3. Atomic Structure and the Periodic Table

3.1 Internal Structure of an Atom

Dalton's Atomic Theory: To account for the chemical reactivity **John Dalton** in his atomic theory postulated that:

1) Matter is composed of small indivisible particles.
2) An element is composed of identical tiny particles called atoms.
3) Compounds are formed when atoms of different elements combine.
4) Chemical Reactions involve rearrangement of atoms to form new compounds.

First and second this postulate is the most important concept in his theory to show clearly for the first time the existence of atoms. This was necessary to explain the fixed properties of an element. Third postulate was necessary to explain the existence of compounds and the breaking of compounds into elements. Fourth postulate was necessary to define and describe the chemical reaction or chemical changes.

Discovery of subatomic particles and nucleus

Radioactivity and instability of elements

Henry Becquerel had already noted that uranium emanations of ionizing radiation and then **Pierre and Marie Curie** measured the ability of emanations from various. Curies tested an ore of uranium, pitchblende's ability to emanate ionization radiation found it 300 times stronger than that produced by pure uranium. The Curies reasoned that a very active unknown element (a new unstable later named polonium) must have been produced must exist within the pitchblende in addition to the uranium (U). They introduced the new term: "radioactive." **Radioactivity** to explain the instability of atomic nuclei of certain lighter and all heavier elements after lead (Pb). These unstable radioactive elements disintegrate into **stable nucleus** while giving out three types of ionizing radiation: 1) α-(He nuclei), 2) β-(fast moving electrons), and 3) γ-(high energy electro magnetic radiation) radiation. Discovery of radioactivity was a prelude to the discovery of the subatomic particles.

Discovery of Electrons:

Thomson's cathode ray tube experiments

Electrons: Electrons are sub-atomic particles with a mass of 9.11×10^{-28}g (1/1833 times mass of a proton) and a negative charge of 1.60×10^{-19} c (c=coulombs) or -1.60×10^{-19} c. Electron was first discovered by J.J. Thompson using cathode-ray tubes or Crook's tubes.

Measuring Electronic Charge: Millikan's oil drop experiments

American physicist **Robert Andrews Millikan** (1868-1953) designed an experiment to measure the electronic charge. He found that electron has a negative charge of 1.60×10^{-19} c (c=coulombs) or -1.60×10^{-19} c.

Discover of Nuclear atom: Rutherford's a-particle experiment

A New Zealander, **Ernest Rutherford** passed Alpha(α-)particles through an extremely thin gold foil. He expected them to go straight through with perhaps a minor deflection. Most did go straight through, but to his surprise some particles bounced directly off the gold sheet! This means there something in the atom that deflected the alpha particles. Rutherford hypothesized that the positive alpha particles had hit a concentrated mass of positive particles, which he termed the **nucleus**.

Nucleus: The mass and the positive (+) charge of an atom are concentrated in the center. This center is called nucleus, and it has radius of about 10^{-13} cm.

Proton: Henry Moseley is credited for the work leading the atomic number and the proton. Proton is a sub-atomic and sub-nuclear particle. A proton has a mass of 1.67×10^{-24} g (which is 1833 times heavier than electrons) and carries a positive charge of 1.60×10^{-19} c.

Neutron: Henry Moseley is credited for the discovery of neutron which is a sub-atomic and sub-nuclear particle with a mass of 1.675×10^{-24} g (which is 1833 times heavier than electrons) and carrying no charge.

An atom is the smallest particle of an element that determines the physical and chemical properties of that element. An atom has a **nucleus** a sphere with a very dense center containing the **protons** and **neutrons** around which negatively charged **electrons** move like the planets around the sun. The atom can be thought of as a sphere of empty space where electrons move and 90% of atom's mass located in the nucleus at the center. **protons**, **neutrons** and **electrons** called **subatomic particles**.

Subatomic particle	Mass		Charge
Electron (e^-)	9.109×10^{-28} g	0.0055 amu	-1.60×10^{-19} C
Proton (p^+)	1.672×10^{-24} g	1.0087 amu	$+1.60 \times 10^{-19}$ C
Neutron (n^0)	1.675×10^{-24} g	1.0073 amu	0

* amu atomic mass units

Nucleus has a radius of about 10^{-13} cm. An atom has a radius of about 10^{-8} cm or 1 Å (angstroms). If an atom were the size of a football stadium, with the electrons out around the upper deck, the nucleus down at midfield would be smaller than the coin flipped at the start of the game.

3.2 Atomic Number and Mass Number

Atomic number (Z): Number of protons in a nucleus of an atom is called atomic number (Z). Z is characteristic of an element. An atom of oxygen always has eight protons and atomic number equal to eight.

Mass Numbers (A): Number of neutrons and protons together in a nucleus of an atom is called mass number (A).

3.3 Isotopes and Atomic Masses

Atoms of an element having different number of neutrons in the nucleus are called isotopes. These atoms of the same element (same **Z**) have different atoms different **Mass Number (A)** values.

Isotopic symbol: Element symbol (**X**) found on the periodic table with number of protons or atomic number (**Z**) written as left subscript, and mass number (**A**), total of number of protons and neutrons written as left superscript.

$${}^{A}_{Z}X \qquad \text{E.g carbon-12: } {}^{12}_{6}C$$

or simply written as ^{12}C because once atomic symbol is known atomic number could be found easily from the periodic table.

Carbon-12 with natural abundance of 99.90%

Carbon-13 with natural abundance of 1.10%

The average atomic weight of carbon is listed as 12.0107

$${}^{1}_{1}H \qquad {}^{2}_{1}H \qquad {}^{3}_{1}H$$

hydrogen-1 **hydrogen-2** **hydrogen-3**

hydrogen-1 isotope has 1 proton and 1 electron

hydrogen-2 isotope (deuterium) has 1 proton, 1 neutron, 1 electron.

Hydrogen-3 isotope (tritium) has 1 proton, 2 neutrons, and 1 electron.

Average Atomic Mass (A.A.M)

Average atomic mass **(A.A.M)**for an element which is reported on the periodic table is calculated based on the masses of isotopes and their relative composition.

Most of the elements have two or more isotopes. Atomic weights based on the masses of isotopes and their relative composition. For example, Gallium in nature consists of two isotopes:

Isotope	Isotope Mass	Fractional Abundance	% Abundance
gallium-69 (^{69}Ga) gallium-71 (^{71}Ga)	68.926 amu (M_a) 70.925 amu (M_b)	0.601 (a) 0.399 (b)	60.1 (%a) 39.9 (%b)
Using factional Abundances A.A.M = M_a x a + M_b x b = 68.926x(0.601)+70.925 x(0.339) = 69.723 A.A.M. (Ga) = = 69.723 **amu** or **g/mol**		**Using % Abundances** A.A.M = $\frac{M_a \text{ x } \%a + M_b \text{ x } \%b}{100}$ AAM = $\frac{68.926x(60.1)+70.925 x(0.39.9)}{100}$ A.A.M. (Ga) = = 69.723 **amu** or **g/mol**	

Silicon exists as a mixture of three isotopes. Determine its average atomic mass based on the following data to correct significant figure.
Isotope Mass (amu or g/mol) Abundance

Isotope	Isotope Mass	Fractional Abundance	% Abundance
Silicon-28 (^{28}Si) Silicon-29 (^{29}Si) Silicon-30 (^{30}Si)	27.976 9265 28.976 4947 29.973 7702	0.9223 0.467 0.310	92.23 % 4.67 % 3.10 %
Using factional Abundances A.A.M = M_a x a + M_b x b + M_c x c = ____x(____)+ ____x(____)+ ____x(____)=____ A.A.M. (Si) = = ____ **amu** or **g/mol**		**Using % Abundances** A.A.M = $\frac{M_a \text{ x } \%a + M_b x\%b + M_c \text{ x } \%c}{100}$ AAM = $\frac{\_\_\_x\_\_\_ + \_\_\_x\_\_\_ + \_\_\_x\_\_\_}{100}$ A.A.M. (Ga) = ____ **amu** or **g/mol** Ans:__________	

The atomic masses of ^{35}Cl (75.53%) and ^{37}Cl (24.47%) are 34.968 amu and 36.956 amu, respectively. Calculate the average atomic mass of chlorine. The percentages in parentheses denote the % relative abundances. Ans:_________

Chemistry at a Glance: Atomic Structure

3.4 The Periodic Law and the Periodic Table

In the early 1800's many elements had been discovered and found to have different properties. **Newlands** – "law of octaves", a pattern of reactivity follows after 8 elements. However, no one had found a clear "order" in their properties until **Mendeleev**, Dmitri (1834-1907) arranged 63 then known elements in the order of **increasing atomic mass** in a periodic table and showed some **chemical properties** would reappear periodically. In

certain cases, he placed a lighter slightly heavier element before a lighter element so that the chemical properties of the vertical columns would be preserved.

In Mendeleev's table, there was a gap. He purposely left blank position in his table so that the consistent vertical columns with the same chemical properties would be preserved. These missing elements were later discovered.

The periodic law is an organized "map" of the elements that relates their structure to their chemical and physical properties. The periodic table is the result of the periodic law, and provides the basis for prediction of such properties as relative atomic and ionic size, ionization energy, and electron affinity, as well as metallic or non-metallic character and reactivity.

The modern periodic table exists in several forms. The most important variation is in group numbering. The tables in the text use the two most commonly accepted numbering systems.

Periods and Groups

Periods are the **horizontal rows** of elements in the periodic table; the **columns** represent **groups** or **families**.

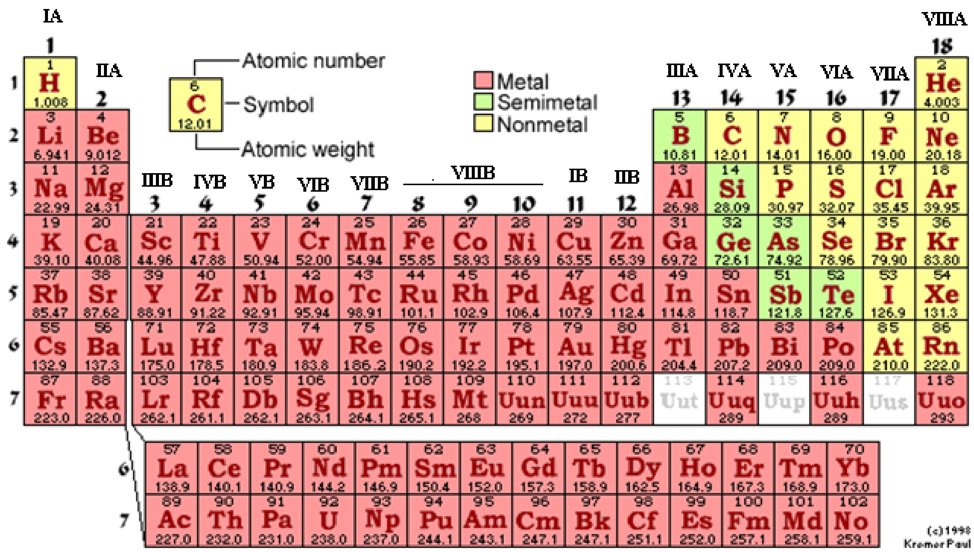
Elements in a **vertical group** have similar chemical properties. The vertical groups are currently named by numbers ranging from **1** to **18**. An older way to identify the vertical groups is to use a Roman number and the capital letters **A** or **B**. Vertical groups of main group elements (or representative elements) were given a Roman numeral plus the letter A. Vertical groups of transition elements were given a Roman numeral plus the letter B.

Representative elements are elements that always lose or gain the same number of electrons in chemical reactions.

Transition elements are elements that can lose or gain variable numbers of electrons in chemical reactions.

Lanthanide series and the **actinide series** are parts of periods **6** and **7**, respectively, and groups that have been named include the **alkali metals**, the **alkaline earth metals**, the **halogens**, and the **noble gases**. **Group A** elements are called representative elements; **Group B** elements are transition elements. **Metals**, **metalloids**, and **nonmetals** can be identified by their location on the periodic table.

These groups are number from **1 - 18**, left to right and groups have their Roman numbers and **A** or **B** classification.



3.5 Metals and Nonmetals

Most of the elements in the periodic table are **metals**. Note the stair step line in the periodic table. Elements to the left of the line are metals. Elements to the right of the line are **nonmetals**. In between metal and non-metals there are **semi-metals** or **metalloids**. Metals lose electrons and nonmetals gain electrons.

Problem: Pick the a) representative elements, b) transition elements, c) inert gas elements, d) elements that from anions, e) semi- metals, and f) elements that from cations from the following list: Ca, Si, K, Ar, Cu, Fe Zn, Ge, Kr, Cl, O, F.

Answers:

a) Representative elements: Ca, Cl, O, F

b) Transition elements: Cu, Fe

c) Inert gas elements: Ar, Kr

d) Elements that from anions: O, F

e) Semi- metals: Si, Ge

f) Elements that from cations: Ca, K, Cu, Fe Zn

Problem: Use your periodic table to find the symbol, atomic number and atomic mass rounded to two decimal place of each of the following elements: a) Magnesium b) Neon c) Selenium d) Gold

Answer:

Mg, atomic number = 12, mass = 24.31 amu

Ne, atomic number = 10, mass = 20.18 amu

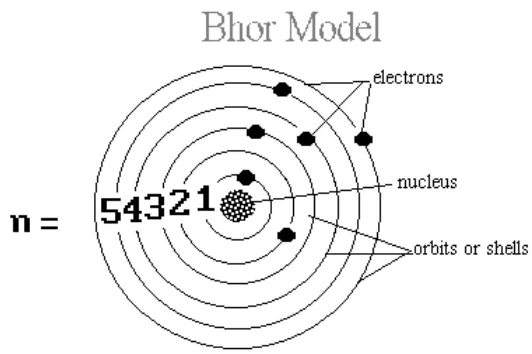
Se, atomic number = 34, mass 78.96 amu

Au, atomic number 79, mass 197.0 amu

3.6 Electron Arrangements within Atoms

Basic postulates of Bohr's theory

Niels Bohr in 1913, developed a theory describing the possible arrangement of electrons around the uncles of the hydrogen atom to explain emission and absorption **electro magnetic radiation (EMR)**. It has four postulates:



1. An electron in hydrogen atom moves in a **circular orbit** or **shell** about the nucleus under the influence of the charged attraction between the electron and the nucleus
2. It is **only allowed** for the electron to move in a circular shell with increasing distance from the nucleus in the following order: **Shell 1**-K (**n=1**), **Shell 2**-L (**n=2**), **Shell 3**-M(**n=3**), **Shell 4**-N (**n=4**), **Shell 5**-O (**n=5**), **Shell 6**-P (**n=6**), **Shell 7**-Q (**n=7**). **n** is called **principle quantum number** of the electron.
3. The electron moving in an allowed shell has fixed energy and the energy of the shells increase in the following order: **Shell (n=1)**< **Shell** (**n=2**)< **Shell <**(**n=3**), **Shell <** (**n=4**), **Shell <** (**n=5**), **Shell <** (**n=6**), **Shell <** (**n=7**).
4. Electromagnetic radiation (EMR) is **emitted** when the electron, initially moving in a shell of higher energy moves to a lower energy shell or **absorbed** when moving from lower to higher.

What is electromagnetic (EM) radiation (EM)?

Electromagnetic radiation is a form of self-propagating waves which does not require a medium to travel. It has its own **electric and magnetic field component** which oscillate in phase perpendicular to each other and to the direction of energy propagation. Examples of EM radiation include radio waves, microwaves, infrared radiation (IR), **visible light**, ultraviolet radiation (UV), X-rays and gamma(γ) rays. Of these, radio waves have the longest wavelengths and Gamma rays have the shortest. Higher wavelength shorter the frequency and lower the energy. the A small window of frequencies, called visible spectrum or light, is sensed by the eye of various organisms.

Which of the following electromagnetic radiation have shortest wavelength?
Infrared radiation or radio waves.

Which of the following electromagnetic radiation have higher frequency?
ultraviolet radiation (UV) or visible light.
]
Which of the following electromagnetic radiation have higher energy?
Infrared radiation (IR) or **gamma(γ) rays**.

Using Bohr model:

Which of the following Shell has the shortest distance to the nucleus?
Shell 1-K (**n=1**), **Shell 2**-L (**n=2**), **Shell 3**-M(**n=3**), **Shell 4**-N (**n=4**), **Shell 5**-O (**n=5**), **Shell 6**-P (**n=6**), **Shell 7**-Q (**n=7**). Ans: **Shell 1**-K (**n=1**)

Which of the following Shell has the highest energy?
Shell 1-K (**n=1**), **Shell 2**-L (**n=2**), **Shell 3**-M(**n=3**), **Shell 4**-N (**n=4**), **Shell 5**-O (**n=5**), **Shell 6**-P (**n=6**), **Shell 7**-Q (**n=7**). Ans: **Shell 7**-Q (**n=7**).

Assign the energy change as emission or absorption for the following electron transitions beween shells with certain n= the principle quantum number

a) **Shell 1**-K (**n=1**) to **Shell 4**-N (**n=4**): Ans: **Absorption**.
b) From **Shell 5**-O (**n=5**) to **Shell 2**-L (**n=2**): **Emission**.

Modifications to Bohr's theory using Wave-mechanical" approach

Bohr in his model of the atom assumed electron as particle carrying an negative charge. A new approach treating electron as an wave called **Wave-mechanical Model** seem to explain much more experimental observations and the arrangement elements in the periodic table.

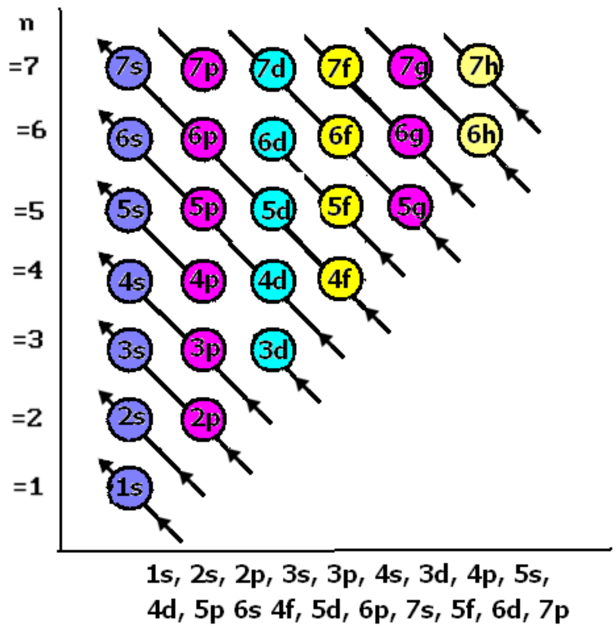
According to new **Wave-mechanical model** an electron a hydrogen atom has addition features:

1) Each shell could have sub-shells called s, p, d and f. Listed below is sub-shell description of each shell with certain principle quantum number:
2) Each sub-shell s, p, d, f, ~~g~~ , ~~h~~ and ~~i~~ in each shell can have 1,3, 5, 7, 9, 11 and 13 atomic orbital's. Even though 6ds, 6fs, 7ds 7fs, g and h sub-shells are possible they are never used for electrons in any of the atoms discovered so far and we ignore them. Sub-shells energy order: s< p < d < f < ~~g~~ < ~~h~~ < ~~i.~~
3) Each atomic orbital can have maximum of 2 electrons with spins ↑ (up) and ↓ (down). The maximum number of electrons is a given shell is calculated using the formula, $2n^2$.
4) The orbital filling order for multi-electron atom: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p 6s 4f, 5d, 6p, 7s, 5f, 6d, 7p

Summary of Wave-mechanical Model

n	**Shell**	**Sub-shells**	**Atomic Orbitals** One s, three p, five d, seven f, nine g, eleven h 1, 3, 5, 7, 9, 11, 13 odd series	**Total elens. ($2n^2$)**
1	1	s	**1s**	2
2	2	s, p	**2s**, **$2p_1$, $2p_1$, $2p_3$**	8
3	3	s, p, d	**3s**, **$3p_1$, $3p_2$, $3p_3$**, **$3d_1$, $3d_2$, $3d_3$, $3d_4$, $3d_5$**	18
4	4	s, p, d, f	**4s**, **$4p_1$, $4p_2$, $4p_3$**, **$4d_1$, $4d_2$, $4d_3$, $4d_4$, $4d_5$** **4f1, 4f2, 4f3, 4f5, 4f6, 4f7**	32
5	5	s, p, d, f, ~~g~~	**5s**, **$5p_1$, $5p_2$, $5p_3$**, **$5d_1$, $5d_2$, $5d_3$, $5d_4$, $5d_5$** **5f1, 5f2, 5f3, 5f5, 5f6, 5f7**, ~~**gs**~~	50
6	6	s, p, d, ~~f~~, ~~g~~, ~~h~~	**6s**, **$6p_1$, $6p_2$, $6p_3$**, ~~**$6d_1$, $6d_2$, $6d_3$, $6d_4$, $6d_5$**~~ ~~**6f1, 6f2, 6f3, 6f5, 6f6, 6f7, gs and hs**~~	72
7	7	s, p, d, ~~f~~, ~~g~~, ~~h,~~ ~~i~~	**7s**, **$7p_1$, $7p_2$, $7p_3$**, ~~**$7d_1$, $7d_2$, $7d_3$, $7d_4$, $7d_5$**~~ ~~**7f1, 7f2, 7f3, 7f5, 7f6, 7f7 gs, hs and is**~~	98

Multi-electron atom orbital filling diagram: Building up principle of electron configuration: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p 6s 4f, 5d, 6p, 7s, 5f, 6d, 7p



Chemistry at a Glance: Shell, Sub-shell and Orbital Interrelationships.

The total number of electrons that can be accommodated in the sub-levels within:
a) n = 1 b) n = 2 c) n = 3 d) n =4 e) n = 5
Ans:
a) n = 1 ($2n^1 = 1$) b) n = 2 ($2n^2 = 8$) c) n = 3 ($2n^2 = 18$)d) n =4 ($2n^2 = 32$) e) n = 5 ($2n^2 = 50$)

How many orbitals are in the following sub-shells:
a) s b) p c) d d) f e) g

Ans:
a) s (1) b) p (3) c) d (5) d) f (7) e) g (9)

How many electrons that can be accommodated in the following sub-shells:
a) s b) p c) d d) f e) g

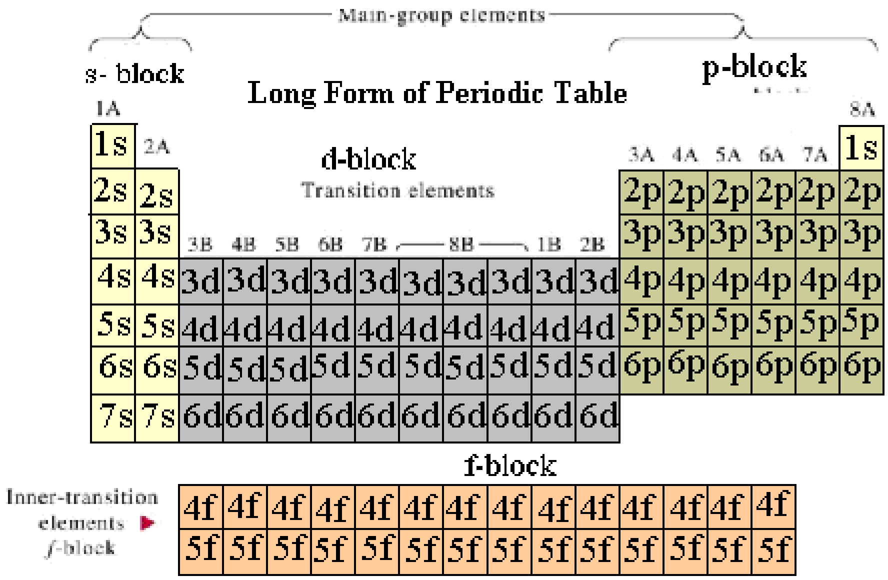
Ans:
a) s (1 x 2= 2) b) p (3x 2= 6)) c) d (5 x 2 =10) d) f (7 x 2 =14) e) g (9 x 2 = 18)

3.7 Electron Configurations and Orbital Diagrams
Electronic configuration element and the periodic table

Electronic configuration of an element: Arrangement of electrons in atomic orbitals in the order of increasing energy. E.g.

H :$1s^1$, **He** :$1s^2$, **C**: $1s^2 2s^2 2p^2$, **O**: $1s^2 2s^2 2p^4$

Periodic Table and the Atomic Orbitals: Periodic table is useful in getting an electron configuration of an atom since modern periodic table is a direct reflection of filling order of electron into a multi electron atom.



Orbital filling order: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p 6s 4f, 5d, 6p, 7s

Assign atomic orbital block where last electron is added in following elements:

a) **alkali metals** b) **alkaline-earth metals** c) **halogens** d) **noble gases**

a) **alkali metals(s-block)**
b) **alkaline-earth metals (s-block)**
c) **halogens (p-block)**
d) **halogens (p-block)**

Electronic configuration for an atom is obtained using following procedure:

1) Number of electron in an atom is equal to its Atomic number:
2) Following atomic orbitals s, p, d , and f can have maximum of 2, 6 , 10 , and 14 electrons respectively.
3) Use the filling order which is obvious in the periodic table: Period number gives principle quantum number, orbital block shows when you add an electron which types of orbital it would be added to.

E.g. Oxygen (O)
Fill the atomic orbitals starting from lowest 1s and assuming that a **s orbital** can only take up 2 electrons p orbital six d orbital ten, f orbital 14 etc.
Atomic number is 8 therefore it has 8 electrons
Orbital filling order: **1s, 2s, 2p**, ~~**3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p 6s 4f, 5d, 6p, 7s**~~
Only fist three lowest energy atomic orbitals are used for 8 electrons.
O: **$1s^2$** ….two in 1s orbital …. **$2s^2$** two in 2s orbital and ….remaining 4 electrons in 2p orbitals **$2p^4$**
Electronic configuration of O: $1s^2 2s^2 2p^4$

What is the electron configuration of atoms of flowing elements: In, Co and Ca?
In
Atomic number is 49 therefore it has 49 electrons
Orbital filling order: **1s, 2s, 2p**, **3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p** ~~**6s 4f, 5d, 6p, 7s**~~
Only fist eleven lowest energy atomic orbitals are used for 49 electrons.
In: **$1s^2$** ….two in 1s orbital …. **$2s^2$** two in 2s orbital and ….remaining 6 electrons in 2p orbitals **$2p^6$..etc.**

Electronic configuration of In: $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6,5s^2, 4d^{10},5p^1$

Electronic configuration of Co: $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^7$

Electronic configuration of Ca: $1s^2, 2s^2, 2p^6$

Valence shell electronic configurations

Complete electronic configurations shows how electrons are added to the subshell of lowest energy until it reaches its capacity. The most important shell of electrons in the atom fro the chemical reactivity is the outermost shell: **The valence shell**. Valence Shell electronic configuration is written by summarizing the **inner shell** or **core electron** configuration using form what we call **inert-gas core format.**

Complete electronic configurations	**Electronic configuration in inert-gas core format.**
C: $1s^2 2s^2 2p^2$	**C**: [He] $2s^2 2p^2$
O: $1s^2 2s^2 2p^4$	**O**: [He]$2s^2 2p^4$
In: $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6,5s^2, 4d^{10},5p^1$	**In:** [Kr] $5s^2, 4d^{10},5p^1$
Co: $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^7$	**Co:** [Ar]$4s^2,3d^7$
Ca: $1s^2, 2s^2,2p^6,3s^2,3p^6,4s^2$	**Ca:** [Ar]$4s^2$

Complete electronic configurations:
C: $1s^2 2s^2 2p^2$
O: $1s^2 2s^2 2p^4$
Electronic configuration in core format:
O: [He]$2s^2 2p^4$
Give the valence electron configuration in core format of following atoms: a) Na b) Cl c) P d) O

Valence-shell Electron Configuration: Electron configuration of the outer most shell (maximum n)

Ans: a) Na: [Ne] $3s^1$ b) Cl: [Ne] $3s^2,3p^5$ c) P : [Ne] $3s^2,3p^3$ d) O : [He] $2s^2,2p^4$

Valence shell orbital diagrams

Shows how electrons the details of the **Complete electronic configurations** and the **valence shell**. Here we mainly focus on **Valence shell orbital diagrams.**

Electronic configuration in inert-gas core format.	**Valence shell orbital diagrams**
C: **[He]** $2s^2$ $2p^2$	$2s^2$ [↓↑] $2p^4$ [↓] [↓] [ ]
O: **[He]**$2s^2$ $2p^4$	$2s^2$ [↓↑] $2p^4$ [↓↑] [↓] [↓]
In: [Kr] $5s^2$, $4d^{10}$,$5p^1$	$2s^2$ [↓↑] $4d^{10}$ [↓↑] [↓↑] [↓↑] [↓↑] [↓↑] $5p^1$ [↓] [ ] [ ]
Co: [Ar]$4s^2$,$3d^7$	$4s^2$ [↓↑] $3d^7$ [↓↑] [↓↑] [↓] [↓] [↓]
Ca: [Ar]$4s^2$	$42s^2$ [↓↑] $4p^0$ [↓] [↓] [ ]

3.8 The Electronic Basis for the Periodic Law and the Periodic Table

Representative elements: **s-block** and **p-block** elements that always lose or gain the same number of electrons in chemical reactions.

Transition elements: d-block elements that can lose or gain variable numbers of electrons in chemical reactions.

Lanthanide series and the **actinide series: f-block** elements are parts of periods **6** and **7**, respectively.

3.9 Classification of the Elements in the periodic table

a**) Alkali metal: Li, Na, K, Rb, Cs, and Fr** **Valence** Li, Na, K, Rb, Cs, Fr **ele.^{n} con^n** $2s^1$ $3s^1$ $4s^1$ $5s^1$ $6s^1$ $7s^1$	Loose one electron and get noble gas electron configuration and forms mono positive cations
b) **Alkaline Earth Metals Be, Mg, Ca, Sr, Ba, and Ra** **Valence** Be, Mg, Ca, Sr, Ba, Ra ele.^{n}con^n $2s^2$, $3s^2$ $4s^2$ $5s^2$ $6s^2$ $7s^2$	Loose two electron and get noble gas electron configuration and forms di-positive cations.
c) **Halogens: F, Cl, Br, and I** **Valence** **F, Cl, Br, I** **ele.^{n} con^n** $2s^22p^5$,$3s^22p^5$,$4s^24p$, $5s^25p^5$	Gains one electron and achieve noble gas configuration and forms mono positive anions
d) **Noble gases: He, Ne, Ar, Kr, Xe and Ra** **Valence** He, Ne, Ar, **ele.^{n}con^n** He :$1s^2$, Ne:$2s^2$ $^e2p^6$, Ar: $3s^23p^6$, Kr, Xe Ra Kr:$4s^24p^6$, Xe:$5s^25p^6$, Ra:$6s^26p^6$	Have closed shell electron configurations. Do not loose or gain electrons.

Alkali metals: ns^1-group
alkaline earth metals: : ns^2 -group, the **halogens**, and the **noble gases**. **Group A** elements are called representative elements; **Group B** elements are transition elements. **Metals**, **metalloids**, and **nonmetals** can be identified by their location on the periodic table.

Chemistry at a Glance: Describe Element Classification Schemes and the Periodic Table
Chemical Connections: Describe heat Protium, Deuterium, and Tritium: The Three Isotopes of Hydrogen; Importance of Metallic and Nonmetallic Trace Elements for Human Health; Electrons in Excited States