What is the valency of Neon?

18TH GROUP ELEMENTS

Continued from 17th November..

STATEMENT TYPE QUESTIONS

1) Both 'I' and 'II' are true. 'II' is correct explanation of 'I'.
2) Both 'I' and 'II' are true. 'II' is not correct explanation of 'I'.
3) 'I' is true but 'II' is false
4) 'I' is false but 'II' is true.

29. Statement I :Balloons made by nylon films are better for containing helium than the conventional rubber balloons.
Statement II : R.M.S. velocity of helium is very high. So helium atoms can effuse out through rubber balloons.

30. Statement I : Compared to other noble gases 'Xe' is chemically active.
Statement II :'Xe' has low IP value and vacant 'd' orbitals, available for the excitation of electrons from 'p' orbitals of valence shell.

31. Statement I:Noble gases have highest ionization energies in their respective periods.
Statement II : The outermost shell of noble gases is completely filled.

32. Statement - I:Deep sea divers use He-O_2 mixture for breathing
Statement - II:Unlike N_2, He is not soluble in blood even under high pressure.

33. Statement - I:Solubility of noble gases in water decreases with increase in atomic size.
Statement - II:Solubility is due to dipole-induced dipole interaction.

34. Statement - I:He -II has high viscosity and flows downward.
Statement - II:Liquid helium is used as cryogenic liquid.

35. Statement - I: In sea diver gases, the nitrogen of normal air is replaced by helium.
Statement - II: Nitrogen becomes more soluble in the body fluids at high pressures and causes conditions similar to alcohol intoxication.

36. Statement - I:Xenon forms fluorides.
Statement - II:Because 5d orbitals are available for valence shell expansion.

37. Match the following.

List-I	List-II
A) XeF_4	1) Distorted octahedral
B) XeF_6	2) Tetrahedral
C) XeO_3	3) Square planar
D) XeO_4	4) Pyramidal

	A	B	C	D		A	B	C	D
1.	1	2	3	4	2.	3	1	4	2
3.	1	3	2	4	4.	2	4	1	3

38. Matrix Matching.

List-I	List-II
A) Gas Thermometers	p) *He*
B) Beacon lamp	q) *Ne*
C) Electric bulbs	r) Xe
D) Flash bulb	s) *Kr*

LEVEL-I A KEY

29) 2 30) 1 31) 1 32) 1 33) 4 34) 4 35) 4
36) 1 37) 2 38) A→p, B→q, C→q,s, D→r

LEVEL-I A HINTS

29. Due to non-inflammable and high R.M.S. velocity, 'He' is filled in balloons.
30. 'Xe' has low I.P. value and vacant 'd' orbitals. It can involve in chemical reactions.
31. In the noble gases, outermost shell is completely filled so that their I.P. values are high.
32. Unlike N_2, He is not soluble in blood at high pressure so that He+O_2 mixture is used for breathing.
33. Solubility of noble gases is due to dipole-induced dipole interaction and the solubility in water increases with atomic number.
34. Liquid 'He' is used as cyrogenic liquid and He-II has high viscosity and flows upward.
35. In sea diver gases at high pressure N_2 is more soluble in body fluids.
36. Xenon forms fluorides because '5d' orbitals are available for valency shell expansion.

LEVEL I B

1. The valency is zero for
1. Neon 2. Fluorine 3. Oxygen 4. Carbon

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2. Oxidation state of zero group elements is
1. -1 2. +1 3. 0 4. -2

3. The atomicity of neon gas is
1. Two 2. One 3. Four 4. Three

4. Which of the following gaseous molecules is monoatomic?
1. Chlorine 2. Helium 3. Oxygen 4. Nitrogen.

5. The number of electrons in the penultimate orbit of krypton atom are
1. 8 2. 2 3. 18 4. 32

6. Which one of the following noble gases is not found in atmosphere ?
1. Rn 2. Kr 3. Ne 4. Ar

7. The first noble gas compound prepared by Bartlett is
1. XeF_2 2. KrF_2 3. $XePtF_6$ 4. XeO_3

8. Number of unpaired electrons in inert gas is
1) Zero 2) 8 3) 4 4) 18

9. Helium is subjected to electrical discharge. The following species is not present in the discharge tube
1. He^+ 2. He_2^+ 3. He_2 4. He

10. The spectrum of helium is expected to be similar to that of
1. H 2. Be 3. Li^+ 4. Ne

11. The gas that gives superfluid on cooling at 2.2K is
1. Ar 2. Rn 3. Kr 4. He

12. Viscosity is very low for
1. Ar 2. He(I) 3. He(II) 4. Kr

13. Which of the following statement is not correct for a noble gas?
1. Argon is used to fill the incandescent bulbs
2. Krypton is obtained in nuclear fission.
3. Radon is present in the atmosphere
4. Xenon cannot form XeF_3

14. Inversion temperature of helium is very low. So when helium is allowed to expand into vacuum it gets
1. Cooled 2. Heated
3. Neither cooled, nor heated 4. Liquified

15. Which of the following is a product in the explosion of hydrogen bomb?
1. Kr 2. Ne 3.He 4. Xe

16. The lightest gas which is non-inflammable is
1) H_2 2) He 3) N_2 4) Ar

17. Which of the following compound cannot be prepared?
1. XeF_2 2. XeF_3 3. XeF_4 4. XeF_6

18. The shape of XeO_3 molecule is
1. planar triangle 2. pyramid
3. linear 4. square planar

19. XeF_2 molecule is
1) Trigonal planar 2) Square planar
3) Linear 4) Pyramidal

20. If N_2 gas is dissolved in the blood, it causes
1. Blindness 2. Headache
3. Bends 4. All

21. Sea divers go deep in the sea water with a mixture of which of the following gases
1) O_2 and He 2) O_2 and Ar
3) O_2 and CO_2 4) CO_2 and Ar

22. The mixture of gases used for respiration by Asthma patients is
1) O_2 and H_2 2) O_2 and He
3) O_2 and Ar 4) O_2 and Ne

23. Shape of $XeOF_4$ is
1) Octahedral 2)Square pyramidal
3) Pyramidal 4) T-Shaped

24. Hybridization and shape of XeF_4 is
1) sp^3d, trigonal bipyramidal
2) sp^3, tetrahedral
3) sp^3d^2, square planar 4) sp^3d^2, hexagonal

25. Which of the following is formed by xenon?
1) XeF_7 2) XeF_4 3) XeF_5 4) XeF_3

26. The structure of XeO_2F_2 is
1) Square pyramidal
2) Trigonal pyramidal (see-sea)
3) Octahedral 4) Tetrahedral

LEVEL-I B KEY

1)1 2)3 3)2 4)2 5)3 6)1 7)3 8)1
9)3 10)3 11)4 12)3 13)3 14)2 15)3 16)2
17)2 18)2 19)3 20)3 21)1 22)2 23)2 24) 3
25)2 26)2

LEVEL II A PROPERTIES

1. Oxidation state of Xe in $Ba_2[XeO_6]$ is
1) 4 2) 6 3) 7 4) 8

2. The elements which occupy the peaks of ionization energy curve are
1) Na,K,Rb,Cs 2) Na,Mg,Cl,I
3) Cl,Br,I,F 4) He,Ne,Ar,Kr

3. The lowest boiling point of helium is due to its
1) inertness 2) Gaseous nature
3) High polarisability
4) Weak van der Waals forces between atoms

4. Noble gases are group of elements which exhibit very:
1) High chemical activity
2) Much paramagnetic proeprties
3) Maximum electronegativity
4) Low chemical activity

5. XeF_6 on complete hydrolysis gives.
1) Xe 2) XeO_2 3) XeO_3 4) XeO_4

6. First stable compound of inert gas was prepared by
1) Rayleigh and Ramsay 2) Bartlett
3) Frankland and Lockyer 4) Cavendish

7. The element which has not yet been reacted with F_2 is
1) Ar 2) Xe 3) Kr 4) Rn

8. Which has the same electronic configuration as of inert gas
1) Ag^{3+} 2) Cu^{2+} 3) Pb^{4+} 4) Ti^{4+}

9. The correct order of enthalpy of vaporisation of noble gases is
1) Xe > Kr > Ar > Ne > He
2) Xe > Ar > He > Ne > Kr
3) He > Ne > Kr > Ar > Xe
4) Ne > Xe > Kr > He > Ar

10. Which of the following exhibits the weakest intermolecular forces?
1) H_2O 2) NH_3 3) He 4) HCl

11. Which of the following noble gas is the most polarized?
1) Radon 2) Krypton 3) Xenon 4) Helium

12. Which of the following noble gas is the least polarized?
1) Radon 2) Krypton 3) Xenon 4) Helium

13. The reaction of Xe with an excess of F_2 at high pressure and 573 K yields
1) XeF_2 2) XeF_4 3) XeF_6 4) XeF_3

STRUCTURE & USES

14. The shape of XeF_5^+ Ion is
1) Pentagonal 2) Octahedral
3) Square pyramidal 4)Trigonal bipyramidal

15. The number of $p\pi - d\pi$ 'pi' bonds present in XeO_3 and XeO_4 molecules respectively [EAM-2009]
1) 3,4 2) 4,2 3) 2,3 4) 3,2

16. The fluoride of Xenon with zero dipole moment is
1) XeF_6 2) XeO_3 3) XeF_4 4) XeO_2F_2

17. XeO_6^{-4} contains
1) Eight bond pairs and no lone pairs at Xe
2) Three bond pairs and three lone pairs at Xe
3) Two bond pairs and six lone pairs at Xe
4) Four bond pairs and four lone pairs at Xe

18. How many lone pairs are associated with xenon in xenon difluoride?
1) 1 2) 2 3) 3 4) 4

19. XeO_3 has
1) Three double bonded O-atoms
2) Trigonal pyramidal geometry
3) One lone pair and sp^3 hybridisation
4) All of these

LEVEL-II A KEY

1) 4 2) 4 3) 4 4) 4 5) 3 6) 2 7) 1
8) 4 9) 1 10) 3 11) 3 12) 4 13) 3 14) 3
15) 1 16) 3 17) 1 18) 3 19) 4

LEVEL II B

1. 1/125th part of nitorgen gas isolated from atm osphere did not combine with any other sub stance due to
1) The chemical inert ness of N_2 gas
2) The presence of Argon
3) The presence of Argon & other noble gases
4) The presence of O_2.

2. In solid state Ar atoms are held together by
1) Ionic bonds 2) Covalent bonds
3) Hydrogen bonds 4) Vanderwaal forces

3. Liquid Helium at 2.2K and at 1atm pressure flows in the upward direction. It is because of its low
1) boiling point 2) heat of vapourisation
3) viscosity 4) surface tension

4. The noble gas which does not form any clathrates is
1) He 2) Ar 3) Kr 4) Xe.

5. Which of the following fluorides of xenon is impossible?
1) XeF_2 2) XeF_3 3) XeF_4 4) XeF_6

6. Which of the following fluorides of Xe has zero dipole moment?
1) XeF_2 2) XeF_6 3) XeF_4 4) Both (1) & (3)

7. Which of the following is formed when O_2F_2 reacts with Xe?
1) XeF_2 2) XeF_4 3) XeF_6 4) None of these

8. Which of the following noble gases can be called the hidden one?
1) Xe 2) He 3) Ar 4) Kr

9. Helium mixed with oxygen is used in the treatment of
1) Beri beri 2) Burning feet
3) Joints burning 4) Asthma

10. The compound in which the number of $d\pi - p\pi$ bonds are equal to those present in ClO_4-
1) XeF_4 2) XeO_3 3) XeO_4 4) XeF_6

LEVEL-II B KEY

1) 3 2) 4 3) 3 4) 1 5) 2 6) 4 7) 1
8) 4 9) 4 10) 2

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Which are called isomers?

NUCLEI

SYNOPSIS

- The nucleus of an atom is at the centre. Most of the mass of an atom is at the centre. The entire positive charge of an atom lies in the nucleus
- All atomic nuclei are made up of elementary particles called protons and neutrons. Proton is the nucleus of the hydrogen atom. It has a positive charge of 1.6×10^{-19} C having a mass of 1.6726×10^{-27} kg. This is nearly equal to 1836 times the electron mass. Neutron is electrically neutral (i.e. neutron carries no charge). Mass of neutron is slightly greater than that of the proton (1.6750 x10-27 kg). Both the proton and neutron together constitute the nucleus. They are called nucleons
- Generally atomic number is denoted by Z and mass number is denoted by A and (A-Z) gives number of neutrons (N) in the nucleus

  $\therefore N = A - Z$; $A = Z + N$
- Nucleus is positively charged and its shape is considered as spherical

TYPES OF NUCLEI:

- **ISOTOPES:** Atomic nuclei having same atomic number but different mass numbers are known as isotopes. They occupy same position in the periodic table and possess identical chemical properties. They have same proton number

  Ex: 1) ${}_3Li^6$ ${}_3Li^7$ 2) ${}_1H^1$, ${}_1H^2$, ${}_1H^3$

  ISOTONES: Atomic nuclei having same number of neutrons are called isotones

  Ex: 1) ${}_{17}Cl^{37}$, ${}_{19}K^{39}$, 2) ${}_7N^{17}$, ${}_8O^{18}$, ${}_9F^{19}$

  ISOBARS: Atomic nuclei having same mass number but different atomic numbers are called Isobars. They have same number of nucleons

  Ex: 1) ${}_{18}Ar^{40}$, ${}_{20}Ca^{40}$, 2) ${}_{32}Ge^{76}$, ${}_{34}Se^{76}$
- **ISOMERS:** Atomic nuclei having same mass number and same atomic number but different nuclear properties are called isomers

  Ex: $m_{35}Br^{80}$ metastable Bromine and $g_{35}Br^{80}$ ground state Bromine are two isomers with different half lives
- **ISODIAPHERS:** Nuclei having different Atomic number (Z) and mass number (A) but with same excess number of neutrons over protons (A-2Z) are called isodiaphers

  Ex: ${}_{11}Na^{23}$, ${}_{13}Al^{27}$

SIZE OF THE NUCLEUS:

- Nuclear sizes are very small and are measured in fermi (or) femtometer.

  1 fermi = 10^{-15} m
- Radius of the nucleus depends on number of nucleons. $R = R_oA^{1/3}$

  Above equation does not apply to heavy nucleides value of $R_o = 1.4 \times 10^{-15}$m
- Radius of the nucleus is in the order of 10^{-15} m
- Size of an atom is in the order of 10^{-10} m
- If an α-particle with an initial kinetic energy E approaches a target of atomic number Z, if the distance of closest approach is "d" then $\frac{1}{4\pi\epsilon_0}\frac{2Ze^2}{d} = E$ (Where 'e' is charge of an electron) If "v" represents the initial velocity of α particle, (m is mass of "α" particle) then $\frac{1}{4\pi\epsilon}\frac{2Ze^2}{d} = \frac{1}{2}mv^2$

Note: If a particle of charge q, mass m is projected towards a nucleus of charge Q with velocity v from infinity then the distance of closest approach d is give by $\frac{1}{4\pi\epsilon_0}\frac{qQ}{d} = \frac{1}{2}mv^2$

Note: If R, S and V be the Radius, surface area and volume of a nucleus with mass number A then $R \propto A^{\frac{1}{3}} \to \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{\frac{1}{3}}$; $S \propto R^2 \propto A^{\frac{2}{3}} \Rightarrow \frac{S_1}{S_2} = \left(\frac{A_1}{A_2}\right)^{\frac{2}{3}}$; $V \propto R^3 \propto A \Rightarrow \frac{V_1}{V_2} = \frac{A_1}{A_2}$

Note: If a stationary nucleus splits in to two lighter nuclei with mass numbers A_1 and A_2 then according to law of conservation of linear momentum, the two lighter nuclei move in opposite directions with equal momenta hence $m_1v_1 = m_2v_2$

Ratio of velocities of the two nuclei

$$\frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{A_2}{A_1} = \left(\frac{R_2}{R_1}\right)^3 (\because m \propto A \propto R^3)$$

Ratio of kinetic energy of the two nuclei

$$\frac{KE_1}{KE_2} = \frac{m_2}{m_1} = \frac{A_2}{A_1} = \left(\frac{R_1}{R_2}\right)^3$$

$$\left(\because KE = \frac{p^2}{2m} \& KE \propto \frac{1}{m} \text{ when p is constant}\right)$$

INTERMEDIATE special SENIOR

DENSITY OF THE NUCLEUS:

- Density of nucleus is independent of mass number of the atom
- Density of the nucleus is 1.45×10^{17} Kgm^{-3}
- The density is maximum at the centre and gradually falls to zero as we move radially out wards
- Radius of the nucleus is taken as the distance between the centre and the point where the density falls to half of its value at the centre
- Density of nucleus is of the order of 10^{14}gm/cc$=10^{17}$cc$=10^{17}$kg/m^3

W.E – 1: Compare the radii of the nuclei of mass numbers 27 and 64

Sol: The ratio of the radii of the nuclei is

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{\frac{1}{3}} = \left(\frac{27}{64}\right)^{\frac{1}{3}} \left(\because R = R_0A^{1/3} = \frac{3}{4}\right)$$

W.E – 2: The radius of the oxygen nucleus ${}^{16}_{8}O$ is 2.8×10^{-15}m. Find the radius of lead nucleus ${}^{205}_{82}Pb$

Sol: $R_0 = 2.8 \times 10^{-15}m, A_o = 16, A_{pb} = 205 R \propto A^{1/3}$

$$\frac{R_0}{R_{pb}}\left(\frac{A_0}{A_{pb}}\right)^{1/3} = \frac{2.8\times10^{-15}}{R_{pb}} = \left(\frac{16}{205}\right)^{1/3}$$

$R_{pb} = 6.55 \times 10^{-15}m$

ATOMIC MASS UNIT (A.M.U):

a) The masses of atoms, nuclei, sub atomic particles are very small. Hence, a small unit is used to express these masses. This unit is called as atomic mass unit (amu). I am u is equal to one twelth part of the mass of carbon (${}_6C^{12}$) isotope

Mass of ${}_6C^{12}$ is exactly 12 amu

b) Now, the mass of 1 gm- mole of carbon is 12 gm and according to Avogadro's Hypothesis it has N (Avogadro's Number) atoms. Thus, the mass of one atom of carbon is (12/N) gm. According to the definition

$$\text{amu} = 1\text{u} = \frac{1}{12} \times (\text{mass of one carbon atom})$$

$$= \frac{1}{12} \times \frac{12}{N} = \frac{1}{N}\text{gm} = \frac{1}{6.023\times10^{23}}\text{gm}$$

$$= 1.660565 \times 10^{-24}\text{gm} = 1.660565 \times 10^{-27}\text{kg}$$

MASS – ENERGY EQUIVALENCE: According to Einstein's mass-energy equivalence principle, mass is another form of energy. Mass can be converted into energy & energy can be converted into mass according to the equation $E = mC^2$

Here m is the mass that disappears and E is the energy liberated. C is the velocity of light in vacuum. When 1 amu of mass is converted in to energy. Energy liberated is given by

$$E = (1.660565 \times 10^{-27}) \times 9 \times 10^{16} j = 931.5 MeV$$

Hence 1 amu of mass is equivalent to 931.5 MeV of energy $\therefore$ $\boxed{1amu = 931.5MeV/C^2}$

The masses of electron, proton and neutron in terms of various units are:

Mass of the electron

$= m_e = 9.1095 \times 10^{-31}kg$

$= 0.000549u = 0.511MeV/C^2$

Mass of the proton

$= m_p = 1.6726 \times 10^{-27}kg$

$= 1.007276\ u = 938.28MeV/C^2$

Mass of the neutron

$= m_n = 1.6750 \times 10^{-27}kg$

$1.008665\ u = 939.573MeV/C^2$

MASS DEFECT, BINDING ENERGY, EINSTEIN'S MASS ENERGY RELATION

- When matter is completely annihilated, energy released is $E=mc^2$
- The energy equivalent to 1amu is 931.5 MeV= 1.4925×10^{-10}J

Mass Defect: Atomic mass is always less than the sum of the masses of constituent particles. The difference between the total mass of the nucleons and mass of the nucleus of an atom gives mass defect.

$$\Delta m = [ZM_p + (A - Z)M_n] - M_{nuclous}$$

Z= Atomic number, M_p = Mass of proton
M_n=Mass of neutron, A=Mass number
$M_{nucleon}$ = Mass of nucleus

Binding Energy: The energy required to being the nucleons from infinity to form the nucleus is called binding energy or it is the energy required to split a nuclens into nucleons.

It is energy equivalent of mass defect BE $= [\Delta m]C^2$

Note : BE = mass defect x 931.5 MeV if mass is expressed in a.m.u.

B.E = per nucleon = Binding fraction

$$\frac{\text{Binding Energy}}{\text{Mass Number}} = \frac{\Delta m \times 931 Mev}{A}$$

Average Binding energy or Binding energy fraction: It is the Binding energy per nucleon (or) the average energy needed to separate a nuclei in to its individual nucleons.

PACKING FRACTION OF A NUCLEUS:

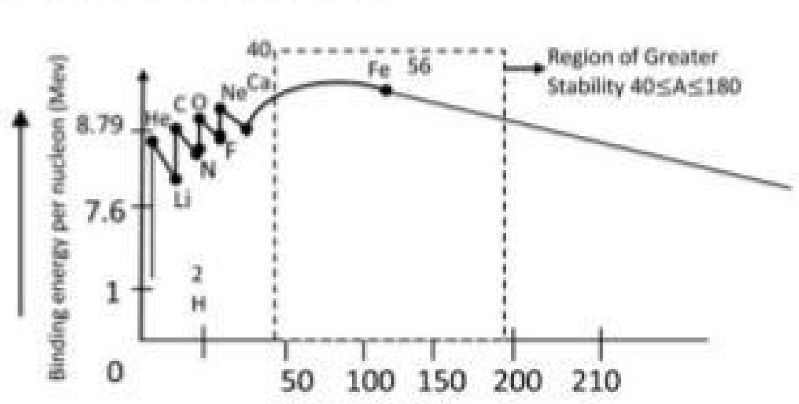
Packing fraction : It is defined as the mass defect per nucleon. Packing fraction $= \frac{\Delta m}{A} = \frac{M-A}{A}$ If the packing fraction is negative then the nucleus is more stable.

If the packing fraction is positive then the nucleus is unstable.

Packing fraction is zero for ${}_6C^{12}$

- Packing fraction measures the stability of a nucleus smaller the value of packing fraction, large is the stability of the nucleus.

VARIATION OF B.E. PER NUCLEON WITH MASS NUMBER



The main features of binding energy curve shown in the figure are :

1) The minimum value of binding energy per nucleon is in the case of deuteron (1.11MeV).

2)The maximum value of $\frac{BE}{A}$ is 8.7MeV for the nucleus ${}_{28}F^{56}$ (iron) which is he most stable.

3)Binding energy is high in the range 28<A<138.The binding energy of these nuclei is very close to 8.7 MeV

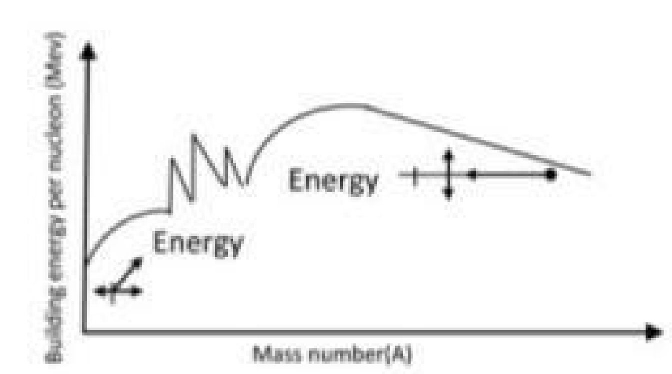
4)Further increase in the mass number binding energy per nucleon decreases and consequently for the heavy nuclei like uranium it is 7.6 MeV.

5) In the region of smaller mass numbers, the binding energy per nucleon curve shows the characteristic minima and maxima. Minima are associated with nuclei containing an odd number of protons and neutrons such as ${}^6_3Li$, ${}^{10}B$, ${}^{14}_7N$ and the maxima are associated with nuclei having an even number of protons and neutrons such as ${}^4_2He$, ${}^{12}_6C$, ${}^{16}_8O$.

6) Nuclei with A > 220 are distinctly unstable. That means from A > 220 single heavy nucleus breaks into two nearly equal nuclei with mass number A < 150 and so which are most stable. This process takes a right of the BE curve as shown in figure.

This process explains the nuclear fission.

7) Light nuclei such as hydrogen combine to form heavy nucleus to form helium for greater stability This process takes at left of the BE curve as shown in figure. This process explains the nuclear fusion.



Note: Iron (${}_{28}Fe^{56}$) whose binding energy per nucleon stands maximum at 8.7 MeV is most stable and will undergo neither fission nor fusion.

Exo-ergic Reaction: the reaction in which energy will be released is called exo-ergic Reaction. A + B → C + D + Q

Here A and B are called Reactants

C and D are called Products

Q is the amount of energy released

In an Exo-ergic Reaction

Mass of reactants > Mass of products

$$\Delta m = M_R - M_P = (M_A + M_B) - (M_C + M_D)$$

Energy Released Q=Δm $\times$ C^2 joule

[Δm is in kg] = Δm $\times$ 931.5 MeV (Δ m is in amu)

If Binding energies are given then for Exo-ergic reactions.

(B.E) Products > (B.E) Reactants

Energy released Q = $(B.E)_p$ = $(B.E)_R$

= $[(B.E)_C + (B.E)_D]$- $[(B.E)_A + (B.E)_B]$

Endo-ergic Reaction: The reaction in which energy will be absorbed is called Endo-ergic Reaction. A + B → C + D – Q

Here A and B are called Reactants

C and D are called Products

Q is the amount of energy absorbed

In an Endo-ergic Reaction

Mass of reactants < Mass of products

$\Delta m = M_P - M_R = (M_C + M_D) - (M_A + M_B)$

Energy absorbed Q = Δm x C^2 joule [Δm is in kg] $\Rightarrow$ Δm $\times$ 931.5MeV (Δ m is in amu)

If Binding energies are given then for Endo-ergic reaction

(B.E) Products < (B.E) Reactants

Energy absorbed Q = $(B.E)_R$ – $(B.E)_P$

= $[(B.E)_A + (B.E)_B]$ – $[(B.E)_C + (B.E)_D]$

Note: A nuclear reaction can occur only if certain conservation laws are followed. These are:

1. Conservation of mass number A
2. Conservation of charge
3. Conservation of energy, linear momentum and angular momentum.

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