Unit 4: The Periodic Table and Trends

Big Ideas:

The modern periodic table is organized based on atomic number and repeating trends. Trends are predicatable and can be explained by using atomic structure and Coulomb's Law.

Monday	Tuesday	Wednesday	Thursday	Friday
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○	○	○	○	○
○	○	○	○	○
○	○	○	○	○

4-2 Table of Contents Unit 4

Learning Objectives for Periodic Table and Trends Unit	
D1	I understand how the periodic table is arranged and can **identify and describe** trends within groups and periods.
D2	I can use Coulomb's Law and atomic structure principles to **explain WHY** trends follow certain patterns

Skills From Previous Units You Need

I can determine the number of valence electrons for an atom.

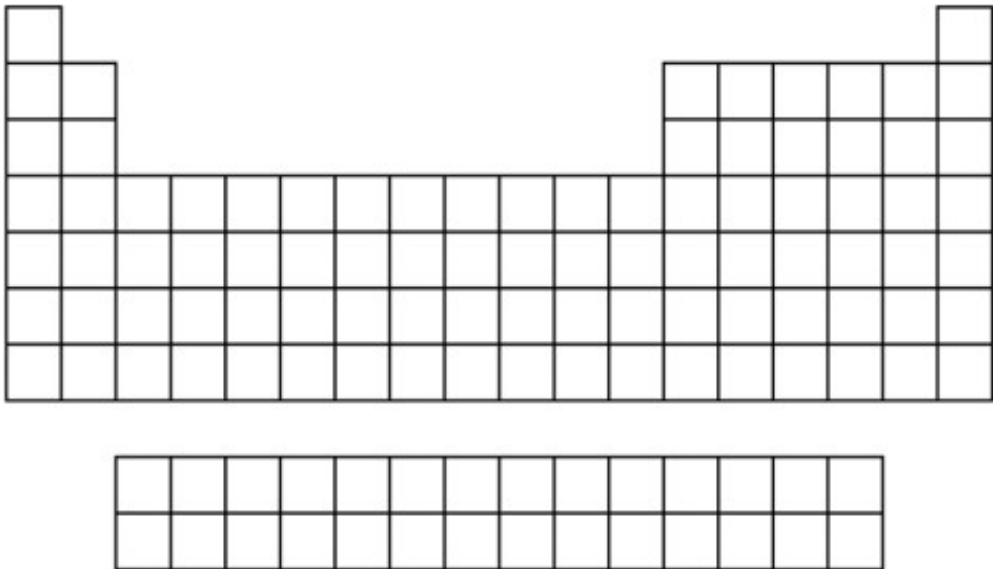
I can determine the charge of common ions.

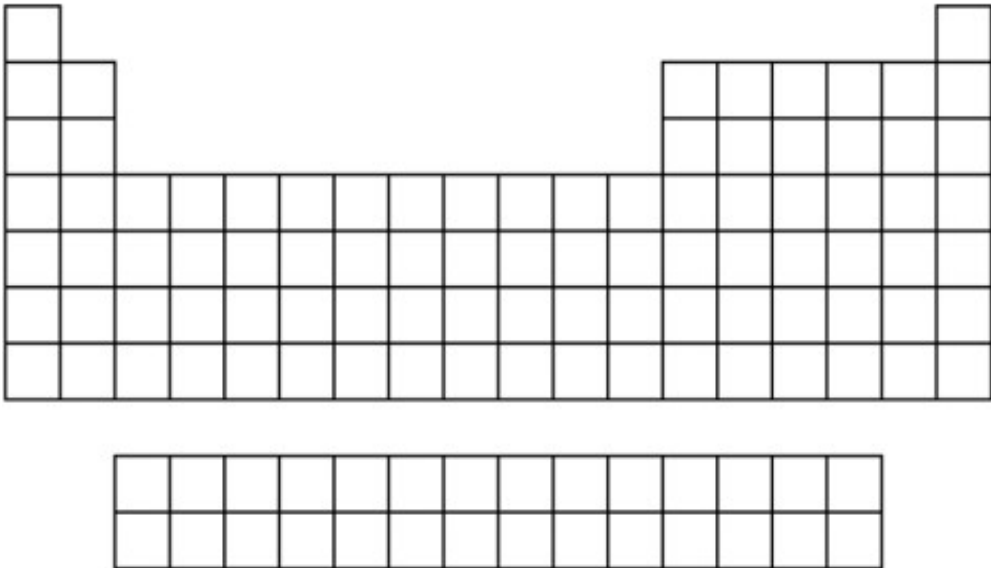
I can write the electron configuration for an element.

4-3 POGIL Read/Write: Coulombic Attraction

	Summarize the KEY points from the activity here. Use complete sentences.

4-4 Structure of the Periodic Table





Memorize:
Metals, Non-Metals, Metalloids, Alkali Metals, Alkaline Earth Metals, Halogens, Noble Gases, Transition Metals, Inner Transition Elements, Rare Earth Elements, Valence Electrons,

4-5 Coulombs Law, Effective Nuclear Charge (Z_{eff})

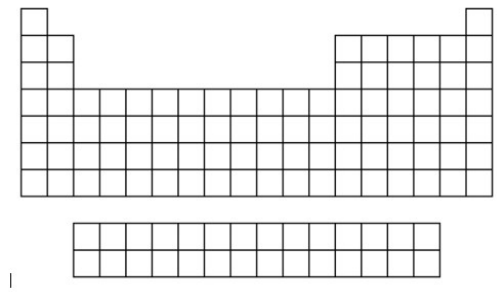
$$F \propto Q_1 Q_2$$

$$F \propto \frac{1}{r^2}$$

$$F \propto \frac{Q_1 Q_2}{r^2}$$

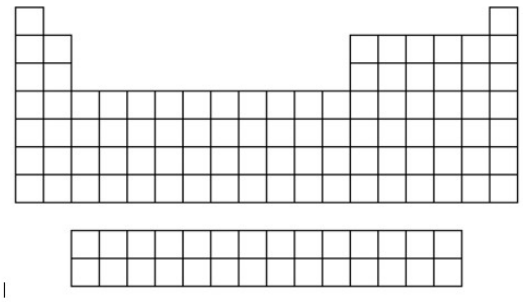
$$F = \frac{k q_1 q_2}{r^2}$$

Effective Nuclear Charge: Z_{eff}



4-6 Periodic Trends

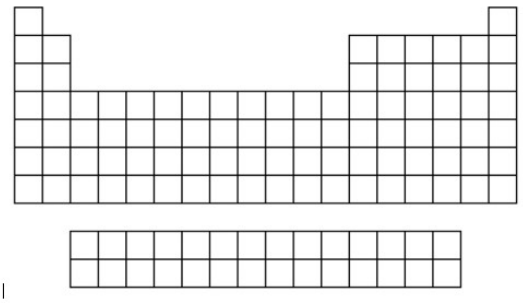
Atomic Radius —



Ex. 1) Arrange the atoms in order of increasing size: Lv, S, Te, O, Se, Po

Ex. 2) Arrange the atoms in order of decreasing radius: F, C, Li, Be, N, B, O

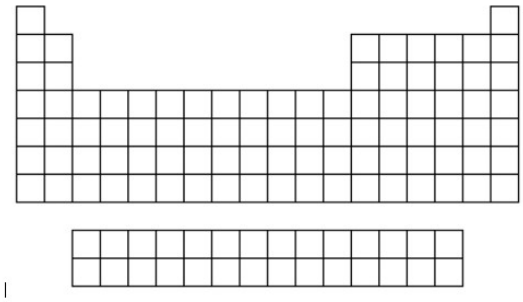
Electronegativity —



Ex. 3) Arrange the atoms in order of increasing electronegativity: Ca, S, F, Cs, Al

Ex. 4) Arrange the atoms in order of decreasing electronegativity: N, Na, F, O

Ionization Energy —



Ex. 5) Arrange the atoms in order of increasing ionization energy: Lv, S, Te, O, Se, Po

Memorize the trends!

Ex. 6) Arrange the atoms in order of decreasing ionization energy: F, C, Li, Be, N, B, O

4-7 Periodic Trends Continued

Ionic Radius —

Cations are _____ than neutral atoms they are formed from because they _____ electrons. Anions are _____ than the neutral atoms they are formed from because they _____ elec-

Isoelectronic Series —

Ex 1.) Which noble gas is isoelectronic with the following ions?

Na^{+} Rb^{+} Sr^{2+} Br^{1-} Te^{2-}

Aluminum ion sulfur ion (sulfide)

Ex 2.) Arrange the following ions in order of increasing radius

Cl^{1-} K^{+} Ca^{2+}

4-8 Successive Ionization Energies

Successive Ionization Energies —

TABLE 8.2 The Ionization Energies (kJ/mol) of the First 20 Elements

Z	Element	First	Second	Third	Fourth	Fifth	Sixth
1	H	1,312					
2	He	2,373	5,251				
3	Li	520	7,300	11,815			
4	Be	899	1,757	14,850	21,005		
5	B	801	2,430	3,660	25,000	32,820	
6	C	1,086	2,350	4,620	6,220	38,000	47,261
7	N	1,400	2,860	4,580	7,500	9,400	53,000
8	O	1,314	3,390	5,300	7,470	11,000	13,000
9	F	1,680	3,370	6,050	8,400	11,000	15,200
10	Ne	2,080	3,950	6,120	9,370	12,200	15,000
11	Na	495.9	4,560	6,900	9,540	13,400	16,600
12	Mg	738.1	1,450	7,730	10,500	13,600	18,000
13	Al	577.9	1,820	2,750	11,600	14,800	18,400
14	Si	786.3	1,580	3,230	4,360	16,000	20,000
15	P	1,012	1,904	2,910	4,960	6,240	21,000
16	S	999.5	2,250	3,360	4,660	6,990	8,500
17	Cl	1,251	2,297	3,820	5,160	6,540	9,300
18	Ar	1,521	2,666	3,900	5,770	7,240	8,800
19	K	418.7	3,052	4,410	5,900	8,000	9,600
20	Ca	589.5	1,145	4,900	6,500	8,100	11,000

8.4

4-9 Explaining Periodic Trends—Atomic Radius

Tips:

How to answer trend questions

1) Determine if it's a group or period trend question.
2) If it's a group question, use the energy level explanation
3) If it's a period question, use the Z_{eff} explanation.

Explaining ***why*** atoms follow a trend is not the same as stating ***what*** the trend is. For example, if you were asked to explain <u>why</u> sodium is a larger atom than lithium and you stated that "sodium is larger because it's beneath lithium on the periodic table" you would get zero credit.

Two factors are used to explain WHY atoms follow the trends:

1) Coulombic attraction: used for explaining trends within period. (Z_{eff})
2) Energy levels: uses for explaining trends within groups.

Ex. 1) Explain why an atom of sodium is larger than an atom of lithium.

The valence electron in Sodium occupies a higher ***energy level*** than the valence electron in Lithium. Since electrons in higher ***energy levels*** are farther from the nucleus, sodium must be a larger atom.

Ex. 2) Explain why an atom of neon is smaller than an atom of argon.

Ex. 3) Explain why an atom of sodium is larger than an atom of sulfur.

Sodium has a lower ***effective nuclear charge*** (Z_{eff} = 1) than sulfur (Z_{eff} = 6). This means the valence electron in sodium experience a smaller ***Coulombic Attraction*** towards the nucleus making sodium a larger atom.

Ex. 4) Explain why an atom of carbon is smaller than an atom of beryllium.

4-10 Periodic Trends: The Why's of Ionization Energy

Explaining ***why*** atoms follow a trend is not the same as stating ***what*** the trend is. For example, if you were asked to explain <u>why</u> sodium has a smaller ionization energy than lithium and stated "sodium has a smaller ionization energy because the trend says ionization energies decrease down a group" would get you zero credit.

Two factors are used to explain WHY atoms follow the trends:

1) Coulombic attraction: used for explaining trends within period. (Z_{eff})
2) Energy levels: uses for explaining trends within groups.

Ex. 1) Explain why sodium has a smaller ionization energy than lithium.

The valence electron in Sodium occupy a higher ***energy level*** than the valence electron in Lithium. Since electrons in higher ***energy levels*** are farther from the nucleus, they experience a lower ***Coulombic Attraction*** and require less energy to remove.

Ex. 2) Explain why potassium has a higher ionization energy than cesium.

Ex. 3) Explain why Carbon has a higher ionization energy than Lithium.

Carbon has a higher ***effective nuclear charge*** (Z_{eff} = 4) than lithium (Z_{eff} = 1). This means the valence electrons in carbon experience a larger ***Coulombic Attraction*** towards the nucleus and require more energy to remove.

Ex. 4) Explain gallium has a lower ionization energy than bromine.

4-11 Exceptions to Trends

Ex 1.) Oxygen has a lower ionization energy than nitrogen. This is contrary to what you have learned. Explain why this is true.

Ex 2.) Boron has a lower ionization energy than beryllium. This is contrary to what you have learned. Explain why this is true.

4-12 Summary