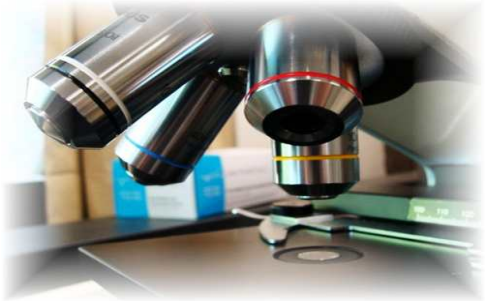

About Science Prof Online PowerPoint Resources

• Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.

• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

• Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.

• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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Alicia Cepaitis, MS
Chief Creative Nerd
Science Prof Online
Online Education Resources, LLC
alicia@scienceprofonline.com

Tami Port, MS
Creator of Science Prof Online
Chief Executive Nerd
Science Prof Online
Online Education Resources, LLC
info@scienceprofonline.com

Image: Compound microscope objectives, T. Port

Atomic Theory & the Periodic Table

For additional resources on this lecture topic, see the Inorganic Chemistry Main Page on SPO.

Image: Chemicals in Flasks, J. Sullivan, Wiki

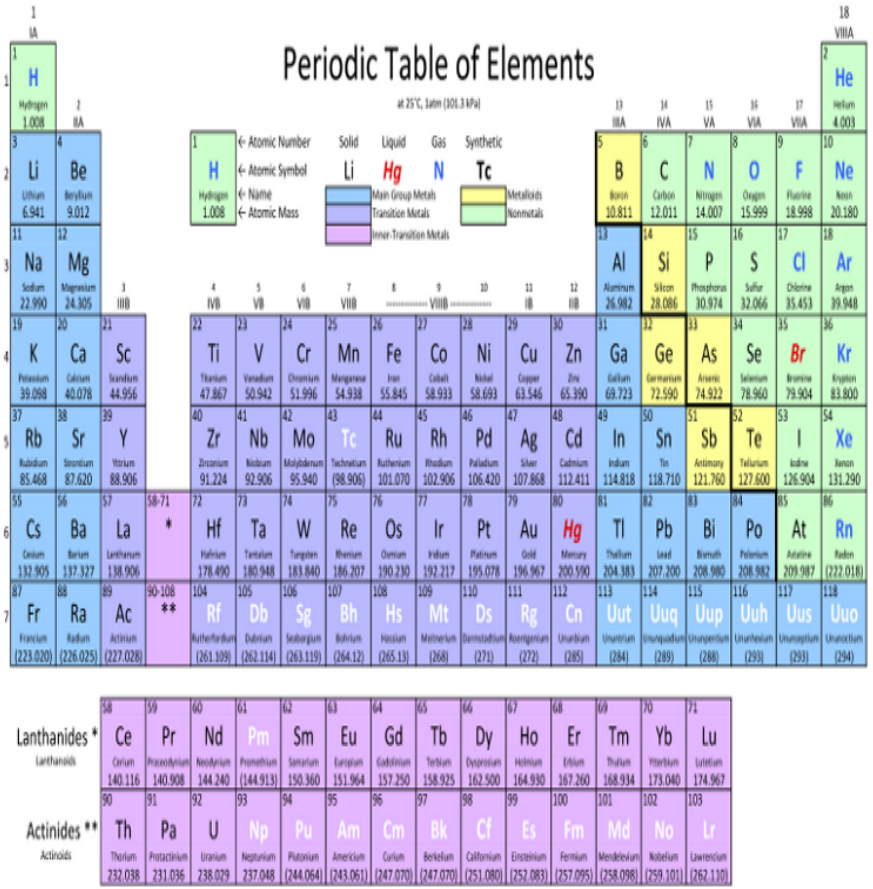
Elements, Atoms & Chemical Symbols

Elements: Substances that can't be broken down any further.

Atom: The smallest unit of an element.

Chemical Symbol

- Begins with **one or two letters** based on elements name.
- ***Q:*** *What if there is more than one element that starts with the same letter?*
- Example: Carbon (C), Calcium (Ca), Chlorine (Cl)



Follow this link to see Daniel Radcliff (Harry Potter) **sing "The Element Song".**

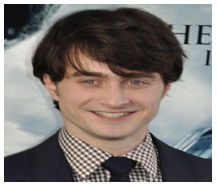


Image: Periodic Table of Elements

The Structure of an Atom

Atoms are the basis for everything in the universe.

Q: *What are the three basic parts of an atom?*

- **?** = "-" negative charge
- **?** = "+" positive charge
- **?** = neutral (a charge of zero)

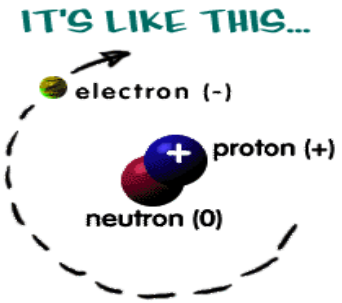
The thing that makes each element unique is the number of protons, since the number of neutrons and electrons can vary.

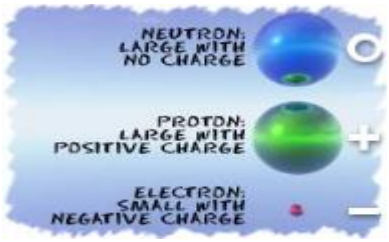
Protons and **neutrons** always in the center of atom (the nucleus).

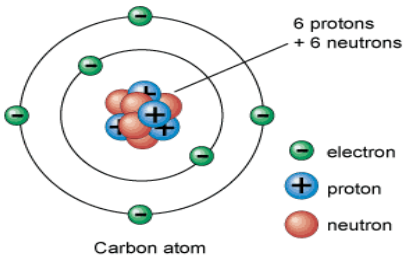
Electrons are found orbiting around nucleus in areas called shells.

Q: *If there is an equal number of electrons and protons in an atom, what is it's charge?*

Here are some examples:







NERDY SCIENCE JOKE: *A neutron walks into a bar and asks "How much for a drink?"*

Q: What does the bartender tell him?

Images: Structure of Atom, Chem4Kids Website; Carbon, Universe Today Website

Protons & Neutrons:
Atomic Number, Mass Number & Atomic Mass

Atomic Number: The ***number of protons*** in the nucleus of an atom.

Q: *What is the atomic number of carbon?*

Atomic Mass: (aka atomic weight): The atomic mass of an element is rarely an even number. This happens because of the **isotopes**.

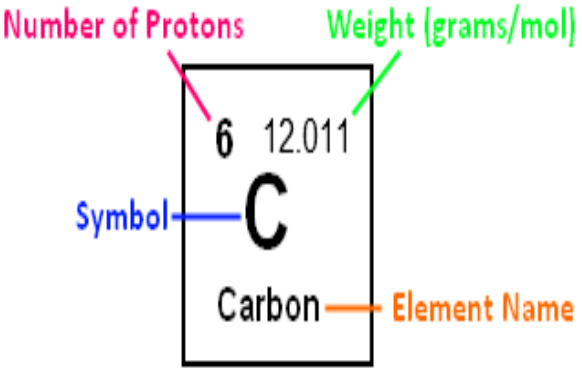
Many elements occur as **isotopes**. They vary in the # of **neutrons** they have.

When an atom has a different number of protons and neutrons, its nucleus becomes unstable.

Q: *What is the atomic mass of carbon?*

Mass Number: The number of protons, plus the number of neutrons.

Q: *How do we know the mass number, if the number of neutrons in an element may vary? Lets look at out Lab Exercise*

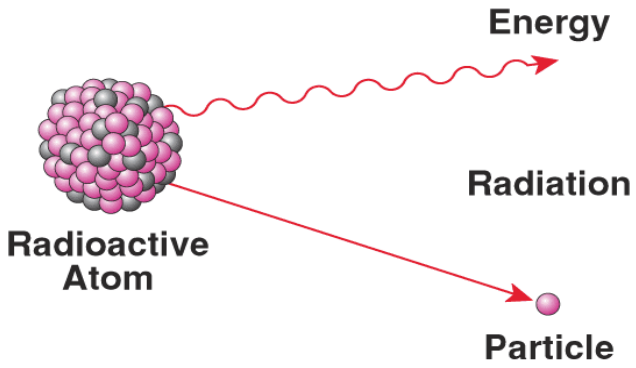


Atomic mass is calculated by figuring out the amounts of each type of atoms isotopes there are in the Universe.

Example: For carbon, there is a lot of C-12, some C-13, and some C-14 atoms. When you average out all of the masses, you get a number that is a little bit higher than 12 (the weight of a C-12 atom). The average atomic mass for Carbon is actually 12.011.

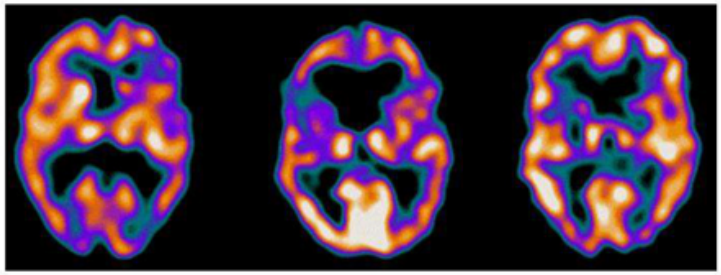
Let's listen to part of the Radiolab podcast episode "Elements" (starting at time 35:00) to learn more about the interesting new use of C-14.

Isotopes & Radioactivity



- Isotope is **radioactive** if nucleus is unstable.
- Most isotopes disintegrate spontaneously with the release of energy by processes of **nuclear** or **radioactive decay**.
- When the nucleus changes in structure, energy and/or subatomic particles are given off.
- Other than radioactivity, isotopes of an element behave similarly: They can participate in molecule / chemical reactions that involve that element.
- When controlled, radioactive isotopes can be valuable medical tools. (Ex. Gamma camera can produce images of soft tissue when radiopharmaceuticals are injected into or ingested by patient.)

1. Schizophrenic female
2. Female with depression
3. Healthy female



From the Virtual Cell Biology Classroom on ScienceProfOnline.com

What about electrons?

In a neutral atom, there are the same number of protons (+) and electrons (-).

Electrons orbit around the atomic nucleus in **shells**.

The inner shell (lowest energy level) of an atom, closest to the nucleus, can have a maximum of two electrons.

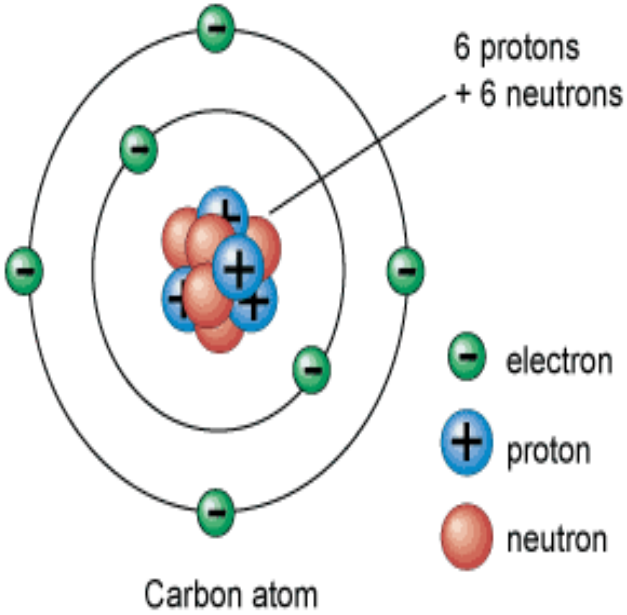
The outermost, highest energy shell, is called the valence shell.

***Eight (8)* is the max number of valence electrons for a full valence shell.**

Number of valence electrons governs an atom's bonding behavior.

Atoms are much more stable, or less reactive, with a full valence shell.

By moving electrons, the two atoms become linked. This is known as **chemical bonding**.

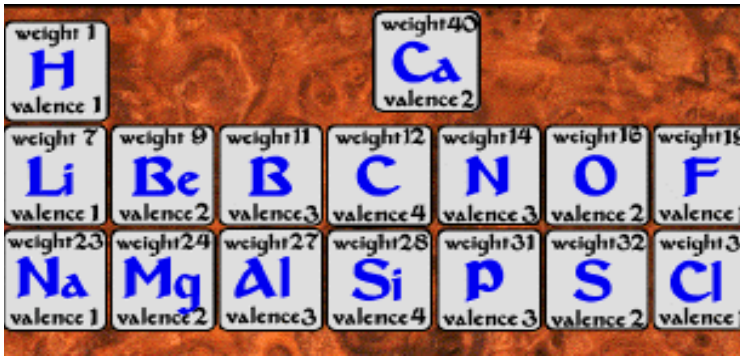


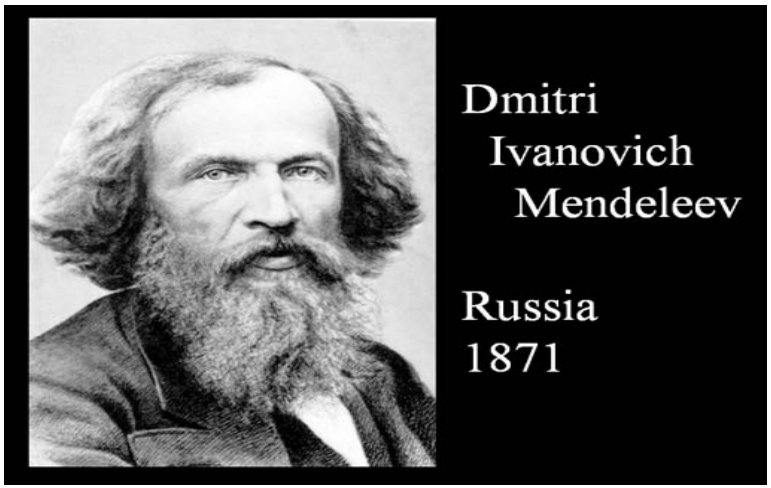
See Rader's Chem4Kids web page on the Periodic Table. Their explanations are extremely helpful!

Images: Carbon, Universe Today Website

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

The Periodic Table





Dmitri Ivanovich Mendeleev
(1834 –1907)

Russian chemist and inventor.

Formulated Periodic Law.
Created his own version of the periodic table of elements, and used it to correct the properties of some already discovered elements and to predict the properties of eight elements that had not been discovered yet!

Group→ / ↓Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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	*	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	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

*	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	71 Lu
**	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	103 Lr

Listen to Radiolab podcast segment on Mendeleev and the periodic table from the episode
"Yellow Fluff and Other Curious Encounters"
(starting at 4:30 into the podcast).

Go to the Chemistry Basics & the Periodic Table Main Page to find a homework assignment based on this podcast.

Image: Periodic Table of Elements

Electrons:

How can I determine the number of **electron shells**? Period ! ⬇

Electrons in an atom are located in different shells or **energy levels**.

Each ROW of the periodic table is called a **Period**.

Period Rule 1: All of the elements in a **Period** have the same number of electron shells.

For example, every element in the top row (the first period) has one shell for its electrons. All elements in the second row (the second period) have two shells for their electrons.

Period Rule 2: As you move down the table, every row adds a shell, up to seven.

Period Rule 3: The innermost (closest to the nucleus) shell of all atoms (other than hydrogen) has two electrons.

Period Rule 4: The electrons in the outermost shell are called **valence electrons**.

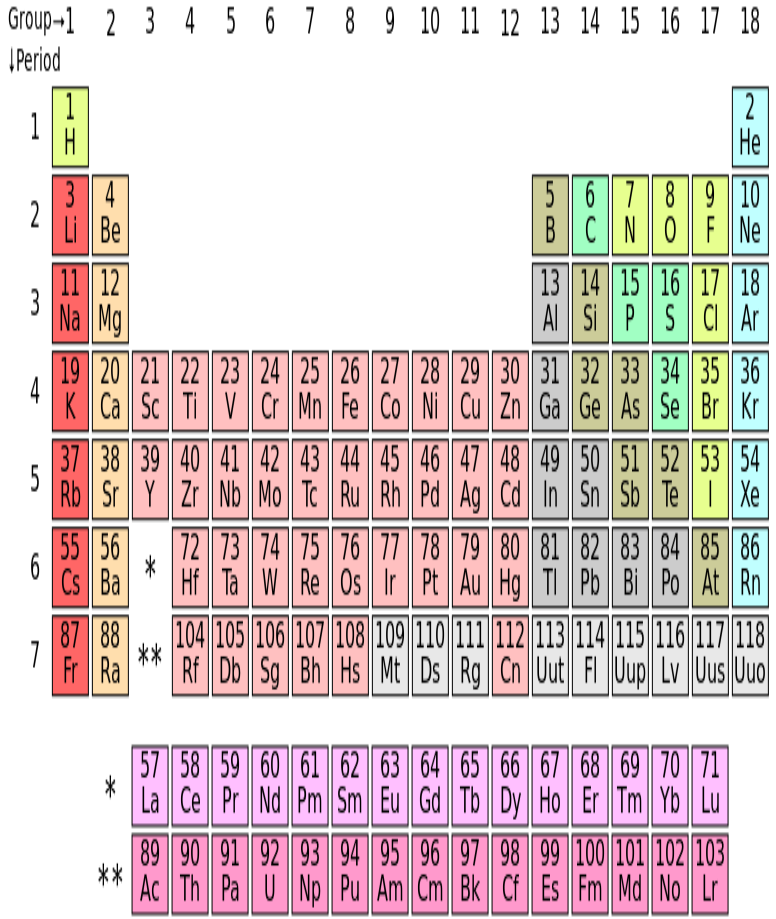


Image: Periodic Table of Elements

Electrons:

How can I determine the number of **outer shell electrons**? Group! ➡

Electrons in the outermost shell are called **valence electrons**.

Each COLUMN of the periodic table is called a **Group**.

Group Rule 1: All elements in the same **Group** (vertical column) have the same number of valence electrons.

Group Rule 2: As you move across the table, (ignoring columns 3 – 12, the transition elements) every row adds a valence electron, up to 8.

Key! If you know the number of shells and valence electrons, you can draw an **electron shell diagram** for any of the non-transitional elements.

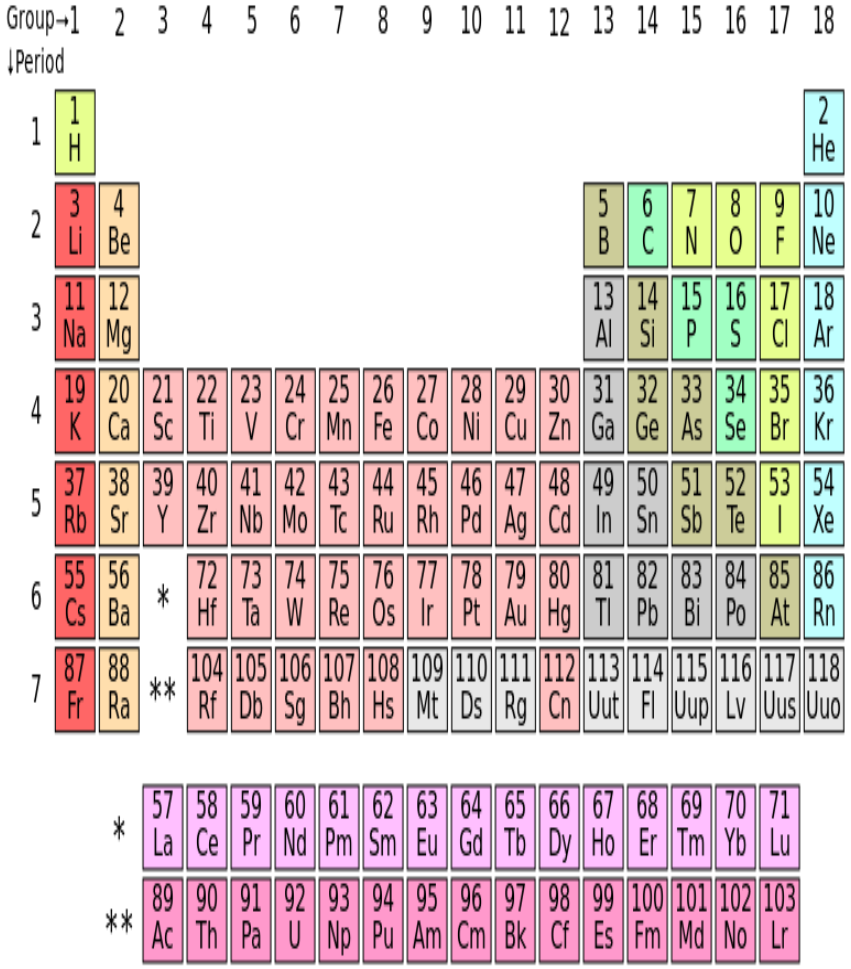


Image: Periodic Table of Elements

Let's listen to "The Periodic Table: Rapping the Elements"

Periodic Table of Elements

at 25°C, 1atm (101.3 kPa)

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 H Hydrogen 1.008																	2 He Helium 4.003
2	3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3	11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
4	19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.390	31 Ga Gallium 69.723	32 Ge Germanium 72.590	33 As Arsenic 74.922	34 Se Selenium 78.960	35 Br Bromine 79.904	36 Kr Krypton 83.800
5	37 Rb Rubidium 85.468	38 Sr Strontium 87.620	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.940	43 Tc Technetium (98.906)	44 Ru Ruthenium 101.070	45 Rh Rhodium 102.906	46 Pd Palladium 106.420	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.600	53 I Iodine 126.904	54 Xe Xenon 131.290
6	55 Cs Cesium 132.905	56 Ba Barium 137.327	57 La Lanthanum 138.906	58-71 *	72 Hf Hafnium 178.490	73 Ta Tantalum 180.948	74 W Tungsten 183.840	75 Re Rhenium 186.207	76 Os Osmium 190.230	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.967	80 Hg Mercury 200.590	81 Tl Thallium 204.383	82 Pb Lead 207.200	83 Bi Bismuth 208.980	84 Po Polonium 208.982	85 At Astatine 209.987	86 Rn Radon (222.018)
7	87 Fr Francium (223.020)	88 Ra Radium (226.025)	89 Ac Actinium (227.028)	90-108 **	104 Rf Rutherfordium (261.109)	105 Db Dubnium (262.114)	106 Sg Seaborgium (263.119)	107 Bh Bohrium (264.12)	108 Hs Hassium (265.13)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Cn Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (293)	117 Uus Ununseptium (293)	118 Uuo Ununoctium (294)

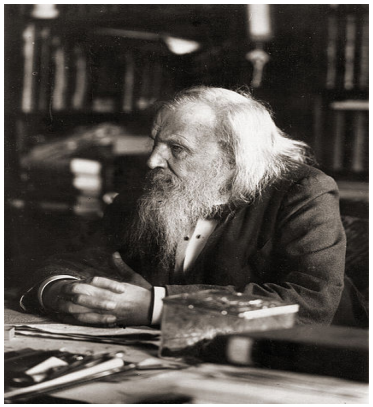
← Atomic Number
← Atomic Symbol
← Name
← Atomic Mass

Example: 1 H Hydrogen 1.008

Solid: Li
Liquid: Hg
Gas: N
Synthetic: Tc

Main Group Metals
Transition Metals
Inner-Transition Metals
Metalloids
Nonmetals

Lanthanides * Lanthanoids	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.240	61 Pm Promethium (144.913)	62 Sm Samarium 150.360	63 Eu Europium 151.964	64 Gd Gadolinium 157.250	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.260	69 Tm Thulium 168.934	70 Yb Ytterbium 173.040	71 Lu Lutetium 174.967
Actinides ** Actinoids	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium (244.064)	95 Am Americium (243.061)	96 Cm Curium (247.070)	97 Bk Berkelium (247.070)	98 Cf Californium (251.080)	99 Es Einsteinium (252.083)	100 Fm Fermium (257.095)	101 Md Mendelevium (258.098)	102 No Nobelium (259.101)	103 Lr Lawrencium (262.110)

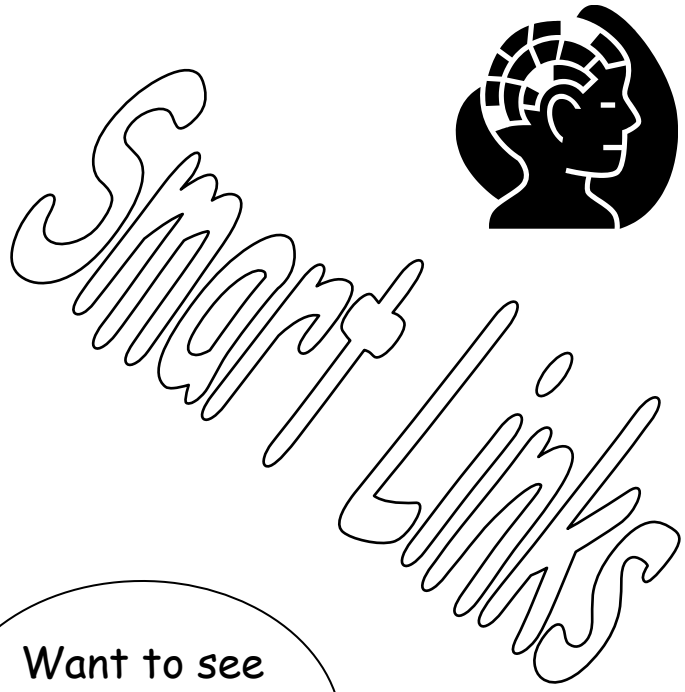


From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Images: Periodic Table of Elements; Mendeleev, Wiki

Confused?

Here are some links to fun resources that further explain Chemistry:

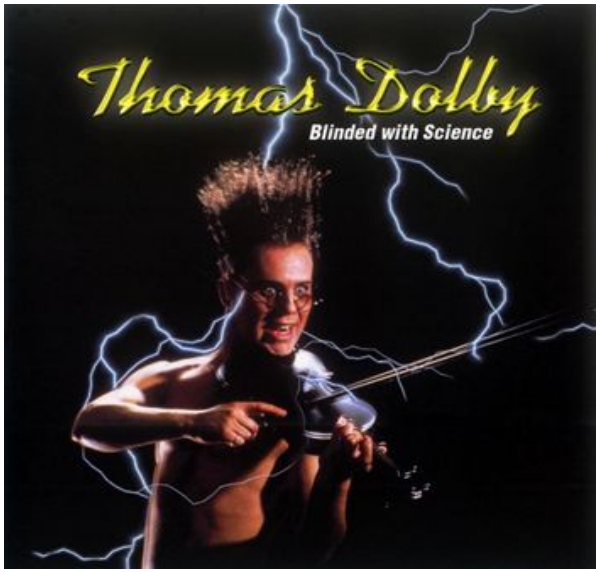


- Inorganic Chemistry Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- "What Kind of Bonds Are These?" song and slide show by Mark Rosengarten.
- Chemical Bond Formation animated science tutorial.
- "Meet the Elements" music video by They Might Be Giants.
- Redox Reactions video lecture by Kahnacademy.
- Chem4Kids website by Rader.
- Neutron Dance …a so-bad-its-good '80s music video by The Pointer Sisters

(You must be in PPT slideshow view to click on links.)

Image: Daniel Radcliff by Joella Marano

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

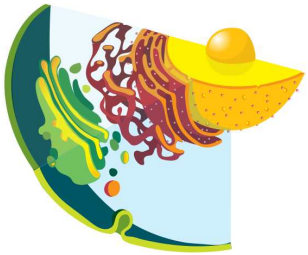


Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)* !

The VCBC is full of resources to help you succeed, including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki