Announcements

Quiz 2 Closes on Friday in the evening (5:00 PM)

Review 1 this week – can attend either Thursday or Friday. Details will be posted on myCourses

SciLearn Peer Collab: Monday and Wednesday 3:00 to 5:00 pm (2001 McGill College Ave)

Office Hours: Thursday 3:00 pm to 4:30 pm in Otto Maass 100

This is what a Chemist looks like

Jennifer Murphy

- McGill Alumna – Professor at University of Toronto
- Atmospheric Chemistry research – trace gases and particles
- Measurement of NH_3 and other reactive nitrogen species in atmosphere – urban air quality, climate change, and effects on ecosystems.

https://sites.chem.utoronto.ca/murphygroup/

Spin Quantum number describes the electron in the orbital

1. Principal Quantum Number (n)

1. Positive integer (1,2,3….)
2. Indicates the relative size of the orbital – relative distance
3. Specifies the energy level (higher n indicated higher energy)

2. Angular Quantum Number (*l*)

1. Positive Integer (0 to n-1)
2. Shape of the orbital
3. The value of n limits *l*; if n=1, *l* can only have the value 0; if n=2, *l* can have the values 0 and 1

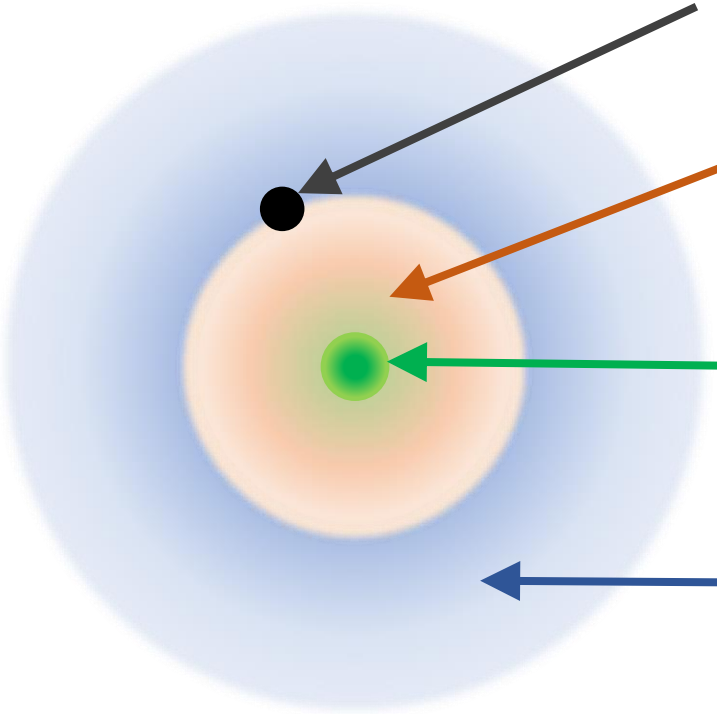
3. Magnetic Quantum Number (m_l)

1. Integer (-*l* to +*l*)
2. Orientation of the orbital around the nucleus
3. The value of l limits m_l; For l=1, values of m_l can be -1,0, and 1

4. Spin Quantum Number (m_s)

1. -1/2 or +1/2
2. Direction of electron's angular momentum

Electron Shielding and Effective Nuclear Charge



Electron of interest

Electrons in between "shield" some of the nuclear charge

Nucleus

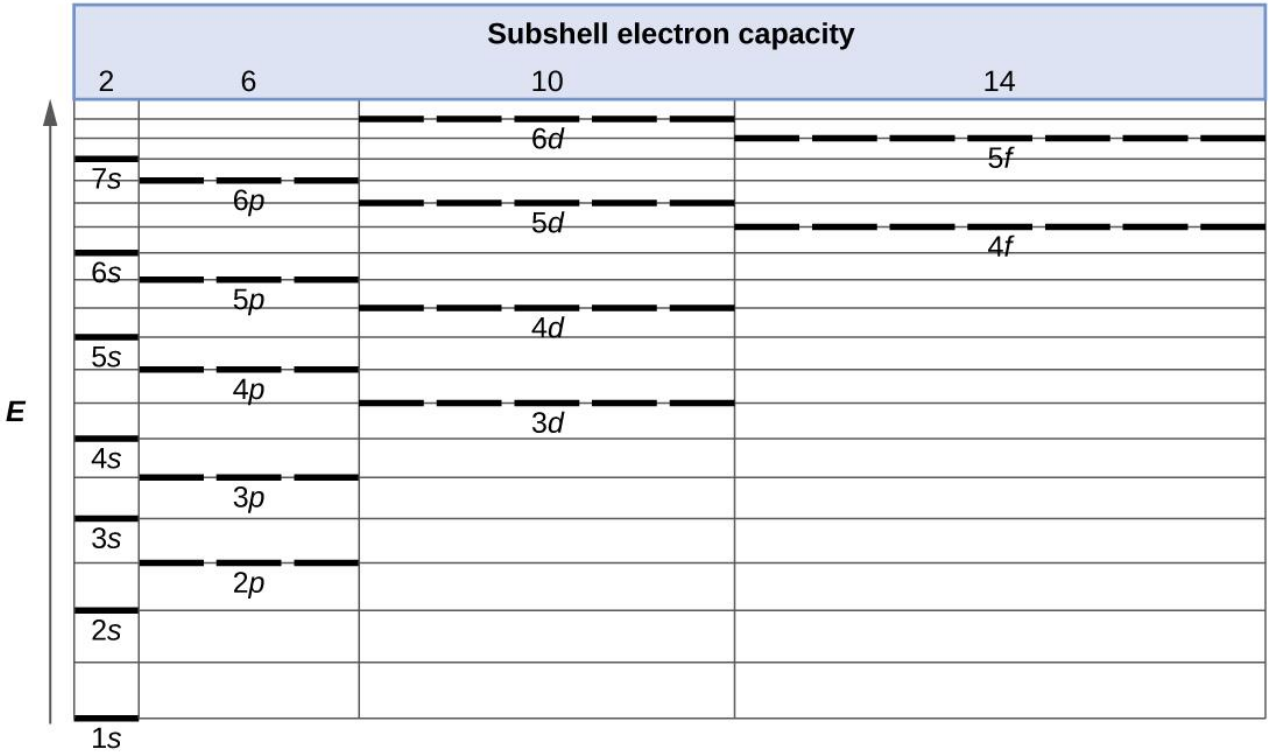
Inner electrons "shield" the outer electrons from the nuclear charge

Electrons on the outside (outer shell) do not have much effect on the nuclear charge the electron experiences

Electrons experience an **"effective" nuclear charge (Z_{eff})** that depends on **atomic number (Z)** and **shielding (S)** by inner electrons

$$Z_{eff} = Z - S$$

Energy Level Diagram for Atomic Orbitals

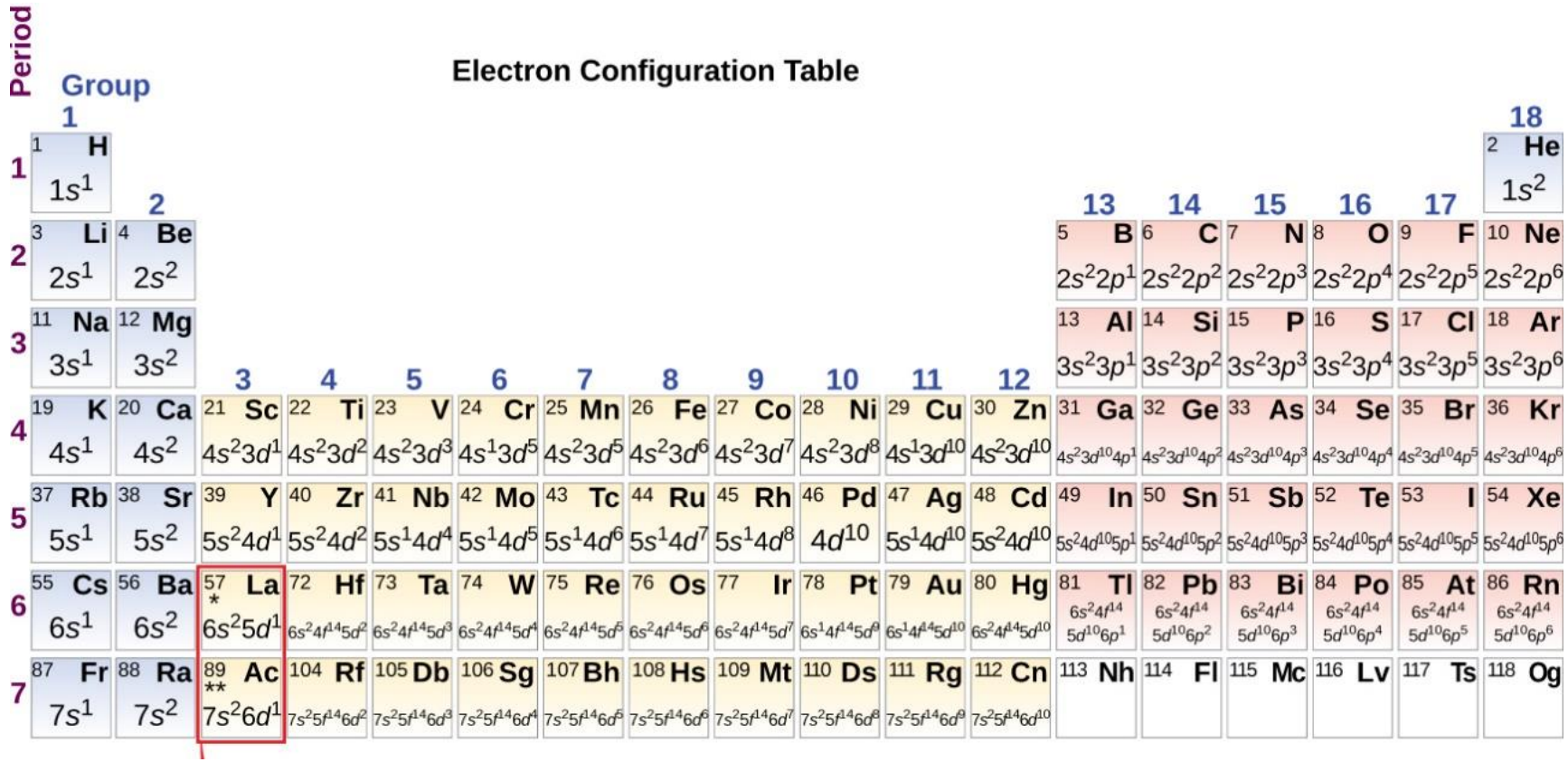


Taking all this shielding into account, we calculate the ENERGY for EACH orbital available, and rank them in order, 'closer' to further', lowest E up to highest E, and that's the order in which the orbitals are filled with electrons

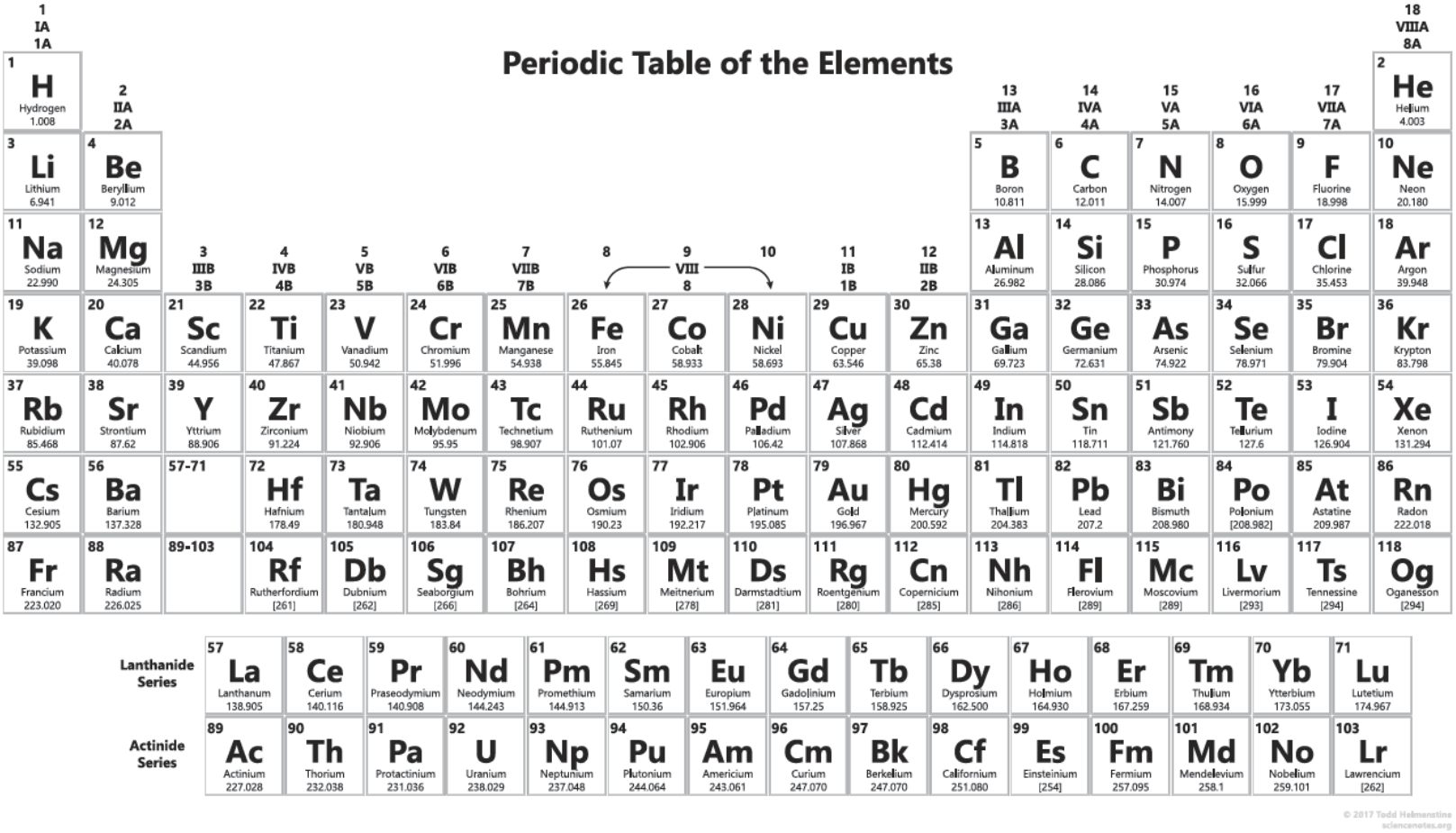
Order of atomic orbitals (lowest to highest energy)

1s<2s<2p<3s<3p<4s<3d<4p<5s<4d<5p<6s<4f…

Periodic Table



Periodic Table (Available on myCourses)



Concept Video 7- Q 1

Give the four quantum numbers that describe the 5^{th} electron of a ground state Carbon atom

Give the four quantum numbers that describe the 5th electron of a ground state Carbon atom

C: $1s^2 2s^2 2p^2$

5th electron will have n=2; l=1

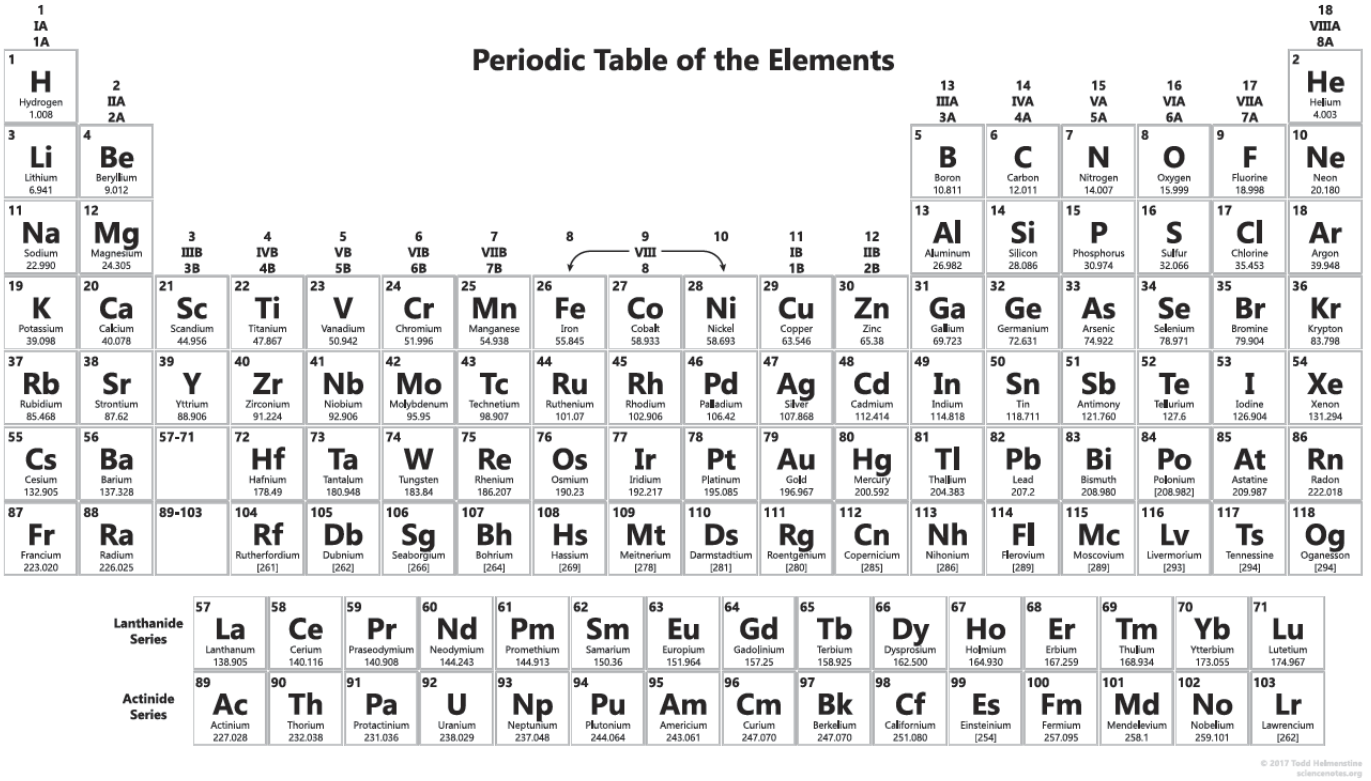
m_l can be 0, -1 or +1

m_s can be +1/2 or -1/2 (conventionally +1/2 – filled spin up first)

Concept Videos 7 – Q 2

Write the ground state electronic configuration (condensed), and the number of valence electrons for the following elements. Would these elements likely form cations or anions? (there may be some that would be difficult to judge)

1) Te
2) I
3) Rb
4) Ga
5) As



Write the ground state electronic configuration (condensed), and the number of valence electrons for the following elements. Would these elements likely form cations or anions? (there may be some that would be difficult to judge)

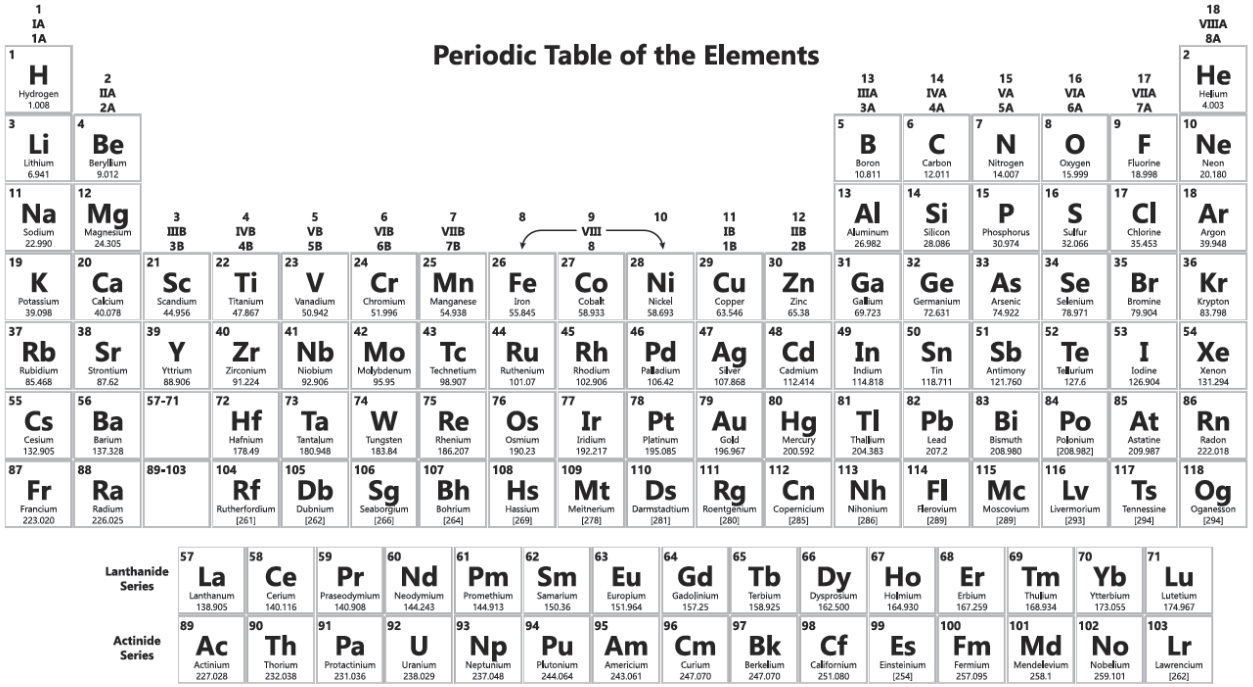
A. Te : $[Kr]5s^2\,4d^{10}5p^4$ (6 valence electrons) (learn more next week)

B. I: $[Kr]5s^24d^{10}5p^5$ (7 valence electrons) (will form I^- anion)

C. Rb: $[Kr]5s^1$ (1 valence electron) ((will form Rb^+ cation)

D. Ga: $[Ar]4s^23d^{10}4p^1$ (3 valence electrons) (learn more next week)

E. As:$[Ar]4s^23d^{10}4p^3$ (5 valence electrons) (learn more next week)



Concept Video 9
Practice Q 1

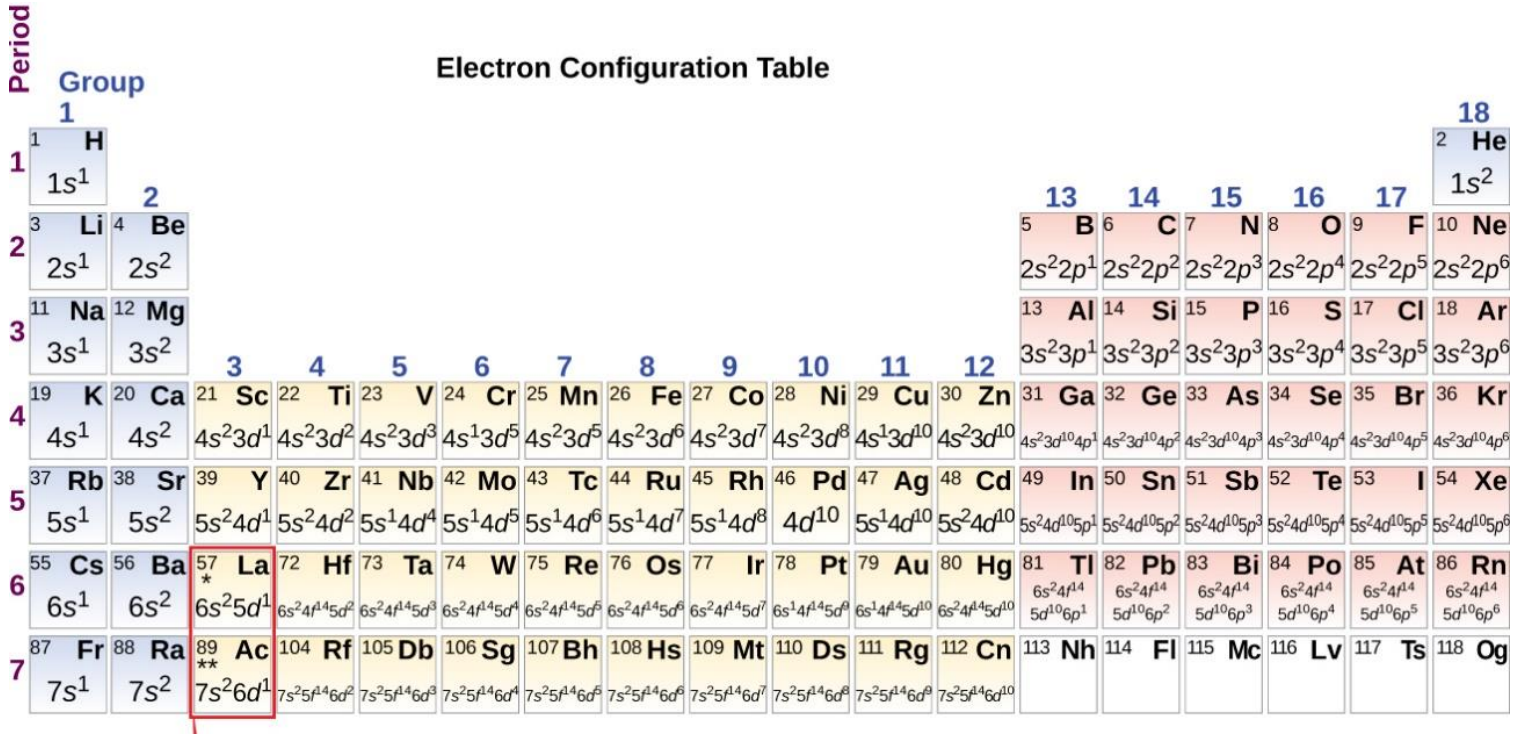
Rank each of these main-group elements in decreasing atomic size?

1) Br, Cs, Ar

Cs> Br> Ar

2) Cl, Mg, Rb

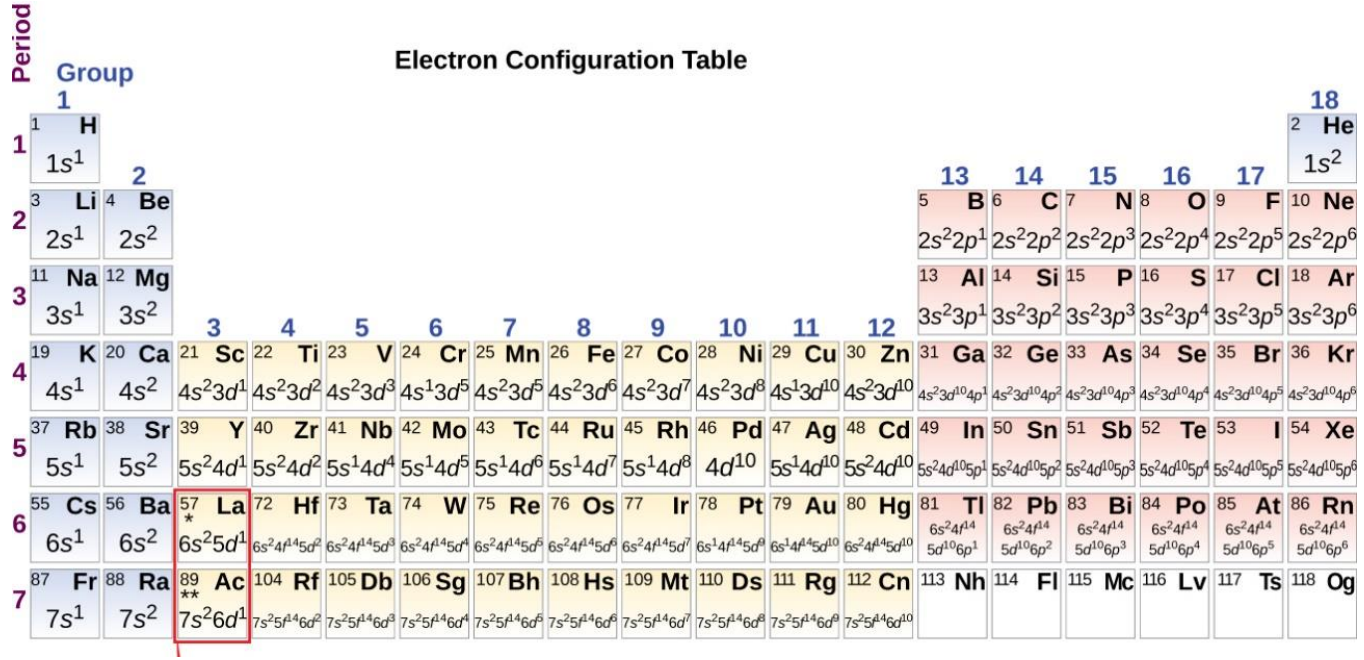
Rb>Mg>Cl



Concept Video 9
Practice Q4

Among the following which of the following ionizations would require the least amount of energy?

1. From $Si_{(g)}$ ([Ne]$3s^2 3p^2$) to $Si^+_{(g)}$ ([Ne] $3s^1 3p^2$) + e^-
2. From $Si_{(g)}$ ([Ne]$3s^2 3p^2$) to $Si^+_{(g)}$ ([Ne] $3s^2 3p^1$) + e^-
3. From $Si^+_{(g)}$ ([Ne]$3s^2 3p^1$) to $Si^{2+}_{(g)}$ ([Ne] $3s^2$) + e^-



Concept Video 9
Practice Question 4

Among the following, which ionizations would require the least amount of energy?

1. From $Si_{(g)}$ ([Ne]$3s^2 3p^2$) to $Si^+_{(g)}$ ([Ne] $3s^1 3p^2$) + e^-
2. From $Si_{(g)}$ ([Ne]$3s^2 3p^2$) to $Si^+_{(g)}$ ([Ne] $3s^2 3p^1$) + e^-
3. From $Si^+_{(g)}$ ([Ne]$3s^2 3p^1$) to $Si^{2+}_{(g)}$ ([Ne] $3s^2$) + e^-

Concept Video 9
Practice Q5

Using electronic configuration, describe IE_1, IE_2, and IE_3 of the following atoms? Circle the largest IE (among IE1/IE2/IE3) for each atom

C

Na

Concept Video 9
Practice Q5

Using electronic configuration, describe IE_1, IE_2, and IE_3 of the following atoms? Circle the largest

C

IE1 $C(g) \longrightarrow C^+(g) + e^-$

$1s^2\ 2s^2\ 2p^2$ $\quad$ $1s^2\ 2s^2\ 2p^1$

IE2 $C^+(g) \longrightarrow C^{+2}(g) + e^-$

$1s^2\ 2s^2\ 2p^1$ $\quad$ $1s^2\ 2s^2$

IE3 $C^{+2}(g) \longrightarrow C^{+3}(g) + e^-$

$1s^2\ 2s^2$ $\quad$ $1s^2\ 2s^1$

Na

IE1 $Na(g) \longrightarrow Na^+(g) + e^-$

$1s^2\ 2s^2\ 2p^6 3s^1$ $\quad$ $1s^2\ 2s^2\ 2p^6$

IE2 $Na^+(g) \longrightarrow Na^{+2}(g) + e^-$

$1s^2\ 2s^2\ 2p^6$ $\quad$ $1s^2\ 2s^2\ 2p^5$

IE3 $Na^{+2}(g) \longrightarrow Na^{+3}(g) + e^-$

$1s^2\ 2s^2\ 2p^5$ $\quad$ $1s^2\ 2s^2\ 2p^4$

For the same element:
IE3 > IE2 > IE1
$IE_{(n+1)}$ is always > $IE_{(n)}$

slido

A main group element belonging to period 3 has the following ionization energies? Without looking at a table with IE values, predict which of the following is it?
IE in kJ/mol:
IE1 = 738; IE2 = 1451; IE3: 7732; IE4: 10542

ⓘ Start presenting to display the poll results on this slide.

Concept Video 9
Practice Q6

An element belonging to period 3 has the following ionization energies? Predict which element is it?

IE in kJ/mol:

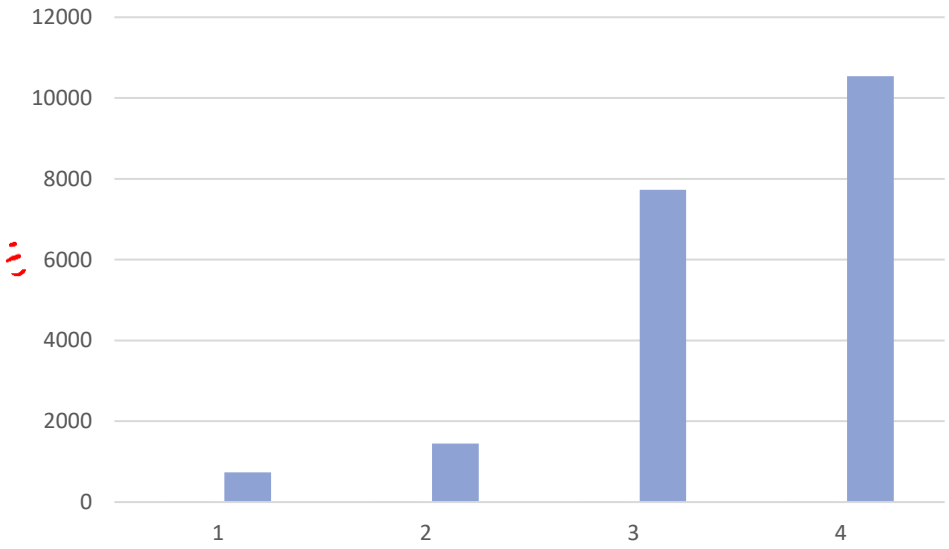
IE_1 = 738; IE_2 = 1451; IE_3: 7732; IE_4: 10542

Concept Video 9
Practice Q4

An element belonging to period 3 has the following ionization energies? Predict which element is it?

IE in kJ/mol:

IE_1 = 738; IE_2 = 1451; IE_3: 7732; IE_4: 10542



Biggest jump between IE2 and IE3

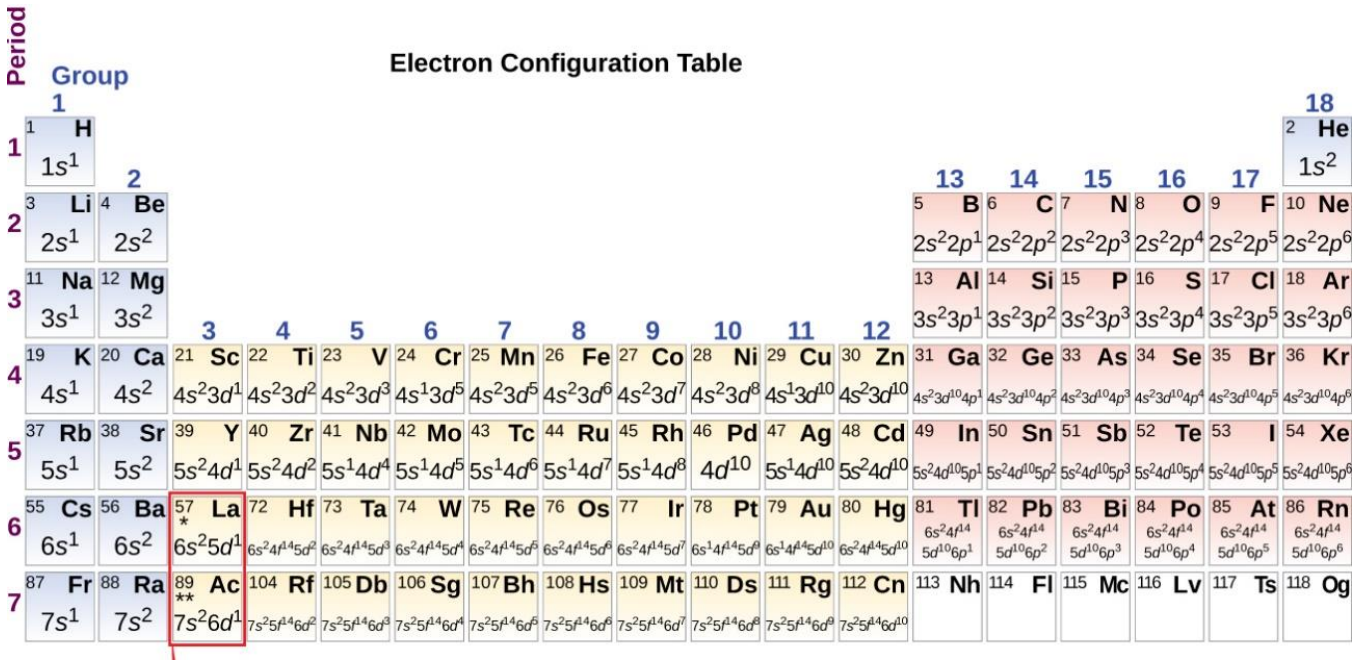
2+ state (A^{2+}) – noble gas configuration

The element is Mg since Mg^{2+} is isoelectronic with Ne

Concept Video 9
Practice Question 7

Arrange the following in decreasing ionic size:

S^{-2}, O^{-2}, Be^{2+}, Li^{+}

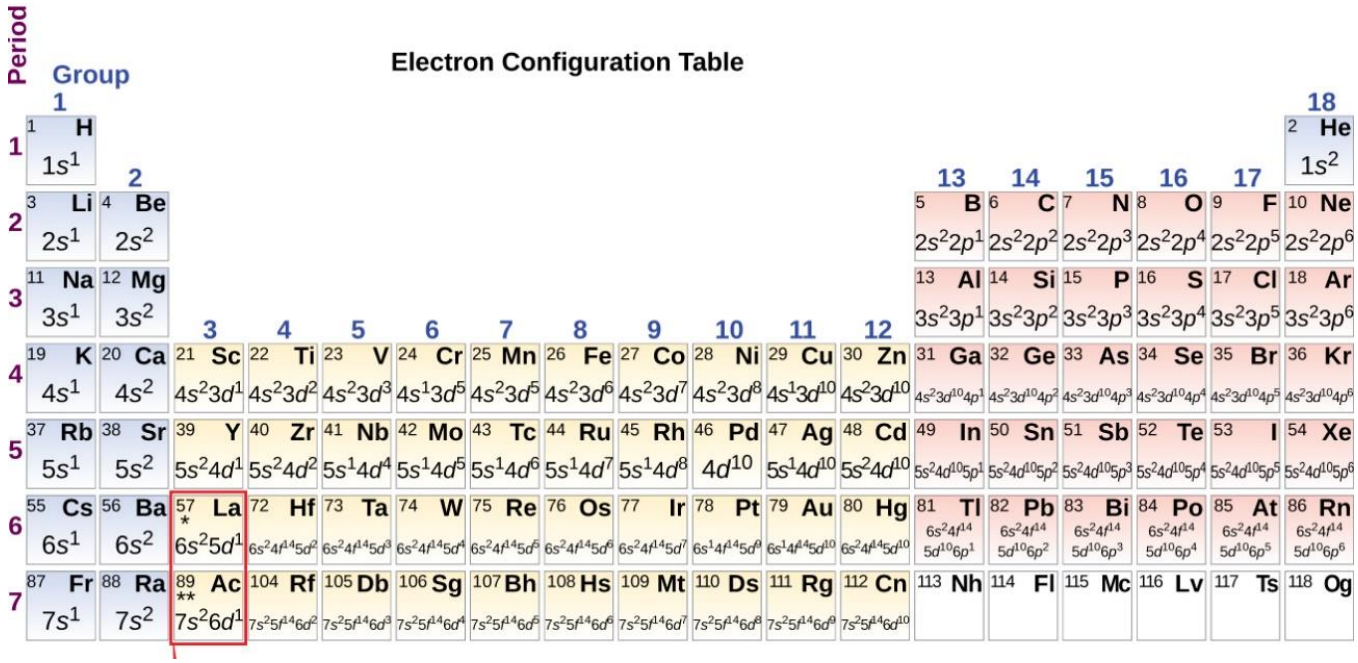


Concept Video 9
Practice Question

Arrange the following in decreasing ionic size:

S^{2-}, O^{2-}, Be^{2+}, Li^{+}

$S^{2-} > O^{2-} > Li^{+} > Be^{2+}$



Concept Video 9
Practice Question 8

Provide the condensed electronic configuration of the following and determine if they are paramagnetic or diamagnetic

Ti

Zn^{2+}

Ti^{2+}

Fe^{3+}

Concept Video 9

Provide the condensed electronic configuration of the following and determine if they are paramagnetic or diamagnetic

Ti $[Ar]4s^2\ 3d^2$

Paramagnetic

Ti^{2+} $[Ar]\ 3d^2$

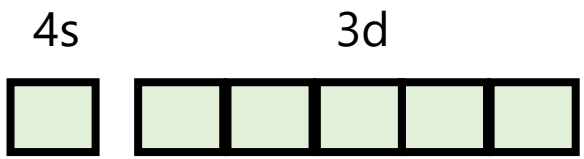
Paramagnetic

Zn^{2+} $[Ar]\ 3d^{10}$

Diamagnetic

Fe^{3+} $[Ar]3d^5$

Paramagnetic



Practice questions:
Which of the following are paramagnetic?

A. Sc^{+}

B. Zn^{2+}

C. Cl^{-}

D. K^{+}

E. La^{3+}