Lecture 1; CH 101: Inorganic Chemistry

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CH 101 – July/Nov 2017 Time Table

✧Slot: **D** and **D_1**

✧Venue: **Lecture Hall – L2 (Div I & III) L3 (Div II & IV)**

✧**Division - I & II:** *Classes in the morning (9 am - 12 noon)*
Division - III & IV: *Classes in the afternoon (2 pm – 5 pm)*

Day	Time	Venue and Divisions		Time	Venue and Divisions	
Monday	11-11:55	L2 Div I ***AC***	L3 Div II ***AK***	2-2:55	L2 Div III; ***AC***	L3 Div IV ***AK***
Wednesay	8-8:55	**Tutorials in various classrooms**				
Thursday	9-9:55	L2 Div I ***BKP***	L3 Div II ***AC***	4-4:55	L2 Div III; ***BKP***	L3 Div IV ***AC***
Friday	10-10:55	L2 Div I ***AK***	L3 Div II ***BKP***	3-3:55	L2 Div III; ***AK***	L3 Div IV ***BKP***

Tutorials and Examinations (Tentative)

- ✧ 27th Jul: Orientation
- ✧ 2nd Aug: P_1
- ✧ 9th Aug: P_2
- ✧ 16th Aug: O_1
- ✧ 17th Aug: Tuesday Timetable
- ✧ 23rd Aug: I_1
- ✧ 30th Aug: **Quiz 1**
- ✧ 31st Aug, 1st Sep: No Class (Techniche)
- ✧ 6th Sep: P_3
- ✧ 13th Sep: O_2
- ✧ 21st Sep: **Mid-semester**
- ✧ 25th, 27th Sep: No Class
- ✧ 4th Oct: I_2
- ✧ 10th Oct: Return of Mid-semester answer scripts
- ✧ 11th Oct: P_4
- ✧ 17th Oct: Thursday Timetable
- ✧ 18th Oct: O_3
- ✧ 25th Oct: I_3
- ✧ 1st Nov: **Quiz 2**
- ✧ 8th Nov: O_4
- ✧ 15th Nov: I_4
- ✧ 22nd Nov: Last day of Instruction
- ✧ 23rd Nov: **End-semester**

Rules

- Students are expected to attend all classes.
- Tutorials are Mandatory.
- Please follow IITG ordinance regarding exams.
- **USE OF MOBILE PHONE IS STRICTLY PROHIBITED DURING CLASS**

Syllabus:

The periodic table of elements;
1st to 3rd week of August (3 Classes)

Shapes of inorganic compounds;
4th week of Aug to 3rd week of Sep (4 Classes)

Coordination compounds: ligand, nomenclature, isomerism, stereochemistry, valence bond, crystal field and molecular orbital theories;
1st week of Oct to 4th week of Oct (4 Classes)

Organometallic chemistry;
1st week of Nov to 3rd week of Nov (3 Classes)

Syllabus: Texts

1. F. A. Cotton, and G. Wilkinson, *Advanced Inorganic Chemistry*, 3rd Ed., Wiley Eastern Ltd., New Delhi, 1972, reprint in 1988.

2. D. J. Shriver, P. W. Atkins, and C. H. Langford, *Inorganic Chemistry*, 2nd Ed., ELBS ,1994.

3. J. E. Huheey, E. A. Keiter and R. L. Keiter, *Inorganic Chemistry: Principle, structure and reactivity*, 4th Ed., Harper Collins, 1993

Science & Chemistry

- Science – Derieved from Latin *"Scientia"* which means to know
- Systematic undertaking that builds and/or organizes knowledge
- Rationalizes, explains and predicts based on observations
- Chemistry – Study of nature, properties and composition of matter and the associated changes

"Central Science" Organic, Inorganic, Physical

Inorganic Chemistry:

Understanding of the physical and chemical properties of all inorganic compounds

Understand atoms to know about molecules

Origin of matter

Behavior of electrons in atoms

Atomic structure, ionization energy, electron affinity, electronegetivity

Origin of Elements:

Occurrence of “Big Bang” about 1.5 billion years ago

Very high initial temperatures (Ca. 10^9 K)

Fundamental particles began to adhere together as the temperature cooled

1. Powerful attractive forces between nucleons
2. Weak but long-range electromagnetic force

Particle	Symbol	Mass	Mass number	Charge	Spin
Electron	e^-	$5.486X10^{-4}$	0	-1	1/2
Proton	p	1.0073	1	+1	1/2
Neutron	n	1.0087	1	0	1/2

Chemical Elements

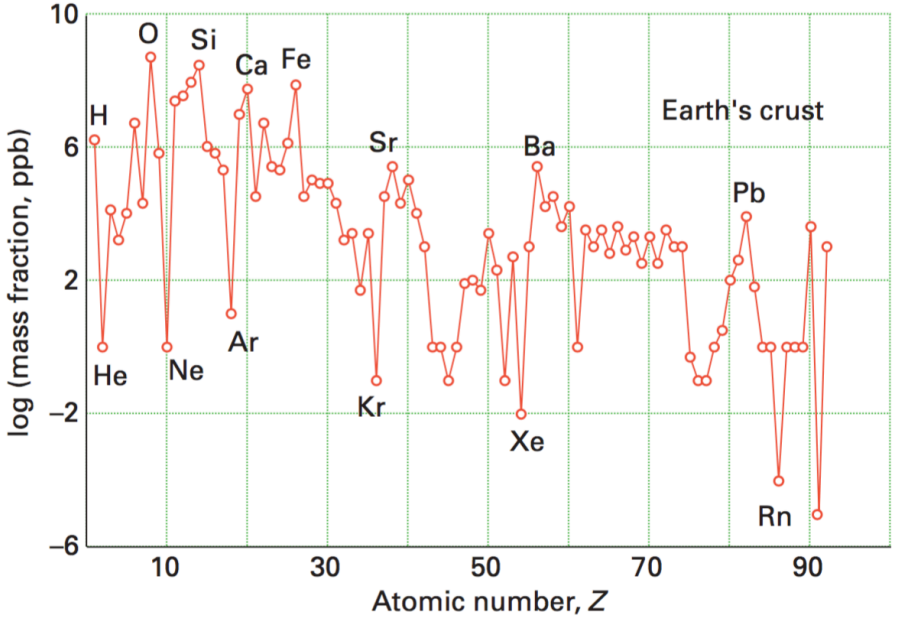
A total of 118 elements are known

94 elements occur naturally, 24 elements synthesized

Distinguished by their atomic number **Z**

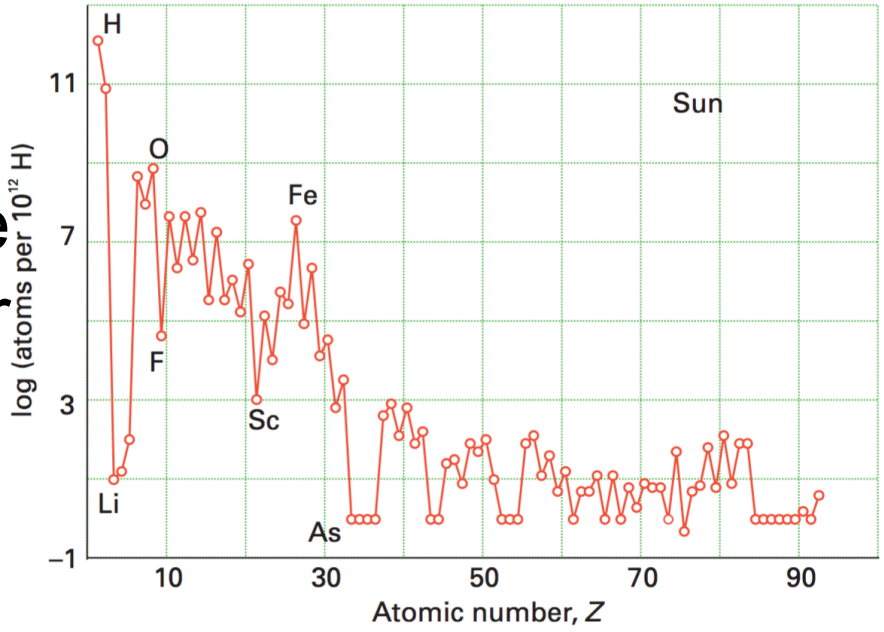
Many elements have isotopes which are atoms with same atomic number but with different atomic mass. Isotopes are distinguished by mass number **A**

Hydrogen (Z =1) has 3 isotopes (^{1}H, ^{2}H, ^{3}H)



The abundances of the elements in the Earth's crust and the Sun.

Elements with odd Z are less stable than their neighbours with even Z.



Structure of atoms

Consider hydrogen-like or hydrogenic atoms which have only one electron (H, He^{+}, C^{5+})

Use the concept to describe structures of many-electron atoms

Spectroscopy: Electrons occupy certain energy levels and emission of discrete frequencies of electromagnetic radiation occurs when electron makes transition within these levels

Structure of atoms

Quantum Mechanics: Electrons can behave as particles or as waves

Schrodinger equation gives wave function which describes the location and properties of electrons in atom

The probability of finding an electron at a given location is proportional to square of the wavefunction

Wavefunctions have regions of positive and negative amplitude and can undergo constructive or destructive interference with one another

Atomic Orbitals

Wave function of an electron in an atom is called atomic orbital

Normally hydrogenic atomic orbitals are used to develop models that are central to the interpretation of inorganic chemistry

Each wavefunction obtained by solving Schrodinger equation is labelled by a set of three integers called quantum numbers n, l and m_l

Quantum Numbers

Principal quantum number *n*; determines energy of the bound electron and indicates the size of the orbital

Orbital angular momentum quantum number *l*; specifies the magnitude of orbital angular momentum and indicates the angular shape of the orbital with the number of lobes increasing as *l* increases

Magnetic quantum number m_l; specifies the orientation of angular momentum (lobes)

Shells, Subshells and Orbitals

All orbitals with a given value of *n* belong to the same shell. Shells with *n* = 1, 2, 3,..... are commonly referred to as K, L, M,..... shells

All orbitals of a given shell with the same value of *l* belong to the same subshell.
For a given value of *n*, the quantum number *l* can have values *l* = 0, 1,….(n-1)
Value of *l* = 0, 1, 2, 3, 4,…
Subshell designation *s*, *p*, *d*, *f*, g

A subshell with quantum number *l* can have 2*l*+1 orbitals which are distinguished by the value of m_l from +*l* to -*l*

Quantum Numbers

Principal quantum number *n*; determines energy of the bound electron and indicates the size of the orbital

Orbital angular momentum quantum number *l*; specifies the magnitude of orbital angular momentum and indicates the angular shape of the orbital with the number of lobes increasing as *l* increases

Magnetic quantum number m_l; specifies the orientation of angular momentum (lobes)

Spin magnetic quantum number m_s; anticlockwise (spin-up) with $m_s = +\frac{1}{2}$ and clockwise (spin-down, $m_s = -\frac{1}{2}$) . *NOTE:* The fifth quantum number *s* is fixed at $\frac{1}{2}$

Atomic Orbitals

Regions where wavefunctions pass through zero are called nodes

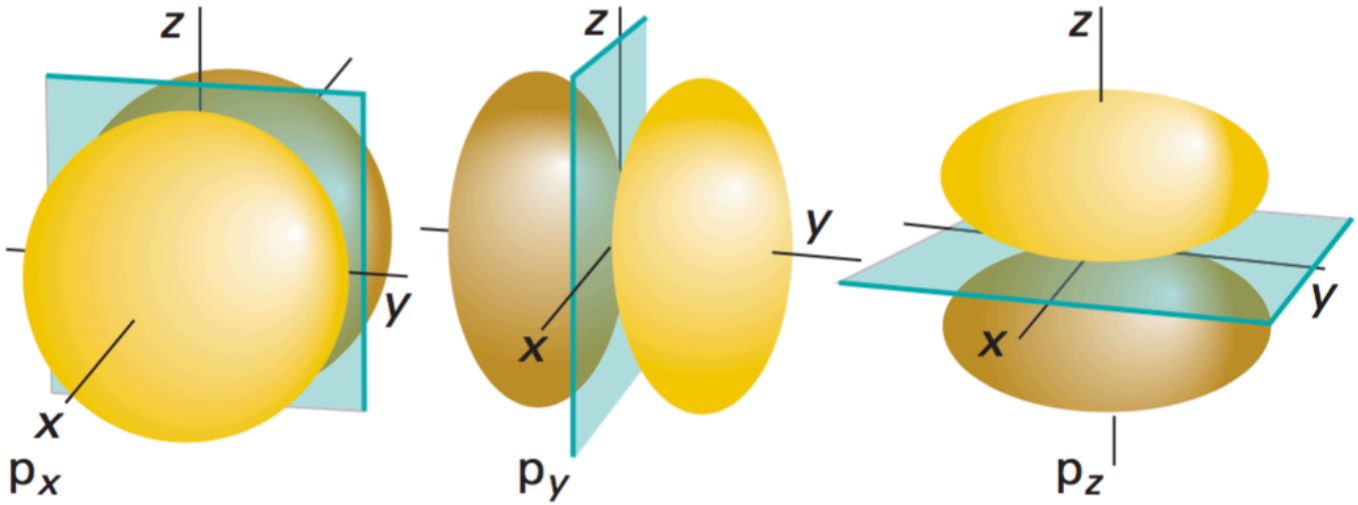
An orbital with quantum number *n* and *l* in general has *n* – *l* – 1 radial nodes

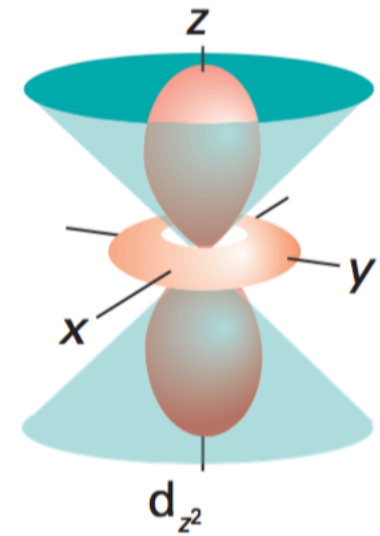
An s orbital has an non-zero amplitude at nucleus

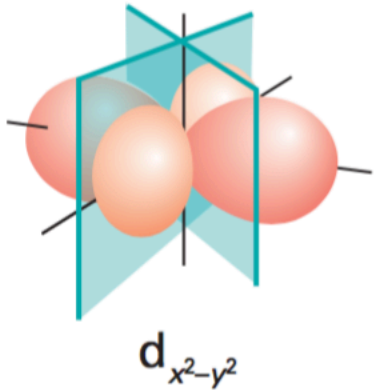
All other orbital with l > 0 vanish at the nucleus

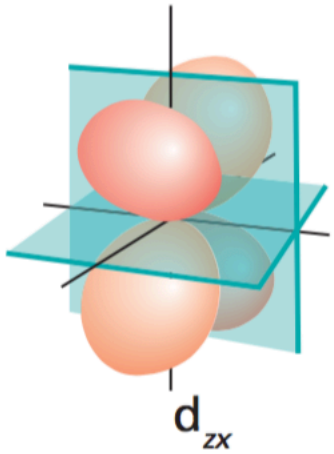
The boundary surface of an orbital indicates the region of space within which the electron is most likely to be found.

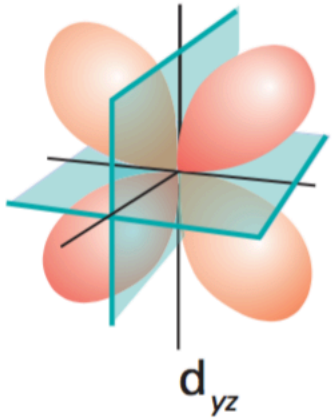
Orbital with quantum number *l* have l nodal planes

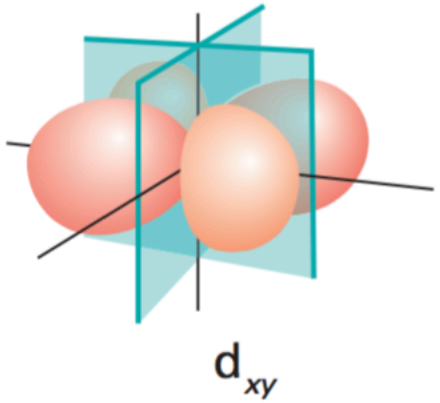

z
y
x
p_x
z
y
x
p_y
z
y
x
p_z


z
y
x
d_{z^2}


$d_{x^2-y^2}$


d_{zx}


d_{yz}


d_{xy}