**Chemistry Concepts**  Name: \_\_\_\_\_\_\_\_\_\_

**Chapter 4:** Arrangement of Electrons in Atoms

4-1: The Development of a New Atomic Model

**The Wave Description of Light**

* **Electromagnetic radiation** - form of energy that exhibits \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as it travels through space.
* **Electromagnetic spectrum** - all the forms of electromagnetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Properties of Light**

* **Wavelength (λ) -** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ corresponding points on adjacent \_\_\_\_\_\_\_\_\_\_.
* **Frequency (v) -** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that pass a given point in a specific time, usually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Frequency and wavelength are mathematically related to each other:

*c* = λv

* *c* - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (in m/s)
* λ - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the electromagnetic wave (in m)
* v - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the electromagnetic wave (in s−1).

**Photoelectric effect -** emission of electrons from a metal when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**The Particle Description of Light**

* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_ -** minimum quantity of energy that can be lost or gained by an atom.

*E* = *h*v

* + *E* - \_\_\_\_\_\_\_\_\_\_\_\_\_\_, in joules, of a quantum of radiation
  + v - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, in s−1, of the radiation emitted
  + *h* – constant known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_ constant; *h* = 6.626 × 10−34 J• s.
  + **\_\_\_\_\_\_\_\_\_\_\_\_\_\_ -** particle of electromagnetic radiation having zero mass and carrying a quantum of energy.

**The Hydrogen-Atom Line-Emission Spectrum**

* **Ground state -**
* **Excited state -** state in which an atom has a higher potential energy . . .
* **Line-emission spectrum -** four bands of light separated as . . .

**Bohr Model of the Hydrogen Atom**

* ***Orbits -*** 
  + The energy of the electron \_\_\_\_\_\_\_\_\_\_\_\_\_ when the electron is in orbits that are successively \_\_\_\_\_\_\_\_\_\_\_\_\_ from the nucleus.
* ***Emission* -** electron \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, a photon is emitted.
* ***Absorption -*** Energy must be added to an atom in order to move an electron from a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4-2: The Quantum Model of the Atom

**Electrons as Waves**

* Electrons, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, can undergo diffraction and interference.
* *Diffraction -* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as it passes by the edge of an object or through a small opening.
* *Interference* occurs \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Heisenberg uncertainty principle** - it is impossible to determine simultaneously both \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or any other particle.

**The Schrödinger Wave Equation**

* **Quantum theory** describes mathematically \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* **Orbital** - three-dimensional region around the nucleus that indicates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Atomic Orbitals and Quantum Numbers**

**Quantum numbers** specify the properties of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the properties of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in orbitals.

* **Principal quantum number (***n)* - indicates the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occupied by the electron.
* **Angular momentum quantum number** (*l)* -indicates the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* **Magnetic quantum number (***m)* - indicates the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ around the nucleus.
* **Spin quantum number** - has only two possible values -- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ -- which indicate the two fundamental \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an electron in an orbital.

4-3: Electron Configurations

**Electron configuration** - arrangement of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in an atom.

* *Ground-state electron configuration* –
* **Rules Governing Electron Configurations**
* **Aufbau principle -** an electron . . .
* **Pauli exclusion principle -** no two electrons in the same atom . . .
* **Hund’s rule -** orbitals of equal energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and all electrons in singly occupied orbitals must have the same spin state.

**Orbital Notation**

* An unoccupied orbital is represented by a line, with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* An orbital containing \_\_\_\_\_\_\_electron is represented as:
* An orbital containing \_\_\_\_\_\_\_ electrons is represented as:
* The lines are labeled with the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and sublevel letter. For example, the orbital notation for helium is written as follows:

**Electron-Configuration Notation**

* The helium configuration is represented by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The superscript indicates that there are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in helium’s \_\_\_\_orbital.

**Sample Problem A**

* The electron configuration of boron is 1*s*22*s*22*p*1. How many electrons are present in an atom of boron? What is the atomic number for boron? Write the orbital notation for boron.

**Electron Configurations**

* *Highest-occupied energy level* - main energy level an electron is located in with the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* *Inner-shell electrons* - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that are \_\_\_\_\_\_\_ in the highest-occupied energy level.

**Noble-Gas Notation**

* **Noble gases** - \_\_\_\_\_\_\_\_\_\_\_\_ elements (helium, neon, argon, krypton, xenon, and radon)
* **Noble-gas configuration** - outer main energy level occupied, in most cases, by \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* **Outer octet** – \_\_\_\_ electrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_ sublevels are filled)

**Sample Problem B**

1. Write the complete electron-configuration notation and noble-gas notation for iron, Fe.
2. How many electron-containing orbitals are in an atom of iron? How many of these orbitals are completely filled? How many unpaired electrons are there in an atom of iron? In which sublevel are the unpaired electrons located?

**Sample Problem C**

1. Write both the complete electron-configuration notation and the noble-gas notation for a rubidium atom.
2. Identify the elements in the second, third, and fourth periods that have the same number of highest-energy-level electrons as rubidium.