Unit 4 – Electrons & Periodic Table

Early Booklet E.C.:	**/ 2**
Unit 4 Hwk. Pts:	**/ 32**
Unit 4 Lab Pts:	**/ 60**
Late, Incomplete, No Work, No Units Fees?	Y / N

Learning Targets for Unit 4

1.1 I can compare the wave and particle natures of light.
1.2 I can define a quantum of energy and explain how it is related to an energy change of matter.
1.3 I can contrast continuous electromagnetic spectra and atomic emission spectra.
1.4 I can compare the Bohr and quantum mechanical models of the atom.
1.5 I can explain the impact of de Broglie's wave-particle duality and the Heisenberg uncertainty principle on the current view of electrons in atoms.
1.6 I can identify the relationships among a hydrogen atom's energy levels, sublevels, and atomic orbitals.
1.7 I can apply the Pauli Exclusion Principle, the aufbau principle and the Hund's rule to write electron configurations using orbital diagrams and electron configuration notation.
1.8 I can define valence electrons, and draw electrons-dot structures representing an atom's valence electrons.
1.9 I can trace the development of the periodic table.
1.10 I can identify key features of the periodic table.
1.11 I can explain why elements in the same group have similar properties.
1.12 I can identify the four blocks of the periodic table based on their electron configuration.
1.13 I can compare period and group trends of several properties.
1.14 I can relate period and group trends in atomic radii to electron configuration.

Unit Vocabulary for Unit 4

Actinide series	Lanthanide series	Alkali metal	Alkaline earth metal
Metal	Metalloid	Noble gas	Inner transitional metal
Halogen	Nonmetal	Group	Period
Periodic law		Transition metal	Representative element
Electronegativity	Ion	Ionization energy	Octet rule

Amplitude	Frequency	Electromagnetic spectrum	Electromagnetic radiation
Atomic.emission spectrum	Photon	Planck's constant	Wavelength
Atomic orbital	Energy sublevel	Ground state	Principal energy level
Quantum number	Principal quantum number	Quantum mechanical model of the atom	Aufbau principal
Electron configuration	Electron-dot structure	Hund's rule	Valence electron
Pauli exclusion principal			

Completed 4.1 Pts.:	**/ 8**
Late, Incomplete, No work, No Units Fee:	- 1 - 2 - 3
Final Score:	**/ 8**

4.1 Problems – Light and Energy

1. Arrange the following types of electromagnetic radiation in order of <u>increasing</u> wavelength: ultraviolet light, microwaves, radio waves, X rays

2. Define the photoelectric effect, and describe an application of it.

Use your electromagnetic Spectrum Resource (Resources Page 2) to solve and answer questions 3 – 7.

3. What type of radiation has a frequency of 8.6 E 11 Hz?

4. What type of radiation has a wavelength of 4.2 nm?

5. What type of radiation has a frequency of 5.6 MHz?

6. What type/types of radiation travels at a speed of 3.00 E 8 m/s?

7. A photon has an energy of 2.93 E-25 J. What is its frequency? What type of electromagnetic radiation is the photon?

8. How long does it take a radio signal from the Voyager spacecraft to reach Earth if the distance between them is 2.72 E 12 m? Use the distance equation: distance = rate • time (d = rt).

4.2 Problems – Quantum Theory

Completed 4.2 Pts.: / 5
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 5

1. According to the Bohr model, how do electrons move in atoms?

2. What is an atomic orbital?

3. How many total energy sublevels are contained in each of the hydrogen atom's first three energy levels? For example, the first energy level has one sublevel.

4. What do the sublevel designations s, p, d, and f specify, with respect to the atom's orbital shapes?

5. What is the maximum number of electrons an orbital can contain?

Completed 4.3 Pts.: / 6
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 6

4.3 Problems – Electron Configuration

1. Why does one electron in a rubidium atom occupy a 5s orbital rather than a 4d or 5f orbital?

2. What are valence electrons? How many of a magnesium atom's 12 electrons are valence electrons?

3. How many valence electrons are in the following elements?

   a. Carbon

   b. Iodine

   c. Calcium

   d. Gallium

4. Write the full electron configuration for oxygen and sulfur. What similarities and differences do these configurations have?

5. What element is represented by each electron configuration?

   a. $1s^2 2s^2 2p^3$

   b. $[Ar]4s^2$

   c. $[Xe]6s^2 4f^4$

   d. $[Kr]5s^2 4d^{10} 5p^4$

6. Why do the elements chlorine (used in laundry bleach) and iodine (a nutrient added to table salt) have similar chemical properties?

Completed 4.4 Pts.: / 6
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 6

4.4 Problems – Development of the Periodic Table

1. Explain the contribution of Newland's law of octaves to the development of the periodic table.

2. What was Mendeleev's contribution to the periodic table? How did his version of the periodic table accommodate future elemental discoveries?

3. If the periodic table were arranged by average atomic mass, which elements would be ordered differently than they are presently? Look at a periodic table to find these elements.

4. Describe two things that the ancient alchemists pursued in their quest for knowledge.

5. One of the transition groups is often called the 'coinage group' because at one time many coins were made of these metals. Which column of the transition metals is it? What element(s) in the group are still used in U.S. coins today?

6. The metal used in many cans has the electronic configuration [Ne] $3s^2 3p^1$. Identify the metal and its group and period.

Completed 4.5 Pts.: / 7
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 7

4.5 Problems – Periodic Trends

1. Explain why each successive ionization of an atom requires a greater amount of energy.

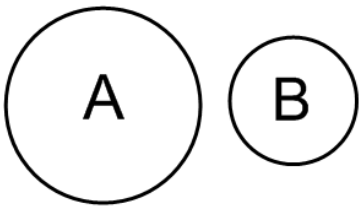
2. Explain why atomic radii decrease as you move from left to right across a period.

3. Which element has the larger ionization energy?
    a. Li or N

    b. Kr or Ne

    c. Cs or Li

Use the following figure to answer questions 4 – 6:



4. If A is an ion and b is an atom of the same element, is the ion positive or negative?

5. If A and B represent the atomic radii of two elements in the same period, what is their order?

6. If A and B represent the ionic radii of two elements in the same group, what is their order?

7. The electron configuration of a chlorine atom is $[Ne]3s^2 3p^5$. When it gains an electron and becomes an ion, its electron configuration changes to$[Ne]3s^2 3p^6$, the electron configuration for argon. Has the chlorine atom changed to an argon atom? Explain.

Chemistry	Lab 4.1 - Flame Test					
Name:						Correction Credit: Half
Lab Points:	E.C.	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
14	1 2		-1 -2 -3 -4			

Theory:

As demonstrated in class, elements produce different colors when heated. In this activity, you will explore some of these metals and their properties.

Safety Concerns:

In this lab we will be using Bunsen burners and chemicals, one of which (barium chloride) is moderately toxic.

You must wear your goggles at all times during the lab.

Materials/Chemicals:

Bunsen burner
Ruler
Flame test wand
12 chamber drop plate
Deionized water
Colored Labeling Pens
Barium chloride ($BaCl_2$)
Calcium chloride ($CaCl_2$)
Strontium chloride ($SrCl_2$)
Lithium chloride (LiCl)
Potassium chloride (KCl)
Sodium chloride (NaCl)
Copper sulfate ($CuSO_4$)
3 unknown chemicals A, B, C

Data Table: (1 point per element and unknowns – 10 points total)

On a separate sheet of paper (or a computer), make a clean, legible data table which lists your chemicals and unknowns, and observations. Surround your information in boxes.

All students must have a blank data table BEFORE they start the lab. **Staple** your data table to this page when you turn it in.

Format of Data Table:

Example Flame Test Data Table	
Chemical	**Observations: Color, duration of flame, other notes**
Barium Chloride	Color = whatever it was. It lasted for a couple seconds. The flames jumped around during heating. Etc.
Unknown A	Color = whatever it was. The flame went out. Etc.
Etc…	Etc... Finish this so each compound has a spot.

Procedure:

1. Place five drops of each chemical into a well labeled drop plate.
2. Rinse your wand with warm tap water, then DI water to clear off residual ions. Test your wand in the flame to check that there is no residual metal on it, but realize that it has a characteristic color too! If it still has a color contamination, re-rinse until it's clean.

Contamination is a real concern for this lab, as some metals have a subtle color that might be masked by another metal with a stronger one.

3. One at a time, gather a small sample of each chemical at the tip of your wand and place it in the flame.
4. Record your observations in your data table.
5. Obtain the unknown chemicals and test them. (1 point extra credit per correctly identified unknown (after the first one)). The unknown compounds are the same as the known compounds.

Clean Up:

Dispose of your chemicals down the drain, then wash your dropper dishes before putting them in the drying rack. Groups that leave a mess will be deducted **five points**.

Analysis: Answer the following questions:

1. Thoroughly explain why each compound produced a flame of a different color, even though most contained chlorine (2 points).

2. Infer the identity of the unknowns, and write them here. Thoroughly explain your reasoning: how do you know the unknowns are what they are? (2 pts for explanation, + 1 E. C. per element after the first.)

Chemistry	4.2 Lab - Atomic Emission				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
18		-1 -2 -3 -4			

Theory:

Elements produce different colors when their electrons return to a lower energy state from an excited one. You saw this during your flame tests, and today you'll see it happen when electricity is used to heat up elemental gasses in a tube. The colors correspond to different frequencies and wavelengths.

The wave equation allows you to calculate the frequency of light:

$$c = \lambda \cdot \nu$$

c = speed of light = 3.0 E 8 m/s

λ = wavelength in meters, and

ν = frequency in Hz.

Once you calculate the frequency of the color, you can use Planck's relation to calculate the energy of one photon of that color:

$E_{photon} = h \cdot \nu$

E = Energy in Joules (J)

H = Planck's Constant (6.63 E -34 J·s)

ν = Frequency (Hz)

In this activity, you will calculate energies associated with different frequencies of light, and compare two elements that are vertical neighbors on the periodic table.

Spectroscope Use:

Your spectroscopes measure the wavelength of the light that you see. The scale inside the scope corresponds to the nanometer range (nm). The scale reads **backwards** from 7 to 4. The numbers are actually 700 to 400 nm, but there wasn't enough room for them on the little plastic screen.

Before computing frequency or energy, you MUST convert from nm to meters. To do this, divide your measured wavelength (in hundreds of nanometers) by one billion.

Part 1. Frequency and Energy of Fluorescent Lights

Procedure:

Use a spectroscope to observe the emission spectrum of the fluorescent lights in the room.

A. Draw a picture of the spectrum, labeling the five wavelengths (in nm) of the brightest bands (2 points).

Figure 1: Scale in 100 nm.

Complete the following table using equations from the beginning of the lab to convert your five wavelengths to meters, and find out:

1. The frequency of each wavelength, (2.5 points total) and
2. The energy (E) of one photon of each frequency (2.5 points total).

Color	Wavelength (λ) measured in nm	Wavelength (λ) converted to m	Frequency (v) in Hz	Energy/photon in Joules (J)

Questions:

1. Which color has the most energy, and how much is it? (2 points)

2. Which color has the least energy, and how much is it? (2 points)

3. Ultraviolet (UV) rays, beyond the blue end of the visible spectrum, cause sunburn. Explain and describe how your energy comparison in the previous problems ties in to this observation. (2 points)

Part 2. Spectra of Helium and Neon

Procedure:

Use a spectroscope and the transmission generator to view and compare the emission spectra of helium and neon.

Draw a colored picture of the two spectra, labeling the wavelengths (in nm) of the brightest bands.

Helium
(1 point)

Figure 2: Scale in 100 nm.

Neon
(1 point)

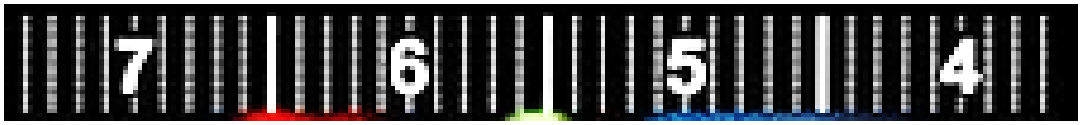


Figure 3: Scale in 100 nm.

Questions:

1. How many electrons do helium and neon have (1 point)?

2. Infer and explain in at least two good sentences why the spectrum of neon is more complex than helium, based on your answer to question 1 (2 points).

Chemistry	4.3 Lab - Periodic Table Scavenger Hunt				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
12		-1 -2 -3			

Instructions: Go to **ptable.com** for a scavenger hunt! Answer each question by filling the element's symbol or pertinent information on the line. Each item is worth ½ a point, except for the free response at the end, which is 2.0 points.

A. <u>Properties:</u>

_____ 1. Which element has the highest melting point?

_____ 2. What is the boiling point of gold?

_____ 3. Which element never freezes?

_____ 4. What is the electronegativity of thorium?

_____ 5. What is the maximum charge (valence) of lanthanum?

_____ 6. What is the maximum charge (valence) of vanadium?

_____ 7. List 2 elements that can lose eight valence electrons (have a charge (valence) of +8).

_____ 8. What is the calculated radius of calcium, in picometers?

_____ 9. Which element has the largest radius?

_____ 10. Which element has the smallest radius?

B. <u>Orbitals:</u>

_____ 11. What is the full electron configuration of selenium?

_____ 12. What is the full electron configuration of gold?

_____ 13. Select the element neodymium and then hover over the $4f^1$ orbital box. How many colored blobs appear in the picture area?

_____ 14. Select the element neptunium and then hover over the $5f^4$ orbital box. How many colored blobs appear in the picture area?

C. Isotopes: Press the 'all' button above nitrogen. This shows all isotopes of any element.

_____ 15. How many isotopes does calcium have?

_____ 16. What is the mass number of the first listed isotope of rubidium?

_____ 17. What is the mass number of the last listed isotope of xenon?

_____ 18. Which is the most abundant isotope of copper?

_____ 19. What is the abundance of sulfur-34?

_____ 20. What is the half-life of carbon-14, in years?

D. Free Response: 2 Points
Describe what you think is the coolest feature about this website in at least two sentences.

Chemistry	4.4 Lab - Minerals Activity				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
18		-1 -2 -3 -4			

Instructions:
You and your partners are element hunters, seeking specific element types in various minerals and pure elements. There are two parts to this: a Mineral Search, and an Element Search.

Minerals (Parts 1 and 2 Only):
Sulfides:
1. Cassiterite – SnS
2. Cinnabar – HgS (Do not touch)
3. Galena – PbS
4. Realgar – AsS (Do not touch)

5. Stibnite – SbS
6. Pyrite – FeS

Carbonates:

1. Azurite – $Cu_3(CO_3)_2(OH)_2$
2. Calcite – $CaCO_3$
3. Malachite – $Cu_2(CO_3)(OH)_2$

Oxides:

1. Hematite – FeO
2. Quartz – SiO_2

Other:

1. Fluorite – CaF_2
2. Ulexite – $NaCaB_5O_9 \cdot 5\ H_2O$

Pure Elements (Part 3 Only):

1. Bismuth – Bi
2. Copper – Cu
3. Gold – Au
4. Gallium – Ga
5. Silicon – Si
6. Sulfur – S

Part 1 - Mineral Search

Find an example of an s-block, p-block, and d-block element from the minerals in the room. Fill in the following table with the information you obtain.

NOTE: you will have to list three different minerals for this part, even though some of them may contain elements in multiple blocks. 2 points each.

Block	Element	Mineral – Name, Formula	Description of Mineral
S			
P			
D			

Part 2 - Mineral Search

Find an example of each of the following representative elements, or specific types of elements. Tell which mineral you found the element in, the mineral's formula, a description of it, and the number of valence electrons it has. You may use the same mineral more than once here. This part is worth 1 point each.

Find This:	Element	Mineral – Name, Formula, and Description	Valence Electrons
Alkali Metal			
Alkaline Earth Metal			
Group 3 Element			

Group 4 Element			
Group 5 Element			
Group 6 Element			
A Halogen			

Part 3 - Pure Element Search

Pick three of the six pure elements from the elements side of the room and fill out the following table. 2 points each.

Element	Description of Element	Group	Period	Electron Configuration

Chemistry	Essential Skill 4.1 - Electron Configuration
Name:	**Period:**
This serves as a practice worksheet to prepare you in the short term for the Configuration Quiz, and for the long term by reinforcing an essential skill in chemistry.	

While this is not worth points, you can use it on your Configuration Essential Skills quiz.
Write the **full** electron configuration for the following elements:

1. Oxygen

2. Titanium

3. Arsenic

4. Magnesium

Write the **noble gas** electron configuration notation for the following:

5. Indium

6. Mercury

7. Ruthenium

8. Thorium

Which elements are represented by the following configurations?

9. [Ar] $4s^2$

10. [Rn] $7s^2 5f^{13}$

11. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

How many valence electrons to the following elements have?

12. Strontium

13. Sulfur

14. Aluminum

Completed Points:	**/ 10**
Late/Inc. Fee: -1 -2 - 3	
Final Score:	**/ 10**

Unit 4 Test Review – Electrons & Periodic Table

This serves as test preparation for the Unit 4 exam. Points earned are based on completion, and we will go over any questions you have during the review. Additionally, you may be called upon to present a selection of these problems to the class.

1. Write the full electronic configurations for strontium (Sr):

2. Use noble gas notation to write the electron configurations for zirconium and calcium.

3. Which element has the configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1 4f^7$?

4. How many valence electrons are there in bromine, nitrogen, lithium, and krypton?

5. What is the energy of a photon with a frequency of 1.3 E 16 Hz? What type of radiation is it?

6. Write molybdenum's electron configuration. It is an exception to the Aufbau principle.

7. What is the frequency of a photon with a wavelength of 5.2 E - 12 m? What type of radiation is it?

8. Describe the photoelectric effect.

9. What is an emission spectrum, and what causes elements to have specific ones?

10. What did the Bohr model of the atom look like, and what were its limitations?

11. Describe the Heisenberg Uncertainty Principle, and how it affected the quantum model.

12. Draw an electromagnetic wave and label the amplitude and wavelength.

13. List four halogens, alkali metals, noble gases, and alkaline earth metals.

14. Explain the "Law of Octaves" and who proposed it?

15. What did Henry Moseley contribute to the development of the modern periodic table?

16. What did Mendeleev achieve in the development of the periodic table?

17. Why does atomic radius increase as you move down a group?

18. Why does ionization energy increase as you go across a period from left to right?

19. Why does atomic radius decrease from left to right across a period?

20. Using the periodic tables in your resource section, indicate the general trend of atomic radius, ionic radius, ionization energy, and electronegativity as you move across a period, and down a group.

21. Why are noble gases unreactive?

22. Which would be larger, a potassium ion or a potassium atom? Explain why you chose how you did.

23. Which would be larger, a sulfur atom or a sulfide ion? Explain your choice.