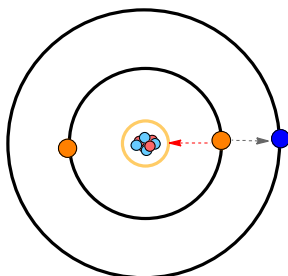


CONCEPT: PERIODIC TREND: EFFECTIVE NUCLEAR CHARGE

- Within an atom, an electron experiences attraction by the nucleus and repulsion by surrounding electrons.



- **Effective Nuclear Charge (Z_{Eff})**: Measurement of attractive force between protons and electrons.
 - ____ Z_{Eff} = ____ attractive force = electrons pulled closer to the nucleus.
- **Shielding Constant (S)**: Measurement of repulsive force between **valence electrons** and **inner core electrons**.
 - ____ S = ____ repulsive force = **valence electrons** pushed further away from the nucleus.

Periodic Trends

- The attractive force between electrons and the nucleus is influenced by shell number and quantity electrons.
 - ____ shell number = ____ distance between electron and nucleus = ____ attractive force.
 - ____ quantity of electrons in the same shell or subshell = ____ attractive force.
 - **Periodic Trend**: Effective nuclear charge ____ moving from left to right across a period and going up a group.

Effective Nuclear Charge ____																	
1A (1)	2A (2)											3A (3)	4A (4)	5A (5)	6A (6)	7A (7)	8A (8)
1 H Hydrogen																	He Helium
2 Li Lithium	Be Beryllium											B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon
3 Na Sodium	Mg Magnesium											Al Aluminum	Si Silicon	P Phosphorus	S Sulfur	Cl Chlorine	Ar Argon
4 K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton
5 Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon
6 Cs Cesium	Ba Barium	La Lanthanum	Hf Hafnium	Ta Tantalum	W Tungsten	Re Rhenium	Os Osmium	Ir Iridium	Pt Platinum	Au Gold	Hg Mercury	Tl Thallium	Pb Lead	Bi Bismuth	Po Polonium	At Astatine	Rn Radon
7 Fr Francium	Ra Radium	Ac Actinium	Rf Rutherfordium	Db Dubnium	Sg Seaborgium	Bh Bohrium	Hs Hassium	Mt Meitnerium	Ds Darmstadtium	Rg Roentgenium	Cn Copernicium	Nh Nihonium	Fl Flerovium	Mc Moscovium	Lv Livermorium	Ts Tennessine	Og Oganesson

EXAMPLE: Which of the following represents a chalcogen with the greatest effective nuclear charge?

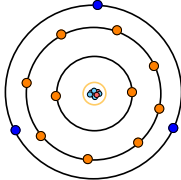
- a) Cl b) Li c) S d) Te e) Ne

CONCEPT: PERIODIC TREND: EFFECTIVE NUCLEAR CHARGE

Calculate without Slater's Rules

- We take a simple approach to calculate the effective nuclear charge of a **valence electron** when only given the _____.

Effective Nuclear Charge



Al (Group 3; Z = 13)

1s² 2s² 2p⁶ 3s² 3p¹

Effective Nuclear Charge Formula

Z_{Eff} = Effective Nuclear Charge

_____ = _____ - _____

S = Shielding Constant (Inner Core Electrons)

EXAMPLE: What is the effective nuclear charge felt by an electron in the third shell of an aluminum atom?

STEP 1: Find the element and its atomic number on the periodic table.

STEP 2: Write its condensed electron configuration and determine its number of **inner core electrons**.

STEP 3: Use the atomic number and the shielding constant, **S**, to determine the effective nuclear charge.

PRACTICE: What is the identity of an element when the effective nuclear charge of its valence electrons is 18 while its shielding constant is 5?

a) P

b) Ar

c) N

d) V

e) Al

CONCEPT: PERIODIC TREND: EFFECTIVE NUCLEAR CHARGE

Calculate with Slater's Rules

- **Slater's Rules:** System used to determine the effective nuclear charge of a specific **electron** within an orbital.

EXAMPLE: Using Slater's Rules, calculate the effective nuclear charge of a 3p orbital electron in calcium.

STEP 1: Group electrons in an electron configuration in order of increasing n value and in this form:

[1s] [2s,2p] [3s,3p] [3d] [4s,4p] [4d] [4f] [5s,5p] [5d]....

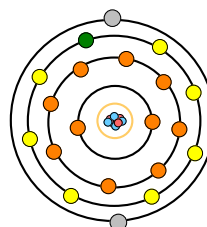
	1A (1)	2A (2)															3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	8A (18)
1	1s																					
2	2s																2p					
3	3s		3B	4B	5B	6B	7B										3p					
4	4s		3d														4p					
5	5s		4d														5p					
6	6s		5d														6p					
7	7s		6d														7p					

4f																						
5f																						

STEP 2: Identify an **electron** within the selected **electron group**.

- Use **lower electron groups** to the left to determine the calculated shielding constant, S_{Cal} .
- Ignore **higher electron groups** to the right (they don't shield).

[1s²] [2s², 2p⁶] [3s², 3p⁶] [4s²]



STEP 3: Use the calculated shielding constant, S_{Cal} , of the electron to determine the effective nuclear charge.

Slater's Rule		
Shielding Constant Formula	Slater's Constant Values	Effective Nuclear Charge Formula
$S_{\text{Cal}} = [(e^- \text{ group}) \cdot (\sigma)] + \Sigma[(\text{ } e^- \text{ groups}) \cdot (\sigma)]$ <p>□ σ = Slater's Constant</p> <p>□ S_{Cal} = Calculated Shielding Constant (Slater's Rule)</p>	<p>For s and p electrons:</p> <ol style="list-style-type: none"> 1) Electrons in the same group: $\sigma = \underline{\hspace{1cm}}$. 2) Electrons in (n-1) group: $\sigma = \underline{\hspace{1cm}}$. 3) Electrons in (n-2) group: $\sigma = \underline{\hspace{1cm}}$. <p>For d and f electrons:</p> <ol style="list-style-type: none"> 1) Electrons in the same group: $\sigma = \underline{\hspace{1cm}}$. 2) Electrons in lower groups: $\sigma = \underline{\hspace{1cm}}$. 	$\underline{\hspace{1cm}} = \underline{\hspace{1cm}} - \underline{\hspace{1cm}}$

CONCEPT: PERIODIC TREND: EFFECTIVE NUCLEAR CHARGE

PRACTICE: In which orbital does an electron in a sulfur atom experience the greatest shielding?

- a) 2p b) 2s c) 3p d) 3s e) 1s

PRACTICE: Rank the following elements by effective nuclear charge, Z_{eff} , for a valence electron: Kr, Se, Ca, K, Ge

PRACTICE: Using Slater's Rules calculate the effective nuclear charge of the 4d orbital electron in iodine.