

Lesson Overview

Secondary Periodic Properties

Objective: The student will be able to describe the secondary periodic properties in terms of the periodic law.

Lesson Outline:

I. Density

II. Valence Electrons

III. Oxidation Numbers

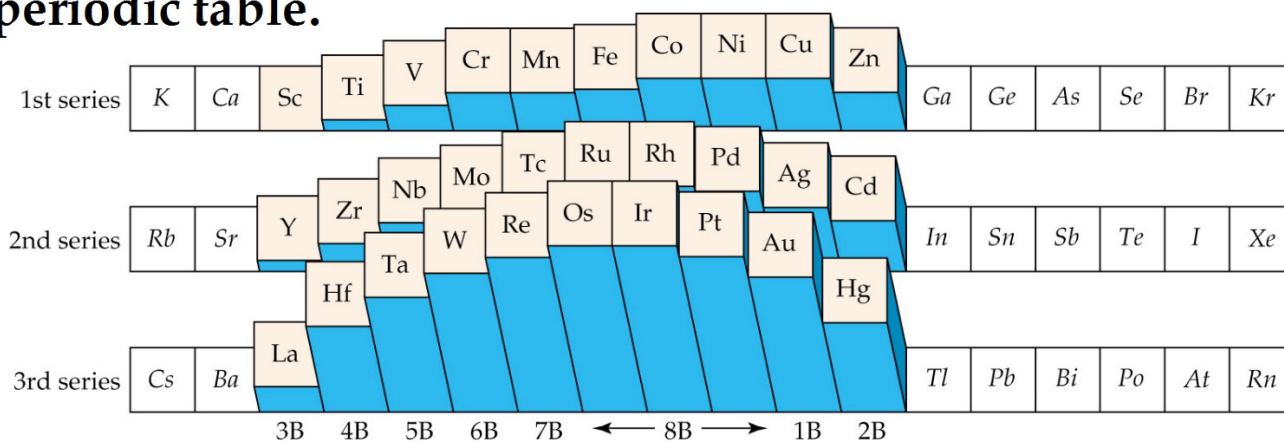
IV. Acid-Base Properties

V. Melting & Boiling Points

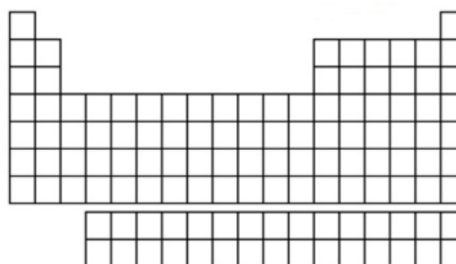
VI. Colors

Density

The most dense elements are located in the center of the periodic table.



Osmium and Iridium are the densest. (They trade off for 1st place!)

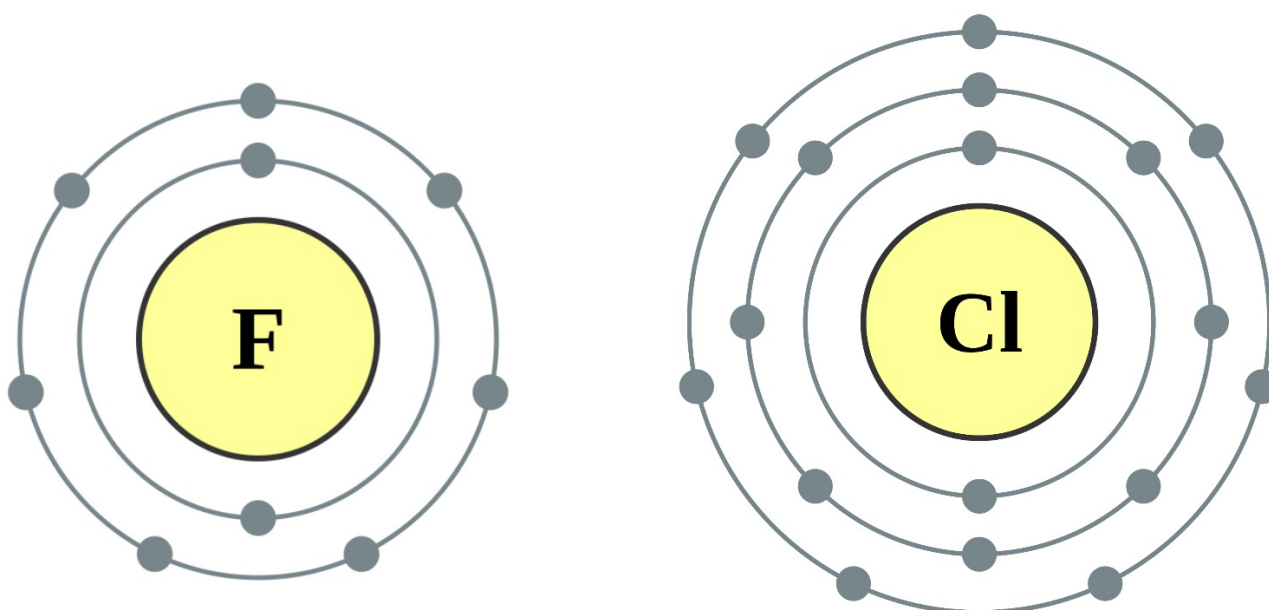


Valence Electron Trend

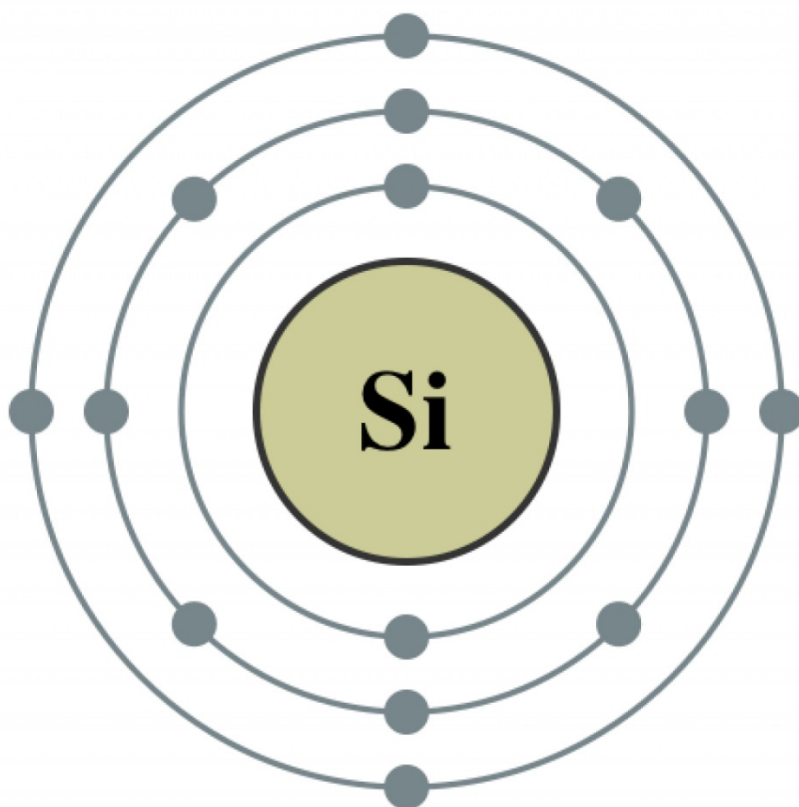
		1A(1)	2A(2)						
		ns^1	ns^2	3A(13)	4A(14)	5A(15)	6A(16)	7A(17)	8A(18)
				ns^2np^1	ns^2np^2	ns^2np^3	ns^2np^4	ns^2np^5	ns^2np^6
Period	2	• Li	• Be •	• B •	• C •	• N •	• O •	• F •	• Ne •
	3	• Na	• Mg •	• Al •	• Si •	• P •	• S •	• Cl •	• Ar •

Show with Bohr diagrams:

Oxidation Number Trend



What about an element like silicon?



Oxidation Number Trend

+1

+2

all positive

multiple ox. no.

+3

+4

-3

-2

-1

0

hydrogen 1 H 1.0079	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180														
lithium 3 Li 6.941	magnesium 12 Mg 24.305											aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948														
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80														
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29														
cesium 55 Cs 132.91	barium 56 Ba 137.33	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04	lutetium 71 Lu 174.967	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	ununbium 112 Uub [277]	ununquadium 114 Uuq [289]	57-70 *	89-102 * *										

* Lanthanide series

** Actinide series

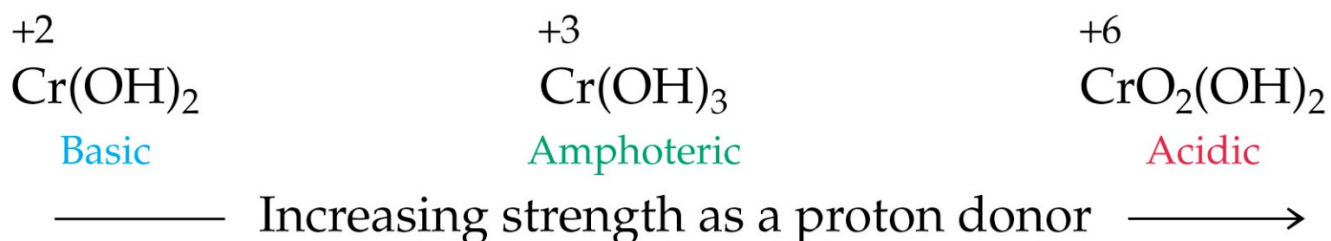
lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Acid-Base Properties

Increasing acidity →

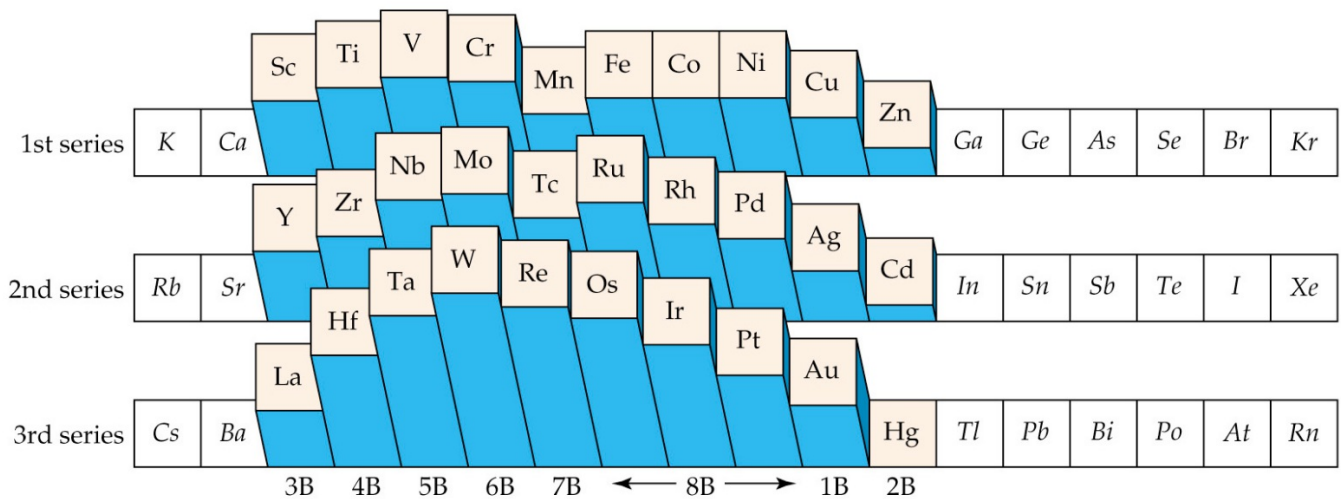
	I	II	III	IV	V	VI	VII	
← Increasing basicity	Li ₂ O	BeO	B ₂ O ₃	CO ₂	N ₂ O ₅	(O ₂)	OF ₂	Increasing acidity →
	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₃	Cl ₂ O ₇	
	K ₂ O	CaO	Ga ₂ O ₃	GeO ₂	As ₂ O ₅	SeO ₃	Br ₂ O ₇	
	Rb ₂ O	SrO	In ₂ O ₃	SnO ₂	Sb ₂ O ₅	TeO ₃	I ₂ O ₇	
	Cs ₂ O	BaO	Tl ₂ O ₃	PbO ₂	Bi ₂ O ₅	PoO ₃	At ₂ O ₇	
								← Increasing basicity

Acid-Base Properties



The acid-base nature of multivalent metals is as variable as their oxidation numbers.

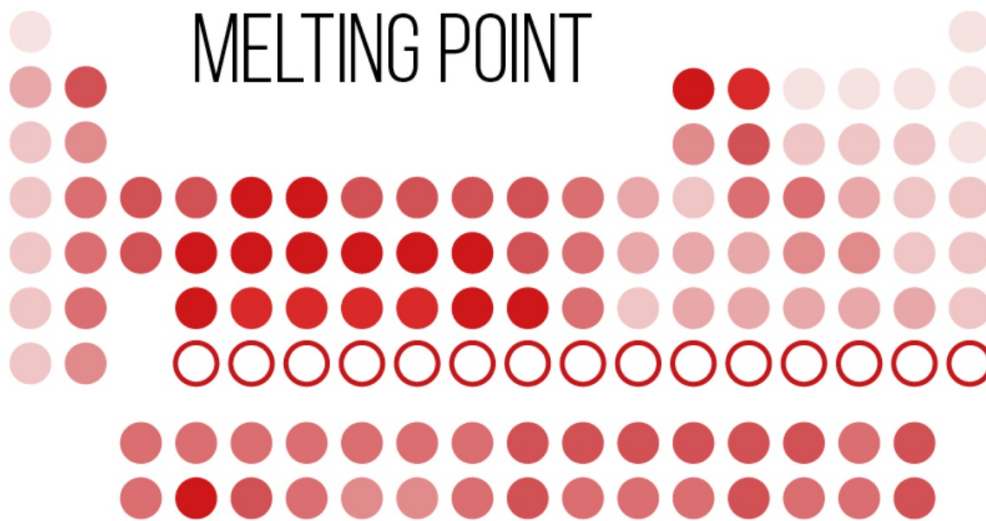
Melting Point & Boiling Point



Tungsten (W) has highest melting point of all metals. Carbon is the highest of all elements.

We will primarily discuss the period (and rarely the group) trend.

MELTING POINT

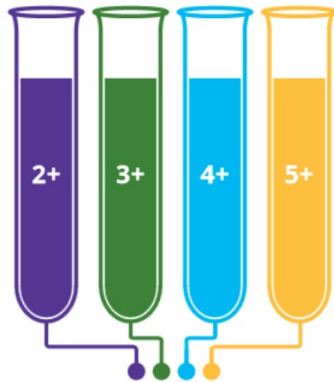


KELVIN

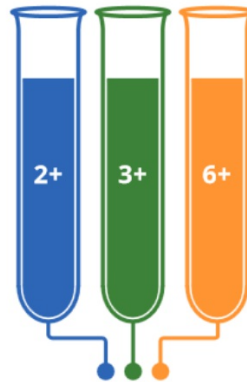




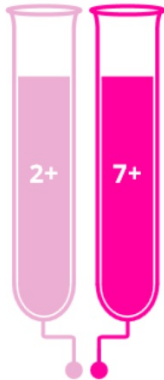
TITANIUM
Ti



VANADIUM
V



CHROMIUM
Cr



MANGANESE
Mn



IRON
Fe



COBALT
Co

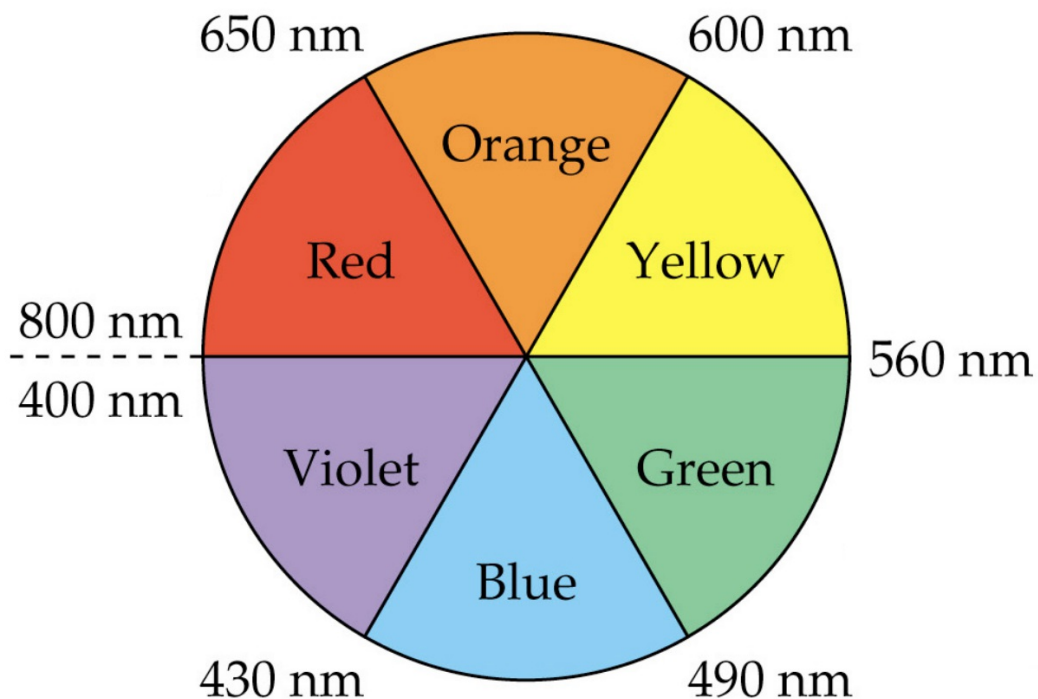


NICKEL
Ni



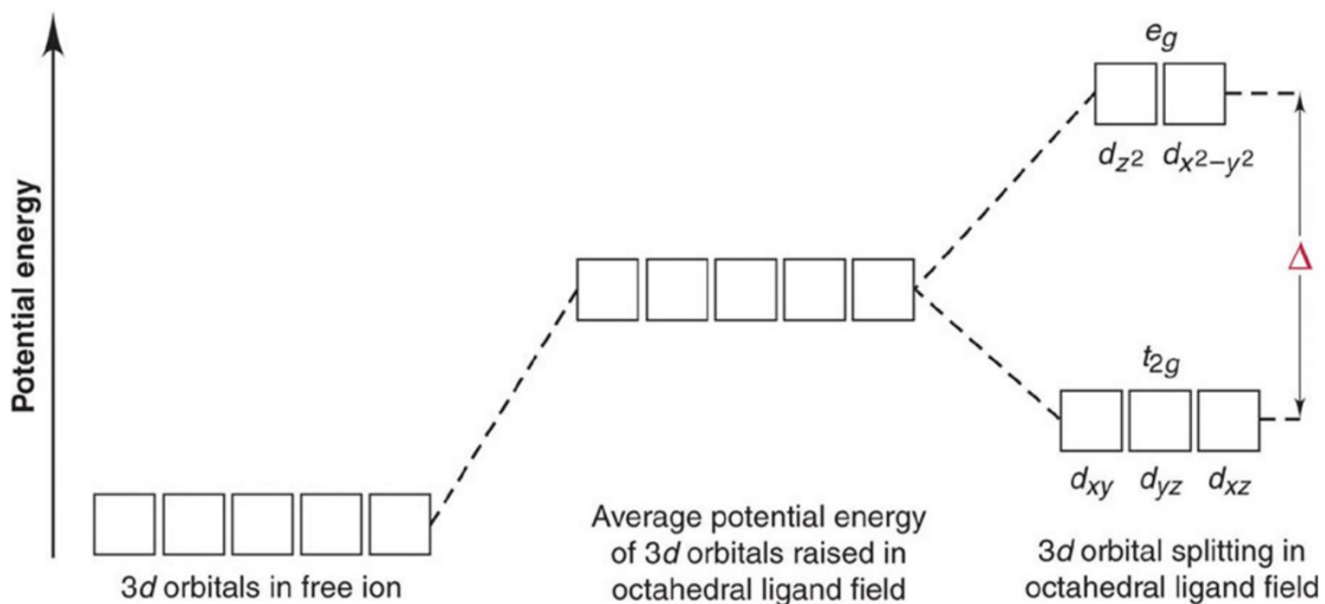
COPPER
Cu

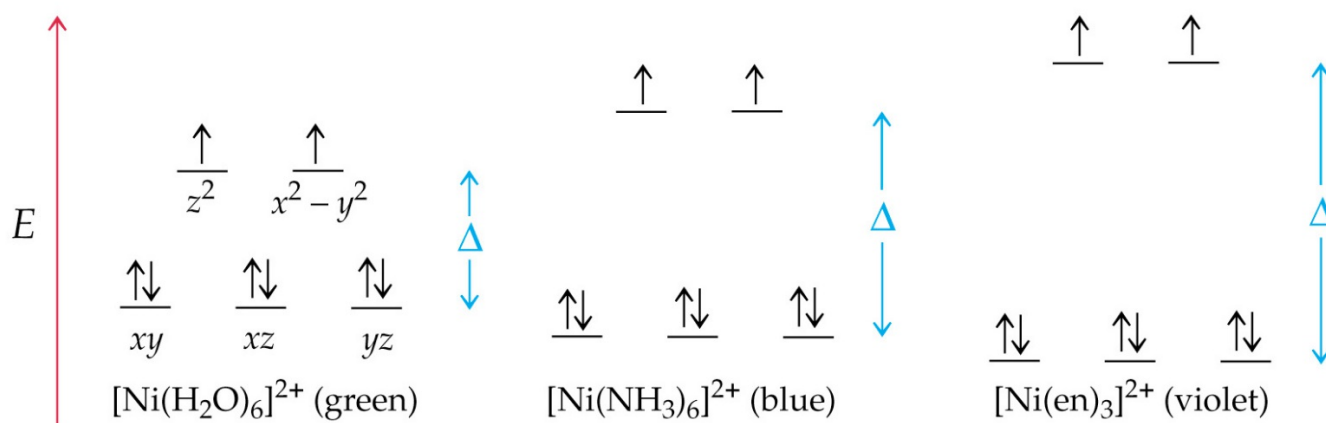
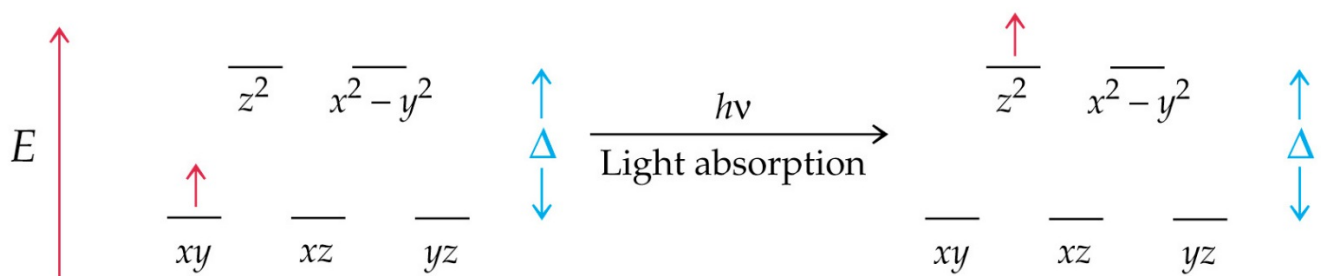
The Color Wheel & Color Theory (it's not just for art class)



An object will have a particular color because (1) it reflects light of that color, or (2) it absorbs light of the complementary color.

A Molecular Approach to the Color Trend





Isoelectronic

