NAME\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ NOTES: UNIT 2 **ELECTRON CONFIGURATION**

**You need know these ideas about electron configuration and ions:**

⮊ the role of valence electrons in reaction chemistry

⮊ that the ion(s) of an element behave differently than the atom of the element

⮊ the production of light energy

⮊ the interpretation of a ground state configuration and excited state configuration

⮊ the relationship between basic electron configuration, atomic number, and the organization of the periodic

table of the elements

I) First, some vocabulary …

A) Atom vs. Element

1) You can think of an element as an aggregation of only one type of atom. **The key is that all**

**the atoms have the same # of protons** (same atomic number). There may be millions of

these atoms all bonded to each other ... but because every atom is of identical atomic number,

the whole mass is classified as an element!

atom element

(a group of atoms of the

same atomic number)

Try using the analogy: **atom is to element as a** brick **is to** brick wall**.**

1 atom represents the whole element, like 1 brick

describes the basic properties of a brick wall

**GIMME’ A METAPHOR**

j0233413

Question: How is a string of pearls like atoms and elements?

What assumption do we make about each individual pearl?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question: Create an analogy in which a lawn is analogized to an element.

What assumption must be made regarding each blade of grass?

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B) Depending upon the date of publication of these notes, there are roughly 118 element

represented on the Periodic Table, and they are divided into:

18 vertical columns (called families or groups),

7 horizontal periods and

2 related series.

1) The elements are organized based upon \*increasing atomic number.

2) We will concern ourselves with the Main Group elements (Groups 1,2,13-18) and the Transition Metal

Elements (Groups 3 -11), and group 12

C) A somewhat arbitrary means of categorizing the elements is based upon the activity of the

outermost electrons (the most loosely held electrons ....and those most likely to participate in

making new bonds) .... the \* valence electrons

Val*a*nce curtain ... While not spelled the same, I like to think of this curtain, being so named, because it is the "outermost" drape .... the furthest from the window (metaphorically, the nucleus)

& the last to be put on (configured) and the first to be taken off. How does this metaphor work for you? Do you have any questions?

<http://oxbowherald.com/writing/blog/with-valances-for-windows-all-you-need-is-your-imagination>

1) Based upon the activity of valence electrons, there are **4** broad categories of elements

a) Metals are elements which lose electrons in a chemical reaction, when reacted with

nonmetals. (Metals become oxidized when reacted with nonmetals.)

i) loss of electrons = \*oxidation

ii) oxidized species become \*more positive in charge, due to a loss of negative

electrons. e.g. 0 to +2 or +2 to +5

iii) You may sometimes hear that fossil fuels are oxidized when combusted in

oxygen. This is generally accurate, as the carbon atoms of the fossil fuel(s)

lose electrons to oxygen, and form carbon dioxide. The carbon of CO2 is

in a +4 oxidation state … a more positive state, then carbon is in the original

fuel. C0 and C+4 have different chemistries...They have a different # of e-.

This holds true as well, for glucose … It is oxidized biochemically, in that

carbon atoms become more positive.

iv) In the case of metals, you will often hear that a metal (such as iron) has been

oxidized (**or rusted**) in the presence of oxygen or some other nonmetal.

In this case, iron atom loses electrons and becomes a +3 or +2 ion.

Note: The chemistry of the atom ≠ the chemistry of the ion ….

Fe0 does not have the same chemistry as Fe3+ or Fe2+ This is important.

v) Oxidation does NOT require oxygen … but derives the name from oxygen.

vi) The key is to grasp that oxidation is a loss of electrons, and many atoms can

become oxidized …. BUT(!) Metal atoms, in the presence of nonmetals are

especially vulnerable to this sort of electron activity.

b) Metalloids (or Semimetals) blend the characteristics of metals and nonmetals & are

elements with properties which fall between the extremes of metallic and

nonmetallic properties. They are associated with the "staircase" of the

periodic table and this staircase separates metals and nonmetals, as well.

c) Nonmetals ***tend*** to gain electrons in a chemical reaction especially when reacted with

a species of lesser electronegativity, like a metal or even another nonmetal.

(Nonmetals tend to become reduced.)

i) Gain of electrons = \*reduction

ii) a reduced species becomes \*more negative, due to the gain of negative

electrons.

iii) electronegativity is the tendency to of one species to gain the electrons of a

bond. The Pauling Scale tend to run from 0.7 to 3.98 (often just “4”)

iv) fluorine is the most readily (easily) reduced element … followed by oxygen.

It is very common for oxygen to change its electron configuration by gaining

2 more electrons from some other atom. Oxygen, **in compounds** is often a

-2 species.

Now, we must stress that an atom of oxygen and an oxide ion behave

differently. O0 can be reduced … but O-2 *is* reduced, and likely found in

compounds.

This is an important idea …

The chemistry of the atom ≠ the chemistry of the ion

d) Noble Gases often seen as a subset of the nonmetals, these elements tend to neither

gain nor lose electrons under normal Earth-like conditions. That, is,

under normal Earth-like conditions, noble gases tend not bond to other

species, and you won’t find them in many compounds. There are a few

exceptions …but not many

3) Elements tend to interact in such a way as to stabilize their valence electron levels, and

lower their overall energy.

a) For first-year students we could look at these reactions, as an attempt to reach 8

valence electrons. This is called the OCTET RULE. However, it is just a guideline

and not always accurate. Let’s just say that often (but not always,) a atom will

react to that it ends up with 8 valance electrons … or as close as possible.

b) Metals tend to Lose Electrons when reacting with nonmetals by Oxidation (LEO) and

the metal atom becomes a positive species.

c) Nonmetals tend to Gain Electrons when reacting with metals by Reduction (GER), and the nonmetal atom becomes a more negative species (due to a gain of electrons)



c) LEO says GER

<http://bananaoilmovies.wordpress.com/2010/11/05/a-farewell/>

**Relative Locations of the 4 Categories of Elements Found on the Periodic Table**

**Non -**

**Metals Noble**

**Gases**

**Metals**

**Metalloids**

**Metals**

II) Electron Configuration: We believe that electrons are ordered from low levels of energy to

higher levels of energy, which correspond statistically to probable locations of the

electrons from the nucleus.

A) According to Bohr:

1) electrons are organized outside of and around the nucleus

2) electrons are found at specific distances from the nucleus. These distances are

called energy shells (K – Q) or principal energy levels (1 – 7). (vocabulary term!!!)

![j0237628](data:None;base64,) 3) \* there are 7 principal energy levels, some with electrons of a quantized energy

Picture it!

4) electrons nearest the nucleus are lowest in energy. The energy of electrons

\* increases as their position from the nucleus increases.

(potential energy argument)

5) Ground State = \* The electrons arranged in the lowest possible energy levels

a) The “shells” (or principal energy levels) tend to have a rule which predicts the

maximum number of electrons = 2n2, where n is the number of the level, 1,2,3,4 …

Check out your periodic table or <https://hobart.k12.in.us/ksms/PeriodicTable/energy%20levels.htm>

b) The rule describes the maximum number of electrons a level may hold … NOT the

the number it MUST hold … Think of this last statement like carrying in a load of

wood, from outside.

6) the configuration found on your periodic table

3Li 4Be 5B 6C 7N 8O 9F 10Ne

11Na 12Mg 13Al 14Si 15P 16S 17Cl 18Ar

e- config. animation: [http://web.visionlearning.com/custom/chemistry/animations/CHE1.3-an-animations.shtml](%20http:/web.visionlearning.com/custom/chemistry/animations/CHE1.3-an-animations.shtml) or <http://tinyurl.com/yvqz8b>

**Practice**

1. Use the ground state electron configuration of 2-8-18-6
2. An atom of which element is represented? \* Se or selenium

b) The configuration suggests that this atom has how many valence electrons? \*6

c) Using the octet rule, which generalizes that atoms react in such a way, so as to attain 8 valence

electrons, will this atom tend to gain or lose electrons? \*gain 2 electrons…

2) Use the ground state electron configuration of 2-8-10-2

a) An atom of which element is represented? \* Ti or titanium

b) How many valence electrons does this atom have? \*2

c) Will this atom tend to gain, or to lose electrons, when reacted with another atom, such as oxygen?

\*lose

d) How many principal energy levels hold electrons? \*4

II) The origin of electromagnetic energy … especially, the origin of visible light (and color)

**There is a connection between light and matter, in terms of how they behave.**

With the work of scientists such as Albert Einstein and Prince Louis de Broglie, it is fairly

common now, to consider energy and matter to have both wave-like properties and particle-like

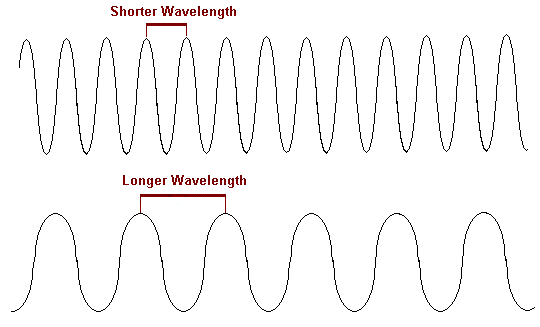
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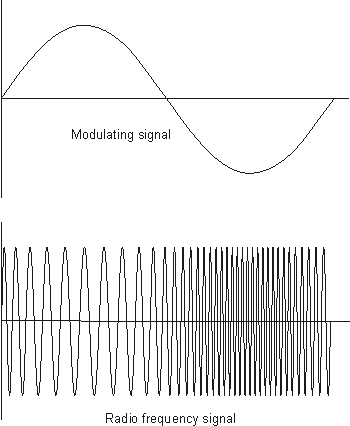
Einstein called a light particle, **a photon.** A photon comes in little discrete packages of energy

called **quanta**. A **quantum** of energy is the amount of energy required to move an electron from

one energy level to another energy level … The electron’s energy is said to be quantized.

Two terms become important: Wavelength and Frequency





<http://www.qrg.northwestern.edu/projects/vss/docs/Communications/1-what-is-wavelength.html>

http://www.electronics-radio.com/articles/radio/modulation/frequency\_modulation/fm.php

A) Excited State: \* When the electrons of an atom absorb certain amounts of energy,

the inner electrons may move temporarily to higher energy levels. When the electron

returns to “normal”, the absorbed energy is often released as wavelengths of light.

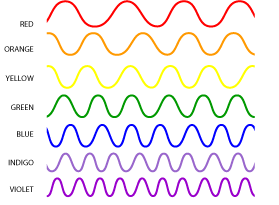
i) e.g.) When the ground state 2-8-1 then an excited state could be \_\_\_\_\_\_\_\_\_\_

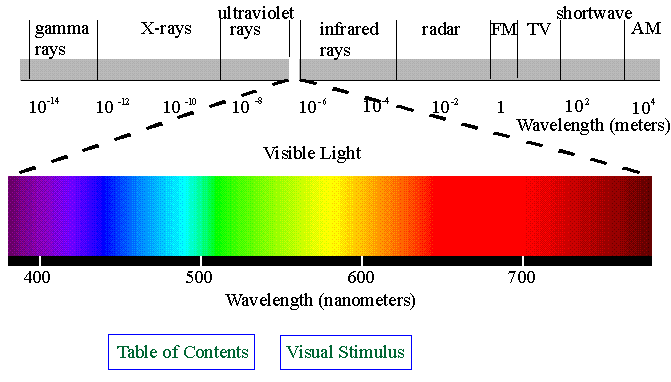
If the ground state is 2-8, then an excited state could be \_\_\_\_\_\_\_\_\_\_

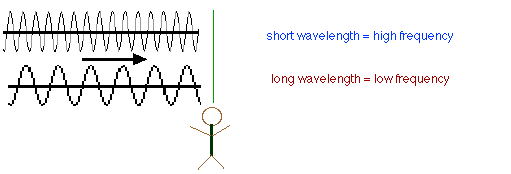
1) The key to understanding why this is of any importance is due to the fact that the electrons

raised to a higher energy level ….. ***temporarily***. This means… what goes “up”, most come

back down …. and when these excited electrons come back down. *Let there be light!*







<http://science.hq.nasa.gov/kids/imagers/ems/visible.html>

http://www.uccs.edu/~tchriste/courses/PES100/100lectures/radio.html

Take Home Message for the Everyday student ….

**Different wavelengths of light energy, \* give us our different colors of light**

EXCITATION AND RETURN TO GROUND STATE….AND THE RELEASE OF VISI BLE LIGHT ENERGY

e

e

e

1

2

e

e

An atom in the ground state

An e- absorbs energy from

an outside source

e

e

3

The absorbed energy pushes the e- farther away from

the nucleus. The e- is pushed to a higher energy level

The e- is “excited”. That is; the potential energy increases

e

e

4

The excited e- is unable to maintain its

excited state, in the absence of the outside

![j0118347](data:None;base64,)

energy source. The e- returns (falls back)

to its original energy level. This drop

brings the e- closer to the nucleus. The

potential energy decreases and the change in

energy (the lost energy) is released in a frequency

we can see (visible (colored) light)

Check out: <https://www.physicsclassroom.com/class/light/Lesson-2/Color-Addition>

<https://www.physicsclassroom.com/class/light/Lesson-2/Color-Subtraction>

Check out: <https://www.compoundchem.com/2014/09/11/autumnleaves/>

**Here is a neat application …Why is water “blue”?**

## Light attenuation in water

Shortwave radiation emitted from the sun wavelengths in the visible spectrum of light that range from 360 nm (violet) to 750 nm (red). When the sun’s radiation reaches the sea-surface, the shortwave radiation is attenuated by the water, and the intensity of light decreases exponentially with water depth. The intensity of light at depth can be calculated using the Beer-Lambert Law.

In clear open waters, visible light is absorbed at the longest wavelengths first. Thus, red, orange, and yellow wavelengths are absorbed at higher water depths, and blue and violet wavelengths reach the deepest in the water column. Because the blue and violet wavelengths are absorbed last compared to the other wavelengths, open ocean waters appear deep-blue to the eye.

In near-shore (coastal) waters, sea water contains more phytoplankton than the very clear central ocean waters. Chlorophyll-a pigments in the phytoplankton absorb light, and the plants themselves scatter light, making coastal waters less clear than open waters. Chlorophyll-a, absorbs light most strongly in the shortest wavelengths (blue and violet) of the visible spectrum. In near-shore waters where there are high concentrations of phytoplankton, the green wavelength reaches the deepest in the water column and the color of water to an observer appears green-blue or green.

<http://en.wikipedia.org/wiki/Attenuation>

Check out: The Aurora Borealis: <https://www.youtube.com/watch?reload=9&v=eJV_wlCm6ms>

And: <https://www.youtube.com/watch?v=5wZSt_LNq3U> (covers a little of nuclear fusion as well)