressure	Force applied per unit area
Atmospheric pressure	The pressure exerted by Earth's atmosphere
Boyle's law	The pressure of a fixed amount of gas maintained at constant temperature is inversely proportional to the volume of the gas

Charles's law	The volume of a fixed amount of gas maintained at constant pressure is directly proportional to the absolute temperature of the gas
Avogadro's law	At constant pressure and temperature, the volume of a gas is directly proportional to the number of moles of the gas present
Ideal gas equation	Describes the relationship among the four variables p, V, T and n. An ideal gas is a hypothetical gas whose pressure-volume-temperature behavior can be completely accounted for by the ideal gas equation
Partial pressure	The pressures of individual gas components in the mixture
Dalton's law of partial pressure	The total pressure of a mixture of gases is just the sum of the pressures that each gas would exert if it were present alone
Mole fraction	A dimensionless quantity that expresses the ratio of the number of moles of one component to the number of moles of all components present
Kinetic energy	Energy of motion
Kinetic molecular theory of gases	A number of generalizations about gas behavior (page 159)
Root-mean-squared spped	An average molecular speed
Diffusion	The gradual mixturing of molecules of one gases with molecules of another by virtue of their kinetic properties
Graham's law of diffusion	Under the same conditions of temperature and pressure, rates of diffusion for gases are inversely proportional to the square roots of their molar masses
Effusion	The process by which a gas under pressure escapes from one compartment of a container to another by passing through a small opening
Van der Waals equation	Relating p, V, T and n for a nonideal gas

Thermodynamics

Begreb	Forklaring
Energy	The capacity to do work.
Work	Directed energy change resulting from a process
Radiant energy	Solar energy
Thermal energy	Energy associated with the random mation of atoms and molecules
Chemical energy	Stored within the strcutural units of chemical substances.
Potential energy	Energy available by virtue of an objects's position
Heat	The transfer of thermal energy between two bodies.
Thermochemistry	The study of heat change om chemical reactions
System	Specific part of the universe that is of interest to us.
Surroundings	Rest of the universe outside the system.
Open system	Can exchange mass and energy usually in the form of heat with the surroundings.
Closed system	Allows the transfer of energy (heat) but not mass.
Isolated system	Does not allow the transfer of either mass or energy.

Exothermic process	Any process that gives off heat, that is the transfer of thermal energy to its surroundings.
Endothermic process	Heat has to be supplied to the system by the surroundings.
Thermodynamics	The scientific study of the interconversion of heat and other kinds of energy.
State functions	Properties that are determined by the state of the system, regardless of how that condition was achieved.
First law of thermodynamics	Energy can be converted from one form to another but cannot be created or destroyed.
Second law of thermodynamics	The entropy of the universe increases in a spontanous process and remains unchanged in an equilibrium process.
Entropy	A measure of how spread out or dispersed the energy of a system is among the different possible ways that system can contain energy.
Creation Enthalpy	change in enthalpy after creation ΔH_f (use appendix 2).
Enthalpy of reaction, ΔH_{rxn}	difference between the enthalpies of the reaction and the enthalpies of the product $\Delta H = H(products) - H(reactants)$
Thermochemical equations	show the enthalpy changes as well as the mass relations.
Specific heat	the amount of heat required to raise the temperature of one gram of the substance by one degree Celsius.
Calorimetry	The measurement of heat changes.
Standard enthalpy of formation	The standard enthalpy of formation of any element in its most stable form is zero.
Hess's law	When reactants are converted to products, the change in enthalpy is the same whether the reaction takes place in one step or in a series of steps.

The Electronic Structure of Atoms

Term	Explanation
Wave	A vibrating disturbance by which energy is transmitted
Wavelength λ	The distance between identical points on successive waves
Frequency ν	The number of waves that pass through a particular point in one second
Amplitude	The vertical distance from the midline of a wave to the peak or trough
Electromagnetic wave	It has an electric field component and a magnetic field component
Electromagnetic radiaion	The emission and transmission of energy in the form of electromagnetic waves
Quantum	The smallest quantity of energy that can be emitted (or absorbed) in the form of electromagnetic radiation
Photons	Particles of light
Ground state	The lowest energy state of a system
Excited state	Higher in energy than the ground state
Nodes	Points in a wave in which the amplitude of the wave is zero
Heisenberg uncertainty principle	It is impossible to know simultaneously both the momentum and the position of a particle with certainty
Electron density	The probability that an electron will be found in a particular region of an atom
Atomic orbital	The wave function of an electron in an atom

Quantum numbers	Descirbes the distribution of electrons in hydrogran and other atoms
Boundary surface diagram	Encloses about 90% if the total electron density in an orbital
Electron configuration	How the electrons are distributed among the various atomic orbitals
Pauli exclusion principle	No two electrons in an atom can have the same four quantum numbers
Paramagnetic	Contain net unpaired spins and are attracted by a magnet
Diamagnetic	Do not contain net unpaired spins and are slightly repelled by a magnet
Hund's rule	The most stable arrangement of electrons in subshells is the one with the greatest number of parallel spins
Aufbau principle	As protons are added one by one to the nucleus to build up the elements, electrons are similarly added to the atomic orbitals

The Periodic table

Term	Explanation
Valence electrons	The outer electrons of an atom which are those involved in chemical bonding
Isoelectronic	Ions, or atoms and ions, that have the same number of electrons and hence the same ground-state electron configuration
Effective nuclear charge (Z_{eff})	The nuclear charge felt by en electron when both the actual nuclear charge (Z) and the repulsive effects (shielding) of the other electrons are taken into account

Chemical Bonding

Term	Explanation
Lewis dot system	Consists of the symbol of an element and one dot for each valence electron in an atom of the element
Atomic radius	One-half the distance between the two nuclei in two adjacent metal atoms
Ionic radius	Radius of a cation or an anion
Ionization energy	The minimum energy (in kJ/mol) required to remove an electron from a gaseous atom in its ground state
Electron affinity	The negative of the energy change that occurs when an electron is accepted by an atom in the gaseous state to form an anion
Ionic bond	The electrostatic force that holds ions together in an ionic compound
Lattice energy	The energy required to completely separate one mole of a solid ionic compound into gaseous ions

Coulomb's law	The potential energy (E) between two ions is directly proportional to the product of their charges and inversely proportional to the distance of separation between them
Born-Haber cycle	Relates lattice energies of ionic compounds to ionization energies, electron affinities and other atomic and molecular properties
Covalent bond	A bond in which electrons are shared by two atoms
Covalent compound	A compound that contain only covalent bonds
Lone pairs	Pairs of valence electrons that are not involved in covalent bond formation
Lewis structure	A representation of covalent bonding in which shared electron pairs are shown either as lines or as pairs of dots between two atoms and lone pairs are shown as pairs of dots on individual atoms
Octec rule	An atom other than hydrogen tends to form bonds until it is surrounded by eight valence electrons
Single bond	Two atoms are held together by one electron pair
Multiple bonds	Two atoms share two or more pairs of electrons
Double bond	Two atoms share two pairs of electrons
Bond length	Distance between the nuclei of two covalently bonded atoms in a molecule
Polar covalent bond/Polar bond	Electrons spend more time in the vicinity of one atom than the other
Electronegativity	The ability of an atom to attract toward itself the electrons in a chemical bond
Formal charge	The electrical charge difference between the valence electrons in an isolated atom and the number of electrons assigned to that atom in a Lewis structure
Resonance structure	One of two or more Lewis structures for a single molecule that cannot be represented accurately by only one Lewis structure
Resonance	The use of two or more Lewis structure to represent a particular molecule
Coordinate covalent bond	A covalent bond in which one of the atoms donates both electrons
Radicals	Odd(numbered)-electron molecules
Bond enthalpy	The enthalpy change required to break a particular bond in 1 mole of gaseous molecules
Valence shell	The outermost electron-occupied shell of an atom; it holds the electrons that are usually involved in bonding
Dipole moment	The product of the charge Q and the distance r between the charges
Polar molecules	Diatomic molecules containing atoms of different elements
Nonpolar molecules	Diatomic molecules containing atoms of the samle element
Hybrid orbitals	Atomic orbitals obtained when two or more nonequivalent orbitals of the same atom combine in preparation for covalent bond formation
Hybridization	The mixing of atomic orbitals in an atom (usually a central atom) to generate a set of hybrid orbitals

Organic chemistry

Term	Explanation
Organic chemistry	The branch of chemistry that deals with carbon compounds
Functional group	A group of atoms that is largely responsible for the chemical behavior of the parent molecule
Hydrocarbons	Group of compounds that are made up of only hydrogen and carbon
Aliphatic hydrocarbons	Do not contain the benzene group or the benzene ring
Aromatic hydrocarbons	Contain one or more benzene rings
Alkanes	Hydrocarbons that have the general formula C_nH_{2n+2} $n \in \mathbb{N}$. They are saturated hydrocarbons
Structural isomers	Isomers that differ in the order in which atoms are connected
Conformations	Different spatial arrangements of a molecule that are generated by rotation about single bonds
Radical	Contains an unpaired electron
Cycloalkanes	Alkanes whose carbon atoms are joined in rings, C_nH_{2n} $n \in \mathbb{N}\backslash 1, 2$
Alkenes	Contain at least one carbon-carbon double bond. Alkenes have the general formula C_nH_{2n} $n \in \mathbb{N}\backslash 1$. They are unsaturated hydrocarbons
Geometric isomers	Have the same type and number of atoms and the same chemical bonds but different spatial arrangements. Such isomers cannot be interconverted without breaking a chemical bond
Cis	Two particular atoms (or groups of atoms) are adjacent to each other
Trans	Two atoms (or groups of atoms) are across from each other
Addition reactions	One molecule adds to another to form a single product
Alkynes	Contain at least one carbon-carbon triple bond. They have the general formula C_nH_{2n-2} $n \in \mathbb{N}\backslash 1$
Delocalized molecular orbitals	Orbitals which are not confined between two adjacent bonding atoms, but actually extend over three or more atoms
Alchohol	Contains the hydroxyl functional group -OH
Ether	Contains the R-O-R' linkage where R and R' are hydrocarbon (aliphatic or aromatic) groups
Condensation reaction	The joining of two molecules and the elimination of a small molecule, usually water
Aldehyde	At least one hydrogen atom is bonded to the carbon in the carbonyl group
Ketone	The carbon atom in the carbonyl group is bonded to two hydrocarbon groups
Carboxylic acids	Acids that contain the carboxyl group, -COOH
Esters	Have the general formula R'COOR, in which R' and be H, an alkyl, or an aromatic hydrocarbon group and R is an alkyl or an aromatic hydrocarbon group
Amies	Organic bases that have the general formula R_3N in which one of the R groups must be an alkyl group or an aromatic hydrocarbon group
Enantiomers	The nonsuperimposable mirror images of a chiral compound

Intermolecular Forces

Term	Explanation
Intermolecular forces	Attractive forces between molecules
Intramolecular forces	Hold atoms together in a molecule
Van der Waals forces	Dipole-dipole, dipole-induced dipole and dispersion forces
Dipole-dipole forces	Attractive forces between polar molecules
Ion-dipole forces	Attract an ion (either a cation or an anion) and a polar molecule to each other
Induced dipole	The separation of positive and negative charges in the atom (or nonpolar molecule) due to the proximity of an ion or a polar molecule
Polarizability	The ease with which the electron distribution in the atom (or molecule) can be distorted
Dispersion forces	Attractive forces that arise as a result of temporary dipoles induced in atoms or molecules
Hydrogen bond	A special type of dipole-dipole interaction between the hydrogen atom in a polar bond such as N-H, O-H or F-H and an electronegative O, N or F atom
Surface tension	The amount of energy required to stretch or increase the surface of a liquid by a unit area (i.e $1 cm^2$
Cohesion	The intermolecular attraction between like molecules
Adhesion	Attraction between unlike molecules
Viscosity	A measure of a fluid's resistance to flow
Crystalline solid	Possesses rigid and long-range order; its atoms, molecules, or ions occupy spcific positions
Unit cell	The basic repeating structural unit of a crystalline solid
Lattice point	A sphere representing an atom, an ion, or a molecule
Coordination number	The number of atoms (or ions) surrounding an atom (or ion) in a crystal lattice
Closest packing	The most efficient arrangement of spheres
Amorphous solids	Solids that lack a regular three-dimensional arrangement of atoms
Phase	A homogeneous part of the system in contact with other parts of the system but separated from them by a well-defined boundary
Phase change	Transformations from one phase to another
Evaporation/Vaporization	At any given temperature, a certain number of the molecules in a liquid possess sufficient kinetic energy to escape from the surface
Condensation	As the concentration of molecules in the vapor phase increases, some molecules return to the liquid phase
Dynamic equilibrium	the rate of a forward process is exactly balanced by the rate of the reverse process
Equilibrium vapor pressure	The vapor pressure measured under dynamic equilibrium of condensation and evaporation
Molar heat of vaporization (ΔH_{vap}	The energy (usually in kilojoules) required to vaporize one mole of a liquid
Boiling point	The temperature at which the vapor pressure of a liquid is equal to the external pressure
Critical temperature (T_c)	Above this temperature, the gas form cannot be made to liquefy, no matter how great the applied pressure. Also, the highest temperature at which a substance can exist as a liquid

Critical pressure (P_c)	The minimum pressure that must be applied to bring about liquefaction at the critical temperature
Melting point	The temperature at which solid and liquid phases coexist in equilibrium
Molar heat of fusion (ΔH_{fus})	The energy (usually in kilojoules) required to melt 1 mole of a solid
Sublimation	The process in which molecules go directly from the solid into the vapor phase
Deposition	From vapor directly to solid
Molar heat of sublimation (ΔH_{sub})	The energy (usually in kilojoules) required to sublime 1 mole of a solid
Phase diagram	Summarizes the conditions under which a substance exists as a solid, liquid or gas
Triple point	The only temperature and pressure at which all three phases can be in equilibrium with one another

Physical Properties of Solutions

Term	Explanation
Saturated solution	A solution that contains the maximum amount of a solute in a given solvent, at a specific temperature
Unsaturated	The solution contains less solute than it has the capacity to dissolve
Supersatured solution	Solution contains more solute than is present in a saturated solution
Crystallization	The process in which dissolved solute comes out of solution and forms crystals
Miscible	When two liquids are completely soluble in each other in all proportions
Solvation	The process in which an ion or a molecule is surrounded by solvent molecules arranged in a specific manner. When the solvent is water, it's called hydration
Molality	The number of moles of solute dissolved in 1 kg of solvent
Thermal pollution	The heating of the environment to temperatures that are harmful to its living inhabitants
Henry's Law	The solutbility of a gas in a liquid is proportional to the pressure of the gas over the solution
Colligative properties	Several important properties of solutions depend on the number of solute particles in solution and not on the nature of the solute particles (vapor-pressure, lowering, boiling-point elevation, freezing-point depression and osmotic pressure)
Nonvolatile	Solute that does not have a measurable vapor pressure
Raoult's Law	The vapor pressure of a solvent over a solution, p_1, is given by the vapor pressure of the pure solvent, $p_1^($HERMIKAEL$)$ times the mole fraction of the solvent in the solution, X_1
Volatile	Measurable vapor pressure
Ideal solution	Any solution that obeys Raoult's law
Semipermeable membrane	Allows solvent molecules to pass through but blocks the passage of solute molecules

Osmosis	The net movement of solvent molecules through a semipermeable membrane from a pure solvent or from a dilute solution to a more concentrated solution
Osmotic pressure (π)	The pressure required to stop osmosis
Ion pair	A cation and an anion held together by electrostatic forces

Physical Properties of Solutions

Term	Explanation
Conjugate acid-base pair	An acid and its conjugate base
Ion-product constant	The product of the molar concentrations of H+ and OH- ions at a particular temperature

Electrochemistry

Term	Explanation
Electrochemistry	The branch of chemistry that deals with the interconversion of electrical energy and chemical energy
Standard reduction potential	The voltage associated with a reduction reaction at an electrode when all solutes are 1 M and all gases are at 1 atm
Anode	Oxidation (releases electrons)
Cathode	Reduction (absorbs electrons)
Battery	A galvanic cell, or a series of combined galvanic cells that can be used as a source of direct electric current at a constant voltage
Corrision	The deterioration of metals by an electron-chemical process
Electrolysis	Electrical energy is used to cause a nonspontaneous chemical reaction to occur
Electrolytic cell	Apparatus for carrying out electrolysis

The Chemistry of Coordination Compounds

Term	Explanation
Coordination compound	Typically consists of a complex ion and counter ion
Ligands	The molecules or ions that surround the metal in a complex ion
Donor atom	The atom in a ligand that is bound directly to the metal atom
Coordination number	The number of donor atoms surrounding the central metal atom in a complex ion
Chelating agents	Bidentate and polydentate ligands. They have an ability to hold the metal atoms "like a claw"
Stereoisomers	Compounds that are made up of the same types and numbers of atoms bonded together in the same sequence but with different spatial arrangements
Crystal field splitting (Δ)	The energy difference between two sets of d orbitals in a metal atom when ligands are present

Spectrochemical series	A list of ligands arrangeed in increasing order of their abilities to slit the d orbital energy levels
Labile complexes	Complexes that undergo rapid ligand exchange reactions
Inert complex	Complex ions that undergo very clow exchange reactions

Organic Polymers - Synthetic and Natural

Term	Explanation
Polymer	A molecular compound distinguished by a high molar mass, ranging into thousands and millions of grams, and up of many repeating units
Monomers	Simple repeating units
Homopolymer	A polymer made up of only one type of monomer
Copolymer	A polymer containing two or more different monomers
Proteins	Polymers of amino acids
Amino acid	A compound that contains at least one amino group (-NH2) and at least one carboxyl group (-COOH)
Denatured proteins	Proteins in a state where they can no longer exhibit normal biological activities
Nuclei acids	High-molar-mass polymers that play an essential role in protein synthesis
Deoxyribonucleic acid (DNA) / Ribonucleic acid	The two types of nucleic acid
Nucleotides	Strands which constist of a base, a deoxyribose, and a phosphate group linked together

Important formulas

Formula	Description
$n = \frac{m}{M}$	stofmængde: n[mol], masse: m[g], M: molarmass $\left[\frac{g}{mol}\right]$
% composition $= \frac{n \cdot M_{\text{element}}}{M_{\text{compound}}}$	stofmængde: n[mol], M: molarmasse$\left[\frac{g}{mol}\right]$
% yield $= \frac{\text{actual yield}}{\text{theoretical yield}} \cdot 100$	
$n = c \cdot V$	stofmængde: n[mol], koncentration: c$\left[\frac{mol}{liter}\right]$
$c_i \cdot V_i = c_f \cdot V_f$	moles of solute before solution and moles of solute after dilution. $c_i = molarity initially, V_i = volume initially, c_f = molarity finally, V_f = molarity finally$
$p = \frac{F}{A}$	p[Pa], F[Newton], A[square meter]

$p_1 \cdot V_1 = p_2 \cdot V_2$

Only applicable with constant temperature

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Only applicable with constant pressure

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$

Only applicable with constant amount (moles) and constant volume

$pV = nRT$

pressure : p[atm], volume: V[L], stofmængde: n[mol], gas constant: R$[\frac{L \cdot atm}{K \cdot mol}]$

$pV = \frac{m}{M}RT$

pressure : p[atm], volume: V[L], masse: m[g], M: molarmass $[\frac{g}{mol}]$, gas constant: R$[\frac{L \cdot atm}{K \cdot mol}]$

$p_T = p_A + p_B = \frac{nRT}{V}$
$X_i = \frac{n_i}{n_T}$
$p_i = X_i \cdot p_T$
$\overline{KE} = \frac{1}{2} \cdot m \cdot \overline{v^2} = C \cdot T$
$\sqrt{\overline{v^2}} = v_{rms} = \sqrt{\frac{3RT}{M}}$
$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$
$(p + \frac{a \cdot n^2}{V^2}) \cdot (V - n \cdot b) = nRT$

Dalton's law of partial pressure
Mole fraction. X[dimensionless]
Partial pressure of i'th component
KE[Joule], m[kg], v$[\frac{m}{s}]$, T[Kelvin]

Root-mean-squared speed. v$[\frac{m}{s}]$

Diffusion rate

van Der Waals equation. Look at page 166 for a and b values for some common gases

$v = \lambda \cdot \nu$
$E = h \cdot v$

v$[\frac{m}{s}]$, λ[m], ν[Hz]
h = Planck's constant[J $\cdot$ s]. ν = frequency$[\frac{1}{s}]$, energy per foton

$\nu = \frac{c}{\lambda}$
$h \cdot \nu = KE + W$
$E_n = -R_H \cdot (\frac{1}{n^2})$

W = work[N * m]
n = principal quantum number, R = Rydberg constant

$\Delta E = h\nu = R_H \cdot (\frac{1}{n_i^2} - \frac{1}{n_f^2})$
$\lambda = \frac{h}{m \cdot v}$

h = Rydberg constant, m = mass, v = velocity

$Z_{(\text{eff})} = Z - \sigma$
$\Delta H = \Sigma BE(\text{reactants}) - \Sigma BE(\text{products})$
$\mu = Q \cdot r$

σ = shielding constant
BE = average bond enthalpy
Dipole moment. $\mu > 0$[D (debye unit)], Q = charge, r = distance

$\ln p = -\frac{\Delta H_{vap}}{RT} + C$

p[mmHg], R = 8.31$[\frac{J}{K \cdot mol}]$, C = constant

$\ln \frac{p_1}{p_2} = \frac{\Delta H_{vap}}{R} \cdot (\frac{T_1 - T_2}{T_1 \cdot T_2})$
$\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$
Percent by mass of solute $= \frac{\text{mass of solute}}{\text{mass of solute + solvent}} \cdot 100$
Molality $= \frac{\text{moles of solute}}{\text{Mass of solvent (kg)}}$
$c = k \cdot p$

c[moles per liter], p[atm], k[mol per liter * atm] = constant (depends on temperature)

$p_1 = X_i \cdot p_1^{(}OGS\mathring{A}HERMIKAAAAAEL)$

X = mole fraction

$p_1^{(}OGHEEEEER) - p_1 = X_2 \cdot p_1^{(}AHHHHHHHHH)$
$\Delta T_b = T_b - T_b^{OGHEEER} = K_b \cdot m$

m = molality, K_b = molal boiling-point elevation constant$[\frac{\deg C}{m}]$

$\Delta T_f = T_f^{OGHEEER} - T_f = K_f \cdot m$

$\pi = cRT$	Osmotic pressure. π [atm], c = molarity of solution, R = gase constant $(0.0821\ L \cdot \frac{atm}{K \cdot mol}$, T = temperature
$\Delta T_b = iK_b m$	Use only for electrolytes. i = van't Hoff factor $(\frac{\text{actual number of particles in solution after dissociation}}{\text{number of formula units initially dissolved in solution}}$
$\Delta T_f = iK_f m$	Use only for electrolytes. i = van't Hoff factor $(\frac{\text{actual number of particles in solution after dissociation}}{\text{number of formula units initially dissolved in solution}}$
$\pi = icRT$	Use only for electrolytes. i = van't Hoff factor $(\frac{\text{actual number of particles in solution after dissociation}}{\text{number of formula units initially dissolved in solution}}$
$E_{cell}^{circkel} = E_{cathode}^{circle} - E_{anode}^{circle}$ $\Delta G = -nFE_{cell}$	n[number of transferred electrons], F = Faraday constant, Ecell[J = volts * coulomb]. Note that at standard states $E_{cell} = E_{cell}^{circle}$
$E_{cell}^{circle} = \frac{RT}{nF} \cdot \ln K$	K = equilibrium constant
$E = E^{circle} - \frac{RT}{nF} \cdot \ln Q$	Nernst equation. Q = reaction quotient
$\Delta = h \cdot \nu$	Δ = Crystal field splitting

Important constants

Constant	Description
Mole	$n = 6.022 \cdot 10^{23}$
Avogadro's number	$N_A = 6.022 \cdot 10^{23} \frac{\text{atoms}}{\text{mole}}$
R	$0.08206 \frac{L \cdot atm}{K \cdot mol}$ or $0.08314 \frac{L \cdot bar}{K \cdot mol}$ or 8.31
c (the speed of light)	$3.00 \cdot 10^8 \frac{m}{s}$
Planck's constant h	$6.63 \cdot 10^{-34}$ Joule $\cdot$ s
Rydberg constant	$2.18 \cdot 10^{-18}$ J
Faraday constant	$9.647 \cdot 10^4 \frac{C}{mol} e^-$

Unit converter

Unit from To	Description
$torr \rightarrow atm$	$\frac{x\ mmHg}{760\ mmHg}$
$atm \rightarrow torr$	$x\ atm \cdot 760\ mmHg$
$bar \rightarrow atm$	$x \cdot 0.9869$
$atm \rightarrow bar$	$x \cdot 1.013$
$Pa \rightarrow atm$	$x \cdot 0.00000987$
$atm \rightarrow Pa$	$x \cdot 101325$
$Celcius \rightarrow Kelvin$	$x + 273.15K$
$Kelvin \rightarrow Celcius$	$x - 273.15K$

$$C \cdot m \to D \qquad \Big| \ \frac{x}{3.336 \cdot 10^{-30} C \cdot m}$$

Redox reaction

1. Find oxidation number

2. Find changes in the oxidation numbers of each element (usually besides oxygen and hydrogen)

3. Make sure to correct the stoichiometric amounts on each side of the arrow so that all elements are present in the same amount (besides oxygen and hydrogen).

4. Count electrical charge on both sides.

5. If electrical charge is different add H^+ (if acid) and OH^- (if basic).

6. Add appropriate amount of water H_2O

7. Check that oxygen matches on both sides of the arrow

Example of redox reaction

$$3\,PbS + 2\,NO_3^- + 8H^+ \to 3\,Pb^{2+} + 3S + 2\,NO + 4H_2O$$

S: $2\uparrow \cdot 3$

N: $3\downarrow \cdot 2$
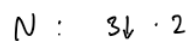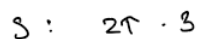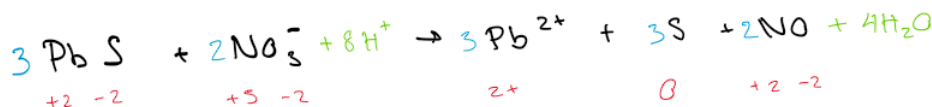
Thermodynamics

Begreb	Forklaring
Exothermic	Gives off heat to the surroundings, $\Delta H < 0$
Endothermic	Heat has to be supplied to the system by the surroundings, $\Delta H > 0$

$$\Delta U = U_f - U_i \tag{1}$$
$$\Delta U = q + w \tag{2}$$
$$\Delta U = U(product) - U(reactants) \tag{3}$$
$$w = -P\Delta V \tag{4}$$

Organic chemistry

Naming

Also see page 372 of the book.

1. Longest continuous chain of carbon atoms.

2. Remove "ane" from straigt-chain alkane name and add "yl", e.g., methane -¿ methyl.

3. Lowest number for branches, so 2-methylpentane instead of 4-methylpentane.

4. Use prefix with more than one alkyl branch, so 2,3-dimethylhexane. If more sort them alphabetically.

5. With substitutes we list them alphabetically and the chain is numbered in the direction with lowest number to the first substitued carbon atom.
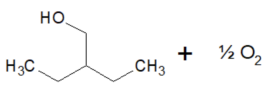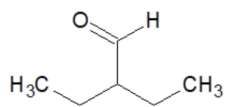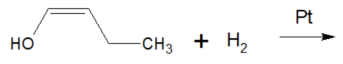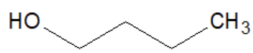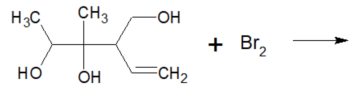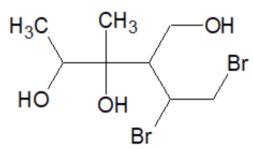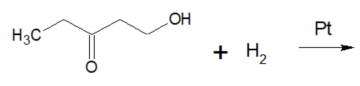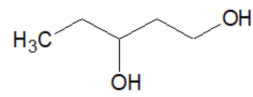
Functional group	Name
——NH_2	Amino
——F	Fluoro
——Cl	Chloro
——Br	Bromo
——I	Iodo
——NO_2	Nitro
——$CH = CH_2$	Vinyl

Tabel 1: Common substituent groups

Name	Functional group
Carbon-carbon double bond	C = C
Carbon-carbon triple bond	— C ≡ C —
Halogen	— X, X = F, Cl, Br, I
Hydroxyl	— O — H
Carbonyl	C = O
Aldehydes	Carbonyl + at least one hydrogen atom e.g, $\begin{smallmatrix}H\\C=O\\R\end{smallmatrix}$
Ketones	Carbonyl + hydrocaron groups e.g, $\begin{smallmatrix}R\\C=O\\R'\end{smallmatrix}$, R, R': hydrocarbon groups
Carboxyl	— C(=O) — OH
Ester	— C(=O) — O — R
Amine	— N(R)(R)
Ether	R — O — R', R: hydrocarbon groups

Reaktioner med funktionelle grupper

Reaktant	Forklaring	Produkt
H₃C␣␣␣␣␣␣␣OH	Alkoholer oxideres til carboxylsyrer	O; H₃C␣␣␣OH; Butansyre
H₃C(OH)CH₃ + ½ O₂	Sekundære alkoholer (alkoholer hvis tætteste carrbon er bundet på to andre) oxideres til ketoner under milde betingelser	O; H₃C␣␣␣CH₃

	Primære alkoholer (alkholer hvis tætteste carbon er bundet videre til ét andet atom) oxideres til aldehyder under milde betingelser	
	Dobbeltbindingen hydrogeneres til en enkeltbinding	
	Dibrom adderes til dobbeltbindingen	
	Dobbeltbindingen i ketonen hydrogeneres til en sekundær alkohol	

Chemical Kinetics

Chemical Equilibrium

The general reaction that we consider is
$$a\,\mathrm{A} + b\,\mathrm{B} \rightleftharpoons c\,\mathrm{C} + d\,\mathrm{D}.$$
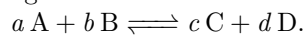
Term	Explanation
Equilibrium constant	Rate at which the forward and backwards rate is equal.
Le Châtelier's Principle	If external stress is applied to a system at equilibrium the system adjusts such that the stress is partially offset to restore equilibrium.
Homogeneous	All reactants and products are in the same phase.
Heterogeneous	Not homogeneous, that is somethings is in a different phase.

Formula	Description
$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$	Law of mass action. General expression of equilibrium constant.
$K_P = \frac{P_B^b}{P_A^a}$	Partial pressures with $a\,A\,(g) \rightleftharpoons b\,B\,(g)$.
$K_P = K_c(0.0821T)^{\Delta n}$	$\Delta n = b - a$ with $a\,A\,(g) \rightleftharpoons b\,B\,(g)$.
$Q_c = \frac{[C]_0^c[D]_0^d}{[A]_0^a[B]_0^b}$	Reaction quotient.

- If $Q_c < K_c$: reactants must be converted to products.

- If $Q_c = K_C$: system is at equilibrium.

- If $Q_c > K_c$: products must be converted to reactants.

Method for calculating equilibrium concentrations Consider the reaction $a\,A \rightleftharpoons b\,B$ with a given equilibrium constant K_c and a start concentration $[A] = y$. Here we construct the table

	$a\,A$	$\rightleftharpoons$	$b\,B$
Initial:	y		0
Change:	$-x$		$+x$
Equilibrium	$y - x$		x

This gives us the equation

$$K_c = \frac{x}{y-x}, \tag{5}$$

which allows us to calculate x.

Reaction Rate

Term	Explanation
Chemical reaction	The area of chemistry concerned with the speed or the rate at which a chemical reaction occurs.
Reaction rate	The change in concentration of a reactant or a product with the time.
Rate constant	A constant of proportionality between the reaction rate and the concentration of the reactants.
Rate law	An expression relating the rate of a reaction to the rate constant and the concentrations of the reactant.
Reaction order	The sum of the powers to which all reactant concentration appearing in the rate law are raised.
Half-life	The time required for the concentration of a reactant to decrease to half of its initial concentration.
Activation energy (E_a)	The minimum amount of energy required to initiate a chemical reaction
Activated complex	The species temporarily formed by the reactant molecules as a result of the collision before they form the product (also called transition state).
Elementary steps	Or elementary reactions are a series of simple reactions that represent the progress of the overall reaction at the molecular level.
Reaction mechanism	The sequence of elementary steps that leads to product formation.
Intermediates	Appear in the mechanism of the reaction but not in the overall balanced equation.
Molecularity of a reaction	The number of molecules reacting in an elementary step.
Bimolecular reaction	An elementary step that involves two molecules
Unmolecular reaction	An elementary step in which only one reacting molecule participates.
Termolecular reactions	Reactions that involve the participation of three molecules in one elementary step (extremely rare)

Formula	Description
$-\frac{1}{a}\frac{\Delta[A]}{\Delta t} = -\frac{1}{b}\frac{\Delta[B]}{\Delta t}$	Reaction rate in which $aA + bB \rightarrow cC + dD$ and $[X]$ is the concentration of the substance.
$rate = k[A]^x[B]^x$	Rate law where k,x,y is found experimentally and $[X]$ is the concentration.
$\ln\frac{[A]_t}{[A]_0} = -kt$	First-order equation, where $[A]_{t0}$ is the initial concentration and $[A]_t$ at $t = t1$
$t_{\frac{1}{2}} = \frac{1}{k}\ln(2)$	Half-life of first order equation.
$\frac{1}{[A]_t} = \frac{1}{[A_0]} + kt$	Second-order equation with the same variables as a the first-order above.
$t_{\frac{1}{2}} = \frac{1}{k[A]_0}$	Half-life second order equation.
$[A]_t = -kt0 + [A]_0$	Zero-order reaction
$t_{\frac{1}{2}} = \frac{[A]_0}{2k}$	Half-life for zero order equation.
$k = Ae^{\frac{-E_a}{RT}}$	Where E_a is the activation energy R is the gas constant $(8.314 J/K \cdot mol)$