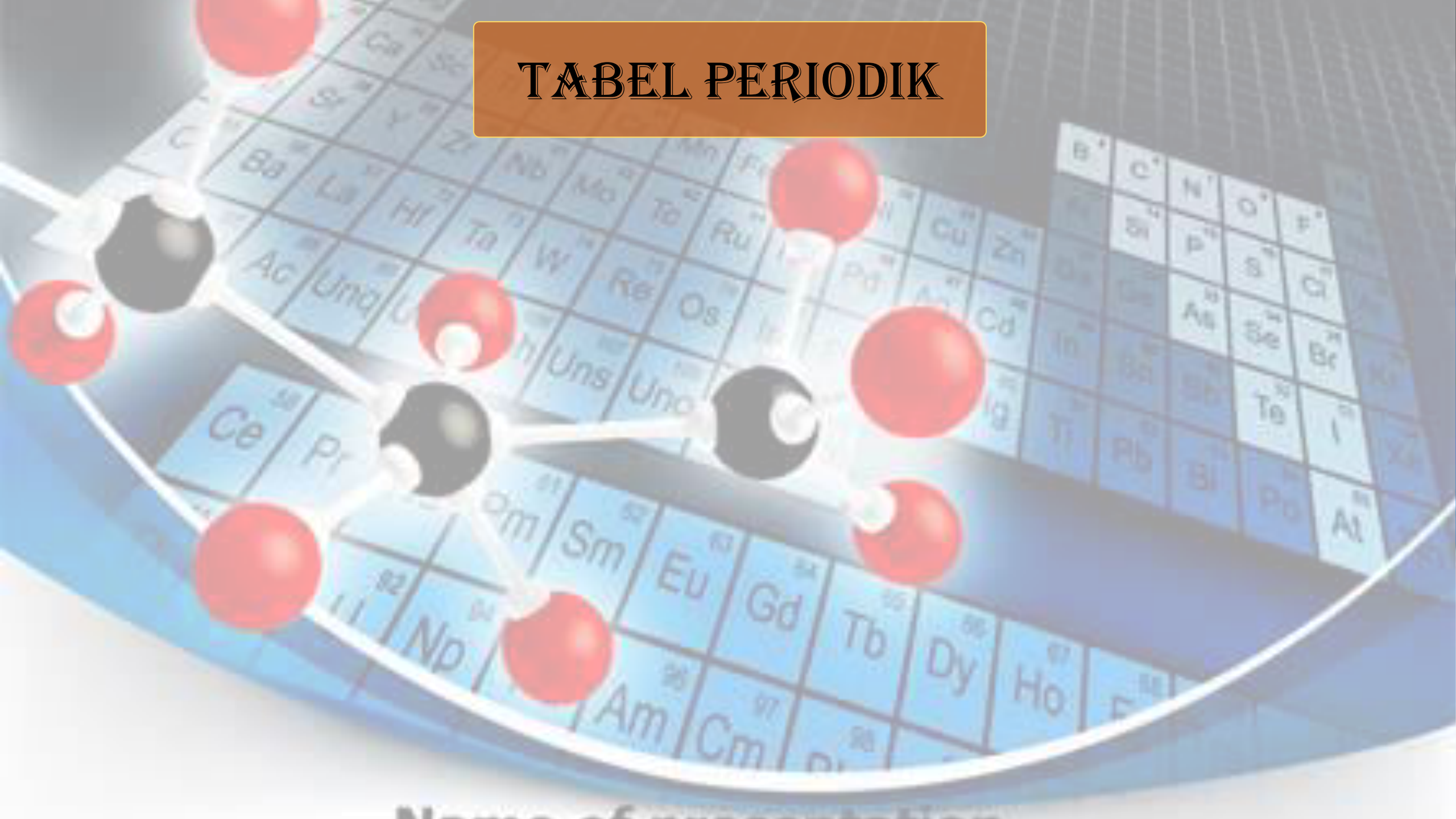
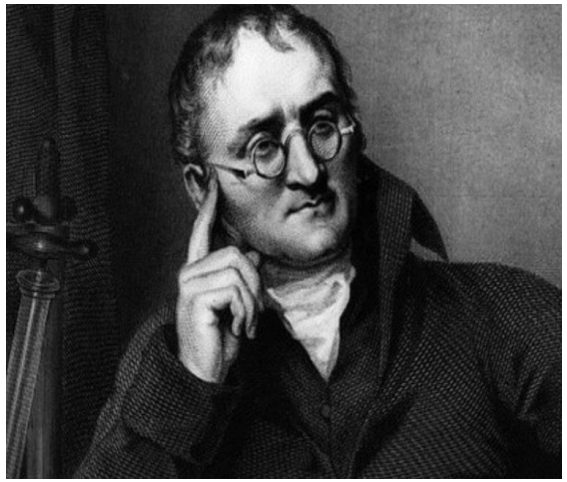
DIKTAT M. K. KIMIA ANORGANIK II (BAGIAN 1)

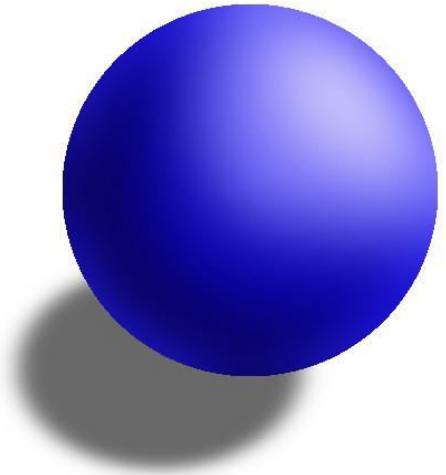
Dosen Pengampu: Familia Novita Simanjuntak, S.P., M.Si

TABEL PERIODIK





Atom merupakan partikel terkecil yang tidak dapat dibagi lagi.



Atom suatu unsur yang sama mempunyai bobot yang sama, sedang unsur yang berbeda atomnya akan berbeda pula.

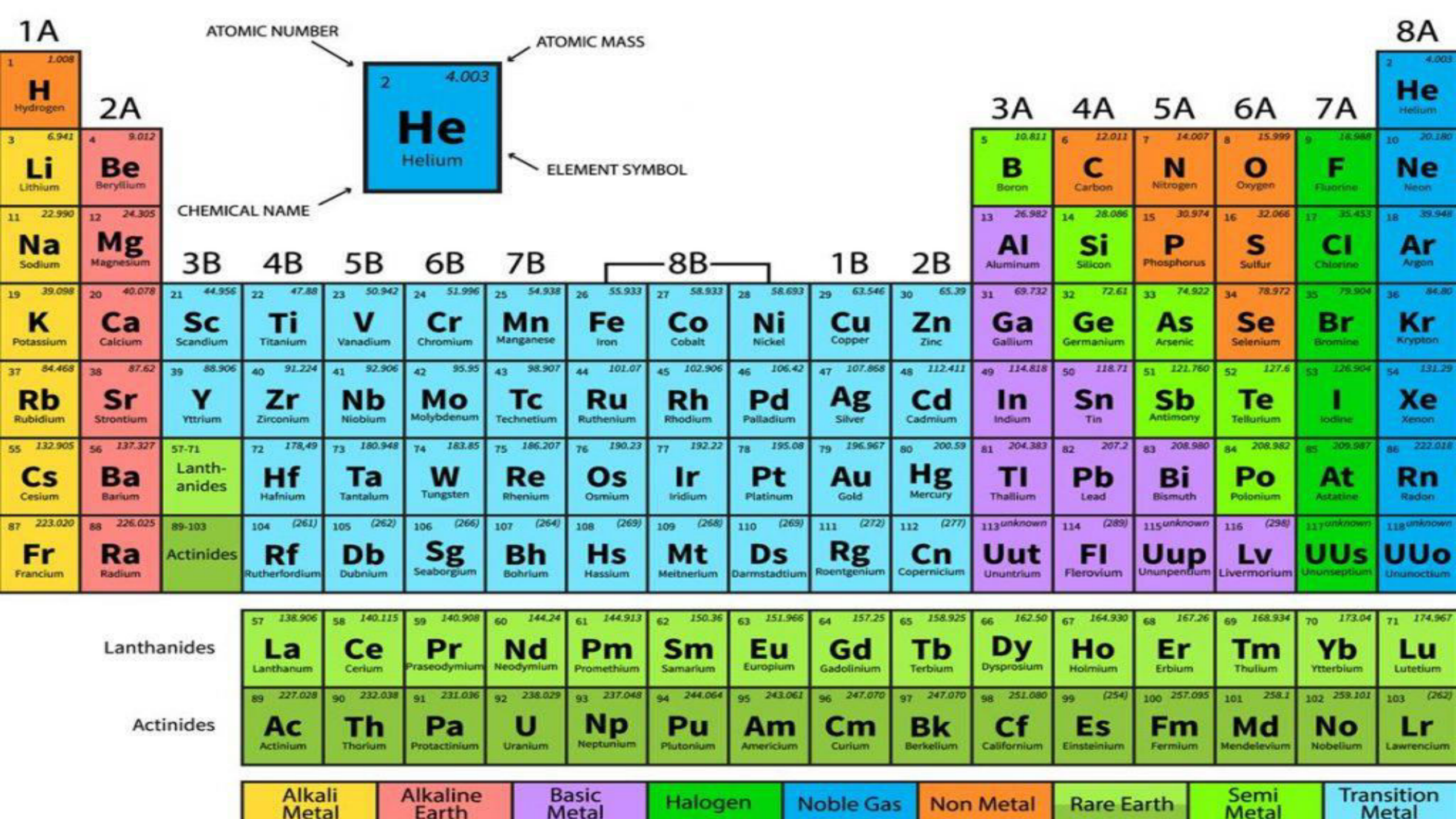
Senyawa dikatakan sebagai hasil dari penggabungan atom-atom yang tidak sama dengan perbandingan bobot yang proporsional dengan bobot atom yang bergabung

Reaksi kimia hanya melibatkan penataulangan atom-atom.

Pada 1808, John Dalton menerbitkan A New System of Chemical Philosophy,
di mana dia mengusulkan Partikel pamungkas dari semua benda homogen memiliki berat yang sama.

Avogadro menggunakan data dari Gay-Lussac untuk menyatakan kesetaraan itu

Pada tahun 1869, Mendeleev 6 dan Meyer 7 diusulkan secara independen tabel periodik hampir seperti yang digunakan saat ini, dan sejak saat itu perkembangan atom teori berkembang pesat


ATOMIC NUMBER
ATOMIC MASS
2 4.003
He
Helium
ELEMENT SYMBOL
CHEMICAL NAME
1A
2A
3A
4A
5A
6A
7A
8A
3B
4B
5B
6B
7B
8B
1B
2B
1 1.008 H Hydrogen
2 4.003 He Helium
3 6.941 Li Lithium
4 9.012 Be Beryllium
5 10.811 B Boron
6 12.011 C Carbon
7 14.007 N Nitrogen
8 15.999 O Oxygen
9 18.988 F Fluorine
10 20.180 Ne Neon
11 22.990 Na Sodium
12 24.305 Mg Magnesium
13 26.982 Al Aluminum
14 28.086 Si Silicon
15 30.974 P Phosphorus
16 32.066 S Sulfur
17 35.453 Cl Chlorine
18 39.948 Ar Argon
19 39.098 K Potassium
20 40.078 Ca Calcium
21 44.956 Sc Scandium
22 47.88 Ti Titanium
23 50.942 V Vanadium
24 51.996 Cr Chromium
25 54.938 Mn Manganese
26 55.933 Fe Iron
27 58.933 Co Cobalt
28 58.693 Ni Nickel
29 63.546 Cu Copper
30 65.39 Zn Zinc
31 69.732 Ga Gallium
32 72.61 Ge Germanium
33 74.922 As Arsenic
34 78.972 Se Selenium
35 79.904 Br Bromine
36 84.80 Kr Krypton
37 84.468 Rb Rubidium
38 87.62 Sr Strontium
39 88.906 Y Yttrium
40 91.224 Zr Zirconium
41 92.906 Nb Niobium
42 95.95 Mo Molybdenum
43 98.907 Tc Technetium
44 101.07 Ru Ruthenium
45 102.906 Rh Rhodium
46 106.42 Pd Palladium
47 107.868 Ag Silver
48 112.411 Cd Cadmium
49 114.818 In Indium
50 118.71 Sn Tin
51 121.760 Sb Antimony
52 127.6 Te Tellurium
53 126.904 I Iodine
54 131.29 Xe Xenon
55 132.905 Cs Cesium
56 137.327 Ba Barium
57-71 Lanth-anides
72 178.49 Hf Hafnium
73 180.948 Ta Tantalum
74 183.85 W Tungsten
75 186.207 Re Rhenium
76 190.23 Os Osmium
77 192.22 Ir Iridium
78 195.08 Pt Platinum
79 196.967 Au Gold
80 200.59 Hg Mercury
81 204.383 Tl Thallium
82 207.2 Pb Lead
83 208.980 Bi Bismuth
84 208.982 Po Polonium
85 209.987 At Astatine
86 222.018 Rn Radon
87 223.020 Fr Francium
88 226.025 Ra Radium
89-103 Actinides
104 (261) Rf Rutherfordium
105 (262) Db Dubnium
106 (266) Sg Seaborgium
107 (264) Bh Bohrium
108 (269) Hs Hassium
109 (268) Mt Meitnerium
110 (269) Ds Darmstadtium
111 (272) Rg Roentgenium
112 (277) Cn Copernicium
113 unknown Uut Ununtrium
114 (289) Fl Flerovium
115 unknown Uup Ununpentium
116 (298) Lv Livermorium
117 unknown UUs Ununseptium
118 unknown UUo Ununoctium
Lanthanides
57 138.906 La Lanthanum
58 140.115 Ce Cerium
59 140.908 Pr Praseodymium
60 144.24 Nd Neodymium
61 144.913 Pm Promethium
62 150.36 Sm Samarium
63 151.966 Eu Europium
64 157.25 Gd Gadolinium
65 158.925 Tb Terbium
66 162.50 Dy Dysprosium
67 164.930 Ho Holmium
68 167.26 Er Erbium
69 168.934 Tm Thulium
70 173.04 Yb Ytterbium
71 174.967 Lu Lutetium
Actinides
89 227.028 Ac Actinium
90 232.038 Th Thorium
91 231.036 Pa Protactinium
92 238.029 U Uranium
93 237.048 Np Neptunium
94 244.064 Pu Plutonium
95 243.061 Am Americium
96 247.070 Cm Curium
97 247.070 Bk Berkelium
98 251.080 Cf Californium
99 (254) Es Einsteinium
100 257.095 Fm Fermium
101 258.1 Md Mendelevium
102 259.101 No Nobelium
103 (262) Lr Lawrencium
Alkali Metal
Alkaline Earth
Basic Metal
Halogen
Noble Gas
Non Metal
Rare Earth
Semi Metal
Transition Metal

Penemuan partikel subatom dan atom bort

Pada tahun 1885, Balmer menunjukkan bahwa energi cahaya tampak yang dipancarkan oleh atom hydrogen.

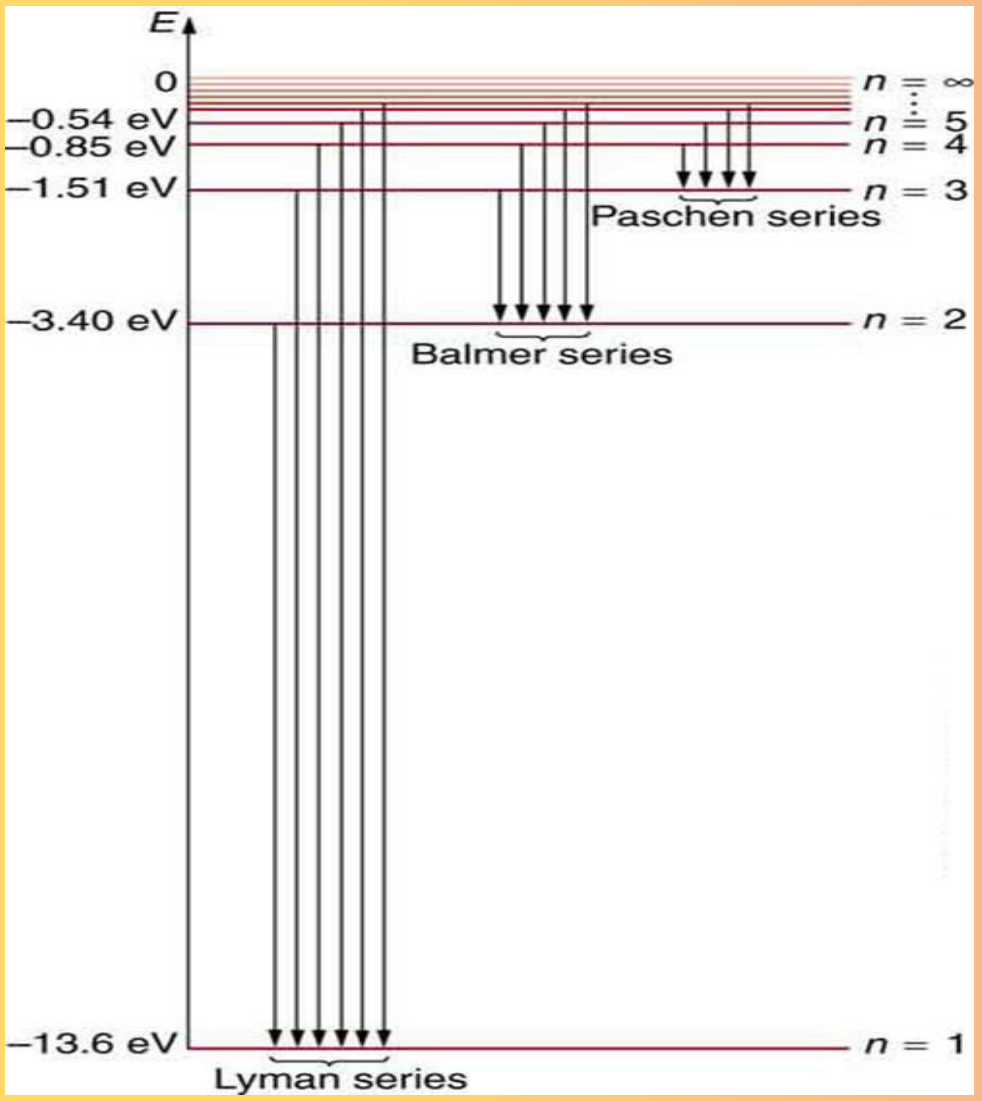
$$\mathrm{E} = \mathrm{R_H}\left(\frac{1}{2^2} - \frac{1}{\mathrm{n_h^2}}\right)$$

$$\mathrm{E} = h\nu = \frac{hc}{\lambda} = hc\bar{\nu}$$

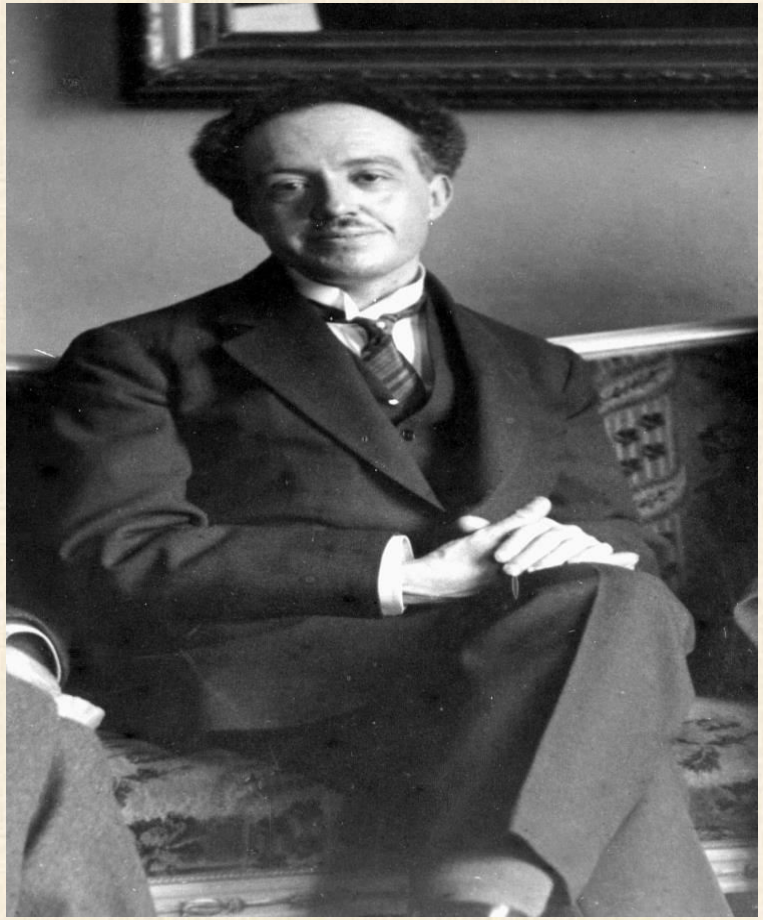
Energi cahaya yang dipancarkan atau diserap dapat ditemukan, menurut model atom hidrogen Bohr, dari persamaan

$$\mathrm{E} = R\left(\frac{1}{n_l^2} - \frac{1}{\mathrm{n_h^2}}\right)$$

$$\mathrm{R} = \frac{2\pi^2 \mu z^2 e^2}{(4\pi\varepsilon 0)^2 h^2}$$



Hanya berlaku untuk atom hidrogen dan situasi satu elektron lainnya seperti He^{+}, Li^{2+}, dan Be^{3+}



Menurut de Broglie, semua partikel yang bergerak memiliki sifat gelombang yang dijelaskan dalam persamaan

$$\lambda = \frac{h}{mu}$$

Prinsip ketidakpastian Heisenberg, yang menyatakan bahwa ada hubungan antara ketidakpastian yang melekat pada lokasi dan momentum sebuah elektron

$$\Delta x \, \Delta p_x \geq \frac{h}{4\pi}$$

Persamaan Schrödinger

Persamaan Schrödinger menjelaskan properti gelombang elektron dalam istilah posisinya, massa, energy total, dan energi potensial.

Rumus:
HΨ=EΨ
H=Operator Hamiltonian
E= Energi elektron
Ψ= Fungsi Gelombang

$$H = \frac{-h^2}{8\pi^2 m}\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right) - \frac{Ze^2}{4\pi\varepsilon_0\sqrt{x^2 + y^2 + z^2}}$$

This part of the operator describes the *kinetic energy* of the electron, its energy of motion.

This part of the operator describes the *potential energy* of the electron, the result of electrostatic attraction between the electron and the nucleus. It is commonly designated as *V*.

where
h = Planck constant
m = mass of the electron
e = charge of the electron
$\sqrt{x^2 + y^2 + z^2} = r$ = distance from the nucleus
Z = charge of the nucleus
$4\pi\varepsilon_0$ = permittivity of a vacuum

$$V = \frac{-Ze^2}{4\pi\varepsilon_0 r} = \frac{-Ze^2}{4\pi\varepsilon_0\sqrt{x^2 + y^2 + z^2}}$$

$$\left[\frac{-h^2}{8\pi^2 m}\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right) + V(x, y, z)\right]\Psi(x, y, z) = E\Psi(x, y, z)$$

Aturan-aturan psi (Ψ)

1. Fungsi gelombang Ψ haruslah bernilai tunggal. Tidak mungkin ada dua kemungkinan untuk elektron di posisi manapun di ruang
2. Fungsi gelombang Ψ dan yang pertama turunan harus kontinu. Probabilitas harus ditentukan di semua posisi di luar dan tidak bisa berubah secara tiba-tiba dari satu titik ke titik berikutnya.
3. Fungsi gelombang Ψ harus didekati nol saat r mendekati tak terhingga. Untuk jarak yang jauh dari nukleus, probabilitas harus tumbuh semakin kecil (atom harus berhingga).
4. Integral $\int_{all\ space} \Psi_A \Psi_a dr = 1$. Probabilitas total suatu makhluk elektron suatu tempat di ruang = 1. Ini disebut menormalkan fungsi gelombang.
5. Integral $\int_{all\ space} \Psi_A \Psi_b = 0$

Partikel dalam Kotak

FIGURE 2.3 Potential Energy Well for the Particle in a Box.

Persamaan gelombang untuk lokasi di dalam kotak adalah

$$\frac{-h^2}{8\pi^2 m}\left(\frac{\partial^2 \Psi(x)}{\partial x^2}\right) = E\,\Psi(x), \quad \text{because } V(x) = 0$$

$$\Psi = A \sin rx + B \cos sx$$

$$\Psi = A \sin rx$$

$$r = \frac{n\pi}{a} = \sqrt{2mE}\frac{2\pi}{h}$$

$$ra = \pm n\pi \quad \text{or} \quad r = \frac{\pm n\pi}{a}$$

$$\Psi = A \sin \frac{n\pi x}{a}$$

$$\int \Psi\Psi^* d\tau = 1 \text{ gives} \quad A = \sqrt{\frac{2}{a}}$$

$$\Psi = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$$

$$r = s = \sqrt{2mE}\frac{2\pi}{h}$$

$$E = \frac{n^2 h^2}{8ma^2}$$

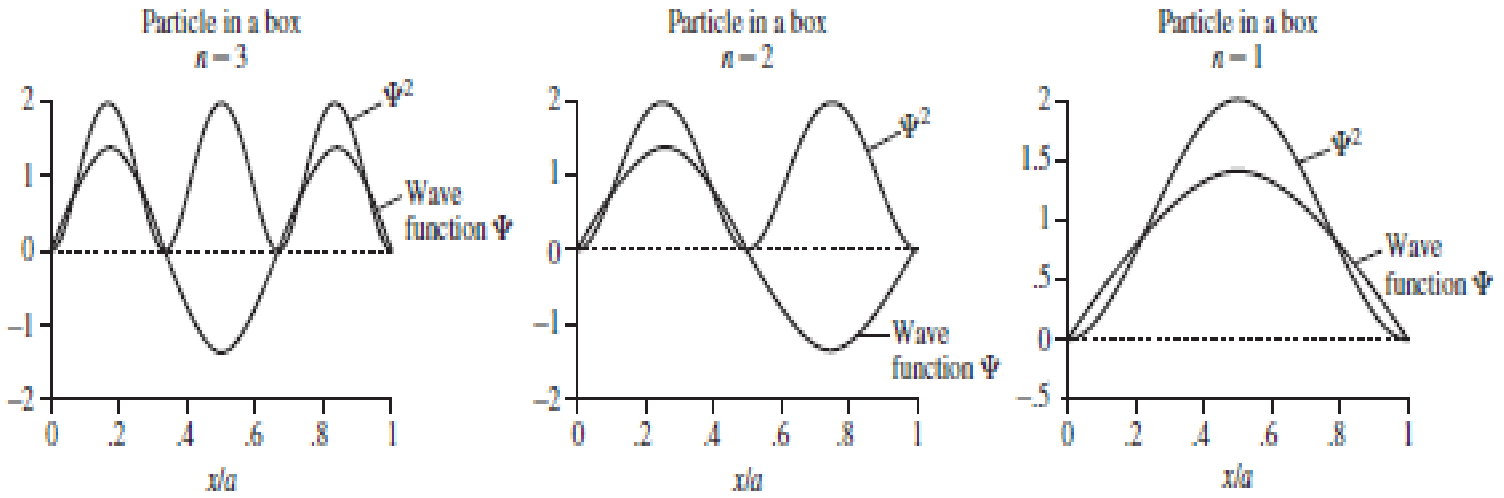
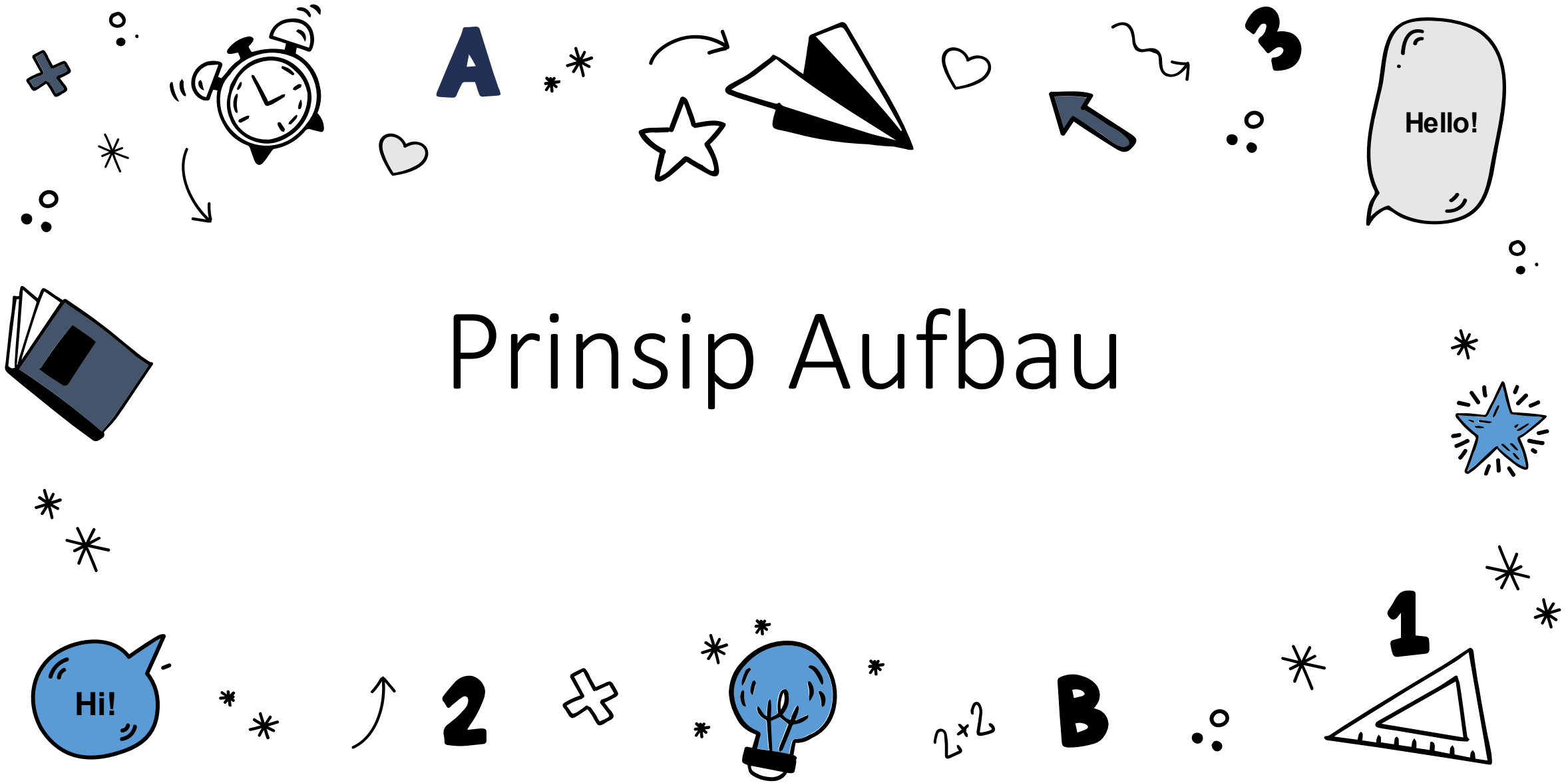
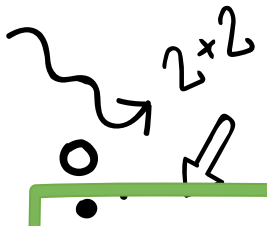


FIGURE 2.4 Wave Functions and Their Squares for the Particle in a Box with $n = 1, 2$, and 3.



Prinsip Aufbau

Metode Ilmiah



Electrons are placed in orbitals to give the lowest total electronic energy to the atom.
This means that the lowest values of *n* and *l* are filled first. Because the orbitals within each subshell (*p* , *d* , etc.) have the same energy, the orders for values of m_l And m_s are indeterminate.

The Pauli exclusion principle requires that each electron in an atom have a unique set of quantum numbers. At least one quantum number must be different from those of every other electron.

Hund's rule of maximum multiplicity requires that electrons be placed in orbitals to give the maximum total spin possible (the maximum number of parallel spins).
Two electrons in the same orbital have a higher energy than two electrons in different orbitals because of electrostatic repulsion (see below);

TABLE 2.6 Hund's Rule and Multiplicity

Number of Electrons	Arrangement	Unpaired e^-	Multiplicity
1		1	2
2		2	3
3		3	4
4		2	3
5		1	2
6		0	1

* Two examples are http://www.orbitals.com and http://winter.group.shef.ac.uk/orbitron.

** This is only one of Hund's rules; others are described in Chapter 11.

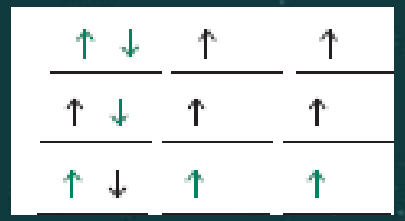
For example, the electron configuration of a carbon atom is $1s^2$ $2s^2$ $2p^2$. The 2*p* electrons can be placed in the *p* orbitals in three ways:

EXAMPLE 2.2

Oxygen

With four *p* electrons, oxygen could have two unpaired electrons (↑↓ ↑ ↑), or it could have no unpaired electrons (↑↓ ↑↓).

a. Determine the number of electrons that could be exchanged in each case, and find the Coulombic and exchange energies.



b. Which state, ↑↓ ↑ ↑, or ↑↓ ↑↓ , is lower in energy?

EXERCISE 2.5 A nitrogen atom, with three 2*p* electrons, could have three unpaired electrons (↑ ↑ ↑), or it could have one unpaired electron (↑↓ ↑).

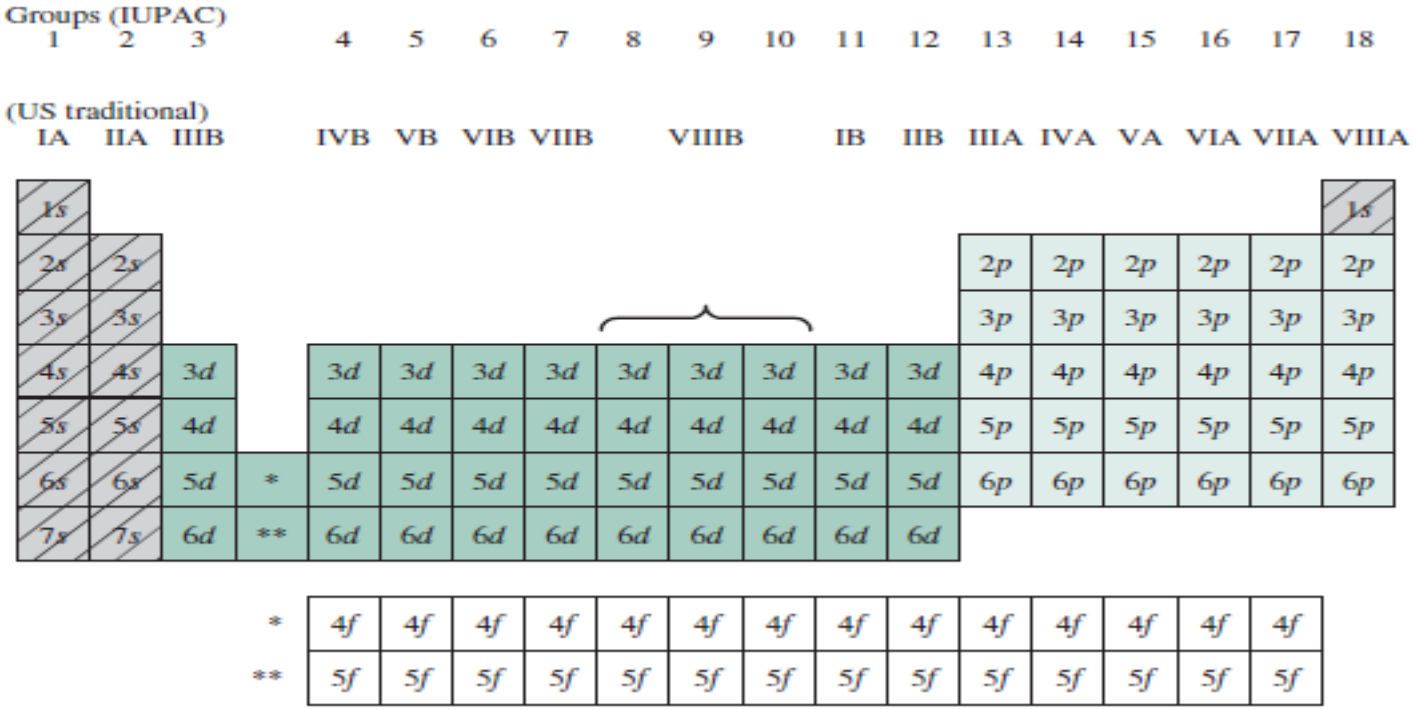
a. Determine the number of electrons that could be exchanged in each case and the Coulombic and exchange energies. Which state would be lower in energy?

Many schemes have been used to predict the order of filling of atomic orbitals. Klechkowsky's rule states that the order of filling of the orbitals proceeds from the lowest available value for the sum $n + l$.

$4s$ and $3d$ (

$4s\,(n + l = 4 + 0)$

$3d\,(n + l = 3 + 2)$.


Groups (IUPAC)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
(US traditional)
IA IIA IIIB IVB VB VIB VIIB VIIIB IB IIB IIIA IVA VA VIA VIIA VIIIA
1s 1s
2s 2s 2p 2p 2p 2p 2p 2p
3s 3s 3p 3p 3p 3p 3p 3p
4s 4s 3d 3d 3d 3d 3d 3d 3d 3d 3d 4p 4p 4p 4p 4p 4p
5s 5s 4d 4d 4d 4d 4d 4d 4d 4d 4d 5p 5p 5p 5p 5p 5p
6s 6s 5d * 5d 5d 5d 5d 5d 5d 5d 5d 5d 6p 6p 6p 6p 6p 6p
7s 7s 6d ** 6d 6d 6d 6d 6d 6d 6d 6d 6d
* 4f 4f 4f 4f 4f 4f 4f 4f 4f 4f 4f 4f 4f 4f
** 5f 5f 5f 5f 5f 5f 5f 5f 5f 5f 5f 5f 5f 5f

ANGKA KUANTUM DAN FUNGSI GELOMBANG ATOMIK

BILANGAN KUANTUM

Simbol	Nama	Nilai	Wewenang
n	Bilangan kuantum utama	1, 2, 3, . . .	Menentukan bagian utama dari energi
l	Bilangin azimut	0, 1, 2, . . ., n^{-1}	Menjelaskan ketergantungan sudut dan berkontribusi pada energi
m_l	Magnetik	0, $\pm$1, $\pm$2,…, $\pm$l	Menjelaskan orientasi dalam ruang
m_s	Spin	$\pm\frac{1}{2}$	Menjelaskan orientasi file spin elektron

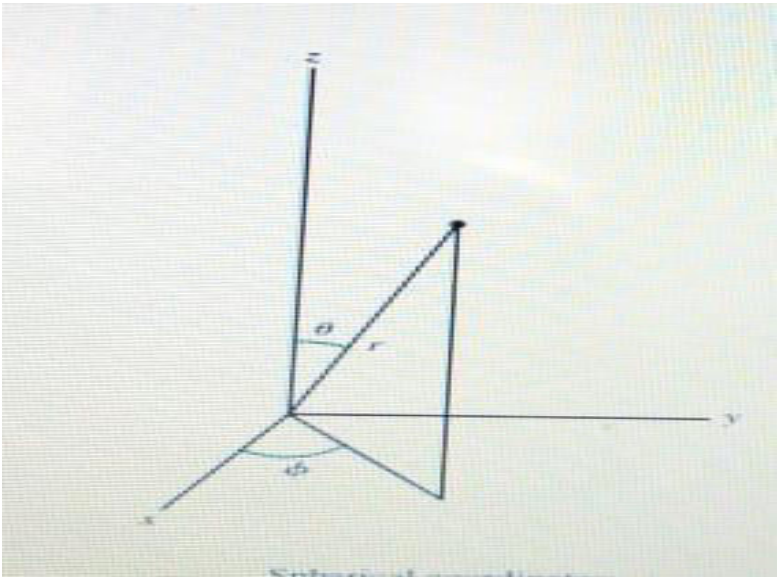
Fungsi Gelombang Atom Hidrogen: Fungsi Sudut

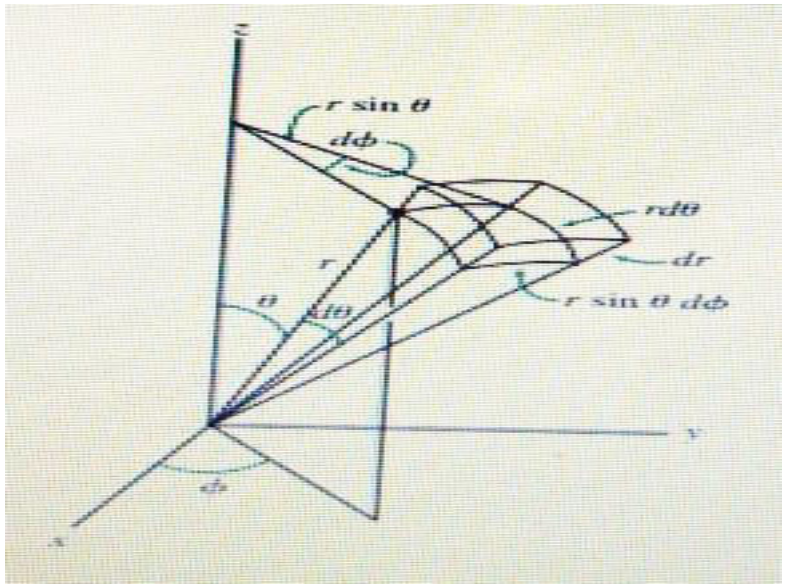
Angular Functions

Angular Factors					Real Wave Functions			
Related to Angular Momentum				Functions of θ	In Polar Coordinates	In Cartesian Coordinates	Shapes	Label
l	m_l	Φ	Θ		$\Theta\Phi(\theta, \phi)$	$\Theta\Phi(x, y, z)$		
0(s)	0	$\frac{1}{\sqrt{2\pi}}$	$\frac{1}{\sqrt{2}}$		$\frac{1}{2\sqrt{\pi}}$	$\frac{1}{2\sqrt{\pi}}$		s
1(p)	0	$\frac{1}{\sqrt{2\pi}}$	$\frac{\sqrt{6}}{2}\cos\theta$		$\frac{1}{2}\sqrt{\frac{3}{\pi}}\cos\theta$	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\frac{z}{r}$		p_z
	+1	$\frac{1}{\sqrt{2\pi}}e^{i\phi}$	$\frac{\sqrt{3}}{2}\sin\theta$		$\frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\cos\phi$	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\frac{x}{r}$		p_x
	−1	$\frac{1}{\sqrt{2\pi}}e^{-i\phi}$	$\frac{\sqrt{3}}{2}\sin\theta$		$\frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\sin\phi$	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\frac{y}{r}$		p_y
2(d)	0	$\frac{1}{\sqrt{2\pi}}$	$\frac{1}{2}\sqrt{\frac{5}{2}}(3\cos^2\theta-1)$		$\frac{1}{4}\sqrt{\frac{5}{\pi}}(3\cos^2\theta-1)$	$\frac{1}{4}\sqrt{\frac{5}{\pi}}\frac{(2z^2-x^2-y^2)}{r^2}$		d_{z^2}
	+1	$\frac{1}{\sqrt{2\pi}}e^{i\phi}$	$\frac{\sqrt{15}}{2}\cos\theta\sin\theta$		$\frac{1}{2}\sqrt{\frac{15}{\pi}}\cos\theta\sin\theta\cos\phi$	$\frac{1}{2}\sqrt{\frac{15}{\pi}}\frac{xz}{r^2}$		d_{xz}
	−1	$\frac{1}{\sqrt{2\pi}}e^{-i\phi}$	$\frac{\sqrt{15}}{2}\cos\theta\sin\theta$		$\frac{1}{2}\sqrt{\frac{15}{\pi}}\cos\theta\sin\theta\sin\phi$	$\frac{1}{2}\sqrt{\frac{15}{\pi}}\frac{yz}{r^2}$		d_{yz}
	+2	$\frac{1}{\sqrt{2\pi}}e^{2i\phi}$	$\frac{\sqrt{15}}{4}\sin^2\theta$		$\frac{1}{4}\sqrt{\frac{15}{\pi}}\sin^2\theta\cos 2\phi$	$\frac{1}{4}\sqrt{\frac{15}{\pi}}\frac{(x^2-y^2)}{r^2}$		$d_{(x^2-y^2)}$
	−2	$\frac{1}{\sqrt{2\pi}}e^{-2i\phi}$	$\frac{\sqrt{15}}{4}\sin^2\theta$		$\frac{1}{4}\sqrt{\frac{15}{\pi}}\sin^2\theta\sin 2\phi$	$\frac{1}{4}\sqrt{\frac{15}{\pi}}\frac{xy}{r^2}$		d_{xy}

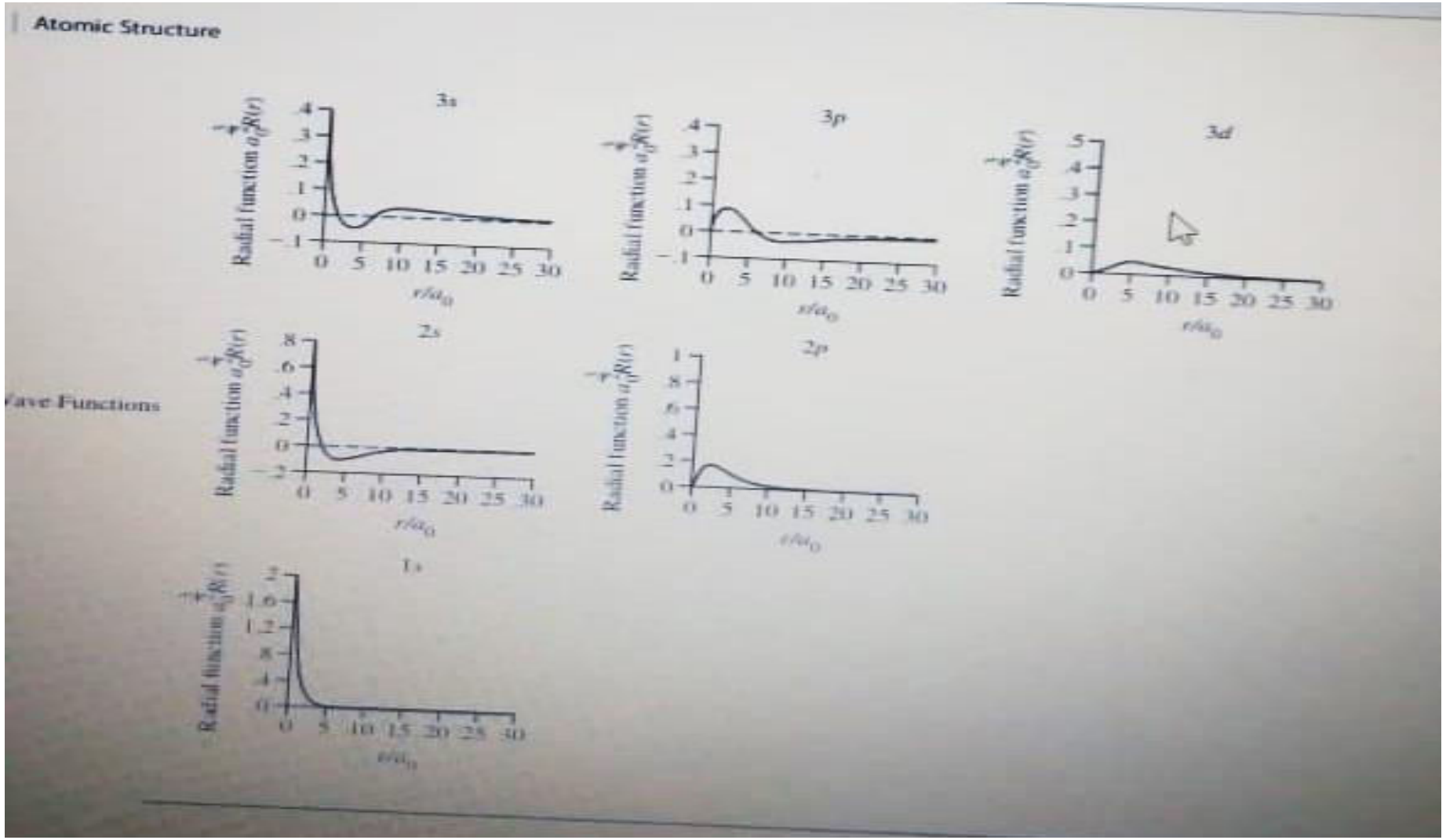
Fungsi Gelombang Atom Hidrogen: Fungsi Radial

Orbital	n	l	Radial Functions $R(r)$, with $\sigma = Zr/a_0$ $R(r)$
$1s$	1	0	$R_{1s} = 2\left[\frac{Z}{a_0}\right]^{3/2} e^{-\sigma}$
$2s$	2	0	$R_{2s} = 2\left[\frac{Z}{2a_0}\right]^{3/2} (2 - \sigma)e^{-\sigma/2}$
$2p$		1	$R_{2p} = \frac{1}{\sqrt{3}}\left[\frac{Z}{2a_0}\right]^{3/2} \sigma e^{-\sigma/2}$
$3s$	3	0	$R_{3s} = \frac{2}{27}\left[\frac{Z}{3a_0}\right]^{3/2} (27 - 18\sigma + 2\sigma^2)e^{-\sigma/3}$
$3p$		1	$R_{3p} = \frac{1}{81\sqrt{3}}\left[\frac{2Z}{a_0}\right]^{3/2} (6 - \sigma)\sigma e^{-\sigma/3}$
$3d$		2	$R_{3d} = \frac{1}{81\sqrt{15}}\left[\frac{2Z}{a_0}\right]^{3/2} \sigma^2 e^{-\sigma/3}$



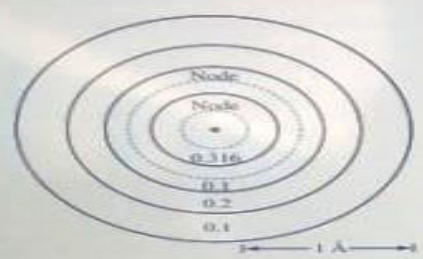


Fungsi radial

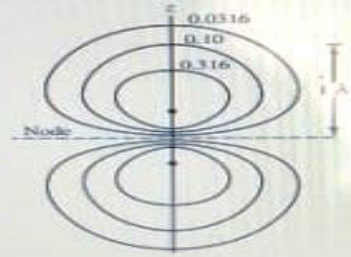


from E. A. Orgyzio and
in *J. Chem. Educ.*, 40, 258.
1963. American Chemical

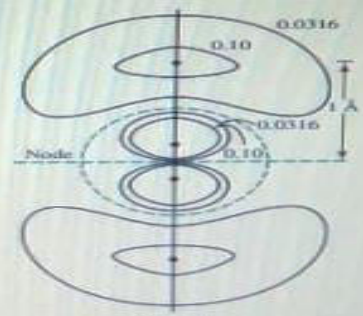
ability does not go quite to zero** on the basis of relativistic arguments.



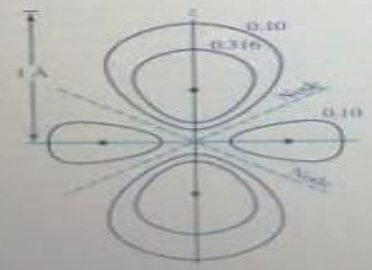
(a) Cl:3s



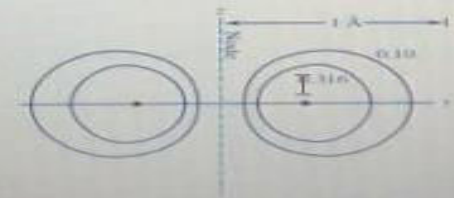
(b) Cl:2p_z



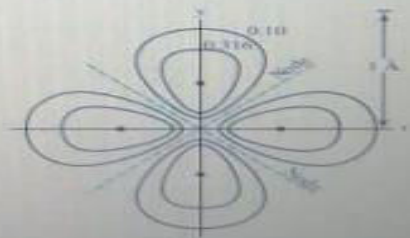
(c) Cl:3p_z



(d) Ti^{2+}: $4d_{z^2}$



(e) Ti^{2+}: $4f_{z^3}$



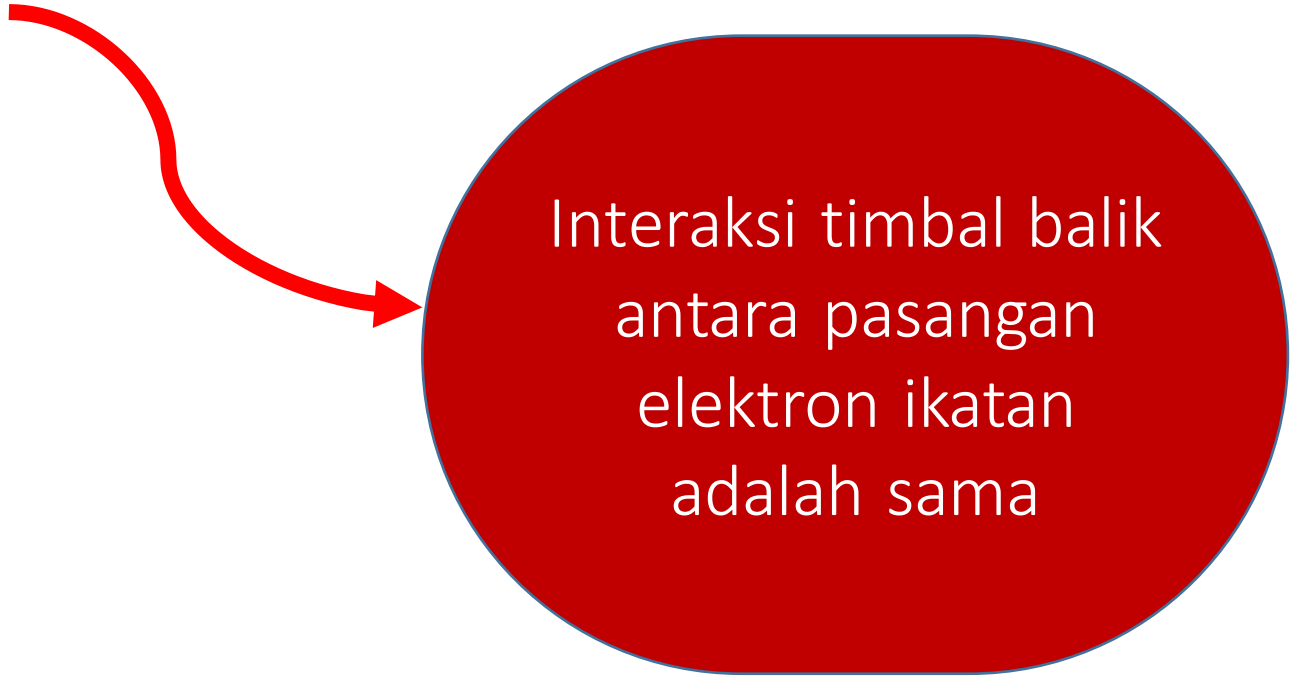
(f) Ti^{2+}: $4f_{xz^2}$

Again, counting a conical nodal surface, such as for a d_{z^2} orbital, as two nodes.

A. Szabo, *J. Chem. Educ.*, 1969, 46, 678 explains that the electron probability at a nodal surface has a very

STRUKTUR MOLEKULER II: SENYAWA LOGAM TRANSISI

9.1 Teori Medan Ligan



H. BETHE dirumuskan sebagai teori medan kristal

Koordinat Oktahedral

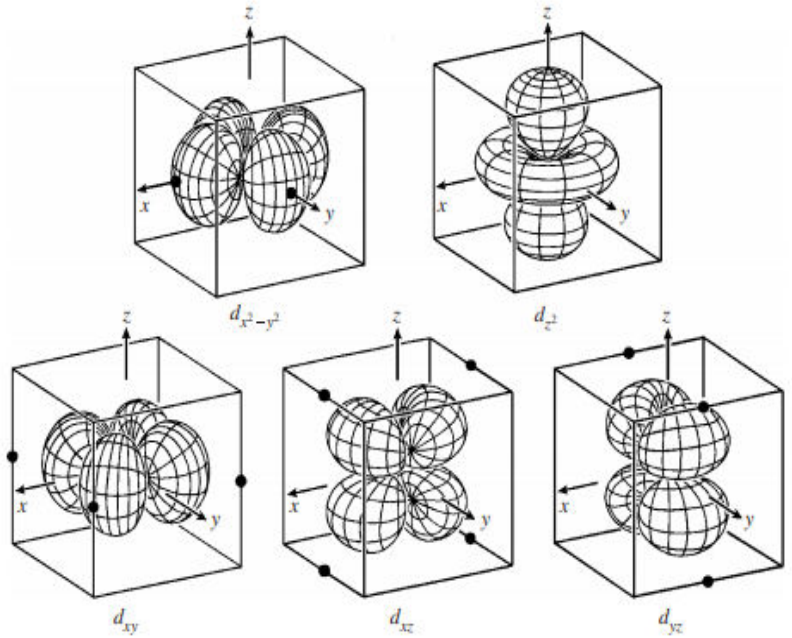
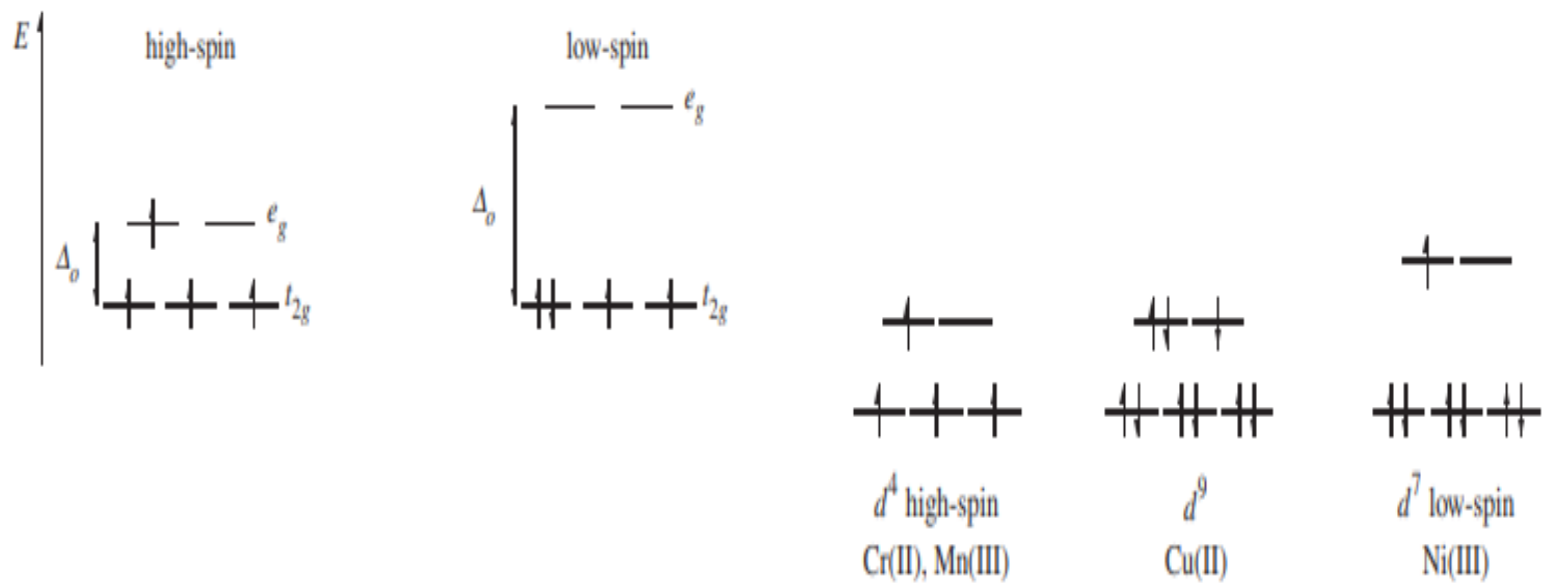


Fig. 9.1 Orientation of the regions of high electron density for 3*d* orbitals. True-to-scale drawings of areas with constant value for the wave functions. The dots • on the circumscribed cubes mark the directions of preferential orientation of the 'partial clouds'


E
high-spin
low-spin
e_g
Δ_o
t_{2g}
d^4 high-spin
Cr(II), Mn(III)
d^9
Cu(II)
d^7 low-spin
Ni(III)

koordinasi tetrahedral

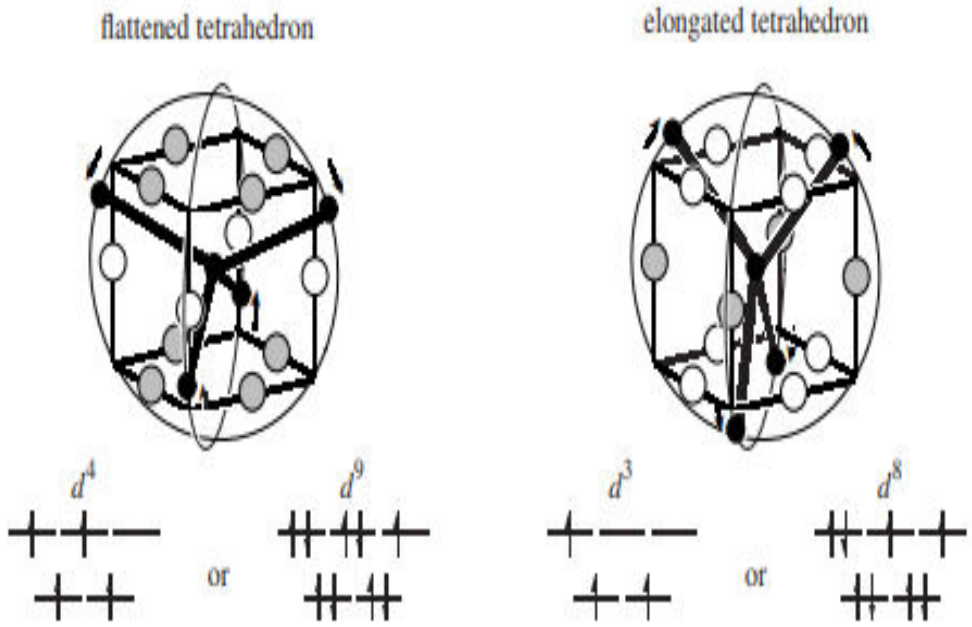


Fig. 9.2 JAHN–TELLER distortions of tetrahedral complexes.

koordinat persegi

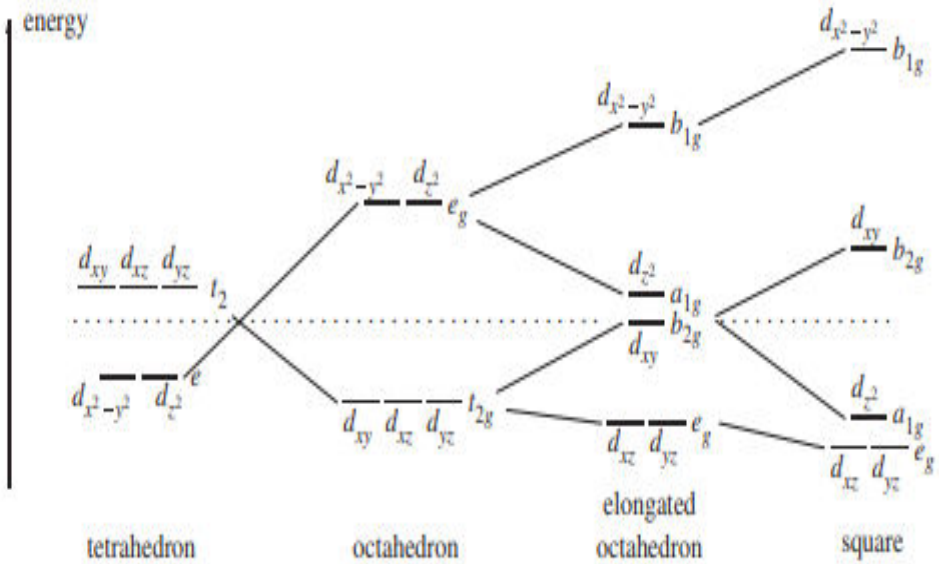


Fig. 9.3 Diagram of the relative energies of electrons in *d* orbitals for different geometric arrangements. The 'centers of gravity' (mean values of the energy levels) for all term sequences were positioned on the dotted line

Energi Stabilisasi Ligan

Energi stabilisasi Ligan

Energi stabilisasi medan kristal (Bahasa Inggris: crystal field stabilization energy), disingkat CFSE, adalah stabilitas yang dihasilkan dari penempatan ion logam pada medan kristal yang dibentuk oleh sekelompok ligan-ligan.

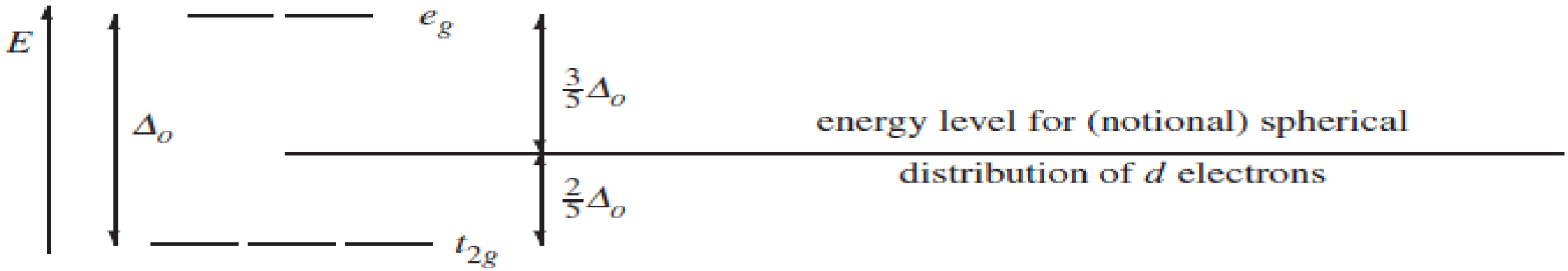

E
e_g
Δ_o
$\frac{3}{5}\Delta_o$
energy level for (notional) spherical
distribution of d electrons
$\frac{2}{5}\Delta_o$
t_{2g}

Table 9.1: Ligand field stabilization energies (LFSE) for octahedral and tetrahedral ligand distributions

	number of d electrons										
	0	1	2	3	4	5	6	7	8	9	10
octahedra, high-spin	electron distribution × energy $/\Delta_o$										
$\frac{3}{5}\Delta_o$ — — e_g	0	0	0	0	$1\times\frac{3}{5}$	$2\times\frac{3}{5}$	$2\times\frac{3}{5}$	$2\times\frac{3}{5}$	$2\times\frac{3}{5}$	$3\times\frac{3}{5}$	$4\times\frac{3}{5}$
$-\frac{2}{5}\Delta_o$ — — — t_{2g}	0	$-1\times\frac{2}{5}$	$-2\times\frac{2}{5}$	$-3\times\frac{2}{5}$	$-3\times\frac{2}{5}$	$-3\times\frac{2}{5}$	$-4\times\frac{2}{5}$	$-5\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$
sum = LFSE $/\Delta_o$	0	$-\frac{2}{5}$	$-\frac{4}{5}$	$-\frac{6}{5}$	$-\frac{3}{5}$	0	$-\frac{2}{5}$	$-\frac{4}{5}$	$-\frac{6}{5}$	$-\frac{3}{5}$	0
octahedra, low-spin	electron distribution × energy $/\Delta_o$										
$\frac{3}{5}\Delta_o$ — — e_g	0	0	0	0	0	0	0	$1\times\frac{3}{5}$	$2\times\frac{3}{5}$	$3\times\frac{3}{5}$	$4\times\frac{3}{5}$
$-\frac{2}{5}\Delta_o$ — — — t_{2g}	0	$-1\times\frac{2}{5}$	$-2\times\frac{2}{5}$	$-3\times\frac{2}{5}$	$-4\times\frac{2}{5}$	$-5\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$	$-6\times\frac{2}{5}$
sum = LFSE $/\Delta_o$	0	$-\frac{2}{5}$	$-\frac{4}{5}$	$-\frac{6}{5}$	$-\frac{8}{5}$	$-\frac{10}{5}$	$-\frac{12}{5}$	$-\frac{9}{5}$	$-\frac{6}{5}$	$-\frac{3}{5}$	0
tetrahedra, high-spin	electron distribution × energy $/\Delta_t$										
$\frac{2}{5}\Delta_t$ — — — t_2	0	0	0	$1\times\frac{2}{5}$	$2\times\frac{2}{5}$	$3\times\frac{2}{5}$	$3\times\frac{2}{5}$	$3\times\frac{2}{5}$	$4\times\frac{2}{5}$	$5\times\frac{2}{5}$	$6\times\frac{2}{5}$
$-\frac{3}{5}\Delta_t$ — — e	0	$-1\times\frac{3}{5}$	$-2\times\frac{3}{5}$	$-2\times\frac{3}{5}$	$-2\times\frac{3}{5}$	$-2\times\frac{3}{5}$	$-3\times\frac{3}{5}$	$-4\times\frac{3}{5}$	$-4\times\frac{3}{5}$	$-4\times\frac{3}{5}$	$-4\times\frac{3}{5}$
sum = LFSE $/\Delta_t$	0	$-\frac{3}{5}$	$-\frac{6}{5}$	$-\frac{4}{5}$	$-\frac{2}{5}$	0	$-\frac{3}{5}$	$-\frac{6}{5}$	$-\frac{4}{5}$	$-\frac{2}{5}$	0

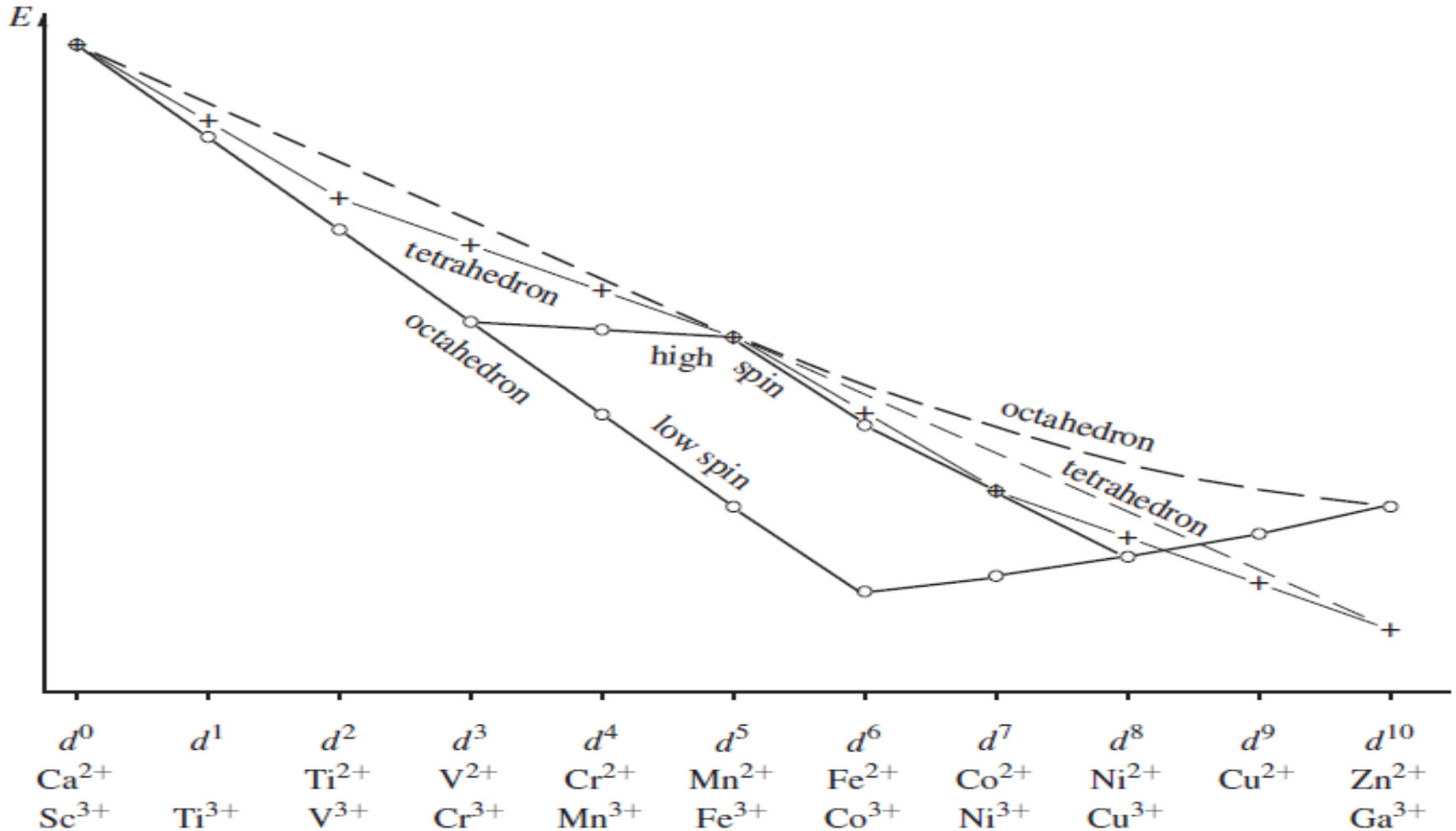


Fig. 9.4 Relative ligand field stabilization energies for 3*d* ions. Thick lines: octahedral field; thin lines: tetrahedral field; dashed lines: energies for (notional) spherical *d* electron distributions

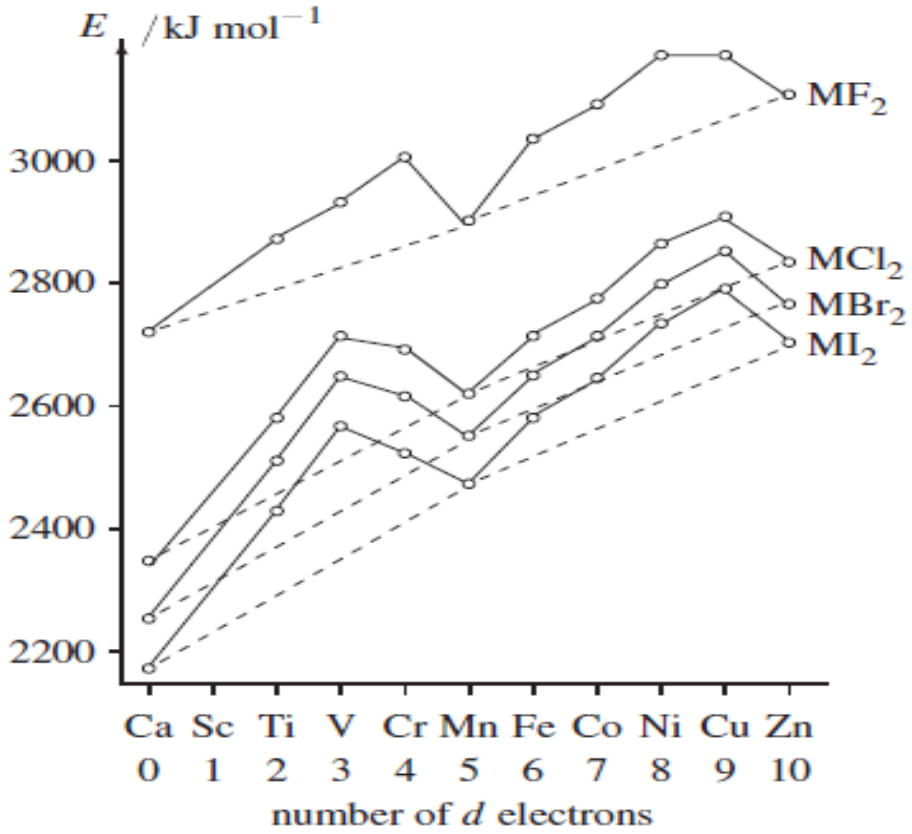


Fig. 9.5
Lattice energies of the dihalides of elements of the first transition metal period

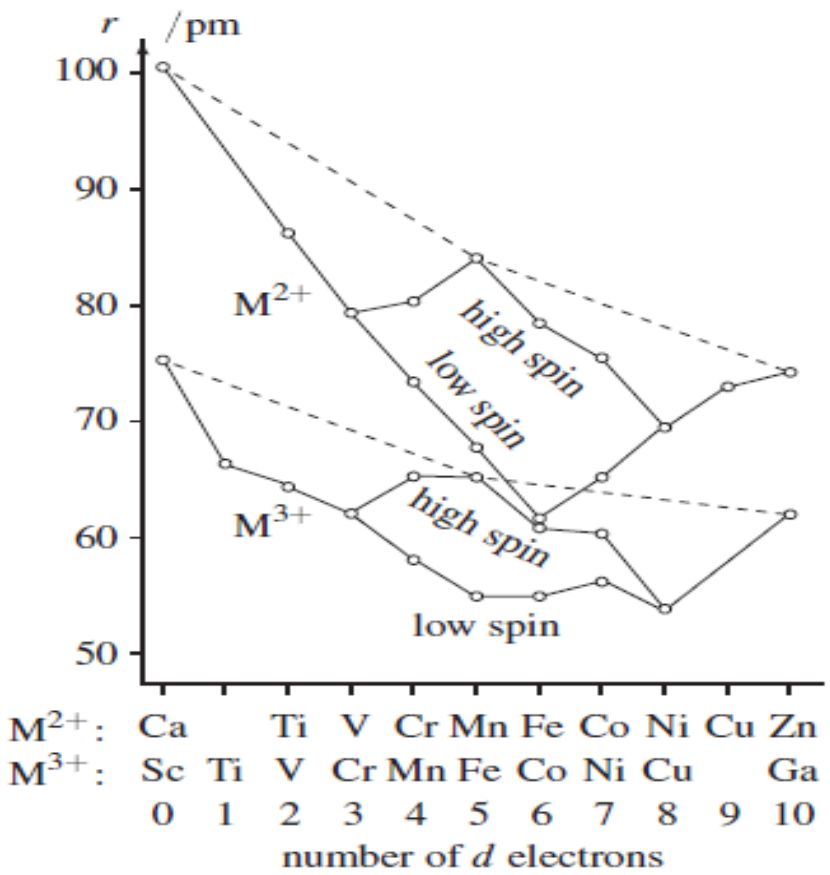


Fig. 9.6
Ionic radii of the elements of the first transition metal period in octahedral coordination

Polyhedra koordinat pd logam

Aturan JAHN TELLER

Ligan Tetrahedral

Ligan Oktahedral

Koordinat Persegi

Koordinat Linear

Table 9.2 Most common coordination polyhedra for coordination numbers 2 to 6 for transition metal compounds

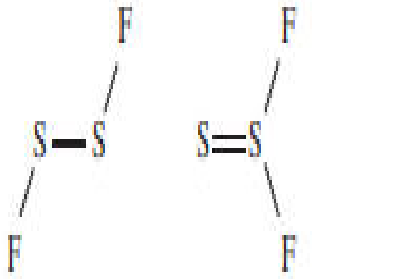
polyhedron	c.n.	electron config.	central atom	examples
linear arrangement	2	d^{10}	Cu(I), Ag(I), Au(I), Hg(II)	Cu_2O, $Ag(CN)_2^-$, $AuCN^*$, $AuCl_2^-$, $HgCl_2$, HgO^*
triangle	3	d^{10}	Cu(I), Ag(I), Au(I), Hg(II)	$Cu(CN)_3^{2-}$, $Ag_2Cl_5^{3-}$, $Au(PPh_3)_3^+$, HgI_3^-
square	4	d^8	Ni(II), Pd(II), Pt(II), Au(III)	$Ni(CN)_4^{2-}$, $PdCl_2^*$, PtH_4^{2-}, $Pt(NH_3)_2Cl_2$, $AuCl_4^-$
tetrahedron	4	d^0	Ti(IV), V(V), Cr(VI), Mo(VI), Mn(VII), Re(VII) Ru(VIII), Os(VIII)	$TiCl_4$, VO_4^{3-}, CrO_3^*, CrO_4^{2-}, MoO_4^{2-}, WO_4^{2-} Mn_2O_7, ReO_4 RuO_4, OsO_4
		d^1	V(IV), Cr(V), Mn(VI), Ru(VII)	VCl_4, CrO_4^{3-}, MnO_4^{2-}, RuO_4
		d^5	Mn(II), Fe(III)	$MnBr_4^{2-}$, Fe_2Cl_6
		d^6	Fe(II)	$FeCl_4^{2-}$
		d^7	Co(II)	$CoCl_4^{2-}$
		d^8	Ni(II)	$NiCl_4^{2-}$
		d^9	Cu(II)	$CuCl_4^{2-}$ †
		d^{10}	Ni(0), Cu(I), Zn(II), Hg(II)	$Ni(CO)_4$, $Cu(CN)_4^{3-}$ $Zn(CN)_4^{2-}$, HgI_4^{2-}
square pyramid	5	d^0	Ti(IV), V(V), Nb(V), Mo(VI), W(VI),	$TiOCl_4^{2-}$, VOF_4, $NbSCl_4$, $MoNCl_4$, $WNCl_4$
		d^1	V(IV), Cr(V), Mo(V), W(V), Re(VI)	$VO(NCS)_4^{2-}$, $CrOCl_4$, $MoOCl_4$, $WSCl_4$, $ReOCl_4$
		d^2	Os(VI)	$OsNCl_4$
		d^4	Mn(III), Re(III)	$MnCl_5^{2-}$, Re_2Cl_8
		d^7	Co(II)	$Co(CN)_5^{3-}$
trigonal bipyramid	5	d^2	V(IV)	$VCl_3(NMe_3)_2$
		d^8	Fe(0)	$Fe(CO)_5$
octahedron	6		nearly all; rarely Pd(II), Pt(II), Au(III), Cu(I)	

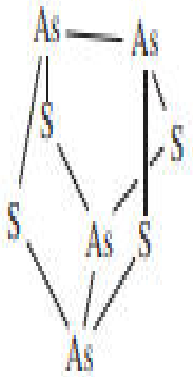
* endless chain † Jahn–Teller distorted

DIKTAT M. K. KIMIA ANORGANIK II (BAGIAN 2)

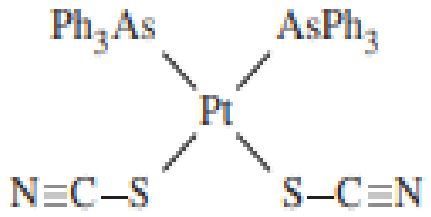
Dosen Pengampu: Familia Novita Simanjuntak, S.P., M.Si

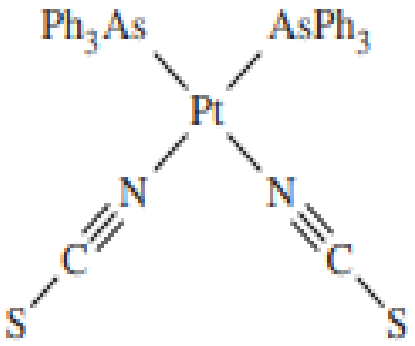
Isomers


F
S
S
F
F
S
S
F


As
As
S
S
S
S
As
S
As


As
S
S
S
S
S
As
As
As


Ph3As
AsPh3
Pt
N≡C–S
S–C≡N


Ph3As
AsPh3
Pt
N
N
C
C
S
S

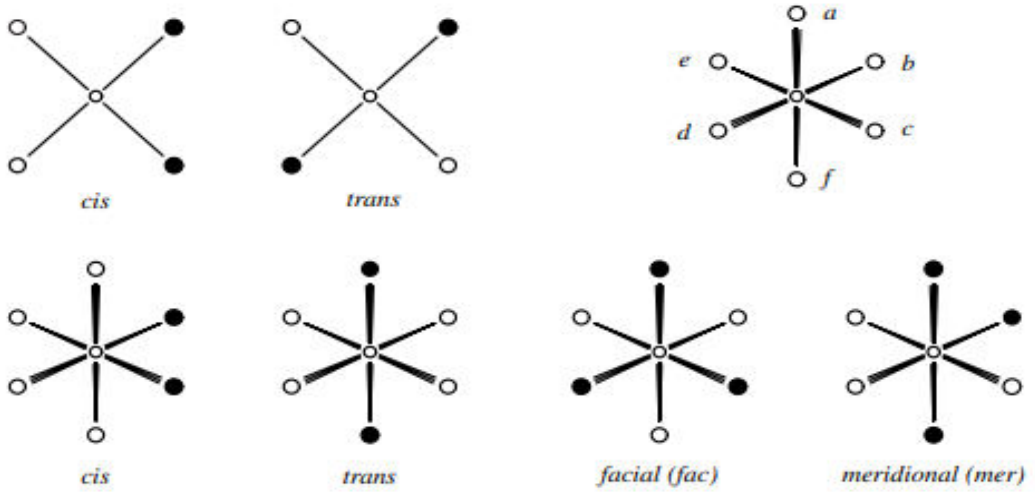


Fig. 9.7 Geometric isomers for square and octahedral coordination with two different ligands. Top right: designation of ligand positions in an octahedral complex

polyhedron	ligands	total number	chiral number	polyhedron	ligands	total number	chiral number
tetrahedron	unrestricted	1	ABCD	octahedron	AB_5	1	0
square	AB_3	1	0		A_2B_4	2	0
	A_2B_2	2	0		A_3B_3	2	0
	ABC_2	2	0		ABC_4	2	0
	ABCD	3	0		AB_2C_3	3	0
trigonal bipyramid	AB_4	2	0		$A_2B_2C_2$	5	1
	A_2B_3	3	0		$ABCD_3$	4	1
	ABC_3	4	0		ABC_2D_2	6	2
	AB_2C_2	5	1		$ABCDE_2$	9	6
	$ABCD_2$	7	3		ABCDEF	15	15
	ABCDE	10	10				

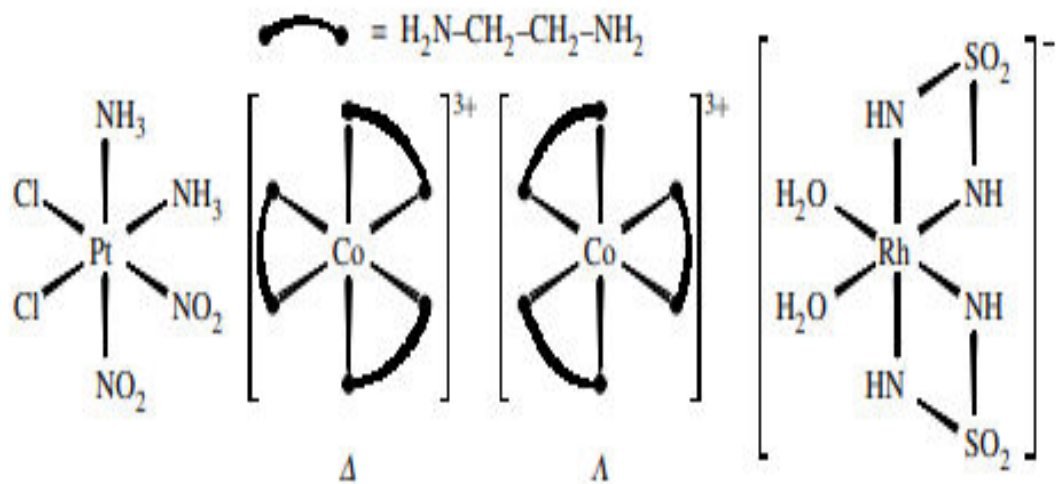


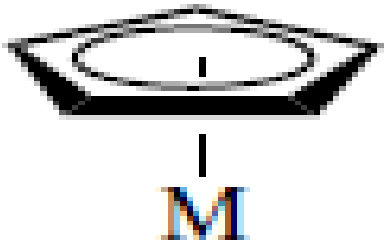
Fig. 9.8 Examples of some chiral complexes with octahedral coordination

TUGAS

- Apa kelompok titik dari kompleks yang ditunjukkan pada Gambar 9.8 DAN MENGAPA MEREKA CHIRAL?

- Sebutkan kompleks spin tinggi oktahedral berikut yang mana yang harus JAHN – TELLER terdistors$TiF_6^{2-}, MoF_6, [Cr(OH_2)_6]^{2+},$, $[Mn(OH_2)_6]^{2+}, [Mn(OH_2)_6]^{3+}, FeCl_6^{3-}, [Ni(NH_3)_6]^{2+}, [Cu\ (NH_3)_6]^{2+}$

7.4 LIGAN SIKLO PENTADIENIEL



7.2

7.4.1 SENYAWA BERBASIS FEROSEN

$Fe(\eta^5\text{-}C_5H_5)_2$ (Cp_2Fe, FcH) a

$[M + H]^+$ i

Ferrocene

$[Cp_2Fe]^{\bullet+}$;

ies. Because

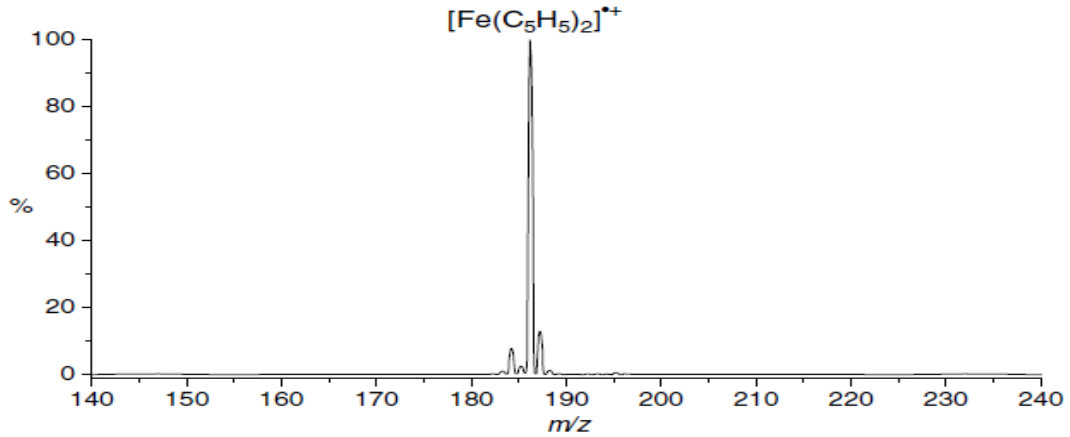


Figure 7.3
High-resolution positive-ion ESI mass spectrum of ferrocene (Cp_2Fe) dissolved in methanol at a cone voltage of 20 V, showing the oxidised $[Cp_2Fe]^+$ ion

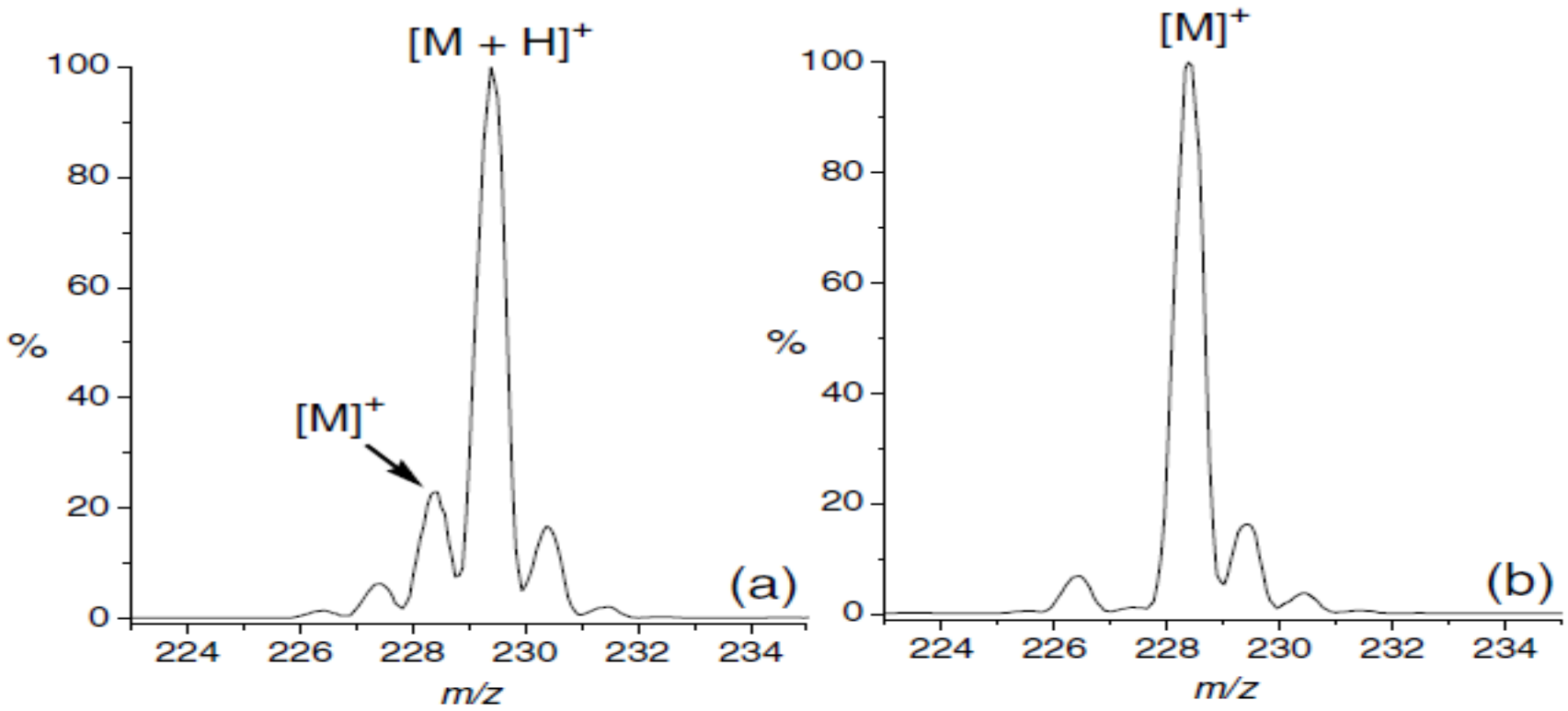


Figure 7.4
Positive-ion ESI mass spectra of acetyl ferrocene, $FcC(O)CH_3$ in methanol solution at a cone voltage of 20 V: (a) initial spectrum, showing a mixture of oxidised (minor, *m/z* 228) and protonated (major, *m/z* 229) ions and (b) spectrum obtained after addition of pyridine base, showing exclusive formation of oxidised ions

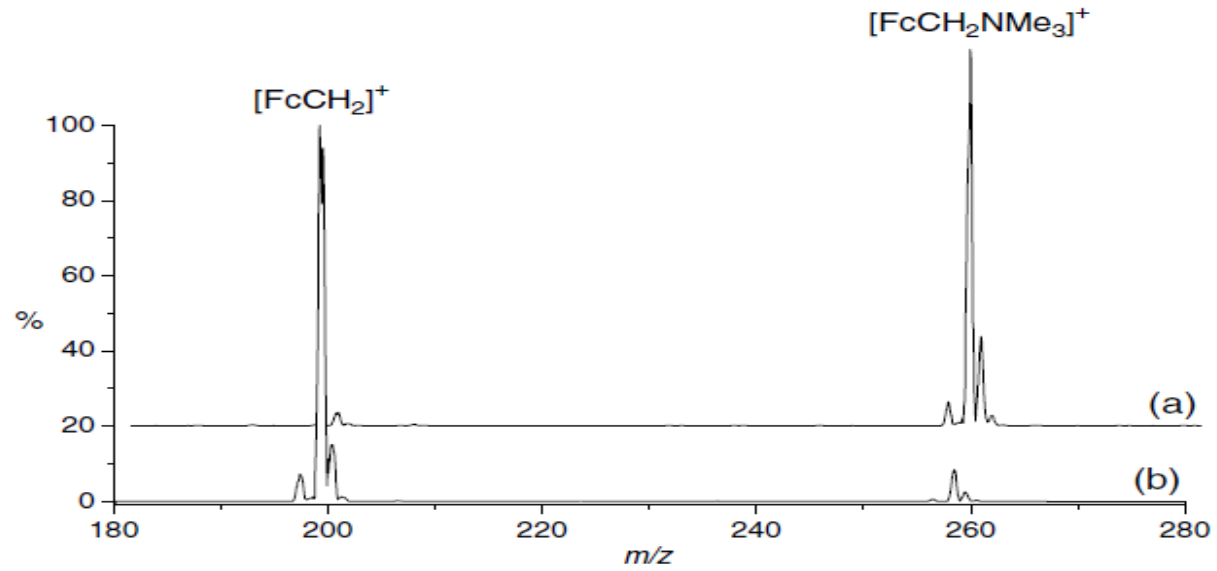
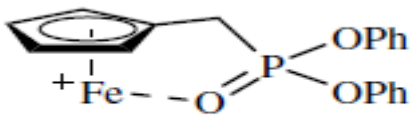
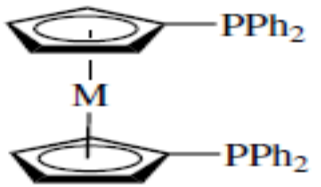


Figure 7.5
Positive-ion ESI mass spectra of $[FcCH_2NMe_3]^+ I^-$ at cone voltages of (a) 10 V, showing the parent $[FcCH_2NMe_3]^+$ cation, and (b) 30 V, showing the facile loss of NMe_3, giving the stabilised carbocation $[FcCH_2]^+$ (*m/z* 199)



7.3

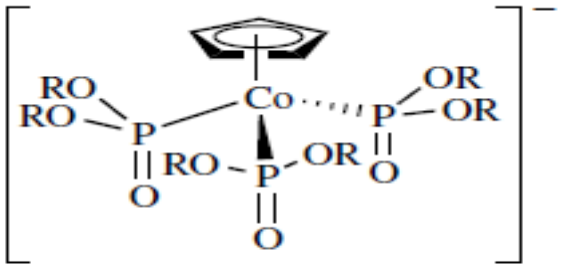


7.4 M = Fe; dppf
7.5 M = Ru, dppr

7.4.2 PENGGUNAAN PERIVAN FEROSEN SEBAGAI DERIVARISASI

7.4.3 Sistem Metalocen Lainnya

7.4.4 KOMPLEKS MONOCYCLOPENDADIENYL



7.6

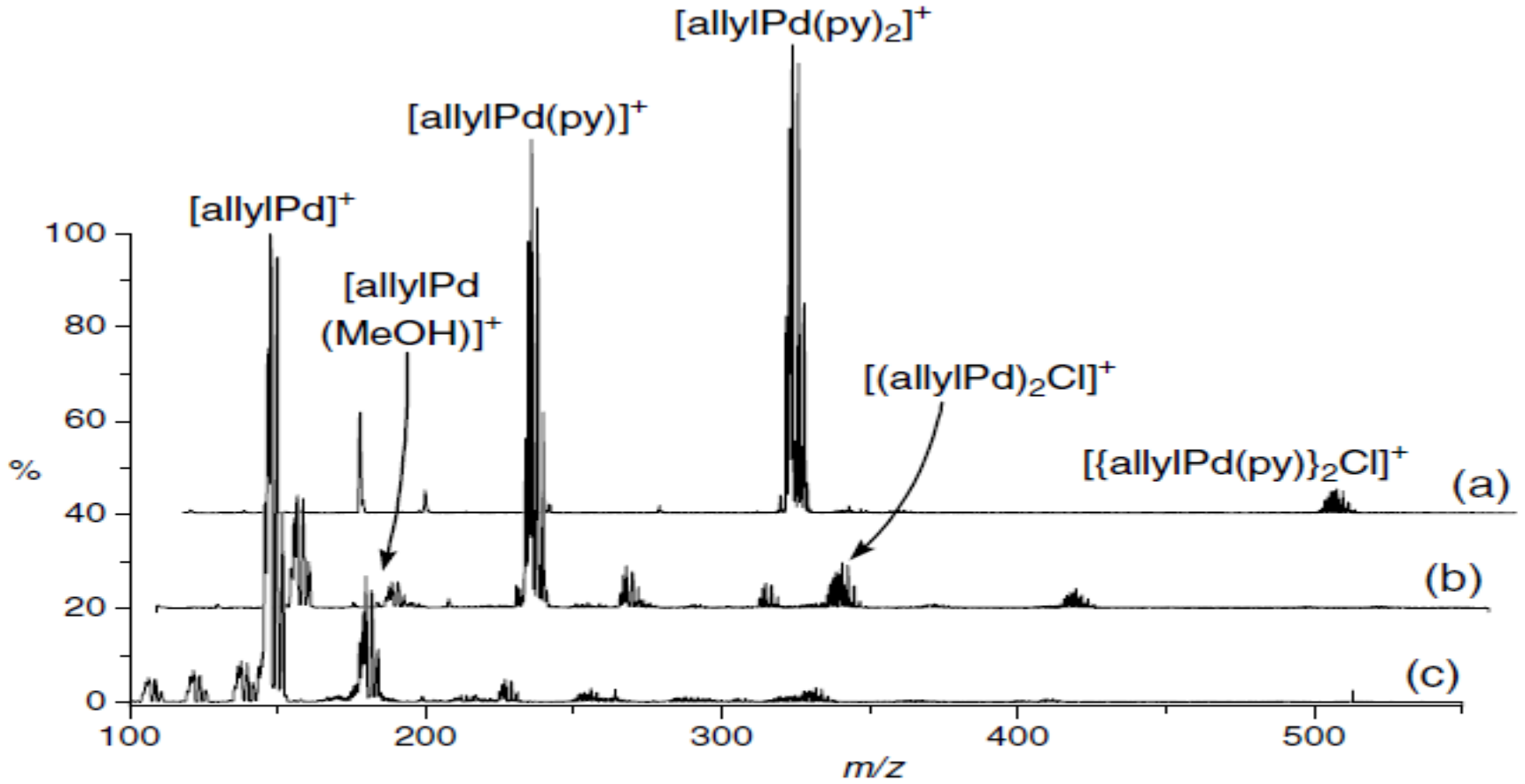


Figure 7.6
The dinuclear palladium allyl complex $[Pd(\eta^3\text{-}C_3H_5)Cl]_2$ behaves as a metal halide complex with a spectator allyl ligand, as shown by positive-ion ESI mass spectra in methanol solution with added pyridine. At a cone voltage of 5 V (a) the $[Pd(allyl)(pyridine)_2]^+$ cation (*m/z* 305) dominates, while at higher cone voltages (b) 40 V and (c) 70 V, the pyridine ligands are lost, ultimately giving the 'bare' $[Pd(allyl)]^+$ cation at *m/z* 147

7.6 KOMPLEKS ARENE LOGAM

7.7 Pembentukkan Kompleks π hidrokarbon dan penggunaanya sebagai bantuan ionisasi

Perilaku Transisi ESI MS Logam dan Organometalik Senyawa Lantanida

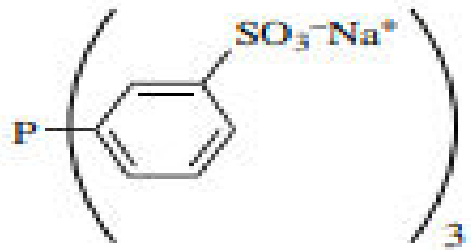
7.2 Kompleks Logam Karbonil

Prekurso berbagai komplek
Cluster logam yg mengandung karbonil sebagai pewkursor katalis.

7.21Senyawa Karbonil Logam Mononuklir Ionik

Logam bermuatan menggunakan ionisasi electrospray, dari larutan kedalam fase gas dengan tema dominan.

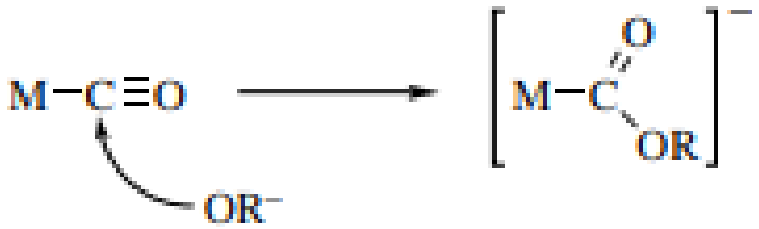
7.2.2 Gugus Karbonil Logam Ionik



7.1

ligan tersulfonasi trifenilfosfin

7.2.3 SENYAWA KARBONIL LOGAM NETRAL



Derivatisasi Alkoksida

Derivatisasi Azide

$$[L_nM\text{-}CO] + N_3^- \longrightarrow [L_nM\text{-}NCO]^- + N_2$$

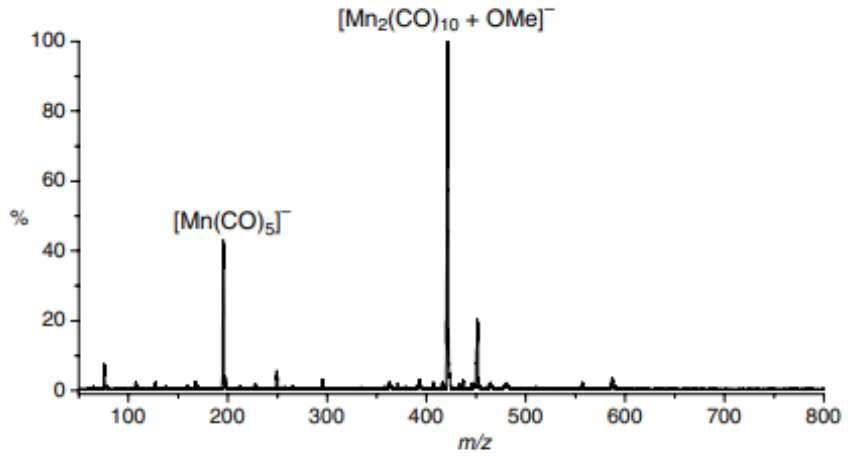


Figure 7.1
Negative-ion ESI mass spectrum of $Mn_2(CO)_{10}$ in methanol solution with added NaOMe, showing the formation of the $[Mn_2(CO)_{10} + OMe]^-$ adduct ion

Adduksi Ion Logam

karbonil logam dapat dianalisis dengan massa ESI spektrometri dengan adduksi ion logam, baik adventif maupun introduksi ion positif

Penambahan Hidrida

Penambahan ion hidrida ke kluster adalah berpotensi menjadi teknik ionisasi kimiawi yang lebih dapat digunakan secara luas untuk cluster netral.

7.2.4 Proses Oksidasi dan Reduksi yang Melibatkan Karbonil Logam

Karbonil biner menghasilkan ion negative tanpa sebelumnya derivatisasi

7.2.5 Karakterisasi Campuran Reaksi yang Melibatkan Klaster Karbonil Logam

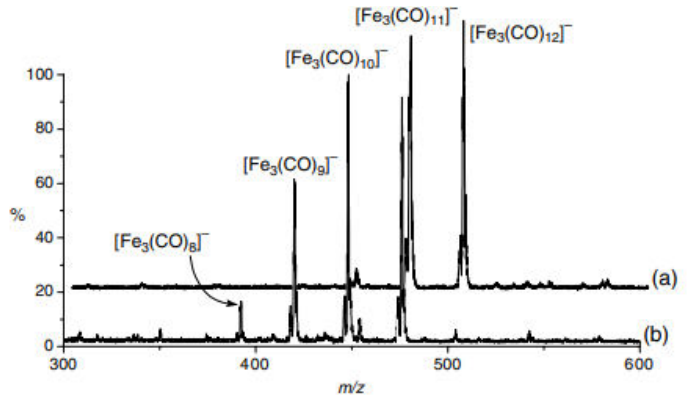


Figure 7.2
(a) Negative-ion ESI mass spectrum of $Fe_3(CO)_{12}$ in methanol solution at a cone voltage of 10 V, showing the formation of $[Fe_3(CO)_{12}]^-$ and the fragment ion $[Fe_3(CO)_{11}]^-$. At a higher cone voltage (20 V, b), further loss of CO ligands occurs

7.2.6 Fragmentasi Cluster Karbonil Logam Transisi; Elektrospray sebagai Sumber Cluster Metal Bare

Anion kluster karbonil logam dikenai CID, hilangnya ligan CO biasanya terjadi.

7.2.7 Penggunaan Ligan 'Ramah Elektrospray' dalam Kimia Organologam

Turunan trifenilfosfin dari karbonil logam 2 tidak memberikan ion apapun dalam spektrum massa ESI ion positifnya. Namun, dengan menggunakan analog fosfin

7.3 Kompleks Isosianida Logam

Ligan isosianida, RNC, isoelektronik terhadap ligan CO, dan menunjukkan banyak kesamaan jika dikoordinasikan dengan pusat logam

BAB 3 TEORI IKATAN SEDERHANA

3.2 TOLAKAN PASANGAN ELEKTRON SELUBUNG VALENSI

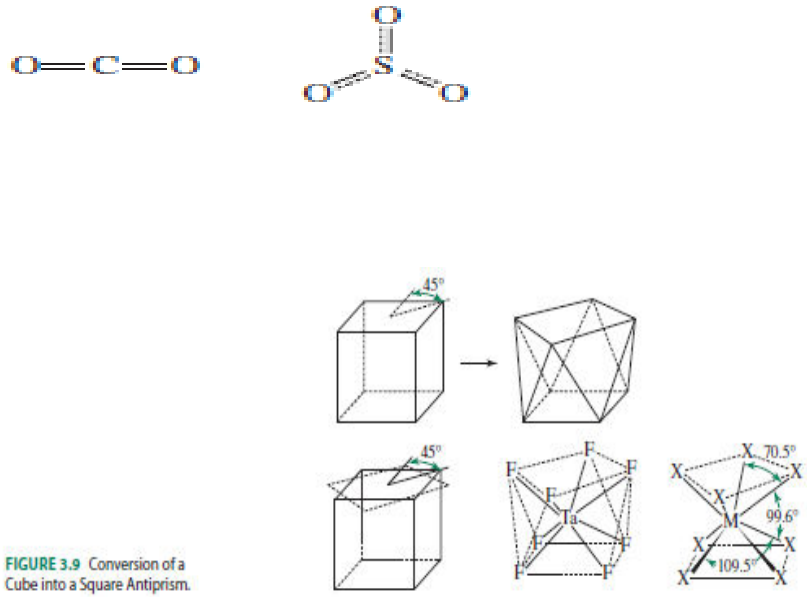


FIGURE 3.9 Conversion of a Cube into a Square Antiprism.

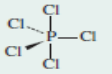
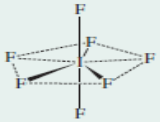
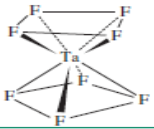
Steric Number	Geometry	Examples	Calculated Bond Angles	
2	Linear	CO_2	180°	O═C═O
3	Trigonal (triangular)	SO_3	120°	
4	Tetrahedral	CH_4	109.5°	
5	Trigonal bipyramidal	PCl_5	120°, 90°	
6	Octahedral	SF_6	90°	
7	Pentagonal bipyramidal	IF_7	72°, 90°	
8	Square antiprismatic	$[TaF_8]^{3-}$	70.5°, 99.6°, 109.5°	

FIGURE 3.8 VSEPR Predictions.

3.2.1 TOLAKAN LONE-PAIR

lp–lp repulsions > lp–bp repulsions > bp–bp repulsions

Nomor Sterik = 4

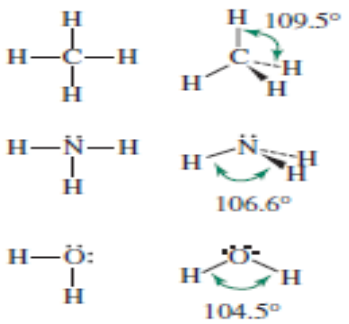
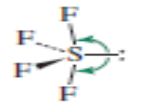
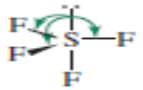


FIGURE 3.10 Shapes of Methane, Ammonia, and Water.

Nomor Sterik = 5



Equatorial lone pair (observed structure)



Axial lone pair

FIGURE 3.11 Possible Structures of SF_4.

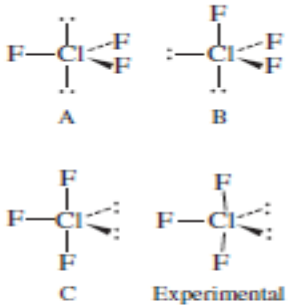
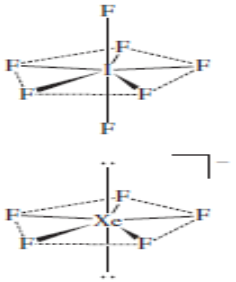


FIGURE 3.12 Possible Structures of ClF_3.

Bilangan Sterik = 6 dan 7



Interaction	Angles in Possible Structures A	B	C	Experimental
lp–lp	180°	90°	120°	Cannot be determined
lp–bp	6 at 90°	3 at 90°	4 at 90°	Cannot be determined
		2 at 120°	2 at 120°	
bp–bp	3 at 120°	2 at 90°	2 at 90°	2 at 87.5°
		1 at 120°		Axial Cl—F 169.8 pm Equatorial Cl—F 159.8 pm

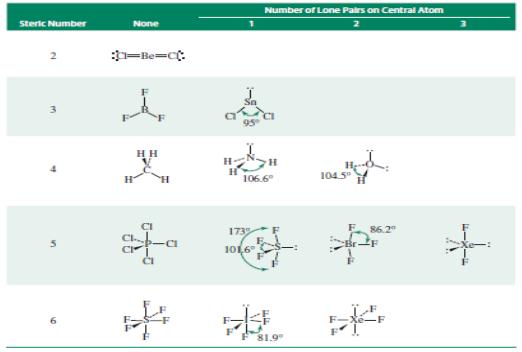


FIGURE 3.13 Structures Containing Lone Pairs.

3.2.2 BANYAK IKATAN

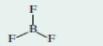
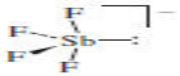
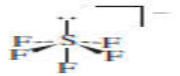
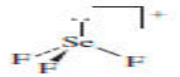
Steric Number	None	Number of Lone Pairs on Central Atom 1	2	3
2	:Cl—Be—Cl:			
3				
4				
5				
6				

FIGURE 3.13 Structures Containing Lone Pairs.







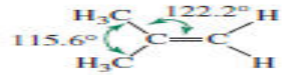
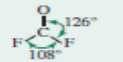
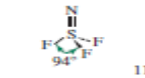
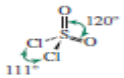
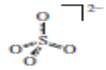
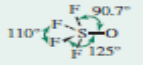
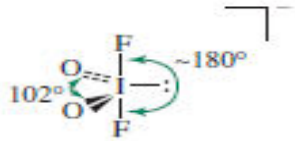


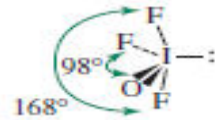
FIGURE 3.14 Bond Angles in $(CH_3)_2C{=}CH_2$.

Steric Number	Number of Bonds with Multiple Bond Character 1	2	3	4
2		O—C—O		
3				
4				
5				
6				

* The bond angles of these molecules have not been determined accurately. However, spectroscopic measurements are consistent with the structures shown.

FIGURE 3.15 Structures Containing Multiple Bonds.





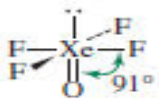


FIGURE 3.16 Structures Containing Both Lone Pairs and Multiple Bonds.

3.2.3 ELEKTRONEGATIVITAS DAN PENGARUH UKURAN ATOM

Skala Elektronegatifitas

$$CE = \frac{n\varepsilon_s + m\varepsilon_p}{n + m}$$

where n = number of s electrons
m = number of p electrons
ε_s, ε_s = experimental 1-electron s and p energies†

TABLE 3.3 Early Values of Pauling Electronegativities

H 2.1			
C 2.5	N 3.0	O 3.5	F 4.0
Si 1.8	P 2.1	S 2.5	Cl 3.0
Ge 1.8	As 2.0	Se 2.4	Br 2.8

TABLE 3.4 Electronegativity Scales

Principal Authors	Method of Calculation or Description
Pauling[14]	Bond energies
Mulliken[15]	Average of electron affinity and ionization energy
Allred & Rochow[16]	Electrostatic attraction proportional to Z^*/r^2
Sanderson[17]	Electron densities of atoms
Pearson[18]	Average of electron affinity and ionization energy
Allen[19]	Average energy of valence shell electrons, configuration energies
Jaffé[20]	Orbital electronegativities

TABLE 3.5 Electronegativity (Pauling Units)

1	2	12	13	14	15	16	17	18
H 2.300								He 4.160
Li 0.912	Be 1.576		B 2.051	C 2.544	N 3.066	O 3.610	F 4.193	Ne 4.787
Na 0.869	Mg 1.293		Al 1.613	Si 1.916	P 2.253	S 2.589	Cl 2.869	Ar 3.242
K 0.734	Ca 1.034	Zn 1.588	Ga 1.756	Ge 1.994	As 2.211	Se 2.424	Br 2.685	Kr 2.966
Rb 0.706	Sr 0.963	Cd 1.521	In 1.656	Sn 1.824	Sb 1.984	Te 2.158	I 2.359	Xe 2.582
Cs 0.659	Ba 0.881	Hg 1.765	Tl 1.789	Pb 1.854	Bi (2.01)	Po (2.19)	At (2.39)	Rn (2.60)

Source: J. B. Mann, T. L. Meek, L. C. Allen, *J. Am. Chem. Soc.*, **2000**, 122, 2780, Table 2.

TABLE 3.5 Electronegativity (Pauling Units)

1	2	12	13	14	15	16	17	18
H 2.300								He 4.160
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Na 0.869	Mg 1.293		Al 1.613	Si 1.916	P 2.253	S 2.589	Cl 2.869	Ar 3.242
K 0.734	Ca 1.034	Zn 1.588	Ga 1.756	Ge 1.994	As 2.211	Se 2.424	Br 2.685	Kr 2.966
Rb 0.706	Sr 0.963	Cd 1.521	In 1.656	Sn 1.824	Sb 1.984	Te 2.158	I 2.359	Xe 2.582
Cs 0.659	Ba 0.881	Hg 1.765	Tl 1.789	Pb 1.854	Bi (2.01)	Po (2.19)	At (2.39)	Rn (2.60)

Source: J. B. Mann, T. L. Meek, L. C. Allen, *J. Am. Chem. Soc.*, **2000**, 122, 2780, Table 2.

Elektronegativitas dan Sudut Ikatan

Molecule	X–P–X Angle (°)	Molecule	X–S–X Angle (°)
PF_3	97.8	OSF_2	92.3
PCl_3	100.3	$OSCl_2$	96.2
PBr_3	101.0	$OSBr_2$	98.2

ve electronegativity of the halogen increases, the halogen exerts a stronger

Molecule	Bond Angle (°)	Molecule	Bond Angle (°)
H_2O	104.5	NCl_3	106.8
H_2S	92.1	PCl_3	100.3
H_2Se	90.6	$AsCl_3$	98.9

TABLE 3.6 Bond Angles and Lengths

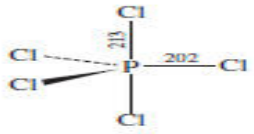
Molecule	Bond Angle (°)	Bond Length (pm)	Molecule	Bond Angle (°)	Bond Length (pm)	Molecule	Bond Angle (°)	Bond Length (pm)	Molecule	Bond Angle (°)	Bond Length (pm)
H_2O	104.5	97	OF_2	103.3	96	OCl_2	110.9	170			
H_2S	92.1	135	SF_2	98.0	159	SCl_2	102.7	201			
H_2Se	90.6	146				$SeCl_2$	99.6	216			
H_2Te	90.2	169				$TeCl_2$	97.0	233			
NH_3	106.6	101.5	NF_3	102.2	137	NCl_3	106.8	175			
PH_3	93.2	142	PF_3	97.8	157	PCl_3	100.3	204	PBr_3	101.0	220
AsH_3	92.1	151.9	AsF_3	95.8	170.6	$AsCl_3$	98.9	217	$AsBr_3$	99.8	236
SbH_3	91.6	170.7	SbF_3	87.3	192	$SbCl_3$	97.2	233	$SbBr_3$	98.2	249

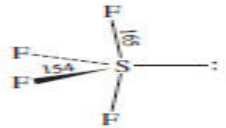
Source: N. N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, 2nd ed., Butterworth-Heinemann, Oxford, 1997, pp. 557, 767; A. F. Wells, *Structural Inorganic Chemistry*, 5th ed., Oxford University Press, Oxford, 1987, pp. 705, 793, 846, and 879; R. J. Gillespie and I. Hargittai, *The VSEPR Model of Molecular Geometry*, Allyn and Bacon, Needham Heights, MA, 1991.

Pengaruh Ukuran

Molecule	C—N—C Angle (°)
$N(CH_3)_3$	110.9
$N(CF_3)_3$	117.9

Molekul yang Memiliki Bilangan Sterik = 5





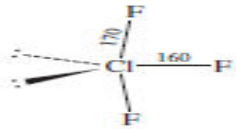


FIGURE 3.17 Bond Distances in PCl_5, SF_4, and ClF_3.

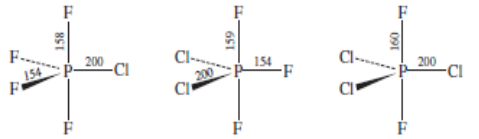


FIGURE 3.18 $PClF_4$, PCl_2F_3, and PCl_3F_2.

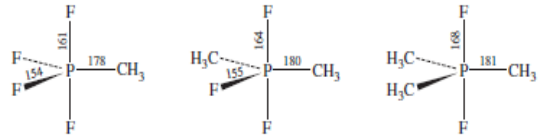


FIGURE 3.19 PF_4CH_3, $PF_3(CH_3)_2$, and $PF_2(CH_3)_3$.

FIGURE 3.20 Bond angles in PF_4Cl, SF_4, and SOF_4.

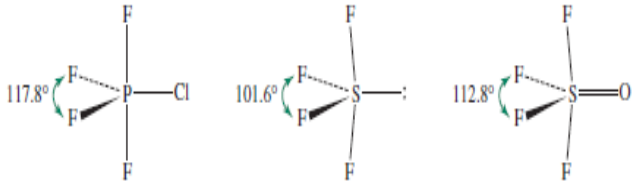
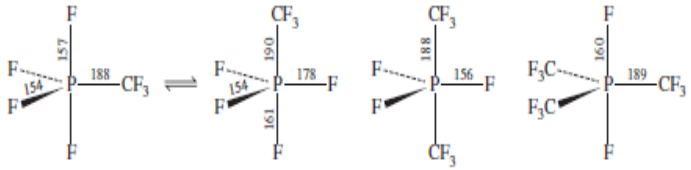


FIGURE 3.21 PF_4CF_3, $PF_3(CF_3)_2$, and $PF_2(CF_3)_3$.



Elektronegativitas Kelompok

$$CF_3 > CHF_2 > CH_2F > CH_3$$

$$CF_3 > CCl_3 \qquad\qquad CH_3 > SiH_3$$

$$F > OH > NH_2 > CH_3 > BH_2 > BeH$$

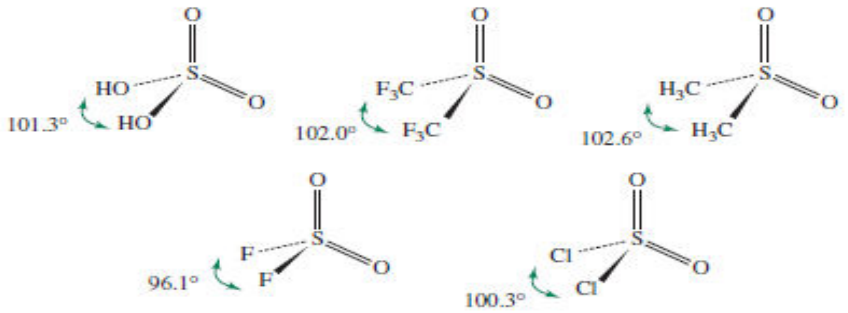


FIGURE 3.22 Bond Angles and Group Electronegativity.

3.2.4 PENGEPAKAN TUTUP LIGAN

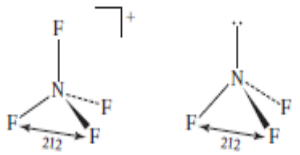
TABLE 3.7 Ligand Close-Packing Data

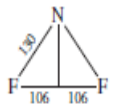
Molecule	Coordination Number of B	B—F Distance (pm)	FBF Angle (°)	F···F Distance (pm)
BF_3	3	130.7	120.0	226
BF_2OH	3	132.3	118.0	227
BF_2NH_2	3	132.5	117.9	227
BF_2Cl	3	131.5	118.1	226
BF_2H	3	131.1	118.3	225
BF_2BF_2	3	131.7	117.2	225
BF_4^-	4	138.2	109.5	226
$BF_3CH_3^-$	4	142.4	105.4	227
$BF_3CF_3^-$	4	139.1	109.9	228
BF_3PH_3	4	137.2	112.1	228
BF_3NMe_3	4	137.2	111.5	229

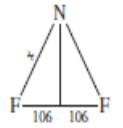
Source: R. J. Gillespie and P. L. A. Popelier, *Chemical Bonding and Molecular Geometry*, Oxford University Press, New York, 2001, p. 119; Table 5.3, R. J. Gillespie, *Coord. Chem. Rev.*, **2000**, 197, 51.

Ligan Tutup Pengepakan dan Jarak Ikatan

FIGURE 3.23 NF_4^+ and NF_3.







[a]Values of ligand radii can be found in R. J. Gillespie, E. A. Robinson, *Compt. Rend. Chimie*, **2005**, *8*, 1631.

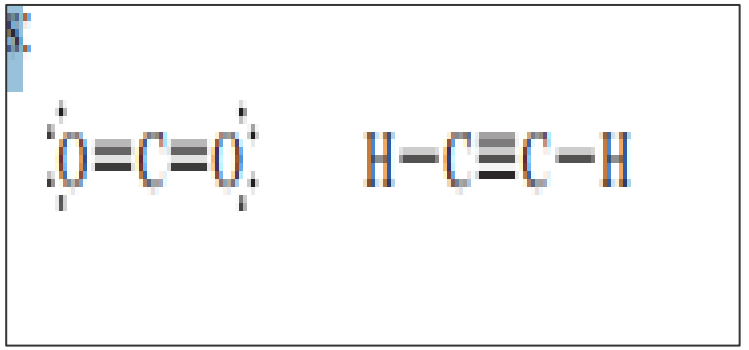
$$\sin\left(\frac{102.3^\circ}{2}\right) = \frac{\frac{1}{2}(\text{F}\cdots\text{F distance})}{x},$$

$$x = \text{N—F bond distance} = \frac{106\text{ pm}}{\sin 51.15^\circ} = 136\text{ pm (experimental: 136.5 pm)}$$

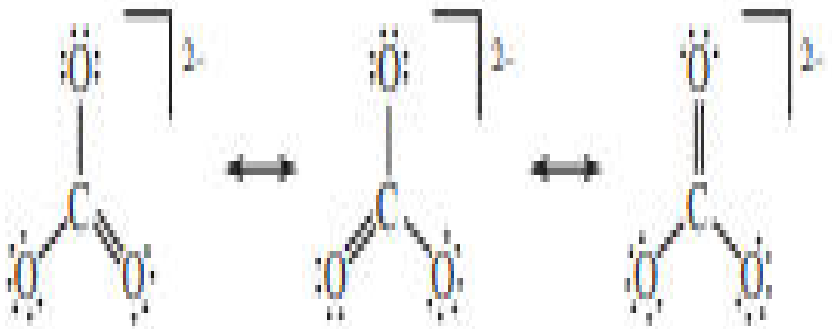
TEORI IKANATAN SEDERHANA

3.1 lewis diagram titik-elektron

3.1.1 resonansi



3.1.2 jumlah elektron yang lebih tinggi



Gambar 3.1

3.1.3 BIAYA FORMAL

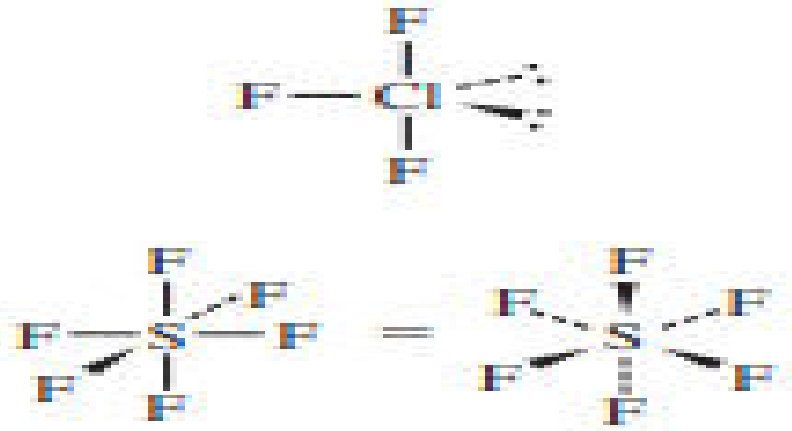


FIGURE 3.2 Structures of ClF_3 and SF_6.

3.1.4 BEBERAPA IKATAN DALAM SENYAWA BE DAN B

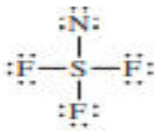
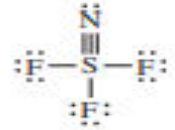
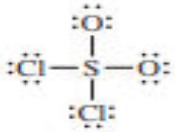
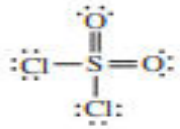
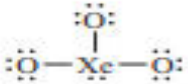
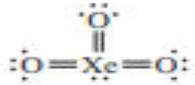
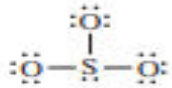
	Octet			Expanded			
Molecule		*Atom*	*Formal Charge*		*Atom*	*Formal Charge*	*Expanded to:*
SNF_3		S N	2+ 2–		S N	0 0	12
SO_2Cl_2		S O	2+ 1–		S O	0 0	12
XeO_3		Xe O	3+ 1–		Xe O	0 0	14
SO_3^{2-}		S O	1+ 1–		S O	0 0,1–	10

FIGURE 3.6 Formal Charge and Expanded Electron Counts on Central Atom

FIGURE 3.7 Structures of BeF_2, $BeCl_2$, and BF_3. (Data from A. F. Wells, *Structural Inorganic Chemistry*, 5th ed., Oxford University Press, Oxford, England, 1984, pp. 412, 1047.)