Chemistry 10: Electron interactions

April 6-April 9

Time Allotment: 40 minutes per day

Student Name: ___________________________________

Teacher Name: ___________________________________

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

____

I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

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Packet Overview

Date	Objective(s)	Page Number
Monday, April 6	*Describe "effective" nuclear charge.*	3
Tuesday, April 7	*Define the "size" of atoms.*	9
Wednesday, April 8	*Relate metal electron configurations to the properties of metals.*	17
Thursday, April 9	*Review this week and last week's material*	21
Friday, April 10	*Holiday – April Break* .	25

Additional Notes:

Hi students,

I—obviously—still miss you all.

This week will be a bit easier. I'd like to enjoin on you now that you are *officially* **advanced chemistry students** (!). This is a big deal and something to be happy about. We'll now be going into some of the details on how atoms work, gases, and things like that.

Having said that, your responsibilities are 1) to use the periodic table frequently, 2) not forget the stuff you've learned, 3) continue to look with an eager and curious (and confused) eye at the physical matter of the universe. You don't understand how gravitation works, nor do you understand the intricacies of magnetism and attraction between electric charges (nor will you (really) for a very long time. Can it be said that anyone understands these things?). You can safely engage, confidently, with theoretical and practical considerations in chemistry, and (to the extent that you're doing the three things above) engage with professional chemists.

Congratulations! The following pages should be fun and a way to tease your brain. Now, let's begin with a question: do you *really* understand the atom?

Have fun this week, and please email as often as you'd like.

-Mr. Luke

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Monday, April 6

Chemistry Unit: Electron interactions
Lesson 1: "Effective" nuclear charge

Unit Overview

Electrons farther from the nucleus experience a weaker pull than electrons closer to the nucleus, and are "shielded" or blocked by electrons closer to the nucleus, which repel outer electrons. This is calculated in the equation $Z_{eff} = Z - S$, where Z is equal to the number of protons in the nucleus, S is equal to the number of electrons in between the nucleus and the electron being considered, and Z_{eff} is the **effective nuclear charge** experienced by the electron being considered.

As you move across the periodic table from left to right, (in general) the effective nuclear charge experienced by the outermost electron(s) increases.

As you move down the periodic table in a column, (in general) the effective nuclear charge experienced by the outermost electron(s) increases **slightly**.

A Question for Lesson 1: What kind of forces do electrons experience when they're around the nucleus?

Objective: Be able to do this by the end of this lesson.
Define "shielding", **effective nuclear charge**, and be able to describe what forces the electron is experiencing when surrounding the nucleus.

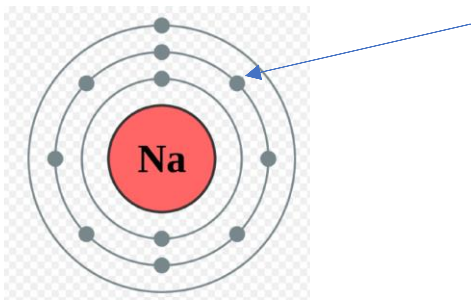
Be able to use the equation $Z_{eff} = Z - S$ to calculate the effective nuclear charge for **any electron** of **any atom**.

Introduction to Lesson 1

A very happy Monday to you.

In a many-electron atom, each electron is simultaneously attracted to the nucleus and repelled by the other electrons.

The charge, therefore, of the nucleus, for electrons further from the core, is less than the charge experienced by electrons closer to the center. We call the charge experienced by an electron, which is usually less than the actual charge of the nucleus, the **effective nuclear charge** (Z_{eff}).



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For instance, consider this electron. It's being kept around the nucleus of the sodium atom because of the positive-negative attraction between the nucleus protons and its own negative charge.

However, since it's further away, it is not as strongly attracted to the nucleus than the two electrons that are closer to the center.[1]

Q: Consider: is there anything else that would block or weaken the electron's attraction to the Na nucleus? Brainstorm for 1.5 minutes and write your thoughts below:

____

____

____

Now, let's consider how we can get a sense of the magnitude of Z_{eff} for an electron in an atom.

Read and annotate p. 264, then answer the questions below.

1. What is electron "shielding" or "screening"?

____

   a. What is being screened?

   ____

2. What is the value of "S" in the equation: $Z_{eff} = Z - S$? Find the value of S for a Na atom.

   ____

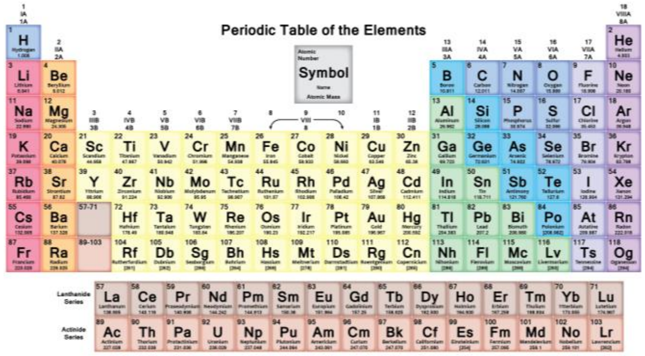
   a. Value of S for Na: _________

3. If Z stands for the actual charge experienced by the outermost electron of the Na atom, write the value for Z and S, then calculate the **effective nuclear charge** experienced by the electron under consideration:

   Z: ______
   S: ______

   $Z_{eff} = Z - S =$ ________________ (answer here)

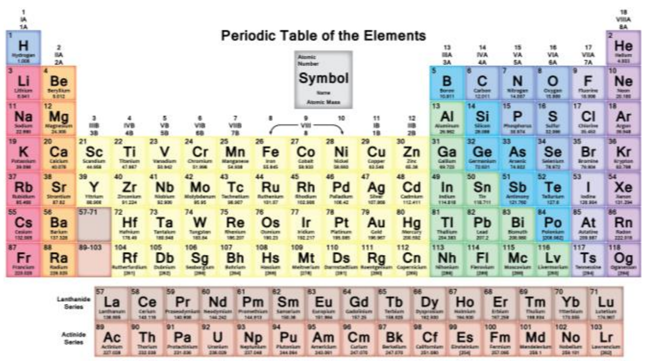
[1] Would it have a higher ionization energy?



Look at each element of the second row (Li, Be, B, etc). Consider an outermost valence electron. Does Lithium or Beryllium's outer electron experience a higher Z_{eff} from the nucleus? Rank all the elements in the row, from highest Z_{eff} to lowest.

____

(which element in the row has the highest ionization energy? _________)



Now look at each element of the first column (H, Li, Na, etc). Consider an outermost valence electron. Does Lithium or Sodium's outer electron experience a higher Z_{eff} from the nucleus? Rank all the elements in the column, from highest Z_{eff} to lowest.

____

(which element in the column has the highest ionization energy? _________)

Now, read and annotate page 265 and answer the questions below.

As you move across the periodic table from left to right, (in general) the effective nuclear charge experienced by the outermost electron(s) ___________________ (increases/decreases)

As you move down the periodic table in a column, (in general) the effective nuclear charge experienced by the outermost electron(s) ___________________ (increases/decreases) but ___________________ (not as much/even more).

Which would you expect to experience a greater effective nuclear charge, a 2p electron of a Na atom or a 3s electron of a Na atom? **Why?**

____

____

Does the outermost electron of a noble gas experience a stronger pull toward the nucleus than the outermost electron of a non-noble-gas element? (i.e. Na vs. Ne) **Why?**

____

____

Tuesday, April 7

Chemistry Unit: Electron interactions
Lesson 2: The "size" of atoms

Unit Overview
We use “angstroms” to measure the distance between atoms.
One angstrom (Å) is equal to 10^{-10} meters.
As you go across a row the size of the atom (the **atomic radius**) decreases.
As you go down a column the size of the atom (the **atomic radius**) increases.

Objective: Be able to do this by the end of this lesson.

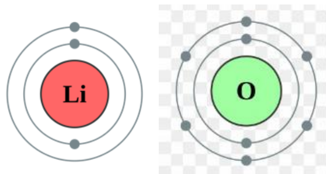
Use Angstroms comfortably and understand what it measures.
Identify whether an element is larger or smaller than another element.
Identify whether an ion is larger or smaller than its parent ion.

A Question for Lesson 2: How do *you* determine how large an element’s atom is?

Introduction to Lesson 2

A very happy Tuesday to you ☺

The distance between two atoms that are covalently bound together (sharing electrons) is pretty small, on the order of 10^{-10} meters. We use "angstroms" to measure the distance between atoms. One angstrom (Å) is equal to 10^{-10} meters.

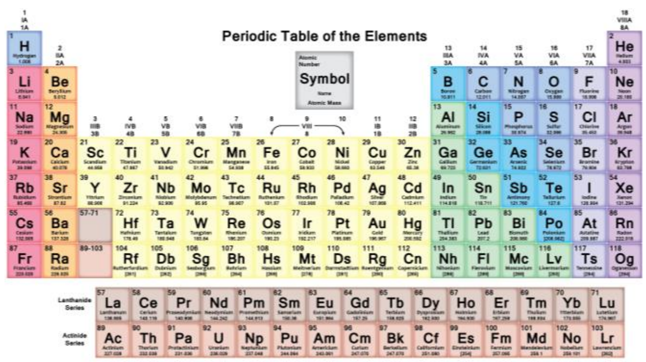


To get an idea of two atoms bonding, picture these two atoms moving together and their electron path lines merging.

What are the other two SI prefixes closest to the Angstrom range?

a. pico-
b. nano-
c. femto-
d. micro-

There's a lot to say about this. We're thinking about the structure of the atom. For now, let's look at the periodic table:



1. As you go across a row (e.g. from Na to Mg to Al, etc.) does the size of the atom (the **atomic radius**) probably increase—or decrease—and **why?**

____

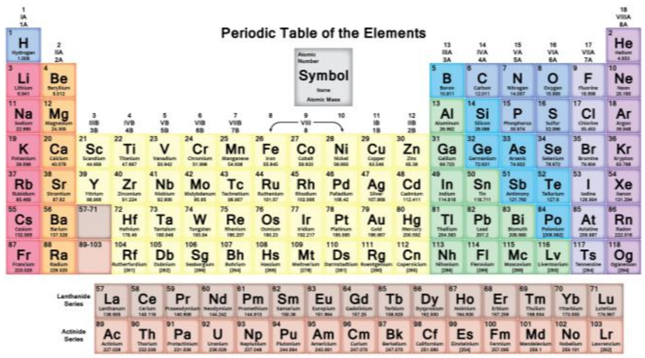
____

____

Why: ____

(Stuck? Answer these questions first)

As you go across a row, the number of protons ________________ (increases/decreases)
As you go across a row, the number of electrons ________________ (increases/decreases)
As you go across a row, the nucleus exerts a ______ (stronger/weaker) pull on electrons. (i.e. the Z_{eff} is larger/smaller).



2. As you go down a column (e.g. from Be to Mg to Ca, etc.) does the size of the atom (the **atomic radius**) probably increase—or decrease—and **why?**

____

____

____

Why: ____

(Stuck? Answer these questions first)

As you go across a row, the number of protons ________________ (increases/decreases)
As you go across a row, the number of electrons ________________ (increases/decreases)
As you go across a row, the nucleus exerts a ______ (stronger/weaker) pull on electrons (i.e. the Z_{eff} is larger/smaller).

Now, read and annotate pages 266 and 267. Go back and check your answers. Then, answer the questions below.

1. What is the difference between a bonding radius and a “non-bonding” radius?

____

   a. Which one is longer, the bonding radius of Oxygen or the non-bonding radius of O?

      ____

2. Arrange the following atoms in order of increasing size (or simply number them):

   Phosphorus, Sulfur, Arsenic, and Selenium

3. Arrange the following atoms in order of increasing atomic radius (i.e. size):

   Mg, Be, Na

Now, read and annotate 268 and 269, then answer the questions below.

Look at figure 7.7 on page 269. Write down the radius length for each of the important species below:

Li _____	Be _____	O _____	F _____	(always include units!)
Na _____	Mg _____	S _____	Cl _____	
K _____	Ca _____	Se _____	Br _____	
Rb _____	Sr _____	In _____	I _____	

True or False

1. A positive ion is smaller than its parent ion ________
   a. Na+ is larger than Na ________
2. A cation is larger than its parent ion _________
3. An anion is larger than its parent ion _________
4. Cl^- is smaller than Cl ___________

Rule: For ions carrying the same charge, size increases as we go down a column in the periodic table.

5. Rank the following ions by size (atomic radius) from smallest to largest:

   Ni^+, Pd^+, and Pt^+

6. Rank the following ions by size (atomic radius) from smallest to largest:

   Nb^+, V^+, and Ta^+: __________________

<u>Wednesday, April 8</u>

Chemistry Unit: Electron interactions
Lesson 3: Relations: electrons – properties of metals

Unit Overview:
You will be reviewing last week's and this week's (this unit's) material.

Lesson 3 Socratic Question: What can the electron configuration of this (metal) element tell me about its property(ies)?

Objective: Be able to do this by the end of this lesson.

Introduction to Lesson 3

Hi. A very happy Wednesday to you.

Just answer the questions below!

1. Would you expect a metal atom, for instance Silver, to have a high ionization energy? Explain.

____

    a. What about a sodium atom? Same thing?

    ____

2. If a metal (say Aluminum) formed an ion, would you expect a cation or anion (+ or -)? **Why?**

____

3. Since a metal likes to lose/gain electrons (circle one), it likes to be oxidized/reduced (circle one).

Read and annotate page 277 and 278, then answer the questions below.

Almost all metals like to react with (circle all that apply)

a. bases
b. acids
c. oxygen (O_2)
d. other metals

Write down the three rules (in *italics*) on page 278:

a. ____

b. ____

Basic things attract ___________.

a. protons (H^+)
b. hydride (H^-)
c. hydroxide (OH^-)
d. electrons

Predict the products of these reactions, keeping in mind this rule:

i. $CuO + H_2SO_4 \rightarrow$ ________ + __________.

ii. $Al_2O_3 + 6\ HNO_3 \rightarrow$ ___ __________ + ____ __________

What makes metal oxides basic (p. 278)?

____

c. ____

Write the electron configurations for: Na^+: _________________ (e.g. $1s^2 2p^6$, etc)
Write the electron configurations for: Ag^+: _________________

Based on their electron configurations, would you expect Na^+ or Ag^+ to exhit more "metallic character" (electrical conductivity, malleability, ductility,

That's it for today. Nice work ☺

Don't forget—circle the part(s) you found challenging and email Mr. Luke immediately to say hi and ask questions.

Thursday, April 1

Chemistry Unit: Electron interactions
Lesson 4: Practice

Unit Overview:
You will be reviewing this week's material.

Lesson 3 Socratic Question: Keep this question in mind as you study this lesson.
How can I tie together what's been learned this week?

Objective: Be able to do this by the end of this lesson.
Put asterisks/mark each section that you require further practice in.
Form questions and/or send an email to Mr. Luke asking for further practice in sections you found difficult.

Introduction to Lesson 4

A very happy Thursday to you.

Today you'll simply be thinking about the few things we/you've learned this week.

Refer to pages 292 through 294 in your textbook as a reference.

Complete:

7.9
7.10b
7.11 (challenging)
7.15 (the second question)
7.16
7.25
7.27

7.18 (Figure 7.6 is on page ___ of your packet)
7.19
7.20
7.21
7.23
7.24

(review from last week)

7.37
7.38
7.39
7.40

7.54
7.55
7.57
7.66

Remember that you're moving into a stage where I'd consider you an **advanced chemistry student**. Look to the periodic table frequently. Use your head. The answers will not be so simple now, but you are not so simple now either. Don't forget the basics. Look up.

Friday, April 10

Want something to do?

Read the CHEMISTRY AND LIFE selection on page 270. Write a 1-paragraph summary of the reading and send it to me.