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SECOND TERM E-LEARNING NOTE

SUBJECT: CHEMISTRY **CLASS: SSS 3**

SCHEME OF WORK

WEEK	**TOPIC**
1.	Revision/Nuclear Chemistry, Types and Nature of Radiations, Half-life as a Measure of the Stability of the nucleus.
2.	Nuclear Reactions i.e Nuclear Fussion and Nuclear Fission with examples, Effect and applications of Radioactivity Comparison of Nuclear Reaction and Ordinary chemical reaction.
3.	Simple molecules and their shapes, covalent molecules e.g methane, ammonia, crystalline solids – their network structure e.g diamond.
4.	Metallic bonding – properties, factors affecting the formation of metals, intermolecular bonding Van-der-waals forces and hydrogen bonds, comparison of all bond styles.
5-6.	Metals and their compound, extraction of metals (e.g aluminium, copper, tin and iron) their properties and their reaction, their uses, alloys, composition and uses.
7.	Introduction to qualitative analysis, test for cation using H_2S, NaOH and HN_4OH, confirmatory test for the cations
8.	Test for amono, identification or gases. E.g CO_2,SO_2 and O_2. Characteristics test for anions e,g SO_4^{2-}, SO_3^{2-}, CO_3^{2}-, NO_3.
9-10.	Volumetric Analysis, calculation based on percentage purity and impurity of substances, percentage amount of the acid, or base, solubility of substances, volume of gases, mole ration of acid to base.
11.	Revision
12-13	Examinations

REFERENCE BOOK

- New School Chemistry for Senior Secondary Schools by Osei Yaw Ababio.
- Practical Chemistry for Senior Secondary Schools by Godwin Ojokuku
- Outline Chemistry for Schools & Colleges by Ojiodu C. C.
- Chemistry Pass Questions for S.S.C.E and UTME.

WEEK ONE

TOPIC: Nuclear Chemistry

CONTENT

- Types and Nature of Radiation
- Half-life as a measure of the stability of the nucleus.

Nuclear Chemistry is an aspect of chemistry that deal with nuclei of atoms.

Radioactivity

This is the spontaneous emission of radiation by radioactive element such as Thorium, Uranium etc.

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Characteristics

1. Spontaneously and continually emitting of radiation by radioactive element
2. Temperature and pressure have no effect on radioactivity
3. The radiation can pass through opaque objects
4. It affects photographic plates
5. It causes ionization of gases through which it passes.
6. It causes fluorescence of certain substance
7. It releases large amount of energy.

Types of Radiation

There are three (3) types of radiation

1. Alpha
2. Beta
3. Gamma

Characteristics of Alpha-Rays

1. they are helium in nature $^{4}_{2}He$ with 4 atomic mass and 2 atomic number
2. alpha rays are fast moving streams of positively charges
3. they are deflected toward the negative plate in an electrostatic field
4. they have very low penetrating power
5. they can be absorbed/stopped by a thin sheet of paper on aluminium foil
6. they cause fluorescence of some materials e.g zinc sulphide

Characteristics of Beta-rays

1. they are electron in nature with a mass number of zero and charge of -1 (^{o}e)
2. they are fast moving stream of electrons
3. they can penetrate than alpha rays

Effects of Electrostatic Field on the Three Radiation

EVALUATION

1. State two (2) properties of á, β, and Y rays each.
2. What do you know about radioactivity.

Detection of Radiation

The radiation can be detected by using the following devices.

a. Geiger Miller Counts
b. Scintillation counter
c. Diffusion cloud chamber

HALF LIFE

The half-life of a radioactive element is the time taken for half of the actual number of atoms in a given substance or radioactive element to decay.

NUCLEAR STABILITY

The spontaneous disintegration/decay of nucleus of an element is due to its instability.
The neutron-proton ration determines the stability of an element.

This varies between unity for the lighter elements and a value of about 1.5 for the heavier element with atomic numbers around eighty.

N.B. Atoms with a neutron – protons less than 1 or greater than 1.5 tends to be unstable.

EVALUATION

1. State two methods through which a radiation can be detected.
2. What is half life as a measure of the stability of the nucleus

GENERAL EVALUATION

1. Define the term nuclear chemistry
2. Define the term radioactivity.
3. Explain the term radioisotopes
4. Give an account of the uses of radioisotopes.

READING ASSIGNMENT

New School Chemistry by O.Y, Ababio pages 299-304.

WEEKEND ASSIGNMENT

1. ____ is an example of radiation (a) Aloha (b) Carbon (c) Uranium (d) Nucleus.
2. Alpha particle was deflected towards negative plate while Beta deflected toward (a) Neutral plate (b) Negative plate (c) Zero plate (d) positive plate
3. The following caused fluorescence of matter except (a) Alpha (b) Beta (c) Gamma (d) X- ray

4. In the above diagram, Z represents (a) Alpha (b) Beta (c) Gamma (d) Radioactive
5. B represents ____ in the diagram above (a) Alpha (b) Beta (c) Gamma (d) Radioactive source

THEORY

1. Find the half-life of a radio isotope element which was found to be 120g initially and later changed to 15g in 24 hours
2. State the three main type of radiation with their properties each.

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WEEK TWO

TOPIC: NUCLEAR REACTIONS

CONTENT

- Nuclear Fusion and Nuclear Fission with Example
- Effects and Application of Radioactivity
- Comparison of Nuclear Reaction and Ordinary Chemical Reactions

Nuclear Reaction

This is the spontaneous emission of radiation that involves the nuclei of radioactive element.

Nuclear Fusion

This is the process in which two or more light nuclei of elements combine together to form a heavier nucleus with release of both energy and radiation.

This process is used to produce hydrogen bomb, it is also believed to be the source of energy of the sun and stars.

Nuclear Fission

This is the process in which the nucleus of a heavy element is split into two nuclei of nearly equal mass with a release of energy and radiation. The process is used to produce atomic bomb.

EVALUATION

1. Write short notes about
   a. Nuclear fission
   b. Nuclear fusion
2. What is the principle of atomic bomb.

Effect of Radioactivity

1. It causes changes in cell structure and body chemistry
2. It leads to anemia, cancer, leukemia and genetic mutations, even death

The thick blocks of lead, iron and high density concrete can be used to get shielded from the harmful effect of radioactive rays.

Application of Radioactivity

1. sterilization
2. medical uses
3. industrial uses
4. agricultural uses
5. as radioactive tracers
6. used for dating techniques

Differences Between Nuclear Reaction and Chemical Reactions

Nuclear Reaction	Chemical Reaction
1. Release large amount of energy	Release little amount of energy when compared to that of nuclear reaction
2. It involves nuclei of atoms of radioactive elements	It revolves the outer most electrons of atoms.
3. This produces different elements	The compound produces contain the same type of element from the reactants.
4. It produces radiation	No radiation produce

5. Temperature and pressure have no effect on chemical reaction	Both temperature and pressure have efects on chemical reaction

Artificial Transmutation

This is the process of transmutation of an element by bombarding it with fast moving atomic particles e.g neutrons, protons, deuterons and alpha particles.

$^{14}_{7}N + ^{1}_{0}n \longrightarrow ^{14}_{6}C + ^{1}_{1}P$

N.B: If the nucleus being bombarded is heavy it captures the neutron to produce an isotope of the original element

$^{59}_{27}Co + ^{1}_{0}n \longrightarrow ^{60}_{27}C_O$

Binding Energy

If mathematical calculations is carried out between the parent nucleus and daughter nuclei together with neutrons and protons on either nuclear fussion or nuclear fission, it will be found that the values are differed.

The loss of mass is known as mass defect and can be accounted for by Albert Einsteins theory of relativity.

$E = MC^2$

E is energy in joule (j)

Radioactive Disintegration

This is the process by which radioactive elements decay spontaneously to release radiation.

During this process, there is usually transmutation of an atom . That is formation of daughter nucleus from the disintegrating nucleus.

Alpha Decay

When an atom losses á particles during disintegration, the atomic number and atomic mass of the atoms is reduced by 2 and 4 respectively. This can be represented as

$^{A}_{Z}K \longrightarrow ^{A-4}_{Z-2}L + ^{4}_{2}He$

e.g $^{238}U \longrightarrow ^{235}Th + ^{4}_{2}He$

Beta Decay

During beta decay the atomic number of the atom increases by one unit, but the atomic mass number remains unaltered.

$^{A}K \longrightarrow _{(2+1)}L + _{-1}e$

$^{234}Th \longrightarrow ^{234}Pa + _{-1}e$

Gamma Decay

Gamma rays usually accompany the emission of either alpha or beta particles e.g

$^{234}Th \longrightarrow ^{234}Pa + _{-1}e + y$

Radioactive Decay Series

Sometimes, if the nuclei of the new elements produced during radioactive decay is not stable, the disintegration continue until a stable nucleus is finally produced e.g. Uranium series, the thorium series and the actinium series.

M is the loss in mass in kilogram (kg) and C is the velocity of light in ms-1

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GENERAL EVALUATION

1. Define the following with an example each (a) Nuclear Fission (b) Nuclear Fusion
2. (a) State two effects of radioactivity.
   (b) State two differences between nuclear reaction and chemical reaction.

READING ASSIGNMENT

New School Chemistry by O. Y. Ababio pages 304-310.

WEEKEND ASSIGNMENT

1. Examples of radioactive elements are except (a) Uranium (b) Polonium (c) Thorium (d) Oxygen
2. $^{235}_{92}U + {}^{1}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n$
   The above nuclear reaction represents (a) nuclear fission (b) nuclear fusion (c) oxidation reaction (d) esterification reaction.
3. $^{238}_{92}U \longrightarrow {}^{234}_{90}Th + A$. In the equation, A represents (a) hydrogen (b) beryllium (c) helium (d) oxygen
4. Chain reaction helps during the preparation of ____ (a) Solar bomb (b) atomic bomb (c) hydrogen bomb (d) nuclear fusion
5. $^{23}_{11}Na + {}^{1}_{0}n \longrightarrow {}^{24}_{11}Na$ The reaction represents (a) artificial radioactivity (b) Natural radioactivity (c) Nuclear fission (d) Binding energy.

THEORY

1. Explain briefly the principle of the operation of a nuclear power plant
2. State five (5) uses of radioactivity

WEEK THREE

TOPIC: SIMPLE MOLECULES AND THEIR SHAPES

CONTENT

- Covalent Molecules e.g methane, diamond, crystalline solid – their network structure e.g diamond.

Simple Molecules and their shapes

The factors that is responsible for the shape of simple covalent molecules are

1. sharing of electron that leads to overlapping of two atomic orbital
2. the central atom and their valence shell electron.

Covalent Molecules

Let consider methane is an example (CH_4).

The central atom is carbon with electronic configuration of $IS^2 2S^2 P^2$ which can be spined as

During the bond formation between the carbon and hydrogen, one electron is promoted from 2S to $2P^2$. That is $IS^2 2S^1 2P^1 x 2P^1 y 2P^1$ or

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In the molecule of methane, the carbon atom has four bond pairs of electrons in its valence shell (the octet rule is obeyed).

The C-H bond in methane are identical. If the 2S and three 2P orbitals are hybridized to from four new orbital which are identical, this new hybrid orbitals are called SP^3. That is one S and three P orbitals are combined. The electron are negatively charged and they move to the corners of a regular tetrahedron. These carbon lies at the apices of the tetrahedron.

Shape of methane

EVALUATION

1. State two (2) factors that determines the shape of simple covalent molecule
2. Draw the shape of methane and explain its formation

Ammonia

In ammonia, NH_3, the central atom is Nitrogen with configuration $1S^2 2S^2 P3$ or
The three unpaired electron in the 2P from the covalent bond with an election of hydrogen atom. It remain one lone pair in the outermost valence shell of nitrogen and the octect rule is satisfied.
The electron clouds of 4 pairs of electrons spaced out but not of the same shape as methane because ammonia contains one lone pair of electrons. This give ammonia a triagonal pyramidal shape.

Shape of Ammonia

Trigonal pyramidal shape of ammonia.

Crystalline Solids

a. the crystalline solids have definite geometric shape
b. the shape of the crystal depend on
    i. the force of attraction between the particle
    ii. whether the particles are the same or different.
    iii. The relative sizes of the particles if they are different.

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There are 3 types of unit cell crystal based on cubic structure.

1. Simple cubic: the particles are placed one at each corner of the cube
2. Faced – centred cubic: the particles are located at each corner and one in the centre of each face of the cube.
3. Body-centred cubic: there is a particle at each corner and one at the centre of the cube.

Types of Crystalline Solids

Crystals can be grouped according to the chemical nature of their particles

i. covalent crystalline solid
ii. ionic crystalline solid
iii. molecular crystalline solid
iv. metallic crystalline solid.

Covalent Crystalline Solid

The best example is chemical crystal which is octahedral in shape. The crystal lattice is build frfom a basic three- dimensional tetrahedral unit cell. The carbon atom is lined to four other carbon atoms by covalent bonds which are directed towards the apices of a regular tetrahedron. Thus, the unit cell is repeated several time to form a giant three dimensional molecules.

Tetrahedral unit of diamond crystal

Octahedral shape of the diamond crystal

Arrangement of the carbon atoms in the diamond

EVALUATION

1. Explain the crystalline solid
2. Draw the structure of
   (a) ammonia
   (b) octahedral shape of diamond

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Ionic Solids

Examples are NaCl and CuSO4 crystal. The shape of these crystals are determined according to how positive and negative ions are arranged, and according to the sizes and changes of the ions.

Molecular Crystals

There the molecules are arranged in regular patterns to give lattices. The molecules are held together by weak intermolecular forces e.gVander Waals force, hydrogen bond, depol-depole.
Examples of the molecules are Naphthalene, iodine and dry ice crystal.

Metallic Solid

The metallic particles are held together in a crystal lattice of closely – packed sphere.
The strength of the metallic bonds varies among different metals e.g iron is more stronger than sodium and potassium.

GENERAL EVALUATON

1. Write short notes on the following
   a. ionic solid
   b. molecular crystals
   c. metallic solid
2. What are the types of attractive forces present in each of the following substances at room temperature and pressure?
   (a) Methane (b) Argon
   (c) Diamond (d) Water
   (e) Aluminium

READING ASSIGNMENT

New School Chemistry by O.Y. Ababio pages 286-294.

WEEKEND ASSIGNMENT

1. A lone pair of electron is found in (a) ammonia (b) methane (c) water (d) carbon(iv) oxide
2. Examples of covalent molecules with linear shapes are except (a) oxygen (b) hydrogen (c) water (d) hydrogen chloride
3. Example of compound with double bonds is (a) water (b) carbon(iv) oxide (c) methane (d) ammonia
4. The following are types of crystalline solid except (a) covalent (b) ionic (c) metallic (d) methane
5. The unit cells based on the cubic structure are the following except (a) simple cubic (b) complex cubic (c) body-centred cubic (d)face-centred cubic

THEORY

1. State three (3) examples of crystalline solids with their shape
2. Explain the following simple covalent molecules and draw their shape (a) methane (b) Water (c) carbon (iv) oxide.

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WEEK FOUR

TOPIC: METALLIC BONDING

CONTENT

- Properties, Factors affecting the formation of metals
- Inter molecular bonding
- Vander-walls forces and hydrogen bonds
- Composition and Uses.

Metallic Bonding

The atoms of metals are held together in crystal lattice by metallic bonds

Properties

1. they are good conductors of electricity and heat
2. high melting and boiling points
3. they are malleable and ductile
4. they ionize by loosing electrons

Factors affecting the formation of metal strength

The Valence Electrons

Intermolecular Bonding

This is the type of chemical bonding which can be found in some molecular solid. Examples of intermolecular forces are

a. vander walls forces
b. Hydrogen force/bond

Vander Waal Forces: this is the weak attractive forces that exist between the molecule.

Importance of Vander waal forces

1. it is important in the liquefaction of gases
2. it is used in the formation of molecular lattices like iodine and naphthalene crystals.

EVALUATION

1. State the properties of the following bonds.
   a. metallic bond b. Vander waal
2. Give the diagram of a named metallic element (bonding diagram)

Hydrogen Bonding

Hydrogen bonding occur when hydrogen is covalently bonded with strongly electronegative element e.g nitrogen, fluorine, oxygen.

These electronegative elements pall the shared pair of electrons in the covalent bonds toward themselves. Thus it results in dipole where the hydrogen is positive and the electronegative element is negative.

An electrostatic attraction set up when the positive pole of one molecule attract the negative pole of another molecule.

NB: The attractive force that exist between the two poles is called hydrogen bond.

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Example of hydrogen bond

1. Hydrogen fluoride molecules

2. Water molecules (ice crystal)

NB: There is covalent bond in a molecule of water while hydrogen bond is formed in molecules of water.

Use

It helps in the formation of water, alkanols and some organic acid molecules

GENERAL EVALUATION

1. Use diagram to differentiate between a molecule of water and molecules of water
2. State the molecules of a substance with strongest hydrogen bond.
3. Explain simple cubic structure

READING ASSIGNMENT

New School Chemistry by O.Y Ababio pg 294-298

WEEKEND ASSIGNMENT

1. An example of intermolecular bonding is (a) Vander wall (b) metallic (c) ionic (d) covalent
2. Both metallic substance and electrovalent compound are similar because (a) Both dissolve readily in water. (b) they have low melting point. (c) they can conduct electricity. (d) they have low boiling point.
3. The dotted line in an intermolecular bond stands for ____ (a) oxygen (b) hydrogen bond (c) ionic bond (d) covalent bond
4. Vander Wall force of attraction can be grouped as (a) Strongest force (b) hydrogen bond (c) weakest force (d) ionic bond.
5. Metallic bond can easily be identified by the presence of (a) positive charge (b) negative charge (c) neutral charge (d) double bonds.

THEORY

1. State the type of chemical bond found in the following substances
   a. Magnesium
   b. Sodium chloride
   c. Ammonium chloride

d. Molecules of hydrogen fluoride
e. A molecule of hydrogen

2. State four properties of the following chemical bonds:
   a. Electrovalent bond
   b. covalent bond
   c. dative bond
   d. hydrogen bond
   e. metallic bond

WEEK FIVE

TOPIC: PRELIMINARY PREPARATION

Metals are found mixed with earthy materials as ores. Ores are often

I. concentrated and
II. converted to oxides before extraction

Concentration of the ore can be done by any of the following ways:

1. washing away the earthy materials
2. Froth- flotation (zinc ore): The ore is agitated (churned up) with oil and water to form a froth. The froth is removed by blowing air through it
3. By passing magnetic ores through a magnetic separator. The ore will be deflected while the non-magnetic or partially magnetic part of the ore will move on.

Roasting in Air

The ore is roasted in air to convert to an oxide. There is no need to roast if the ore is already an oxide.

Principle of Extraction of metals

Those metals which are found in a combined state can be extracted through electrolysis or by chemical and thermal methods. The selected method of extraction of any given metal depends on the stability of the ore. The stability of the ore depends on the reactivity of the metal.

Metal	Reactivity	Most common ore	Method of extraction
K Na Ca Mg	Very reactive	Chlorides	Electrolysis of fused hydroxides and chlorides
		Chlorides & Trioxocarbonates	Electrolysis of fused chlorides
Al Zn Fe Sn Pb	Moderately reactive	Oxides CO32- and Sulphide	Roasting of CO32- & sulphides to form oxides reduction of oxides by C of CO
		sulphides	Roasting in air
			Heating in air
Cu Hg Ag Au	Least reactive	Free element	Mined as free elements

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EVALUATION

I. Explain froth floatation
II. State two ways of concentrating an ore

SODIUM

OCCURRENCE

Sodium occurs as NaCl (rock salt), NaNO and Na_2CO_3.is often known as Chile saltpeter because it is found abundantly in Chile. It also occurs as borax and in complex trioxosilicates (iv) found in clay soil.

Extraction: It is extracted by electrolysis of fused NaCl using the Downs cell. The cathode is a steel cylinder. Fused NaCl (mp:801°c) is put in the cell where it is heated to keep it molten. $CaCl_2$ is often added to lower the melting point of NaCl to about 600oC. Sodium and chloride are the products.
As the electrolysis progresses, the molten Na collects in the cathode chamber where it gets to the top and is collected through a pipe. A hood guides the gaseous chloride at the anode for collection.

At the cathode: $Na^+ + e^- \longrightarrow Na_{(s)}$ (Reduction)
At the anode : $Cl^- \longrightarrow Cl + e^-$ (Oxidation)
$Cl + Cl \longrightarrow Cl_{2\,(g)}$

Overall electrolysis reaction.
$2Na^+(g) + 2Cl^-(i) \longrightarrow 2Na_{(s)} + Cl_{2(g)}$

Physical Properties

1. Silvery solid with metallic luster
2. Flaots on water (density of 0.98)
3. very malleable
4. melting point of 97°C (Low for a metal)
5. Good conductor of heat and electricity.

EVALUATION

I. Write the cathodic and anodic half cell equations in the electrolysis of fused NaCl
II. What is the function of $CaCl_2$ introduced into the electrolytic cell during the electrolysis above.

Chemical Properties

1. Reaction with air

$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$
$Na_2O(s) + H_2O(g) \longrightarrow 2NaOH\ (aq)$
$2NaOH\ (aq) + CO_2(g) \longrightarrow Na_2CO_{3(s)} + H_2O\ (i)$

Sodium tarnishes easily when exposed to air due to presence of oxygen.
Sodium is stored in paraffin oil, toluene or naphtha to prevent its oxidation by air. In excess air the reaction can be represented as follows:

$2Na_{(g)} + O_{2(g)} \longrightarrow Na_2O_{2(g)}$

2. Combination reaction: with H_2, Cl_2,S,P (with non-metals except Boron,carbon & Nitrogen)

$2Na_{(s)} + H_{2(g)} \longrightarrow 2NaCl_{(g)}$
$2Na_{(s)} + Cl_{2(g)} \longrightarrow 2NaCl_{(g)}$
$2Na_{(s)} + S_{(g)} \longrightarrow Na_2S_{(s)}$
$3Na_{(s)} + P_{(g)} \longrightarrow Na_2P_{(s)}$

In Hg

$Na(s) + Hg(l) \longrightarrow Na/Hg(l)$

With water: it reacts violently with cold water giving out a lot of heat and liberating hydrogen gas.

$2Na + H_2O \longrightarrow Na_2O + H_2$

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

4. With acid:

$2Na_{(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O$

NB: The reaction is explosive and extremely dangerous

5. with ammonia

$2Na_{(s)} + 2NH_{3\,(g)} \longrightarrow 2NaNH_{2(s)} + H_{2\,(g)}$

Test for sodium ions

Flame test: Na compounds give a golden yellow colour for non-luminous flame.

Note: Potassium gives a lilac (pale purple) flame which looks common (deep red) when viewed through a blue gas.

USES OF SODIUM

1. It is used in manufacturing important compounds such as tetraethyl lead (Iv) .$(Pb(C_2H_5)_4$
2. Sodium vapour lamps (orange-yellow light) are used to light high ways and airports
3. it is used in liquid form as a coolant in nuclear reactors
4. Can be used as a reducing agent in combination with ethanol or sodium amalgam.
5. Can be sued in the extraction of titanium to reduce titanium tetrachloride to the metal.

Compound of Sodium The following are compounds of sodium: Na_2O, Na_2O_2, NaOH, NaCl, Na_2SO_4, $NaNO_3$, $NaCO_3$.

SODIUM TRIOXOCARBONATE (Na_2CO_3)

Na_2CO_3 exists.

i. As soda ash in the anhydrous state
ii. As a monohydrate, $Na_2CO_3.H_2O$.
iii. As a decahydrate (more often) $Na_2CO_3.10H_2O$ called washing soda

The laboratory preparation follows the three equations below:

a. $2NaOH_{(aq)} + CO_{2(g)} \longrightarrow Na_2CO_3. + H_2O_{(l)}$
b. $Na_2CO_{3(aq)} + H_2O + CO_{2(g)} \longrightarrow 2NaHCO_{3\,(s)}$
c. $2NaHCO_{3(s)} \longrightarrow NagCO_3 + H_2O_{(g)} + CO_{2(g)}$

The NaHCO formed as a white ppt is filtered off, washed and heated to give he anhydrous Na_2CO_3. Na_2CO_3 is prepared industrially using the Solvay process.

SOLVAY PROCESS – INDUSTRIAL PREPARATION

A concentrated sodium chloride solution is saturated with NH_3 gas to produce ammoniacal brine this is allowed to fall into the top of a large tower. As the solution passes through a series of baffle-plates (baffles) it react with CO2 which is forced up the tower under pressure.

i. $NH_3(aq) + CO_{2(g)} + H_2O \longrightarrow NH_4HCO_{3(aq)}$
ii. $NH_4HCO_{3(aq)} + NaCl_{(aq)} \longrightarrow NaHCO_3(s) + NH_4Cl_{\,(aq)}$

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The $NaHCO_{3(aq)}$ is filtered, washed and heated to yield anhydrous $NaCO_3$, steam and CO_2. the CO_2 is used again in the tower.

iii. $2NaHCO_3(s) \xrightarrow{heat} Na_2CO_{3(s)} + H_2O + CO_2(g)$

The soda ash (anh. Na_2CO_3) can be dissolved in hot H_2O and re-crystallized as washing soda

iv. $Na_2CO_{3(s)} + 10HsO_{(l)}$

The economic importance of the process.

1. The CO_2 required in the process is obtained by heating $CaCO_3$ in a lime kiln.
   $CaCO_3(s) \longrightarrow CaO(s) + CO_{2(g)}$
2. $CaO(s) + 2\ NH_4Cl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)}$
   The NH3 is recycled. The raw materials are NaCl, $CaCO_3$. The only waste product is $CaCl_2$.

GENERAL EVALUATION

1. Write an equation to show the reaction of sodium with air.
2. Explain briefly the economics of the Solvay process.
3. Explain the reaction of sodium with cold water.
4. Explain what happens to the following when they are exposed to the atmosphere;
   (a) washing soda (b) caustic soda pellets

WEEKEND ASSIGNMENT

1. Which of these is not an alkali? (a) Sodium hydroxide (b) Potassium hydroxide (c) Aqueous ammonia (d) none of the above
2. Which compound is added to fused NaCl to lower its melting point? (a)$CaCO_3$ (b) $CaCl_2$ (c) $Ca(OH)_2$ (d) $Ca(NO_3)_2$
3. $NaHCO_3$ is also called? (a) Chalk (b) Baking powder (c) Lime (d) Slaked lime
4. What is the colour of sodium flame (a) white (b) red (c) black (d) green
5. Sodium reacts explosively with cold water to liberate (a) Hydrogen (b) CO_2 (c) O_2 (d) Na_2O.

THEORY

1. (a) Explain the Solvay process
   (b) What is the function of NH_3 in the process
2. Why is it necessary to concentrate the ore before extraction of any metal?

READING ASSIGNMENT

New School Chemistry by O.Y Ababio pages 419-442.

WEEK SIX

TOPIC: METALS AND THEIR COMPOUND

CONTENT

- Aluminum
- Occurrence

Aluminum can be obtained as Kaolin, $Al_2O_3.2SiO_3.2H_2O$, cryolite. Na_3AlF_6, Corundum Al_2O_3 and mica $K_2O.Al_2O_3.6SiO_2$.

NB: the main source of aluminum is bauxite $Al_2O_3.2H_2O$

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Extraction

Aluminum can be found in clay and rocks, but due to their high silica content, they can not be used for extraction of aluminum. The extraction of aluminum is carried out by electrolysis of bauxite.
The extraction proceeds in two stages.

1. **Purification of Bauxite**

Bauxite is first heated with caustic soda solution under pressure to form soluble sodium aluminate(III)
$Al2O3 + 2NaOH + 3H2O \longrightarrow 2NaAl(OH)4$
The impurities, iron III oxide and trioxosilicates (iv) can be filtered off as a sludge.
The filterate contains aluminate (III) and then seeded with aluminum hydroxide crystals to induce precipitation of aluminum hydroxide.
$NaAl(OH)_4 \quad Al(OH)_3 + NaOH$
The $Al(OH)_3$ is then filtered off, washed, dried and heated strongly to yield pure aluminium oxide or alumina while the NaOH is concentrated and used again.

$2Al(OH)_3 \quad Al_2O_3 + 3H_2O$

Chemistry of the Reaction

Alumina consist of aluminum and oxygen ions

At the Cathode

The aluminum ions gain three electrons each at the cathode to deposit as metallic aluminum.
$Al^{3+} + 3e \quad Al$

At the Anode

The oxygen ions donate two electrons each to form atomic oxygen, which then pair off to form gaseous molecules.
$O^{2-} \longrightarrow O + 2e-$
$O + O \longrightarrow O_2$
Overall Reaction
$4Al_3 + 6O^{2-} \longrightarrow 4Al + 3O_2$

Physical Properties

1. It is silvery white solid
2. Aluminum has density of 2.7glcm3
3. It is very malleable and ductible
4. It can be rolled into a foil
5. It has melting point of 660o
6. It is a very good conductor of heat and electricity
7. It has moderate tensile strength but high in alloys.

Chemical Properties

1. Reaction with air

$4Al + 3O_2 \longrightarrow 2Al_2O_3(s)$
$2Al + N_2 \longrightarrow 2AlN_{(s)}$

2. Reaction with non-metals e.g Sulphur, Nitrogen phosphorus, carbon and halogen

$2Al + 3Cl_2 \longrightarrow 2AlCl_3$

3. Reaction with Acids

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

$2Al + 6H_2SO_4 \longrightarrow Al_2(SO_4)_2 + 6H_2O + 3SO_2$

NB: Aluminum can not react with either dilute HNO_3 or conc. HNO_3 due to formation of a protective layer of aluminum oxide.

4. Reaction with Alkali

$2Al + 2NaOH + 6H_2O \quad 2NaAl(OH)_4 + 3H_2$

5. Reaction with iron III oxide

$2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2F_3$.

Test for Aluminum Ions

Add drops of sodium hydroxide solution to the unknown salt solution. Formation of a white gelatinous precipitate which dissolve in an excess of sodium hydroxide solution indicates the presence of aluminum ions.

Add a few drops of aqueous NH_3 solution to the unknown salt solution. The formation of white gelatinous precipitate which dissolve in excess of aqueous NH3 confirms the presence of aluminum ion .

$Al^{3+} + 3OH^- \longrightarrow Al(OH)_3$

USES

1. Aluminium is used in making cooking utensil
2. It is sued in making overhead electric cables
3. It is used in making alloys e.g duralumin
4. Aluminium powder suspended in oil is used in paints mirrors and cars.

Iron

Occurences

Iron is usually found as haematite, Fe_2O_3, magnetite Fe_3O_4, iron pyrites, FeS_2, siderite or spathic iron ore $FeCO_3$ and limonite $Fe_2O_3.H_2O$.

Iron is the second most abundant metal in the earth's crust after aluminium. It is also present in clay haemoglobin and chlorophyll in plants.

Extraction

The iron e.g haematite is first roasted in air to produce iron (III) oxide.

The iron (III) oxide is then mixed with coke and lime stone and heated to a very high temperature in a blast furnace.

In the lower part of the furnace, the white hot coke is oxidized by the oxygen in the hot air to liberate carbon (Iv) oxide. $C + O_2 \longrightarrow CO_2$.

The CO_2 change to carbon(ii) oxide at the top of the furnace and then react with iron (III) oxide and reduce it to iron

$Fe_2O_3 + 3CO \longrightarrow 2F_3 + 3CO_2$

The limestone present decomposes at high temperature to yield calcium oxide, which then combine with the silicon(Iv) oxide, impurity, to form calcium trioxosilicate (iv)

$Ca\,CO_3 \longrightarrow CaO + CO_2$

$SiO_2 + CaO + CaSiO_3$

The molten iron sinks to the bottom of the furnace and is tapped off. It is run into moulds where it sets as pig iron.

Physical Properties

1. Iron is silvery solid with luster
2. It has relative density of 7.9
3. It is very ductile
4. It has high tensile strength
5. It has melting point of 1530oC
6. It is good conductor of heat and electricity

NB: It can be magnetized easily.

Chemical Properties

Reaction with Air

$4Fe + 3O_2 + 2xH_2O \longrightarrow 2Fe_2O_3.X_{H2}O$

Reaction with steam

$3Fe + 4H_2O \quad Fe_3O_4 + 4H_2$

Reaction with non-metals e.g sulphur, chlorine,

$2Fe + eCl_2 \longrightarrow 2FeCl_3$

$Fe + S \longrightarrow FeS$

Reaction with Acid

$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$

NB: No reaction is observed when conc. HNO_3 is added to iron.

Uses

NB: Fe^{2+} is used as confirmatory test for oxidizing agent in the laboratory.

Cast iron is used for making objects which do not require high tensile strength e.g stove, cookers, lamp post radiator etc

Cast iron is used for making nails, chains, iron rods, and sheets of iron, agricultural implements etc.

GENERAL EVALUATION

1. What is the main source of Aluminium in nature?
2. Using a diagram and equations, explain how pure Aluminium is extracted from the above source.
3. With the aid of a diagram and the equation of the reaction, show how you would mend a broken iron rod by the thermit process.

READING ASSIGNMENT

New School Chemistry by Osei Yaw Ababio, pages 442 – 478.

WEEKEND ASSIGNMENT

1. Aluminium reacts readily with all common mineral acids except
   A. HNO_3 B. HCl C. H_2SO_4 D. H_3PO_4
2. The great affinity of aluminium for oxygen at high temperatures is employed in the
   A. electrolytic process B. thermit process C. Haber process D. lead chamber process

3. Aluminium materials should not be exposed to alkalis because aluminium is A. basic B. acidic C. an oxidizing agent D. a reducing agent
4. Wrought iron is the A. purest form of iron B. most brittle form of iron C. most impure D. form of iron containing no carbon
5. Which one is the most common iron ore? A. Magnetite B. Haematite C. Carnallite D. Dolomite

THEORY

1. (a) Write the electronic configuration of iron?
   (b) Iron forms the iron(II) ion, Fe^{2+} and the iron(III) ion, Fe^{3+}.
   (i) Write the electronic configurations of these ions.
   (ii) Which of them is more stable?
   (iii) Give reason for your answer.
2. Explain why iron but not aluminium corrode easily on exposure to air despite the fact that aluminium is above iron in the electrochemical series.

WEEK SEVEN

TOPIC: INTRODUCTION TO QUALITATIVE ANALYSIS

- Introduction to Qualitative Analysis

Test for carbons using H2S, NaOH and NH4OH, Confirmatory Test for the cat ions.

Introduction to Qualitative Analysis

Qualitative analysis involves examination of colour, flame test, effect of heat and confirmatory test for cat ion and anions.

Cations are metallic ions e,g Ca^{2+}, Pb^{2+}, Al^{3+}, Cu^{2+}, Fe^{2+} , Fe^{3+}, etc

Rules in Qualitative Analysis

1. Your test solution should not be diluted too much
2. Use only small quantity of reagents

Examination of colour and physical state of specimen

	Substance	colour	physical state
1.	Sulphur	yellow	solid
2.	Copper(ii)oxide	black	solid
3.	Iodine	dark brown	solid
4.	Nitrogen iv oxide	reddish brown	gas
5.	Mercury	white	liquid

Flame test

I. Deep green colour of flame indicate the presence of copper
II. Deep yellow colour indicate the presence of sodium
III. Brick red indicate calcium.

EVALUATION

1. State ten (10) examples of cations
2. Give the colour of the following substance.
   a. Distilled water
   b. Iron filling
   c. Manganese(iv) oxide

d. Benzoic acid.

Test for Cations

The Cations are Ca^{2+}, Zn^{2+}, Al^{3+}, Pb^{2+}, Fe^{2+}. Fe^{3+}, Cu^{2+}, $NH4^{+}$

Test for Ca^{2+}

Test	Observation	Inferences
Sample + H_2O	dissolve to give a Colourless solution	soluble
+ NaOH in drop in excess	white powdery precipitate insoluble in excess	Ca^{2+} present
soln + NH_3 soln	No noticeable reaction	Ca^{2+} present

Test for Zn^{2+}

Sample + H_2O	dissolve in water to Give a colourless solution	soluble
Soln + NaOH in Drop in excess	white gelatinous precipitate soluble in excess	Zn^{2+}, pb^{2+}, Al^{3+} may be present
Soln + NH_3 soln In drop In excess	white gelatinous precipitate ppt soluble in excess	Zn^{2+} present
	Test for Al^{3+}	
Sample +H_2O	dissolve in water to give a colourless solution	soluble
soln + NaOH in drop in excess	white gelatinous precipitate soluble in excess	Zn^{2+},pb^{2+} Al^{3+} may be present
Soln + NH_3OH In drops In excess	white gelatinous ppt insoluble in excess	Al^{3+} or pb^{2+}
	Test for Pb^{2+}	
Sample + H_2O	dissolve in water to give Colourless solution	soluble
Soln + NaOH In drop In excess	White gelatinous ppt soluble in excess	Zn^{2+},Pb^{2+}, Al^{3+} may be present
Soln+ NH_3 soln In drop In excess	white gelatinous ppt insoluble in excess	Al^{3+} or Pb^{2+} may be present
Soln + dil HCl	white ppt	Pb^{2+} present
Ppt + heat	ppt dissolve when hot and Reappear when cool	Pb^{2+} present
Soln + K_2CrO_4	yellow precipitate	Pb^{2+} present

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Test for Fe^{2+}

Test	Observation	Inferences
Sample + H_2O	dissolve in water	soluble
Soln +NaOH soln In drops In excess	dirty green gelatinous ppt insoluble in excess	Fe^{2+} present
Soln +NH_3 in Drop In excess	Dirty green gelatinous precipitate insoluble in excess	Fe^{2+} present

Test for CU^{2+}

Test	Observation	Inference
Sample +H_2O	dissolve in water	soluble
Soln +NaOH in Drops In excess	Blue gelatinous ppt insoluble in excess	Cu^{2+} present
Soln+NH_3 in drop In excess	pale blue gelatinous ppt soluble in excess to give a Deep blue solution	Cu^{2+} present

Test for NH_4^+

Test	Observation	Inferences
Sample + H_2O	dissolve in water to give a Colourless solution	soluble
Soln +NaOH In drop + warm	No ppt, but effervescence occur with libration of colourless gas with choking smell	
Gas + moist Litmus paper	It turns moist red litmus paper blue.	Alkaline gas
Gas + con HCl	It gives white fumes with con HCl	NH_3 gas from NH_4^+

GENERAL EVALUATION

1. Give the common reagents used for confirmatory test for cations.
2. State the colour of the solution when the sample that contains the following dissolve in water:
   a. Fe^{2+} b. Cu^{2+} c. Fe^{3+}

WEEKEND ASSIGNMENT

1. The following give white gelatinous precipitate in NaOH except? (a) Al_{3+} (b) pb_{2+} (c) CU_{2+} (d) Zn_{2+}
2. One of the following gives 'pop' sound when contact with lighted splint. (a) O_2 (b) H_2 (c) NH_3 (d) CO_2
3. Example of cations that gives gas during its confirmatory test is (a) SO_3^{2-} (b) SO_4^{2-} (c) CO_3^{2-} (d) NH_4^+
4. Deep green colour of flame indicate the presence of (a) sodium (b) calcium (c) copper (d) iron
5. The only alkaline gas that changes moist red litmus paper to blue is (a)NH_3 (b) HCl (c) NaOH (d) NH_4OH

THEORY

1. Explain the confirmatory test for the following cations

2. State the flame test for the following :
   a. Calcium b. Copper c. sodium d. iron

READING ASSIGNMENT

School Chemstry by O.Y Ababio pages 165 - 183
Practical chemistry by R. I. Makanjuola pages 31-36.
Practical Chemistry for Schools and Colleges by Godwin O. Ojokuku pages 30 – 98.

WEEK EIGHT

Test for Anions,
Identification of gases e.g CO_2, SO_2 and O_2.
Characteristics test for anions e.g SO_4^{2-},SO_3^{2-},CO_3^{2-},NO^{-3}, Cl^-, etc.
The anions are negatively change ions examples of anions are SO_4^{2-},SO_3^{2-},CO_3^{2}-,S^{2-} etc.

Identification of Gases

	Gases	identification
1.	H_2	It gives a 'pop' sound when the gas is contact with a lighted splint.
2.	O_2	It rekindles a glowing splint.
3.	CO_2	It is colourless and odourless. It turns lime water milky.
4.	Cl_2	A green wish yellow gas, it turns moist iodide paper black.
5.	SO_2	Colourless gas with irritating smell. It turns damp blue litmus paper to red. That is acidic gas.

EVALUATION

1. State two (2) examples of anions with their gases.
2. Identify Cl_2 and NH_3 gases.

Test For Anions

Test for SO_4^{2-}

Test	Observation	Inferences
Sample +H_2O	dissolve in water	soluble
Soln +$Bacl_2$+	white ppt	SO_4^{2-}, SO_3^{2-},CO_3^{2-}
Dil HCl	ppt insoluble	SO_4^{2-}, confirmed.
Soln + dil HCl	No visible reaction	SO_3^{2-},CO_3^{2-},S^{2-} are absent
Soln + $Bacl_2$	white precipitate	SO_4^{2-}, confirmed

Test for SO_3^{2-}

Soln+$Bacl_2$ + dil HCl	white precipitate dissolve in dil HCl	SO_3^{2-} or CO_3^{2-}
soln+acidified soln of $KMnO_4$	decolourise the purple colour to colourless	SO_3^{2-} confirmed
soln + acidified $K_2Cr_2O_7$	the orange colour change to green (reducing property)	SO_3^{2-} confirmed

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Test for CO_3^{2-}

Soln+dil HCl	Effervescence occurred and a Colourless gas is librated	SO_3^{2-},CO_3^{2-}, S^{2-} may be present
Gas+litmus paper	it changes moist blue litmus paper To red.	acidic gas
Gas + lime water	The gas turned lime Water milky.	gas is CO_2 from CO_3^{2-}

Test for S^{2-}

Test	Observation	Inferences
Soln + dil HCl	A colourless gas evolved With rotten egg smell	H_2S gas from S^{2-}
Gas +$KMnO_4$ soln	purple colour is decolourised With a deposit of sulphur	S^{2-} present

Test for Cl^-

Soln + dil HNO_3	No visible reaction	SO_3^{2-} or CO_3 are absent
Soln + $AgNO_3$	white precipitate	Cl- present

GENERAL EVALUATION

1. Give the common reagents for confirmatory test of anions
2. State how you would confirm/test for NO^{3-}
3. Name three gases that are colourless and acidic to litmus.
4. Sodium chloride and silver trioxonitrate(V) crystals are separately soluble in water to give colourless solutions. Explain what happens when their solutions are mixed together.

READING ASSIGNMENT

School Chemstry by O.Y Ababio pages 165 – 183
Practical Chemistry by R. I Makanjuola pages 27-33.
Practical Chemistry for Schools and Colleges by Godwin O. Ojokuku pages 30 – 98.

WEEKEND ASSIGNMENT

1. Brown ring test is used to confirm (a) S^{2-} (b)NO^{3-} (c) SO_4^{2-} (d) SO_3^{2-}
2. The presence of SO_3^{2-} change the colour of acidified $K_2Cr_2)^7$ from (a) green to red (b) purple to colourless (c) orange to green (d) green to orange
3. A greenish yellow gas that change moist iodide paper black is (a) Cl_2 (b) SO_2 (c) H_2 (d) O_2
4. Sometimes in the presence of conc $HsSO_4$, copper turning and heat NO^{3-} gives (a) brown ring reaction (b) pure brown fume (c) reddish brown (d) effervescence
5. The gas that turns lime water milky is (a) H_2 (b) SO_2 (c) NH_3 (d) CO_2.

THEORY

1. State the colour of these solutions a. $KMnO_4$ b. $K_2Cr_2O_3$ c. HOBr d. $CuSO_4.5H_2O$ e. $Ca(OH)_2$
2. Carry out the following exercises on sample K. add about 10cm3 of distilled water to K in a test tube. Divide the solution into four.
   a. To the 1st portion add NaOH drop wise and in excess.
   b. To the 2nd portion add NH_3 solution drop wise and then in excess.
   c. To the 3rd portion, add it drops of BaCl2 follow by the addition of dil HCl
   d. To the 4th portion, add dil HCl follow by the addition of $BaCl_2$.

   Record your observation and inferences then name the salt K.

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WEEK NINE

TOPIC: VOLUMETRIC ANALYSIS

CONTENT

- Calculation Based on Percentage Purity and Impurity of substances.
- Percentage/amount of water of crystallization,
- Molar mass of the acidic base
- Solubility of substances
- Volume of gases
- Mole ratio of acid to base

Volumetric Analysis

Volumetric analysis involves acid base titration.

Mole Ratio

Mole ratio is the ratio of the reacting species. This determines the ratio of the acid that would react with the base.

Examples are

1. $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

$\frac{CaVa}{CbVb} = \frac{1}{2}$

2. $2HCl + Na_2CO_3 \longrightarrow 2NaCl + H_2O + CO_2$

$\frac{CaVa}{CbVb} = \frac{2}{1}$

EVALUATION

1. What is volumetric analysis
2. Give the ratio of the reaction species in the following chemical reactions
   a. $CaCO_3 + 2\ HCl \longrightarrow CaCl_2 + H_2O + CO_2$
   b. $KHCO_3 + 2HCl \longrightarrow KCl + H_2O + CO_2$

Calculation Involving Titration

1. Mole Ratio

A is a solution of an acid hydrogen chloride .B is a solution of sodium trioxocarbonate(iv) containing 0.05 mole per dm^3 solution A was titrated against 25cm^3 of solution B, using methyl orange as indicator during the process, the following data were obtained.

Burette reading (cm^3)	Rough	1st	2nd	3rd
Final burette reading (cm^3)	24.65	48.95	24.30	24.30
Initial burette reading (cm^3)	0.00	24.65	0.00	0.00
Volume of acid used (cm^3)	24.65	24.30	24.30	24.30.

1. Calculate the average titre value
2. Calculate the concentration of the acid in $moldm^3$.
3. Calculate the concentration of the acid in g/dm^3.

The equation of the reaction

$NaCO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

Solution

1. Average titre value = $\frac{24.30 + 24.30 + 24.30}{3}$

$= 24.30cm^3$

2. Concentration of A in $moldm^3$

from

$\frac{CaVa}{CbVb} = \frac{Na}{Nb}$

$\frac{Ca \times 24.30}{0.05 \times 25} = \frac{2}{1}$

$Ca = \frac{0.05 \times 25 \times 2}{24.30}$

$Ca = 0.103moldm^3$.

OR

From no of mole = Conc. In moldm-3 X vol/dm^3

No of moles = $0.05 \times \frac{25}{1000}$

equation of the reaction.

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

1 : 2

1 mole of Na_2CO_3 react with 2 moles of HCl

:. 0.00125 mole of Na_2CO_3 will require 0.00123 x 2 of HCl

:. No of mole of A = 0.0025 mole

From conc of A in moldm-3 = $\frac{\text{No of mole}}{\text{Volume in dm3}}$

$= \frac{0.0025 \times 10000}{24.30}$

1000

$\frac{0.0025 \times 1000}{24.30.}$

$= 0.103moldm^3$

3. Concentration of A in g/dm^3

From:- conc in g/dm3 = conc in $moldm^{-3}$ x molar mass

Molar mass of HCl = 1 + 35.5 = 36.5 g/mol.

:. Conc in g/dm3 = 0.103 x 36.5

$= 3.76g/dm^3$

PERCENTAGE PURITY AND IMPURITY

During the titration process of an impure acid or base is titrated only the pure part of either acid or base react with the base or acid. Therefore the percentage (%) purity or impurity can be calculated.

% purity = $\frac{\text{Conc in } g/dm^3 \text{ of pure solution}}{\text{Conc in } g/dm^3 \text{ of impure solution}} \times \frac{100}{1}$

% impurity = $\frac{\text{conc of impure – conc of pure}}{\text{conc in } g/dm^3 \text{ of impure}} \times \frac{100}{1}$

Mass of pure substance = Conc of pure in $moldm^{-3}$ x Molar Mass

Mass of impurity = Conc of impure – pure

Example

A is a solution of 020mole of HCl per dm^3. B is a solution of an impure sodium trioxocarbonate(iv) containing 3.0g per $250cm^3$.

a. Calculate the

(i) percentage purity of A

(ii) percentage impurity of A

$Va = 20.40cm^3$ $Vb = 25.00cm^3$

The equation of reaction

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

(Na = 23 C= 12 O = 16 H = 1, Cl = 35.5)

Solution

$$\frac{CaVa}{CbVb} = \frac{na}{nb}$$

$$\frac{0.20 \times 20.40}{25 \times cb} = \frac{2}{1}$$

$$Cb = \frac{0.20 \times 20.40 \times 1}{25 \times 2}$$

$Cb = 0.0823\ moldm^3$

Conc in g/dm^3 of pure

From

Conc in g/dm^3 = $Moldm^3$ x molar mass

Molar mass of $Na_2CO^3 = 2(23) + 12 + 3\ (16)$

Molar mass of $Na_2CO_3 = 106g/mol$

∴ Conc in g/dm^3 of pure = 0.082×106

$= 8.692\ g/dm^3$

Conc of impure Na_2XO_3

$250\ cm^3$ dissolve 3.0g of Na_2CO_3

1 cm3 dissolves $\frac{3.0}{250} \times 1000$

$= 12.0g/dm^3$

1. ∴ % purity = $\frac{\text{Conc of pure}}{\text{Conc of impure}} \times \frac{1000}{1}$

$= \frac{8.69}{12} \times \frac{100}{1}$

$= 72.4\%$

% impurity = $\frac{\text{Conc of impure – pure}}{\text{Conc of impure}} \times \frac{100}{1}$

% impurity = $\frac{12 - 8.6g}{12} \times \frac{100}{1}$

$= 27.6\%$

Name_____ Date_____

PERCENTAGE AMOUNT OF WATER OF CRYSTALLIZATION

Water of crystallization in the wager given off when an hydrated salt is heated or exposed to the atmosphere

Hydrated salt does not contain water

Amount of water of crystallization is calculated as follows:

$$\frac{\text{Conc of anhydrous}}{\text{Conc of hydrated}} = \frac{\text{moalr mass of anhydrous}}{\text{molar mass of hydrated}}$$

Percentage Water of Crystallization is calculated as follows:

$$\%\ \text{water of crystallization} = \frac{\text{Hydrated} - \text{Anhydrous}}{\text{Hydrated}} \times \frac{100}{1}$$

Example

Solution A is a solution of hydrogen chloride acid containing 0.095 $moldm_3$ of solution.

B is a solution of hydrated salt $Na_2CO_3.XH_2O$ containing 3.94g which was made up to 250cm_3 of solution with distilled water

Va = 29.00cm^3, Vb = 25.00$cm^{3.}$

Calculate the

I. value of X

II. percentage of water of crystallization.

Equation of the reaction

$$Na_2CO_3.XH_2O + 2HCl \longrightarrow 2NaCl + H_2O + H_2O + CO_2$$

Solution

i. Value of x

From

$$\frac{CaVa}{CbVb} = \frac{Na}{Nb} \qquad \frac{CaVa}{CbVb} = \frac{2}{1}$$

$$\frac{0.095 \times 29}{Cb \times 25} = \frac{2}{1}$$

$$Cb = \frac{0.095 \times 29 \times 1}{25 \times 2.}$$

$Cb = 0.0550 moldm^3$

Conc in g/dm3 of Na_2CO_3 = $moldm^{-3}$ x m.m

Molar mass of Na_2CO_3 = 2 (23) + 12 + 3(16) = 106 g/mol

Conc in g/dm^3 = 0.055 x 106 = 5.83 g/dm^3

Conc in g/dm^3 of hydrated:

$$\frac{\text{Mass}}{\text{Volume}} \times \frac{1000}{1}$$

$$\text{Conc in g/dm}^3 = \frac{3.94 \times 1000}{250}$$

$= 15.8 g/dm^3$

$$\frac{\text{Conc of anhydrous}}{\text{Conc of hydrated}} = \frac{\text{molar mass of anhydrous}}{\text{molar mass of hydrated.}}$$

$$\frac{5.83}{} = \frac{106}{}$$

$\frac{15.76}{(106 \times 18x)\ 5.83} = \frac{106 \times 15.76}{106 + 18x}$

$106 + 18x = \frac{106 \times 15.76}{5.83}$

$106 + 18x = 286.55$

$18x = 286.55 - 106$

$18x = 180.55$

$x = \frac{180.55}{18.}$

$x = 10$

The salt is $Na_2CO_3.10H_2O$

READING ASSIGNMENT

Practical Chemistry by Makanjuola pages 1-15.
New School Chemistry by Osei Yaw Ababio pages 165 – 183
Practical Chemistry for Schools and Colleges pages 100 - 170

GENERAL EVALUATION

1. What is volumetric analysis
2. Name five apparatus used in volumeric analysis.
3. Define the following terms; a. Indicator b. Buffers c. pH scale

WEEKEND ASSIGNMENT

1. C + water give colourless solution (a) c is a soluble salt (b) c is partially dissolve in water (c) c is a filterate (d) c is a residue
2. _____ is the apparatus use to convert vapor into liquid during distillation. (a) conical flask (b) distillation column (c) lie-big condenser (d) round bottom flask
3. X which fumes in most air can be suitably stored (a) under paraffin or naphtha (b) In a white bottle (c) inside a corked conical flask (d) inside a burette.
4. The observation in bubbling SO_2 into acidified $KMnO_4$ solution is (a) The solution turns to green (b) the solution becomes decolourized (c) no visible reaction (d) the solution turns steam
5. The two substances that can give both H_2 and $ZnSO_4$ when added to H_2SO_4 are: (a) Magnesium and Zinc (b) Magnesium and CuO (c) Sodium and NaOH (d) iron and copper

THEORY

1. State what would observe on
   a. mixing Zinc dust with $CuSO_4$ solution
   b. adding concentrated HNO_3 to freshly prepared $FeSO_4$ solution
2. A salt sample was suspected to be either Na_2CO_3 or $NaHCO_3$. A student who was required to identify it, tested a portion for solubility in water and for effects on litmus paper.
   a. What was the observation in each case?
   b. State the reason why the student's procedure was unsuitable.
   c. Describe briefly how you would have identified the salt.