Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Regents Chemistry

Practice Packet

Unit 4: Atomic Structure



Vocabulary: Check your understanding. Describe each term in your words (not the textbook definition). Include pictures or examples to assist you.

Anion:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Atomic Mass: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Atomic Mass Unit (amu):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Atomic Number:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cation:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Deflect: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Electron:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Emit: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Excited State:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ground State: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ion:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Isotope: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Kernel:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Neutron:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Nuclear Charge: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Nucleon:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Nucleus: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Orbital:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Proton: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Shell (Principal Energy Level):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Stable Octet: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Valence Electrons:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**LESSON 1: ATOMIC THEORY**

***Objective:***

* Describe how the modern model of the atom has evolved over a long period of time through the work of many scientists
* Relate experimental evidence to models of the atom
* Describe in detail Rutherford’s Experiment and the conclusions he made

**Rutherford**

Ernest Rutherford performed the “Gold Foil” experiment in 1911 which helped him develop the “solar system’” or “nuclear” model of the atom. He used alpha particles (small but dense positive charged particles emitted like x-rays) and shot them at gold foil. He assumed that either the particles would go straight through the foil like an x-ray through a person’s skin, or they would be deflected back like x-rays on the lead suit you wear at the dentist. So he placed a detection chamber around his experiment to detect the alpha particles (and to shield himself from the radiation) and guess what? Both scenarios happened! He suggested that atom in mostly empty space with a dense positive nucleus in the center. Electrons orbit around the nucleus like planets around the sun.



1. If you threw a stream of tennis balls at a brick wall what would happen?
2. If you threw a stream of tennis balls at smoke what would happen?
3. If Dalton’s model is correct and the atom is a solid sphere; when alpha particles (tennis balls) were shot at the gold foil (wall), what should happen?
4. If Thomson’s model is correct and the atom is a positive cloud (smoke) with electrons scattered throughout; when alpha particles (tennis balls) were shot at the gold foil (wall), what should happen?
5. When Rutherford performed his experiment, for every 8000 alpha particles, only one particle was deflected. All other 7999 particles travelled straight through the foil.
	1. What does deflected mean?
	2. Was the probability of hitting the nucleus high or low?
	3. Does that mean the nucleus is small or large?
	4. Is that atom mostly solid or mostly empty?
	5. If the alpha particles were negatively charged, what would happen if they hit the positive nucleus?
	6. Rutherford knew the alpha particles are positive, so how did Rutherford know the nucleus was positive?
	7. Where is most of the mass of the atom?
	8. Where could the negatively charged electrons be?
	9. Are the electrons massive? How can you tell?
	10. Draw the Rutherford model labeling the protons, neutrons, electrons, nucleus and how alpha particles may be deflected or go straight through.

**Regents Practice:**

1.) J.J. Thomson’s Cathode Ray Tube experiment led to the discovery of

1. the positively charged subatomic particle called the electron
2. the positively charged subatomic particle called the proton
3. the positively charged subatomic particle called the electron
4. the negatively charged subatomic particle called the electron

2.) According to the Bohr Model,

1. electrons are found in areas of high probability called orbitals
2. electrons travel around the nucleus in circular paths called orbits
3. electrons are found in areas of high probability called orbits
4. electrons travel around the nucleus in random paths called orbitals

3.) According to the Wave-Mechanical Model,

1. electrons are found in areas of high probability called orbitals
2. electrons travel around the nucleus in circular paths called orbits
3. electrons are found in areas of high probability called orbits
4. electrons travel around the nucleus in random paths called orbitals

4.) In Thomson’s cathode-ray experiment, what evidence led him to believe that the ray consisted of particles, and why did he conclude that the ray was negatively charged?

5.) *One model of the atom states that atoms are tiny particles composed of a uniform mixture of positive and negative charges. Scientists conducted an experiment where alpha particles were aimed at a thin layer of gold atoms. Most of the alpha particles passed directly through the gold atoms. A few alpha particles were deflected from their straight-line paths. An illustration of the experiment is shown below.*

1. Most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of the gold atoms?

* 1. A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms
	2. How should the original model be revised based on the results of this experiment?

6.)*In 1897, J. J. Thomson demonstrated in an experiment that cathode rays were deflected by an electric field. This suggested that cathode rays were composed of negatively charged particles found in all atoms. Thomson concluded that the atom was a positively charged sphere of almost uniform density in which negatively charged particles were embedded. The total negative charge in the atom was balanced by the positive charge, making the atom electrically neutral. In the early 1900s, Ernest Rutherford bombarded a very thin sheet of gold foil with alpha particles. After interpreting the results of the gold foil experiment, Rutherford proposed a more sophisticated model of the atom.*

a. State *one* conclusion from Rutherford’s experiment that contradicts one conclusion made by Thomson.

b. State *one* aspect of the modern model of the atom that agrees with a conclusion made by Thomson.

 7.) Which group of atomic models is listed in historical order from the earliest to the most recent?

 a. hard-sphere model, wave-mechanical model, electron-shell model

 b. hard-sphere model, electron-shell model, wave-mechanical model

 c. electron-shell model, wave-mechanical model, hard-sphere model

 d. electron-shell model, hard-sphere model, wave-mechanical mode

**LESSON 2: SUBATOMIC PARTICLES**

***Objective:***

* Identify the subatomic particles of an atom (proton, neutron, and electron)
* Determine the number of protons, neutrons, electrons, nucleons and nuclear charge in a neutral atom

**ATOMS ARE NEUTRAL WHICH MEANS # of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ = # of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

*Fill in the table below using the periodic table and table S in your reference table.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Atomicsymbol | Atomicnumber | Protons | Neutrons | Electrons | Atomicmass |
| B |  |  | 6 |  |  |
|  | 11 |  |  |  | 24 |
|  |  | 31 | 37 |  |  |
|  |  |  |  | 39 | 89 |
|  | 29 |  | 35 |  |  |
|  |  | 43 |  |  | 100 |
| Pb |  |  |  |  | 207 |
|  |  |  | 102 | 70 |  |
|  |  | 89 |  |  | 225 |
| Mo |  |  | 53 |  |  |
|  | 81 |  |  |  | 206 |
|  | 100 |  | 159 |  |  |
| No |  |  |  |  | 261 |
| Yb |  |  |  |  | 174 |
|  |  | 106 | 159 |  |  |

`The term **nuclear charge** represents the number and sign of the charge inside the nucleus. Protons which are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ charged and neutrons which are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ charged, are in the nucleus. This means the nucleus is always \_\_\_\_\_\_\_\_\_\_\_\_\_\_ charged. The # of **nucleons** is the number of particles in the nucleus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ plus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

*Complete the table below (all are neutral):*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Atom** | **Protons** | **Electrons** | **Neutrons** | **Mass** **#** | **Atomic #** | **Nuclear charge** | **# of Nucleons** | **Nuclear diagram** | **Element’s Symbol** |
| **A** | **44** |  |  | **102** |  | **+44** |  | **58 n****44 p** |  |
| **B** |  | **84** | **125** |  |  |  |  |  |  |
| **C** |  |  |  | **56** |  |  |  |  | **Mn** |
| **D** |  |  |  |  | **89** |  | **229** |  |  |
| **E** |  |  | **30** |  |  | **+28** |  |  |  |
| **F** |  | **92** |  |  |  |  | **233** |  |  |
| **G** |  |  | **82** |  |  |  |  |  | **Ba** |

1. The number of protons in the nucleus of 32P is:

15

(1) 15 (2) 17 (3) 32 (4) 47

1. What is the total number of electrons in an atom with an atomic number of 13 and a mass number of 27?

(1) 13 (2) 14 (3) 27 (4) 40

1. The mass number of an atom is equal to the total number of its
	1. electrons only (2) protons only (3) electrons and protons (4) protons and neutrons
2. Which atom has a mass of approximately two atomic mass units?

|  |  |  |  |
| --- | --- | --- | --- |
| (1) 1H | (2) 2H | (3) 3He | (4) 4He |
| 1 |  1 |  2 |  2 |

1. The atomic number of an atom is always equal to the total number of
	1. neutrons in the nucleus (2) protons in the nucleus

(3) neutrons plus protons in the atom (4) protons plus electrons in the atom

1. What is the total number of neutrons in an atom of 39K?

19

(1)19 (2) 20 (3) 39 (4) 58

1. An Atom of 226Rn contains:

 88

* 1. 88 protons and 138 neutrons (2) 88 protons and 138 electrons

(3) 88 electrons and 226 neutrons (4) 88 electrons and 226 protons

1. Which nuclide contains the greatest number of neutrons

(1) 37 Cl (2) 39 K (3) 40 Ar (4) 41 Ca

1. Compare the masses of protons, neutrons and electrons.
2. Why does the nucleus have a positive charge?
3. What affect do neutrons have on the overall charge of the nucleus?

**LESSON #3: IONS**

***Objective:***

* Determine the number of protons, neutrons, and electrons in an ion

**An ION is an ATOM with a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; which means it will have a different number of protons and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

1. *Complete the following table*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Atomicsymbol | Atomicnumber | Protons | Neutrons | Electrons | Atomicmass |
| Na+1 |  |  |  |  |  |
| Cl-1 |  |  |  |  |  |
| P-3 |  |  |  |  |  |
| Fe+2 |  |  |  |  |  |
| Ag+1 |  |  |  |  |  |
| Br-1 |  |  |  |  |  |
| C-4 |  |  |  |  |  |
| I-1 |  |  |  |  |  |
| S-2 |  |  |  |  |  |
| K+1 |  |  |  |  |  |
| Co+2 |  |  |  |  |  |
| O-2 |  |  |  |  |  |
|  |  | 7 |  | 10 | 14 |
|  |  | 56 |  | 54 | 137 |

Since all atoms strive to become stable (8 electrons in their valence shell) when they gain or lose electrons to form ions they become stable. The resulting electron configuration of the ion is the SAME as that of a noble gas. For example, look at the electron configuration of oxygen.

The unstable atom of oxygen has an electron configuration of **2-6**.

To become stable the atom gains **2** valence electrons resulting in 8 valence electrons and a electron configuration of **2-8** which is the same configuration as the noble gas **Neon.**

2. *Complete the following Table*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ion** | **Charge** | **# of protons** | **# of electrons** | **Electron configuration** | **Electron Configuration same as…** | **Ion larger or smaller than atom?** |
| **Al3+** | **+3** | **13** | **10** | **2-8** | **Ne** | **smaller** |
| **P3-** |  |  |  |  |  |  |
| **Sr2+** |  |  |  |  |  |  |
| **Na+** | **+1** |  |  |  |  |  |
|  | **+2** | **12** |  |  |  |  |
|  | **+1** | **1** | **0** | **0** | **a proton** |  |
|  | **-2** | **8** |  |  |  |  |
|  | **-1** | **17** |  |  |  |  |
| **K+** |  |  |  |  |  |  |
| **F-** |  |  |  |  |  |  |

3. Explain, in terms of subatomic particles, why an oxygen atom is electrically neutral.

4.**.** Explain, in terms of subatomic particles, why an oxide ion, O2-, has a negative charge.

5. Compare the number of protons to the number of electrons in a positive ion.

6. Compare the number of protons to the number of electrons in a negative ion.

7. Explain, in terms of subatomic particles, why a chlorine ion is larger than a chlorine atom



**LESSON #4: ISOTOPES AND AVERAGE ATOMIC MASS**

***Objective:***

* Differentiate between atomic number, mass number, and (average) atomic mass
* Calculate the (average) atomic mass for all isotopes of an element
* Calculate the number of neutrons in an isotope

In terms of subatomic particles, **isotopes** are atoms of the same element, which have a different number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but the same number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Thus the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ number is the same but the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ number is different. Isotope names can be followed by the mass number. **Example:** Carbon -14 and Carbon-12. Isotope symbols include the element’s symbol with the mass number on the top left and the atomic number on the bottom left. **Example:**  146C and 126C

For each pair below, look up the element’s atomic mass from the reference table and decide which isotope is more abundant. Circle the more abundant isotope’s name.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Isotope Symbol** | **Atomic Mass** | **Atomic Number** | **Neutrons** | **Protons** | **Electrons** | **Nuclear Charge** |
| Lithium-6 |  |  |  |  |  |  |  |
| Lithium-7 |  |  |  |  |  |  |  |
| Boron-10 |  |  |  |  |  |  |  |
| Boron-11 |  |  |  |  |  |  |  |
| Sodium-22 |  |  |  |  |  |  |  |
| Sodium-24 |  |  |  |  |  |  |  |
| Aluminum-26 |  |  |  |  |  |  |  |
| Aluminum-27 |  |  |  |  |  |  |  |
| Iron-55 |  |  |  |  |  |  |  |
| Iron-56 |  |  |  |  |  |  |  |
| Zinc-65 |  |  |  |  |  |  |  |
| Zinc-66 |  |  |  |  |  |  |  |

1. What subatomic particle is different between the two isotopes?



1. Explain why the mass of Carbon-12 and Carbon-14 are different.
2. Can two different elements have the same number of neutrons?

**Calculating average atomic mass**

# What is your quarter grade if your categories have the following weights?

Your Grades: Test (*60% of the average of all tests scores*) **70**

Labs (*30% of the average of all lab scores*) **90**

Quiz (*10% of the average of all quiz scores*) **95**

1. What is the average isotopic mass of an unknown element X if the element has the following isotopes:

90% of all the existing element is : X35

10% of all the existing element is: X33

Avg atomic mass? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the most common isotope? \_\_\_\_\_\_\_

1. What is the isotopic mass of element Z if this element has the following isotopes:

 95% of all of the existing element is: Z80

4% of all of the existing element is: Z78

1% of all the existing element is: Z77

 Avg atomic mass? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the most common isotope? \_\_\_\_\_\_\_\_\_

1. Calculate the atomic mass for each element below, given the relative abundances and the mass numbers of the isotopes. Show ALL work. (GSSC)
2. 19.78% of B-10

80.22% of B-11

1. 78.70% of Mg-24

10.13% of Mg-25

11.17% of Mg-26

1. Base your answers to the following questions on the data table below, which shows three isotopes of neon.

****

1. In terms of *atomic particles,* state one difference between these three isotopes of neon.
2. Based on the atomic masses and the natural abundances shown in the data table, show a correct numerical setup for calculating the average atomic mass of neon.

1. Based on natural abundances, the average atomic mass of neon is closest to which whole number?
2. Naturally occurring elemental carbon is a mixture of isotopes. The percent composition of the two most abundant isotopes is listed below.

• 98.93% of the carbon atoms have a mass of 12.00 atomic mass units.

 • 1.07% of the carbon atoms have a mass of 13.00 atomic mass units.

1. Show a correct numerical setup for calculating the average atomic mass of carbon.
2. Describe, in terms of *subatomic particles found in the nucleus*, one difference between the nuclei of carbon-12 atoms and the nuclei of carbon-13 atoms. The response must include both isotopes.

7. The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are closest to

(1) 31% A-63 and 69% A-65 (2) 50% A-63 and 50% A-65
(3) 69% A-63 and 31% A-65 (4) 100% A-63 and 0% A-65

8. A 100.00-gram sample of naturally occurring boron contains 19.78 grams of boron-10 (atomic mass = 10.01 atomic mass units) and 80.22 grams of boron-11 (atomic mass = 11.01 atomic mass units). Which numerical setup can be used to determine the atomic mass of naturally occurring boron?

** **

** **

1. If the mass of a proton (1 amu) is the same as the mass of a neutron (1 amu), why do all of the atomic masses in the periodic table have decimals?
2. What is the most abundant or common isotope of Vanadium (V)?

 a) 50V b) 52V c) 51V d) 49V

**LESSON #5: BOHR DIAGRAMS**

***Objective:***

* ***Construct Bohr diagrams for atoms and ions***

**Bohr diagrams** show the number of protons and neutrons in the nucleus and the number of electrons in their energy levels. The electron configuration shows how many electrons are in each level in the ground state, or under normal conditions. An example of a Bohr diagram is given below:

**Magnesium (Mg)**

*Atomic number* 12

*Mass number* (rounded) 24

 12p+, 12 e-, 12no

12p+

12n0

2

12n0

8

12n0

2

12n0

**Draw the Bohr diagrams of the following:**

|  |  |  |  |
| --- | --- | --- | --- |
|  **H-1** | **K-40** | **Li-7** | **Be-9** |
| **B-11** | **C-14** | **Ne-20** | **O-16** |
| **F-19** | **Cl-35** | **Al-27** | **S-28** |
| **S-32** | **N-14** | **Mg-24** | **P-31** |

Valence electrons are the electrons in the outermost shell. They are the furthest from the nucleus, escaping the protons pulling on them. Therefore, they have the \_\_\_\_\_\_\_\_\_\_ energy out of all the electrons. Do any of the elements above have the same number of valence electrons? List the pairs:

**LESSON #6 GROUND VS. EXCITED STATE AND BRIGHT LINE SPECTRUM**

***Objective:***

* ***Differentiate between excited and ground state***
* ***Explain how light is produced***
* ***Identify substances based upon their bright line spectra***
1. Complete the table below. The first one is done for you.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Electron configuration** | **Total # of** **e-‘s** | **Total # of** **e- shells** | **e- shell with the highest energy e-‘s** | **Excited- or ground-state** | **Atom’s symbol** |
| **Atom A** | **2-8-4** | **14** | **3** | **3rd** | **ground** | **Si** |
| **Atom B** | **2-3-1**  |  |  |  |  |  |
| **Atom C** | **2-8-7-1** |  |  |  |  |  |
| **Atom D** | **2-8-18-6** |  |  |  |  |  |
| **Atom E** | **2-8-18-17-5** |  |  |  |  |  |
| **Atom F** | **1-7** |  |  |  |  |  |

1. Complete the table below. The first one is done for you.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element symbol** | **Element name** | **Ground-state electron configuration** | **# of valence electrons** | **An excited-state electron configuration**  |
| **O** | **oxygen** | **2-6** | **6** | **2-5-1** |
| **Mg** |  |  |  |  |
| **He** |  |  |  |  |
| **K** |  |  |  |  |
| **N** |  |  |  |  |
| **P** |  |  |  |  |
| **F** |  |  |  |  |
| **Sr** |  |  |  |  |
| **Al** |  |  |  |  |
| **Br** |  |  |  |  |
| **Cu** |  |  |  |  |

1. Electron transitions from one shell to another are given for four different atoms below:

 Atom G: 3rd shell to 2nd shell Atom I: 4th shell to 6th shell

 Atom H: 1st shell to 4th shell Atom J: 5th shell to 3rd shell

a. In which atom(s) is energy absorbed during the e- transition?

b. In which atom(s) is energy released during the e- transition?

c. In which atom(s) would spectral lines be observed?

d. In which atom is the greatest amount of energy absorbed?

e. In which atom is the greatest amount of energy released?

f. In atom G, compare the energy of the electron in the 3rd shell to that of the electron in the 2nd shell.

Base your answers to questions 4 and 5 on the diagram below, which shows bright-line spectra of selected elements.

 

10 Identify the *two* elements in the unknown spectrum. \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11 Explain how a bright-line spectrum is produced, in terms of *excited state* and *ground state.*

Base your answers to questions 12 and 13 on the information and the bright-line spectra represented below.


Many advertising signs depend on the production of light emissions from gas-filled glass tubes that are subjected to a high-voltage source. When light emissions are passed through a spectroscope, bright-line spectra are produced.

12 Identify the two gases in the unknown mixture. \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

**LESSON #7 LEWIS DOT DIAGRAMS**

***Objective:***

* ***Construct Lewis dot diagrams for atoms and ions***

******Lewis diagrams** show only the atom’s symbol and dots representing the valence electrons. The most valence electrons an atom can have is \_\_\_\_ so the most dots you will draw is \_\_\_\_. Please make dots very visible!

 **Examples of atoms: Examples of Ions:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Protons** | **Neutrons** | **Electrons** | **Electron Configuration** | **Valence Electrons** | **Lewis Diagram** |
| Rubidium-85 |  |  |  |  |  |  |
| Cesium-133 |  |  |  |  |  |  |
| Strontium-88 |  |  |  |  |  |  |
| Barium-138 |  |  |  |  |  |  |
| Germanium-72 |  |  |  |  |  |  |
| Tin-119 |  |  |  |  |  |  |
| Arsenic-75 |  |  |  |  |  |  |
| **Name** | **Protons** | **Neutrons** | **Electrons** | **Electron Configuration** | **Valence Electrons** | **Lewis Diagram** |
| Antimony-121 |  |  |  |  |  |  |
| Selenium-79 |  |  |  |  |  |  |
| Tellurium-127 |  |  |  |  |  |  |
| Bromine-80 |  |  |  |  |  |  |
| Iodine-127 |  |  |  |  |  |  |
| Xenon-131 |  |  |  |  |  |  |
| Krypton -84 |  |  |  |  |  |  |

1. Why are the valence electrons the most important electrons? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. The **kernel electrons** are all electrons except the valence electrons. How many kernel electrons does magnesium have? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Draw the Lewis dot diagram of Cs+1, Sr+2, Te-2 and Br -1
4. All cations have \_\_\_\_\_\_\_\_\_ dots and all anions have \_\_\_\_\_\_\_ dots.

**Unit 4 REVIEW/STUDY GUIDE**

**SCIENTIFIC THEORIES**

**Dalton** theorized that atoms were the smallest particle and could not be divided. Atoms can bond with one another in whole number ratios to form compounds but cannot be created or destroyed. Atoms of the same element are identical. Dalton’s model is known as the **hard sphere model**.

1. According to Dalton, what is inside the atom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What part of Dalton’s theory has been disproven? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Thompson** worked with the cathode ray tube and discovered a ray of light travelling to the positive plate in the tube. This particle was the **electron** which must have a negative charge. Because atoms are neutral, Thompson assumed there must be invisible positively charged particles as well. These discoveries lead to Thompson’s **plum pudding model**.

1. Draw the plum pudding model:
2. Explain why Thompson concluded that electrons are negative.

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

**Rutherford** shot alpha particles at gold foil in an effort to disprove either Dalton or Thompson’s theory. If Dalton were right, the alpha particle would deflect, if Thompson were right the alpha particle would go straight through. 99% of the alpha particles went straight through. Rutherford concluded the atom was mostly empty space with a dense positive **nucleus** containing **protons** and **neutrons**. His model is known as the **nuclear model**.

1. Draw the nuclear model:
2. If alpha particles are positive and bounce off of the nucleus, what is the charge of the nucleus?

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

**Bohr** used complicated mathematics to organize electrons into **orbits** around the nucleus with specific energies. His model is known as the **planetary model**.

 a. Draw the planetary model:

 b. Have the placement of p+ and no changed in Bohr’s model since Rutherford’s model? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**SUBATOMIC PARTICLES**

Atoms are neutral and contain subatomic particles. **Protons** are positively charged particles located in the nucleus**. Neutrons** are neutral particles located in the nucleus. **Electrons** are negatively charged particles found in orbit around the nucleus. Protons and neutrons both weigh 1 amu and the electron’s mass in negligible.

 a. Fill in the chart below:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Charge | Mass | Location |
| Proton |  |  |  |
| Neutron |  |  |  |
| Electron |  |  |  |

b. What is an amu? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What does “the electron’s mass in negligible” mean? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 d. If atoms are neutral, then the number of protons \_\_\_\_\_\_\_\_\_ the number of electrons because

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

The **atomic number** is the identity of an element. The periodic table and table S are arranged according to the atomic number. It tells you how many protons an atom has.

1. Which element has 36 protons? \_\_\_\_\_\_\_\_\_\_\_\_\_
2. How many protons does chlorine have? \_\_\_\_\_\_\_\_\_\_\_

The **mass number** of an element is a whole number equal to the number of protons and neutrons. Every atom has it’s own mass number.

1. Why aren’t electrons counted in the mass number? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. How many electrons does C-12 have? \_\_\_\_\_\_\_\_ B-11? \_\_\_\_\_\_\_\_\_\_\_ O-16? \_\_\_\_\_\_\_\_\_\_

**IONS**

**Ions** represent atoms that have either gained or lost electrons forming anions and cations. A list of allowable charges is listed on the top right corner of every element box on the periodic table.

1. Why can’t atoms gain protons to become positive? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Why can’t atoms lose protons to become negative? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What are negative ions called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What are positive ions called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. A sample has 35 protons and 36 electrons. Give the element symbol and charge. \_\_\_\_\_\_\_
6. A sample has 1 protons and 0 electrons. Give the element symbol and charge. \_\_\_\_\_\_\_
7. A sample has 19 protons and 18 electrons. Give the element symbol and charge. \_\_\_\_\_\_\_

**ISOTOPES**

**Isotopes** are atoms of the same element with the same number of protons. But they have different number of neutrons and a different mass.

1. What do isotopes have in common? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. How are isotopes different? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 c. Which of the following are isotopes?

 126C 157N 146C 157N 125B

The **atomic mass** of an element is the weighted average mass of the naturally occurring isotopes.

a. Explain how mass number and atomic mass are different. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What the atomic mass of Carbon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. If there are two isotopes of carbon, C-12 and C-14, which is more abundant? \_\_\_\_\_\_\_\_\_\_

 d. Calculate the atomic mass of a sample of element X which contains 45% X-118 and the rest is X-120.

**ELECTRONS, BOHR, AND SPECTRA**

Neils **Bohr** organized the electrons into energy levels. Electrons closer to the nucleus have less energy than electrons further from the nucleus. The first level holds only 2 electrons. The second level holds 8, third holds 18 and fourth 32. These numbers are reported on the periodic table. Each element’s box has an **electron configuration** in the **ground state** showing how many electrons are in each level.

1. What is the electron configuration of Neon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the electron configuration of Strontium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Which element has the excited state electron configuration 2-8-9-3? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Draw the Bohr diagram of the following:

F-19-

S-32

C-14

The last level contains **valence** electrons that can be lost or gained to form ions involved in bonding. **Cations** are positive ions that have lost electrons, therefore having more positive protons than negative electrons. **Anions** are negative ions that have gained electrons and then have fewer protons than electrons.

1. How many valence electrons does Sodium have? \_\_\_\_\_\_\_\_
2. How many valence electrons does fluorine have? \_\_\_\_\_\_\_\_
3. If an atom has 8 protons and 10 electrons, what is the charge? \_\_\_\_\_ What type of ion is it? \_\_\_\_\_\_
4. If an atom has 12 protons and 10 electrons, what is the charge? \_\_\_\_ What type of ion is it? \_\_\_\_\_\_
5. Draw the Lewis diagram of the following:

 F S P-3 Na+

When energy is added to the atom, electrons can move up to higher energy levels, in the excited state. The excited state is unstable. When the electrons return to the ground state they release energy in the form of light called a spectra. Every atom has a different spectrum.

1. Energy is \_\_\_\_\_\_\_\_\_\_\_\_\_ when electrons move from higher to lower energy levels.
2. Energy is \_\_\_\_\_\_\_\_\_\_\_\_\_ when electrons move from lower to higher energy levels.
3. Spectra is observed when electrons move from \_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_ energy levels.
4. Why can you identify atoms by their spectra? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. Identify which two gases (A, B, C, or D) are in the unknown mixture: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



1. Why are spectra a better identifier than the flame test?

g. How are spectra and flame test similar?