Grade 11 chemistry
Chapter two part 1
Atomic Structure
and the Periodic Table

historical development of the atomic nature of substances

- ✓ The concept of an atom began in ancient Greek
- ✓ The idea of an atoms was believed to have originated with the Greek philosophers Leucippus and his student Democritus

Democritus

- ✓ proposed the first atomic theory
- ✓ atom is indivisible or uncuttble
- ✓believed in particle theory that is discontinuous theory
- ✓ believed that world was made of two thing atom and empty space

historical development of the atomic nature of substances

Aristotle

- ✓ was the opponent of Democritus
- ✓believed in particle theory that is discontinuous theory
- ✓Plato-believed that earth, air, fire, and water are compromised of unchanging geometric solid
- ✓Parmenides-believed that all change is illusion

DALTON'S ATOMIC THEORY AND THE MODERN ATOMIC THEORY

- ✓**Atomic theory is the study of the nature of the atoms and forces that hold them together.**
- ✓**Atomic theory is the idea that element are mad up of atom**
- ✓**Dalton was the founder or the father of modern atomic theory**
- ✓the laws that are the basis for Dalton's atomic theory are the law of conservation of mass and the law of definite proportions

Postulates of Dalton's Atomic Theory and the modern atomic theory

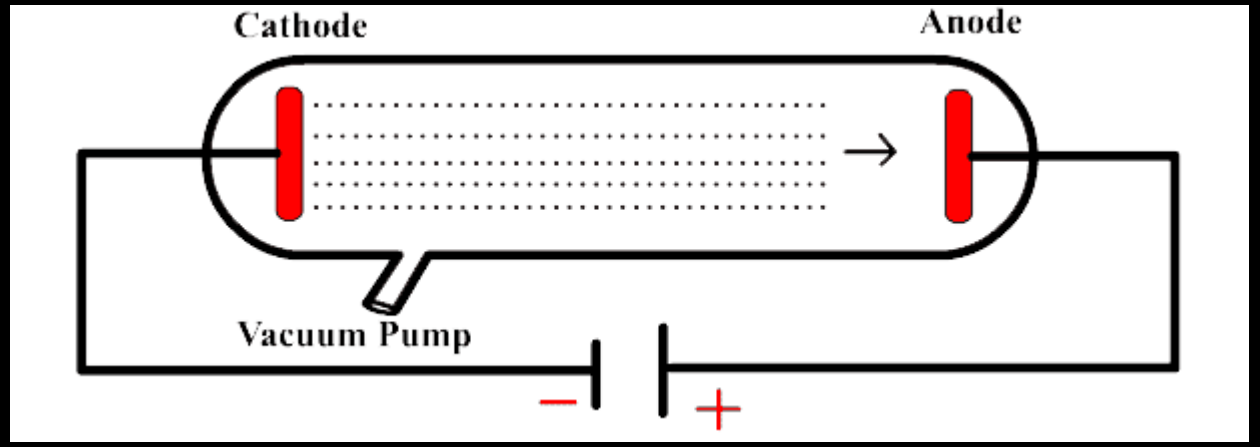
Daltons atomic theory	Modern atomic theory
Elements are made up of small particle called atom	Elements are made up of small particle called atom
Atoms are indestructible	Atoms are indestructible during ordinary reaction
Atoms of the same element are identical in mass and other properties	Atoms of the same element have different mass due to isotopes
Atoms combine in small whole numbers ratio to form compounds	Atoms combine in small whole numbers ratio to form compounds
Atoms of the different element are different	Atoms of the different element are different
Atoms are indivisible	Atoms are divisible

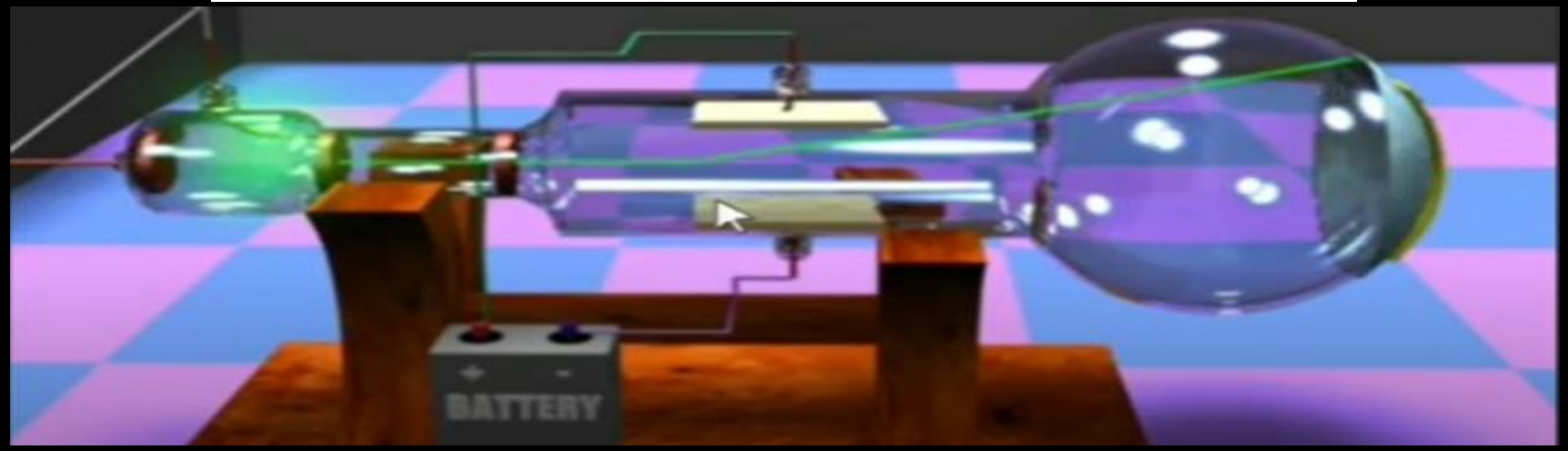
How the Modern Theory Explains the Mass Laws

- ✓***Law of multiple proportions*** chemical compounds are formed when atoms combine in whole-number ratios.
- ✓***law of constant(definite) composition*** A given compound always has the same relative number and types of atoms.
- ✓*law of conservation of mass* In a chemical reaction, the mass of the reactants (*starting materials*) equals the mass of the reaction products provided no reactant remains.

EARLY EXPERIMENTS TO CHARACTERIZE THE ATOM

Discovery of the Electron





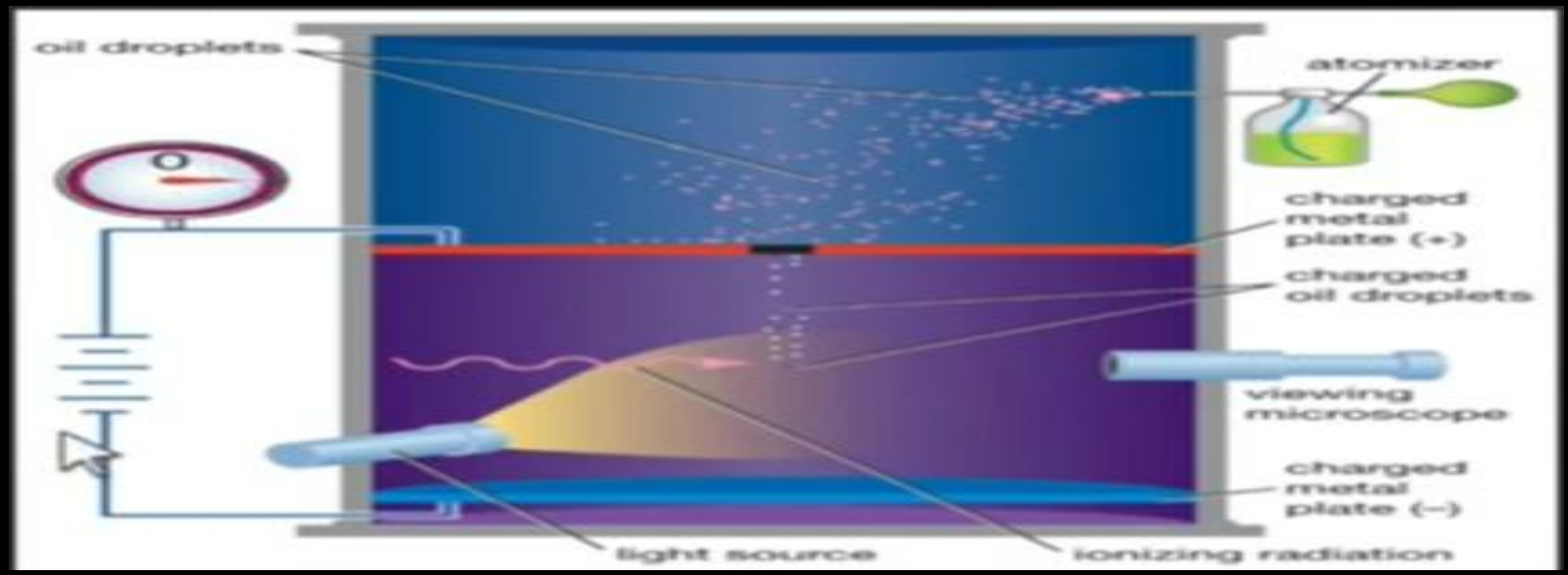
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Discovery of the Electron

- ✓Was discovered by J.J Thomson
- ✓Was the first sub atomic particle to be identified
- ✓Is negatively charged particle
- ✓Has the smallest mass
- ✓The highest speed and charge to mass ratio
- ✓The charge to mass ratio mass ratio of an electron was determined by J.J Thomson and found to be -1.76 $\times 10^8 \frac{C}{g}$

cont…….

✓The charge of an electron determined by R.Millikan by oil drop experiment and found to be be -1.6 $\times 10^{-19} C$



Radioactivity and Discovery of Nucleus

- ✓Radioactivity is the spontaneous emission of radiation from the unstable nuclei of certain isotopes. Isotopes that are radioactive are called radioactive isotopes or radio isotopes
- ✓Radioactive decay is defined as a nuclear breakdown in which particles or (electromagnetic) radiation is emitted
- ✓the radiation emitted from radioactive substance is of three main types

  1) alpha (α) particles

  2) beta (β) particles

  3) gamma (γ) rays

1) alpha (α) particles

- ✓particles which consist of particles that have amass that is about four times that of a hydrogen atom
- ✓They also have a charge twice the magnitude of an electron but positive rather than negative.
- ✓ An alpha particle is now known to be a doubly-ionized helium atom, that is, He^{2+}.

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2) beta (β) particles

- ✓A second type of radiation was shown to consist of negatively-charged particles, identical to cathode rays.
- ✓These particles are called beta (β) particles, which are electrons, coming from inside the nucleus.

3) Gamma (γ) rays

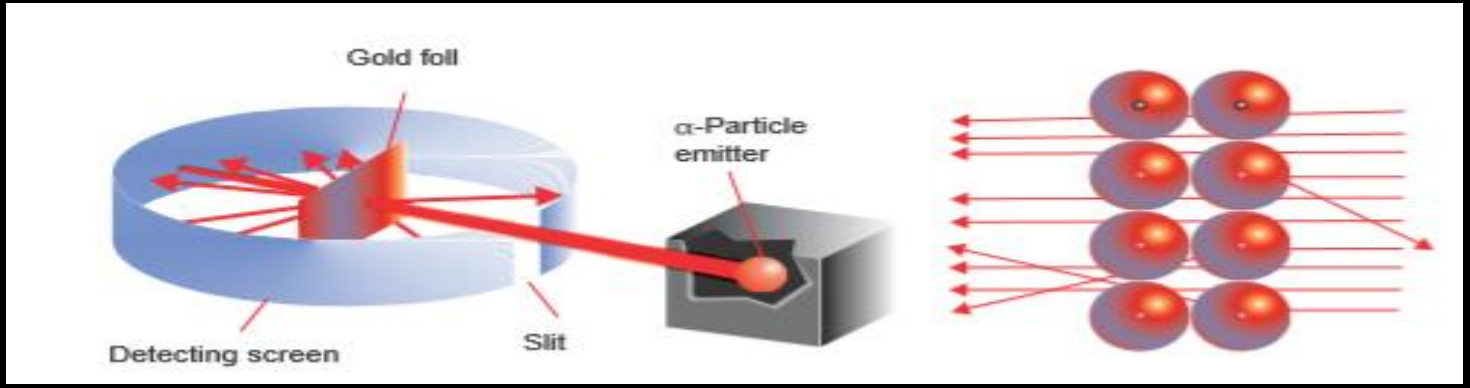
- ✓The third type of radiation, called gamma (γ) rays,
- ✓is a form of electromagnetic radiation much like the X-rays but of even higher energy.
- ✓Like X-rays, but unlike alpha and beta particles, gamma rays are a form of energy and not a form of matter.

Discovery of nucleus

- ✓Discovered by Ruther ford by alpha scattering experiment
- ✓Is the core of an atom made up of proton and neutron
- ✓Is positively charged
- ✓Is small in size but massive

Discovery of nucleus

- ✓Rutherford explained the result as a follow:
- ✓Most of the alpha particle pass through the gold foil .this indicates most of the space in an atom is empty
- ✓Few alpha particle deflected back. this shows that the nucleus has a positive charge concentrated in the nucleus
- ✓The heavily positively charged nucleus is responsible for the deflection and bouncing back of the alpha particle



Discovery of neutron

- ✓Neutron-discovered by James Chadwick
- ✓ it has no charge
- ✓ has almost equal mass with that of proton
- ✓ it reduce the electrostatic repulsion force between protons

Atomic number and mass number

- **Atomic number** is the number of protons in an atom.

Atomic number= proton number=electron number

✓**Mass number(A)** is the sum of proton and neutron numbers

✓Mass number = proton number +neutron number

= atomic number + neutron number

Atomic mass and isotopes

Isotopes are atoms of the same element with the same proton number but different neutron or mass number.

✓ Isotopes can be represented by

-nuclear symbol notation

example- ${}_{1}^{1}H$ ${}_{1}^{2}H$ ${}_{1}^{3}H$

- Hyphen notation example H-1,H-2, H-3

$$\text{Atomic mass of an atom} = \frac{absolute\ mass\ of\ an\ atom}{1.66 \times 10^{-24}\ \frac{g}{amu}}$$

Example 1: An atom has 38 protons, 38 electrons and 40 neutron. what is the mass number

Example 2: Find the number of protons neutrons and electrons in

A) $^{80}_{35}Br$ B) $_{26}{}^{56}Fe^{3}$

Example 3: Calculate the atomic mass of magnesium the absolute mass of magnesium atom is 4.0×10^{-23}g

Average / relative /atomic mass

Is defined as the average mass of the atom or its isotopes expressed in amu.

Example 4: There are two isotopes of lithium found on earth. Isotope 6Li (6.01512 mu) accounts for 7.42% of the total, and isotope 7Li (7.01600 mu) accounts for the remaining 92.58%. What is the average atomic mass of lithium?

Example 5: The element gallium, Ga, has two stable naturally occurring isotopes, 69Ga and 71Ga

Given	that isotope	mass in amu
	69Ga	68.9
	71Ga	70.9

the average atomic mass of gallium is 69.7amu. Calculate the relative abundance of each isotope.

Electromagnetic Radiation

- ✓In 1873, James Clerk Maxwell proposed that light consists of electromagnetic waves.
- ✓According to his theory, an electromagnetic wave has an **electric field** component and a **magnetic field** component.
- ✓Further, his theory accurately describes how energy, in the form of radiation, propagates through space as electric and magnetic fields.
- ✓ **Electromagnetic radiation** is the emission and transmission of energy in the form of electromagnetic waves.

Cont.....

- ✓The wave properties of electromagnetic radiation are described by two interdependent variables, **frequency** and **wavelength** the other is **speed.**
- ✓ **Wavelength (λ , Greek lambda)** is the distance between any point on a wave and the corresponding point on the next wave.
- ✓ **Frequency (ν, Greek nu)** is the number of cycles that pass a given point in space per second, expressed in units of s^{-1} or hertz (Hz).
- ✓ **Speed(c)** –indicate how fast a given peak moves through space

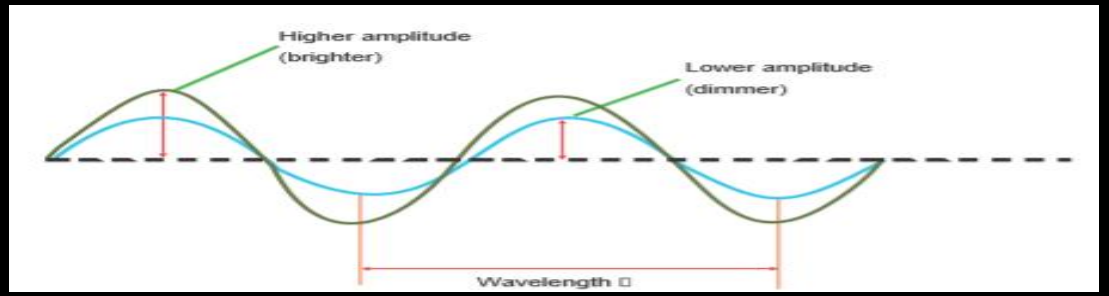
  -it is the product of frequency and wave length

$$c_0 = \nu \times \lambda$$

- ✓ In vacuum, light travels at a speed of 3.0×10^8

Cont……..

- ✓The speed of an electromagnetic wave depends on the nature of the medium through which the wave is travelling.
- ✓Electromagnetic radiation are also characterized by their amplitude or intensity.
- ✓ Amplitude is related to the intensity of the radiation, which we perceive as brightness in the case of visible light.
- ✓The amplitude of an electromagnetic wave is a measure of the strength of its electric and magnetic fields.
- ✓The electromagnetic waves in the different spectral region travel at the same speed but differ in **frequency** and **wavelength**.



Cont.....

- electromagnetic radiation is divided in to the various class depend on wavelength

Gamma rays, x-rays, ultraviolet, visible, infrared, micro wave, radio wave



Increasing wavelength and decreasing frequency or energy

- Light of a single wavelength is called monochromatic (Greek “one colour”),
- light of many wavelengths is polychromatic (Greek “many colours”). White light is polychromatic

Cont….

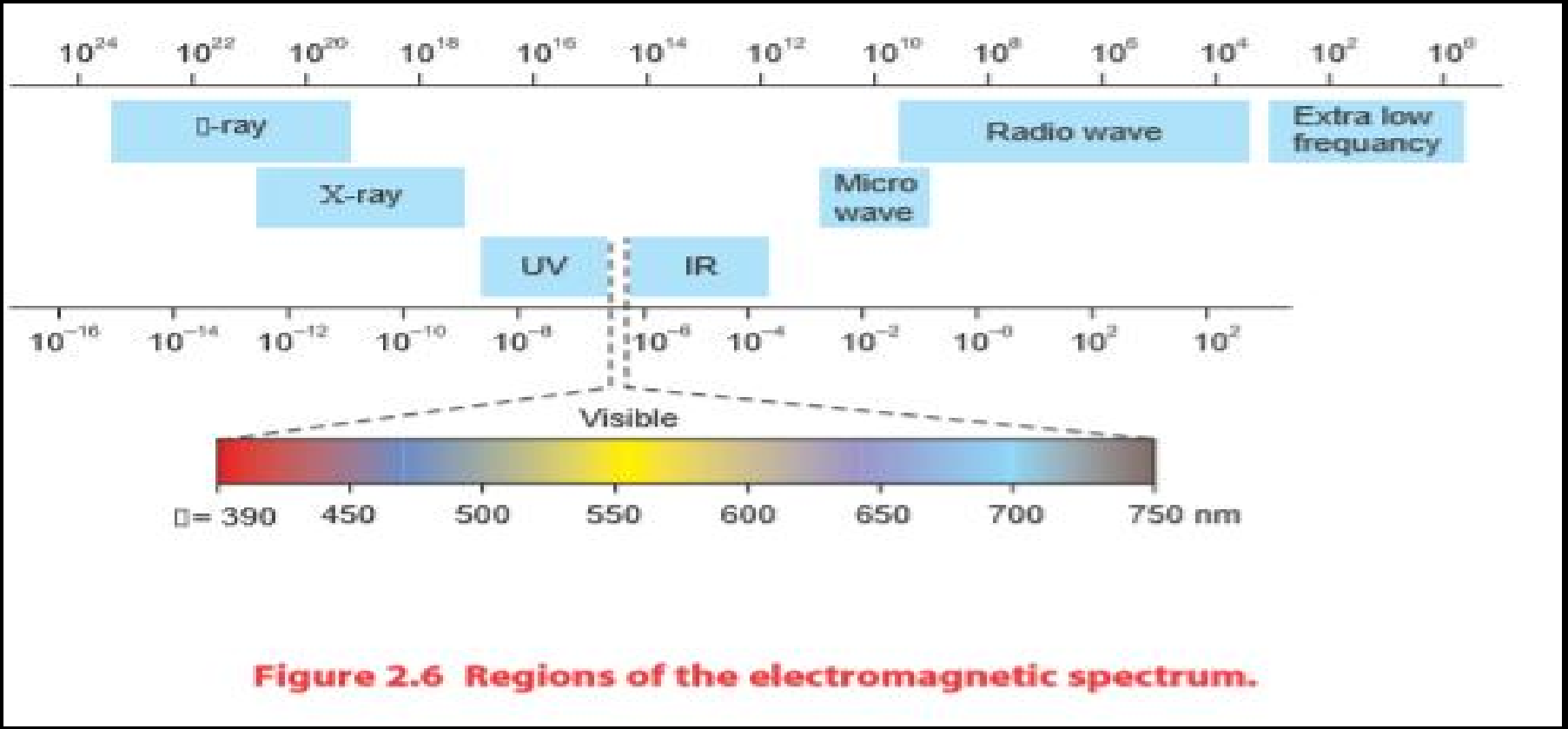


Figure 2.6 Regions of the electromagnetic spectrum.

- ✓The colors in the visible region of the electromagnetic spectrum in increasing order

  Violent< indigo< blue< green< yellow<orange<red

- ✓Abbreviate as VIBGYOR

Example 6: The yellow light given off by a sodium lamp has a wavelength of 589 nm. What is the frequency of this radiation?

Example 6: Some diamonds appear yellow because they contain nitrogenous compounds that absorb purple light of frequency $7.23 \times 1014\ s^{-1}$. Calculate the wavelength (in nm) of the absorbed light

The Quantum Theory and Photon

- ✓ The main idea of quantum theory is that energy is not continuous but comes in discrete packets.
- ✓ The quantum theory is concerned with the rules that govern the gain or loss of energy from an object.
- ✓ In 1900, the German physicist Max Planck came to an entirely new view of matter and energy.
- ✓ He proposed that a hot glowing object could emit (or absorb) only certain amounts of energy

Cont…….

$E = nh\nu$

where E is the energy of the radiation,

ν is the frequency,

n is a positive integer (n = 1, 2, 3, ...) called quantum number

h is proportionality constant now called Planck's constant.

✓ With energy in joules (J) and frequency in second (s–1), h has units of J s; (h = $6.626 \times 10–34$ J s)

Example 7: Calculate the amount of energy (that is, the quantum of energy) that an object can absorb from yellow light, whose wavelength is 589 nm.

The Photoelectric Effect

- ✓Light shining on a clean metallic surface can cause the surface to emit electrons. This phenomenon is known as **the photoelectric effect.**
- ✓The Photoelectric Effect occurs when light bombards the surface of a metal and electron are ejected.
- ✓The minimum amount of energy required to remove an electron from the metal surface is called **work function(Φ).**

$$\Phi = h\nu_o$$

- ✓ ν_o -the minimum frequency required to remove an electron from the metal surface .it is also called **threshold frequency**.

Cont……

- ✓If the energy more than work function is supplied by using radiation, the excess energy goes in to kinetic energy of the ejected electrons

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

$$h\nu = \Phi + KE,$$

$$h\nu = h\nu_o + KE$$

$$KE = h(\nu - \nu_o)$$

- ✓Electromagnetic radiation exhibit wave and particle properties.

$E=mc^2$ Einstein famous equation

$E=h\nu$, max planks equation

- ✓If we relate the two equation we gate $m=\frac{h}{\lambda v}$

Example 8: The maximum kinetic energy of the photoelectrons emitted from a metal is 1.03×10^{-19} J when light that has a 656 nm wavelength shines on the surface. Determine the threshold frequency, ν o, for this metal. Given quantities: $h=6.626\times10^{-34}$ J s, $\lambda = 656$nm, kinetic energy of photoelectron $E_k = 1.03\times10^{-19}$ J.

Example 9: The threshold frequency for metallic potassium is 5.46 × 1014 s–1. Calculate the maximum kinetic energy and velocity that the emitted electron has when the wavelength of light shining on the potassium surface is 350 nm. (The mass of an electron is 9.11 × 10–31 kg.)

Atomic Spectra

- ✓Atomic or line spectra are produced from the emission of photons of electromagnetic radiation (light).
- ✓Atomic spectra appears as a lines rather than as a continuous because each atoms energy only has a certain discrete energy level or state
- ✓Each element produces its own unique line spectrum
- ✓ Line spectra serve as sensitive and useful tools for detecting the presence and relative abundance of an element
- ✓The emission of a particular frequencies of a light from an excited from the excited atom can be observed by **spectroscope** or **spectrometer**.
- ✓The spectrum produced by sunlight is called a continues spectrum because one color merges in to the next with out any gap or missing color.

The Bohr Model of the Hydrogen Atom

Bohr proposed the following three postulates for his model.

1. The hydrogen atom has only certain allowable energy levels, called stationary states
2. The atom does not radiate energy while in one of its stationary states. That is, even though it violates the ideas of classical physics, the atom does not change energy while the electron moves within an orbit.
3. The electron moves to another stationary state (orbit) only by absorbing or emitting a photon whose energy equals the difference in the energy between the two states.

Cont…….

$$E_{ph} = E_f - E_i = h\nu$$

The subscripts f and i represent the final and the initial states, respectively

- ✓Bohr derived an equation for the energy of an electron $E_n = -R_H \frac{Z^2}{n^2}$
- ✓where RH is the Rydberg constant, has a value of, $R_H = 2.18 \times 10^{-18}$ J.
- ✓The number n is an integer called the principal quantum number (n=1, 2, 3, ...).
- ✓Z is the charge of the nucleus.
- ✓The negative sign in the equation appears because it is defined as zero energy when the electron is completely moved form the nucleus,

i.e. $E_n = 0$ when $n = \infty$, so, $E_n < 0$ for any smaller n.

Cont…….

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Cont…….

For the H atom, Z = 1, so we have

$$En=2.18 \times 10^{-18}\ J\times.\frac{1}{n^2}$$

This equation is easily adapted to find the energy difference between any two levels:

$$\mathbf{En=2.18 \times 10^{-18}\ J\times.\left(\frac{1}{nf^2} - \frac{1}{ni^2}\right)}$$

Series of line in hydrogen atom

series	ni	nf
Lyman	1	2,3,4,….∞
Balmer	2	3,4,5,…. ∞
paschen	3	4,5,6,…. ∞
bracket	4	5,6,7…. ∞
pfund	5	6,7,8…∞

Example 10: Calculate the energies of the states of the hydrogen atom with n = 2 and n = 3, and calculate the wavelength of the photon emitted by the atom when an electron makes a transition between these two states.

Grade 11 chemistry
Chapter two part 3
Quantum mechanical model

Limitations of the Bohr Theory

- ✓The Bohr model failed to predict the wavelengths of spectral lines of atoms more complicated than hydrogen, even that of helium, the next simplest element.
- ✓Bohr could not explain the further splitting of spectral lines in the hydrogen spectra on application of magnetic field and electric fields.

The quantum mechanical model of the atom

- ✓The sophisticated mathematical description of atomic structure based on the wave properties of subatomic particles is called wave mechanics or quantum mechanics.
- ✓It also called wave mechanical model or Schrodinger model of an atom
- ✓The wave equations that are acceptable solutions to the Schrödinger equation are called **wave functions**

The Heisenberg's Principle

- ✓Heisenberg formulated what is known as the Heisenberg uncertainty principle, which states that it is impossible to know simultaneously both the momentum p ($p = m\nu$) and speed of electron or the position of a particle with certainty.

Quantum Numbers

- ✓An atomic orbital is specified first by three quantum numbers that are associated respectively, with the

  orbital's size (energy)

  shape

  orientation

  the electron spin

- ✓ The first three sets of quantum numbers have a hierarchical relationship:

  The size-related number limits the shape related number

  The shape-related number in turn limits the orientation-related number.

Quantum Numbers

✓Three among the four quantum numbers characterize

❖ The orbitals in the atom. That is, they describe the orbital or the space the electron is supposed to occupy.

✓The fourth quantum number is used to describe

❖ The spin of the electrons that occupy the orbitals

The four quantum numbers are:

1) principal quantum number (n)

❖is a positive integer having values n = 1, 2, 3, ...

It gives the following information:

a) Size of orbital

❖ Relative size of the orbital or the relative distance of the electron from the nucleus.

❖Size of orbital increases with the increase of principal quantum number n.

b) Energy of the orbital.

❖Higher the n value, greater is the energy.

c) Number of orbital

❖Number of orbital=n^2

❖Maximum number of electrons present in any shell (given by the formula $2n^2$).

The four quantum numbers are:

2) Azimuthal quantum number (l)

- it also known as angular momentum or subsidiary quantum number.
- It is an integer having values from 0 to (n – 1). For an orbital with n = 1, l can have a value only of 0
- the number of possible l values equals the value of n.
- For a given value of n, the maximum possible value of l is (n – 1).
- Number of orbitals =2l+1

The **azimuthal quantum number** gives the following information:

- Number of subshell present within any shell
- It describes the shape of the orbital and is sometimes also called the orbital-shape quantum number.

The four quantum numbers are:

3) magnetic quantum number (ml)

- Is also known as the **orbital-orientation quantum number**
- It is an integer having values from –l through 0 to +l.
- The number of possible ml values or orbitals for a given l value is (2l+1).
- The possible values of an orbital's magnetic quantum number are set by its angular momentum quantum number (that is, l determines ml)
- It prescribes the orientation of the orbital in the three-dimensional space about the nucleus

The four quantum numbers are:

4) Electron spin quantum number (ms)

- has only two possible values, +½ (represented by the arrow, ↑) and – ½ (represented by the arrow ↓).
- suggests that electrons have a spinning motion
- It is related the electron only

The quantum numbers specify the energy states of the atom

- The atom's energy levels or shells are given by the **n** value.
- The atom's sublevels or subshells are given by the **n** and **l** values. Each level contains sublevels that designate the shape of the orbital.
- The atom's orbitals are specified by the **n**, **l** and **ml** values. Thus, the three quantum numbers that describe an orbital express its size (energy), shape and spatial orientation. Each sublevel is designated by a letter:

l = 0, is a s sublevel

l = 1, is a p sublevel

l = 2, is a d sublevel

l = 3, is a f sublevel

- The letters s, p, d, and f are derived from the names of spectroscopic lines: s, **sharp**; p, principal; d, diffuse; and f, fundamental

1. What values of the angular momentum quantum number (l) and magnetic quantum number (ml) are allowed for a principal quantum number (n) of 3? How many orbitals are allowed for n = 3?

1. What values of the angular momentum quantum number (l) and magnetic quantum number (ml) are allowed for a principal quantum number (n) of 3? How many orbitals are allowed for n = 3?

2. Give the name, magnetic quantum numbers, and numbers of orbitals for each sublevel with the following quantum numbers:

a) $n = 3, l = 2$

b) $n = 2, l = 0$

c)$n = 5, l = 1$

d)$n = 4, l = 3$

3. Indicate whether each of the following is a permissible set of quantum numbers. If the set is not permissible, state why it is not.

a) $n = 3, l = 1, m_l = +2$

b) $n = 0, l = 0, m_l = 0$

c) $n = 4, l = 3, m_l = -3$

d) $n = 3, l = 3, m_l = -3$

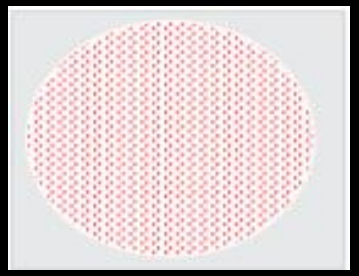
e) $n = 3, l = 2, m_l = -2$

4.List all the possible quantum number values for an orbital in the 5f sub shell.

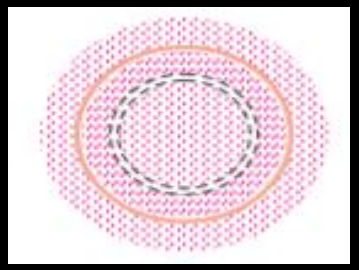
5. In which specific subshell will an electron be present if the quantum numbers n = 3, l = 1, and ml = –1?

Shapes of Atomic Orbitals

- ✓S-orbital has spherical shape
- ✓Geometric shape of 1s-orbital



- ✓Geometric shape of 2s-orbital

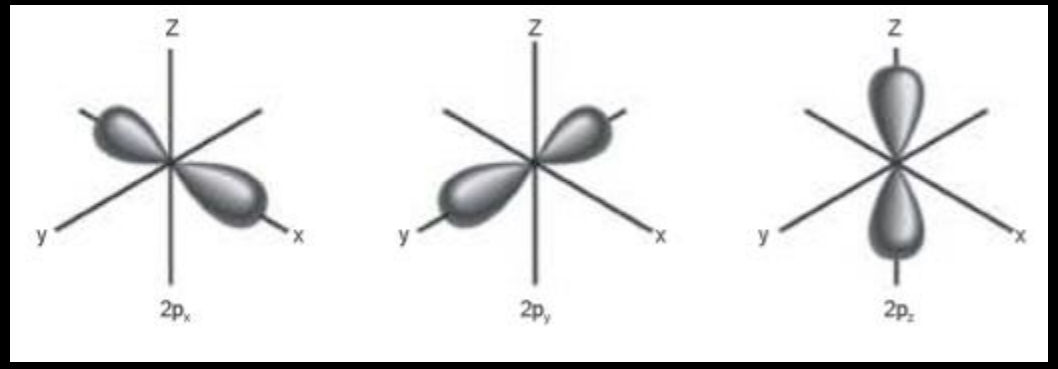


- ✓Higher level s-orbitals (3s, 4s, ...) have similar overall shapes, that is, spherical symmetry.

Shapes of Atomic Orbitals

- ✓The second principal energy level (n = 2) consists of four different orbitals. One having l = 0, is the 2s orbital just described. The other three orbitals of the n = 2 level have l = 1. They are described by dumb bell-shaped regions
- ✓P-orbitals have dumb bell shaped region

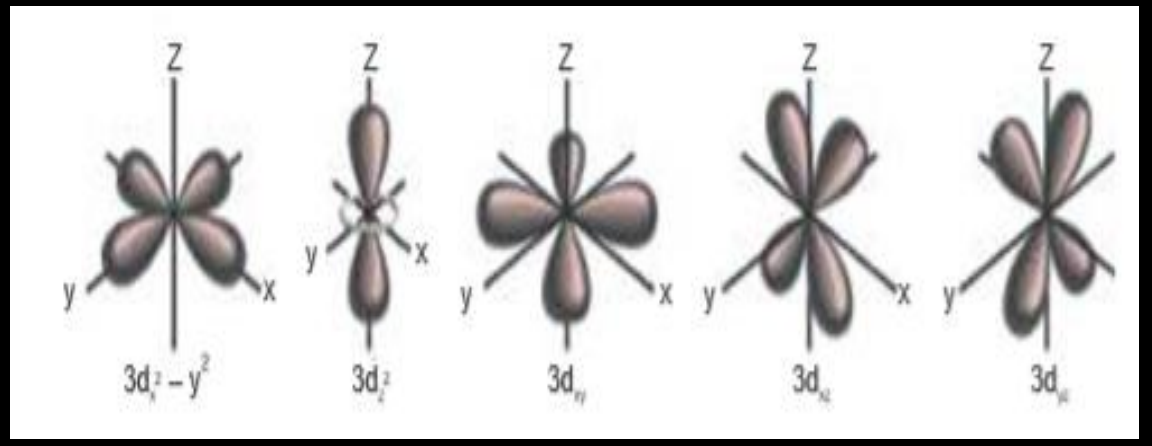
  -there are three types of p-orbitals p_x, p_y, p_z



Shapes of Atomic Orbitals

- ✓The third principal energy level (n = 3) is divided in to three sublevels: one 3s orbital, three 3p orbitals, and five 3d orbitals. The d orbitals are described
- ✓d-orbitals- are more complicated than p-orbital

  - there are 5 five d- orbitals



End of part 3
Thank you

Grade 11 chemistry
Chapter two part 4
Electronic configurations and orbital diagrams

ELECTRONIC CONFIGURATIONS AND ORBITAL DIAGRAMS

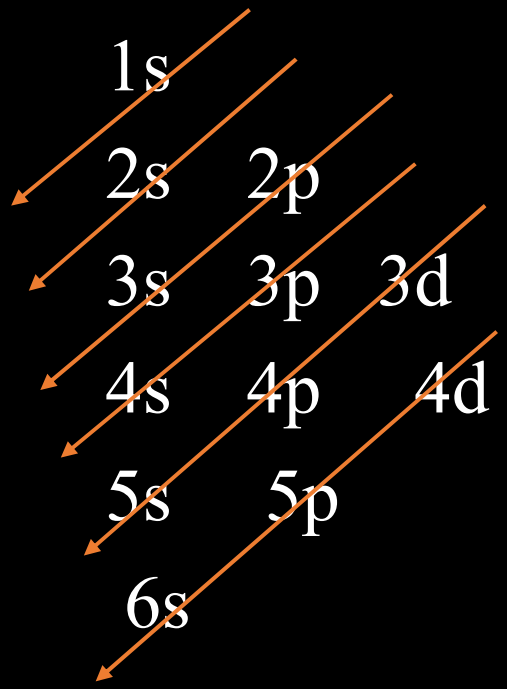
- ✓the electron configuration of an atom is a particular distribution of electrons among available atomic shells.
- ✓There are different types of electron configuration
  - -main shell electron configuration
  - - sub shell electron configuration
  - -orbital diagram configuration

CONT….

The electron configuration for any atom follows three principle

1)The Aufball principle (building up principle)

✓States that orbitals with the lowest energy filled first



cont….

2) Hund's Principle

- ✓ Equal energy orbitals (degenerate orbitals) are each occupied by a single electron before the second electrons of opposite spin enters the orbital
- ✓State that the orbitals with the same energy (degenerate orbitals)are each occupied by single electron before pairing up
- ✓For example $2p_x$, $2p_y$, $2p_z$ are degenerate orbitals each gates single electron before the second electron of opposite spin enters the orbitals

3) Pauli's Exclusion Principle

- ✓No two electrons can have the same four quantum numbers. i.e. they must differ in at least one of the four quantum numbers.
- ✓For example two electron in 1s orbital

Ground State Electronic Configuration of the Elements

- ✓ Two general methods are used to denote electron configurations.
- ❖ The subshell (sublevel) notation uses numbers to designate the principal energy levels or principal quantum number and
- ❖ the letters s, p, d and f to identify the sublevels or subshells.

ELECTRONIC CONFIGURATIONS AND THE PERIODIC TABLE OF THE ELEMENTS

The Modern Periodic Table

- ✓Periodic relationships can be summarized by the general statement called periodic law.
- ✓State that the properties of elements are a periodic function of their atomic number
- ✓In modern periodic table there are
  - 18 Group
  - 7 periods

Classification of the Elements

Representative or main group elements(IA-VIIIA)

- ✓These consist of all s- and p-block elements.
- ✓The chemical properties of the representative elements are determined by the number of valence electrons in their atoms.

Transition elements

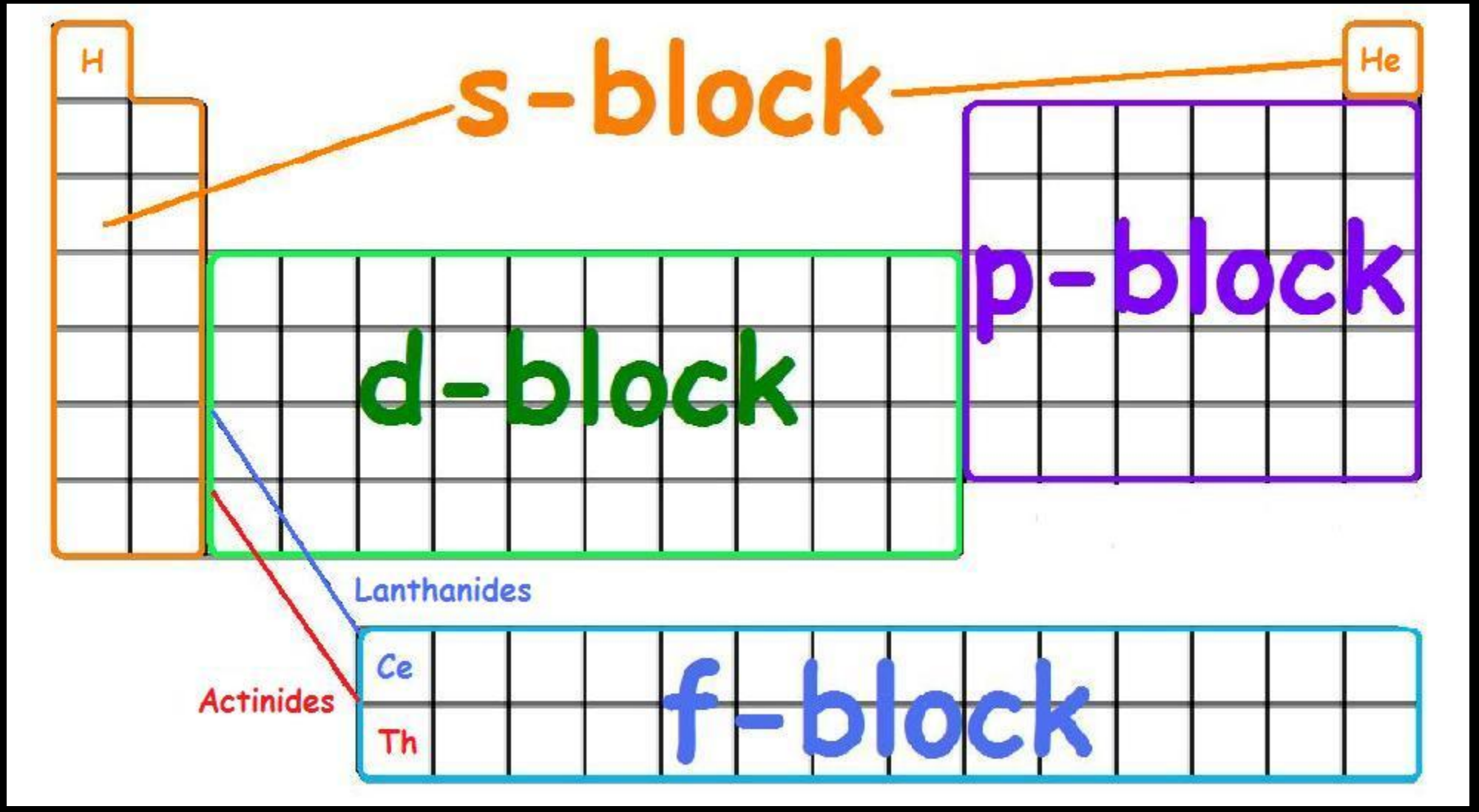
- ✓These are d-block elements.
- ✓There are four series of transitional elements, 3d, 4d, 5d and 6d depending on the energy levels of d-orbitals.
- ✓All are metals
- ✓They form complex compound and make colored compounds
- ✓Have variable valance electron

cont.…

Inner transition elements

- ✓These are the f-block elements.
- ✓There are two series of f-block elements, 4f and 5f series called lanthanides and actinides, respectively
- ✓They are called rare earth metals
- ✓They have a separate place in the periodic table due to their electronic configuration is not identical

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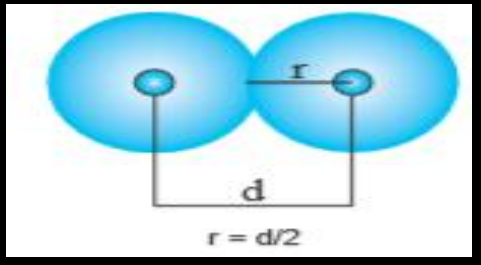

H
He
s-block
d-block
p-block
Lanthanides
Actinides
Ce
Th
f-block

Periodic Properties

Atomic Size (Atomic Radii)

- ✓ What can be measured is the distance between the nuclei of two adjacent atoms, and can derive a property called the atomic radius from this distance.
- ✓Exact size of an atom can not be measured because its outer most electron have a chance of being found at relatively large distance from the nucleus.
- ✓The size of an atom is determined from its molecule
- ✓One of the most common methods to determine atomic radius is to assume that atoms are spheres that touch each other when they are bonded together

For example, the distance between iodine atoms in an iodine molecule I2, (I—I) is 2.66 Å, so we can define the radius of an iodine atom to be half this distance: 1.33 Å:



cont….

- ✓Atomic size increases down a group because number of shell increase
- ✓Atomic size decreases across a period from left to right because effective nuclear charge (zeff)increase

Zeff =z-s where z-atomic number , s-core or screening electron

The effective nuclear charge increases from left to right in a period of representative elements in the periodic table. Because the effective nuclear charge increases, valence electrons are pulled in toward the nucleus and held more tightly.

cont….

- ✓In a series of B-group elements (transition elements), electrons enter an inner electron shell, not the valence shell. In this process, the effective nuclear charge remains essentially constant instead of increasing.
- ✓ For example, compare the effective nuclear charges, Zeff, of iron, cobalt, and nickel.

Fe: [Ar] $3d^6 4s^2$ Co: [Ar] $3d^7 4s^2$ Ni: [Ar] $3d^8 4s^2$

Zeff = +26 – 24 = +2 Zeff = +27 – 25 = +2 Zeff = +28 – 26 = +2

- ✓Because the effective nuclear charges are almost the same, we conclude that the radii should also be almost the same
- ✓Note the size of cation less than its neutral form while the anoin is greater than its neutral form

Ionization Energy (IE)

- ✓The ionization energy (IE) is the amount of energy required to remove the outermost electron in an isolated gaseous atom or ion.

$$M(g) + IE \rightarrow M^{n+}(g) + ne^-$$

- ✓In general ionization energy increase across a period but decrease down a group because the attraction between the nucleus and the outer electrons increases, so an electron becomes more difficult to remove

The five ionization steps and their ionization energies, IE1 through IE5, are:

$B(g) \rightarrow B^{+}(g) + e^{-}$; IE 1 = 801 kJ mol^{-1}

$B^{+}(g) \rightarrow B2^{+}(g) + e^{-}$; IE 2 = 2427 kJ mol–1

$B^{2+}(g) \rightarrow B^{3+}(g) + e^{-}$; IE 3 = 3660 kJ mol–1

$B^{3+}(g) \rightarrow B^{4+}(g) + e–$; IE 4 = 25,025 kJ mol^{-1}

$B^{4+}(g) \rightarrow B^{5+}(g) + e^{-}$; IE 5 = 32,822 kJ mol–1

✓The energies required to remove the first , second, third, and fourth valance electron valance electron are called first , second and third and fourth ionization energies respectively

$$IE_1 < IE_2 < IE_2 < IE_3 < IE_4$$

cont….

Note fulfilled and half filled orbitals are stable and need higher ionization energy

Exception period -2 Be > B N > 0

period-1 Mg > Al

For the representative elements, removing a core electron requires much more energy compared to removing a valence electron.

cont….

Arrange the following in increasing order of ionization energy

a) K^+, Ar, Cl^- b)Fe,Fe^{2+}, Fe^{3+} c)Na, Mg, Al

cont…

Electron Affinity (EA)

- ✓Is the energy release when an electron is added to an atom

$$x(g) + ne^- \rightarrow X^{n-}(g) + EA$$

- ✓In general electron affinity decreases down group but increase across period
- ✓Ionization energy refers to the process of forming a gaseous positive ion from a gaseous atom.
- ✓The corresponding atomic property for the formation of a gaseous negative ion
- ✓The process is exothermic

Electronegativity

- ✓The power of an atom to attract electron towards it self
- ✓Atoms of the elements in the upper right of the periodic table (small, non-metal atoms)
- ✓attract bonding electrons most strongly
- ✓The most electronegative element is fluorine assigned a value of 4
- ✓The least electronegativity element is cesium has electronegativity value of 0.7

Metallic Character (electro positivity)

- ✓Metals lose electrons and form positive ions . As result they are called electro positive elements
- ✓Metallic character increase down group due to the lesser attraction from the nucleus to the valence electron
- ✓ decrease across a period from left to right as atoms because they are more likely to gain electrons to fill their valance shell rather than to lose them to remove the shell

Advantages of Periodic Classification of the Elements

- ✓Useful for predicting formula of compound
- ✓Used for predicting chemical and physical properties of element
- ✓Used for predicting the nature of element
- ✓Used to refer the name symbol, name, atomic number and atomic mass of the element
- ✓Used to remember the properties of elements in a simple way

End of part 4
Thank you