Unit four
Chapter (1): Heat content

Part(1): Thermochemistry

Basic concepts of thermodynamics

- Energy is important for all living organisms to carry out their mental or muscular activities.
- Living organisms can get their energy from burning sugar inside their bodies.
-Heat energy is a form of energy that can be obtained from burning of natural gas.

Thermodynamics:

The science that deals with the study of energy and how it transfers.

Thermochemistry:

Branch of chemistry that studies the heat effects that accompanied the chemical reactions.

- There are different forms of energy as (heat , light , electric, kinetic, ….) , all these forms are related to each other by law of conservation of energy.

Law of conservation of energy:

Energy in any physical or chemical change can be neither created nor destroyed but it is transformed from one form to another.

What is the relation between chemical reaction and energy

-All chemical reactions is associated with changing in energy either release or absorb energy

-Energy exchange occurs between reaction mixture and surrounding.

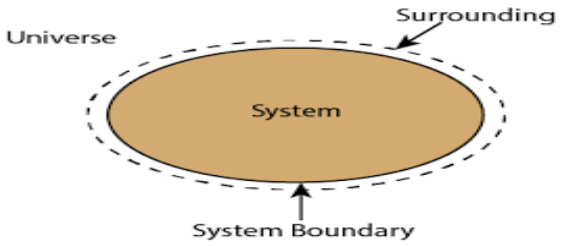
System:

It is the part of the substance under study.

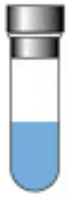
It is the part of the universe in which physical or chemical change occurs.

Surrounding:

It is the part outside the system and exchange energy with it in the form of heat or work.



Types of systems

Isolated system	Open system	Closed system
It does not exchange neither energy or matter with its surroundings. 	It freely exchange matter and energy with its surroundings.  Closed	It exchange energy but not matter with its surroundings in the form of heat or work.  Isolated

❖ **The medical thermometer is considered as a closed system.(G.R)**

Beause it allows the exchange of energy only with the surrounding

First law of thermodynamics:

The total energy of an isolated system is constant even the system is changed from one state to another

The relation of energy exchange between the system and surrounding

Universe = System + Surrounding

Change in universe energy = Change in system energy + Change in surrounding energy

$\triangle E_{universe} = \triangle E_{System} + \triangle E_{surrounding}$

Any change in system energy is accompanied by similar change in the surrounding energy but with opposite sign to keep the total energy constant

$\triangle E_{system} = -\triangle E_{surrounding}$

Heat and temperature

Heat flow from one position to another depending on the difference in temperature between the two positions.

Temperature:

It is indication of hotness or coldness of an object.

Or It is measurement of the average kinetic energy of matter molecules.

-Matter consists of molecules or atoms , they are in continuous motion but they differ in speed according to their kinetic energy.

- When the system absorbs heat energy, kinetic energy increase the temperature increase.

Measuring units of quantity of heat

Calorie	Joule
It is the quantity of heat needed to raise the temperature of 1 g of water by 1^{o} C	It is the quantity of heat needed to raise the temperature of 1 g of water by $\frac{1}{4.18}$ ^{o} C

Specific heat:

The quantity of heat needed to raise the temperature of one gram of the substance 1^{0} C.

Unit: $J/g^{0}C$

- Each substance has definite specific heat .
- The substance that has high specific heat need large quantity of heat to rise its temperature and also takes a long time to lose this heat again.
  - Water has the highest specific heat.

❖ **Water causes a moderate climate in a coastal areas.(G.R)**

Because it has high specific heat.

Calculating the quantity of heat

The quantity of heat absorbed or released from the system calculated by this relation.

$q_p = m.c.\triangle T$

q_p The quantity of heat at constant pressure.(joule)

m The mass of substance(g)

c The specific heat($J/g.^{0}C$)

$\triangle T = T_2 - T_1$ (final temperature – initial temperature) (^{0}C)

Example: **Using the calorimeter, 0.28 g of propanol was burned. The temperature of water increased by 21.5 ^{0}C if you knew that the mass of water in the calorimeter is 100 g , calculate the released quantity of heat from the burning of this amount of fuel.**

Answer:

$q_p = m.c.\triangle T$

$= 100 \times 4.18 \times 21.5$

$=9030$ J

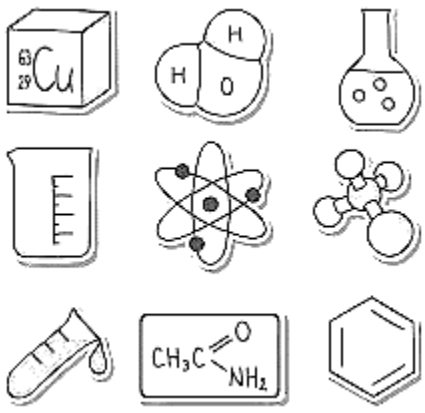
Example: **Dissolve one mole of ammonium nitrates in an amount of water. Complete the solution volume to 100 ml of water. You notice that the temperature decreases from 25^{0}C to 17^{0}C calculate the quantity of absorbed heat.**

Answer:

The mass of 100 ml water is 100 g

$q_p = m.c.\triangle T$

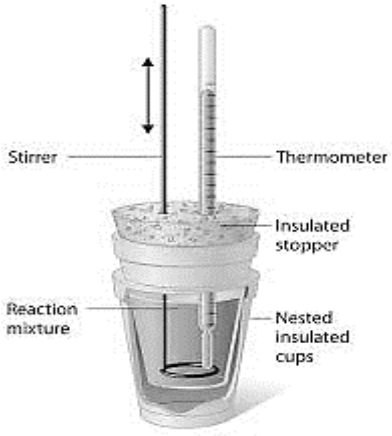
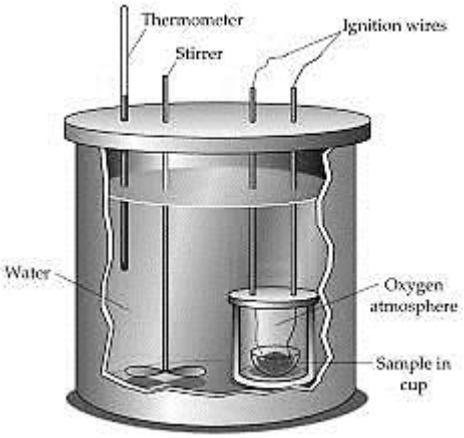
$q=100 \times 4.18 \times (17 - 25) = - 3344$ J



The calorimeter

It is an isolated system that allows us to measure the change in temperature of isolated system because it prevents lose or gain of heat or substance to the surroundings .

Types of calorimeter:

	Coffee – cup calorimeter	Bomb Calorimeter
Structure	-Isolated container -Stirrer -Thermometer -Reactants	-Isolated container -Stirrer -Thermometer -Reactants -Ignition wires
Use	Measure the change in temperature	Measure the heat of combustion
Shape		
Note	Water is used in both types of Calorimeter. Why? Because it has high specific heat	

Unit (4)
Chapter (1)
Part [1]

1)Write the scientific term:

1-Energy can be neither created nor destroyed. (……..……)

2-A part of the universe in which physical or chemical change occur.

(……..……)

3-A system does not exchange either energy or matter with its surrounding.

(……..……)

4-The total energy of an isolated system is constant (……..……)

5-The quantity of heat required to raise the temperature of 1 g of water by 1^0C.

(……..……)

6-The quantity of heat required to raise the temperature of 1 g of water by $1/4.18^0$C (……..……)

7-The quantity of heat required to raise the temperature of 1 g of substance by 1^0C.

(……..……)

8-An isolated system used to measure the heat of combustion of some compounds (……..……)

2) Choose the correct answer:

1-All the physical and chemical changes accompanied with a change in……..

a) color b) mass c) energy d) density

2- Calorie =……..joule

a) 2.18 b) 3.18 c) 4.18 d) 5.18

3-The temperature of a substance is doubled, its specific heat will be…….

a) decrease to half b)constant

c)increase to double d)increase to four times

4-Thermometer is considered as ……system

a)open b)closed d)isolated d)no correct answer

3)Give reasons for:

1-The medical thermometer is a closed system

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2-Water is used in calorimeter.

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4)Problems:

1-Calculate the quantity of heat required to raise the temperature of 50 cm^3 of water from 30^o C to 50^o C expressed in joule (C_s of water is 4.184 J/g.^{o}C).

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2-A piece of copper its mass is 400 g absorbed a quantity of heat equals 9360 J and its temperature raised from 20^{0}C TO 80^{0}C. What is the specific heat of copper?

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Unit four
Chapter (1): Heat content

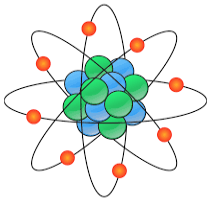
Part (2): Heat content

Heat content

*Each chemical substance has a different number and type of atoms and different type of bonds between its atoms so it has a specific amount of energy called internal energy.

- The internal energy of a chemical substance is the summation of energies stored in it.

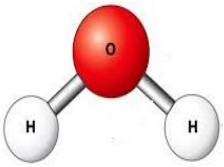
1) Stored chemical energy in the atom



Is represented in the energy of electrons in the energy level

Energy of electron = kinetic energy + potential energy.

2) Stored chemical energy in the molecule:

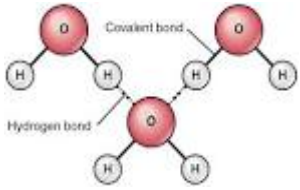


It is the energy of chemical bonds between its atoms ionic or covalent.

3) Intermolecular forces:

The attraction force between molecules is called **Van der Waals force**

4) Hydrogen bond :



If the compound is polar and has hydrogen in its structure.

- The summation of these energies are called **Heat content**

Heat content of a substance (molar enthalpy) H

The sum of the stored energy in one mole of a substance.

- **Heat content for the element = zero**

Heat content change (△H)

The difference between the sum of the heat content of the products and the sum of the heat content of the reacting substances.

Heat content = Heat content of products – Heat content of reactants

$$\triangle H = \sum H_{Products} - \sum H_{reactants}$$

Standard heat content $\triangle H^0$ $\quad \triangle H^0 = \frac{q}{n}$

Comparison of values of different reactions under standard conditions

-Pressure = 1 atm

-Temperature = 25^0C

-Solution concentration 1 M

***Thermo chemical equation:**

It is a symbolic chemical equation that includes the heat change accompanying the chemical reaction and this heat change is represented in the equation as one of the reactants or products.

Example: Calculate the change in heat content △ H resulted from the decomposition of 136 g of ammonia gas under constant pressure to give hydrogen and nitrogen gases.

$2NH_3 \longrightarrow N_2 + 3H_2$ $\quad \triangle H = 92.2$ kJ

Answer:

Molar mass of $NH_3 = 14 + (3x1) = 17$ g/mol

No. of moles of $NH_3 = \frac{136}{17} = 8$ mol

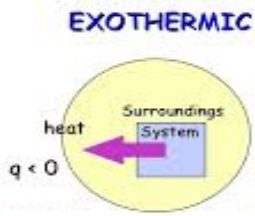
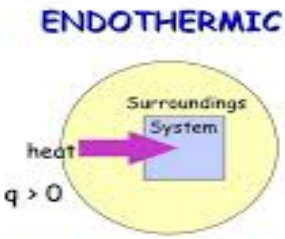
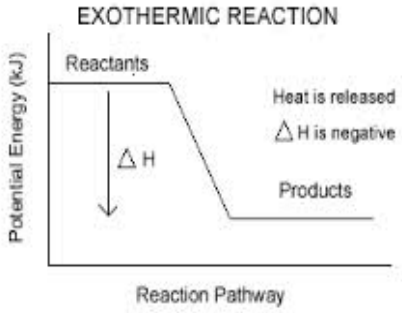
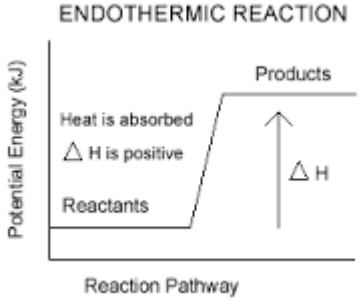
From the equation:

2mol of ammonia……92.2 KJ

8mol ……??

$\triangle H = 368.8$KJ

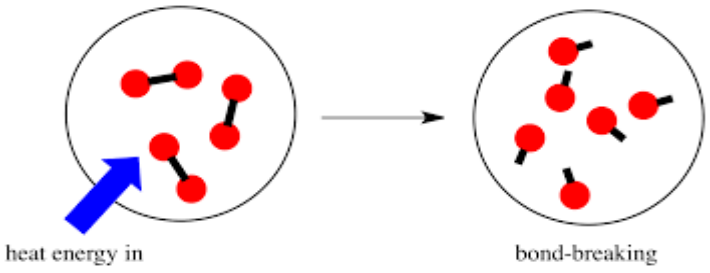
- **Types of chemical reactions:**

Exothermic reactions	Endothermic reactions
Release energy	Absorb energy
Heat transfer from the system to the surrounding 	Heat transfer from the surrounding to the system 
Heat content of product less than reactants	Heat content of reactant less than the product
△ H negative	△ H positive
$H_{prod} < H_{react}$	$H_{prod} > H_{react}$
	

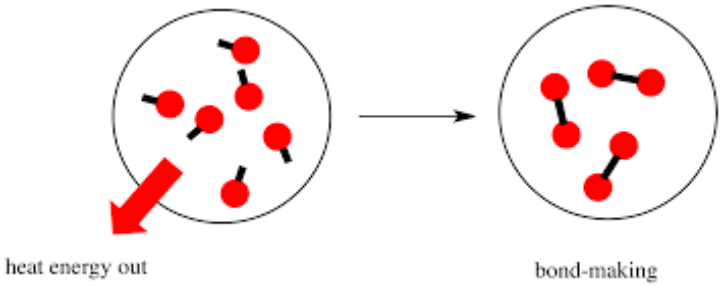
Bond energy:

It is the amount of energy absorbed to break the bonds or released during formation of bonds in one mole of the substance

- **Breaking bonds is endothermic reaction(absorb energy from the surrounding)**



- **Formation of bonds is exothermic reaction (energy of the surrounding increases)**



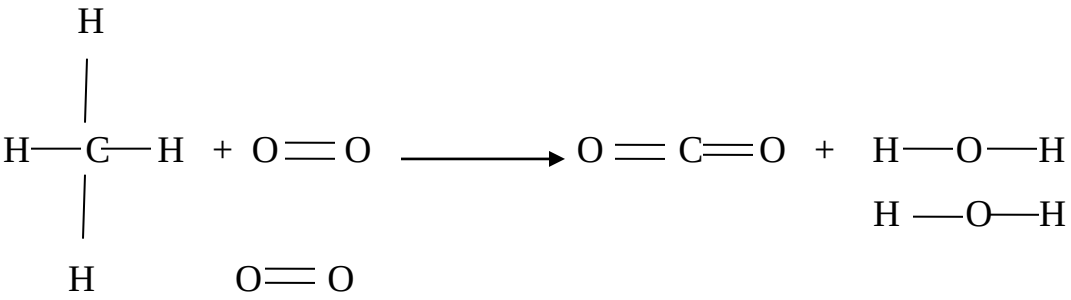
*Energy must be absorbed to break the bond or energy released when the bond is formed in one mole of the substances

Example:

Calculate the heat of the following reaction and determine if the reaction is exothermic or endothermic.

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$$

Knowing that the bond energy is estimated by the unit (KJ/mol) as follows (C═O)745, (O – H) 467, (C – H) 413 , (O═O)498



The energy required to break reactant bonds = [4 × (C – H)] + [2 × (O═O)]

=[4 × 413] + [2 × 498]=2648 KJ

The energy released from formation of bonds in the products = [2 × (C═O)] + [2 × 2(O—H)]

=[2 × 745] + [2×2×467]=3358KJ

△H = (PRODUCT + REACTION)

= (-3358) +2648 = -710 KJ

The reaction is exothermic because △H is negative

Unit (4)
Chapter (1)
Part [2]

1)Write the scientific term:

1-The sum of stored energy in one mole of a substance. (……..……..……)

2-The chemical reaction in which the heat transferred from the surrounding to the system. (……..……)

3-An energy must be absorbed to break the bond in one mole of the substance (…….)

2) Choose the correct answer:

1-The formation of bond is…….. process.

a) releasing energy b) exothermic c) endothermic d) a & b are correct

2-If the heat content of products is lower than that of reactants, thus the reaction……

a) endothermic b)exothermic

c)its △H value has a positive sign d)whose △H value = zero

3)Give reasons for:

1-△H value of exothermic reactions has a negative sign.

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2-The chemical reaction is accompanied with change in heat content

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4)Problems:

1-Calculate the change in heat content for the following reaction.

$CH_4 + 3\ Cl_2 \longrightarrow CHCl_3 + 3HCl$

Where the heat content of CH4= -74.85 KJ/mol , CH3Cl = -132 KJ/mol , HCl = -92.3 KJ/mol

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2-Calculate the molar enthalpy for water vapor from the following reaction

$CH_4 + H_2O \longrightarrow CH_3OH + H_2$ $\triangle H = -78$ KJ/mol

The molar enthalpy for CH_4 and CH_3OH are 75 KJ/mol, 293 KJ/mol respectively

Then calculate the absorbed heat when 64 g of CH_4 reacts with excess of water

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3-Draw the energy graph of the following reaction

$H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$ $\triangle H = -285.8$ KJ/mol

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4- Calculate the change in enthalpy in the following reaction

$C_2H_2 + \frac{5}{2} O_2 \longrightarrow 2CO_2 + H_2O$

Where the bond energy of

(C – H) =413 KJ/mol , (C≡C) = 835 KJ/mol

(O – H) = 467 KJ/mol , (C=O) =803 KJ/mol , (O=O) =498 KJ/mol

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Unit four

Chapter (2): Forms of changes in heat content

1- standard heat of solution $\triangle H^{o}_{sol}$

2- Standard heat of dilution $\triangle H^{o}_{dil}$

1- Standard heat of solution: $\triangle H^{o}_{sol}$

It is quantity of heat absorbed or released on dissolving one mole of solute in certain amount of solvent to obtain standard solution in standard conditions.

- Dissolving solute in solvent may cause

Inc. intemp& it will be exothermic solution

dec. in temp & it will be endothermic solution

- Calculate heat of solution $q=m.c_s.\triangle T$

m-------mass = Volume in mL

Bec. Density of water $1g/cm^3$

C_s-------Specific heat of water = 4.18 J/g.^oC

If volume = 1L **it is called molar heat of solution**

Molar heat of solution:

The heat changes on dissolving one mole of solute to form one liter of solution.

$$\text{Molar heat of solution} = \frac{\text{amount of heat}}{\text{numbers of moles}} \qquad \triangle H = \frac{q}{n}$$

Example: **By dissolving 1mol of sulphuric acid in an amount of water to produce a solution of 1000 ml volume, the temperature increases by 17^0C. Calculate the amount of released energy**

$q = m \cdot c_s \cdot \triangle T$

$= 1000 \times 4.18 \times 17 = 71060$ J

What is the source of heat of solution??

1- Separating solvent molecules from each other

$\triangle H_1$ need energy ⟶ endothermic process +ve value

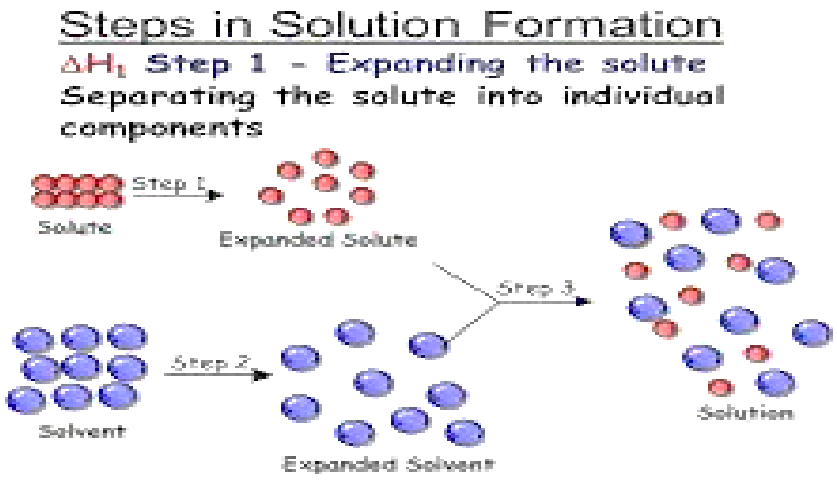
2- Separating solvent molecules from each other

$\triangle H_2$ need energy ⟶ endothermic process +ve value

3- Dissolving process (attaching solute and solvents molecules)

$\triangle H_3$ release energy ⟶ exothermic – ve value

$\triangle H^o_{sol} = \triangle H_1 + \triangle H_2 + \triangle H_3$



If

$(\triangle H_1 + \triangle H_2) < \triangle H_3$

$\triangle H^o_{sol}$ ⟶ -ve

exothermic

$(\triangle H_1 + \triangle H_2) > \triangle H_3$

$\triangle H^o_{sol}$ ⟶ +ve

endothermic

If the solvent is water, dissolving process is called hydration

Hydration:

attaching of dissociated ions with water.

2- Standard heat of dilution: $\triangle H^o_{dil}$

It is the quantity of heat released or absorbed for each one mole of solute when diluting the solution from high concentration to low concentration in standard state.

Dilution process occurs in two processes:

1- Separating process (separate solute from each other)

need energy ⟶ endothermic

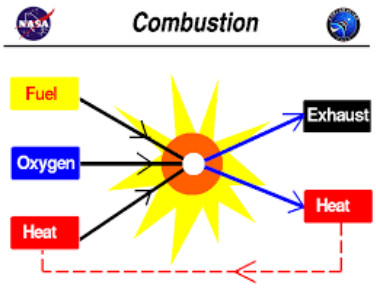
2- Attaching process (attaching solute to solvent)

Release energy ⟶ exothermic

Heat changes accompanying chemical changes

1- Standard heat of combustion

2- Standard heat of formation



***Combustion**:

Combination between the substance and oxygen.

***Heat of combustion**:△ Hc

Quantity of heat released when one mole of substance completely burned in excess amount of oxygen

Standard heat of combustion: $\triangle H^{o}_{C}$

Quantity of heat released when one mole of substance completely burned in excess amount of oxygen at standard conditions.

Examples:

Burning of fuel – burning of glucose inside body.

Notes:

- All combustion reaction release energy ⟶ exothermic

(△H is always negative value)

- Any combustion produces CO_2 & H_2O

2- Heat of formation: $\triangle H_f$:

Quantity of heat absorbed or released during formation of one mole of compound from its elements.

- Standard heat of formation: $\triangle H^o_f$:

Quantity of heat released or absorbed during formation of one mole of compound from its elements in standard conditions.

Heat formation of element = zero

$\triangle$H = sum of heat formation of products – Sum of heat formation of reactants

Example: Calculate the change in the heat content of the following reaction:

$CH_4 + 2\ O_2 \longrightarrow CO_2 + 2H_2O$

By knowing that $\triangle H^o_f$ of CH_4 , CO_2 and H_2O is

(-74.6 , - 393.5 , -241.8 KJ /mol) in order

$\triangle H = \triangle H_P - \triangle H_R$

$= [(-393.5 + (2 \times -241.8)] - [(-74.6) + (0)]$

$= -802.5$ KJ/mol

* Relation between heat of formation and stability of the compound.

Stable compound	Unstable compound
-Heat content of product smaller than reactant -exothermic compounds H has -ve value	-Heat content of product larger than reactant -endothermic compounds H has +ve value

Hess's law:

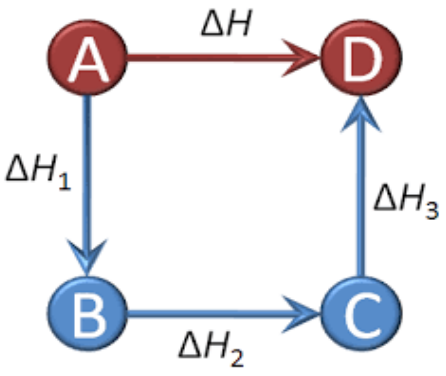
Heat of reaction is constant amount in standard conditions, whether the reaction is carried out in one step or a number of steps.

It is used to calculate heat of reactions such as

1-very slow reactions as rust

2-Dangerous reactions

3-Some reactions that their heat changes is difficult to measure.



Unit four
Chapter (2)

1-Write the scientific term:

1-Combination of the dissolved ion with water. (……..……)

2-The change in heat content resulting from dissolving 1 mol of solute in one liter of solution. (……..……)

3-The quantity of released or absorbed heat for each one mole when diluting the solution from a high concentration to another lower concentration in standard condition. (……..……)

4-Combination between the substance and oxygen accompanying with releasing an amount of energy as light or heat. (……..……)

5-The heat change accompanying the formation of the compound from its constituent elements. (……..……)

2)Choose the correct answer:

1- Dilution process is accompanied with……

a) releasing heat b) absorbing heat

c) releasing or absorbing heat d) no heat change

2-The stability of compound……by increasing its heat content.

a) increase b) decrease c)doesn't change d)is constant

3-Most reactions move in the direction of the formation of……..compounds.

a) endothermic b)less stable c)more stable d)higher heat content

3)Give reason:

1-Dissolving sodium hydroxide in water is accompanied with rising in solution temperature.

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2-Ion separating energy for a solute has a positive sign.

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3-There is a relation between the stability of compounds and heat of formation.

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4)Problems:

1-Calculate $\triangle H$ for the following reaction

$S + O_2 \longrightarrow SO_2$ By using the following thermo chemical equation

(1) $2SO_2 + O_2 \longrightarrow 2SO_3$ $\triangle H_1 = -196$ KJ/mol

(2) $2S + 3O_2 \longrightarrow 2SO_3$ $\triangle H_2 = -790$ KJ/mol

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2-Calculate the heat of combustion of nitric oxide gas NO, according to the following equation

$NO + \frac{1}{2} O_2 \longrightarrow NO_2$ By using the following thermo chemical equation

(3) $\frac{1}{2}N_2 + \frac{1}{2} O_2 \longrightarrow NO$ $\triangle H_1 = +90.29$ KJ/mol

(4) $\frac{1}{2}N_2 + O_2 \longrightarrow NO_2$ $\triangle H_2 = +33.2$ KJ/mol

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3-If the heat of formation of methane is -74.6 kJ/mol, that of carbon is -393.5 KJ/mol and that of water is -24.8 KJ/mol, calculate the change in the heat content of the reaction shown in the following equation

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

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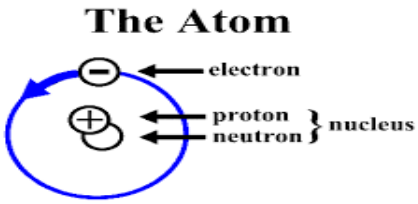
Unit five
Nuclear chemistry

Atom components:

Atom contain three particles.



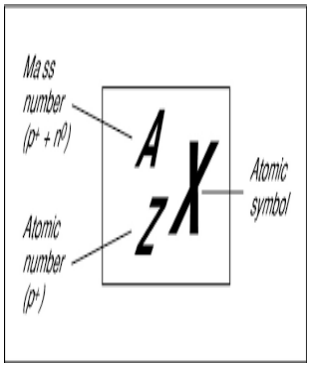
Proton	Neutrons	Electrons
-Positive charged -in the nucleus -has large mass = 1800 times mass of election	-Neutral charged -in the nucleus -it is mass nearly equal proton mass	-Negative change -around nucleus in energy levels -neglected mass

-Atom is neutral charged. Why ?

Bec. No. of negative electrons equal no. of + ve protons

-Mass of atom concentrated in nucleus .Why ?

Bec. It contain protons & neutrons while mass of electrons is negligible



Atomic number: number of proton or electrons.

Mass number: number of protons and neutrons.

No of neutrons = mass number – atomic number

Isotopes:

Atoms of some elements have same atomic number and different in mass number due to difference in number of neutrons.

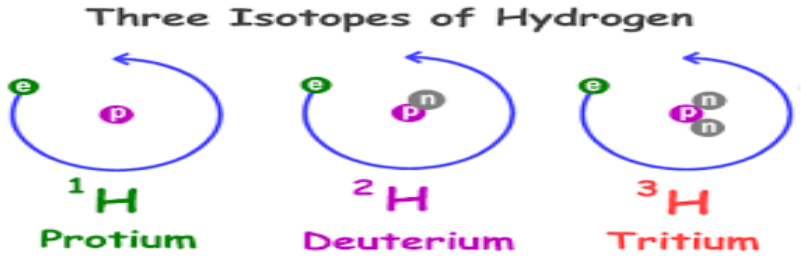
Isotopes have same chemical properties. Why ?

Bec. They have the same number of electrons.

Example :

isotopes of hydrogen.

P.O.C	Protium	Deutrium	Tritium
Symbol	$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
Atomic no.	1	1	1
Mass no.	1	2	3
Neutron	1 – 1 = 0	2 – 1 = 1	3 – 1 = 2



Mass of isotopes:

Measured in atomic mass unit

a.m.u or u

$u = 1.66 \times 10^{-27}$ Kg

Relation between mass and energy

$E = m.C^2$

E = energy (joule)

m= mass (Kg)

C ----- Speed of light=(3×10^8 m/s)

Units of energy:

Joule (J)

Electronvolt(ev)

Million electron volt (Mev)

$1ev = 1.602 \text{ X } 10^{-19}J$

$1Mev = 10^6 ev$

$1Mev = 1.602 \text{ X } 10^{-13}J$

Atomic models:

Ruther ford atomic model	Bohr atomic model
- Heavy nucleus in center with positive charge. - Electrons revolve around nucleus	- Negative charged electrons rotate around nucleus in fixed orbits called energy levels

Protons & neutrons called nucleons

Forces in nature :

Four main kinds

Strong nuclear force > Electromagnetic force > Weak nucleate force > Gravitation force.

Nuclear force :

Force that bind nucleons with each other.

Prop. Of nuclear force:

1- Great force

2- Short range force

3- Doesn't depend on type of nucleons

may be between (proton – proton) , (proton – neutron) (neutron – neutron)

****

Source of nuclear binding energy

Actual mass of nucleons is smaller than theoretical mass ?

Bec. Diff. in energy is converted into binding energy.

B.E = mass defect($\triangle$m) × 931

$\triangle$m = theoretical Mass – actual mass

B.E = [($Zm_p + Nm_n$) - M_x] × 931

Z------atomic no. m_p -------mass of proton

N------no of neutron ` m_n---------mass of neutron

B.E per nucleon = $\frac{B.E}{A}$

A --------mass number

Calculate the binding energy in the nucleus of helium atom $_2{}^4He$

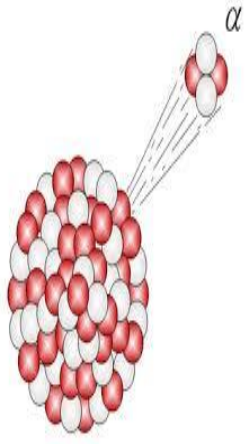
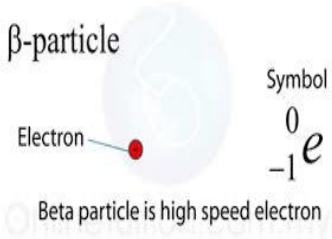
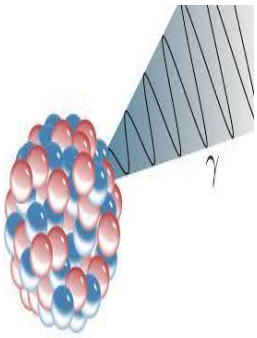
Actual mass = 4.00150 u , mass of proton = 1.00728 u and the mass of neutron =1.00866u

B.E = [($Zm_p + Nm_n$) - M_x] × 931

= [(2 × 1.00728) + (2 × 1.00866) – 4.00150] × 931 = 28.28378 MeV

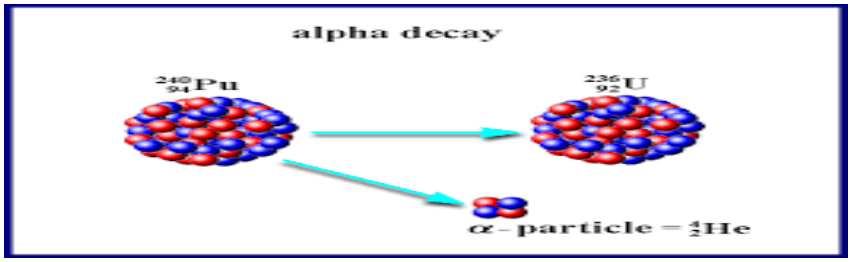
Unit five
Chapter Two
Radio activity

Radio active elements may emit α – β -

	Alpha	βeta	Gamma
Symbol	α	β	
Nature of radiation	^4_2He Helium nucleus 2 proton & 2 neutron	$^o_{-1}e$ electron	Electromagnetic waves
Mass	Four time proton mass	$\frac{1}{1800}$ of proton mass	No mass as it is wave
Ability to ionize medium	strong	Less than alpha	Least power
Ability to permeate	Weak cannot pass through thin paper	Average 5mm aluminum slice prevent passing.	High pass through lead slice with thickness few centimeters.
Deviation in magnetic or electric filed	Small deviation	Large deviation	Doesn't deviate
			

- **Emitting α:** decrease atomic no. by 2 & mass no. by 4

$_{92}{}^{238}U \longrightarrow {}_{90}{}^{234}Th + {}_{2}{}^{4}He$



- **Emitting β:** increase atomic no. by 1

$_{6}{}^{12}C \longrightarrow {}_{7}{}^{14}N + {}_{-1}{}^{0}e$

-Emitting gamma ray: cause no change in atomic or mass number because it is a wave.

Half life time ($t_{\frac{1}{2}}$)

It is the time required to disintegrate half the original number of atom nuclei of a Radio active element.

Example: **Calculate the half life time of a radioactive element , knowing that a sample of 12 g of it converted to 1.5 g after passing 45 days**

12g $\xrightarrow{(t_{\frac{1}{2}})_1}$ 6 g $\xrightarrow{(t_{\frac{1}{2}})_2}$ 3 g $\xrightarrow{t(_{\frac{1}{2}})_3}$ 1.5 g

Number of periods (D) =3

$t_{\frac{1}{2}}$= t/D = 45 / 3 = 15 days

***The difference between chemical reactions and nuclear reactions:**

Chemical reactions	Nuclear reactions
Occur between the electrons of outermost level of the atom	Occurs between the nuclei of the atoms
There is no transformation of an element to another	Almost there is transformation of an element to another or its isotope
The products are the same if we used different isotopes of the same element	Isotopes of the same element give different products
Produce small amount of energy	Produce large amount of energy

Unit five

1)Write the scientific term:

1-Particles with a very small mass and have a negative charge

(……..……)

2-The number of protons inside the nucleus. (……..……)

3-Sum of the number of neutrons and protons inside the atom nucleus.

(……..……)

4-Particles which emitted from the nucleus of a radioactive element leads to forming a new element with an atomic number increase by one.

(……..……)

5-Electromagnetic waves when emitted from the nucleus of a radioactive element don't cause a change in its atomic and mass number. (……..……)

6-The time required to decrease the number of nuclei of the radioactive element to its half number. (……..……)

2) Choose the correct answer:

1-The mass of atom is concentrated in the……

a) nucleus b) protons c) neutrons d) electrons

2-The scientist…….discovered that atom's nucleus contains protons

a) Bohr b) Einstein c) Nevil sidgwik d) Rutherford

3-Mass of proton is larger than the mass of electron by…….times

a) 4×10^{-15} b) 931 c)1800 d) 3×10^{8}

3) Give reasons for:

1-The atom is electrically neutral

……

……

2-The mass of the atom is concentrated in the nucleus.

……

……..

4)Problems:

1- Calculate the binding energy of deuterium in MeV. Actual mass of deuterium $_1^2H$=2.014102 u , mass of proton = 1.00728 u and mass of neutron = 1.00866 u

……

……

……

……..

2-Calculate the half life of 32 g of a radioactive element, if the mass remained after 100 days is 1 g.

……

……

……

……..

3-12 g of a radioactive element stored in a safe place and remained mass after 50 days is 0.75 g calculate the half life time.

……

……

……

……

Unit Four Thermochemistry

Lesson (1) Heat content

Definitions

Thermochemistry: *One of the branches of thermodynamics which studies thermal changes associated with chemical and physical transformations.*

System: *A part of the universe in which chemical or physical changes occur* ***or*** *the certain part of matter which we study.*

Surrounding: *The region surrounding the system which exchanges energy with it in the form of heat or work.*

Conservation law of energy: *Energy can be neither created nor destroyed, but can change from one form to another.*

First law of thermodynamics: *The total energy of any isolated systems remains constant, even if the form of the system changed.*

Temperature: *The measurement of the average kinetic energy of the molecules of substance, which determines if it is hot or cold.*

Heat: *Form of energy which is transferred between two objects of different temperatures.*

Specific heat: *The amount of heat required to raise the temperature of 1g of matter 1◦C.*

Calorie (cal): *The amount of heat required to raise the temperature of 1g of water 1◦C*

Joule (J): *The amount of heat required the raise the temperature of 1g of water 1/4.184 ◦C*

Heat capacity: *The amount of heat required to raise the temperature of an object 1◦C*

Heat content (molar enthalpy): *The sum of energies stored in one mole of matter.*

Change in heat content (ΔH): *The difference between the total heat content of products and that of reactants in a chemical reaction.*

Bond energy: *The energy required to break the bonds between molecules in one mole of matter.*

Thermochemical equation: *A balanced chemical equation which includes the thermal (enthalpy) change associated with the reaction (as one of the reaction products or reactants)*

.

Give reasons

1- Thermometer is an example of closed system

Because it allows the transfer of energy between the surrounding and system, which gives it the ability to measure temperatures. But it doesn't allow the transfer of mass.

2- Water in an open sea is an example of open system

Because it allows the transfer of both energy and mass (water vapour) between the system (the sea) and the surrounding (anything around the sea).

3- Water plays an important role in climate on the surface of the earth.

Because the high specific heat of water enables it to absorb great amounts of energy and lose them in much time, which makes the climate of earth suitable for life in winter and summer, in the morning and at night.

4- Dissolution of potassium iodide in water is an exothermic reaction.

Because the change of heat content ΔH° has a negative sign, as the heat content of the reactants is greater than that of products. Thus, the difference of energy is released with the reactants.

Questions

1- Choose the correct answer:

1- The measuring unit of specific heat is ……

A- Joule B- J/mol C- J/g D- J / g$^\circ$C

2- Which one of the following substances has the greatest specific heat?

A- 1g of water B- 1g of iron C- 1g of aluminum D- 1g of mercury

3- In exothermic reactions …

A- Heat transfers from the surrounding to system

B- Heat transfers from the system to the surrounding

C- Heat doesn't transfer between the system and surrounding

D- Heat transfers between the system and surrounding at the same time.

4- In isolated system…

A- Heat and mass are exchanged between the systems and surrounding

B- Heat is exchanged between the systems and surrounding.

C- Mass is exchanged between the systems and surrounding

D- Neither mass nor heat are exchanged between the systems and surrounding

5- The standard conditions for reaction are ….

A- Pressure 1 atm and temperature 0°C

B- Pressure 1 atm and temperature 25◦C

C- Pressure 1 atm and temperature 50◦C

D- Pressure 1 atm and temperature 100◦C

2- What is the meaning of:

1- Specific heat of water = 4.18 J/g◦C

3- Write the scientific term:

1- The amount of heat required to increase the temperature of an object one degree Celsius.

2- Chemical equation which includes thermal changes associated with the reaction.

4- Correct the underlined words:

1- Specific heat is constant in all substances.

2- C= q / v x ΔT

3- Heat capacity depends on the volume of object...

4- Heat capacity is the sum of the energies stored in one mole of matter.

***5**- Find the final temperature of 4.5g of gold particles which absorbed 276 Joules of energy when they were heated, the initial temp. Was 25◦C and specific heat of gold equals 0.13 J/g?*

***6**- An unknown substance of mass 155g absorbed 5700J of energy, which increases its temp. Form 25◦C to 40◦C. Calculate its specific heat*

***7**- Calculate the amount of heat released from cooling down 350g of mercury from 77◦C to 12◦C. The specific heat of mercury = 0.14 J/g◦C*

Lesson (2) Forms of change in heat content.

Definitions

Standard heat of solution (ΔH_s°): *The amount of heat released or absorbed when dissolving one mole of solute in a certain quantity of solvent to get a saturated solution in standard conditions.*

Molar heat of solution: *Thermal change resulted from the dissolution of one mole of solute in solvent forming one liter of solution.*

Standard heat of dilution ΔH_{dil}° : *The amount of heat absorbed or released per every mole of solute when decreasing the concentration of solution (in case it is in its standard conditions.*

Standard heat of combustion ΔH_c°: *The amount of energy released from the complete combustion of one mole of matter in standard conditions.*

Standard heat of formation ΔH_F° : *The amount of heat absorbed of released when forming one mole from its elements, its elements should be in standard condition.*

Hess's law: *Heat of reaction has a constant value which doesn't change in standard conditions, even if the reaction took place in one or more steps.*

Give reasons for

1- Exothermic reactions form thermally stable products

Because exothermic reactions give off energy, which increases the stability of products, as compounds with less heat content are more stable.

2- Solution process is associated with thermal change.

Because dissolution process causes the separation of solvent molecules (which absorbs energy -endothermic-), the separation of solute molecules (which also absorbs energy – endothermic-) and dissolution process (which gives off energy – exothermic) which is the linkage of solute ions to solvent.

3- Dilution process is accompanied with release of energy

Because when we dissolve a quantity of solute in solvent, this makes the ions of solvent pull away from each other, which absorbs energy. When we increase the no. of solute molecules, ions bind to more molecules which gives off energy. These two processes cause change in heat content and release of energy.

4- Heats of formation of compounds play an important role in their stability

Because compounds with low heat of formation (low heat content) are more stable and don't tend to decompose, whereas compounds with high heat of formation (high heat content) are less stable and tends to decompose to achieve stability.

5- Scientists use indirect methods to measure the heat of reaction

Because:-

- Products and reactants may be mixed with other substances

- Some reactions take long time to occur (Ex. Rusting of iron)

- It may be dangerous to measure the heat of reaction practically

- It is hard to measure the heat of some reactions in standard conditions for heat and pressure.

6- Burning glucose inside living organisms is one of the most important combustion reactions.

Because living organisms burn glucose in oxygen gas, which forms carbon dioxide and water, and gives off energy which is important to carry out vital processes.

$$C_6H_{12}O_{6\,(s)} + 6O_{2\,(g)} \rightarrow 6CO_{2\,(g)} + 6H_2O \qquad \Delta H_c^\circ = -2808\ kJ/mol$$

7- Hess's law is a form of the first law of thermodynamics

Because Hess's law states that reaction has constant heat which doesn't change in standard conditions, and the first law of thermodynamics also states that the total energy of isolated systems remains constant, even if the form of the system changed.

8- Hess's law is used to measure the heat of formation of carbon monoxide.

To know the heat of formation of carbon monoxide indirectly using reactions with known heat of formation.

Questions

1- Write the scientific term:

1- The amount of heat released or absorbed when dissolving one mole of solute in a certain quantity of solvent to get a saturated solution in standard conditions.

2- The linkage of disassociated ions with water molecules.

3- The amount of heat absorbed or released per every mole of solute when decreasing the concentration of solution (in case it is in its standard conditions.

4- The amount of heat absorbed of released when forming one mole from its elements.

5- Heat of reaction has a constant value which doesn't change in standard conditions, even if the reaction took place in one or more steps.

Question (2)

Hydrogen gas is used as a fuel for space rockets because when it burns in oxygen, it releases a huge quantity of energy, its combustion reaction is:-

$$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(g)} \qquad \Delta H = -484\ kJ/mol$$

Find the amount of energy released from burning 1g of hydrogen gas.

Question (3)

Calculate the standard change in heat content of the following reaction:-

$$H_2S_{\,(g)} + 4F_{2\,(g)} \rightarrow 2HF_{\,(g)} + SF_{6\,(g)}$$

H_2S = - 21 kJ/mol, HF = -273 kJ/mol, SF_6 = -1220 kJ/mol

Question (4)

When dissolving one mole of ammonium nitrate in water, and we completed the solution to 1000ml, the solution temperature decreased by 6◦C. Calculate the amount of absorbed energy.

*(**N.B:** The specific heat of solution = 4.18 J/g◦C , the density of solution = 1g/ml)*

Question (5)

The change in heat content of octane (C_8H_{18}) = -1367 kJ / mol. Write the chemical equation which describes the combustion of one mole of octane in oxygen completely.

(N.B: the products of the reaction are water and carbon dioxide gas)

(C=12, O=16, H=1)

Unit Five Nuclear Chemistry

Lesson (1) Atomic nucleus and elementary particles

Definitions

Isotopes: *Atoms of the same element which have the same atomic number (z), but different no. of neutrons (N)*

Nuclear forces: *They are forces which hold the nucleons of nucleus together.*

Elementary particles: *A group of particles which form matter, they are not affected by strong nuclear forces.*

Quark: *It is a primary particles that cannot be existed freely and all nucleons are formed from it.*

Give reasons

1- The actual mass of an atom is less that the sum of masses of its components.

Because that loss in mass (mass defect) is transformed into nuclear binding energy (which holds the nucleons of nucleus together) according to Einstein's law of the equivalence of mass and energy.

Questions

1- Choose the correct answer

1- Atomic unit (u) is …….

A- Mass of hydrogen atom B- Mass of proton C- Mass of neutron

D- Mass of 1/12 of carbon-12 atom.

2- If nuclear binding energy of $^{4}_{2}He$ *equals 28 MeV, the nuclear binding force per nucleon equals…….*

A- 7 B- 14 C- 56 D- 114

3- The difference between the sum of masses of nucleons forming iron nucleus and the actual mass of nucleus equals 0.5u, the nuclear binding energy equals

A- 0.5 MeV B- 0.5 Joule C- 0.8×10^{-19} *MeV D- 465.5 MeV*

4- Each of the following is one of the energy unit, except--------.

A- eV B- u. C- J . D-MeV

5-The Value of Q for a (u) quark is equal to ------

A- 0 B- + 1/3 C- +2/3 D- -1

6- Nucleon is a name which describes ….

A- Neutrons and protons

B- Neutrons and electrons

C- Protons and electrons

D- Electrons and mesons

7- One of the following properties doesn't belong to isotopes.

A- They have similar chemical properties

B- They have similar atomic numbers

C- They have the same no. of neutrons

D- They have the same no. of protons

8- Strangeness number (S) of quark (d) equals

A- 0 B- - 1/3 C- + 2/3 D- 1

Problem:

Calculate the nuclear binding energy per nucleon in the nucleus of $_2^4$He atom , the actual mass = 4.00150u, mass of proton = 1.00728 u and mass of neutron = 1.00866 u.

Lesson (2) Radioactivity and nuclear reactions

Definitions

Half-life: *The time in which the no. of nuclei of a radioactive element decreases to half the real number by radioactive decay.*

Nuclear reaction: *Changing the structure of reactant nuclei and forming new nuclei when reactant nuclei collide with each other.*

Conservation law of charge: *The sum of atomic numbers on the right side of nuclear equation should equal the sum of atomic numbers on its left side.*

Nuclear fission: *A nuclear reaction in which a nucleus splits into two smaller nuclei.*

Nuclear fusion: *A nuclear reaction in which two light nuclei join to form a heavier nucleus.*

Give reasons

1- Some radioactive nuclei emit alpha particles

To achieve stability, as their atomic numbers are very great.

2- Some radioactive nuclei emit beta particles

To achieve stability by turning a proton into neutron, as the ratio between the no. of protons (Z) and no. of neutrons (N) is less than the ratio required for stability.

3- Some particles emit gamma rays

In order to get rid of excess energy to achieve stability

4- Neither mass number nor atomic number changes when a nucleus emits gamma rays

Because gamma rays are electromagnetic waves that carry no charges, a nucleus emits them in order to get rid of excess energy to achieve stability

5- Nuclear fusion reactions cannot be conducted at laboratories

Because they require very high temperature that may reach 10 million degree Celsius.

6- Nuclear chain reactions should be controlled

In order to produce energy and prevent the occurrence of explosions

7- Neutrons are used as nuclear projectiles in nuclear fission reactions

Because they are perfect projectiles, as they can enter nuclei without being repulsed because they are neutral.

8- Control rods are used to control the rate of nuclear fission reactions

Because they control the no. of neutrons produced from nuclear fission by absorbing them.

9- Radiation plays an important role in the treatment of caner

Because:-

1- Gamma rays emitted from cobalt-60 and cesium-17 isotopes are used to kill cancerous cells by targeting them to the centre of tumor

2- Radioactive radium-226 needles are implanted into cancerous tumors to kill their cells.

10- Radiation plays an important role in agriculture field

Because:-

1- Seeds are exposed to different dosages of gamma rays to help in:-

- *The occurrence of mutations in them*
- *choosing suitable seeds which give out more producing and more resistant plants.*

2- Gamma rays are used to sterilize plant and animal products which:-

- *Protects them from damage*
- *Extends their storage periods*

3- Gamma rays are used to make male insects infertile to prevent the spread of pests.

11- Gamma rays are used in the sterilization of male insects

To prevent the spread of pests.

12- Gamma rays are used to sterilize plants products

In order to extend their storage periods and protect them from damage

13- Seeds are exposed to dosages of gamma rays

to help in:-

- *The occurrence of mutations in them*

- *choosing suitable seeds which give out more producing and more resistant plant.*

14- Radiation helps in scientific researches

Because:-

1- Research reactors are used to prepare radioactive isotopes which are being used in scientific researches.

2- We can know what happens inside plants by putting radioactive substances in substances used by plants, and tracking the radiations emitted from radioactive substances, which helps us know more about plant cycles

15- Ionizing radiation destroys living cells

Because it ionizes water molecules in cell which causes it damage, the occurrence of genetic changes and breaking up of chromosomes. Which causes in long-term

- The death of cell

- Delay or prevention of cell division or the increase of cell division rate which causes cancerous tumors.

- The occurrence of permanent changes in cell (mutations) which are inherited to the offspring

16- People who live near mobile towers suffer from loss in memory, headache and sickness

Because radiations emitted from mobile towers cause physiological changes to nervous system

17- Frequent use of mobile phones is bad for health

Because radio waves emitted from them increase the temperature of cells.

18- Men shouldn't put laptops on their knees

Because it affects their fertile.

Questions

1- Choose the correct answer:

1- Which one of the following properties belongs to gamma rays?

A- They have positive charge *B- They have negative charge*

C- They are composed of electrons *D- They are electromagnetic waves*

2- When $^{B}_{A}X$ *nucleus emits an alpha particle, which equation describes the reaction?*

A- $^{B}_{A}X \rightarrow {}^{B-4}_{A-2}X + {}^{4}_{2}He$ *B-* $^{B}_{A}X \rightarrow {}^{B+4}_{A+2}X + {}^{4}_{2}He$

C- $^{B}_{A}X \rightarrow {}^{A-2}_{B-4}X + {}^{4}_{2}He$ *D-* $^{B}_{A}X \rightarrow {}^{A+2}_{B-4}X + {}^{4}_{2}He$

3- In the equation $^{4}_{2}He + {}^{9}_{4}Be \rightarrow {}^{12}_{6}C + X$ *, X stands for*

A- Electron *B- Proton* *C- Neutron D- Gamma ray*

4- When thorium $^{228}_{90}Th$ *decays to polonium* $^{216}_{84}Po$ *and ……. Alpha particles.*

A- 2 *B-3* *C-4* *D-5*

5- When nucleus (X) emitted 5 alpha particles successively, it turned into nucleus of element $^{206}_{80}X$ *. The nucleus of (X) is …….*

A- $^{216}_{82}X$ B- $^{216}_{90}X$ C- $^{226}_{94}X$ D- $^{226}_{90}X$

6- A sample of radioactive element has $4.8x10_{12}$ atoms, if its half-life equals two years, the no. of atoms after 8 years equals…….

A- $3x10_{11}$ atoms B- $4.2x10_{12}$ atoms C- $4.5x10_{12}$ atoms D- $3.8x10_{11}$ atoms

7- When nucleus $^{B}_{A}X$ emits an alpha particle then beta particle, it turns into nucleus ……

A- $^{B-4}_{Z-1}X$ B- $^{B-4}_{Z}X$ C- $^{B-1}_{A-4}X$ D- $^{B-1}_{A}X$

8- Which one of the following properties doesn't belong to alpha radiation?

A- Composed of helium nuclei

B- Most able to ionize air

C- Most able to penetrate air

D- Affected by electromagnetic field

9- After 12 minutes, 75% of nuclei of a radioactive element decayed, half-life of this element equals ….

A- 3 min. B- 4 min. C- 6 min. D- 9 min.

Question (2)

Compare between alpha and beta radiation in terms of:-

- Charge - Ability to penetrate air - Ability to ionize air.

Question (3)

Radium nucleus $^{220}_{88}Ra$ *decays giving an alpha particle. Write a balanced nuclear equation for this reaction*

t

Explain the stages of radiation damage to cells

Question (5)

Mention the harms of radiations emitted from mobile phones and laptops

Question (6)

Mention the difference between:-

- Chemical and nuclear reactions

- Nuclear fusion and nuclear fission

- Ionizing and non-ionizing radiation.