*Lecture 1  362  January 14, 2019*

*This course.  Getting to know you/me/those who will help you and expectations.*

*Handouts:  1)  How I best learn.*

*2)  Some information (missing poster project preference)*

*3)  Syllabus*

*4) Schedule*

*5)  Project #1*

**CHEM 362** Prof. Marcetta Darensbourg, Rm. 408. Phone # 845-5417
***Descriptive Inorganic Chemistry***
Spring 2019 ✧ MWF 10:20 - 11:10 AM ✧ 255 Chemistry

Website: http://www.chem.tamu.edu/rgroup/marcetta/
Office hours: Immediately following class on W or F, or by appointment

**TEACHING ASSISTANTS**:
**~~Xuemei Yang** <xuemeiyang@tamu.edu>; 418 Chemistry; Phone # 845-4837
Office hours: Tuesdays 4-5 pm.
**~~Kyle Burns**; 420 Chemistry; Phone # 845-4837
Office hours: Fridays 5-6 pm.

**UNDERGRADUATE MENTORS: PEER LED TEAM LEARNING (PLTL) LEADERS**
**REBECCA BEAM SUNDAY AT 4 PM**
**HALEY NAUMAN SUNDAY AT 5 PM**
**OSIRIS CARRANZA WEDNESDAY 6 PM**

**ADMINISTRATIVE ASSISTANT:** (All Grade Records and special appointments)
Abbey Kunkle darensbourg_asst@chem.tamu.edu; 407 Chemistry; Phone # 845-5417
Office hours: Monday-Friday 8:30 am – 4 pm

**WEBPAGE**: http://www.chem.tamu.edu/rgroup/marcetta/chem362
**TEXT:** "*Inorganic Chemistry*", $6^{th}$, 7th Edition, Shriver & Atkins, Weller Armstrong
(ISBN-10: 1-4292-9906-1 | ISBN-13: 978-1-4292-9906-0)

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***Descriptive Inorganic Chemistry***

Spring 2019 ✧ MWF 10:20 - 11:10 AM ✧ 255 Chemistry

| COURSE GRADING: | | SCHEDULE |
| --- | --- | --- |
| HOUR EXAM 1 | 15% | FEBRUARY 15 |
| HOUR EXAM 2 | 15% | MARCH 22 |
| HOUR EXAM 3 | 15% | APRIL 19 |
| **FINAL EXAM** | **25%** | **MAY 6** |
| PROJECTS | 15% | |
| QUIZZES: | 15% | |
| **POSTER DAY 1** | | **APRIL 10** |
| **POSTER DAY 2** | | **APRIL 12** |

***Projects and the PLTL program***: We are participating in the Peer Led Team Learning program. You will have available to you a former 32 student to advise you as you work on projects (especially the Posters) and also homework/review questions.

Their scheduled times are Sunday at and 5 p.m. and Wednesday at 6.
The rooms, and student leaders are in the syllabus..
You are expected to select one leader within the team and stick with that team throughout the semester. The main project is the Poster, and each of these Leaders are expert in poster preparation. They will guide you through the process.

# The Scope of Inorganic Chemistry

**Medicine**
- MRI
- X-ray contrast imaging
- drugs (arthritis, cancer,…

**Biochemistry/Biology**
- metalloproteins
- metalloenzymes
- $O_2$ binding
- catalysis
- ion transport

**Organic Chemistry**
- organometallics
- metal compounds in synthesis/catalysis

**INORGANIC CHEMISTRY**
- new compounds
- geometrical and electronic structures
- reactivity

**Materials Science**
- electrical and magnetic properties of solids
- solid state structures
- semiconductors
- superconductors (high $T_c$)

**Geology/Geochemistry**
- synthesis and structure of minerals
- stellar evolution
- astrochemistry

**Organometallic Chemistry**
- new compounds
- structures
- catalysis

If some universal catastrophe were to engulf the world, and humankind
Could retain one scientific concept in order to rebuild civilization, what
would that one concept be?

**Response for physicists (Richard Feynman in "Six Easy Pieces"):**

***The modern idea of atoms*.**

**Response for chemists:**

***The periodic table***

**The periodic table encapsulates the concept of elements, organizes physical and chemical trends of substances, and compares the structure of the different atoms— All in a very small space.**

*Inorganic Chemists think they own the Periodic Table.*

*So, How did it all start?*

Well,. . . . https://www.youtube.com/watch?v=CMSYv_Z4SI8

Our whole universe was in a hot, dense state
Then nearly fourteen billion years ago expansion started, wait
The earth began to cool, the autotrophs began to drool
Neanderthals developed tools
We built a wall (we built the pyramids)
Math, science, history, unraveling the mysteries
That all started with the big bang! Hey!
Since the dawn of man is really not that long
As every galaxy was formed in less time than it takes to sing this song
A fraction of a second and the elements were made
The bipeds stood up straight, the dinosaurs all met their fate
They tried to leap but they were late
And they all died (they froze their asses off)
The oceans and Pangea, see ya wouldn't wanna be ya
Set in motion by the same big bang!
It all started with the big bang!

*The first project: The Elements*

*Stable vs .Unstable Isotopes*

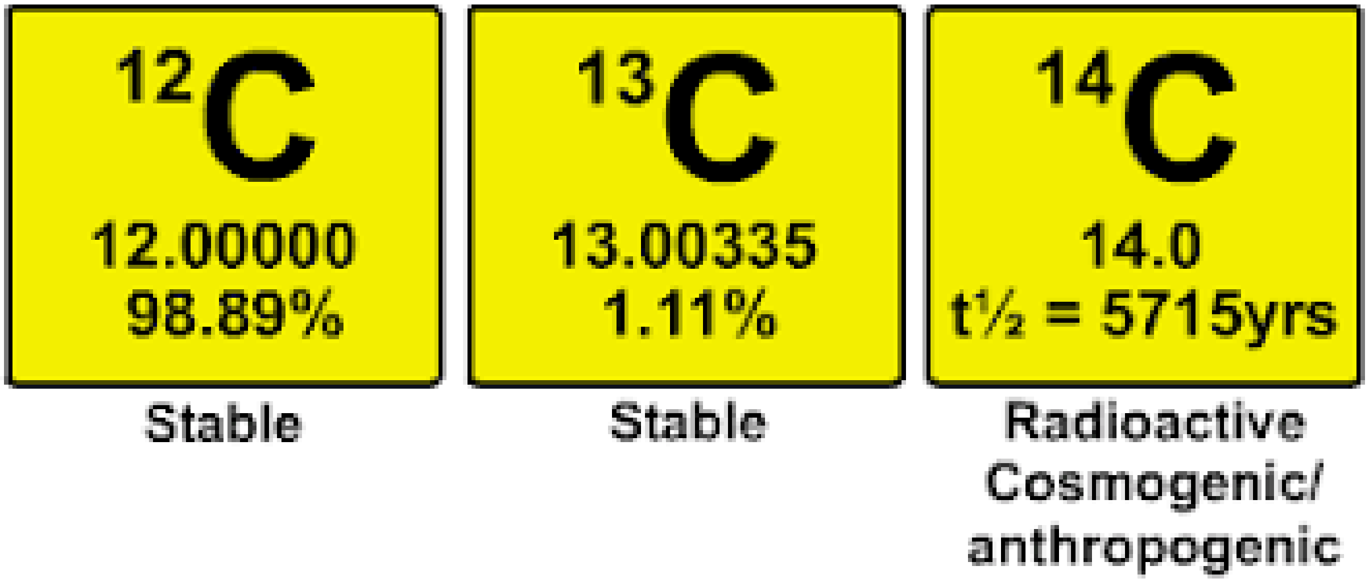
*Naturally Abundant—percent abundance—*
*See WebElements Periodic Table*

The nucleus characterized by
1) Size
2) Density
3) **Charge**
4) Atomic mass unit
5) Nuclear mass
6) Binding Energy
7) Spin

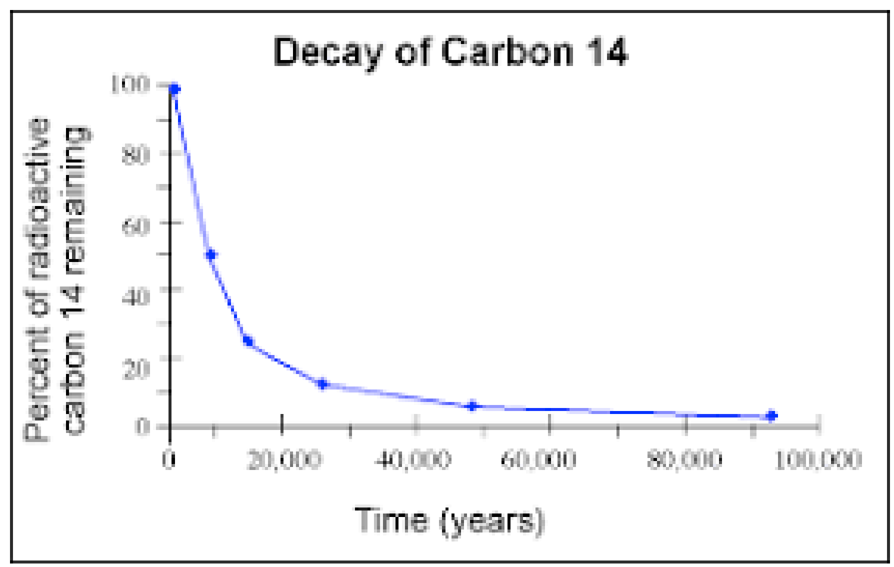
*Radioisotopes—Decay by several processes;*
*characterized by nuclear particles involved in decay processes and the rate of decay or half-life.*

*Distribution of Stable Isotopes*
*Atomic Mass  Detection by Mass Spectrometry*

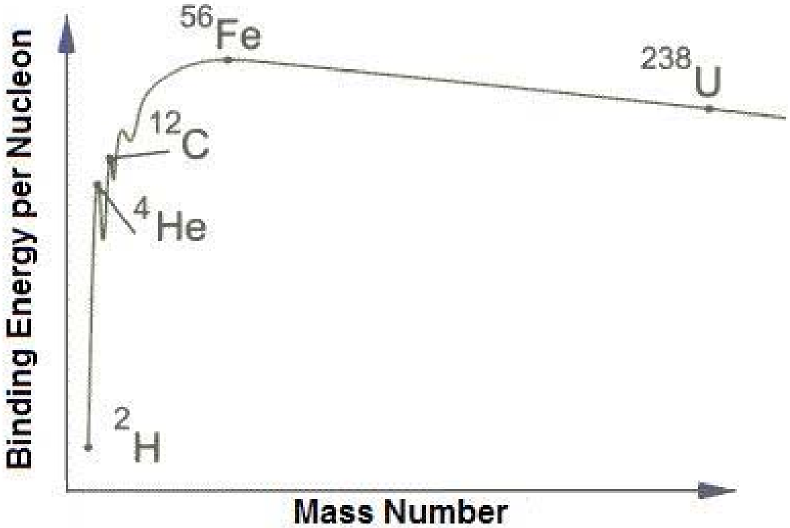
Carbon: Atomic no. of 6; Mass differs by # of neutrons

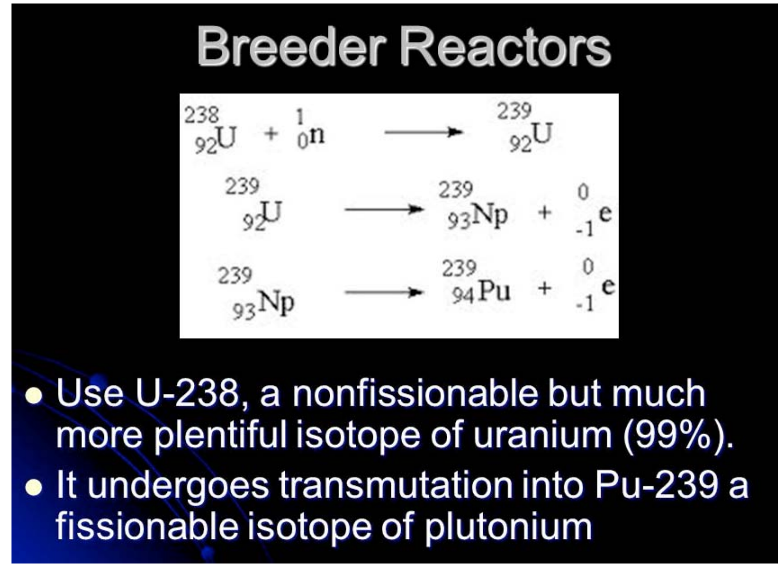


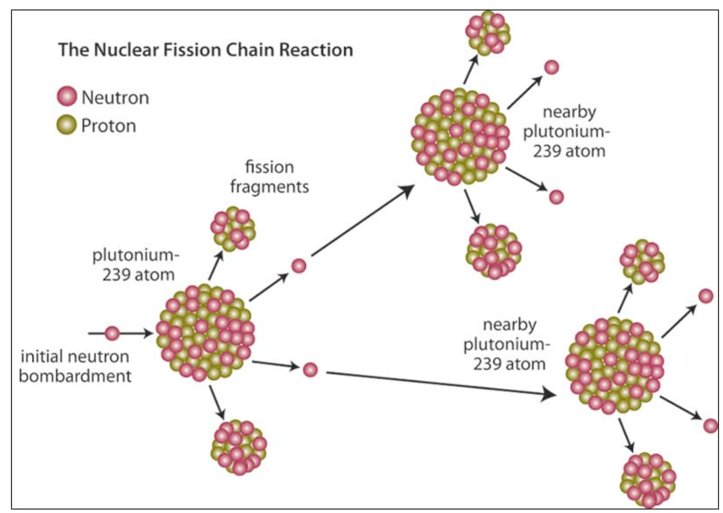

$^{14}_{6}C \rightarrow {}^{14}_{7}N + e^{-} + \nu_e$



# Stable vs. Unstable or Fissionable Nuclei

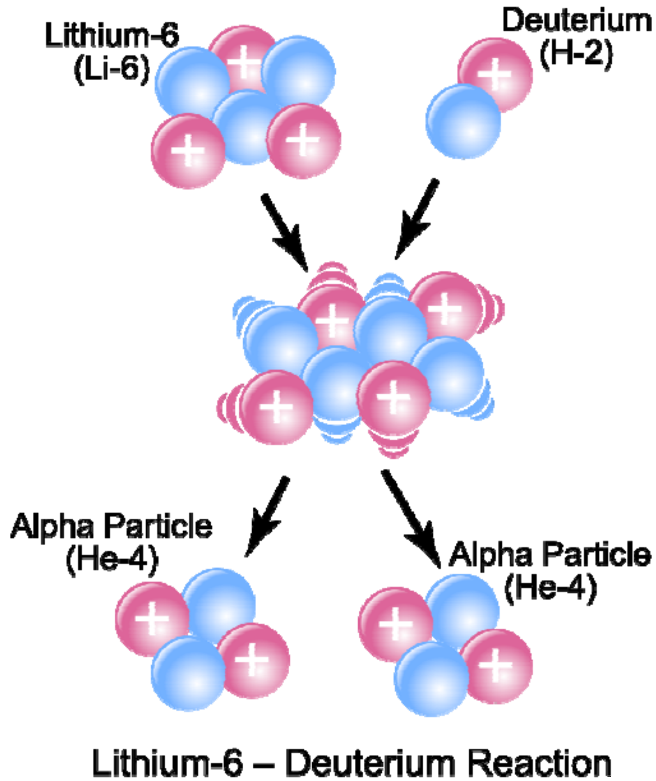



***Project no. 1. Nuclear Reactions; Web Elements; Mass Spectrometry***

## An example of nuclear FUSION and the creation of an unstable isotope of Be



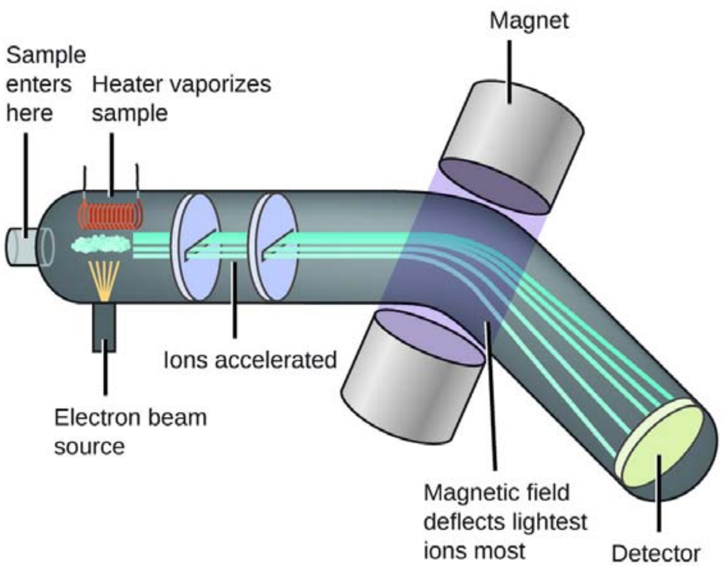

${}_4^8$Be with $t_{1/2}$ of ca. $10^{-18}$ sec

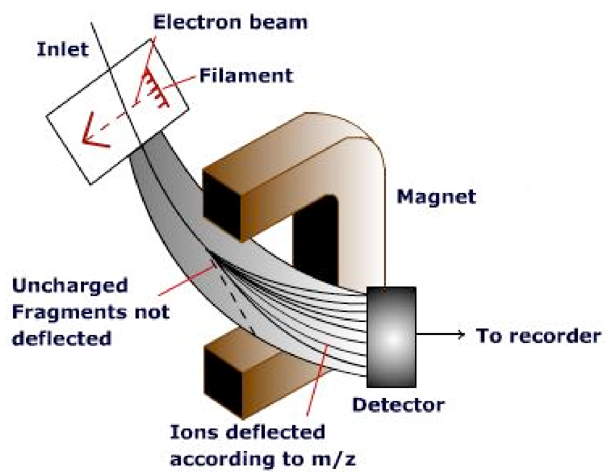
$$ {}^6_3\text{Li} \quad + \quad {}^2_1\text{H} \quad \longrightarrow \; 2\; {}^4_2\text{He} \; + \; \text{Energy} $$

*The first project: The Elements*

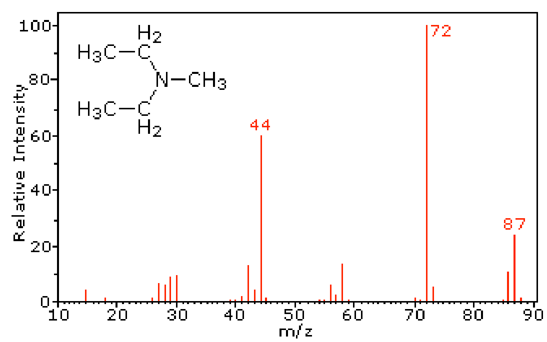
*Stable vs.Unstable Isotopes: See Web Elements Periodic Table*

*Distribution of Stable Isotopes and Atomic Mass*
*Detection by Mass Spectrometry*




Parent Peak
Base Peak
Fragments



# WebElements™ Periodic Table

| Group | 1 | 2 | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | | | | | | | | | | | | | | | | | | | |
| 1 | 1 H | | | | | | | | | | | | | | | | | | 2 He |
| 2 | 3 Li | 4 Be | | | | | | | | | | | | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne |
| 3 | 11 Na | 12 Mg | | | | | | | | | | | | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar |
| 4 | 19 K | 20 Ca | | 21 Sc | 22 Ti | 23 V | 24 Cr | 25 Mn | 26 Fe | 27 Co | 28 Ni | 29 Cu | 30 Zn | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr |
| 5 | 37 Rb | 38 Sr | | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |
| 6 | 55 Cs | 56 Ba | * | 71 Lu | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| 7 | 87 Fr | 88 Ra | ** | 103 Lr | 104 Rf | 105 Db | 106 Sg | 107 Bh | 108 Hs | 109 Mt | 110 Ds | 111 Rg | 112 Uub | 113 Uut | 114 Uuq | 115 Uup | 116 Uuh | 117 Uus | 118 Uuo |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lanthanoids | * | 57 La | 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb |
| **Actinoids | ** | 89 Ac | 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No |

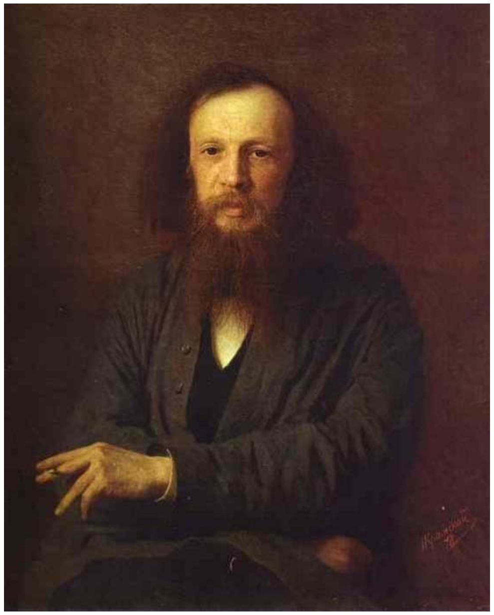
http://www.webelements.com

Mass Spectra computer:

http://www.sisweb.com/mstools/isotope.htm

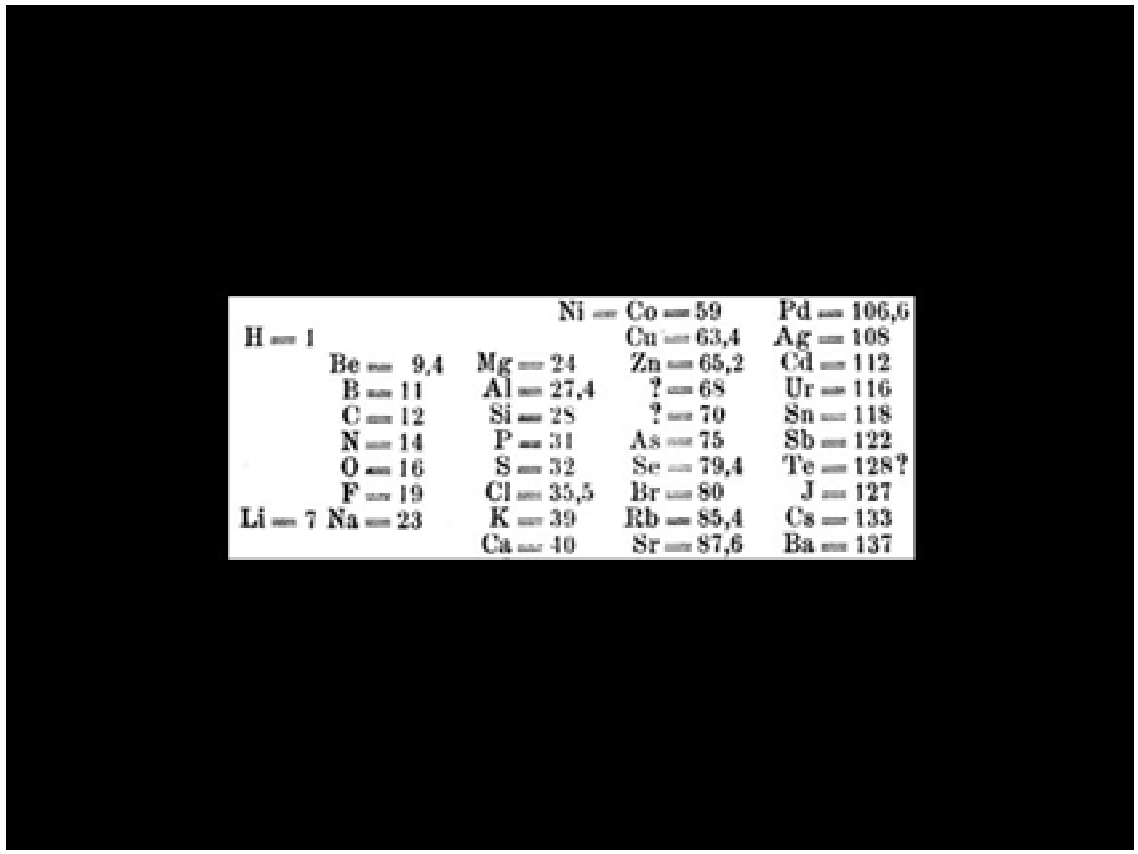
http://www.sisweb.com/mstools/isotope.htm

Consider $CO_2$



Dimitri Mendeleev

1834-1907

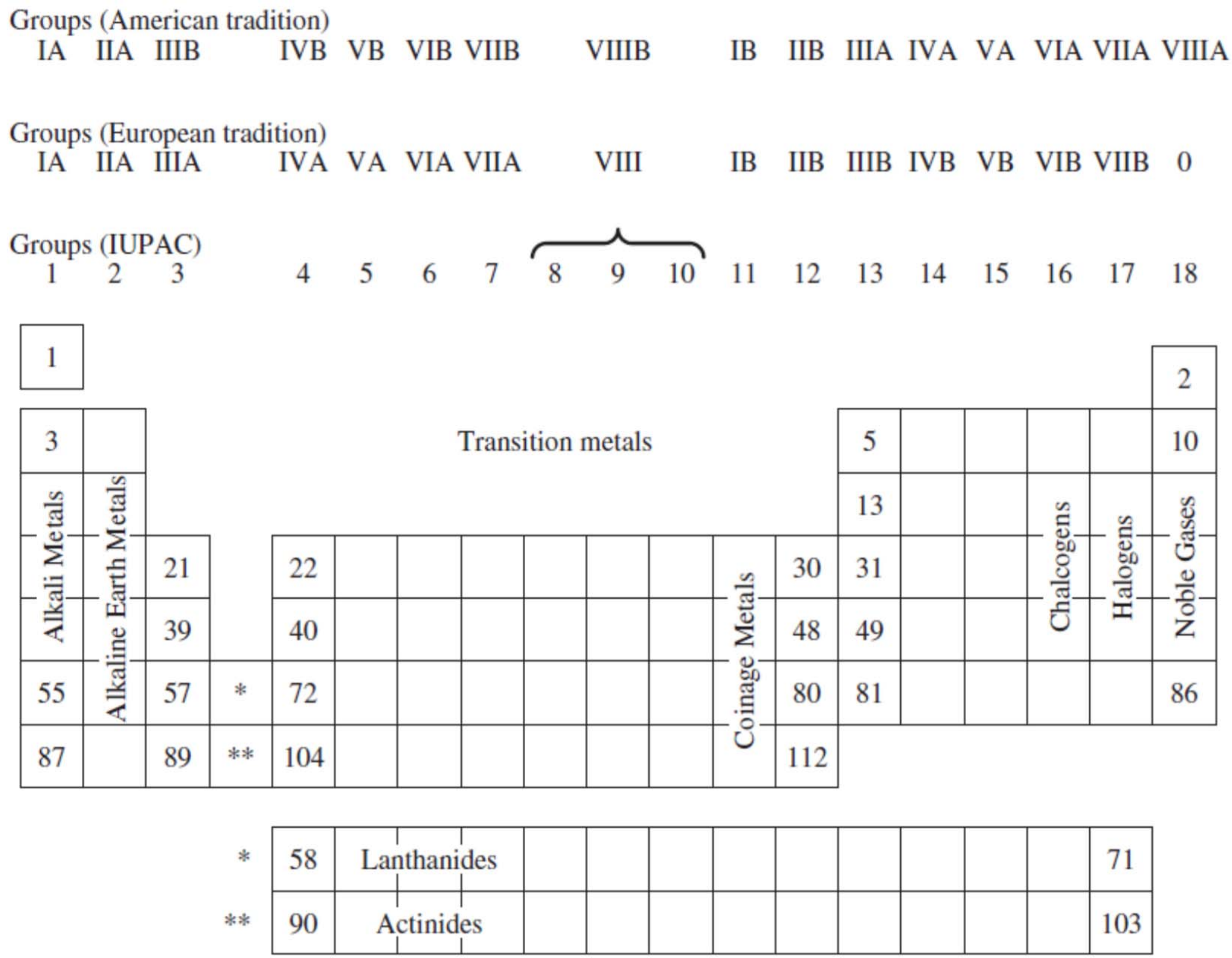


| | | | | |
|---|---|---|---|---|
| | | | Ni = Co = 59 | Pd = 106,6 |
| H = 1 | | | Cu = 63,4 | Ag = 108 |
| | Be = 9,4 | Mg = 24 | Zn = 65,2 | Cd = 112 |
| | B = 11 | Al = 27,4 | ? = 68 | Ur = 116 |
| | C = 12 | Si = 28 | ? = 70 | Sn = 118 |
| | N = 14 | P = 31 | As = 75 | Sb = 122 |
| | O = 16 | S = 32 | Se = 79,4 | Te = 128? |
| | F = 19 | Cl = 35,5 | Br = 80 | J = 127 |
| Li = 7 | Na = 23 | K = 39 | Rb = 85,4 | Cs = 133 |
| | | Ca = 40 | Sr = 87,6 | Ba = 137 |

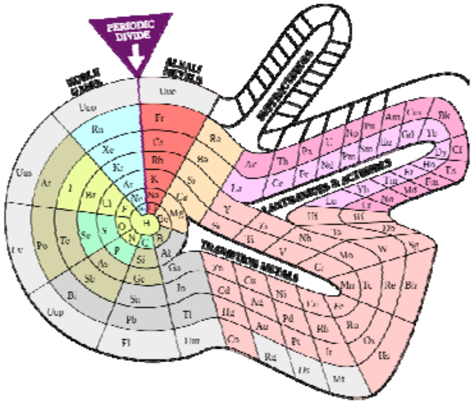
$^{A}_{Z}E$

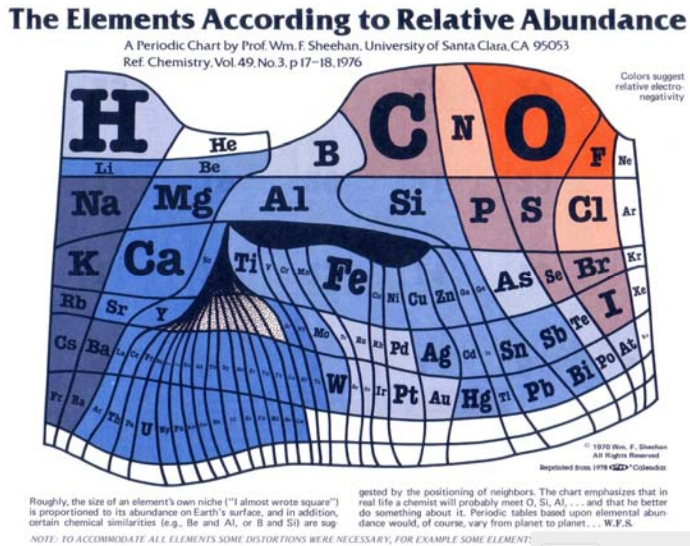
Z = No. protons in nucleus, Atomic number

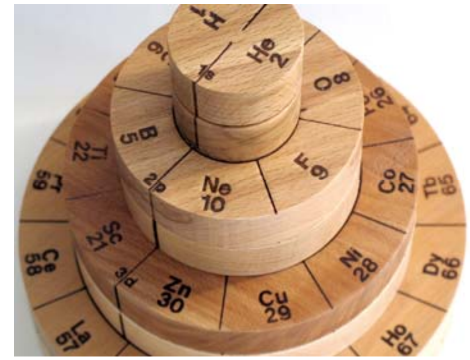
A = Mass number; no. of protons + neutrons in nucleus

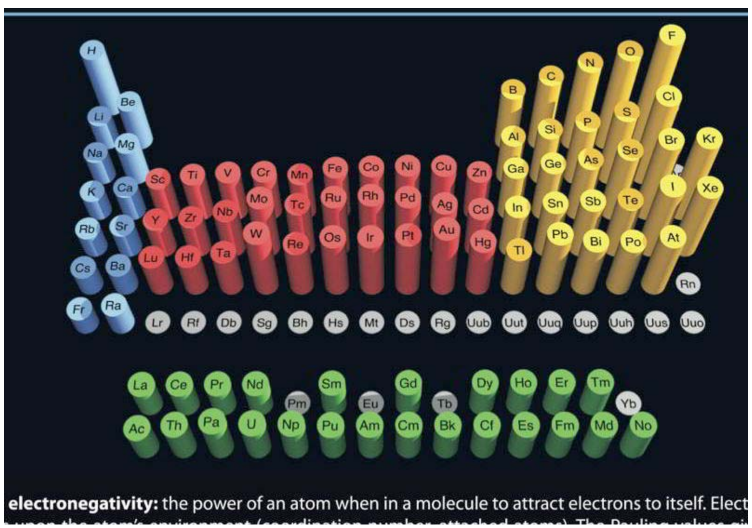


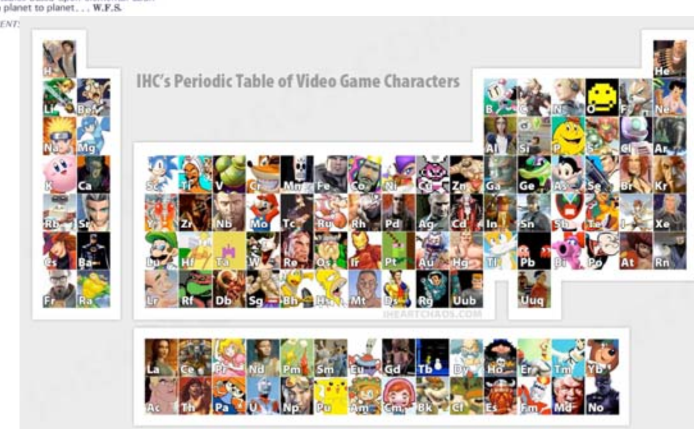
Groups (American tradition)
IA IIA IIIB IVB VB VIB VIIB VIIIB IB IIB IIIA IVA VA VIA VIIA VIIIA
Groups (European tradition)
IA IIA IIIA IVA VA VIA VIIA VIII IB IIB IIIB IVB VB VIB VIIB 0
Groups (IUPAC)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1
2
3
5
10
Transition metals
13
21
22
30
31
39
40
48
49
55
57
*
72
80
81
86
87
89
**
104
112
Alkali Metals
Alkaline Earth Metals
Coinage Metals
Chalcogens
Halogens
Noble Gases
* 58 Lanthanides 71
** 90 Actinides 103

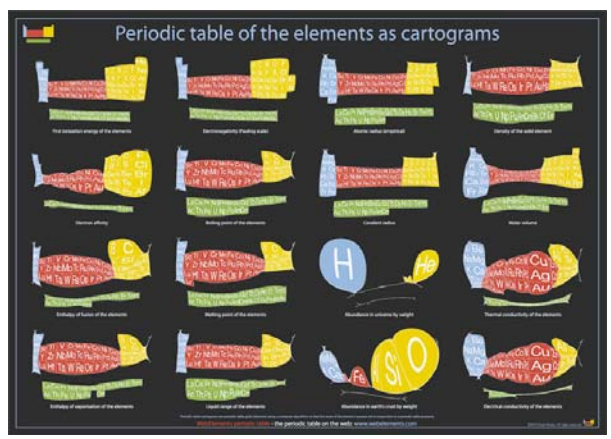

PERIODIC DIVIDE


The Elements According to Relative Abundance
A Periodic Chart by Prof. Wm. F. Sheehan, University of Santa Clara, CA 95053
Ref. Chemistry, Vol. 49, No. 3, p 17–18, 1976
Colors suggest relative electro-negativity
Roughly, the size of an element's own niche ("I almost wrote square") is proportioned to its abundance on Earth's surface, and in addition, certain chemical similarities (e.g., Be and Al, or B and Si) are suggested by the positioning of neighbors. The chart emphasizes that in real life a chemist will probably meet O, Si, Al, . . . and that he better do something about it. Periodic tables based upon elemental abundance would, of course, vary from planet to planet. . . W.F.S.




electronegativity: the power of an atom when in a molecule to attract electrons to itself. Elect


IHC's Periodic Table of Video Game Characters


Periodic table of the elements as cartograms

*Lecture 2  362  January 16, 2019*

*Paradigm Shift:*
*Development of Current Atomic Theory—*
*Spectroscopy and Energy Levels in Atoms*

*OR,*
*"Show me the Electrons!"*

| **Color** | **Metal Flame Colors** |
| --- | --- |
| Red | *Carmine*: Lithium compounds. Masked by barium or sodium.<br>*Scarlet or Crimson*: Strontium compounds. Masked by barium.<br>*Yellow-Red*: Calcium compounds. Masked by barium. |
| Yellow | Sodium compounds, even in trace amounts. A yellow flame is not indicative of sodium unless it persists and is not intensified by addition of 1% NaCl to the dry compound. |
| White | *White-Green*: Zinc |
| Green | *Emerald*: Copper compounds, other than halides. Thallium.<br>*Blue-Green*: Phosphates, when moistened with $H_2SO_4$ or $B_2O_3$.<br>*Faint Green*: Antimony and $NH_4$ compounds.<br>*Yellow-Green*: Barium, molybdenum. |
| Blue | *Azure*: Lead, selenium, bismuth, $CuCl_2$ and other copper compounds moistened with hydrochloric acid.<br>*Light Blue*: Arsenic and come of its compounds.<br>*Greenish Blue*: $CuBr_2$, antimony |
| Violet | Potassium compounds other than borates, phosphates, and silicates. Masked by sodium or lithium.<br>*Purple-Red*: Potassium, rubudium, and/or cesium in the presence of sodium when viewed through a blue glass. |

## ***Atomic Emission (Spectroscopy)***

- An emission spectrum requires first the addition of energy to a material.

- The addition of energy promotes electrons of that material from the ground state to the excited state.

- As the electrons “fall” from the excited state to the ground state, they emit the energy they absorbed in the form of electromagnetic radiation (heat, light, etc.)

## Comments

- Atomic emission is used in street lamps, fluorescent lights, and neon signs.
- Two common street lamps using this are the mercury lamp and the sodium lamp.
- “Neon” signs frequently implement the emission spectra of other gases such as argon and krypton.
- Very sophisticated instrumental techniques such as “flame photometry” and “atomic absorption” are based on the principles of atomic emission.