Name: ____________________________ **Unit 2 Study Guide: Atomic Theory**

Honors Chemistry

Chm.1.1.1 Analyze the structure of atoms, isotopes, and ions.

- Characterize protons, neutrons, electrons by location, relative charge, relative mass (p=1, n=1, e=1/2000). ***(questions 25, 29, 31, 32, 33)***
- Use symbols: A= mass number, Z= atomic number ***(questions 28, 30)***
- Use notation for writing isotope symbols: ${}^{235}_{92}U$ or U-235 ***(questions 28, 30)***
- Identify isotope using mass number and atomic number and relate to number of protons, neutrons and electrons. ***(questions 23-30)***
- Differentiate average atomic mass of an element from the actual isotopic mass and mass number of specific isotopes. (Use example calculations to determine average atomic mass of atoms from relative abundance and actual isotopic mass to develop understanding). ***(question 1)***

Chm.1.1.2 Analyze an atom in terms of the location of electrons

- Analyze diagrams related to the Bohr model of the hydrogen atom in terms of allowed, discrete energy levels in the emission spectrum. ***(questions 6, 8, 12, 14, 22)***
- Describe the electron cloud of the atom in terms of a probability model. ***(questions 6, 8, 12, 14, 22)***
- Relate the electron configurations of atoms to the Bohr and electron cloud models. ***(questions 6, 8, 11, 13, 14, 15, 22)***

Chm.1.1.3 Explain the emission of electromagnetic radiation in spectral form in terms of the Bohr model

- Understand that energy exists in discrete units called quanta.
- Describe the concepts of excited and ground state of electrons in the atom:
    1. Gaining energy results in the electron moving from its ground state to a higher energy level ***(questions 9, 10, 21)***.
    2. When the electron moves to a lower energy level, it releases the energy difference in the two levels as electromagnetic radiation (emissions spectrum). ***(question 4)***
- Articulate that this electromagnetic radiation is given off as photons. ***(question 4)***
- Understand the inverse relationship between wavelength and frequency, and the direct relationship between energy and frequency. ***(questions 2, 3, 4, 5)***
- Use the “Bohr Model for Hydrogen Atom” and “Electromagnetic Spectrum” diagrams from the Reference Tables to relate color, frequency, and wavelength of the light emitted to the energy of the photon. ***(questions 2, 4)***
- Explain that Niels Bohr produced a model of the hydrogen atom based on experimental observations. This model indicated that:
    1. an electron circles the nucleus only in fixed energy ranges called orbits;
    2. an electron can neither gain or lose energy inside this orbit, but could move up or down to another orbit;
    3. that the lowest energy orbit is closest to the nucleus. ***(question 16)***
- Describe the wave/particle duality of electrons.

Chm.1.1.4 Explain the process of radioactive decay by the use of nuclear equations and half-life.

- Use the symbols for and distinguish between alpha (${}^{4}_{2}He$), and beta (${}^{0}_{-1}e$) nuclear particles, and gamma (γ) radiation include relative mass). ***(questions 17)***
- Use shorthand notation of particles involved in nuclear equations to balance and solve for unknowns. ***(questions 19)***
- Compare the penetrating ability of alpha, beta, and gamma radiation. ***(question 18)***
- Conceptually describe nuclear decay, including:
    1. Decay as a random event, independent of other energy influences
    2. Using symbols to represent simple balanced decay equations ***(question 19)***
    3. Half-life (including simple calculations) ***(question 20)***
- Compare radioactive decay with fission and fusion

Practice Questions:

1) The element Magnesium has three stable isotopes with the following masses and abundances:

Isotope	Mass (amu)	Abundance
${}^{24}Mg$	23.9850	78.99%
${}^{25}Mg$	24.9858	10.00%
${}^{26}Mg$	25.9826	11.01%

Calculate the average atomic mass of magnesium from these data.

Show work as you solve problems 2-4:

2) What is the wavelength of a radio wave with frequency 8.95 x10^7 Hz?

What is the energy of each photon with that frequency?

3) If the energy required to remove an electron from sodium is 8.23x10^{-19}J, what frequency of light will cause sodium to ionize?

What will be the wavelength of that light?

4) Calculate the frequency of light emitted in the hydrogen atom with the energy transition goes from n = 4 to n = 1. (Use the Bohr model in your reference packet to answer this question)

5) Of x-rays, visible light and radio waves:
   a. Which is the longest in wavelength?
   b. Which is the highest in frequency?
   c. Which is the highest in energy?

6) Seven questions about sulfur:
   a. Write out the electron configuration of sulfur which has ____ e^-.
   b. Write the orbital diagram for sulfur.
   c. Explain what stable ion sulfur should form based on its electron configuration.
   d. Sketch and label the orbital that contains sulfur's outermost electron.
   e. Sketch and label the orbital that contains sulfur's innermost electron.
   f. How many valence electrons does sulfur have?
   g. Sulfur and oxygen have the same number of valence electrons. Which atom has a larger size? Support your answer with a reason.

7) What block of the periodic table are the following elements in?

   Mg = _____________ Fe = _____________ U = _____________ Ar = _____________

8) How many electrons can go into each type of sublevel? s_____ p _____ d _____ f ______

9) An electron that is in the lowest possible energy level is in the _____________ ______________.

10) What do we mean if we say an electron is "excited"?

11) How many electrons are in each of the following?
   a. A filled p orbital
   b. A filled d sublevel
   c. The 2nd energy level when it's full
   d. A half-filled p-sublevel
   e. A half-filled d orbital

12) There is an orbital with the label $3p_y$. What makes this orbital different from each of the following orbitals?
   a. $3d_{xy}$
   b. $2p_y$

13) <u>Write the electron configuration for the following atoms and ions.</u> **Identify the element that each <u>ion</u> is isoelectronic** (has the same electron configuration) **with.**

   a. Cl

   b. Br^{1-} — Br^{1-} is isoelectronic with = ____

   c. Na

   d. Al^{3+} — Al^{3+} is isoelectronic with = ____

14) <u>Write the noble gas configuration for each of the following atoms.</u>

   a. Mn
   c. Cs

   b. As
   d. Zr

15) Is Hund's rule going to be important when writing an electron configuration or drawing an orbital in a diagram? Why?

16) Is the Aufbau principle important in electron configurations, orbital diagrams, or both? Explain.

17) Arrange the following decay particles in order of increasing mass: $^{4}_{2}\alpha,\ ^{0}_{-1}\beta,\ ^{0}_{0}\gamma$

18) Arrange the following decay particles in order of increasing penetrating power: $^{4}_{2}\alpha,\ ^{0}_{-1}\beta,\ ^{0}_{0}\gamma$

19) Balance each nuclear reaction by filling in the missing particle in each case.

   a. $^{148}_{64}Gd \rightarrow \qquad + \ ^{144}_{62}Sm$
   b. $^{35}_{14}Si \rightarrow \ ^{0}_{-1}e \ +$

20) The half-life of a radioactive isotope is 20.0 minutes. How much of a 1.00 gram sample of this isotope remains after 1.00 hour?

<u>Circle the best answer for each of the following multiple choice questions:</u>

21) Lighting fireworks pushes electrons into a higher energy level. Which of these terms describes the state of these electrons?
   A) Energetic
   B) Excited
   C) Ground
   D) Stable

22) Which of these is correct electron configuration for a neutral atom of fluorine?
   A) $1s^22s^22p^5$
   C) $1s^22s^2sp^4$
   B) $1s^22s^22p^6$
   D) $1s^22s^22p^63p^5$

23) How many protons are found in an atom of calcium?

A) 6 B) 20 C) 40 D) 38

24) A potassium ion has a charge of 1+. How many electrons does the atom have?

A) 18 B) 19 C) 20 D) 39

25) The mass of an element is concentrated in the nucleus of the atom and is based on what two subatomic particles?

A) Protons and electrons
B) Protons and neutrons
C) Electrons and neutrons
D) Neutrinos and protons

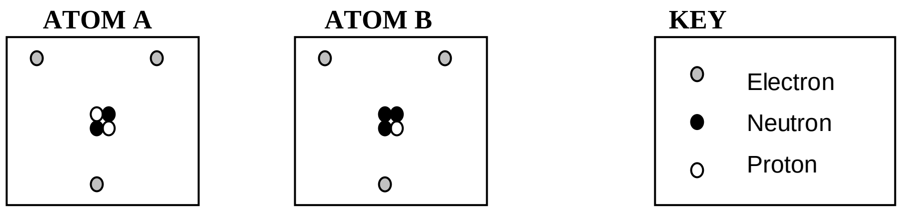
26) Which of these is the only difference between isotopes of an element?

A) The number of electrons
B) The number of protons
C) The number of neutrons
D) The atomic number

27) An isotope of phosphorus has 15 protons and 17 neutrons. Which of these is the correct name for this isotope?

A) Phosphorus-32
B) Phosphorus-15
C) Phosphorus-17
D) Phosphorus-2

Use the following diagram for Questions 28-30



28) How many neutrons are shown in Atom B?

A) A B) 2 C) 3 D) 4

29) What is the charge of Atom A?

A) 1+ B) 1- C) 2+ D) 4+

30) Which of these best describes the two atoms?

A) They are ions of the same elements.
B) They are ions of different elements.
C) They are isotopes of the same element.
D) They are neutral atoms of different elements.

31) Which of these statements about the structure of an atom is <u>false</u>?

A) Electrons have a negative charge and are found inside the nucleus
B) Protons have a positive charge and are found inside the nucleus
C) Neutrons have a mass of 1 amu and have no charge
D) The mass of protons and neutrons are almost the same

32) Which of these must be equal in a neutral atom?

A) Protons and neutrons
B) Neutrons and electrons
C) Protons and electrons
D) Protons, neutrons and electrons

33) Which of these describes the difference between the calcium atom and the Ca^{2+} ion?

A) The calcium ion has gained two e^-
B) The calcium ion has lost two e^-
C) The calcium ion has gained two p^+
D) The calcium ion has lost two p^+