

Monday/Tuesday, November 18 & 19, 2019 – Quantum Chemistry & Periodic Trends (Chapter 12 Part 2)

- I. **Warm-Up** – Define the words *wavefunction* and *probability density*. Also draw a Bohr model of the atom and discuss the important takeaways from the model.

II. Quantum Numbers, Orbitals, & Electron Configurations

Quantum Number	Formal Name	What it tells you	Range of Values
n			
l			
m_l			
m_s			

Orbitals

s orbitals



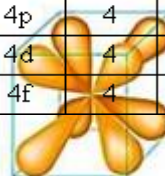
p orbitals



d orbitals



f orbitals



	n	l	m	s
1s	1	0	0	$\frac{1}{2}, -\frac{1}{2}$
2s	2	0	0	$\frac{1}{2}, -\frac{1}{2}$
2p	2	1	1, 0, -1	$\frac{1}{2}, -\frac{1}{2}$
3s	3	0	0	$\frac{1}{2}, -\frac{1}{2}$
3p	3	1	1, 0, -1	$\frac{1}{2}, -\frac{1}{2}$
3d	3	2	2, 1, 0, -1, -2	$\frac{1}{2}, -\frac{1}{2}$
4s	4	0	0	$\frac{1}{2}, -\frac{1}{2}$
4p	4	1	1, 0, -1	$\frac{1}{2}, -\frac{1}{2}$
4d	4	2	2, 1, 0, -1, -2	$\frac{1}{2}, -\frac{1}{2}$
4f	4	3	3, 2, 1, 0, -1, -2, -3	$\frac{1}{2}, -\frac{1}{2}$

- How many electrons in any one atom can have the following quantum numbers?
 - $n = 5$
 - $n = 6, l = 0$
 - $n = 4, l = 2$
 - $n = 4, l = 3, m_l = -2$
 - $n = 2, l = 0, m_l = 0, m_s = -1/2$
- Write the ground state electron configuration to determine the number of unpaired electrons in each of the following:
 - Cl
 - Ni
 - Cr
 - Ag
 - Te^{2-}
 - Ba^{2+}

Order of Orbital Filling

Electron Configuration:

Pauli Exclusion Principle:

3. Which of the following is *not* determined by the principal quantum number, n , of the electron in a hydrogen atom?
- the size of the corresponding atomic orbital(s)
 - the shape of the corresponding atomic orbital(s)
 - the energy of the electron
 - the minimum wavelength of the light needed to remove the electron from the atom.
 - All of the above are determined by n .

4. Determine if each of the following corresponds with an excited state or ground state electron configuration.
- $[\text{Ar}]4s^24p^5$
 - $[\text{Kr}]6s^1$
 - $[\text{Ne}]3s^23p^4$

III. Periodic Trends

5. Which of the following has the largest radius?
- Al or Si
 - F or Cl
 - S or S^{2-}
 - K or K^+

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00644	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 101.07	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.90768	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93482	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967	
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (264)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110	111	112	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93482	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.0381	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

6. Which of the following has the greatest ionization energy?
- K or Ca
 - P or As
 - Sr or Sr^{2+}
7. Which of the following has the most negative electron affinity?
- Br or Kr
 - C or Si

The successive ionization energies for an unknown element are:

$$I_1 = 896 \text{ kJ/mol}$$

$$I_2 = 1752 \text{ kJ/mol}$$

$$I_3 = 14,807 \text{ kJ/mol}$$

$$I_4 = 17,948 \text{ kJ/mol}$$

Which family does the unknown element most likely belong?

Effective Nuclear Charge (Z_{eff}):

Atomic Radii:

First Ionization Energy:

Electron Affinity: