

**St. Catherine University**

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**From the Selected Works of Natasha Yates, MA**

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March 14, 2016

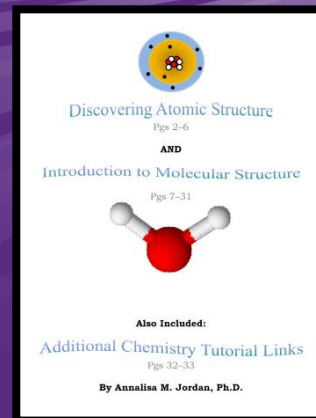
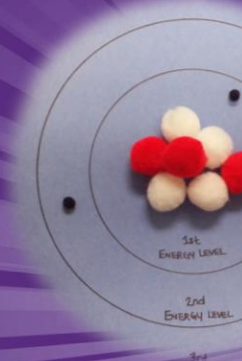
## Jordan and Yates ACS 2016 V2.pdf

Natasha L Yates



Available at: <https://works.bepress.com/natasha-yates/4/>

# A discovery learning approach to atomic structure and the periodic table:



**Training current and future teachers what really *matters* in NGSS**

Annalisa Jordan Ph.D., Chemistry  
Natasha Yates M.A., Education  
**ST. CATHERINE UNIVERSITY**

# *Structure and Properties of Matter*

Elementary, Middle and High school

Particles too  
small to be seen



Density  
Chemical reactivity

*Submicroscopic events*  
with macroscopic assessments

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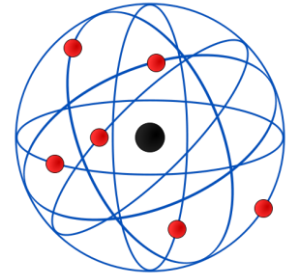


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# Foundations in Chemistry Concepts: How we do it

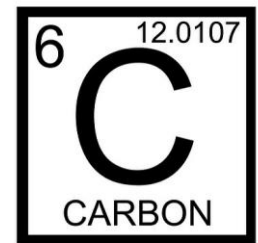


1. Define basic chemistry terms
2. Discovery Learning: *Atomic Structure*
3. Discovery Learning: *Periodic Table*
4. Relating to material: *Elements in Our Pockets*



Periodic Table of the Elements

1	2																	18	19	20																																
H	He																	Ar	K	Ca																																
Li	Be									B	C	N	O	F	Ne	Na	Mg																																			
Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																											
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																		
Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	Rf	Db	Sg	Bh	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Lanthanides																																																				
Actinides																																																				



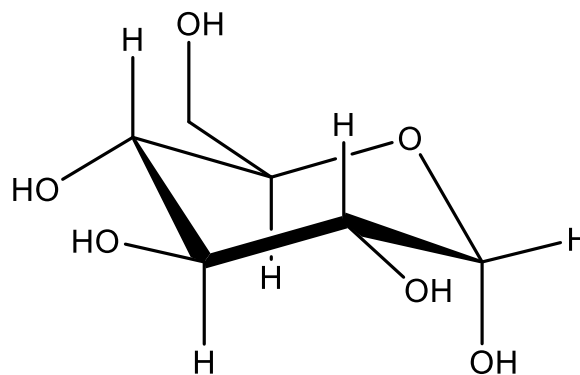
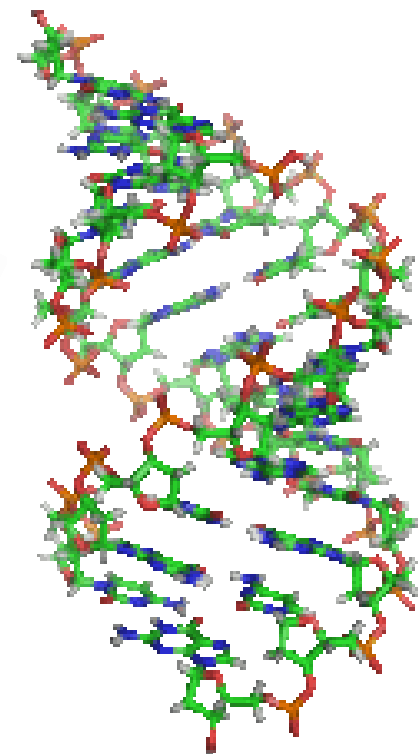
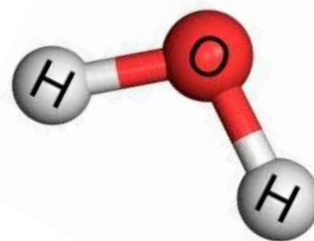
*Make the students active learners in studying the foundational concepts.*

# 1. Intro to chemistry with questions

## Inquiry

- *List as many chemicals as you can in 60 seconds...*

- *What is chemistry?*
- *What are examples of chemicals?*
- *Where is chemistry in your personal life?*



- *EDIT SLIDE PICTURES AND TEXT*

coffee bean

12 x 8 mm



carbon atom




340 pm

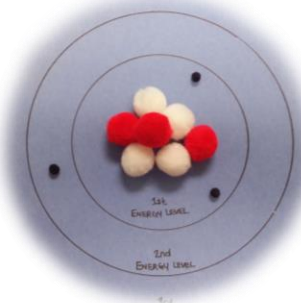
<http://learn.genetics.utah.edu/content/begin/cells/scale/>

**How small is an atom?**



# Subatomic Particles


	Proton	Neutron	Electron
Symbol	 or $p^+$	 or $n^0$	 or $e^-$
Charge	+1	0	-1
Location	Nucleus	Nucleus	Orbitals in energy levels around the nucleus
Mass	1 amu	1 amu	~0 amu



Discovering Atomic Structure  
Pgs 2-6

AND

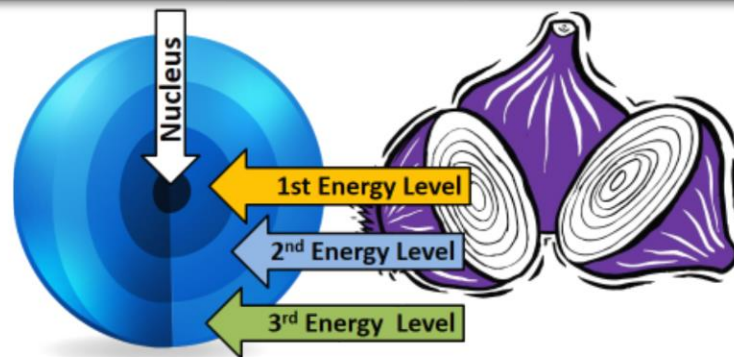
Introduction to Molecular Structure  
Pgs 7-31



Also Included:

Additional Chemistry Tutorial Links  
Pgs 32-33

By Annalisa M. Jordan, Ph.D.



*Atoms are like onions...  
they have layers*

nts  
0

nucleus

8

**$e^-$  in Energy Levels**  
Only so many electrons can fit in each Energy Level

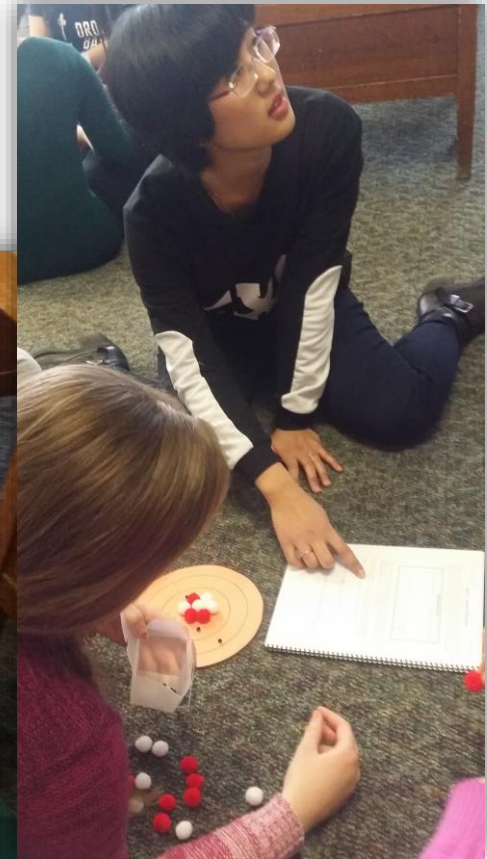
Elements 1-20

Energy Level	# electrons
1	2 $e^-$
2	8 $e^-$
3	8 $e^-$

Elements and larger

Energy Level	# electrons
1	
2	
3	

But where do electrons go in these energy levels?



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# 4. Relating to Material: *Elements in Our Pockets*

**Inquiry to Engage:** 1<sup>st</sup> engage the students by asking...

*Anyone have any elements in your pocket?*



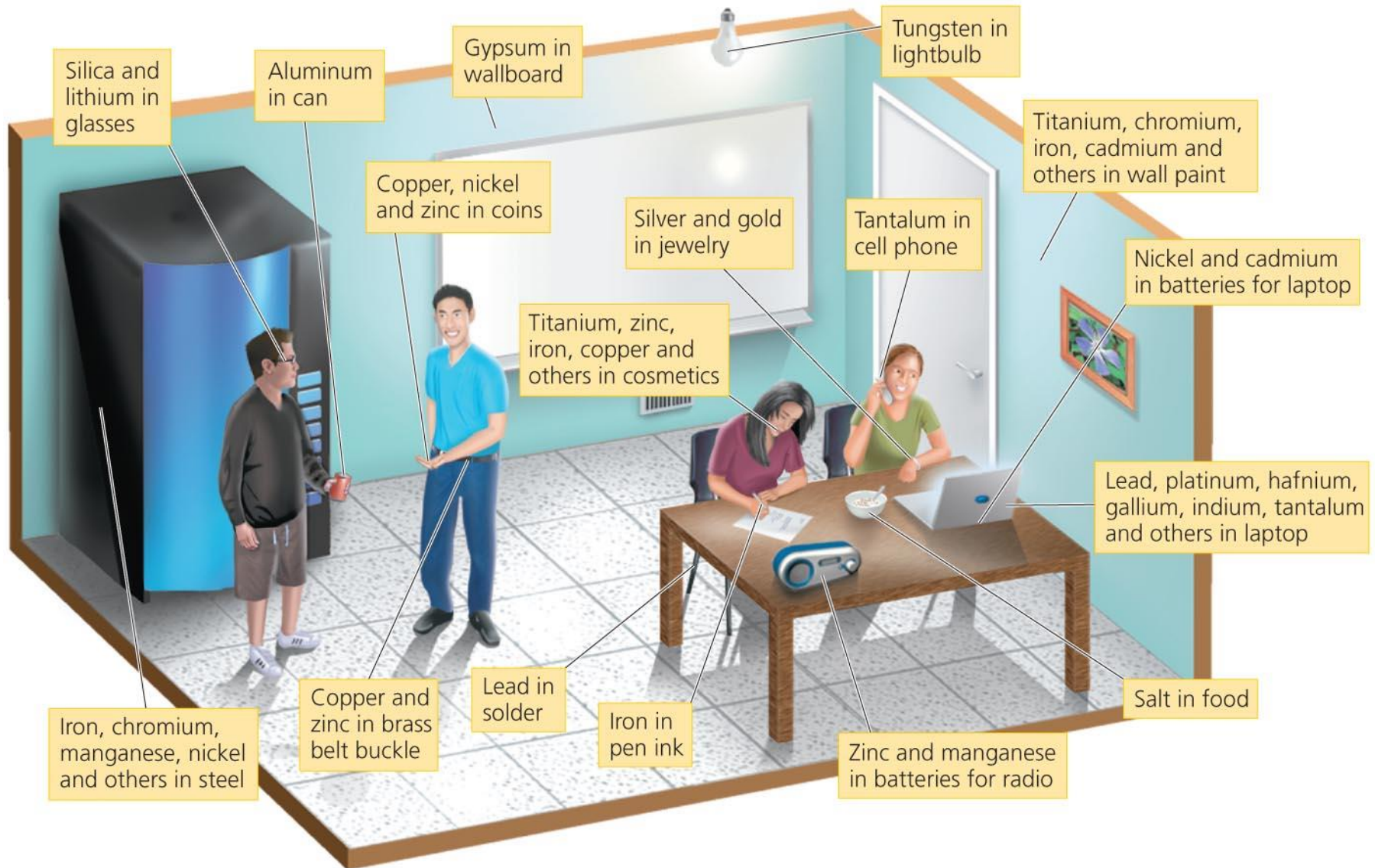
re

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Periodic Table of the Elements																		18 VIIIA 8A																	
1 IA 1A		2 IIA 2A												2 He Helium 4.003																					
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											
11 Na Sodium 22.990		12 Mg Magnesium 24.305		3 IIIB 3B		4 IVB 4B		5 VB 5B		6 VIB 6B		7 VIIB 7B		8 VIII 8		9 VIII 9		10 VIII 10		11 IB 1B		12 IIB 2B		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	
19 K Potassium 39.098		20 Ca Calcium 40.078		21 Sc Scandium 44.956		22 Ti Titanium 47.88		23 V Vanadium 50.942		24 Cr Chromium 51.996		25 Mn Manganese 54.938		26 Fe Iron 55.933		27 Co Cobalt 58.933		28 Ni Nickel 58.693		29 Cu Copper 63.546		30 Zn Zinc 65.39		31 Ga Gallium 69.723		32 Ge Germanium 72.61		33 As Arsenic 74.922		34 Se Selenium 78.09		35 Br Bromine 79.904		36 Kr Krypton 84.80	
37 Rb Rubidium 84.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906		40 Zr Zirconium 91.224		41 Nb Niobium 92.906		42 Mo Molybdenum 95.94		43 Tc Technetium 98.907		44 Ru Ruthenium 101.07		45 Rh Rhodium 102.906		46 Pd Palladium 106.42		47 Ag Silver 107.868		48 Cd Cadmium 112.411		49 In Indium 114.818		50 Sn Tin 118.71		51 Sb Antimony 121.760		52 Te Tellurium 127.6		53 I Iodine 126.904		54 Xe Xenon 131.29	
55 Cs Cesium 132.905		56 Ba Barium 137.327		57-71		72 Hf Hafnium 178.49		73 Ta Tantalum 180.948		74 W Tungsten 183.85		75 Re Rhenium 186.207		76 Os Osmium 190.23		77 Ir Iridium 192.22		78 Pt Platinum 195.08		79 Au Gold 196.967		80 Hg Mercury 200.59		81 Tl Thallium 204.383		82 Pb Lead 207.2		83 Bi Bismuth 208.980		84 Po Polonium [208.982]		85 At Astatine 209.987		86 Rn Radon 222.018	
87 Fr Francium 223.020		88 Ra Radium 226.025		89-103		104 Rf Rutherfordium [261]		105 Db Dubnium [262]		106 Sg Seaborgium [266]		107 Bh Bohrium [264]		108 Hs Hassium [269]		109 Mt Meitnerium [268]		110 Ds Darmstadtium [269]		111 Rg Roentgenium [272]		112 Cn Copernicium [277]		113 Uut Ununtrium unknown		114 Fl Flerovium [289]		115 Uup Ununpentium unknown		116 Lv Livermorium [293]		117 Uus Ununseptium unknown		118 Uuo Ununoctium unknown	
Lanthanide Series		57 La Lanthanum 138.906		58 Ce Cerium 140.115		59 Pr Praseodymium 140.908		60 Nd Neodymium 144.24		61 Pm Promethium 144.913		62 Sm Samarium 150.36		63 Eu Europium 151.966		64 Gd Gadolinium 157.25		65 Tb Terbium 158.925		66 Dy Dysprosium 162.50		67 Ho Holmium 164.930		68 Er Erbium 167.26		69 Tm Thulium 168.934		70 Yb Ytterbium 173.04		71 Lu Lutetium 174.967					
Actinide Series		89 Ac Actinium 227.028		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 [254]		100 Fm Fermium 257.095		101 Md Mendelevium 258.1		102 No Nobelium 259.101		103 Lr Lawrencium [262]					
Alkali Metal		Alkaline Earth		Transition Metal		Basic Metal		Semimetal		Nonmetal		Halogen		Noble Gas		Lanthanide		Actinide																	



# Minerals are everywhere in our products



# Economically useful mineral resources





# Let's look at Tantalum

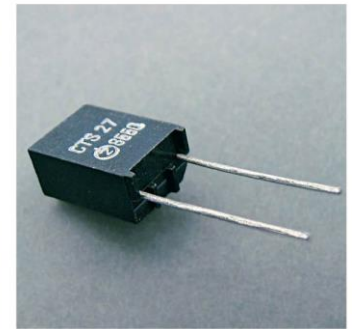
- **Atomic Number:** 73
- **Atomic Weight:** 180.94788
- **Melting Point:** 3290 K (3017°C or 5463°F)
- **Boiling Point:** 5731 K (5458°C or 9856°F)
- **Density:** 16.4 grams per cubic centimeter
- **Phase at Room Temperature:** Solid
- **Element Classification:** Metal
- **Period Number:** 6 **Group Number:** 5



(a) Coltan ore



(b) Capacitor containing tantalum



<http://images-of-elements.com/tantalum.php>  
<http://education.jlab.org/itselemental/ele073.html>

# Central Case: Mining for ... cell phones?



# Foundations in Chemistry Concepts: How we do it

1. Define basic chemistry terms
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*Make the students active learners in studying the foundational concepts.*

Edit slide so that it is a summary of pictures from our work (Atomic Structure Activity, PT, and Coltan)





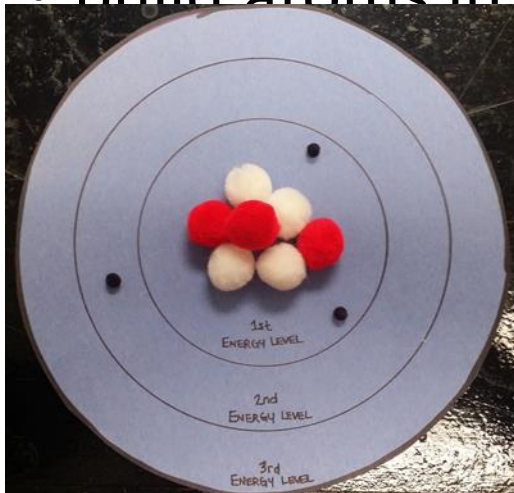
# Questions?



## 2. Atomic Structure Activity

### Activity:

- build atoms in pairs
- activities



### Formative Assessments:

- Worksheets, Answering questions verbally.

#### SAMPLE NOTECARD:

- Add picture of cards

# p <sup>+</sup>	# n <sup>0</sup>	# e <sup>-</sup>	Atomic #	Atomic Mass

# Now organize what you have done

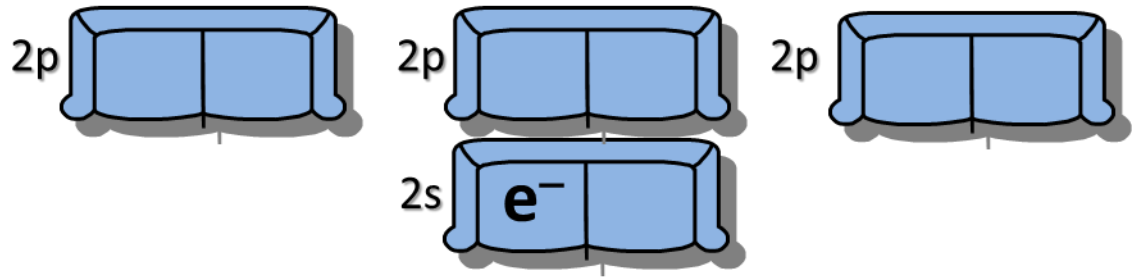
## Objective:

- Organize the 20 simplest atoms *THREE* different ways.

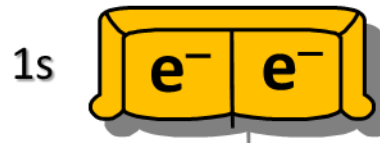
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2nd Energy Level: 1 e<sup>-</sup> in 1 orbital



1<sup>st</sup> Energy Level: 2 e<sup>-</sup> 1 orbital



# 3. Discovery Learning: *Periodic Table*

## Objective:

- Organize the 20 simplest atoms *THREE* different ways.
  - By atomic #
  - By # of energy levels of  $e^-$
  - By # of  $e^-$  in the outermost energy level

