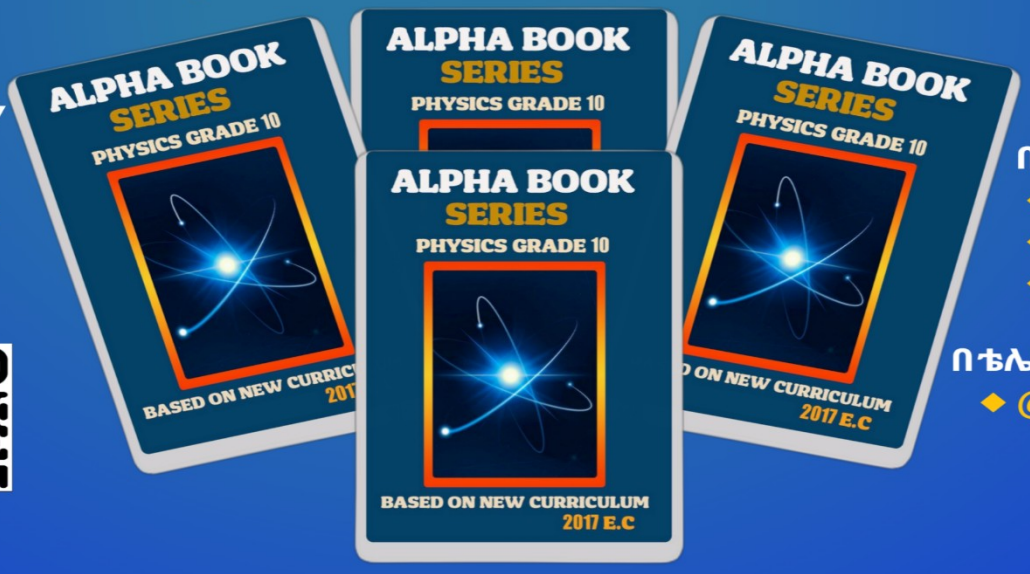
Follow us
ALPHA BOOKS



Alpha
ከ9ነኛ - 12ተኛ
ላሉ ተማሪዎች

ከ9ነኛ እስከ 12ተኛ ክፍል ላሉ ተማሪዎች
በአማርኛ ማብራርያ የተዘጋጅ
አጋዥ መጽሐፍቶች



በነጻ መጽሐፍቶችን በከፊል ለማግኘት telegram ላይ " @ethiogelagle " ብለው ያገኙናል።

በስልክ ለመመዝገብ
◆ 0986143927
◆ 0703185779
◆ 0707349725

በቴሌግራም ለመመዝገብ
◆ @gelagle912bot

ማሳሰቢያ
1. መጽሐፍቶቹ በtelegram ስለሚሰጡ በቅድሚያ ሊንኩን በመጠቀም ወይም በቀጥታ በመደወል መመዝገብ ይኖርቦታል።
ለሀሳብና አስተያየት = @gelagleQRbot

Unit 1

Atomic Structure and Periodic property of an Element

1.1Introduction

- The philosophers of ancient Greece wondered about the composition of matters: is matter continuously divisible into ever smaller and smaller pieces, or is there an ultimate limit? Although most philosophers, including Plato and Aristotle, believed that matter is continuous, Democritus disagreed.

በጥንቱ የግሪክ ፍልስፍና ውስጥ ከነበሩ ጥያቄዎች መካከል ቁስአካላት ብንከፋፍላቸው ክፍልፍላቸው ያበቃል ወይስ ደግሞ እየከፋፈልን ብንሄድ የመጨረሻው ቅንጣት ላይ አንደርስም የሚለው አንዱ ነበር። እንደ ፕሌቶ ና አርስቶትል ያሉ ፈላስፎች ቁስአካላት እየከፍፈልን ብንሄድ የመጨረሻው ቅንጣት ላይ አንደርስም ሲሉ ይህን በመቃረን ደግሞ እንደ ዲሞክራቱስ ያሉት የመጨረሻው ቅንጣት ላይ መድረስ ይቻላል ብለው ይሞግታሉ።

- The Greek philosopher Democritus (460-370 BC) suggested that if you divided matter into smaller and smaller pieces, you would eventually end up with tiny, indestructible particles called atomos, or "atoms", meaning "indivisible".

ዲሞክራተስ ይህን የመጨረሻውን ቅንጣት ወደ ሌላ ትናንሽ ቅንጣቶች የማይከፈል በጣም ትንሽ ቅንጣት ሲሆን በዚህም ምክንያት ቅንጣቱን አቶም(Atom) በማለት ጠራው። አቶም አቶመስ(atomos) ከሚለው የጽርሕ(የግሪክ ቋንቋ) የተገኘ ሲሆን ትርጉሙም የማይከፋፈል ማለት ነው።

1.2Dalton Atomic Theory and The modern Atomic Theory

- Scientific laws usually develop based on previous scientific findings. The laws that are the basis for Dalton's atomic theory are the law of conservation of mass and the law of definite proportions.

ዲሞክራተስ ምንም እንኳ ስለ አቶም ቢናገርም አቶም መኖሩን ምንም አይነት ማረጋገጫ አላስቀመጠም። በማረጋገጫ፣ በሙከራና በሳይንሳዊ ሕጎች ላይ የተመሠረተ የመጀመሪያውን የአቶም ቲዮሪ ያዘጋጀው ጆን ዳልተን ይባላል። ይህም ቲዮሪ Law of conservation of mass ፣ Law of Definite proportion እና Law of multiple proportion በሚባሉ ሳይንሳዊ መላምቶች ላይ የተመሠረተ ነበር።እያንዳንዳቸውን እንመልከት።

1-law of conservation of mass:-ይህ ማለት ቁስ አካላት አይጠፉም አይፈጠሩም ወደ ሌላ ቁስ አካላት ግን ይለወጣሉ።ለምሣሌ:-ቤት እናታችሁ እሳት አቀጣጥሉ አለቻችሁ።ታዲያ ማንደጃ ወስዳችሁ ከሰል ጨምራችሁ ክብሪት ለኩሳችሁ....መቀጣጠል ጀመረ። ትንሽ ቆይታችሁ ስትመጡ ጭሱ ወደ ላይ እየተምዘገዘገ በምታዩበት ሰዐት ከሰሉ እየጠፋ ይሄዳል። ነገርግን አንድ ጥያቄ ልጠይቃችሁ። በእውኑ ከሰሉ እየጠፋ ነውን?መልሱ አይደለም ምክንያቱም ወደ ጭስነት (ጋዝነት) ተለወጠ

Follow us
ALPHA BOOKS

ሚለያዩ ከሆነ [ልክ እንደ H2O እና H2O2 ማለቴ ነው] በሁለቱ ውህዶች ውስጥ ያሉ ንጥረነገሮች ግንኙነት በሙሉ ቁጥር መልክ (simple whole number ratio)መግለጽ ይችላል። ሙሉ ቁጥር(whole number) ስንል 0,1,2,3,4...ማለቴ ነው። ለምሳሌ:-H20 ውስጥ ያለው የሃይድሮጅን(H) እና የኦክስጀን(O) መጠነ ቁስ (mass) ስንት ነው? አሺ! 50g ሃይድሮጅን ቢኖረን የሚኖረን ኦክስጀን(O) መጠነ ቁስ(mass) 129.0119968g ይሆናል። አንዴት መጣ የሚለውን እለፉት ቦታውም ጊዜውም አይደለም ።እንቀጥል! በ H202 ውስጥ ያለው የሃይድሮጅን(C) እና የኦክስጀን(O) መጠነ ቁስ (mass) ስንት ነው?ያው የ H መጠናቸው ሁለቱም ላይ 2 ስለሆነ እንደ ቀድሞ 50g H እንወስዳለን። 50 H ስንወስድ ግን የምናገኘው የ O መጠን ግን ይለያያል። ስንት? መልሱ=65.509984g ይሆናል።እሺ አሁን ሁለቱንም አንጻጽሩልኝ!

	ውሃ[H2O]	Hydrogen peroxide[H2O2]	ንጽጽር
የ H መጠነ ቁስ	50g	50g	50g÷50g=1 ወይም 1:1 👈 👈 simple whole number ratio
የ O መጠነ ቁስ	65.509984g	129.0119968g	65.509984g÷129.0119968g=0.5 ወይም 1:2 👈 👈 simple whole number ratio

- Dalton proved that these laws are entirely reasonable if the elements are composed of tiny particles, which he called atoms.

ዳልተን ከላይ ያሉት ሳይንሳዊ ሕጎች ቁስ አካላት ላይ ከሰሩ ቁስ አካላት የግዴታ ከአቶም መፈጠር አለባቸው ብሎ ደምድሟል።ቅድም ዳልተን ሳይንሳዊ ሕጎችን የተከተለ ሰዉ ነበር ብለን የተከተለውን ሳይንሳዊ ሐግ አይተናል አሁን ደግሞ ሳይንሳዊ ምልከታዎቹን በአጭሩ እንመልከት።

- The basic postulates of Dalton's Atomic Theory are summarized as follows:

1.All elements are made up of small particles called atoms.

ሁሉም element የተሰሩት ከአቶም ነው። ምሳሌ:-ሃይድሮጅን element የተሠራው ከሃይድሮጅን አቶም ነው።

2.Atoms are indivisible and indestructible.

አቶም ወደ ሌላ ንዑስ አካል አይከፈልም።

3-All atoms of a given element are identical in mass and in all other properties.

ለምሳሌ:-1 mole ሃይድሮጅን ውስጥ ያሉ ሃይድሮጅን አቶሞች በሁሉም ባህሪያቸው ተመሣሣይ ናቸው።

4-Atoms are neither created nor destroyed in chemical reactions.

አቶም በኬሚካላዊ ጽግበራ ጊዜ አይጠፋም አይፈጠሩም።

5-Compounds are formed when atoms of more than one element combine.

Follow us
ALPHA BOOKS

❖ than about the internal structure of atoms. The modern theories about the physical structure of atoms did not begin until J.J. Thomson discovered the electron in 1897.

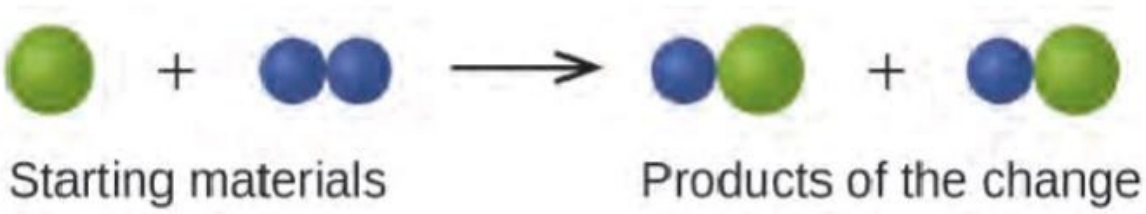
ዳልተን ለዘመናዊው አቶማዊ ቲዮሪ እንደ አስጀማሪ ቢታይም ነገር ግን ጥናቱ ስለ አቶም ውስጣዊ አወቃቀር ግንዛቤን የሚሰጥ አልነበርም። ይልቁንም አቶም ከሌሎች አቶሞች ጋር እንዴት እንደሚዋሃድ መግለጽ ላይ ያተኩራል። ይህ ዘመናዊ አቶማዊ ቲዮሪ ዳልተን ያላካተታቸውን የአቶም ውስጣዊ መዋቅርን የሚያብራራ ሲሆን ለዚህ የበቃው ብዙ ከዳልተን መነሳት በኋላ የተነሱ ሳይንቲስቶች ያገኙት ግኝቶችን እንደ ግብዓት በመጠቀም ነው።

Exercise 1.2

1. Describe the limitations of Dalton's atomic theory.
2. Explain the postulates of the modern atomic theory.
3. List the three fundamental laws of chemistry.
4. How does the modern atomic theory explain the three fundamental laws of chemistry?

Teacher's Mind

1. In the following drawing, the green spheres represent atoms of a certain element. The purple spheres representatoms of another element. If the spheres of different elements touch, they are part of a single unit of a compound.The following chemical change represented by these spheres may violate one of the ideas of Dalton's atomic theory.Which one?



2. Which postulate of Dalton's theory is consistent with the following observation concerning the weights of reactants and products? When 100 grams of solid calciumcarbonate is heated, 44 grams of carbon dioxide and 56grams of calcium oxide are produced.

3. Identify the postulate of Dalton's theory that is violated by the following observations: 59.95% of one sample of titanium dioxide is titanium; 60.10% of a different sample of titanium dioxide is titanium.

4. Samples of compound X, Y, and Z are analyzed, with results shown here.

Compound	Description	Mass of Carbon	Mass of Hydrogen
X	clear, colorless, liquid with strong odor	1.776 g	0.148 g
Y	clear, colorless, liquid with strong odor	1.974 g	0.329 g
Z	clear, colorless, liquid with strong odor	7.812 g	0.651 g

Do these data provide example(s) of the law of definite proportions, the law of multiple proportions, neither, or both? What do these data tell you about compounds X, Y, and Z?

Answer Key

1. The starting materials consist of one green sphere and two purple spheres. The products consist of two green spheres and two purple spheres. This violates Dalton's postulate that that atoms are not created during a chemical change, but are merely redistributed.

3. This statement violates Dalton's fourth postulate: In a given compound, the numbers of atoms of each type (and thus also the percentage) always have the same ratio.

1.3Early Discoveries to characterizes the atoms

1.3.1 Discoveries of Electron

Cathode Rays

Entrance 2010

15. Which of the following particle was discovered by the cathode rays experiment?

A.electrons

B.neutrons

C.nucleus

D.protons

Answer = A

- One of the first experiments on subatomic particles was carried out by the English physicist J.J. Thomson in 1897. Figure 1.1 shows an experimental apparatus similar to the one used by Thomson. In this apparatus, two electrodes

Follow us
ALPHA BOOKS

❖ D.contain particles, which are positively charged

Explanation:

Cathode rays - travel in straight lines from anode to cathode contain negatively charged particles found in all matter

Answer = d

❖ After the cathode rays leave the negative electrode, they move toward the anode, where some rays pass through a hole to form a beam (Figure 1.1).

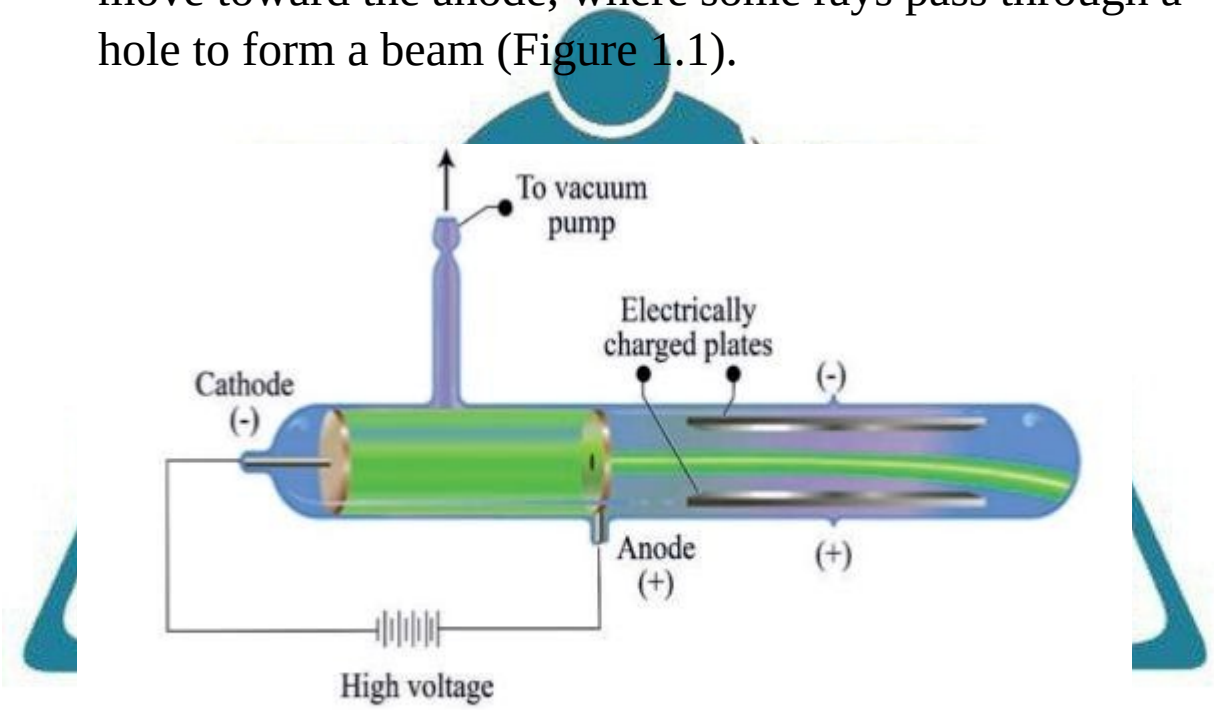


Figure 1.1: Formation of cathode rays

ይህ cathode ray ከላይ በምስሉ እንደምትመለከቱት ወደ anode ከተጓዘ በኋላ አንዳንዶቹ ጨረሮች በትንሽዬ ቀዳዳ ውስጥ ያልፉና ቀጥ ያለ መንገድን የሚጓዝና ዝርው ያልሆነ ጨረር ይሰራሉ። ይህ ጨረርን ነው Beam የሚለው።

- This beam bends away from the negatively charged plate and toward the positively charged plate.

ይህንን ቀጥ ያለ ጨረር ደግሞ በጉዞው ከላይ በኩል ኔጋቲቭ ቻርጅ ከጉዞው ከታች በኩል ቻዘቲቭ ቻርጅ የያዘ ቁስ አካል እንዲኖር አደረገ። ይህ ጨረር(beam) በእነዚህ ቁስአካላት መካከል ማለፍ ሲጀመር ጨረሩ ወደ ፓዘቲቭ ቻርጁ መሰበር ጀመረ።

What did Thomson conclude from this observation?

ምን ሊወስን ይችላል ካልን ጨረሩ ውስጥ ኔጋቲቭ ቻርጅ መኖሩን ነው። ተመሳሳይ ቻርጆች ይገፋፋሉ። ተቃራኒ ቻርጆች ይሳሳባሉ። ስለዚህ ጨረሩ አንደኛ ኔጋቲቭ ቻርጅ የያዘውን ቁስአካል በመሸሽ በተመሳሳይ ወደ ፓዘቲቭ ቻርጅ ወደ አለው ሊሳቡ የቻሉት ከኔጋቲቭ ጋር ተመሳሳይ ወይም ከፓዘቲቭ ጋር ተቃራኒ ቻርጅ ቢኖራቸው ነው። ለዛም ነው Cathode ray ኔጋቲቭ ቻርጅ በውስጡ ይዟል ሊባል የቻለው።

- Figure 1.2 shows a similar experiment, in which cathode rays are seen to bend when a magnet is brought toward them. Thomson showed that the characteristics of cathode rays are independent of the material making up the cathode. From such evidence, he concluded that a cathode ray consists of a beam of negatively charged particles (or electrons) and that electrons are constituents of all matter.

ቀጥሎ ደግሞ ኔጋቲቭ ቻርጅ የተፈጠረው ጨረሩ ከተሳበት ቁስ አካል የተነሳ ወይስ በራሱ ጨረር ውስጥ ኔጋቲቭ ቻርጅ የያዙ ቅንጣት ይገኛሉ የሚለው ጥያቄ መጣ? ለዛም ቶምሰን Cathode ray በሚጓዝበት ቦታ ላይ ማግኔት በማስጠጋት ከታች እንደምትመለከቱት ሙከራ ሰራ።

Follow us
ALPHA BOOKS



fell under the influence of gravity. Based on careful experiments, Millikan established the charge on an electron as e-1.602 x 10-19 C. He used this value and Thomson's mass/charge ratio to calculate an electron's mass to be 9.109 x 10-31 kg.

Thomson charge to mass ratio ን ያገኘው cathode ray በኤሌክትሪክ እና በማግኔቲክ ፊልድ በምን ያህል መጠን ይሰበራል የሚለውን ከተረዳ በኋላ ነው ። የዚህ ratio መጠንም 5.686 x 10-12 kgC-1 (kilograms per coulomb)ነው።ግን ይህ J.J.thomson የሚባለው ሳይንቲስት ቀጥታ መጠነ ቁሱን አላገኘም። ያገኘው ቻርጁን በመጠነቁሱ ስናካፍለው ምን ያህል መጠን እንዳለው ነው። ቀጥሎ Robert millikan የሚባለው

$$m_e = \frac{m_e}{e} \times e = -5.686 \times 10^{-12}\ \text{kg C}^{-1} \times -1.602 \times 10^{-19}\ \text{C}$$

$$= 9.109 \times 10^{-31}\ \text{kg}$$

ሳይንቲስት የዚህን ቅንጣት ቻርጅ መጠኑን oil drop experiment በመጠቀም አገኘ። የዚህ ቻርጅ መጠንም e-=-1.602 x 10-19 C ነው።ስለዚህ የሁለቱን ሙከራዎች በመጠቀም የቅንጣቱን መጠነ ቁስ ማግኘት ይቻለናል።

ከዚህ ግኝት በኋላ ይህ ቅንጣት መጠነ ቁስ አለው ማለት ብቻ ሳይሆን መጠነ ቁሱን በእርግጠኝነት በቁጥር መንገር ተቻለ።

1.3.2 Radioactivity and the Discovery of the Nucleus

Radioactivity

Follow us
ALPHA BOOKS



Entrance 2008

36. Which of the following types of rays combine to form atoms of Helium?

A.gamma rays

B.beta

C.alpha

D.X-ray

Explanation:

alpha particle is a positively charged nuclear particle, consisting of two protons bound to two neutrons.

a particles are produced when He-4 atom are completely ionized to give He2+ ion.

- Beta rays, or ß particles, are electrons coming from inside the nucleus and are deflected by the negatively charged plate.

Beta particle የሚባሉት ደግሞ ኒጋቲቭ ቻርጅ በውስጡ ያለው ነው።

Entrance 2007

6. Of the three types of radioactivity characterized by Rutherford, which of the following are particles?

A.gama-rays

B. ß-rays

Follow us
ALPHA BOOKS

The Discovery of the Nucleus

- Thomson proposed a "plum-pudding" model (Figure 1.4) for the atom in which the electrons and protons were randomly distributed in a positively charged cloud like plums in a pudding.

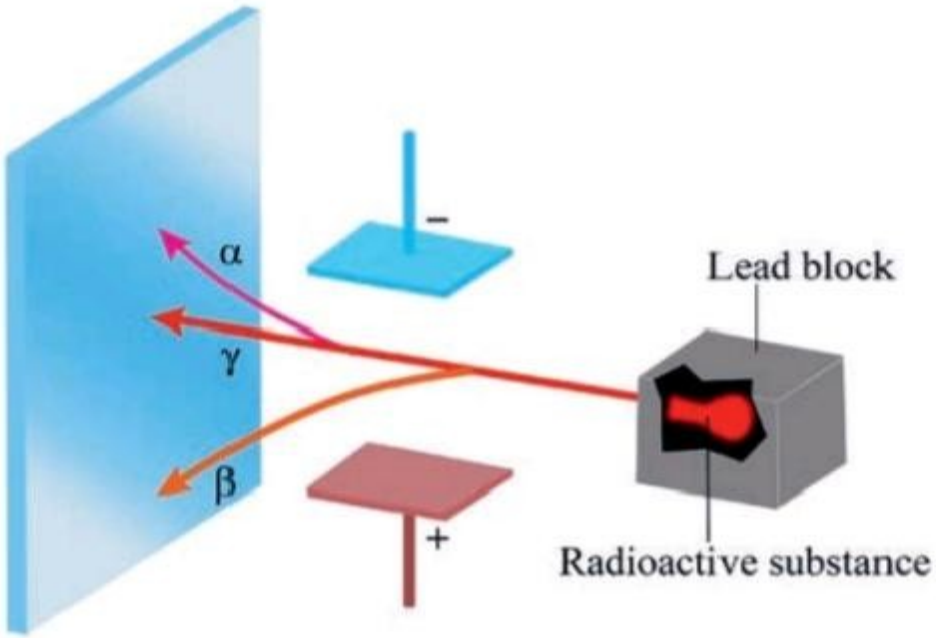


Figure 1.3: Three types of ray emitted by radioactive elements

Thomson ኤሌክትሮን የሚባል ቅንጣት አለ ብሎ ካለ በኋላ ታዲያ አቶም ውስጥ ያላቸው አቀማመጥ ምን ይመስላል የሚለውን model አዘጋጅቷል። ይህ ሞዴል plum pudding model ይባላል። አቀማመጣቸውም ልክ እንደ ሐብሐብ(watermelon) ነው። ሐብሐብ ውስጥ ጥቃቅን የሆኑ ፍሬዎች አሉ። ከዛ ደግሞ ቀይ የሚበላው ክፍል ያለው ሲሆን ፍሬዎቹ በቀዩ ውስጥ ተሸጉጠው(embedded) ሆነው ይገኛሉ።ልክ እንደዚሁ ኤሌክትሮኖች እንደ ፍሬዎቹ ቁዩ ክፍል ደግሞ እንደ ፓዘቲቭ ቻርጅ ይሆንና Thomson ያለው ኤሌክትሮኖች በፓዘቲቭ ቻርጅ በያዘ ሉል(sphere) ውስጥ ተሸጉጠው ይገኛሉ የሚል ነው።እንደ

thomson ገለጻ ከሆነ ኤሌክትሮኖች ሊሸጎጡ የቻሉት ከሃይድሮጅን አቶም አንጻር 2000 እጥፍ ያነሱ በመሆናቸው ነው።

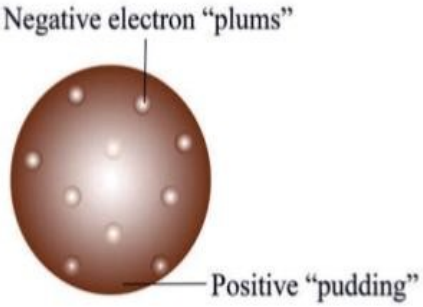


Figure 1.4: Thomson's "plum-pudding" model of an atom



❖ In 1911. Ernest Rutherford worked with Thomson to test this model. In Rutherford's experiment, positively charged particles were aimed at a thin sheet of gold foil (Figure 1.5). If the Thomson model were correct, the particles would travel in straight paths through the gold foil.

Follow us
ALPHA BOOKS



ላይ የ alpha particle ዎችን አየ። ይባስ ብሎ አንዳንዶቹ ቅንጣቶች እየተጋጩ ወደ ተነሱበት ቦታ መመለስ ጀመሩ።

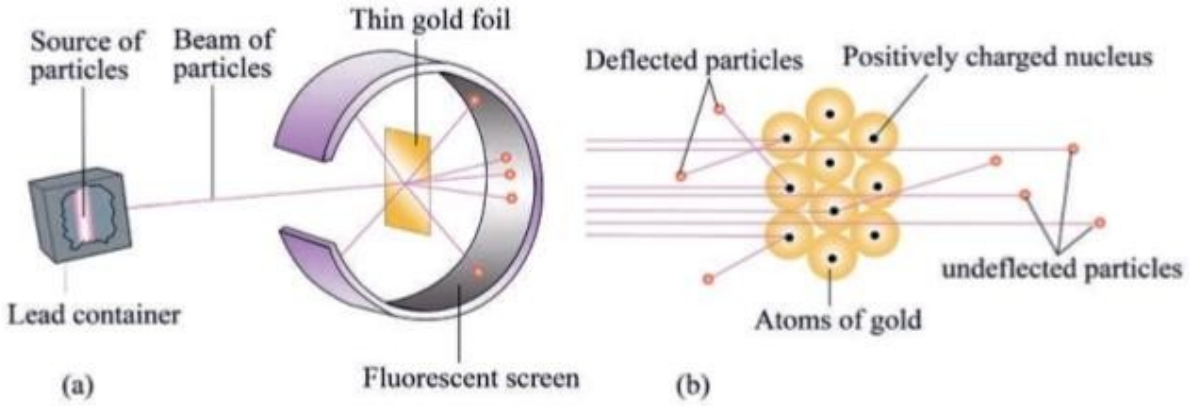


Figure 1.5: (a) α-particles aimed at a piece of gold foil, (b) Magnified view of α-particles passing through and being deflected by nuclei

ስለዚህ ከዚህ ሙከራ በመነሳት የሚከተሉትን ነገሮች Rutherford ደመደመ።

1 ኛ- አብዛኛቹ particle ምንም አይነት defelction (መሰበር) አላደረጉም። ቀጥታ በውስጡ አልፈዋል። ይህ ማለት የአቶም አብዛኛው ክፍል ውኖ ቦታ ና ምንም አይነት ነገር የሌለው ነው የሚል ድምዳሜ ላይ ያስደርሳል። ስለዚህ :- **Most space of an atom is empty** ማለት ነው።

2 ኛ - አንዳንዶቹ ቅንጣቶች በጣም በትንሽ አንግል ተሰብረዋል። ይህ ማለት የ alpha particle ን ጉዞ ሊቀይር የሚችል ግጭት አቶም ውስጥ ተፈጥሯል ማለት ነው። ይሽ ሊሆን የሚችለው ደግሞ በአቶሙ ውስጥ ያሉ ቻርጆች ተጠጋግተው በሚገኙበት ቦታ ውስጥ ነው። እንዲሁም ሲሰበሩ ደግሞ ከተጋጩበት ቦታ እየራቁ ነው የሚሄዱት ። ይሽ የሚያሳየን ደግሞ ከ alpha particle ጋር ተመሳሳይ የሆነ ቻርጅ

Follow us
ALPHA BOOKS

Answer = C

1.3.3 Discovery of the Neutron

- The neutron was also discovered by alpha-particle scattering experiments. When beryllium metal is irradiated with alpha rays, a strongly penetrating radiation is obtained from the metal. In 1932 the British physicist James Chadwick (1891- 1974) showed that this penetrating radiation consists of neutral particles, called neutrons. The neutron is a nuclear particle having a mass almost identical to that of the proton but with no electric charge. The mass of a neutron, m = 1.67493 × 10-27 kg, which is about 1840 times the mass of an electron.

James Chadwick የሞከረው ሙከራ አንድ alpha particle ሊለቅ የሚችል radioactive ንጥረ ነገር ከ Beryllium ብረት ፊትለፊት አድርጎ alpha particle ወደ ብረቱ እንዲለቅበት አደረገ። ከዚያን በኋላ ከታች በምትመለከቱት አጸግብሮት ካርቦን አቶም ና ሌላ ቅንጣት ተፈጠረ።

$$Be_4^9 + He_2^4 \rightarrow {}^{12}_{6}C + n_0^1$$

ይሽን ከካርቦን ጋር የተፈጠረውን ቅንጣት በ Detector ማለትም ጫፍ ና ጫፍ ላይ -ve ና + ve ቻርጅ ያለበት ውስጥ ቢያሳልፈው ይሽ ቅንጣት ምንም አይነት መሰበር አላሰየም። ይሽ ማለት ቻርጅ አልባ ነገር ግን የራሱ መጠነ ቁስ ያለው ቅንጣት መሆኑን ተረዳ።ይሽም ቅንጣት Neutron (n0) ብሎ ሰየመው።

1.4 Make-up of the Nucleus

Follow us
ALPHA BOOKS



ንሽ ስለሆነ ለቀመራዊ(calculations) ሂደት እንዲጠቅም ትንሹ ቁጥር በትልቅ ቁጥር አንጻርነት(ወካይነት) ይቀመጣል። ይህ ቁጥር Atomic mass unit(amu) ይባላል። ይህም 1amu የአንድ C-12 አቶም መጠነቁስ 1/12 ኛ የሚወክል ነው።በዚህ ወካይ ቁጥር አማካኝነት የ subatomic particle መጠነ ቁስ በትልቅ ቁጥር መግለጽ ይቻላል።ፕሮቶን ከኒውትሮን ጋር በኒውክለስ ውስጥ ይገኛል።

Table 1.1: Properties of subatomic particles

Particle	Actual mass (kg)	Relative mass (amu)	Actual charge (C)	Relative charge
Proton (p)	1.672622×10^{-27}	1.007276	1.602×10^{-19}	+1
Neutron (n)	1.674927×10^{-27}	1.008665	0	0
Electron (e^-)	9.109383×10^{-31}	5.485799×10^{-4}	-1.602×0^{-19}	-1

- The atomic number (Z) of an element equals the number of protons in the nucleus of each of its atoms. All atoms of a particular element have the same atomic number, and each element has a different atomic number from that of any other element. The total number of protons and neutrons in the nucleus of an atom is its mass number (A). The mass number and atomic number of an element X are often written with the symbol,

አቶማዊ ቁጥር(Z) ለአንድ ንጥረ ነገር ልክ እንደ ማንነቱ ነው። ይህ ማለት አንድ ሰው ከራሱ ውጪ ከሌሎች ጋር ተመሳሳይ ማንነት ሊኖረው አይችልም። ልክ አንደዚሁ ንጥረ ነገሮች የተሰሩበት የራሱ አቶሞች ተመሳሳይ የሆነ atomic number (Z) ይኖራቸዋል። ይህ ካልሆነ አንድ ወጥ ማንነት ያለው ንጥረነገር መስራት አይችሉም። በአንጻሩ ደግሞ

ከሌሎች ንጥረ ነገር ከተሰሩባቸው አቶሞች ጋር ተመሳሳይ የሆነ atomic number ያለው አቶም ሊገኝ አይችልም። ለምሳሌ:-የኦክስጅን ንጥረ ነገር ከኦክስጅን አቶም የተሰራ ነው። የኦክስጅን አቶም አቶማዊ ቁጥሩ 8 ነው። ከኦክስጅን አቶሞች ውጪ ይህን አቶማዊ ቁጥር የያዘ አቶም የለም። እንዲሁም ይህ አቶማዊ ቁጥር ከኘሮቶን ቁጥር ጋር እኩል ነው።ሌላኛው ደግሞ የአቶማዊ መጠነ ቁስ(Atomic mass number -A) የምንለው በአቶሙ ውስጥ ያሉ የሁሉም ቅንጣቶች መጠነቁስ ድምር ነው። ይህ ማለት የኘሮቶን መጠነቁስ + የኤሌክትሮን መጠነ ቁስ + የኒውትሮን መጠነ ቁስ ማለት ነው። ነገር ግን የኤሌክትሮን መጠነ ቁስ በጣም ትንሽ ከመሆኑ የተነሳ እንደ ዜሮ የሚቆጠር ነው።ለዛ **Atomic mass=Proton +Neutron** ይኾናል ማለት ነው።

1.4.2 Atomic Mass and Isotopes

- All atoms of an element are identical in atomic number but not in mass number. Isotopes of an element are atoms that have different numbers of neutrons and different mass numbers. For example :- all carbon atoms have six protons in the nucleus (Z=6) but only 98.89% of naturally occurring carbon atoms have six neutrons in the nucleus (A12). A small percentage (1.11%) have seven neutrons in the nucleus (A13), and even fewer (less than 0.01%) have eight (A14). Hence, carbon has three naturally occurring isotopes: 12C, 13C, and 14C.

Follow us
ALPHA BOOKS

አብዛኛው ንጥረ ነገር የአይሶቶፕ ቅልቅል ነው። እዚጋ ልንጠይቀው የሚገባው ጥያቄ በአንድ ንጥረ ነገር ውስጥ የተለያዩ መጠነ ቁስ ያላቸው አቶሞች(አይሶቶፖች) የሚገኙ ከሆነ የአንድን ንጥረ ነገር ጠቅላላ መጠነ ቁስ በአንድ ቁጥር እንዴት ማስቀመጥ ይቻላል? የሚለውን ነው። መልሳችን የሚሆነው የሁሉንም የንጥረ ነገሩ አቶሞች መጠነ ቁስ አማካይ ቁጥር በመፈለግ ነው።ይህ አማካይ ስንፈልግ ግን እያንዳንዱ ንጥረ ነገር አይሶቶፖች በእኩል መገኘት(abundance) ስለሌሉ አማካይ ስሌት ውስጥ Abundance ማስገባት ይኖርብናል።ስሌቱም እንደሚከተለው ይኾናል።

A=A1f1 +A2f2 +A3f3 +……+Anfn

A=አጠቃላይ አቶማዊ መጠነ ቁስ

A1=የአንዱ አይሶቶፕ አቶማዊ መገቁስ

f1= አይሶቶፑ በስንት መጠን እንደሚገኝ…

Example 1.2

There are two naturally occurring isotopes of silver. Isotope ^{107}Ag (106.90509 amu) accounts for 51.84% of the total abundance, and isotope ^{109}Ag (108.90476) accounts for the remaining 48.16%. Calculate the atomic mass of silver?

Solution:

Find the portion of the atomic mass from each isotope:

Portion of atomic mass from ^{107}Ag: = isotopic mass × fractional abundance
= 106.90509 amu × 0.5184 = 55.42 amu

Portion of atomic mass from ^{109}Ag: = 108.90476 amu × 0.4816 = 52.45 amu

Find the atomic mass of silver:

Atomic mass of Ag = 55.42 amu + 52.45 amu = 107.87 amu

Entrance 2012

8.Sliver (Z=47) has several known isotopes, but two occur naturally, 107Ag and 109 Ag. Given the following mass spectrometric data, calculate the atomic mass of Ag

Isotope	Mass(amu)	Abundance (%)
^{107}Ag	106.90509	54.84
^{109}Ag	108.90476	48.16

A.108.9 amu B.107.94 amu C.107.4 amu D.107.86 amu

Explanation

$$Atomic\ mass = A_1f_1 + A_2f_2$$

$$= 106.90509 \times \frac{51.84}{100} + 108.90476 \times \frac{48.16}{100} = 107.87amu$$

Answer = D

Exercise 1.3

1. How many protons and neutrons are in the nucleus of each of the following atoms?

   a. $^{27}_{13}Al$ b. $^{32}_{16}S$ c. $^{64}_{30}Zn$ d. $^{207}_{82}Pb$

2. Element X is toxic to humans in high concentration but essential to life at low concentrations. It has four naturally occurring isotopes that contain 24 protons. Identify element X and give the atomic symbol for the isotopes with 26, 28, 29, and 30 neutrons.
3. Naturally occurring boron consists of two isotopes, ^{10}B and ^{11}B, with the isotopic masses 10.013 amu and 11.009 amu, respectively. The observed atomic mass of boron is 10.811 amu. Calculate the abundance of each isotope
4. The two naturally occurring isotopes of lithium, lithium-6 and lithium-7, have masses of 6.01512 amu and 7.01600 amu, respectively. Which of these two occurs in greater abundance?

Entrance 2012

8. An element X has two naturally occurring isotopes. X (10.013 amu) and X (11.01 amu). The first accounts for 19.9% of the total and the second accounts for remaining 80.1%. What is the average atomic mass of the elements X?

A.10.812 B.10.211 C.10.521 D.10.125

Explanation: Average atomic mass = A_1F_1 + A2F2 =10.013 x 19.9/100 + 11.01 x 80.1 = 10.812 amu

Answer = a

Teacher's Mind

5. The existence of isotopes violates one of the original ideas of Dalton's atomic theory. Which one?

6. How are electrons and protons similar? How are they different?

7. How are protons and neutrons similar? How are they different?

8. Predict and test the behavior of α particles fired at a "plum pudding" model atom.

(a) Predict the paths taken by α particles that are fired at atoms with a Thomson's plum pudding model structure.

Explain why you expect the α particles to take these paths.

(b) If α particles of higher energy than those in (a) are fired at plum pudding atoms, predict how their paths will differ from the lower-energy α particle paths. Explain your reasoning.

9. Predict and test the behavior of α particles fired at a Rutherford atom model.

(a) Predict the paths taken by α particles that are fired at atoms with a Rutherford atom model structure. Explain why you expect the α particles to take these paths.

(b) If α particles of higher energy than those in (a) are fired at Rutherford atoms, predict how their paths will differ from the lower-energy α particle paths. Explain your reasoning.

(c) Predict how the paths taken by the α particles will differ if they are fired at Rutherford atoms of elements other than gold.

What factor do you expect to cause this difference in paths, and why?

10. In what way are isotopes of a given element always different? In what way(s) are they always the same?

11. Write the symbol for each of the following ions:

(a) the ion with a 1+ charge, atomic number 55, and mass number 133

(b) the ion with 54 electrons, 53 protons, and 74 neutrons

(c) the ion with atomic number 15, mass number 31, and a 3− charge

(d) the ion with 24 electrons, 30 neutrons, and a 3+ charge

12. Write the symbol for each of the following ions:

(a) the ion with a 3+ charge, 28 electrons, and a mass number of 71

(b) the ion with 36 electrons, 35 protons, and 45 neutrons

(c) the ion with 86 electrons, 142 neutrons, and a 4+ charge

(d) the ion with a 2+ charge, atomic number 38, and mass number 87

16. Determine the number of protons, neutrons, and electrons in the following isotopes that are used in medical diagnoses:

(a) atomic number 9, mass number 18, charge of 1−

(b) atomic number 43, mass number 99, charge of 7+

(c) atomic number 53, atomic mass number 131, charge of 1−

(d) atomic number 81, atomic mass number 201, charge of 1+

(e) Name the elements in parts (a), (b), (c), and (d).

17. The following are properties of isotopes of two elements that are essential in our diet. Determine the number of protons, neutrons and electrons in each and name them.

(a) atomic number 26, mass number 58, charge of 2+

(b) atomic number 53, mass number 127, charge of 1−

18. Give the number of protons, electrons, and neutrons in neutral atoms of each of the following isotopes:

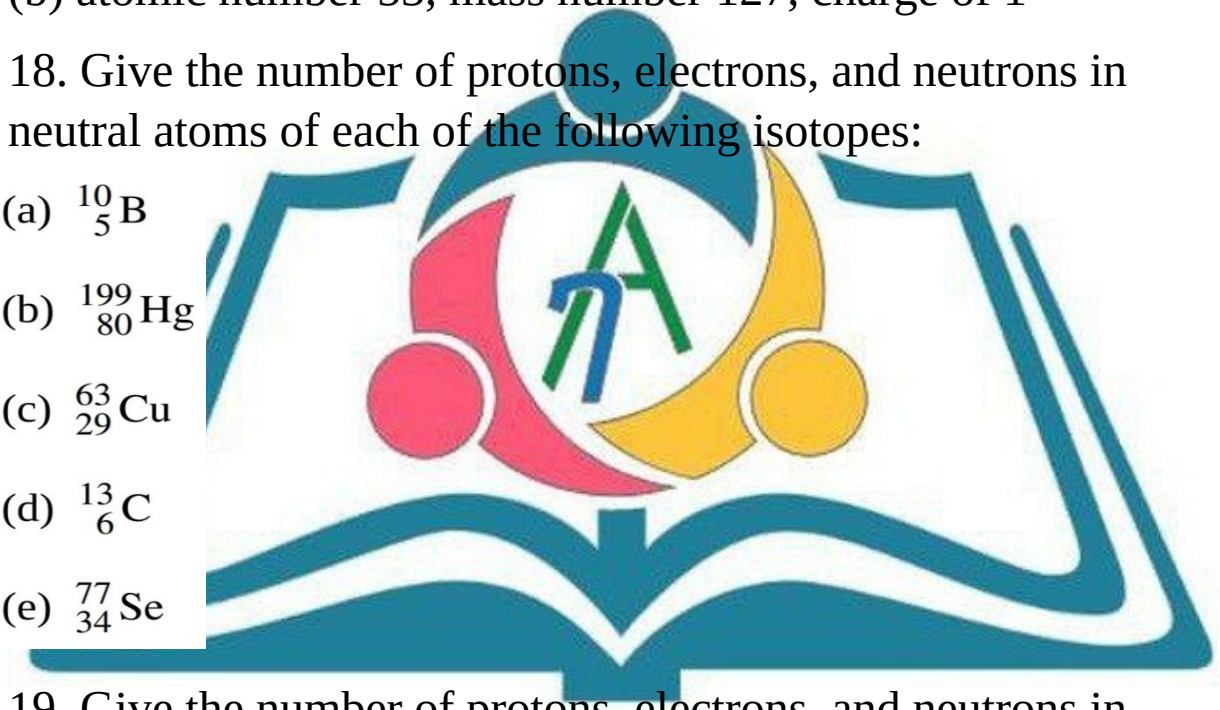
(a) $^{10}_{5}B$

(b) $^{199}_{80}Hg$

(c) $^{63}_{29}Cu$

(d) $^{13}_{6}C$

(e) $^{77}_{34}Se$



19. Give the number of protons, electrons, and neutrons in neutral atoms of each of the following isotopes:

(a) $^{7}_{3}Li$

(b) $^{125}_{52}Te$

(c) $^{109}_{47}Ag$

(d) $^{15}_{7}N$

(e) $^{31}_{15}P$

22. An element has the following natural abundances and isotopic masses: 90.92% abundance with 19.99 amu, 0.26% abundance with 20.99 amu, and 8.82% abundance with 21.99 amu. Calculate the average atomic mass of this element.

23. Average atomic masses listed by IUPAC are based on a study of experimental results. Bromine has two isotopes 79Br and ^{81}Br, whose masses (78.9183 and 80.9163 amu) and abundances (50.69% and 49.31%) were determined in earlier experiments. Calculate the average atomic mass of bromine based on these experiments.

24. Variations in average atomic mass may be observed for elements obtained from different sources. Lithium

provides an example of this. The isotopic composition of lithium from naturally occurring minerals is 7.5% 6Li and 92.5% 7Li, which have masses of 6.01512 amu and 7.01600 amu,

respectively. A commercial source of lithium,recycled from a military source, was 3.75% 6Li (and the rest 7Li). Calculate the average atomic mass values for each of these two sources.

25. The average atomic masses of some elements may vary, depending upon the sources of their ores. Naturally occurring boron consists of two isotopes with accurately known masses (10B, 10.0129 amu and 11B, 11.0931 amu).The actual atomic mass of boron can vary from 10.807 to 10.819, depending on whether the mineral source is from Turkey or the United States. Calculate the percent abundances leading to the two values of the average atomic masses of boron from these two countries.

26. The 18O:16O abundance ratio in some meteorites is greater than that used to calculate the average atomic mass of oxygen on earth. Is the average mass of an oxygen atom in these meteorites greater than, less than, or equal to that of a terrestrial oxygen atom?

Answer Key

5. Dalton originally thought that all atoms of a particular element had identical properties, including mass. Thus, the concept of isotopes, in which an element has different masses, was a violation of the original idea. To account for the existence of isotopes, the second postulate of his atomic theory was modified to state that atoms of the same element must have identical chemical properties.

7. Both are subatomic particles that reside in an atom’s nucleus. Both have approximately the same mass. Protons are positively charged, whereas neutrons are uncharged.

Follow us
ALPHA BOOKS

(b) 52 protons, 52 electrons, 73 neutrons

(c) 47 protons, 47 electrons, 62 neutrons

(d) 7 protons, 7 electrons, 8 neutrons

(e) 15 protons, 15 electrons, 16 neutrons

23. 79.904 amu

25. Turkey source: 0.2649 (of 10.0129 amu isotope); US source: 0.2537 (of 10.0129 amu isotope)

1.5Electromagnetic Radiation and Atomic Spectra

1.5.1 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 and magnetic field components. These two components vibrate in two mutually perpendicular planes (Figure 1.6). EMR is the emission and transmission of energy in the form of electromagnetic waves.

Follow us
ALPHA BOOKS



very short wavelengths, in nanometers (nm), picometers (pm), or angstrom (Å). Frequency (v, Greek letter nu) is the number of cycles the wave undergoes per second and is expressed in units of l/second (1/s; also called hertz, Hz).

- ❖ Wave has a speed which depends on the type of wave and the nature of the medium through which it is traveling (for example, air, water, or a vacuum). The speed (c) of a wave is the product of its wavelength and its frequency:

$$C=hv$$

- ❖ In a vacuum, electromagnetic waves travel at 3 x 10 m/s, which is a physical constant called the speed of light.

የኤሌክትሮማግኔቲክ ሞገድ ሶስት መሠረታዊ ጠባያት አሉት። 1-Wave length 2-Frequency 3-Speed እያንዳንዱን እንመልከታቸው።

1-Wave length :-በግሪኩ lambda ፊደል የሚወከል ሲሆን ይህም አንድ ሞገድ በአንድ ሙሉ ዙር ወደ ነበረበት ቦታ ሲመለስ ከተነሳበት እስከ ደረሰበት ያለው ርቀት(distance) ነው። ለምሳሌ:-ከታች ባለው wave ላይ ከሞገዱ ከላይ ከተነሳት one cycle ማለት ዞሮ ወደ እዛው ቦታ(ከላይ) ላይ ሲደርስ ማለት ነው። ከዛም ከተነሳበት ጀምሮ እስከ ደረሰበት ያለው ርቀት Wave length ይባላል።

Follow us
A L P H A B O O K S

light wave የሞገዱ አይነት electromagnetic wave ነው። sound wave ደግሞ mechanical wave ነው። Mechanical ስንል ለመስተላለፍ የሆነ አስተላላፊ medium የሚፈልጉ ማለታችን ነው። ለምሳሌ:- የድምጽ ሞገድ(sound wave) ለመስተላለፍ አየር ይፈልጋል። ያለ ምንም ማስተላለፊያ ማለትም እንደ ውኖ ቦታ(Vacuum) ውስጥ ሊስተላለፍ አይችልም።እንዲሁም ሞገዶች ከሚስተላለፊበት medium ወደ አንዱ ሲሄዱ ፍጥነታቸው ይለዋወጣል። ለምሳሌ:- ብርሃን ከአየር ወደ ውሃ ውስጥ ሲገባ ፍጥነቱ ይቀንሳል። ይህ ሁነት ነው የብርሃን መሰበርን(Light refraction) የሚፈጥረው። እንደ Electromagmetic wave ካየን ግን ሞገዱ በውኖ ቦታ (Vacuum) ውስጥ ስለሚስተላለፍ በዚህ ውስጥ ፍጥነቱ 3×108 m/sec ነው።

Entrance 2008

37.What is the relationship between frequency (v), wavelength (λ) and the speed of light (c)?

A. λ/v=c

B.vc = λ

C.hc/λ = v

D.C = vλ

Explanation:

The smaller the frequency (v), the higher the wave length (λ). i.e

vα 1/λ

=> C=vλ, but E = λv

Answer =D

38. What is the magnitude of quantum energy and the frequency for an object whose wave length is 0.6 x 10-6m?

A.3.31 x 10-9j, 5 x 1014s-1

B.3.98 x 10-40j, 2 x 10-15s-1
C.1.99 x 10-25j, 3.98 x 10-40s-1
D.9.94 x 10-12j, 1.99 x 10-25sec
Explanation:
ε = hc/λ, where h= 6.63 x 10-34j.s, C = 3.0 X 108m/s

ε = 6.63 x 10-34 x 3.0 x 108m/s/6.0 x 107m = 3.31 x 10-19j

v = c/λ = 3.0 x 108m/s/6.0 x 107m = 5 x 1014s-1

Answer = A

Entrance 2009

9. The normal human eye responds to visible light of wavelength ranging from about 390 to 710 nm. What is the frequency range of the human eye?
A.7.7 x 10^{14}s-1 to 4.2 x 10^{14}s-1
B.4.2 x 10^{14}s-1 to 7.7 x 10^{14}s-1
C.1.3 x 10^{-15}s-1 to 2.4 x 10^{-15}s-1
D.2.4 x 10^{-15}s-1 to 1.3 x 10^{-15}s-1
Explanation:
v=c/λ =(3 x 10^{8})/(390 x 10^{-9}) =7.7 x 10^{14}s-1

v=c/λ =(3 x 10^{8})/(710 x 10^{-9})=4.2 x 10^{14}s-1

14. What is the frequency of a radiation (in Hz) from an atom if its wavelength is 1.0 x 10-9 nm?
A.3.3 x 10^{-27}
B.3.0 x 10^{17}
C.3.0 x 10^{8}
D.3.0 x 10^{26}
Explanation:

$v=c\lambda =(3.0 \times 10^{8}\ m/s)/(1.0 \times 10^{-9} \times 10^{-9}\ m)\ (3.0 \times 10^{8}\ m/s)/(1.0 \times 10^{-18})$

$V=3.0 \times 1026\ Hz$

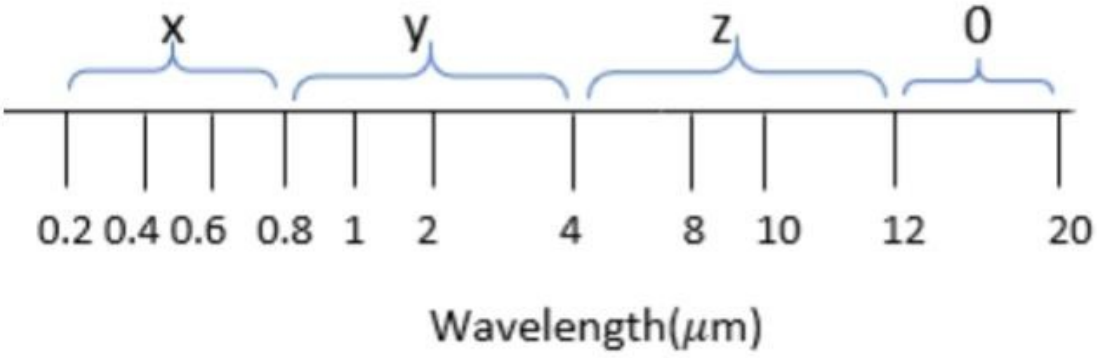
Answer = D

- EMR comes in a broad range of frequencies called the electromagnetic spectrum (Figure 1.8). A rainbow is an example of a continuous spectrum. Different wavelengths in visible light have different colors from red (= 750 nm) to violet (= 380 nm). Radiation provides an important means of energy transfer. For instance, the energy from the Sun reaches the Earth mainly in the form of visible and ultraviolet radiation. The glowing coals of a fireplace transmit heat energy by infrared radiation. In microwave ovens, microwave radiation is used to heat water in foods, causig the food to cook quickly.

ቅድም የአንድ ሞገድ(wave) ባህሪ ብለን ከጠራናቸው ነገሮች ውስጥ አንደኛው frequency ነው። ይህ ማለት ሞገዶች frequency እንደሚለያይባቸው መጠን የተለያየ ባህሪ ያሳያሉ ማለት ነው። ስለዚህም Electromagnetic wave ውስጥ ያለው energy ማለት Electromagnetic radiation እንደ frequency ው መለያየት የተለያየ ስራዎችን መስራት ይችላል ማለት ነው።ለምሳሌ:- electromagnetic wave ሆኖ 300GHz እስከ 400THz ድረስ frequency ያለው Infrared radiation(IR) ይባላል። ይሽውም ከሰል ከተቀጣጠለ በኃላ የከሰሉ

Follow us
ALPHA BOOKS

Follow us
ALPHA BOOKS



A.X B.0 C.y D.z

Explanation: The visible light spectrum range is from 390 to 750nm or from 0.39 to 0.75μm. Hence x represents visible light.
Note:- 1 micrometer (um) =1000 nanometers (nm).

Answer =A

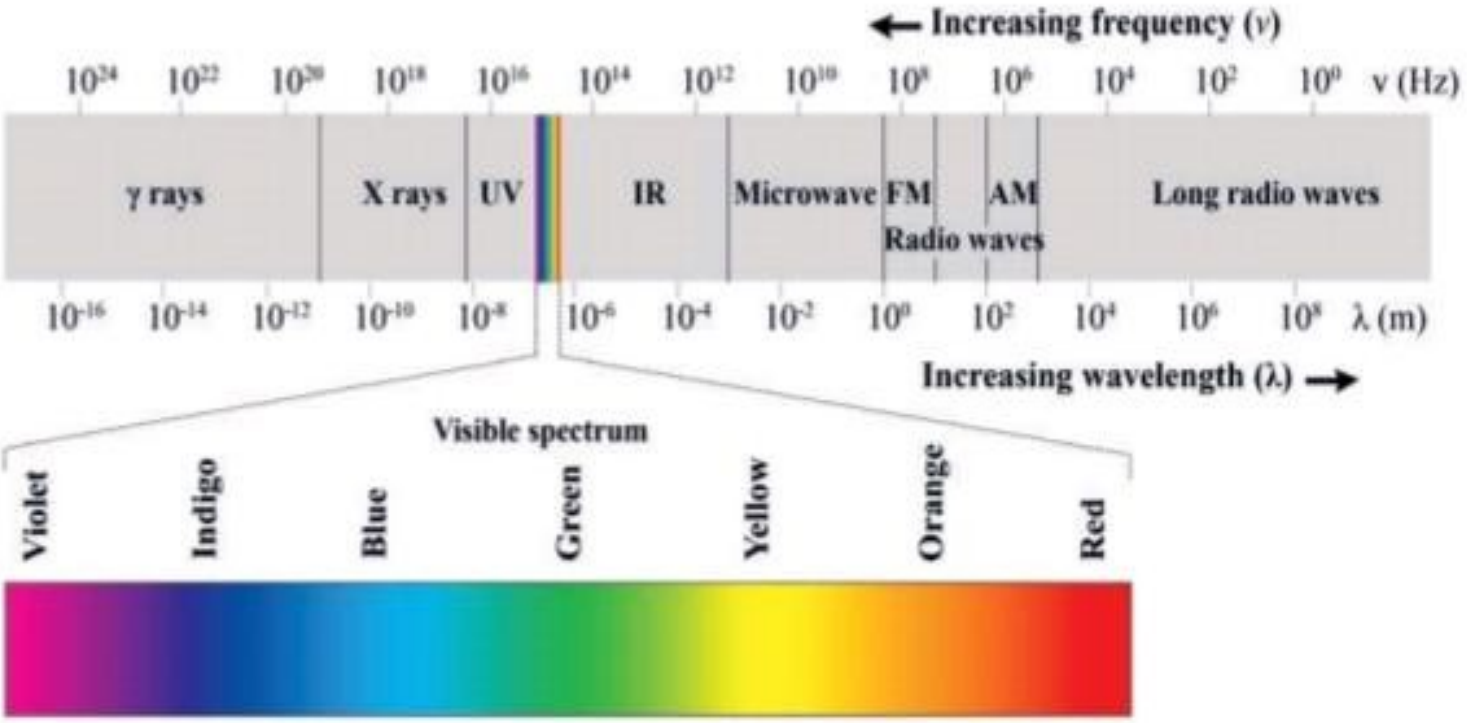


Figure 1.8: The electromagnetic spectrum

Example 1.3

Ethiopian National Radio, Addis Ababa station broadcasts its AM signal at a frequency of 2400 kHz. What is the wavelength of the radio wave expressed in meters?

Solution:

We obtain the wavelength of the radio wave by rearranging **Equation 1.1**

$$\text{so, } \lambda = \frac{c}{\nu} = \frac{3.00 \times 10^{8}\ \text{m/s}}{2.4 \times 10^{6}\ \text{s}} = 125.0\ \text{m}$$

Exercise 1. 4

1. The most intense radiation emitted by the Earth has a wavelength of about 10.0 μm. What is the frequency of this radiation in hertz?
2. Addis Ababa Fana FM radio station, broadcasts electromagnetic radiation at a frequency of 98.1 MHz. What is the wavelength of the radio waves, expressed in meters?

1.5.2 The Quantum Theory and Photon

- In 1900, Max Planck, the German physicist, came to an entirely new view of matter and energy. He made a revolutionary proposal, energy like matter is discontinuous.
- According to Planck, atoms and molecules could emit or absorb energy only in. discrete quantities, like small packages or bundles. Each of these small "packets" of

energy is called a quantum. The energy of a quantum is proportional to the frequency of the radiation. The energy E of a single quantum is given by:

$$E=hv$$

- Where s h is plank's constant and v is the frequency of radiation. The value of Planck's constant is 6.63 x 10-14 J. s.

እንደ planck ገለጻ ከሆነ አቶም ና ሞሎኪዮሎች ኃይል የሚቀበሉት ወይም የሚለቁት በተወሰነ መጠን (discrete quantity) ነው እንጂ እንዲሁ በዘፈቀደ አይደለም። ለምሳሌ:- ስኳር በኪሎ ተለክቶ ይሸጣል እንጂ አንዲቷ አንዲቷ የስኳር ቅንጣት ዋጋ የላትም። ወይም በእጃችንን ዘግነን የዚህ ስኳር ዋጋ ስንት ነው? ማለት አንችልም። ምክንያቱም ስኳር የሚሸጥበት የራሱ የሆነ መጠን(discrete quantity) አለው። ልክ እንደዚያው energy ከአንድ አቶም ወደ ሌላ አቶም ለመሄድ የራሱ የሆነ መጠን(diacrete quantity) አለው። ይህ መስተላለፍ የሚችል የኃይል ክምችት quantum ተብሎ ይጠራል።ይህ quantum ኃይሉን ከተሸከመው ሞገድ(wave) ጋር ርቱዕ ወደረኝነት (direct proportionality) አለው። እንደ plank ገለጻ ከሆነ E=hv ይኾናል። V ማለት frequency ሲሆን h ደግሞ የታወቀ የ plank ቁጥር(plank's constant)=6.63×10-14J/sec ነው።

Entrance 2009

13. What is the energy associated with one photon of a microwave radiation having a frequency of 2.45x 10^{9}s-1?
    A. 1.62 x 10^{24} J
    B.2.45x 10^{-9} J

Follow us
ALPHA BOOKS

According to quantum theory, energy is always emitted or absorbed in integral multiples of hv; for example, hv, 2hv, 3hv, etc. A system can transfer energy only in whole quanta. Thus, energy seems to have particulate properties.

በዚህ የ quantum theory ህግ መሠረት ኃይል የሚስተላለፈው በ hv ብዜቶች መጠን ውስጥ ነው። ለምሳሌ:-hv ,2hv,3hv ውሰጥ ይስተላለፋል። ነገር ግን በ 2hv እና በ 3hv መካከል ያለ ኃይል 2hv ያህል



Example 1.4

The blue color in fireworks is often achieved by heating copper (I) chloride (CuCl) to about 1200 °C. Then the compound emits blue light having a wavelength of 600 nm. What is the increment of energy (the quantum) that is emitted at 600 nm by CuCl?

Solution:

The quantum of energy can be calculated from the **Equation 1.2**:

$$E = h\nu$$

The frequency (ν) for this case can be calculated as follows:

$$\nu = \frac{c}{\lambda}$$

$$= \frac{3.0 \times 10^{8}\ \cancel{ms^{-1}}}{6.0 \times 10^{-7}\ \cancel{m}}$$

$$= 0.5 \times 10^{15}\ s^{-1}$$

So, $E = h\nu$

$$= 6.63 \times 10^{-34}\ J.\cancel{s} \times 0.50 \times 10^{15} s^{-1}$$

$$= 3.315 \times 10^{-19}\ J = 3.32 \times 10^{-19}\ J$$

Follow us
ALPHA BOOKS

ተስተላለፈና ኤሌክተሮንን አንቀሳቀሰ።ይህ ማለት የ plank እሳቤ በአልበርት ስራዎች ውስጥ ያሉ መሆኑን የሚያሳይ ነው።

- Photons are particles of light or energy packet. The minimum energy required to remove an electron is:

$$Eo = hvo$$

Where Eo is the minimum energy (of the photon), and, Vo the threshold frequency.

Energy በነጠላ ሳይሆን እንደ ክምችት ወይም እንደ ጥርቅም ሆኖ ይስተላለፋል ብለናል። ይህ photon ይባላል። ቅድም Thershold frequency ኤሌክትሮን ለማስወጣት የሚያስፈልገው ትንሹ frequency ብለናል። ይህ frequency የሚፈጥረው ኃይል ደግሞ እንደ plank ህግ ከሆነ hvo ይሸናል። ይሽ ኃይል መስተላለፍ የሚችለው ትንሹ (መነሻ) የሆነ ኃይል (Eo) ነው።ስለዚህ ከዚህ ኃይል ካነሰ ኃይሉ ወደ ብረቱ ሊስተላለፍና ስራ ሊሰራ አይችልም።ስራው ኤሌክትሮን እንዲወጣ ማድረግ ነው። ነገር ግን የሚስተላለፈው ኃይል ከ Eo ከበለጠ (E>Eo) ከሆነ በመጀመሪያ Eo ስለያዘ ኤሌክትሮኑን ማስወጣት(Ejected) ይችላል። በተረፈችው የኃይል መጠን ደግሞ ኤሌክትሮኗ እንድትንቀሳቀስ(Movement) ያደርጋል። ይህ ማለት ኤሌክትሮኑን ማስወጣትና ኤሌክትሮኑን ማንቀሳቀስ ራሳቸውን ችለው የተለየ ኃይል የሚፈልጉ እንደሆነ መገንዘብ አለብን።ለማንቀሳቀስ የሚያስፈልገው ኃይል Kinetic energy(KEe) ይባላል። እርሱም መጀመሪያ ከመጣው ኀይል ላይ ኤሌክትሮኑን እንዲወጣ ካደርግንበት ኃይል በመቀነስ እናገኘዋለን።

$$KE=\tfrac{1}{2}mv2= hv - hvo$$

Where KE is the kinetic energy of an electron, m is mass of an electron, v is the velocity of an electron, hv, is the energy of an

incident photon, and hv is the energy required to remove an electron from the metal's surface.

Duality Nature of Light

ለብዙ ጊዜ ሳይንቲስቶችን ያከራከር ከነበሩ ጥያቄዎች ብርሃን እንደ ሞገድ(wave) ነው ወይስ እንደ ቅንጣት(particle) የሚል ነበር። እንደ Isaac Newton ያሉ ሳይንቲስቶች ብርሃን የራሱ የሆኑ ቅንጣቶች አሉት። የተሰራውም ከነዚህ ነው ይላል። እንደ Huygen ገለጻ ደግሞ ብርሃን እንደ ሞገድ(Wave) አይነት ባህሪ ያለው ነው።ይኸ ለመሆኑ ደግሞ ሞገድ(wave) ያሉት ባህሪያት በብርሃን ላይ እንዳሉ አሳይቷል። ለምሳሌ:- እንደ Diffraction ፣ Refraction ፣ Reflection ያሉ የሞገድ ባህሪያት ብርሃን ውስጥም አሉ። ለምሳሌ:-ብርሃን Refracted ስለሚሆን ነው የምናየው። ይህ ካልሆነ ብርሃን ራሱ የማይታይ(invisible) ነው። እንደ Plank ያሉ ሳይንቲስቶች ደግሞ እንዳየነው ኃይል የሚስተላለፈው በሆነ የክምችት መጠን ነው(energy is quanatized) በማለት ብርሃን ልክ የቅንጣት ተፈጥሮ(particle nature) እንዳለው ገለጹ።ለምሳሌ :- የአንድ በቆሎ ቅንጣት ስትበላ መቼስ አትሰብሩትም። የሚበላው በበቆሎው ቅንጣት መጠን ነው። ልክ እንደዚሁ ኃይል በሆነ ክምችት ነው መስተላለፍ ያለበት ማለት ኃይል ቅንጣት(particle) አይነት ጠባይ አለው ማለት ነው። ለዚህ ኃይል የ particle nature አለው የሚለውን ሌላ ደጋፊ የሳይንሱ ንጉሥ አልበርት ኢንስታይን(Albert Einstein) ነው።አልበርት ብርሃን particle nature ያለው መሆኑን የሚያስረግጡ የተለያዩ ግኝቶችን አግኝቷል።

- In his theory of relativity in 1905, Einstein derived the famous equation:

$$E = mc^2$$

በዚህ የአልበርት ታዋቂዋ ህግ መሠረት ኃይል የራሱ መጠነ ቁስ አለው ። Energy has a mass የሚል ድምዳሜ ላይ ያስደርሰናል። ይህን Energy በ photon በመተካት photon ሊኖረው የሚችለውን መጠነ ቁስ መፈለግ ይቻላል።

$$E_{\text{photon}} = \frac{hc}{\lambda} \qquad m = \frac{E}{c^2} = \frac{\left(hc/\lambda\right)}{c^2} = \frac{h}{c\lambda}$$

መጠነ ቁስ አለው ማለት ደግሞ particle nature እንዳለው ይገልጻል ይላል አልበርት።

- We can summarize the important conclusions from the work of Planck and Einstein as follows:

Energy is quantized. It can occur only in discrete units called photon or quanta. EMR, which was previously thought to exhibit only wave properties, seems to show certain characteristics of particulate matter as well. This phenomenon is sometimes referred to as the dual nature of light and is illustrated Figure 1.9.

Follow us
ALPHA BOOKS



Light as a wave phenomenon

2. The maximum kinetic energy of the photoelectrons emitted from a give metal is 1.5×10^{-20} J when a light that has a 750 nm wavelength shines on the surface. Determine the threshold frequency, v_o, for this metal. Calculate the corresponding wavelength, λ_o.

Solution:

a) Determination of the threshold frequency, v_o

Solve for v from $c = v \times \lambda$

Thus, $v = c/\lambda = (3.0 \times 10^8 \text{ m/s})/7.5 \times 10^{-7} \text{ m})$

Similar

$v_o =$

=

=

=

Therefo

require

b) Calcul

$$= \frac{3.0 \times 10^{8} \text{ m/s}}{3.77 \times 10^{14} \text{ s}^{-1}}$$

$$= 0.796 \times 10^{-6} \text{ m}$$

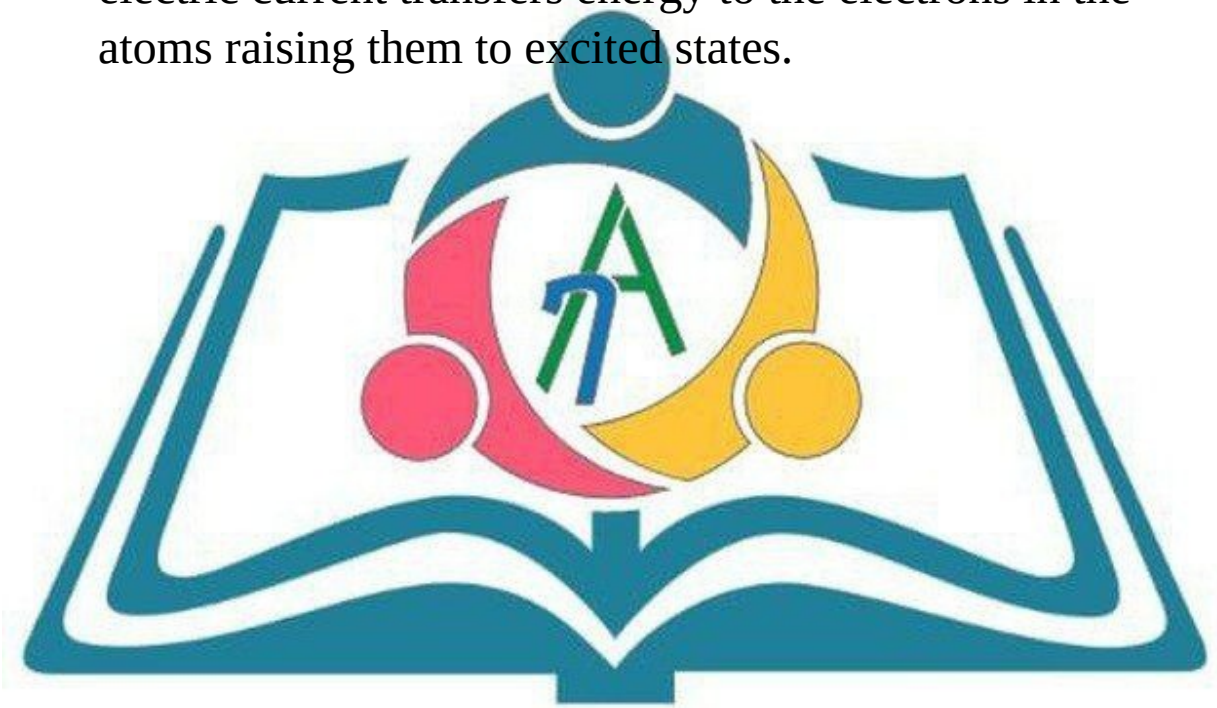
$$= 796 \text{ nm}$$

Exercise 1.5

1. The following are representative wavelengths in the infrared, ultraviolet, and X-ray regions of the electromagnetic spectrum, respectively: 1.0×10^{-6} m, 1.0×10^{-8} m, and 1.0×10^{-10} m.
   a. What is the energy of a photon of each radiation?
   b. Which has the greatest amount of energy per photon?
   c. Which has the least?
2. A clean metal surface is irradiated with light of three different wavelengths λ_1, λ_2, and λ_3. The kinetic energies of the ejected electrons are as follows: λ_1: 7.2×10^{-20} J; λ_2: approximately zero; λ_3: 5.8×10^{-19} J. Which light has the shortest wavelength and which has the longest wavelength? Determine the threshold frequency, v_o, for this metal.
3. The minimum energy required to cause the photoelectric effect in potassium metal is 3.69×10^{-19} J. Will photoelectrons be produced when visible light, 520 nm and 620 nm, shines on the surface of potassium? What is or are the velocities of the ejected electron/s?

1.5.3. Atomic Spectra

❖ Atomic or line spectra are produced from the emission of photons of electromagnetic radiation (light). Different kinds of spectrum are observed when an electric discharge, or spark, passes through a gas such as hydrogen. The electric discharge is an electric current that excites, or energizes, the atoms of the gas. More specifically, the electric current transfers energy to the electrons in the atoms raising them to excited states.



Follow us
ALPHA BOOKS

አንዱ አቆመ ሳይባል ሌላው ጀምሮ ይገኛል። ይኸ አይነት ሕብር continuous spectra ይባላል። በአቶም ውስጥ የምናየው Atomic spectra ግን ይኸ አይነት ሳይሆን በ prism በተሰበሩ ጊዜ የተለያዩ wavelength ያላቸው ቀለማት ተለያይተውና ተለይተው ከታች እንደምናየው የራሳቸውን መስመር ይሰራሉ ። ይኸ አቶም የሚያሳየው spectra = line spectra ይባላል።

- The wavelengths of these spectral lines are characteristic of the element producing them, and used for their identification.

በአንድ አቶም ውስጥ ያሉ ኤሌክትሮኖች መነሻ energy level እና የሚወድቁበት energy level ማለት የሚለቁት የኃይል መጠን በሌሎች አቶሞች ውስጥ ካሉ ኤሌክትሮኖች ይለያል። ምክንያቱም የእያንዳንዱ አቶም መዋቅርና የያዙት የ energy level ስለሚለያይ ነው።ይህ ደግሞ የሚፈጠሩትን የቀለም መዋቅር እንዲለያይ ያደርጋል። ይህን ልዩነት በመጠቀም ወይም አንድ ንጥረ ነገር ያለውን line spectra በመመልከት ንጥረ ነገሩ ምን እንደሆነ ማወቅ ይቻላል። ስለዚህ identification purpose አለው ማለት ነው።

- For example, the emission (line) spectrum of hydrogen atom is show in Figure 1.11.

Follow us
ALPHA BOOKS



Entrance 2015

45. Which of the following explains the emission spectra of atoms consisting of a series of fine lines?

A.electron undergoes a transition by energy changes corresponding to photon of specific wave length

B.An electron can have specific energy values in atom

C.An electron that revolves around the nucleus emits radiation

D.The energy of the atoms is continuous with discreet frequencies

Answer = A

Teacher's Mind

1. The light produced by a red neon sign is due to the emission of light by excited neon atoms. Qualitatively describe the spectrum produced by passing light from a neon lamp through a prism.
2. An FM radio station found at 103.1 on the FM dial broadcasts at a frequency of 1.031 x 108 s-1 (103.1 MHz). What is the wavelength of these radio waves in meters?
3. FM-95, an FM radio station, broadcasts at a frequency of 9.51 x 107 s-1 (95.1 MHz). What is the wavelength of these radio waves in meters?
4. A bright violet line occurs at 435.8 nm in the emission spectrum of mercury vapor. What amount of energy, in joules, must be released by an electron in a mercury atom to produce a photon of this light?
5. Light with a wavelength of 614.5 nm looks orange. What is

the energy, in joules, per photon of this orange light? What is the energy in eV (1 eV = 1.602 × 10-19 J)?

6. Heated lithium atoms emit photons of light with an energy of 2.961 x 10-19 J. Calculate the frequency and wavelength of one of these photons. What is the total energy in 1 mole of these photons? What is the colour of the emitted light?

7. A photon of light produced by a surgical laser has an energy of 3.027 x 10-19 J. Calculate the frequency and wavelength of the photon. What is the total energy in 1 mole of photons? What is the color of the emitted light?

8. When rubidium ions are heated to a high temperature, two lines are observed in its line spectrum at wavelengths (a) 7.9 x 107 m and (b) 4.2 x 107 m. What are the frequencies of the two lines? What color do we see when we heat a rubidium compound?

9. The emission spectrum of cesium contains two lines whose frequencies are (a) 3.45 x 1014 Hz and (b) 6.53 x 1014 Hz. What are the wavelengths and energies per photon of the two lines? What color are the lines?

10. Photons of infrared radiation are responsible for much of the warmth we feel when holding our hands before a fire.These photons will also warm other objects. How many infrared photons with a wavelength of 1.5 x 10 m must be absorbed by the water to warm a cup of water (175 g) from 25.0 °C to 40°C?

11. One of the radiographic devices used in a dentist's office emits an X-ray of wavelength 2.090 × 10-11 m. What is the energy, in joules, and frequency of this X-ray?

12. The eyes of certain reptiles pass a single visual signal to the

brain when the visual receptors are struck by photons of a wavelength of 850 nm. If a total energy of 3.15 x 10-14 J is required to trip the signal, what is the minimum number of photons that must strike the receptor?

15. What is the threshold frequency for sodium metal if a photon with frequency 6.66 x 1014 s1 ejects a photon with 7.74 x 10-20 J kinetic energy? Will the photoelectric effect be observed if sodium is exposed to orange light?

Answer Key

1. The spectrum consists of colored lines, at least one of which (probably the brightest) is red.

3. 3.15 m

5. 3.233 × 10−19 J; 2.018 eV

7. ν = 4.568 × 1014 s; λ = 656.3 nm; Energy mol−1 = 1.823 × 105 J mol−1; red

9. (a) λ = 8.69 × 10−7 m; E = 2.29 × 10−19 J

(b) λ = 4.59 × 10−7 m; E = 4.33 × 10−19 J; The color of (a) is red; (b) is blue.

11.E = 9.502 × 10−15 J; ν = 1.434 × 1019 s −1

15. 5.49 × 1014 s −1; no

1.5.4.The Bohr Model of the Hydrogen Atom

- In 1913, Niels Bohr (a Danish physicist) explained why the orbiting electron does not radiate energy as it moves around the nucleus. He introduced the fundamental idea that the

absorption and emission of light by hydrogen atoms was due to energy changes of the electrons within the atoms. The fact that only certain frequencies are absorbed or emitted by an atom tells us that only certain energy changes are possible. Thus, energy changes in an atom are quantized.

Bohr የተባለው ሳይንቲስት ደግሞ ልክ እንደ ሃይድሮጅን ያሉ አቶሞች የሆነ ኃይል (energy) መጠን ይቀበላሉ እንጂ ወደ አቶሙ የመጣው የኃይል መጠን ወደ አቶሙ አይገባም። ይኸ ማለት ወደ አቶሙ የሚገባው ወይም የሚወጣው የኃይል መጠን የተወሰነ (discrete quantity) ነው። Bohr በጥቅሉ ያለው **energy changes in the atom is quantized** የሚል ነው።

Entrance 2008

39. What new concept did Bohr adapt and use to formulate his made of the atom?

A.Electromagnetic theory developed by Maxwell

B.The quantum concept developed by plank

C.Photoelectric theory developed by Thompson

D.Newtron theory developed by Chadwick

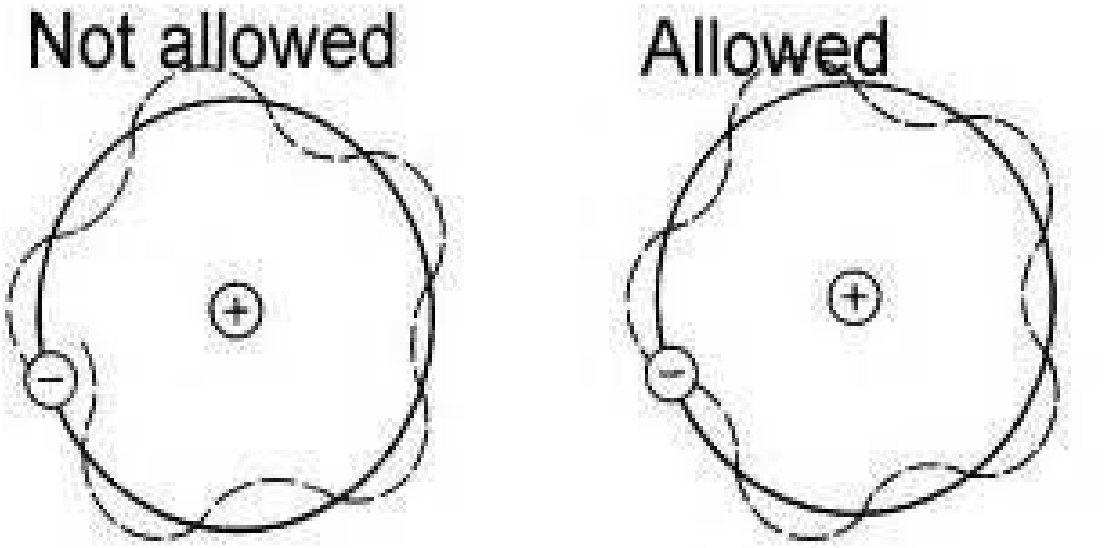
Explanation:

In 1913 the Danish physicist Neils Bohr applied planck's quantum hypothesis to explain why the orbiting electron does not radiate energy as it moves around the nucleus and to explain the line spectrum of the hydrogen atom.

Follow us
ALPHA BOOKS



ይሽ እንዴት ነው የመጣው የሚለውን ለማወቅ ስለ de brogile's principle ማወቅ ይጠበቅብናል። በአጭሩ debrogile principle የሚባለው wave length = plank constant(h) / linear momentum ነው። ይሽን በኋላ በራሱ ርዕስ እናየዋለን። ለአሁን ግን ይሽን ቀመር ያዙ ።



ከላይ በምስሉ እንደምትመለከቱት ኤሌክትሮን በአቶም ምህዋሮች ላይ ሲዞር standing wave እያሳየ ነው። በዚህ standing wave ውስጥ ዞረን ብንመጣ ከተነሳንበት ቦታ እንደርሳለን። የክቡ ዙሪያ 2*r ነው። ይሽ የክቡ ዙሪያ wave length ን ዞሮ ለመምጣት Wavelength ኡ በተደጋገመበት ቁጥር(n) ከምናባዛው ጋር እኩል ነው።

5. As long as an electron stays in a given orbital, it neither gains or losses energy. That means, the atom does not change its energy while the electron moves within an orbit.

ኤሌክትሮን በአንድ ምህዋር ላይ እስከዞረ ድረስ የሚያጣው ወይም የሚቀበለው ኃይል የለም። ነገር ግን ካለበት ምህዋር ከቀየረ የኃይል ለውጥ ይኖረዋል። ይሽ የ bohr እይታ ከዚህ በፊት የነበረውን አቶም በምህዋር

ላይ ሆኖ ሲዞር ኃይል ይለቃል የሚለውን የ classical physics አስተሳሰብ የሚቃረን ነው።

6. The electron moves to a higher energy orbit only by absorbing energy in the form of light, and emitting light when it falls to a lower energy orbit. The energy (photon) of the light absorbed or emitted is exactly equal to the difference between the energies of the two orbits

አንድ ኤሌክትሮን ካለበት ምህዋር በኃይል ወደ ሚበልጠው ምህዋር ለመሄድ ኃይልን መቀበል አለበት። ይህን ኃይል የሚያኘው በብርሃን ኃይል(light energy) መልክ ነው።ወይም በኃይል ዝቅ ወዳለው ምህዋር የሚወድቅ ከሆነ ኃይልን መልቀቅ አለበት።

Entrance 2013

10.Which of the following statement is correct about energy changes When an electron changes its energy level?

A.When an electron jumps from a lower energy level to a higher Level, the photon emitted is equal to the difference between the two Energy levels

B.When an electron falls from a higher energy level to a lower energy Level, the energy is equal to the difference between the two energy Levels is observed

Follow us
ALPHA BOOKS

ቅድም እንደተነጋገርነው የኤሌክትሮኑ angular momentum=n × h/2π ጋር እኩል መሆን አለበት። angular momentum(L) ማለት linear momentum × r =mv × r ማለት ነው።ይህ ኤሌክትሮን በምህዋር ዙሪያ የሞገድ (wave like) ባህሪይውን ጠብቆ ለመዞር የሚያስችለው ነው።ይህን ሁነት quantum condition ተብሎ ይጠራል።

$$\frac{mv^2}{r}=\frac{ke^2}{r^2}\rightarrow\frac{mv^2}{r}=\frac{ke^2}{r^2}\rightarrow mv^2=\frac{ke^2}{r}\rightarrow v^2=\frac{ke^2}{mr}$$

$$L=n\frac{h}{2\pi}\rightarrow mvr=n\frac{h}{2\pi}\rightarrow v=n\frac{h}{2\pi mr}$$

From the above two equations :-

$$v^2=\frac{ke^2}{mr}\rightarrow\left(n\frac{h}{2\pi mr}\right)^2=\frac{ke^2}{mr}\rightarrow n^2\frac{h^2}{4\pi^2m^2r^2}=\frac{ke^2}{mr}\rightarrow n^2\frac{h^2}{4\pi^2m^2r^2}=\frac{ke^2}{mr}\rightarrow r=n^2\frac{h^2}{k4\pi^2e^2m}$$

$$\frac{h^2}{k4\pi^2e^2m}=a_o=0.53\,\text{Å}$$

$$r=n^2a_0=(0.53\,\text{Å})n^2$$

ከላይ በምትመለከቱት ፎርሙላ ውስጥ n =1,2,3… እያለ የሚሄድ ሲሆን ይኸውም quantum number በመባል ይታወቃል።ይህ quamtum number ምህዋሮችን ለመወከል እንጠቀምበታለን።

$$r\alpha n^2$$

Radius ከ Quantum number ጋር ያለውን ግንኙነት ስናይ የአንድ አቶም Quantum number ኡ በአንድ በጨመረ ቁጥር ያለው Radius በሁለት ዕጥፍ ይጨምራል ።

Derivation of Bohr Energy

እንዲሁም በአንድ ምህዋር ላይ ኤሌክትሮኖች ሊኖራቸው የሚችለውን የ energy መጠን ማወቅ Bohr ችሏል።

- Consider hydrogen atom with an electron with constant speed, v, circulating the nucleus in an orbit of radius, r. The total energy of the electron is the sum of the kinetic energy (energy of movement) and the potential energy (energy of position):

እንደ Bohr ገለጻ ከሆነ ኤሌክትሮን በምህዋሮች ሲዞር የመጀመሪያው የሚዞርበት የእንቅስቃሴ ኃይል(kinetic energy) ይኖረዋል። ከመዞሩ በተጨማሪ ግን ርቀቱን ጠብቆ መዞር አለበት።ይህ ርቀቱን ጠብቆ የሚዞርበት ኃይል potential energy ይባላል።ስለዚህ በኤሌክትሮን ውስጥ ያለው ኃይል የሁለቱ ኃይል ድምር ውጤት ነው።

$$\frac{mv^2}{r}=\frac{ke^2}{r^2}\rightarrow\frac{mv^2}{r}=\frac{ke^2}{r^2}\rightarrow mv^2=\frac{ke^2}{r}$$

$$kinetic\ energy=\frac{1}{2}mv^2$$

$$therefore\ \frac{1}{2}mv^2=\frac{1}{2}\frac{ke^2}{r}$$

$$kinetic\ energy=\frac{1}{2}\frac{ke^2}{r}\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$Potential\ energy=\frac{kq1q2}{r}$$

$$U=\frac{-ke^2}{r}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$Total\ energy=kinetic\ energy+Potential\ energy$$

$$E=\frac{1}{2}\frac{ke^2}{r}+\left(\frac{-ke^2}{r}\right)$$

$$E=\frac{-1}{2}\frac{ke^2}{r}\rightarrow r=n^2a_0$$

Follow us
ALPHA BOOKS

$$E = \frac{-1}{2}\frac{ke^2}{n^2 a_0}$$

$$E = \frac{1}{n^2}\left[\frac{-1}{2}\frac{ke^2}{a_0}\right]$$

$$\frac{-1}{2}\frac{ke^2}{a_0} = -2.18 * 10^{-18} J$$

$$Rydberg\ constant = R_H = 2.18 * 10^{-18} J$$

$$E = \frac{-R_H}{n^2}$$

- The negative sign is an arbitrary convention, signifying that the energy of the electron in the atom is lower than the energy of a free electron, which is an electron that is infinitely far from the nucleus. The energy of a free electron is given a value of zero.

Follow us
ALPHA BOOKS

በላይ ያሉት ማለትም n=2,3,4…,እያሉ የሚቀጥሉት ደግሞ ከ ground state የበለጠ ኃይል ስላላቸው excited state ተብለው ይጠራሉ።

- Using Bohr's Equation, relating the energy (E) and energy level (n) for an electron it is possible to calculate the energy of a single electron in a ground state or excited state, or the energy change when an electron moves between two energy levels.

ከላይ ያለውን ፎርሙላ በመጠቀም በአንድ ምህዋር ውስጥ አንድ electron ሊኖረው የሚችለውን የ energy መጠን እንዲሁም ከአንድ ምህዋር ወደ ሌላ ምህዋር ለመሄድ የሚያስፈልገው quantized energy መጠኑ ማወቅ ይቻላል። ከታች በምሳሌ ብናየው።

Example 1.6

Consider the $n = 5$ state of hydrogen atom. Using the Bohr model, calculate the radius of the electron orbit, the velocity and the energy of the electron.

Solution:

To determine the radius, **Equation 1.15** is used:

$$r = (0.53\ \text{Å}) \times 5^2 = 15.24\ \text{Å} = 1.524\ \text{nm}$$

Velocity of the electron is determined using **Equation 1.13:**

$$v = \frac{nh}{2\pi mr}$$

$$= \frac{5\left(6.63 \times 10^{-34}\ \cancel{kg}\ \text{m}^{\cancel{2}}\ \text{s}^{-1}\right)}{2 \times 3.14 \times 9.11 \times 10^{-31}\ \cancel{kg} \times 1.524 \times 10^{-9}\ \cancel{\text{m}}}$$

$$= 3.8 \times 10^5\ \text{m/s}$$

Equation 1.16 is used to solve E_5

$$E_5 = -\frac{2.18 \times 10^{-18}\ \text{J}}{5^2} = 8.72 \times 10^{-20}\ \text{J}$$

Calculate the energies of the hydrogen electron in $n = 1$, $n = 2$ and $n = 3$

Solution: Using **Equation 1.16:**

For $n = 1$, $E_1 = -\frac{2.18 \times 10^{-18}\ \text{J}}{1^2} = -2.18 \times 10^{-18}\ \text{J}$

$n = 2$, $E_2 = -\frac{2.18 \times 10^{-18}\ \text{J}}{2^2} = -5.54 \times 10^{-19}\ \text{J}$

$n = 3$, $E_3 = -\frac{2.18 \times 10^{-18}\ \text{J}}{3^2} = -2.42 \times 10^{-19}\ \text{J}$

እንዲሁም የእያንዳንዱ ምህዋር የኃይል መጠን ከታወቀ ኤሌክትሮኖች ከአንድ ምህዋር ወደ ሌላ ምህዋር ለመሄድ የሚያስፈልጋቸው ኃይል የሁለቱ ምህዋር መካከል ያለው የኃይል ልዩነት ይሸናል።

$$\Delta E = E_f - E_i$$

$$\Delta E = -R_H \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$= -2.18 \times 10^{-18}\ \text{J} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$\Delta E = h\nu = -2.18 \times 10^{-18}\ \text{J} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

❖ Notice that when nf>ni E is positive, indicating that the system has absorbed energy. But, ni>nf E is negative and this corresponds to emission of energy.

ከላይ ባለው ፎርሙላ እንደምንመለከተው nf>ni ከሆነ ልዩነታቸው -ve ነው። ከዛም ውጪ ካለችው -ve ጋር ሲባዛ +ve ይኾናል። energy +ve ወይም -ve ተብሎ ሲገለጽ energy –ve ቁጥር ይኾናል ለማለት ሳይሆን energy ወደ አቶሙ ገብቶአል የሚለውን +ve ምልክት ሲያሳይ -ve ደግሞ energy ከአቶሙ ወጥቷል የሚለውን ያሳያል።

Example 1.7

Calculate the energy emitted when an electron moves from the $n = 3$ to the $n = 2$ energy level. Determine the wavelength of the emitted energy.

Solution:

Equation 1.19 is used, to determine the emitted energy:

$$\Delta E = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 3.03 \times 10^{-19}\ \text{J}$$

To obtain λ, **Equation 1.19:**

$$\Delta E = h\nu = \frac{hc}{\lambda}$$

Thus,
$$= \frac{hc}{\Delta E} = \frac{6.63 \times 10^{-34}\ \text{J s} \times 3.0 \times 10^{8}\ \frac{\text{m}}{\text{s}}}{3.03 \times 10^{-19}\ \text{J}}$$

$$= 6.56 \times 10^{-7}\ \text{m} = 656\ \text{nm}$$

Exercise 1.6

1. What is the wavelength of a photon (in nanometers) emitted during a transition from the $n = 5$ state to the $n = 2$ state in the hydrogen atom?
2. Calculate the frequency of the green line arising from the electron moving from $n = 4$ to $n = 20$ in the visible spectrum of the hydrogen atom using Bohr's theory.

Entrance 2007

40. Which of the following transitions will emit maximum energy in the hydrogen atom?

Follow us
ALPHA BOOKS

= -2.18 x 10-18 x ((1/4)(1/16))J

= -2.18 x 10-18 x 0.94

= -2.05 x 10-18 J

λ=(hc/ΔE)=(6.626 X10-34 Js x 3 x106 m/s)/2.05X10-18=9.69x10-10 m

The transition from n4 to n1 has the highest energy and the minimum wave length because energy is inversely proportional to wave length n4→ n1 < n3→ n1 < n2→ n1 < n4→ n2

Answer = A

Entrance 2011

23. Consider the following two possibilities for electron transfer in a hydrogen atom, given below:First:- The electron drops from the Bohr orbit n=3 to the orbit n=2 followed by the transition from n=2 to n=1 Second:- The electron drops from the Bohr orbit n=3 directly to the orbit n=1

Which of the following is correct about the energy change of these transitions?

A.The sum of the energies for the first transitions is less than the energy of transition of the second.

B.The sum of the energies for the first transitions is greater than the energy of transition of the second.

C.The sum of the energies for the first transitions is equal to the energy of transition of the second.

Follow us
ALPHA BOOKS

Explanation:

ΔE = hc/λ = (6.63 x 10-34 JS) (3.00 x 108m/s)/(434 x 10-9m)

(6.63 x 10-34) (3.00 x 108)/(4.34 x 10-7) Joules

Answer = B

Entrance 2012

11. How much energy would be released as an electron is moved from The n = 4 to the n = 3 energy level?(RH=2.18 × 10^{-18}J)

A.1.050 × 10^{-19}J

B.1.938 x 10^{-19}J

C.2.043 x 10^{-18} J

D.3.981 x 10^{-18}J

Explanation:

ΔE= 2.18 × 10^{-18} J(1/ni2 - 1/nf2) =2.18 x 10^{-18} J(1/4^2 - 1/3^2)

=1.050 × 10^{-19}J

Answer =A

Bohr ከሰራቸው ስራዎች በተጨማሪ በሃይድሮጅን አቶም ውስጥ ሊኖረው የሚችለውን Atomic spectra አብራርቷል።

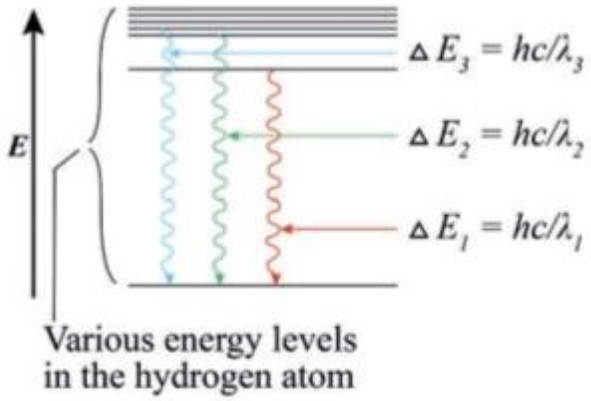


Figure 1.12: A change between two discrete energy levels emits a photon of light

ሃይድሮጅን አቶም ከአንዱ የኃይል ምህዋር ወደ ሌላኛው የኃይል ምህዋር ሲሄድ የተለያዩ ቀለማት የያዙ visible light ውስጥ ያሉ ሞገዶችን ብቻ ሳይሆን ከታች በሠንጠረዡ እንደምትመለከቱት ከ UV ጨረር እስከ infrared ጨረር ያሉትን ይለቃል። ይኸ ማለት ከ hydrogen አቶም የሚለቀቀው ኃይል በሚታዩ ቀለማት መልክ ብቻ ላይሆን እንደሚችልና እንደ ultraviolet እንዲሁም infrared ያሉ ሞገድን በውስጡ እንደሚያካትት ያስረዳናል።እነዚህንም በተለያዩ ስያሜዎች(series) ሰይሟቸዋል። ፈተና ላይ ስለሚወጡ መነሻ ና መድረሻ quantum number ቸውን በደንብ ያዙ።

Table 1.2: The various series in atomic hydrogen emission spectrum

Series	n_f	n_i	Spectrum region
Lyman	1	2, 3, 4, …	Ultraviolet
Balmer	2	3, 4, 5, …	Visible and ultraviolet
Paschen	3	4, 5, 6, . . .	Infrared
Brackett	4	5, 6, 7, . . .	Infrared

Entrance 2012

10.Which statement is correct for the emission spectrum of the hydrogen atom?

A.The lines are produced when electrons move from second to Fourth

B.The lines in the visible region involve electron transitions into the Energy level closest to the nucleus

C.The lines are produced when electrons move from lower to higher Energy levels

D.The line corresponding to the greatest emission of energy is in the Ultraviolet region

Explanation:

Emision spectrum is the spectrum of frequencies of EMR Emitted due to an atom or molecule making a transition from a higher To lower energy state.

Answer=D

Follow us
ALPHA BOOKS

physical theory. In 1924, Louis de Broglie, the French physicist, proposed a surprising reason for fixed energy levels: if energy is particle-like, perhaps matter is wavelike. De Broglie reasoned that if electrons have wavelike motion and are restricted to orbits of fixed radii that would explain why they have only certain possible frequencies and energies.

energy ከ wave አይነት ተፈጥሮው በተጨማሪ እንደ ቅንጣት አይነት ተፈጥሮ(particle nature) አለው ብለናል ። De Broglie የተባለው ፊዚስት ደግሞ ገልብጦ ማሰብ ጀመረ። ማለትም ቅንጣት (particle) ተፈጥሮ ውስጥ የሚገኙ ቁስ አካላት (mass) በ ሞገድ(wave) ተፈጥሮ ይገኙ ይኾን ? ብሎ። ለዚህም ታዲያ ኤሌክትሮን ተጠቃሽ ናቸው በግኝት ተፈጥሮቸው ልክ እንደ ቅንጣት(particle) ያሉ ሆነው ሳለ ነገር ግን የ wave አይነት ጠባይን ያሳያሉ። ታዲያ ለምን ሌሎቹ ቁስ አካላት ለምሳሌ:- ወንበር ፣ ጠረጴዛ ፣ በሮች ወዘተረፈ ለምን የ wave አይነት ጠባይ አላሳዩም። ምንስ ገደባቸው ? የሚለው de brogile ፎርሙላ ሰርቶ አብራራው።

- By combining Einstein's equation for the quantity of energy equivalent to a given amount of mass ($E=mc^2$) with Planck's equation for the energy of a photon ($Ehv=hc/k$), de Broglie derived an equation for the wavelength of any particle of mass, m, whether a planet, ball, or electron-moving at speed, v.

Follow us
ALPHA BOOKS



- ❖ dual character of matter and energy is known as the wave-particle duality.

ከዚህ በመነሳት የምንደርስበት ድምድሜ wave like ና particle ጠባይ የተለያየ አይነት ተፈጥሮ የሚመስለን በግዙፉ ዓለም ንጻሬ(ርዕዮት) ስናይ ነው። ነገር ግን ምልከታችንን ወደ ጥቃቅኑ ዓለም ውስጥ ካስገባን ግን የተለያየ ተፈጥሮ ናቸው ያልናቸው ነገሮች የአንድ ነገር ጠባያት ሆነው እናገኛቸዋለን። ለምሳሌ:- ኤሌክትሮን ሁለቱንም ተፈጥሮ ይዟል። ከዚህ በመነሳት ቁስ አካላት (matter) የሞገድነትም(wave like) የቅንጣትንነትም(particle like) ተፈጥሮ አለው። እንዲሁም ኃይል (energy) የቅንጣትንነትም(particle like) የሞገድነትም(wave like) ተፈጥሮ አለው። ይኸ አይነት ተፈጥሮ wave – particle duality ተብሎ ይጠራል።

Follow us
ALPHA BOOKS

Example 1.8

Calculate the de Broglie wavelength of an electron that has a velocity of 1.00×10^6 m/s. (electron mass, $m_e = 9.11 \times 10^{-31}$ kg; $h = 6.63 \times 10^{-34}$ J.s).

Solution:

$$\lambda = \frac{h}{m_e v} = \frac{6.63 \times 10^{-34}\ \text{kg}\ \frac{\text{m}^2}{\text{s}}}{1.00 \times 10^6\ \frac{\text{m}}{\text{s}} \times 9.11 \times 10^{-31}\ \text{kg}}$$

$$= 0.73 \times 10^{-9}\ \text{m} = 0.728\ \text{nm}$$

What is the speed of an electron that has a de Broglie wavelength of 1.00 nm

Solution:

$$v = \frac{h}{m_e \lambda} = \frac{6.63 \times 10^{-34}\ \cancel{\text{kg}}\ \frac{\text{m}^2}{\text{s}}}{1.00 \times 10^{-9}\ \cancel{\text{m}} \times 9.11 \times 10^{-31}\ \cancel{\text{kg}}}$$

$$= 0.728 \times 10^6\ \frac{\text{m}}{\text{s}} = 7.28 \times 10^5\ \frac{\text{m}}{\text{s}}$$

Exercise 1.8

1. What is the characteristic wavelength of an electron (in nm) that has a velocity of 5.97×10^6 m/s ($m_e = 9.11 \times 10^{-31}$ kg)?
2. Calculate the wavelength (in nanometers) of an H atom (mass = 1.67×10^{-27} kg) moving at 7.00×10^2 cm/s.
3. Calculate the wavelength (in nm) of a photon emitted when a hydrogen atom undergoes a transition from $n = 5$ to $n = 2$.

Teacher's Mind

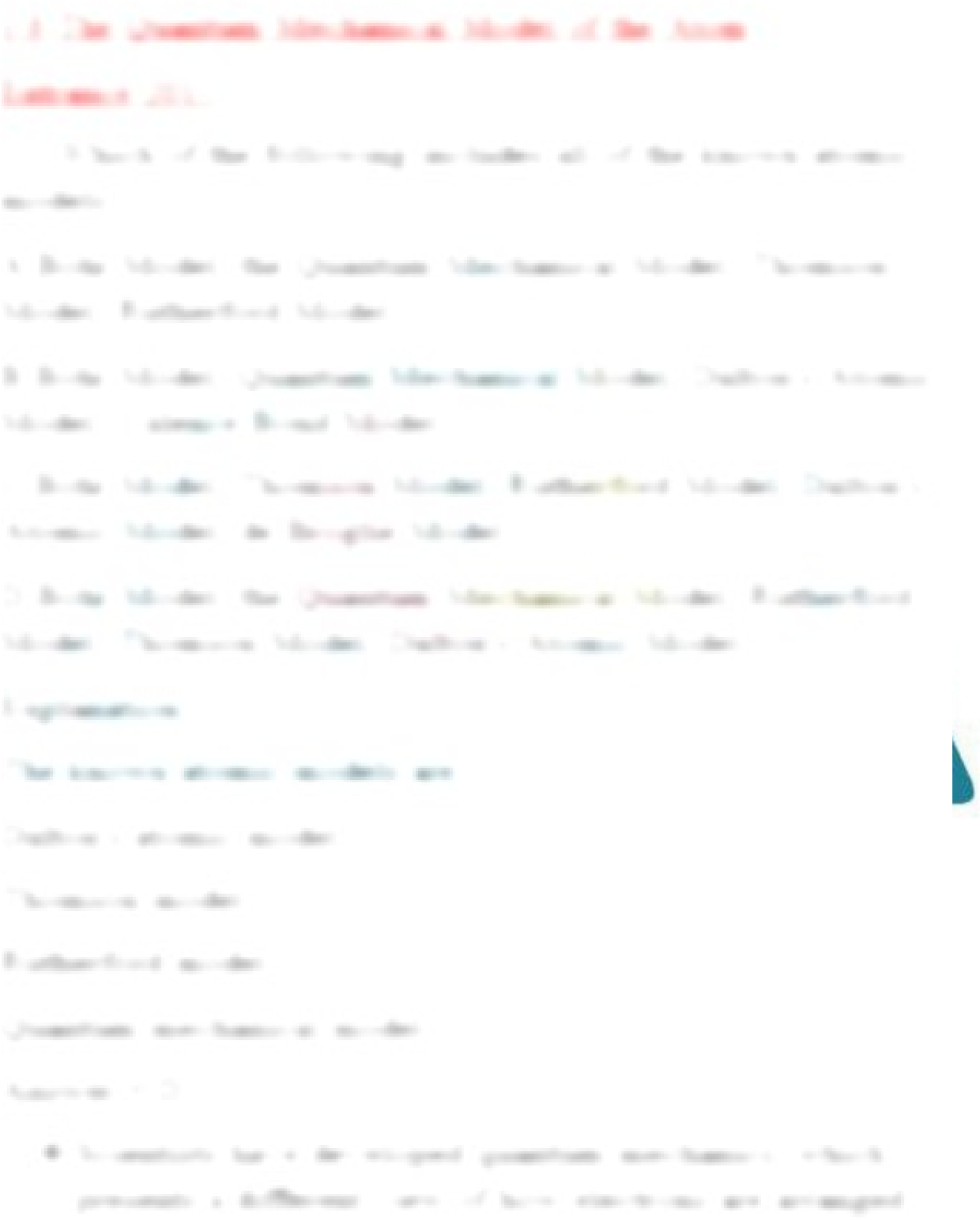
16. Why is the electron in a Bohr hydrogen atom bound less tightly when it has a quantum number of 3 than when it has a quantum number of 1?
17. What does it mean to say that the energy of the electrons in an atom is quantized?
18. Using the Bohr model, determine the energy, in joules, necessary to ionize a ground-state hydrogen atom. Show your calculations.
19. The electron volt (eV) is a convenient unit of energy for expressing atomic-scale energies. It is the amount of energy that an electron gains when subjected to a potential of 1 volt; 1 eV = 1.602 x 10-19 J. Using the Bohr model, determine the energy, in electron volts, of the photon produced when an electron in a hydrogen atom moves from the orbit with n = 5 to the orbit with n = 2. Show your calculations.
20. Using the Bohr model, determine the lowest possible energy, in joules, for the electron in the Li2+ ion.

Answer Key

17. Quantized energy means that the electrons can possess only certain discrete energy values; values between those quantized values are not permitted.

19.
$$E = E_2 - E_5 = 2.179 \times 10^{-18}\left(\frac{1}{n_2^2} - \frac{1}{n_5^2}\right)\text{J}$$
$$= 2.179 \times 10^{-18}\left(\frac{1}{2^2} - \frac{1}{5^2}\right) = 4.576 \times 10^{-19}\ \text{J}$$
$$= \frac{4.576 \times 10^{-19}\ \text{J}}{1.602 \times 10^{-19}\ \text{J eV}^{-1}} = 2.856\ \text{eV}$$

Follow us
ALPHA BOOKS



about the nucleus in the atom. This view depends on two central concepts: the wave behavior of matter and the uncertainty principle. The combination of these two ideas leads to a mathematical description of electronic structure.

ከ Bohr በኋላ ሳይንቲስቶች አዲስ ስለ አቶም ና ኤሌክትሮኖች ሊያብራራ የሚችል Quantum Mechanics የሚል ጽንሰ ሐሳብ አመጡ። ይኸ ጽንሰ ሐሳብ በሁለት መሠረታዊ የሆኑ ዕይታዎች ላይ የተመሠረተ ነው።

1 ኛ- Wave behaviour of matter ሲሆን

2 ኛ -Uncertainty Principle ናቸው።

Wave particle duality በዚህ በፊት አይተናል አሁን Uncertainty principle እንመልከት።

1.6.1 The Heisenberg Uncertainty Principle

- Discovery of the wave properties of matter raised a new and very interesting question. If a subatomic particle can exhibit the properties of a wave, is it possible to say precisely where that particle is located. A wave, extends in space, so its location is not defined precisely.

እንደ ኤሌክትሮን ያሉ ቅንጣቶች የ particle ና የ wave like ጠባይ በግልጽ ያሳዩናል።ታዲያ Wave ውስጥ የሚስተላለፈውን ኃይል ይኸ ቦታ ነው ያለው ተብሎ መናገር አይቻልም Wave በሚሄድበት የመላ ነው። በአንድ በኩል ደግሞ ቅንጣት ያለበት ቦታ ይታወቃል።ይኸ ቦታ ተብሎ መናገር ይቻላል። ስለዚህ የሁለቱም ተፈጥሮ አንድ ኤሌክትሮን እንዴት አብሮ ሊያሳይ ይችላል?

Entrance 2009

11. The Heisenberg uncertainty principle states that

A.Two atoms of the same element must have the same number of protons

B.No two electrons in the same atom can have the same set of four quantum numbers.

C.It is impossible to determine both position and momentum of an electron simultaneously.

D.Electrons of atoms in ground state enter energetically equivalent set of orbitals singly before they pair any orbitals of the set.

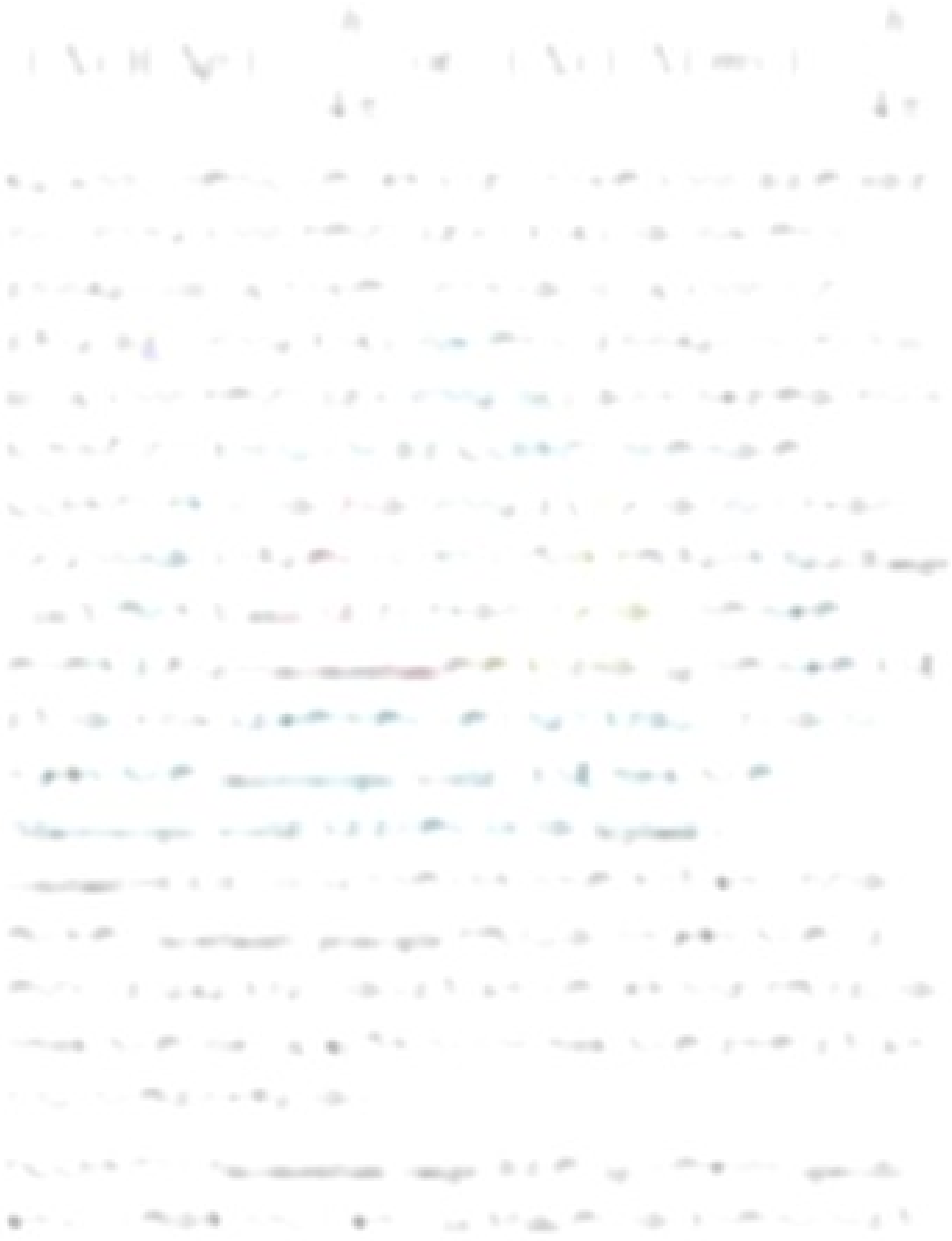
Answer = C

- In 1827, Werner Heisenberg, the German physicist, proposed the Heisenberg uncertainty principle, stating that it is not possible to know with great certainty both an electron's position and its momentum p (where p = mV) at the same time.

Heisenberg የተባለው ሳይንቲስት የአንድን ኤሌክትሮን የሚገኝበትን ቦታ ና Momentum (mV) በተመሳሳይ ሰዓተሰ መገመት አይቻልም የሚል ሐሳብ አረቀቀ። ይሽ ነው Henisenberg Uncertanity principle ተብሎ የሚጠራው።

- Heisenberg was able to show that if Δp is the uncertainty in the momentum and Δx is the uncertainty of the position of the electron, then:

Follow us
ALPHA BOOKS



ማለት ያለበትን ቦታ (x) ና የሚሄድበትን momentum (p) በተመሳሳይ ሰዓት ማወቅ አይቻልም።

- ❖ This equation shows that if we measure the momentum of a particle precisely (i.e., ifΔp is very small), then the position will be correspondingly less precise (i.e, Δx will become larger). In simpler terms, if we know precisely where a particle is, we cannot know precisely where it has come from or where it is going. If we know precisely how a particle is moving, we cannot know precisely where it is.
- ❖ The Heisenberg uncertainty principle has no practical consequence in everyday objects in the macroscopic world. However, it has very significant consequences when applied to atomic and subatomic particles.

Entrance 2012

9.Which statement correctly describes Heisenberg's uncertainty principle?

A.If we measure the momentum of a particle precisely then its Position will be correspondingly precise

B.A particle with a mass moving at a given speed can be described By the wave characteristics of material particles

C.A small particle like the electron can behave both as a particle and a wave

D.Both the location and the momentum of a subatomic particle like The electron cannot be precisely known

Answer = d

1.6.2 Quantum Numbers

- In quantum mechanics, each electron in an atom is descried by four quantum numbers. Three of the quantum numbers specify the wave function that gives the probability of finding an electron at various place in spaces. The fourth one is used to describe the spin (magnetic property) of the electrons that occupy the orbitals. The four quantum numbers are:

በዚህ quantum mechanics ሞዴል ውስጥ ስለ ኤሌክትሮኖች ለመግለጽ የምንጠቀምባቸው 4 quantum numbers አሉ።ከነዚህም ኤሌክትሮን ሊኖሩበት የሚችሉበት ቦታ ለመግለጽ የሚያገለግሉቱ 3 ቱ ሲሆኑ አንዱ ደግሞ magnetic quantum number የኤሌክትሮኖቹ ማግኔታዊ ጠባይ ለመግለጽ ይረዳል።

1. The principal quantum number (n) describes the main energy level, or shell, an electron occupies. It may be any positive integer, n = 1, 2, 3, 4, etc. It describes the size and energy of the shell in which the orbital resides and it is analogous to the energy levels in Bohr's model.

የመጀመሪያው principal quantum number(n) ሲባል ይኸውም በባለፈው በ bohr ሞዴል ላይ ከተነጋገርነው ጋር ተመሳሳይነት አለው። እያንዳንዱ ምህዋር n=1,2,3.. ቁጥሮች ይወከላል። ይኸንንም ቁጥር በመጠቀም የአንድ ምህዋር ውስጥ ምን ያህል ኤሌክትሮን እንደሚይዝ(size of the shell) እንዲሁም ምን ያህል በዛ ውስጥ ያሉ ኤሌክትሮኖች ኃይል እንዳላቸው(energy of the shell) ማወቅ ይቻላል።

Entrance 2007

16.How many orbital are there in an atom with n= 4?

A.2 B.8 C.16 D.25

Explanation:

The number of orbitals is given by n^2. n = 4 => 4×4 = 16 orbitals

4s =1 orbital 4d = 5 orbitals

4p=3orbitals 4f = 7 orbitals

total = 16 orbitals

Answer = C

2. The angular momentum quantum number (l) designates the shape of the atomic orbitals. Within a shell different sublevels or subshells are possible, each with a characteristic shape. It takes values from 0 to n-1. Orbitals of the same, but different are said to belong to different subshells. It is also called azimuthal quantum number or subsidiary quantum number. A given energy level, n, has n total number of orbitals. For example, in n=4, I has values of 0, 1, 2, and 3. Each value of I corresponds to an orbital label and an orbital shape.

ሁለተኛው angular quantum number(l) ተብሎ ይጠራል። እንዲሁም azimuthal quantum number ወይም subsidiary quantum number ተብሎ ይጠራል። ይኸ quantum number ከላይ ባነሳነው main energy level(n) ውስጥ ሊገኙ የሚችሉ orbital አይነታቸውን(types) ና ቅርጻቸውን(shapes) ለመለየት ይረዳል። መጠኑም የሚታወቀው ከ 0 እስከ n-1 በማድረግ ነው። ለምሳሌ:- n=5 የሆነውን የ energy level

Follow us
ALPHA BOOKS

D.0,1,2,3
Explanation:
l is the angular momentum quantum number, and takes values from 0 to n-1. Therefore, when n=4, the possible values of l are: l= 0, l = 1, l= 2 and l = 3

Answer = D

3. The magnetic quantum number (ml) is also called the orbital-orientation quantum number. It has integral values between -l and l, including 0. The value of ml is related to the orientation of the orbital in space relative to the other orbitals in the atom. The number of possible ml,vlues values or orbitals for a given & value is 2l+ 1

ሦስተኛው magnetic quantum number ይባላል። በሌላም አጠራር orbital-orientation quantum number ይባላል።ይኸ ደግሞ azimuthal ላይ ያገኘናቸውን ቁጥሮች ሁለተኛ እነርሱ በኔጋቲቭ ተባዝተው የሚሰጡንን ቁጥር ሦስተኛ ደግሞ ዜሮን በውስጡ ይይዛል።ለምሳሌ :- p sub shell ያለው azimuthal ስንት ነው? መልሱ l=1 ነው። ስለዚህ magnetic quantum number (ml)=-1,01 ይኸናል ማለት ነው። ይኸ ማለት እያንዳንዱ ኤሌክትሮን ወደ p -shell ሲገባ ሊቀመጥባቸው የሚችልባቸው ሦስት መቀመጫዎች አላቸው ። እያንዳንዱ መቀመጫ ሁለት ሁለት ኤሌክትሮን መያዝ ይችላል። ስለዚህ p-shell ስንት ኤሌክትሮን ይሸከማል ከተባልን 3× 2=6 ይኸናል።አደራደራቸውም የራሱ የሆነ ሕግ አለው ይኸን ቀጣይ እንመጣበታለን።

4. The electron spin quantum number (ms) refers to the spin of an electron and the orientation of the magnetic field produced by this spin. For every set of n, l, and ml values, can take the value

+½ or-½. Each atomic orbital cannot accommodate more than two electrons, one with ms=+½ and another with ms= -½

አራተኛው ደግሞ electron spin quantum number ተብሎ ይጠራል። ይሽውም በሆነ መሽመጫ ወሰስጥ የሚቀመጡ ኤሌክትሮኖች በምን አይነት አቀማመጥ እንደሚቀመጡ ይገልጻል። አቀማመጣቸው የሚወሰነው በማግኔቲክ ፊልድ ላይ በሚዲሳዩት ባህሪይ rule of tumb በመጠቀም ነው። ለምሳሌ :- ኤሌክትሮኑ magnetic field ውስጥ ሲገባ ወደ በሰዓት አቅጣጫ (clock wise) ከሆነ በ rule of tumb መሠረት አውራ ጣታችን ወደ ታች ይሽናል። ይሽ ms =-1/2 ይወከላል። እንዲሁም በ magnetic field ውስጥ ከሰዓት በተቃራኒ (counter clock wise) ከዞረ በ rule of tjmb ሕግ ጣታችን ወደ ላይ ይሽናል። ይሽ ደግሞ ms =+1/2 ተብሎ በዚህ electron spin quantum number ይወከላል።ከነዚህ ሁለት ቁጥሮች ውጪ ms ሌላ መጠን(value) አይኖረውም::

በጥቅሉ አራቱን quamtum number በመጠቀም በመጀመሪያ በምን energy level ላይ ይገኛል? ከዚያም በዛ emergy level በተኛው sub level ላይ ነው ያለው? ከዛ በዛው sub level በሜን አይነት መቀመጫ orientation መልክ ተገኝቷል?በዛ አቀማመጥ ውስጥ ምን አይነት ማግኔታዊ ባህሪይ አለው? የሚለውን ማወቀና መለየት ይቻለናል።

Exercise 1.9

1. What are the values of n and ℓ for the following subshells?
   a. 1s c. 4s e. 4f
   b. 3p d. 3d
2. Write the subshell notations that correspond to
   a. $n = 3$ and $\ell = 0$ c. $n = 7$ and $\ell = 0$
   b. $n = 3$ and $\ell = 1$ d. $n = 3$ and $\ell = 2$
4. Can an orbital have the quantum number $n = 2$, $\ell = 2$, $m_\ell = 2$
5. For an orbital with $n = 3$ and $m_\ell = 1$, what is (are) the possible value(s) ℓ?
6. Which of the following orbitals do not exist: 1p, 2s, 2d, 3p, 3d, and 3f?

Follow us
ALPHA BOOKS

Example 1.10

1. What are the allowed values of the quantum numbers through $n = 2$?

Solution: The allowed quantum number values in $n = 2$ are:

n	ℓ	m_ℓ	m_s	Electron capacity of subshell $4\ell + 2$	Electron capacity of shell $2n^2$
1	0 (1s)	0	+½, -½	2	2
2	0 (2s)	0	+½, -½	2	8
2	1(2p)	-1, 0, 1	±½ for each value of m_ℓ	6	8

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

Solution:

Determining ℓ values:

For $n = 3$, $\ell = 0, 1, 2$

Determining m_ℓ for each ℓ value:

For $\ell = 0$, $m_\ell = 0$

For $\ell = 1$, $m_\ell = -1, 0, +1$

For $\ell = 2$, $m_\ell = -2, -1, 0, +1, +2$

Number of orbitals in $n = 3$ is $n^2 = 3^2 = 9$ orbitals

These orbitals are:

3s: 1 orbital

3p: 3 orbitals

3d: 5 orbitals

Total = 9 orbitals

Entrance 2007

5. Which one of the following represents an acceptable possible set of quantum numbers (in the order n, 1, m_1, ms) for an electron in an atom?

A.2,1,0,0

B.2,0, 2, +1/2

C.2,1,-1,+1/2

D.2,0, 1, -1/2

Explanation:

n is the principal quantum number having values n=1,2,3--- l is the azimuthal quantum number having values from 0 to n-1 ml is the magnetic quantum number having values from-l to +1. ms, is the spin quantum number having values +1/2 or -1/2. When n=2,1 = 0,1 m_1 = -1,0 , +1, Ms = ± ½

2, 1, -1, 1/2 is an acceptable possible set of quantum numbers. Other possible sets when n=2 include: 2,0,0,±1/2 ; 2,1,0,±1/2 ; 2,1,1,±1/2R

Answer = C

37. The maximum number of electrons in P-orbital with n=6, ml=0 is

A.2 B.6 C.16 D.14

Explanation: n=6=>1=0,1,2,3,4,5=> ml =-5,-4,-3,-2,0,1,2,3,4,5 P orbital means, I=1 ml=-1,0,1 => ml =px,py,pz(3 orbitals) In

each orbital there are a maximum of 2 electrons, and there are a maximum of 6 total electrons on the p orbital.

Answer =A

Teacher's Mind

31. How are the Bohr model and the quantum mechanical model of the hydrogen atom similar? How are they different?
32. What are the allowed values for each of the four quantum numbers: n, l, ml, and ms?
33. Describe the properties of an electron associated with each of the following four quantum numbers: n, I, ml and ms.
34. Answer the following questions:
(a) Without using quantum numbers, describe the differences between the shells, subshells, and orbitals of an atom.
(b) How do the quantum numbers of the shells, subshells, and orbitals of an atom differ?
35. Identify the subshell in which electrons with the following quantum numbers are found:
(a) n = 2,1=1
(b) n = 4, 1=2
(c) n=6,1=0
37. Identify the subshell in which electrons with the following quantum numbers are found:
(a) n = 3,1=2
(b) n = 1,1=0
(c) n = 4,1=3

42. State the Heisenberg uncertainty principle. Describe briefly what the principle implies.

43. How many electrons could be held in the second shell of an atom if the spin quantum number ms could have three values instead of just two? (Hint: Consider the Pauli exclusion principle.)

44. Which of the following equations describe particle-like behavior? Which describe wavelike behavior? Do any involve both types of behavior? Describe the reasons for your choices.

(a) $c = \lambda\nu$

(b) $E = \frac{m\nu^2}{2}$

(c) $r = \frac{n^2 a_0}{Z}$

(d) $E = h\nu$

(e) $\lambda = \frac{h}{m\nu}$

45. Write a set of quantum numbers for each of the electrons with an n of 4 in a Se atom

Answer Key

31. Both models have a central positively charged nucleus with electrons moving about the nucleus in accordance with the Coulomb electrostatic potential. The Bohr model assumes that the electrons move in circular orbits that have quantized energies, angular momentum, and radii that are specified by a single quantum number, n = 1, 2, 3, …, but this quantization is

an ad hoc assumption made by Bohr to incorporate quantization into an essentially classical mechanics description of the atom. Bohr also assumed that electrons orbiting the nucleus normally do not emit or absorb electromagnetic radiation, but do so when the electron switches to a different orbit. In the quantum mechanical model, the electrons do not move in precise orbits (such orbits violate the Heisenberg uncertainty principle) and, instead, a probabilistic interpretation of the electron's position at any given instant is used, with a mathematical function ψ called a wavefunction that can be used to determine the electron's spatial probability distribution. These wavefunctions, or orbitals, are three-dimensional stationary waves that can be specified by three quantum numbers that arise naturally from their underlying mathematics (no ad hoc assumptions required): the principal quantum number, n (the same one used by Bohr), which specifies shells such that orbitals having the same n all have the same energy and approximately the same spatial extent; the angular momentum quantum number l, which is a measure of the orbital's angular momentum and corresponds to the orbitals' general shapes, as well as specifying subshells such that orbitals having the same l (and n) all have the same energy; and the orientation quantum number m, which is a measure of the z component of the angular momentum and corresponds to the orientations of the orbitals. The Bohr model gives the same expression for the energy as the quantum mechanical expression and, hence, both properly account for hydrogen's discrete spectrum (an example of getting the right answers for the wrong reasons, something that many chemistry students can

sympathize with), but gives the wrong expression for the angular momentum (Bohr orbits necessarily all have non-zero angular momentum, but some quantum orbitals [s orbitals] can have zero angular momentum).

33. n determines the general range for the value of energy and the probable distances that the electron can be from the nucleus. l determines the shape of the orbital. m1 determines the orientation of the orbitals of the same l value with respect to one another. ms determines the spin of an electron.

35. (a) 2p; (b) 4d; (c) 6s

37. (a) 3d; (b) 1s; (c) 4f

43. 12

45.

n	l	m_l	s
4	0	0	$+\frac{1}{2}$
4	0	0	$-\frac{1}{2}$
4	1	−1	$+\frac{1}{2}$
4	1	0	$+\frac{1}{2}$
4	1	+1	$+\frac{1}{2}$
4	1	−1	$-\frac{1}{2}$

1.6.3 Shapes of Atomic Orbitals

- The three-dimensional aspects of the orientation of the atomic orbitals are usually represented by drawing a boundary surface diagram that encloses the highest probability (about 90%) of the total electron density in an orbital.

Orbital የምንለው ኤሌክትሮኖች በአቶሙ ዙሪያ ሊገኙበት ይችላሉ ተብሎ በሚገመትበት ቦታ ነው። ታዲያ ለዚህ በግምት ለተገለጸ ቦታ ድንበር ወጥቶለት እንዴት ቅርጽ ይይዛል ? ካልን የቅርጹ ድንበር እስከ 90% የሚያህለውን የኤሌክትሮን የመገኘት ዕድል መሠረት በማድረግ ነው።

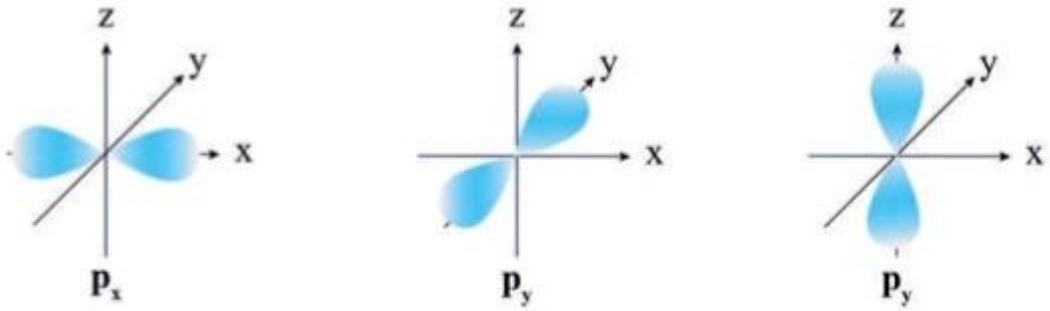


Figure 1. 16: The three p - orbitals

Figure 1. 15: The three s-orbitals

Figure 1.15, shows that the region of the greatest probability of finding an s electron is in a spherically symmetrical space whose origin is the atomic nucleus. The 1s orbital is the smallest, the 2s Higher principal energy levels (n >3) have five d orbitals in

Follow us
ALPHA BOOKS

addition to, one s orbital, three 3p orbitals. The special orientations of d orbitals are much more complex in shape than p orbitals. Figure 1.17 shows the different distribution of the five d atomic orbitals.

D -subshell ያለው azimuthal (l)=2 ስለሆነ ያለው አቀማመጥ (ml)=-2,-1,0,1,2 ይኾናል። ይህ ማለት 5 orbitals በውስጡ ይይዛል ማለት ነው። እነዚህ orbital አቀማመጣቸው እንደ p subshell በ xyz plane ላይ ቢሆንም ነገር ግን ከ p subshell አንጻር አቀማመጣቸው በጣም ውስብስብ ነው።አቀማመጣቸው ከታች በምስሉ ላይ የምትመለከቱትን አይነት ይመስላል።

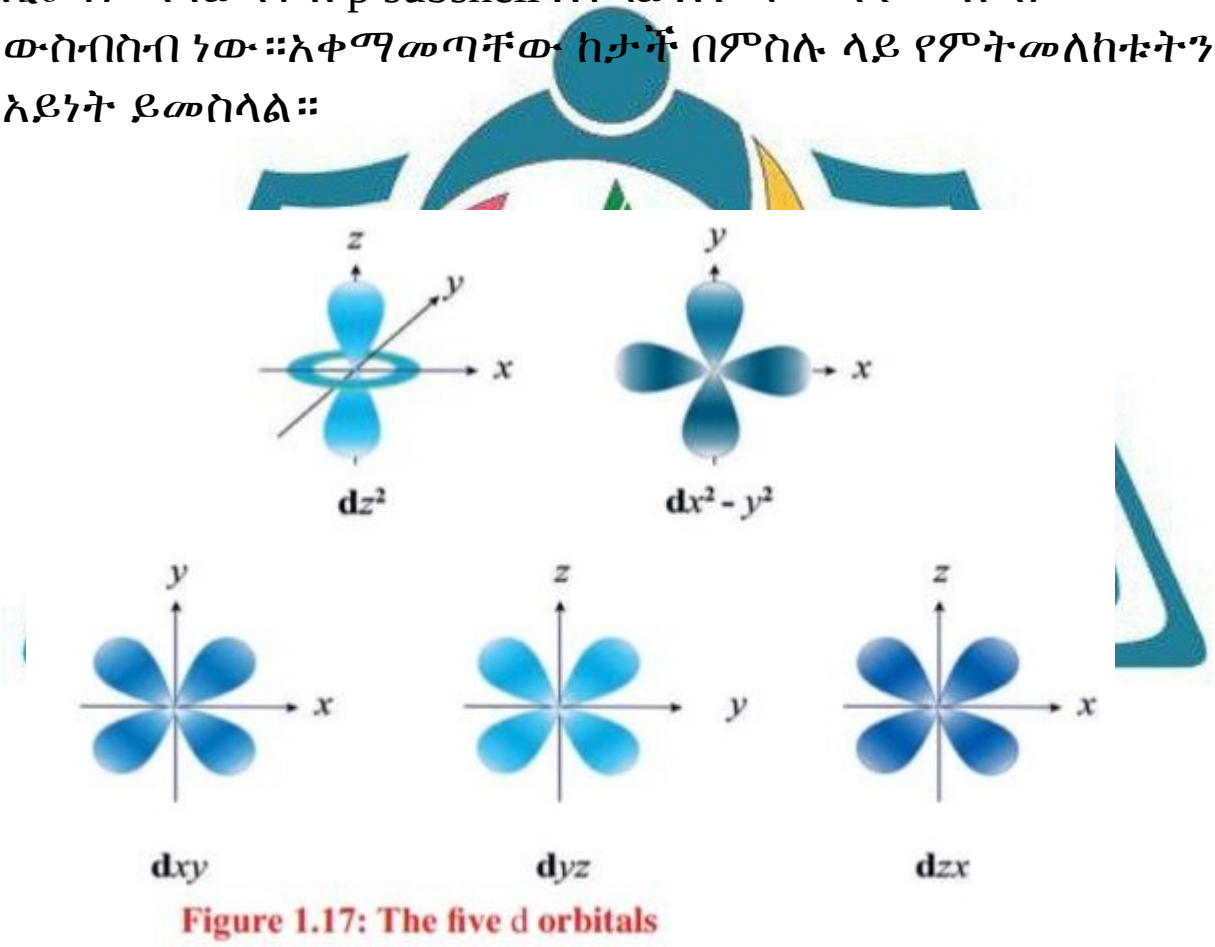


Figure 1.17: The five d orbitals

Entrance 2008

32. What is the maximum number of unpaired electron in a d subshell?

Follow us
ALPHA BOOKS

- This is a scheme used to reproduce the electron configurations of the ground state of atoms by successively filling with electrons in a specific order (the building up order). In general, electrons occupy the lowest-energy orbital available before entering the higher energy orbital. Accordingly, the ground state electron configurations of atoms are obtained by filling the subshell in the following order; 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, and so on, as indicated in Figure 1.18.

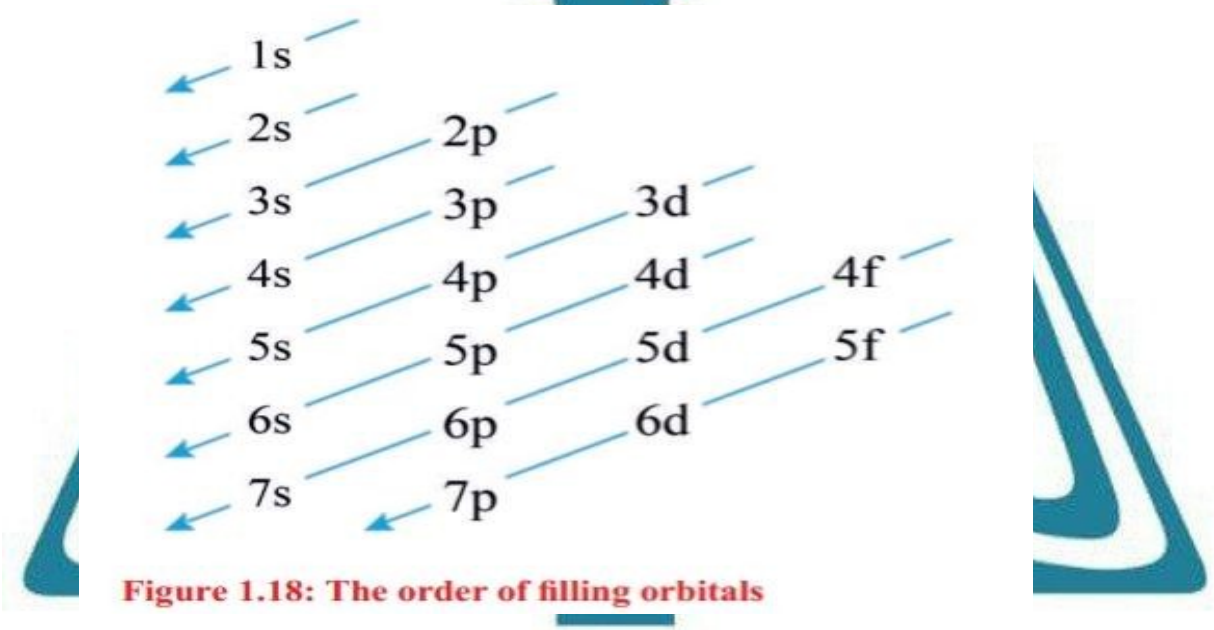


Figure 1.18: The order of filling orbitals

Aufubau principle የሚለን ምንድነው ኤሌክትሮኖች መጀመሪያ ትንሽ energy ያለውን orbital መሙላተሰ ይኖርባቸዋል። ይሽን ከሞሉትና ከተረፉ ከዝቅተኛው energy ቀጣይ ያለውን ትልቅ energy ያለውን orbital ይሞሉታል። ከላይ በምስሉ ላይ እንደምትመለከቱት መጀመሪያ ከ n=1 ይጀምራል። አዚህ ውስጥ የሚገኘው subshell = s – subshell ብቻ ነው።s-sub shell አንድ orbital አለው። በአንድ orbital ውስጥ ደግሞ በተለያየ ማግኔታዊ ጠባይ(electron spin) ወይም በ+1/2 ና -1/2 ሁለት ኤሌክትሮኖች ይቀመጣሉ። እነዚህ ሁለቱ ይሽን orbital ሳይሞሉ ወደ p-

shell አይሻገሩም።ወደ p sub shell ሊሻገር የማችል ከሁለት በላይ ኤሌክትሮን መጠን ካላቸው n=2 energy level በ 2p aubshell እንዲሁም እንደብዛታቸው 2px ,2py እና 2pz orbital እየሞሉ ይሄዳሉ።

Entrance 2008

31. Which of the following electrons, identified only by their n and l quantum numbers have the highest energy?

A.n=3, l=2

B.n=4, l=1

C.n=4, l=2

D.n=3, l=0

Explanation:

n-quantum number defines the main energy level of the electron.

-quantum number defines the shape of the orbital.

l=2 represents d-orbital

l=1 represents p-orbital

l=0 represents s-orbital

n=3, l=2 shows 3d orbital

n=4, l=1 shows 4p orbital

n=4, l=2 shows 4d orbital

n=3, l=0 shows 3s orbital

In energy 4d > 4p > 3d > 3s

Follow us
ALPHA BOOKS

Entrance 2013

13. According to Hund's rule equal energy (degenerate) orbitals are filled with

A.two electrons of opposite spins placed in the first orbitals

B.maximum number of unpaired electrons with parallel spins

C.two electrons of parallel spins placed in the first orbital

D.maximum number of unpaired electrons with opposite spins

Answer =B

2. Pauli's Exclusion Principle:

Entrance 2012

13. What is Pauli Exclusion Principle? The Pauli Exclusion Principle States that

A.all electron in an atom are in the same energy state

B.no two electrons in atom can have the same set of the four quantum numbers

C.two electrons in an atom can have the same set of four quantum Numbers

D.An orbit can old hold a maximum of two electrons with the same Quantum number ms

Answer = B

Follow us
ALPHA BOOKS

Electron configuration ማለት ኤሌክትሮኖች በአቶም ዙሪያ ባሉ orbital የቱ ጋር? እንዴት? ሊቀመጡ እንደሚገባ የሚገልጽ የአቀማመጥ ሥርዓት ነው።

- Two general methods are used to denote electron configurations.

ይኸ የአቀማመጥ ሥርዓት በሁለት መልኩ መገለጽ ይችላል።

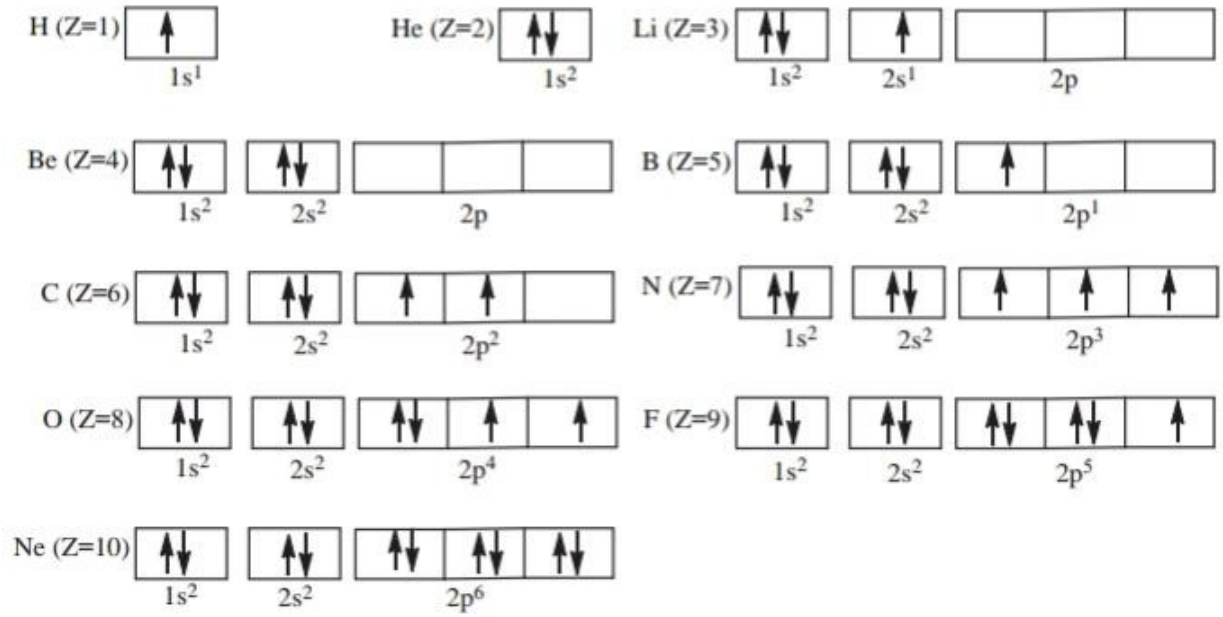
- The subshell (sublevel) notation uses numbers to designate the principal energy levels and the letters s, p, d and f to identify the sublevels. A superscript number following a letter indicates the number of electrons (e) in the designated subshell. The designation can be written as n For instance, the ground state electron configuration of H (Z=1) is 1s1

የመጀመሪያው subshell notation ብለን የምንጠራው ሲሆን ይኸውም የ aufbau principle በመከተል ኤሌክትሮኖችን በ subshell ላይ ማስቀመጥ ነው። ለምሳሌ:- 11Na በውስጡ 11 ኤሌክትሮኖች አሉት። electron configuration =1s2,2s2,2p6,3s1 ይኾናል። 1s2 በሚለው ላይ መጀመሪያ ያለችው 1 = principal quantum number (n) ይገልጻል። s= sub shell (sub energy level) ያስረዳል። ከላይ ያለችው 2=number of electron ያስረዳል።

- The other way to present this information is through an orbital diagram, which consists of a rectangular box (or circle, or just a line) for each orbital available in a given energy level, with an arrow indicating the electron's presence and its direction of spin. Traditionally, represents, ms=+1/2 whereas ↓ designates m =-1/2

ሁለተኛው electron configuration ልንገልጽበት የምንችለው መንገድ ደግሞ orbital diagram በመጠቀም ነው። ይኸ diagram(ንድፍ) orbital ን በሆነ ምስል የመወከል መንገድ ነው። ይኸ ምስል ከታች በምስሉ እንደምትመለከቱት ወየ ሳጥን ፣ ክብ ወይም መስመር ሆኖ በዩ ላይ ወይመሰ በውስጡ የኤሌክትሮኖችን የሚወክሉና የኤሌክትሮኖቹን ማግኔታዊ ጠባይ(spin) የሚያሳዩ ምልክቶች አሉበት። የምልክቶቹ ቀስት የሚያመለክተው በ rule of tumb ውስጥ የአውራ ጣቱን አቅጣጫ ነው። ከታች ለምሳሌ የተመጡትን orbital diagram ተመልከቱ!

❖ The orbital diagrams for the first ten elements are:



ከላይ ባሉት ምሳሌ ላይ የ Boron (B) electron configuration ላይ Psub shell ላይ ያለችውን ኤሌክትሮን ወካይ ምስል ወደ quantum

Follow us
ALPHA BOOKS

Table 1.3: Ground state electron configurations of some atoms

Atom	Atomic number (Z)	Electron configuration
H	1	$1s^1$
He	2	$1s^2$
Be	4	$1s^22s^2$ or $[He]2s^2$
O	8	$1s^22s^22p^4$ or $[He]2s^22p^4$
Ne	10	$1s^22s^22p^6$ or $[He]2s^22p^6$
Cl	17	$1s^22s^22p^63s^23p^5$ or $[Ne]\ 3s^23p^5$
Ar	18	$1s^22s^22p^63s^23p^6$ or $[Ne]\ 3s^23p^6$
Ca	20	$1s^22s^22p^63s^23p^64s^2$ or $[Ar]\ 4s^2$
Sc	21	$1s^22s^22p^63s^23p^64s^2\ 3d^1$ or $[Ar]\ 4s^23d^1$
Cr	24	$1s^22s^22p^63s^23p^64s^1\ 3d^5$ or $[Ar]\ 4s^13d^5$

Entrance 2011

52. The sublevel that can be occupied by a maximum of 10 electrons is identified by the letter

A.S B.f C.p D.d

Explanation:

The maximum number of electrons occupied by the sublevels are:

S-2 electrons

d-10 electrons

p - 6 electrons

f-14 electrons

Answer =D

- Notice that in the electron configuration of an atom, the electrons in the outermost principal quantum level of an atom are called valence electrons. For example, the valence electrons of the Be atom, are the 2s electrons. For the Ne atom, the valence electron is the electrons are in the 2s and 2p electrons. Valence electrons are the most important electrons to chemists since they are involving in bonding, as you will learn in the next chapter. The inner electrons are known as core electrons.

በ electron configuration ላይ በመመስረት ኤሌክትሮኖቸን በሁለት እንከፍላቸውን እነዚህም valance electron እና core electron ናቸው።valance electron የሚባለው በአቶሙ peincipal quamtum number (n) ቀውጪ በኩል የሚገኙ ኤሌክትሮኖች ናቸው። ለምሳሌ :- ከላይ ባለው ስንጠረዥ ብንመለከት Oxygen (O2) የመጨረሻው(የውጪው) n=2 ነው። ይህን principal quantum number ውስጣቸው የያዙ ሁለት sub shell በ electron configuration ውስጥ አሉ ።2s2 እና 2p4 ።valance electron ለማወቅ በሁለቱ subshell ውስጥ ያለው ጠቅላላ የኤሌክትሮን ነው። ስለሆነም v.e=2+4=6 e- ይኸናል።core electrin በምንላቸው በውስጥ በኩል ባለ principal quantum number (n) ውስጥ ያሉ ኤሌክትሮኖች ማለታችን ነው። ከላይ ባየነው ምሳሌ በውጪ በኩል ያለው n=2 ከሆነ በውስጥ በኩል አንድ ሌላ ምህዋር አለ ማለት ነው። ይኸውም n=1 ነው። በዚህ ላይ ያለችው ኤሌክትሮን ብዛት =2e- ነው። በ 11Na ላይ ብንመለከትም 1s22s2sp63s1 ነው።

Follow us
ALPHA BOOKS

3d subshell 10 ኤሌክትሮን በውስጡ ይሸከማል። 10 ኤሌክትሮን መያዝን ወይንም full filled መሆንን ይፈልጋል። ካልተገኘ ደግሞ 5 ኤሌክትሮንን መያዝ ወይንም half filled መሆንን ይፈልጋል።ማለትም ይህ አይነት ሁነት ኤሌክትሮኖቹን የተሻለ በዛ አቶም ውስጥ የመቀመጥ ዕድላቸውን(stability wuth lower energy state) ይጨምረዋል ወይንም ባለፈው እንደተነጋገርነው n=3 ከ n=4 ያነሰ ኃይል ያለው ምህዋር ነው። ኤሌክትሮኖች ደግሞ ትንሽ ኃይል ያለበት ሁነት (lower energy state ይፈልጋሉ ለዛም ነው ኤሌክትሮኗ ከ 4s ወደ 3d መሸጋገርን የመረጠችው።

- Because there is little difference between the 4s and 3d orbital energies, expected and observed electron configurations are quite close in energy. At higher principal quantum numbers, the energy difference between certain subshell is even smaller than that between the 3d and 4s subshells. As a result, there are still more exceptions to the Aufabu principle among the heavier transition elements.

በስሌት የምንሰራውም ሆነ በእዉኑ የምናየው ነገር የተለያየ ቢሆንም ነገር ግን የ ኃይል መጠናቸው ይሄን ያህል ልዩነት የለውም። ይሽ ልዩነት ደግሞ የ n ቁጥር እየጨመረ በሄደ ቁጥር ይቀንሳል። ከዚያም ግምት ውስጥ የማይገባ ይሆናል። ግምት ውስጥ የማይገባ መሆኑ ግን ልዩነት አለመኖርን አያሳይመሰ። ስለዚህ በ d- block element ላይ ከላይ ያየነውን አይነት ልዩነት ልናስተውል እንችላለን።

Entrance 2013

12. The correct electronic configuration For chromium (Cr, Z = 24) is

A.$1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4d^2$

B.$1s^2 2s^2 2p^6 3s^2 3p^6 4s° d^6$

C.$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

D.$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4s^2 3d^4$

Explanation:

Cr (Z=24) = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

Answer =C

Entrance 2015

13. The electron configuration of Cu (Z = 29) is:

A.[Ar]4s24d9

B.[Ar]4s23p8

C.[Ar]4s13d10

D.[Kr]4s23d9

Explanation:

Copper violates the Aufbau principle due to stability of orbital. Thus, its correct electron configuration is [Ar]4s13d10

Answer =C

Teacher's Mind

48. Using complete subshell notation (not abbreviations, 1s22s22p6, and so forth), predict the electron configuration of each of the following atoms:

(a) C

(b) P

(c) V

(d) Sb

(e) Sm

49. Using complete subshell notation (1s22s22p6 and so forth), predict the electron configuration of each of the following atoms:

a) N

(b) Si

(c) Fe

(d) Te

(e) Tb

50. Is 1s2, 2s2 , 2p6 the symbol for a macroscopic property or a microscopic property of an element? Explain your answer.

51. What additional information do we need to answer the question "Which ion has the electron configuration 1s2,2s2,2p6,3s2,3p6 ‘’ ?

52. Draw the orbital diagram for the valence shell of each of the following atoms:

(a) C (b) P (c) V (d) Sb (e) Ru

53. Use an orbital diagram to describe the electron configuration of the valence shell of each of the following:

(a) N (b) Si (c) Fe (d) Te (e) Mo

54. Using complete subshell notation (1s22s22p6 and so forth), predict the electron configurations of the following ions.

(a) N-3 (b) Ca+2 (c)S - (d) Cs+2 (e) Cr+2 (f) Gd+3

55. Which atom has the electron configuration $1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^2$?

56. Which atom has the electron configuration $1s^22s^22p^63s^23p^63d^74s^2$?

57. Which ion with a +1 charge has the electron configuration $1s^22s^22p^3s^23p^3d^{10}4s^24p^6$? Which ion with a -2 charge has this configuration?

58. Which of the following atoms contains only three valence electrons:Li ,B ,Ne,F,N?

59. Which of the following has two unpaired electron

(a)Mg

(b) Si

(c) S

(d) Both Mg and S

(e) Both Si and S.

60. Which atom would be expected to have a half-filled 6p subshell?

61. Which atom would be expected to have a half-filled 4s subshell?

62. In one area of Australia, the cattle did not thrive despite the presence of suitable forage. An investigation showed the cause to be the absence of sufficient cobalt in the soil. Cobalt forms cations in two oxidation states, Co+2 and Co+3. Write the electron structure of the two cations.

63. Thallium was used as a poison in the Agatha Christie mystery story "The Pale Horse." Thallium has two possible cationic forms, +1 and +3. The +1 compounds are the more stable. Write the electron structure of the +1 cation of thallium.

64. Write the electron configurations for the following atoms or ions:

(a) B+3

(b) O-

(d) Ca+2

(e) Ti

65. Cobalt-60 and iodine-131 are radioactive isotopes commonly used in nuclear medicine. How many protons, neutrons, and electrons are in atoms of these isotopes? Write the complete electron configuration for each isotope.

66. Write a set of quantum numbers for each of the electrons with an n of 3 in a Sc atom.

Answer Key

49. (a) 1s 2 2s 2 2p 3

(b) 1s 2 2s 2 2p 6 3s 2 3p 2

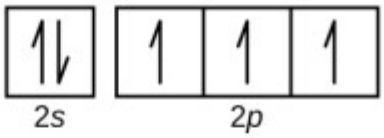
(c) 1s 2 2s 2 2p 6 3s 2 3p 6 4s 2 3d 6

(d) 1s 2 2s 2 2p 6 3s 2 3p 6 4s 2 3d 104p 6 5s 2 4d 105p 4

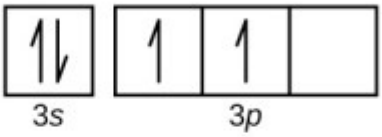
(e) 1s 2 2s 2 2p 6 3s 2 3p 6 4s 2 3d 104p 6 5s 2 4d 105p 6 6s 2 4f 9

51. The charge on the ion.

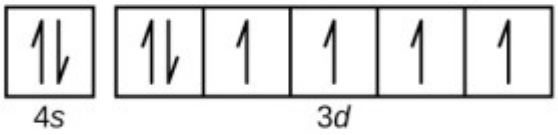
53. (a)



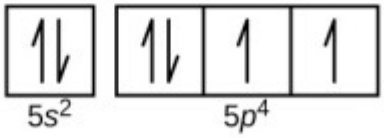
(b)



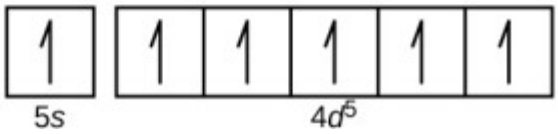
(c)



(d)



(e)



55. Zr

57. Rb^{+} , Se^{2-}

59. Although both (b) and (c) are correct, (e) encompasses both and is the best answer.

61. K

63. 1s 2 2s 2 2p 6 3s 2 3p 6 3d 104s 2 4p 6 4d 105s 2 5p 6 6s 2 4f 145d 10

65. Co has 27 protons, 27 electrons, and 33 neutrons: 1s 2 2s 2 2p 6 3s 2 3p 6 4s 2 3d 7 .

I has 53 protons, 53 electrons, and 78 neutrons: 1s 2 2s 2 2p 6 3s 2 3p 6 3d 104s 2 4p 6 4d 105s 2 5p 5 .

1.8 Electronic Configurations and the Periodic Table of the Elements

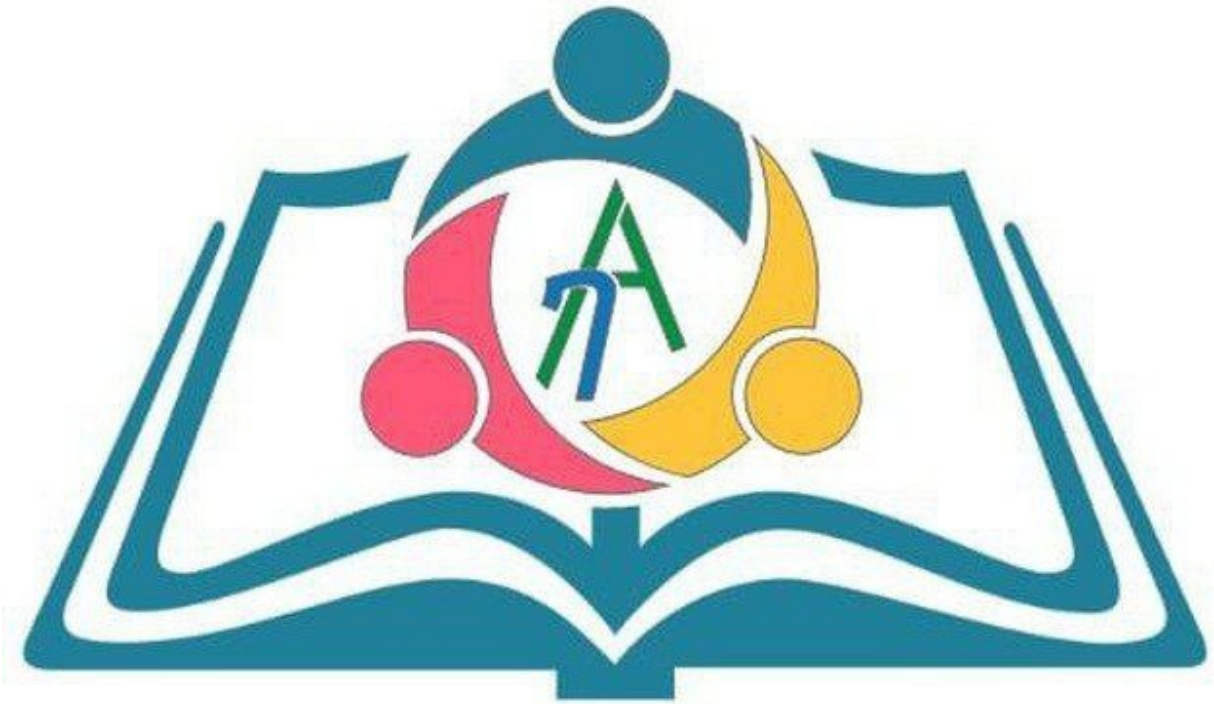
1.8.1 The Modern Periodic Table

- The modern periodic law states that the properties of the elements are periodic function of their atomic numbers.

modern periodic law የሚለን ንጥረነገሮች በአቶማዊ ክብደታቸው ቅድምተከተል ሳይሆን በአቶማዊ ቁጥር(atomic number)ቅድመ ተከተል ነው መቀመጥ ያለባቸው ምክንያቱም ለ element ልዩ የሆነ ቁጥራየው atomic number ነው። isotope እንኳ ቢሆኑ ተመሣሣይ atomic number ነው ያላቸው።አሁን የምንጠቀምበት periodic table ይኸን መሠረት ያደረገ ነው።

Period ስንል The horizontal rows of elements in the periodic table ማለትም በሠንጠረዡ አግድም የሆነው ክፍል ሲሆን Group ስንል the vertical columns of elements in the periodic table ማለትም በሠንጠረዡ ቁም የሆነው ክፍል ማለታችን ነው ያው ሠንጠረዥ

ለመስራት አግድምና ቁም ክፍል ሊኖረው ግድ ነው።ማስተዋል ያለብን ነገር በተመሣሣይ period ላይ ያሉ ንጥረ ነገሮች same numer of shell ማለትም ተመሣሣይ የሆነ የምህዋር ቁጥር አላቸው። Al እና Cl



Follow us
ALPHA BOOKS

14.In the modern periodic table

A.non-metals are placed on the right hand side of the periodic table

B.elements with similar properties are placed in the same period

C.metals are placed on the right hand side of the periodic table

D.transition and inner transition elements are placed in the middle of The periodic table

Answer=A

1.8.3 Periodic Properties

- The electron configurations of the atoms display a periodic variation with increasing atomic number (nuclear charge). As a result, the elements show periodic variations of physical and chemical behavior. In this section you will examine some periodic atomic properties like atomic radii, ionization energies, electron affinities, electronegativity, and metallic character.

በአንድ አቶም ውስጥ ያለው electron configuration አቶማዊ ቁጥር ሲጨምር periodic variation ያሳያል። ለምሳሌ:-Group IA ላይ የ 3Li electron configuration =2,1 ነው። የ 11Na =2,8,1 ነው። ከእርሱ ስር ያለው 19K ደግሞ 2,8,8,1 ነው። እንደምትመለከቱት በእነዚህ ንጥረ ነገሮች መካከል ያለው valamce electron ተመሳሳይ ሲሆን ነገር ግን በ electron configuration ይለያያሉ። እንዲሁም ወደ ጎን በ period 2 ላይ ብንሄድ የ 3Li=2,1 ፣ የ 4Be=2,2 ፣ የ 5B =2,3 እያለ ይቀጥላል። እንደምትመለከቱት ተመሳሳይ የሆነ የምህዋር ብዛት ይዘው ባላቸው electron configuration ግን ይለያያሉ።ይሽን ነው periodic variation

ብለን የምንጠራው።ከዚህ የተሳ አቶሞች በ periodic table ላይ በ period ና group ስንከፍላቸው የሚያሳዩን የአካላዊ ና ኬሚካላዊ ባህሪያት periodic variation አሉ። እነዚህ ባህሪያት Periodic property ተብለው ይጠራሉ። ከዚህ በታች periodic property የምንላቸውን አንድ በአንድ እናያለን።

Atomic Size (Atomic Radii)

- Exact size of an isolated atom cannot be measured because the electron cloud surrounding the atom does not have a sharp boundary. However, an estimate of the atomic size can be made by measuring the distance between the nuclei of two adjacent atoms. This property is called the atomic radius.

ኤሌክትሮኖች በአቶም ዙሪያ የሚገኙትበትን ትክክለኛ ርቀት ማግኘት አንችልም በአንጻሩ ግን የመገኘት ዕድል(probablity) ይታወቃል ብለን

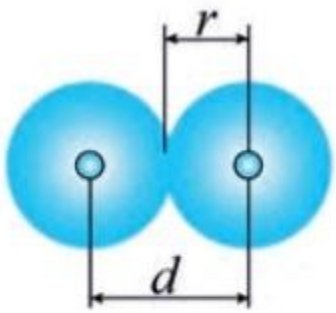


Figure 1.19: Atomic radius for a diatomic molecule.

$$r = \frac{d}{2}$$

Follow us
ALPHA BOOKS

ጋር ስለሚገፋፉ በአቶሙ ኒውክለስ እንዳይሳብ እንደ መጋረጃ ይኾናሉ። የእነዚህ ኤሌክትሮኖች(inner electron) ተጽዕኖ shelding effect ተብሎ ይጠራል። ስለዚህ አቶሙ ያለውን ኒውክለር ቻርጅ ውጪያዊውን ኤሌክትሮን እንዳይስብ ከሚያደርጉት ከ shelding electron (s)ላይ ስንቀንስ ኒውክለሱ እና ውጪያዊው ኤሌክትሮን የሚሰሰቡበትን መጠን(zeff) እናገኛለን።ስለዚህ Zeff =Z-S ይኾናል።

- ❖ Atomic radius generally increases in a group from top to bottom but it decreases in a period from left to right. These trends hold well for the main-group elements but not as for the transition elements (electrons enter an inner electron shell, not the valence shell).

Atomic radii በ period ከግራ ወደ ቀኝ ስንሄድ እየቀነሰ ይመጣል። ለምን? በምሳሌ ብንመለከት 3Li ና 9F በ period 2 ላይ ይገኛሉ ። የ 3Li atomic radii ከ 9F ይበልጣል። የ 3Li electrin configuration =2,1 ነው። zeff = Z-S =3-2=+1 ይኾናል። የ 9F Electron configuration =2,7 ነው። Zeff= 9-2=+7 ይኾናል። የሁለቱን Zeff ስናነጻጽር የሚነግረን Florine የበለጠ በኒውክለሱ ና በውጪያዊው ኤሌክትሮን መካከል መሳሳብ እንዳለ ነው። ለዛ ነው የ atomic radius እንዲያንስ ያደረገው።በአንጻሩ በ group ከላይ ወደ ታች ስንወርድ Zeff ቋሚ ነው አይለዋወጥም። ነገር ግን የ principal quantum number ይጨምራል። ለምሳሌ:-3Li electrkn configuration =2,1 ነው።ስለዚህ Zeff=Z-S=3-2=+1 ሲሆን n=2 ነው። 11Na electron configuration=2,8,1 ነው።Zeff=11-10=+1 ሲሆን n=3 ነው። n ሲጨምር ደግሞ orbital size ስለሚጨምር ከዛ ጋር ተያይዞ የ atomic

Follow us
ALPHA BOOKS

የመገፋት ሁኔታ ስለሚያጋጥማት ወደ ውስጥ ለመሳብ አቅም ያንሳታል።በዚህም r እየጨመረ ይመጣል።

Exercise 1.12

1. What are the factors affecting the size of an atom of an element? Explain your answer using examples.
2. Using the periodic table, rank each set of main-group elements in order of decreasing atomic size:
   a. Ca, Mg, Sr b. K, Ga, Ca c. Br, Rb, Kr d. Sr, Ca, Rb
3. Why is the difference in atomic radius between the elements $Z = 11$ (Na; 186 pm) and $Z = 12$ (Mg; 160 pm) so large, whereas between $Z = 24$ (Cr; 125 pm) and $Z = 25$ (Mn; 124 pm) the difference is very small. (Note that "pm" is picometers.).

Ionization Energy(IE)

- The ionization energy (IE) is the energy (in kJ) required for the complete removal of 1 mol of electrons from 1 mol of gaseous atoms or ions.

IE ማለት 1mol ኤሌክትሮን ከአንድ አቶም ላይ ለማውጣት የሚያስፈልግ የኃይል መጠን ማለት ነው።

- Multi-electron atoms can lose more than one electron, so the ionization energies required to remove each electron are numbered in sequence from the ground-state atom. For instance, boron atom has five electrons, two in an inner core (1s2) and three valence electrons (2s22p1). The five

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

$B\ (g)$	$\rightarrow B^{+}$	$(g) + e^{-}$	IE_1	$= 801\ kJ\ mol^{-1}$
$B^{+}\ (g)$	$\rightarrow B^{2+}$	$(g) + e^{-}$	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	$= 32{,}822\ kJ\ mol^{-1}$

በአንድ አቶም ከአንድ mol በላይ ኤሌክትሮን ሊለቅ ይችላል። በዚህ ጊዜ ለእያንዳንዱ 1 mol የሚያስፈልገው የ IE መጠን ይለያያል።ስለዚህ የተለያየ IE ያስፈልገናል። ለምሳሌ:- ከላይ እንደምትመለከቱት Boron አቶም 5 ኤሌክትሮኖችን ለመልቀቅ ቢፈልግ ለእያንዳንዱ ኤሌክትሮን የሚያስፈልገው የ IE መጠን ይለያያል። ለዛም IE1,IE2, IE3...እያልን የኃይል መጠኑን እንሰይማለን። ነገር ግን ለምን ተለያየ የሚለው መሠረታዊ ጥያቄ ነው።

- The first ionization energy (IE1) of an atom is the minimum energy needed to remove the first electron from the outermost shell of a gaseous atom to produce a gaseous ion.

$$Atom\ (g) \rightarrow Ion^{+}(g) + e^{-} \quad \Delta E = IE_1 > 0$$

የመጀመሪያውን ኤሌክትሮን ከአቶሙ ለማስወጣት የሚያስፈልገው ኃይል First ionization energy ሲባል ይሽ ኃይል ከሁሉም ትንሹ የሚያስፈልገው ኃይል ነው። ምክንያቱም የውጪያዊው ኤሌክትሮኖቹ በወጡ ቁጥር አቶሙ ያለውን orbital እያጣ ና ወደ ኒውክለስ እየቀረበ

Follow us
ALPHA BOOKS

- largest ionization energies in any period occur for the noble-gas elements. This general trend increasing ionization energy with atomic number in a given period is due to the fact that as we move across a period, Zeff generally increases so atomic radii become smaller. As a result, the attraction between the nucleus and the outer electrons increases, so an electron becomes more difficult to remove.

IE በ period ከግራ ወደ ቀኝ ስንሄድ እየጨመረ ይመጣል። ይሽ ምክንያቱ የ Zeff መጨመር ነው። Zeff ሲጨምር Atomic Size ይቀንሳል። ይሽ ከሆነ ደግሞ በውጪያዊው ኤሌክትሮን ና በውስጠኛው ኒውክለስ መካከል ያለው መሳሳብ ይጨምራል። ስለዚህ ውጪያዊውን ኤሌክትሮን ለማስለቀቅ ከባድ የሆነ የኃይል መጠን ይፈልጋል። ለዛ IE ይጨምራል።

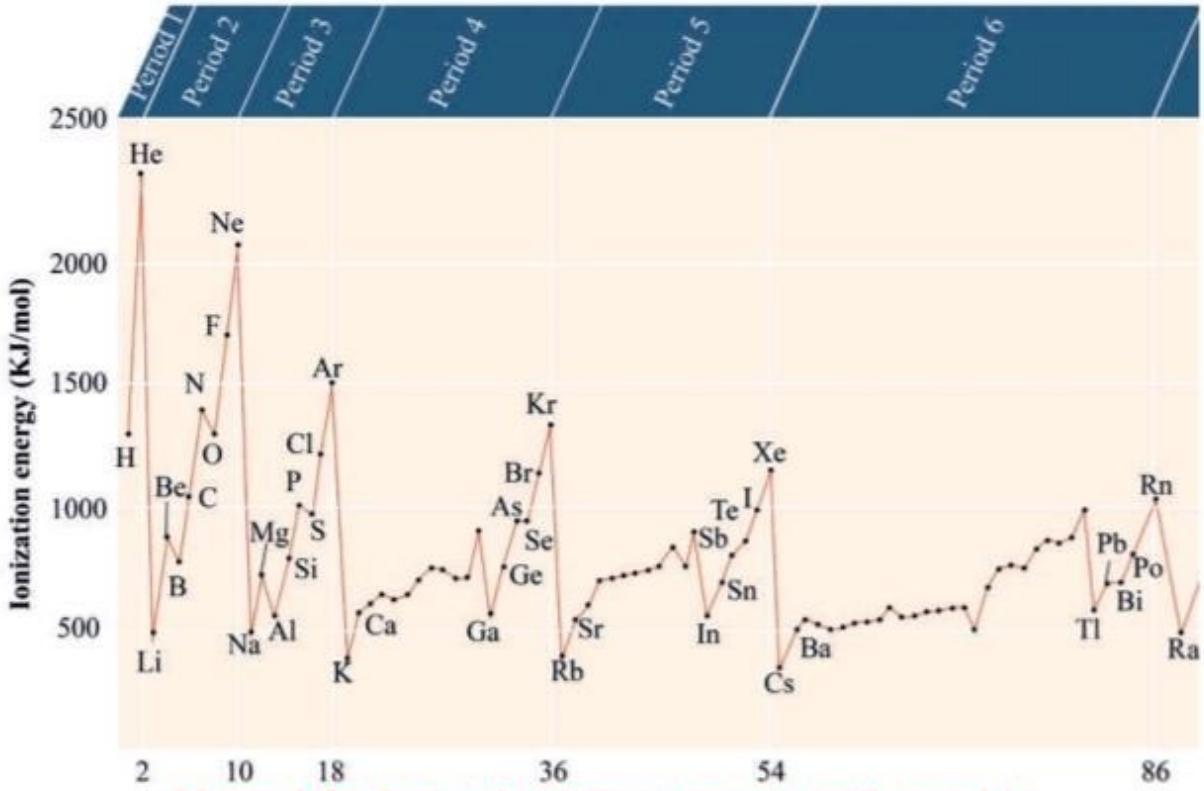


Figure 1.20: Ionization energy versus atomic number

- Small deviations from this general trend occur. A Group IIIA element (ns2np1) has a smaller ionization energy than the preceding Group IIA element (ns2). Apparently, the np electron of the Group IIIA element is more easily removed than one of the ns electrons of the preceding Group IIA element.

ይሽ በ period የ IE መጨመር ግን ቋሚ አይደለም። ከላይ ባለው ምስል እንደምትመለከቱት በአንዳንድ ቦታ ይቀንሳል። ለምሳሌ:- ከ Mg ወደ Al ሲሄድ መጨመር የነበረበት ቢሆንም IE ቀንሷል። ይሽ ለምን ሆነ ካልን ከ Subshell electron configuration ጋር የተያያዘ ነው። የ Mg configuration =1s2,2s2,2p6,3s2 ነው። የ Al configuration

=1s2,2s2,2p6,3s2,3p1 ነው።አንድ አቶም ውጪያዊው ኤሌክትሮኖች በ porbital ላይ የሚገኙ ከሆነ ውጪያዊው ኤሌክትሮን s orbital ላይ ከሚገኙት ከኒውክለሱ የበለጠ ርቀዋል ምንም ያህል በአንድ quantum number (n) ላይ ቢሆኑም። p orbital ይርቃል ማለት ደግሞ በትንሽ ኃይል (IE) ኤሌክትሮኑን ልናስወጣ እንችላለን ማለት ነው። ለዛ ነው የ Al IE የቀነሰው።

- ❖ Also note that a Group VIA element (ns2np4) has a smaller ionization energy than the preceding Group VA element. As a result of electron repulsion, it is easier to remove an electron from the doubly occupied np orbital of the Group VIA element than from a singly occupied orbital of the preceding Group VA element.

በአንጻሩ ደግሞ ከ P ወደ S ሲሄድ አሁንም ሲቀንስ እንመለከታለን። ለምን ? ካልን በ electron repulsion ምክንያት ነው። የ 15P configuration =1s2,2s2,2p6,3s2,3px1,3py1,3pz1 ነው። የ 16S configuration =1s2,2s2,2p6,3s2,3px2,3py1,3pz1 ነው።16S 3Px ላይ ሁለት ኤሌክትሮኖች ስለሚገኙ ተመሳሳይ ቻርጅ ስለሚገፋፉ ይገፋፋሉ። በመጠፋፋታቸው ምክንያት ውጪያዊ የሆነ ላስወጣችሁ የሚል ትንሽ ኃይል (IE) ሲመጣ እሺ በእጄ ብለው ይቀበላሉ ።ለዛ ነው IE የ 16S ሊቀንስ የቻለው። በጥቅሉ ግን IE በ period ከግራ ወደ ቀኝ ይጨምራል በ Group ከላይ ወደ ታች ይቀንሳል።

Entrance 2011

22. Which of the following elements has the highest fifth lonization energy(IE_5)?

A.Al B.S C.P D.Si

Explanation: lonization energy increases from left to right across a period. Hence, S has the highest ionization energy.

Answer = B

Exercise 1.13

1. Choose the element with the higher ionization energy from each pair:
   a. As or Bi b. As or Br c. Al or In d. K or Ge
2. The first and second ionization energies of potassium, K, are 419 kJ mol^{-1} and 3052 kJ mol^{-1} and those of calcium, Ca, are 590 kJ mol^{-1} and 1145 kJ mol^{-1}, respectively. Compare their values and comment on the differences.
3. Based on their positions in the periodic table, predict which atom of the following pairs will have the larger first ionization energy:
   a. Ga or Ge b. Br or Sb c. K or Cr d. Mg or Sr e. O or Ne
4. Name the period 3 element with the following ionization energies (in kJ/mol), and write its electron configuration:

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6
1012	1903	2910	4956	6278	22,330

Electron Affinity (EA)

❖ The electron affinity is the energy change for the process of adding an electron to a neutral atom in the gaseous state to form a negative ion:

Follow us
ALPHA BOOKS

ላይ ነው። አቶሙም ኤሌክትሮኑም ኔጋቲቭ ቻርጅ ናቸው። ለዛ ኤሌክትሮኑን ወደ ራስ ለመሳብ ኃይል ማውጣት ሳይሆን መጠፋፋቱን የሚያስቀር የተሰወነ መጠን ያሐው ኃይል(absorbed energy) ማስገባት አለበት። ለዛ ነው EA2 ፖዘቲቭ ቁጥር የሆነው።

IA (1)	IIA (2)	IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	VIIIA (18)
H -72.8							He (0.0)
Li -59.6	Be ≤0	B -26.7	C -122	N +7	O -144	F -328	Ne (+29)
Na -52.9	Mg ≤0	Al -42.5	Si -134	P -72	S -200	Cl -349	Ar (+35)
K -48.4	Ca -2.37	Ga -28.9	Ge -119	As -78.2	Se -195	Br -325	Kr (+39)
Rb -46.9	Sr -5.03	In -28.9	Sn -107	Sb -103	Te -190	I -295	Xe (+41)
Cs -45.5	Ba -13.95	Ti -19.3	Pb -35.1	Bi -91.3	Po -183	At -270	Rn (+41)

Figure 1. 21: Electron affinities of the main-group elements (in kJ/mol)

- Electron affinities, EA, have a periodic variation, just as atomic radii and ionization energies do. Broadly speaking, the general trend is toward more negative electron affinities from left to right in any period.

EA በ period ከግራ ወደ ቀኝ ስንሄድ EA ኔጋቲቭ ቁጥር እየሆነ ይሄዳል። ነገር ግን ይሽ ወጥነትነት የለውም በመካከል ላይ ወደ ፖዘቲቭ ቁጥርም ሊመጣ ይችላል።

- Note that the Group VIA and Group VIIA elements have the largest negative electron affinities of any of the main-group elements. The trend in going across a period is rather

Follow us
ALPHA BOOKS

- Electronegativity indicates the extent of attraction by which the electrons of the bond pair are attracted by an atom linked by this bond.

Electronegativity የምንለው አንድ አቶም ኬሚካል ቦንድ የሰሩትን ኤሌክትሮኖችን ወደ ራሱ የመሳብ አቅም ነው።

- Linus Pauling, an American scientist, in 1922 assigned arbitrarily a value of 4.0 to fluorine, the element considered to have the greatest ability to attract electrons. This is known as the Pauling scale.Approximate values for the electronegativity of a few elements are given in Table 1.4.

Table 1.4: (a) Electronegativity values (on Pauling scale) across the periods

Atom (Period II)	Li	Be	B	C	N	O	F
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Atom (Period III)	Na	Mg	Al	Si	P	S	Cl
Electronegativity	0.9	1.2	1.5	1.8	2.1	2.5	3.0

Table 1.4: (b) Electronegativity values (on Pauling scale) down a group

Atom (Group IA)	Electronegativity value	Atom (Group VIIA)	Electronegativity value
Li	1.0	F	4.0
Na	0.9	Cl	3.0
K	0.8	Br	2.8
Rb	0.8	I	2.5
Cs	0.7	At	2.2

Pauling የተባለ ተመራማሪ የአቶሞችን electronegativity ከ 0-4 ባሉ ቁጥሮች በመወከል በቅድመተከተለስ ለማስቀመጥ የሞከረ ሲሆን

Follow us
ALPHA BOOKS

Metallic Character ማለት አንድ ንጥረ ነገር ያለው ብረት የመሆን ጠባይ ማለታችን ነው። ብረት የመሆን ጠባዩ ምንድነው? ካልን ኤሌክትሮንን የመልቀቅ ና ወደ cation የመምጣት ጠባይን በዋነኝነት እንጠቅሳለን።

- ❖ Metallic character decreases as you move across a period in the periodic table from left to right. This occurs as atoms more readily accept electrons to fill a valence shell than lose them to remove the unfilled shell.

Metallic character በ period ከግራ ወደ ቀኝ ስንሄድ ይቀንሳል። ለምን? ካልን ብረቶች የሚገኙት ከ period table በስተግራ በኩል ነው። non metal ደግሞ በስተ ግራ ።ስለዚህ ከቀኝ ወደ ግራ ብሄድ አቶሞቹ ኤሌክትሮን የመልቀቅ ሳይሆን ኤሌክትሮን የመቀበል ፍላጎታቸው እየጨመረ ይመጣል።

- ❖ Metallic character increases as you move down an element group in the periodic table. This is because electrons become easier to lose as the atomic radius increases, where there is less attraction between the nucleus and the valence electrons because of the increased distance between them.

Metallic character በ group ከላይ ወደ ታች በወረድን ቁጥር እየጨመረ ይመጣል። ለምን? ካልን atomic radii ከላይ ወደ ታች እየጨመረ ስለሚመጣ ውጪያዊው ኤሌክትሮን በቀላሉ ወደ አቶሙ ኒውክለስ በቀላሉ አይሳብም። ይኸ ማለት በቀላሉ ኤሌክትሮን የመውጣት የብረት ጠባይ ይኖረዋል ማለት ነው።

Teacher's Mind

67. Based on their positions in the periodic table, predict which has the smallest atomic radius: Mg, Sr, Si, Cl, I.

68. Based on their positions in the periodic table, predict which has the largest atomic radius: Li, Rb, N, F, I.

69. Based on their positions in the periodic table, predict which has the largest first ionization energy: Mg, Ba, B, O, Te.

70. Based on their positions in the periodic table, predict which has the smallest first ionization energy: Li, Cs, N,F,I.

71. Based on their positions in the periodic table, rank the following atoms in order of increasing first ionization energy: F, Li, N, Rb

72. Based on their positions in the periodic table, rank the following atoms or compounds in order of increasingfirst ionization energy: Mg, O, S, Si.

73. Atoms of which group in the periodic table have a valence shell electron configuration of ns2np3?

74. Atoms of which group in the periodic table have a valence shell electron configuration of ns2?

75. Based on their positions in the periodic table, list the following atoms in order of increasing radius: Mg, Ca, Rb, Cs.

76. Based on their positions in the periodic table, list the following atoms in order of increasing radius: St, Ca, Si,Cl

77. Based on their positions in the periodic table, list the following ions in order of increasing radius: K+, Ca+2,Al+3 , Si+4

78. List the following ions in order of increasing radius: Li+, Mg+2, Te-2,Br-

79. Which atom and/or ion is (are) isoelectronic with Br-: Se2+, Se, As+3,Kr, Ga3+, Cl-?

80. Which of the following atoms and ions is (are) isoelectronic with S+2: Si4+, C13+, Ar, As-3, Si, Al+3?

81. Compare both the numbers of protons and electrons present in each to rank the following ions in order of increasing radius: As, Br-, K+, Mg2+.

82. Of the five elements Al, Cl, I, Na, Rb, which has the most exothermic reaction? (E represents an atom.) What name is given to the energy for the reaction? Hint: note the process depicted does not correspond to electron affinity

$$E^+(g) + e \rightarrow E(g)$$

83. Of the five elements Sn, Si, Sb, O, Te, which has the most endothermic reaction? (E represents an atom.) What name is given to the energy for the reaction?

$$E(g) \rightarrow E^+(g) + e$$

84. The ionic radii of the ions S-2, Cl-, and K+ are 184, 181, 138 pm respectively. Explain why these ions have different sizes even though they contain the same number of electrons.

85. Which main group atom would be expected to have the lowest second ionization energy?

86. Explain why Al is a member of group 13 rather than group 3?

Answer Key

67. Cl

69. O

71. Rb < Li < N < F

73. 15 (5A) 75. Mg < Ca < Rb < Cs

77. $Si^{4+} < Al^{3+} < Ca^{2+} < K^{+}$

79. Se, As^{-}

81. $Mg^{2+} < K^{+} < Br^{-} < As^{3-}$

83. O, IE1

85. Ra

1.8.4 Advantages of Periodic Classification of Elements

Some of the advantages of periodic classification of elements are:

1. The classification of elements is based on the atomic number, which is a fundamental property of an element.

2. Isotopes are averaged in one place, as the classification is on the basis of atomic number (For example, chlorine (atomic number 17) is given the atomic mass 35.5.)

3. It explains the periodicity of the properties of the elements and relates them to their electronic configurations.

4. The position of the elements that were misfits on the basis of mass number (anomalous pairs like argon and potassium) could be justified on the basis of

atomic number.

5. The lanthanides and actinides are placed separately at the bottom of the periodic table.

6. The table is a simple, systematic and an easy way of remembering the properties of various elements, as it is based on the electronic configuration.