Chem 111

Lecture 24

Homework

- Continue Reading Chapter 7
- Owl Homework

Recap

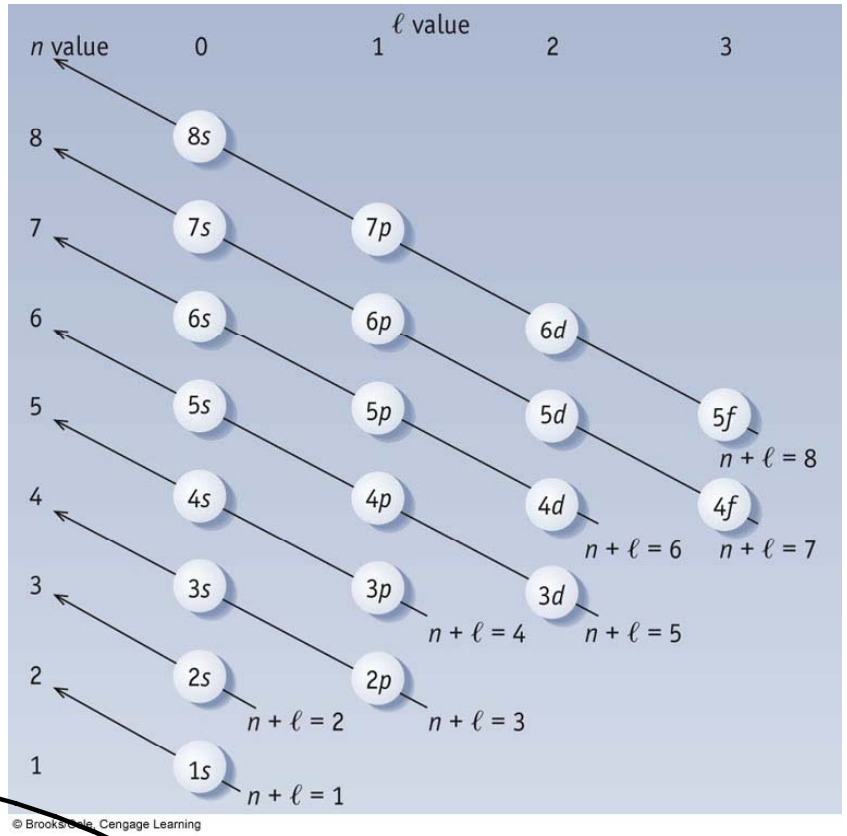
- Electron Configuration

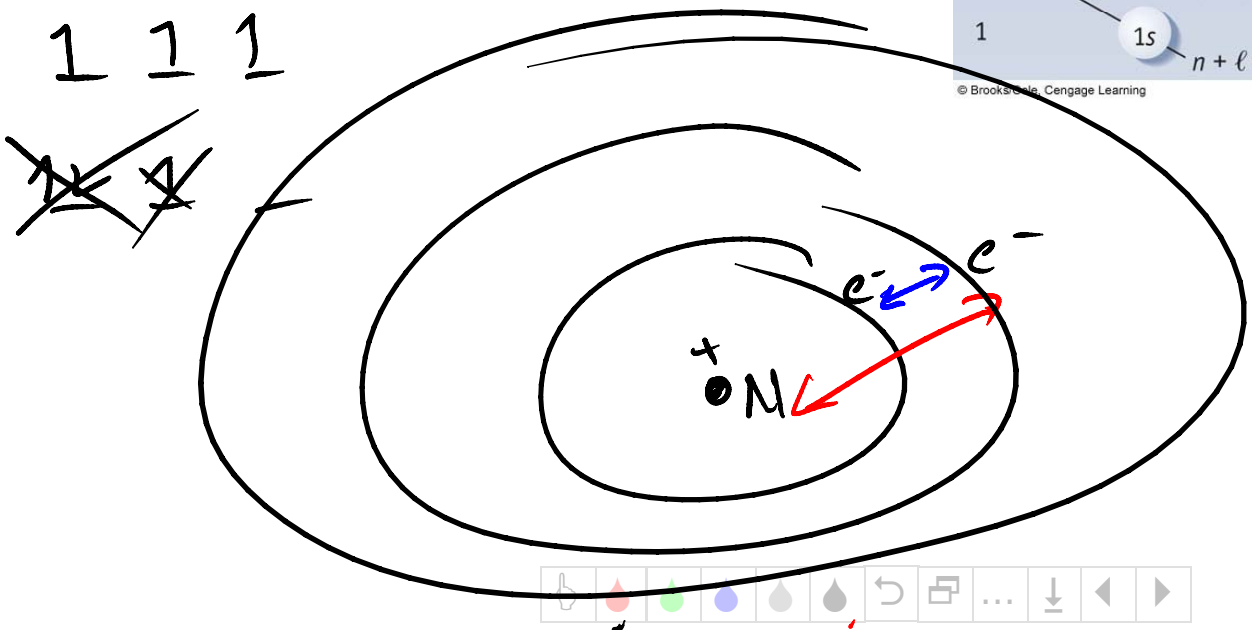
memorize

- Pauli exclusion principle

- Effective Nuclear Charge

- Hund's Rule





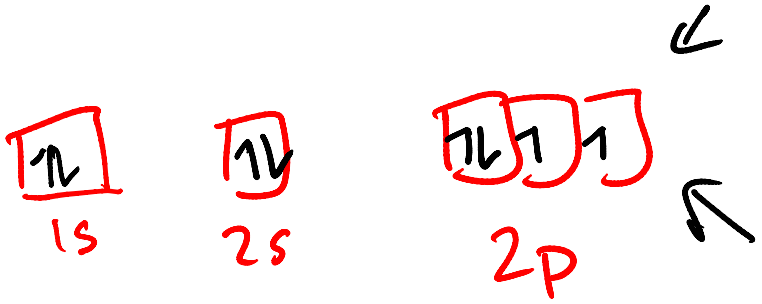
n+l

1s 3p
2s 4s
2p 3d
3s

Let's Practice

Draw the orbital diagram representation for the electron configuration of atomic oxygen. What is its electron configuration?

atomic # 8 ⇒ 8 e⁻



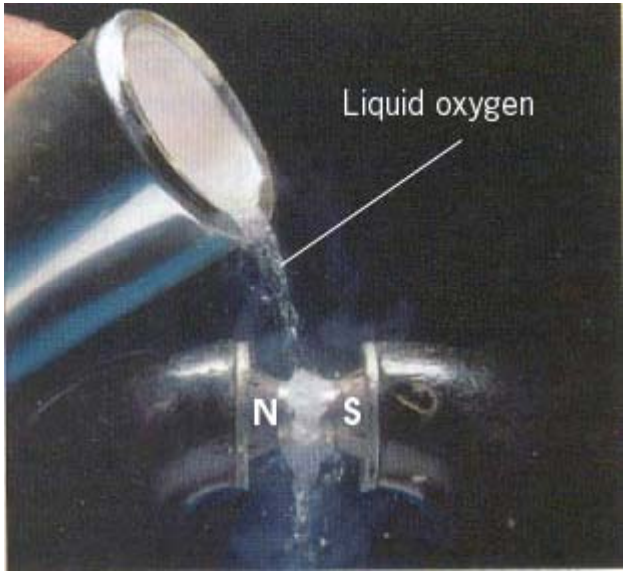
$1s^2 2s^2 2p^4$

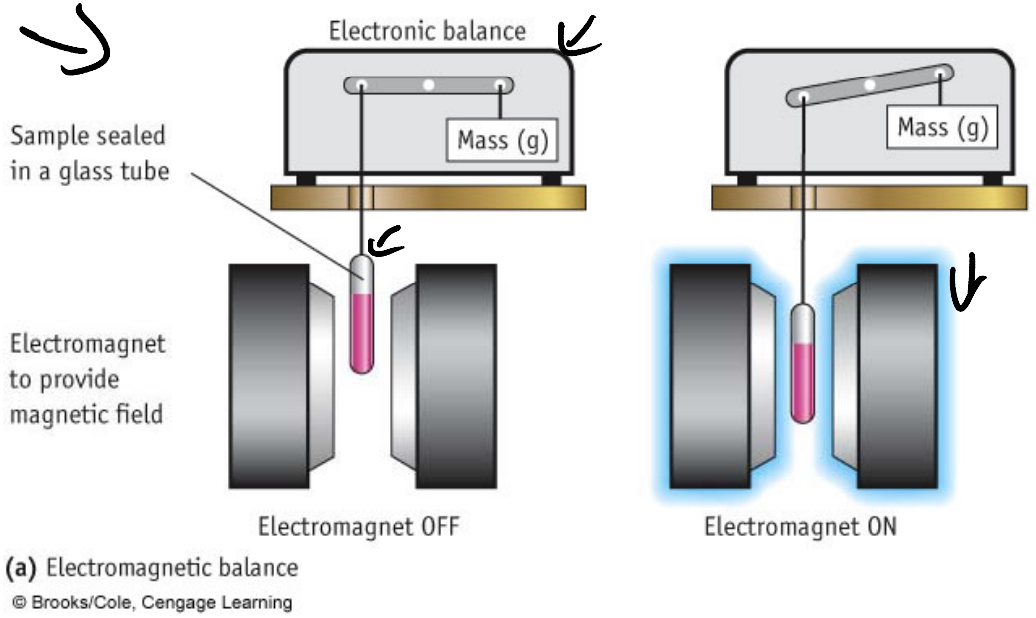
$1s^2 2s^2 2p_x^2 p_y^1 p_z^1$

Magnetism

Paramagnetism: is caused by the presence of at least one unpaired electron orbital (i.e., an unpaired spin) in the atoms, molecules, or ions. Attracted to magnets.

Diamagnetism: is caused when all electrons are paired. Slightly repulsed by magnets.





(a) Electromagnetic balance

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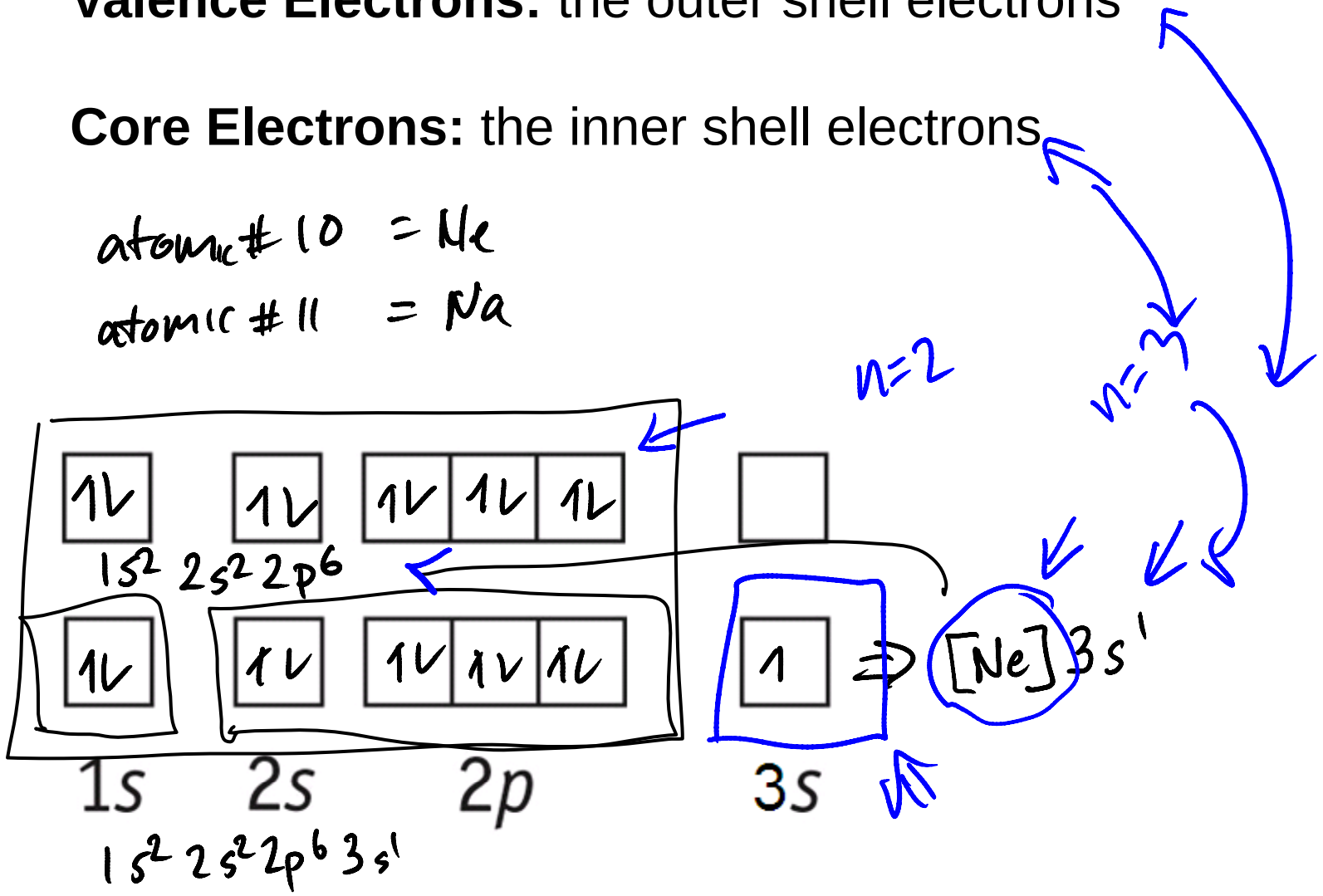
Neon & Sodium

Valence Electrons: the outer shell electrons

Core Electrons: the inner shell electrons



D-block

$3d^4\,4s^2$ $3d^5\,4s^1$ 20 $3d^9\,4s^2$ $3d^{10}\,4s^1$

TABLE 7.4 Orbital Box Diagrams for the Elements Ca Through Zn

		3d	4s
Ca 20	$[Ar]4s^2$	☐☐☐☐☐	↑↓
Sc	$[Ar]3d^14s^2$	↑☐☐☐☐	↑↓
Ti	$[Ar]3d^24s^2$	↑↑☐☐☐	↑↓
V	$[Ar]3d^34s^2$	↑↑↑☐☐	↑↓
Cr*	$[Ar]3d^54s^1$	↑↑↑↑↑	↑
Mn	$[Ar]3d^54s^2$	↑↑↑↑↑	↑↓
Fe	$[Ar]3d^64s^2$	↑↓↑↑↑	↑↓
Co	$[Ar]3d^74s^2$	↑↓↑↓↑	↑↓
Ni	$[Ar]3d^84s^2$	↑↓↑↓↑↓	↑↓
Cu*	$[Ar]3d^{10}4s^1$	↑↓↑↓↑↓	↑
Zn	$[Ar]3d^{10}4s^2$	↑↓↑↓↑↓	↑↓

*These configurations do not follow the "$n + \ell$" rule.

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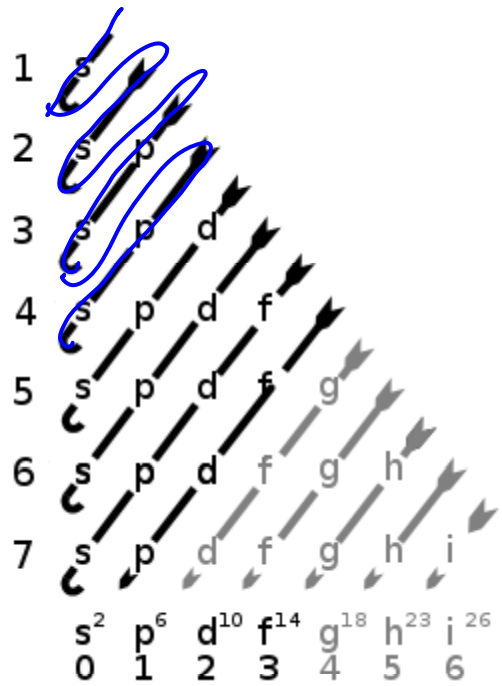
4p



3d↔4s

p↔s

n highest

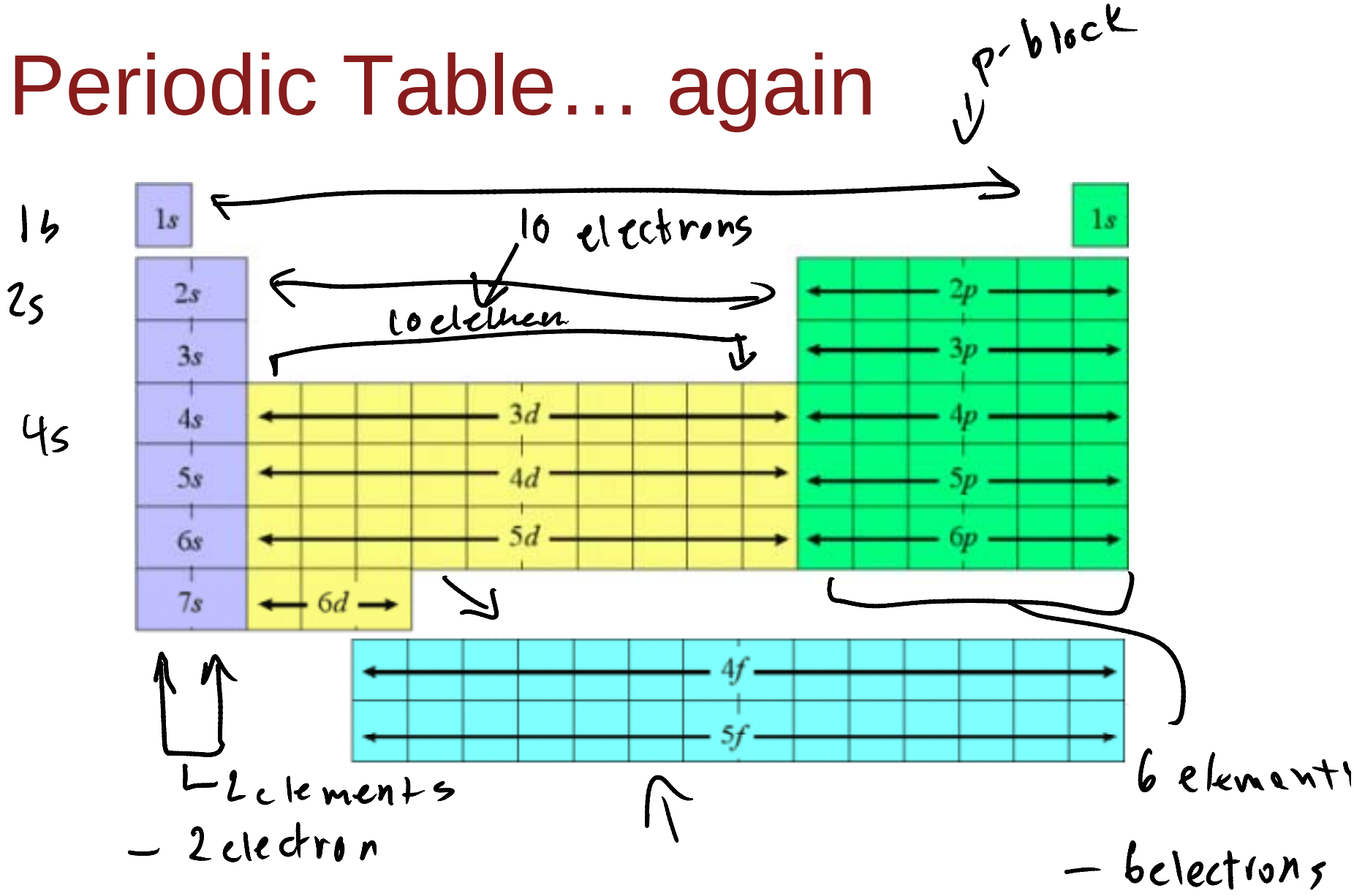
ℓ left right

Heavy Elements

don't have memorize

Element	Z	Electron Configuration	Element	Z	Electron Configuration	Element	Z	Electron Configuration
			Lanthanum	57	[Xe] $6s^2$ $5d^1$	Actinium	89	[Rn] $7s^2$ $6d^1$
			Cerium	58	[Xe] $6s^2$ $4f^1$ $5d^1$	Thorium	90	[Rn] $7s^2$ $6d^2$
			Praseodymium	59	[Xe] $6s^2$ $4f^3$	Protactinium	91	[Rn] $7s^2$ $5f^2$ $6d^1$
			Neodymium	60	[Xe] $6s^2$ $4f^4$	Uranium	92	[Rn] $7s^2$ $5f^3$ $6d^1$
			Promethium	61	[Xe] $6s^2$ $4f^5$	Neptunium	93	[Rn] $7s^2$ $5f^4$ $6d^1$
			Samarium	62	[Xe] $6s^2$ $4f^6$	Plutonium	94	[Rn] $7s^2$ $5f^6$
			Europium	63	[Xe] $6s^2$ $4f^7$	Americium	95	[Rn] $7s^2$ $5f^7$
			Gadolinium	64	[Xe] $6s^2$ $4f^7$ $5d^1$	Curium	96	[Rn] $7s^2$ $5f^7$ $6d^1$
			Terbium	65	[Xe] $6s^2$ $4f^9$	Berkelium	97	[Rn] $7s^2$ $5f^9$
Yttrium	39	[Kr] $5s^2$ $4d^1$	Lutetium	71	[Xe] $6s^2$ $4f^{14}$ $5d^1$	Lawrencium	103	[Rn] $7s^2$ $5f^{14}$ $7p^1$
Zirconium	40	[Kr] $5s^2$ $4d^2$	Hafnium	72	[Xe] $6s^2$ $4f^{14}$ $5d^2$	Rutherfordium	104	*(unknown)*
Niobium	41	[Kr] $5s^1$ $4d^4$	Tantalum	73	[Xe] $6s^2$ $4f^{14}$ $5d^3$			
Molybdenum	42	[Kr] $5s^1$ $4d^5$	Tungsten	74	[Xe] $6s^2$ $4f^{14}$ $5d^4$			
Technetium	43	[Kr] $5s^2$ $4d^5$	Rhenium	75	[Xe] $6s^2$ $4f^{14}$ $5d^5$			
Ruthenium	44	[Kr] $5s^1$ $4d^7$	Osmium	76	[Xe] $6s^2$ $4f^{14}$ $5d^6$			
Rhodium	45	[Kr] $5s^1$ $4d^8$	Iridium	77	[Xe] $6s^2$ $4f^{14}$ $5d^7$			
Palladium	46	[Kr] $4d^{10}$	Platinum	78	[Xe] $6s^1$ $4f^{14}$ $5d^9$			
Silver	47	[Kr] $5s^1$ $4d^{10}$	Gold	79	[Xe] $6s^1$ $4f^{14}$ $5d^{10}$			
Cadmium	48	[Kr] $5s^2$ $4d^{10}$	Mercury	80	[Xe] $6s^2$ $4f^{14}$ $5d^{10}$			
Indium	49	[Kr] $5s^2$ $4d^{10}$ $5p^1$	Thallium	81	[Xe] $6s^2$ $4f^{14}$ $5d^{10}$ $6p^1$			

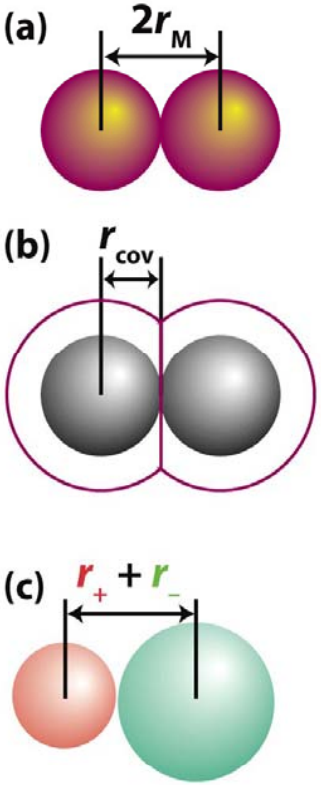
Periodic Table… again

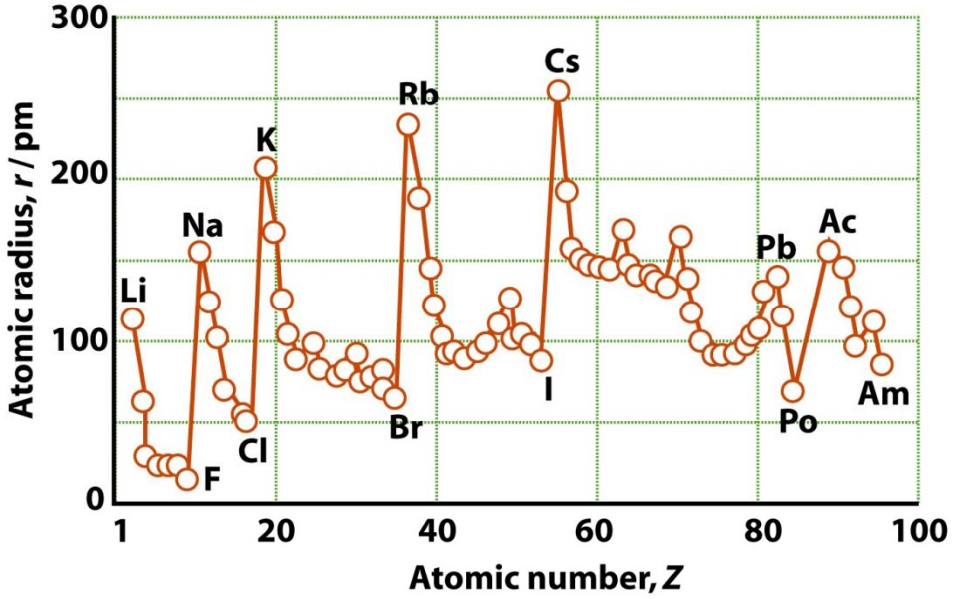


Let’s Practice

What is the characteristic outer shell electron configuration of the group 7A elements, the halogens?

Atomic Radii





Ionization energy

- Ease in which an electron can be removed
- $A(g) \rightarrow A^+(g) + e^-(g)$

$Na(g) \rightarrow Na^+(g) + e^-(g)$

- $I = E(A^+) - E(A)$
- First Ionization Energy, I_1

- Second Ionization, I_2

$Na^+(g) \rightarrow Na^{2+}(g) + e^-(g)$

$I_1 < I_2 < I_3$

Electron Configuration of Ions

- Sodium

Na: $[1s^2 2s^2 2p^6 3s^1]$ → Na^+: $[1s^2 2s^2 2p^6]$ + e^-

- Germanium

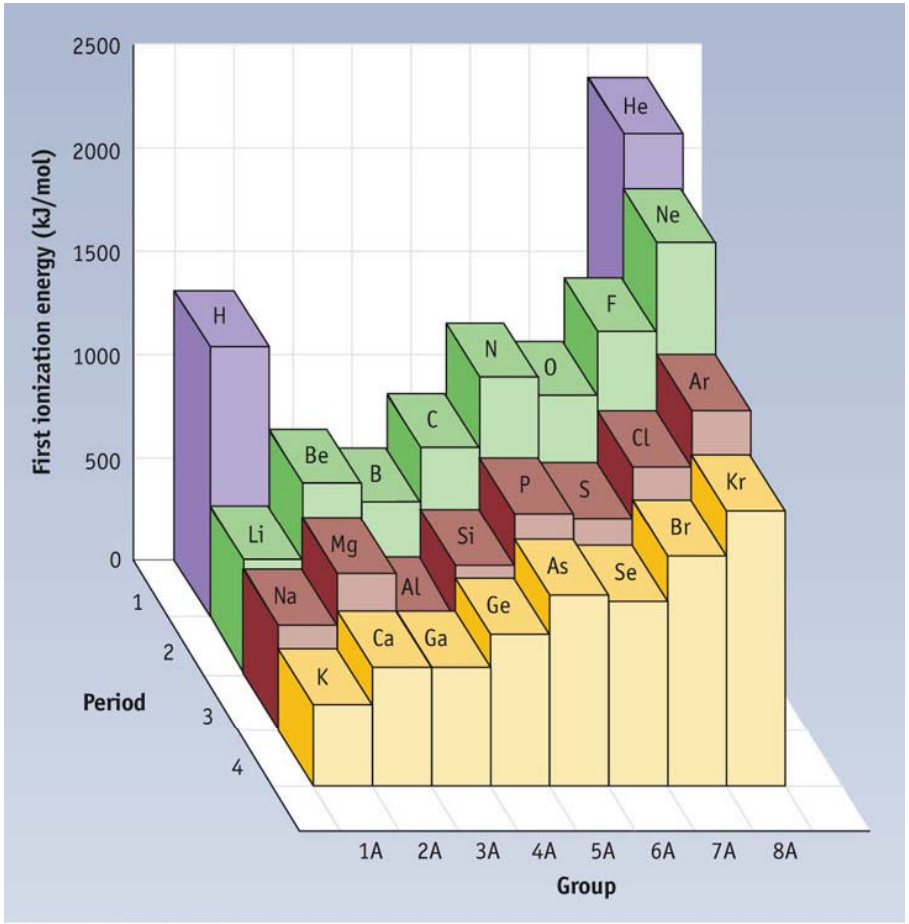
Ge: $[Ar]3d^{10}4s^2 4p^2$ → Ge^{2+}:$[Ar]3d^{10}4s^2$ + $2e^-$

- Iron

Fe: $[Ar]3d^6 4s^2$ → Fe^{2+}:$[Ar]3d^6$ + $2e^-$

Fe: $[Ar]3d^6 4s^2$ → Fe^{3+}:$[Ar]3d^5$ + $3e^-$

Ionization energy



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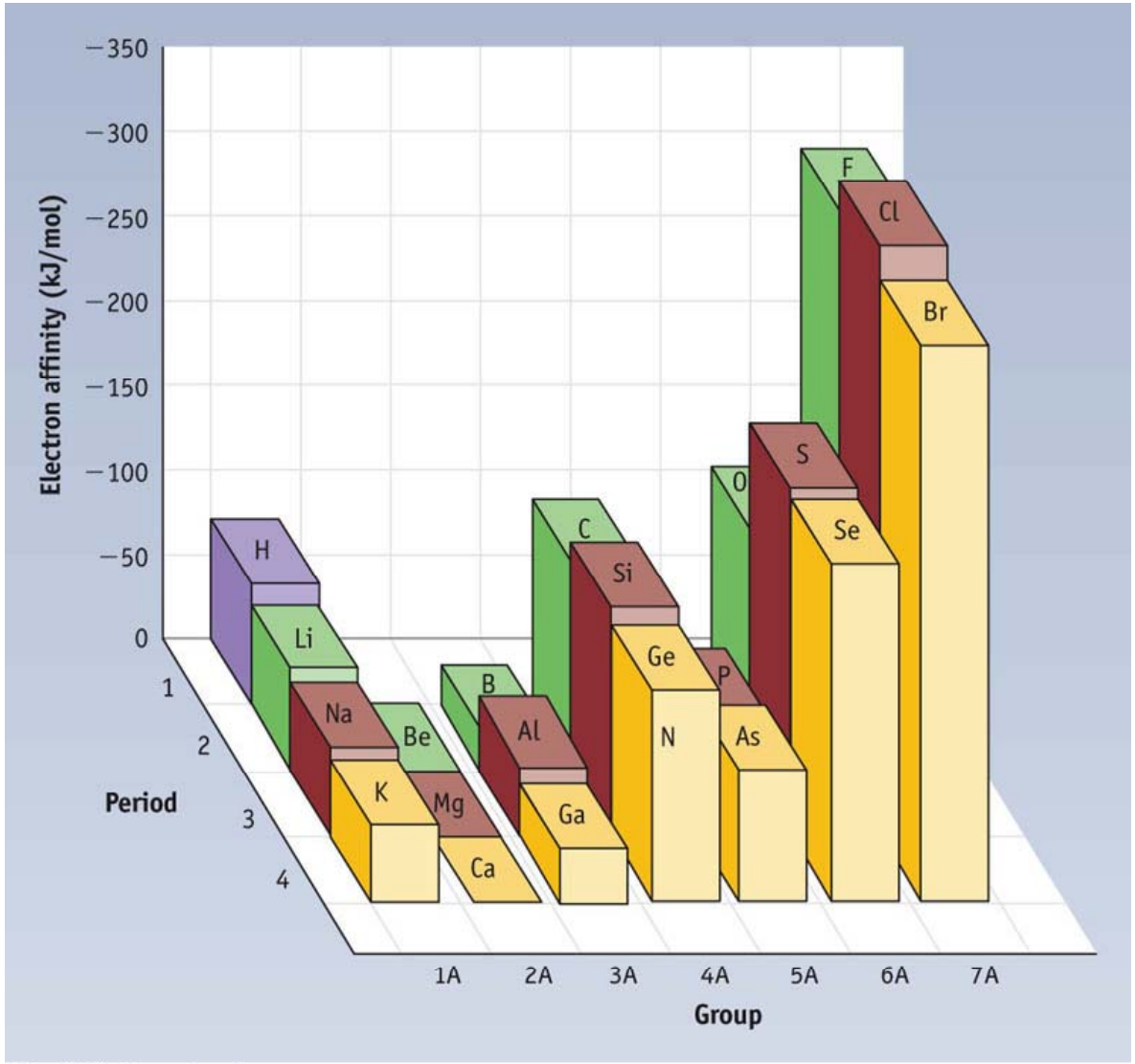
Electron affinity

- Ease in which an electron can be added
- $A(g) + e^-(g) \rightarrow A^-(g)$

$Cl(g) + e^-(g) \rightarrow Cl^-(g)$

- $E_a = E(A) - E(A^-)$
- The more negative E_a the easier it is to put an electron on to the atom.

Electron affinity



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Summary of Trends