**CHEMISTRY SS 3**

**SECOND TERM**

**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 H2S, NaOH and HN4OH,       confirmatory test for the cations

8.   Test for amono, identification or gases. E.g CO2,SO2 and O2. Characteristics test      for anions e,g SO42-, SO32-, CO32-, NO3.

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 a field of study that delves into the intricate realm of atomic nuclei.

**Radioactivity**

Radioactivity is the spontaneous emission of radiation by certain radioactive elements, including Thorium and Uranium.

Characteristics of Radioactivity:

1. Spontaneous and Continuous Emission: Radioactive elements consistently emit radiation without external influence.

2. Temperature and Pressure Independence: Radioactivity is unaffected by variations in temperature and pressure.

3. Penetrating Radiation: The emitted radiation can traverse opaque objects.

4. Photographic Impact: Radioactivity leaves its mark on photographic plates.

5. Ionization of Gases: As radiation passes through gases, it ionizes them.

6. Fluorescence Induction: Radioactivity can incite fluorescence in certain substances.

7. Energy Release: This process liberates a substantial amount of energy.

Types of Radiation:

There are three primary types of radiation:

1. Alpha

2. Beta

3. Gamma

Characteristics of Alpha-Rays:

1. Alpha particles are helium nuclei, composed of 2 protons and 2 neutrons (42He).

2. These particles are fast-moving streams of positively charged particles.

3. They are deflected toward the negative plate in an electrostatic field.

4. Alpha particles have limited penetrating power.

5. They can be stopped by a thin sheet of paper or aluminum foil.

6. Alpha radiation causes fluorescence in certain materials, such as zinc sulfide.

Characteristics of Beta-Rays:

1. Beta particles are electrons with a mass number of zero and a charge of -1 (0e).

2. Similar to alpha particles, they are fast-moving.

3. Beta particles can penetrate more than alpha rays.

Effects of an Electrostatic Field on the Three Radiation Types

EVALUATION:

1. State two properties of α, β, and γ rays each.

2. Provide a brief explanation of radioactivity.

Detection of Radiation

Radiation can be detected using various devices:

a. Geiger-Müller Counters

b. Scintillation Counters

c. Diffusion Cloud Chambers

HALF LIFE

The half-life of a radioactive element is the duration required for half of the initial number of atoms within the substance to undergo decay.

NUCLEAR STABILITY

The spontaneous disintegration or decay of a nucleus results from its instability. Nuclear stability is determined by the neutron-proton ratio. This ratio varies from unity for lighter elements to approximately 1.5 for heavier elements with atomic numbers around eighty. It's essential to note that atoms with neutron-proton ratios less than 1 or greater than 1.5 tend to be unstable.

EVALUATION:

1. Identify two methods for detecting radiation.

2. Explain the concept of half-life as a measure of nuclear stability.

GENERAL EVALUATION:

1. Define the term nuclear chemistry.

2. Explain the concept of radioactivity.

3. Define the term radioisotopes.

4. Describe the various applications 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.

**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
2. Nuclear fission
3. Nuclear fusion
4. 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 It revolves the outer most electrons of

elements 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 Both temperature and pressure have

on chemical reaction 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.

147N + 10n 146C + 11P

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

5927Co + 10n 6027CO

**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 = MC2

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 ά particles during disintegration, the atomic number and atomic mass of the atoms is reduced by 2 and 4 respectively. This can be represented as

AZK A-4 Z-2L + 4 2He

e.g 238 U 235Th + 4 2He

**Beta Decay**

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

AK (2+1)L + -1 e

234Th 234Pa + -1 e

**Gamma Decay**

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

234 Th 234Pa + -1e + 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

**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 92U + 1n → 141 ­ 56Ba + 92 36Kr + 3 1 0n

The above nuclear reaction represents (a) nuclear fission (b) nuclear fusion (c) oxidation reaction (d) esterification reaction.

1. 238 92U 234 90Th + A. In the equation, A represents (a) hydrogen (b) beryllium

(c) helium (d) oxygen

1. Chain reaction helps during the preparation of \_\_\_\_ (a) Solar bomb (b) atomic bomb (c) hydrogen bomb (d) nuclear fusion
2. 23 11Na + 01n 2411Na 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 (CH4).

The central atom is carbon with electronic configuration of IS22S2P2 which can be spined as

During the bond formation between the carbon and hydrogen, one electron is promoted from 2S to 2P2. That is IS22S12P1x2P1y2P1 or

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 SP3. 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, NH3, the central atom is Nitrogen with configuration 1S22S2P3 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**

1. the crystalline solids have definite geometric shape
2. the shape of the crystal depend on
3. the force of attraction between the particle
4. whether the particles are the same or different.
5. The relative sizes of the particles if they are different.

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

1. covalent crystalline solid
2. ionic crystalline solid
3. molecular crystalline solid
4. 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

**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.

**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

1. vander walls forces
2. 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

1. 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.

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.

1. 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
2. Magnesium
3. Sodium chloride
4. Ammonium chloride
5. Molecules of hydrogen fluoride
6. A molecule of hydrogen
7. State four properties of the following chemical bonds:
8. Electrovalent bond
9. covalent bond
10. dative bond
11. hydrogen bond
12. metallic bond

**WEEK FIVE**

**TOPIC: PRELIMINARY PREPARATION**

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

1. concentrated and
2. 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 |

**EVALUATION**

1. Explain froth floatation
2. State two ways of concentrating an ore

**SODIUM**

**OCCURRENCE**

Sodium occurs as NaCl (rock salt), NaNO and Na2CO3.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:801oc) is put in the cell where it is heated to keep it molten. CaCl2 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- Na(s) (Reduction )

At the anode : Cl- Cl + e- (Oxidation)

Cl + Cl Cl2 (q)

Overall electrolysis reaction.

2Na+(g) + 2Cl-(i) 2Na(s) + Cl2(g)

**Physical Properties**

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

**EVALUATION**

1. Write the cathodic and anodic half cell equations in the electrolysis of fused NaCl
2. What is the function of CaCl2 introduced into the electrolytic cell during the electrolysis above.

**Chemical Properties**

1. Reaction with air

4Na (s) + O2(g) 2Na2O(s)

Na2O(s) + H2O(g) 2NaOH (aq)

2NaOH (aq) + CO2(g) Na2CO3(s) + H2O (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) + O2(g) Na2O2(g)

2. Combination reaction: with H2, Cl2,S,P (with non-metals except Boron,carbon & Nitrogen)

2Na(s) + H2(g) 2NaCl(g)

2Na(s) + Cl2(g)  2NaCl(g)

2Na(s) + S(g) Na2S(s)

3Na(s) + P(g)  Na2P(s)

In Hg

Na(s) + Hg (l) Na/Hg(l)

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

2Na + H2O Na2O + H2

2Na + 2H2O 2NaOH + H2

4. With acid:

2Na(s) + 2HCl(aq) 2NaCl(aq) + H2O

NB: The reaction is explosive and extremely dangerous

5. with ammonia

2Na(s) + 2NH3 (g) 2NaNH2(s)  + H2 (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(C2H5)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: Na2O, Na2O2, NaOH, NaCl, Na2SO4, NaNO3, NaCO3.

**SODIUM TRIOXOCARBONATE (Na2CO3)**

Na2CO3 exists.

1. As soda ash in the anhydrous state
2. As a monohydrate, Na2CO3.H2O.
3. As a decahydrate (more often) Na2CO3.10H2O called washing soda

The laboratory preparation follows the three equations below:

a. 2NaOH(aq) + CO2(g) Na2CO3. + H2O(l)

b. Na2CO3(aq) + H2O + CO2(g) 2NaHCO3 (s)

c. 2NaHCO3(s) NagCO3 + H2O(g) + CO2(g)

The NaHCO formed as a white ppt is filtered off, washed and heated to give he anhydrous Na2CO3. Na2CO3 is prepared industrially using the Solvay process.

**SOLVAY PROCESS – INDUSTRIAL PREPARATION**A concentrated sodium chloride solution is saturated with NH3 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.

1. NH3(aq) + CO2(g) + H2O NH4HCO3(aq)
2. NH4HCO3(aq) + NaCl(aq)  NaHCO3(s) + NH4Cl (aq)

The NaHCO3(aq) is filtered, washed and heated to yield anhydrous NaCO3, steam and CO2. the CO2 is used again in the tower.

1. 2NaHCO3(s) heat Na2CO3(s) + H2O + CO2 (g)

The soda ash (anh. Na2CO3) can be dissolved in hot H2O and re-crystallized as washing soda

1. Na2CO3(s) + 10HsO (l)

The economic importance of the process.

1. The CO2 required in the process is obtained by heating CaCO3 in a lime kiln.

CaCO3(s) CaO(s) + CO2(g)

1. CaO(s) + 2 NH4Cl(aq)  CaCl2(aq) + H2O (l)

The NH3 is recycled. The raw materials are NaCl, CaCO3. The only waste product is CaCl2.

**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)CaCO3 (b) CaCl2

(c) Ca(OH)2  (d) Ca(NO3)2

* 1. NaHCO3 is also called? (a) Chalk (b) Baking powder (c) Lime (d) Slaked lime
  2. What is the colour of sodium flame (a) white (b) red (c) black (d) green
  3. Sodium reacts explosively with cold water to liberate (a) Hydrogen (b) CO2 (c) O2 (d) Na2O.

**THEORY**

1. (a) Explain the Solvay process

   (b) What is the function of NH3 in the process

1. 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, Al2O3.2SiO3.2H2O, cryolite. Na3AlF6, Corundum Al2O3 and mica K2O.Al2O3.6SiO2.

NB: the main source of aluminum is bauxite Al2O3.2H2O

**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 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 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 Al2O3 + 3H2O

**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.

Al3+ + 3e Al

**At the Anode**

The oxygen ions donate two electrons each to form atomic oxygen, which then pair off to form gaseous molecules.

O2- O + 2e-

O + O O2

Overall Reaction

4Al3+ 6O2- 4Al + 3O2

**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 + 3O2 2Al2O3(s)

2Al + N2 2AlN(s)

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

               2Al + 3Cl2 2AlCl3

3. Reaction with Acids

2Al + 6HCl 2AlCl3 + 3H2

2Al + 6H2SO4 Al2(SO4)2 + 6H2O + 3SO2

NB: Aluminum can not react with either dilute HNO3 or conc. HNO3 due to formation of a        protective layer of aluminum oxide.

4. Reaction with Alkali

    2Al + 2NaOH + 6H2O 2NaAl(OH)4 + 3H2

5. Reaction with iron III oxide

2Al + Fe2O3 Al2O3 + 2 F3.

**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 NH3 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 .

      Al3+ + 3OH- 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, Fe2O3, magnetite Fe3O4, iron pyrites, FeS2, siderite or spathic iron ore FeCO3 and limonite Fe2O3.H2O.

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 + O2  CO2.

The CO2 change to carbon(ii) oxide at the top of the furnace and then react with iron (III) oxide and reduce it to iron

Fe2O3 + 3CO 2F3 + 3CO2

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 CO3 CaO + CO2

SiO2 + CaO + CaSiO3

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 + 3O2 + 2xH2O 2Fe2O3.XH2O

Reaction with steam

3Fe + 4H2O Fe3O4 + 4H2

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

2Fe + eCl2 2FeCl3

Fe + S FeS

Reaction with Acid

Fe + H2SO4 FeSO4 + H2

NB: No reaction is observed when conc. HNO3 is added to iron.

**Uses**

**NB:** Fe2+ 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. HNO3 B. HCl C. H2SO4 D. H3PO4

1. 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

1. Aluminium materials should not be exposed to alkalis because aluminium is A. basic B. acidic C. an oxidizing agent D. a reducing agent
2. 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
3. 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, Fe2+ and the iron(III) ion, Fe3+.

1. Write the electronic configurations of these ions.
2. Which of them is more stable?
3. Give reason for your answer.
4. 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 Ca2+, Pb2+, Al3+, Cu2+, Fe2+ , Fe3+, 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**

1. Deep green colour of flame indicate the presence of copper
2. Deep yellow colour indicate the presence of sodium
3. Brick red indicate calcium.

**EVALUATION**

1. State ten (10) examples of cations
2. Give the colour of the following substance.
3. Distilled water
4. Iron filling
5. Manganese(iv) oxide
6. Benzoic acid.

**Test for Cations**

The Cations are Ca2+, Zn2+, Al3+, Pb2+, Fe2+. Fe3+, Cu2+, NH4 +

**Test for Ca2+**

**Test Observation Inferences**

Sample + H2O dissolve to give a soluble

Colourless solution

+ NaOH in drop white powdery precipitate

in excess insoluble in excess Ca2+ present

soln + NH3 soln No noticeable reaction Ca2+ present

**Test for Zn2+**

Sample + H2O dissolve in water to soluble

Give a colourless solution

Soln + NaOH in white gelatinous precipitate Zn2+, pb2+,

Drop in excess soluble in excess Al3+ may be present

Soln +  NH3 soln white gelatinous precipitate

In drop

In excess ppt soluble in excess Zn2+ present

Test for Al3+

Sample +H2O dissolve in water to give soluble

a colourless solution

soln + NaOH

in drop white gelatinous precipitate   Zn2+,pb2+ Al3+ may be

in excess soluble in excess present

Soln + NH3OH white gelatinous ppt

In drops

In excess insoluble in excess  Al3+ or pb2+

Test for Pb2+

Sample + H2O dissolve in water to give  soluble

Colourless solution

Soln + NaOH

In drop White gelatinous ppt Zn2+,Pb2+, Al3+

In excess     soluble in excess  may be present

Soln+ NH3 soln

In drop      white gelatinous ppt Al3+ or Pb2+

In excess     insoluble in excess may be present

Soln + dil HCl    white ppt            Pb2+ present

Ppt + heat ppt dissolve when hot and

Reappear when cool Pb2+ present

Soln + K2CrO4 yellow precipitate Pb2+ present

**Test for Fe2+**

**Test**  **Observation Inferences**

Sample + H2O dissolve in water soluble

Soln +NaOH soln

In drops dirty green gelatinous ppt Fe2+ present

In excess insoluble in excess

Soln +NH3 in Dirty green gelatinous

Drop precipitate Fe2+ present

In excess insoluble in excess

**Test for CU2+**

**Test Observation Inference**

Sample +H2O dissolve in water soluble

Soln +NaOH in

Drops Blue gelatinous ppt

In excess insoluble in excess Cu2+ present

Soln+NH3 in drop pale blue gelatinous ppt

In excess soluble in excess to give a

Deep blue solution Cu2+ present

**Test for NH4+**

**Test Observation Inferences**

Sample + H2O dissolve in water to give a

Colourless solution soluble

Soln +NaOH No ppt, but effervescence occur

In drop + warm with libration of colourless gas

with choking smell

Gas + moist It turns moist red litmus paper Alkaline gas

Litmus paper blue.

Gas + con HCl It gives white fumes with con HCl NH3 gas from NH4+

**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) pb2+ (c) CU 2+

(d) Zn2+

1. One of the following gives ‘pop’ sound when contact with lighted splint. (a) O2 (b) H2 (c ) NH3

(d) CO2

1. Example of cations that gives gas during its confirmatory test is (a) SO32- (b) SO42- (c) CO32-

(d) NH4+

1. Deep green colour of flame indicate the presence of (a) sodium (b) calcium (c) copper (d) iron
2. The only alkaline gas that changes moist red litmus paper to blue is (a)NH3 (b) HCl (c) NaOH (d) NH4OH

**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 CO2, SO2 and O2.

Characteristics test for anions e.g SO42-,SO32-,CO32-,NO-3, Cl-, etc.

The anions are negatively change ions examples of anions are SO42-,SO32-,CO32-,S2- etc.

**Identification of Gases**

Gases identification

1. H2 It gives a ‘pop’ sound when the gas is contact with a lighted splint.

2. O2 It rekindles a glowing splint.

3. CO2 It is colourless and odourless. It turns lime water milky.

4. Cl2 A green wish yellow gas, it turns moist iodide paper black.

5. SO2 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 Cl2 and NH3 gases.

**Test For Anions**

**Test for SO42-**

Test Observation Inferences

Sample +H2O dissolve in water soluble

Soln +Bacl2+ white ppt SO42-, SO32-,CO32-

Dil HCl ppt insoluble SO42-, confirmed.

Soln + dil HCl No visible reaction SO32-,CO32-,S2- are absent

Soln + Bacl2 white precipitate SO42-, confirmed

**Test for SO32-**

Soln+Bacl2 white precipitate

+ dil HCl dissolve in dil HCl SO32- or CO32-

soln+acidified decolourise the purple

soln of KMnO4 colour to colourless SO32- confirmed

soln + the orange colour change SO32- confirmed

acidified K2Cr2O7 to green (reducing property)

**Test for CO32-**

Soln+dil HCl Effervescence occurred and a SO32-,CO32-, S2-

Colourless gas is librated may be present

Gas+litmus paper it changes moist blue litmus paper acidic gas

To red.

Gas + lime water The gas turned lime gas is CO2 from CO32-

Water milky.

**Test for S2-**

Test Observation Inferences

Soln + dil HCl A colourless gas evolved H2S gas from S2-

With rotten egg smell

Gas +KMnO4 soln purple colour is decolourised

With a deposit of sulphur S2- present

**Test for Cl-**

Soln + dil HNO3 No visible reaction SO32- or CO3 are absent

Soln + AgNO3 white precipitate Cl- present

**GENERAL EVALUATION**

1. Give the common reagents for confirmatory test of anions
2. State how you would confirm/test for NO3-
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) S2- (b)NO3- (c) SO42- (d) SO32-
2. The presence of SO32- change the colour of acidified K2Cr2)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) Cl2 (b) SO2 (c) H2 (d) O2
4. Sometimes in the presence of conc HsSO4, copper turning and heat NO3- gives (a) brown ring reaction (b) pure brown fume (c ) reddish brown (d) effervescence
5. The gas that turns lime water milky is (a) H2 (b) SO2 (c) NH3 (d) CO2.

**THEORY**

* 1. State the colour of these solutions a. KMnO4 b. K2Cr2O3 c. HOBr d. CuSO4.5H2O 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.
  3. To the 1st portion add NaOH drop wise and in excess.
  4. To the 2nd portion add NH3 solution drop wise and then in excess.
  5. To the 3rd portion, add it drops of BaCl2 follow by the addition of dil HCl
  6. To the 4th portion, add dil HCl follow by the addition of BaCl2.

Record your observation and inferences then name the salt K.

**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. H2SO4 + 2NaOH Na2SO4 + 2H2O

CaVa = ½

CbVb

2. 2HCl + Na2CO3  2NaCl +H2O + CO2

CaVa = 2

CbVb 1

**EVALUATION**

1. What is volumetric analysis
2. Give the ratio of the reaction species in the following chemical reactions

a. CaCO3 + 2 HCl CaCl2 + H2O + CO2

b. KHCO3 + 2HCl KCl + H2O + CO2

**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 dm3 solution A was titrated against 25cm3 of solution B, using methyl orange as indicator during the process, the following data were obtained.

Burette reading (cm3) Rough 1st  2nd  3rd

Final burette reading (cm3) 24.65 48.95 24.30 24.30

Initial burette reading (cm3) 0.00 24.65 0.00 0.00

Volume of acid used (cm3) 24.65 24.30 24.30 24.30.

* 1. Calculate the average titre value
  2. Calculate the concentration of the acid in moldm3.
  3. Calculate the concentration of the acid in g/dm3.

The equation of the reaction

NaCO3 + 2HCl 2NaCl +H2O + CO2

Solution

1. Average titre value = 24.30 + 24.30 + 24.30

3

= 24.30cm3

2. Concentration of A in moldm3

from

CaVa = Na

CbVb Nb

Ca x 24.30 = 2

0.05 x 25 1

Ca = 0.05 x 25 x 2

24.30

Ca = 0.103moldm3.

OR

From no of mole = Conc. In moldm-3 X vol/dm3

No of moles = 0.05 x 25

1000

equation of the reaction.

Na2CO3 + 2HCl 2NaCl + H2O + CO2

1. : 2

1 mole of Na2CO3 react with 2 moles of HCl

:. 0.00125 mole of Na2CO3 will require 0.00123 x 2 of HCl

:. No of mole of A = 0.0025 mole

From conc of A in moldm-3 = No of mole

Volume in dm3

= 0.0025 × 10000

24.30

1000

0.0025 x 1000

24.30.

= 0.103moldm3

3. Concentration of A in g/dm3

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/dm3

**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 = Conc in g/dm3 of pure solution X 100

Conc in g/dm3 of impure solution 1

% impurity = conc of impure – conc of pure X 100

conc in g/dm3 of impure 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 dm3. B is a solution of an impure sodium trioxocarbonate(iv) containing 3.0g per 250cm3.

a. Calculate the

(i)   percentage purity of A

(ii) percentage impurity of A

Va = 20.40cm3 Vb = 25.00cm3

The equation of reaction

Na2CO3 + 2HCl 2NaCl + H2O + CO2

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

Solution

CaVa = na

CbVb nb

0.20 x 20.40 = 2

25 x cb 1

Cb = 0.20 x 20.40 x 1

25 x 2

Cb = 0.0823 moldm3

Conc in g/dm3 of pure

From

Conc in g/dm3 = Moldm3 x molar mass

Molar mass of Na2CO3 = 2(23) + 12 + 3 (16)

Molar mass of Na2CO3 = 106g/mol

:. Conc in g/dm3 of pure = 0.082 x 106

= 8.692 g/dm3

Conc of impure Na2XO3

250 cm3 dissolve 3.0g of Na2CO3

1 cm3 dissolves 3.0 X 1000

250

= 12.0g/dm3

1. :. % purity = Conc of pure X 1000

Conc of impure 1

= 8. 69 X 100

12 1

= 72.4%

% impurity = Conc of impure – pure X 100

Conc of impure 1

% impurity = 12 – 8.6g X 100

12 1

= 27.6%

**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:

Conc of anhydrous = moalr mass of anhydrous

Conc of hydrated molar mass of hydrated

**Percentage Water of Crystallization is calculated as follows:**

% water of crystallization = Hydrated – Anhydrous X 100

Hydrated 1

Example

Solution A is a solution of hydrogen chloride acid containing 0.095 moldm3 of solution.

B is a solution of hydrated salt Na2CO3. XH2O containing 3.94g which was made up to 250cm3 of solution with distilled water

Va = 29.00cm3, Vb = 25.00cm3.

Calculate the

I. value of X

II. percentage of water of crystallization.

Equation of the reaction

Na2CO3.XH2O + 2HCl 2NaCl + H2O + H2O + CO2

Solution

i. Value of x

From

CaVa = Na CaVa = 2

CbVb Nb CbVb 1

0.095 x 29 = 2

Cb x 25 1

Cb = 0.095 x 29 x 1

25 x 2.

Cb = 0.0550moldm3

Conc in g/dm3 of Na2CO3 = moldm-3  x m.m

Molar mass of Na2CO3 = 2 (23) + 12 + 3(16) = 106 g/mol

Conc in g/dm3 = 0.055 x 106 = 5.83 g/dm3

Conc in g/dm3 of hydrated:

Mass X 1000

Volume 1

Conc in g/dm3 = 3.94 x 1000

250

= 15.8g/dm3

Conc of anhydrous = molar mass of anhydrous

Conc of hydrated molar mass of hydrated.

5.83 = 106

15.76 106 x 18

(106 x 18x) 5.83 = 106 x 15.76

106 + 18x = 106 x 15.76

5.83

106 + 18x = 286. 55

18x = 286.55 – 106

18x = 180.55

x = 180.55

18.

x = 10

The salt is Na2CO3.10H2O

**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 SO2 into acidified KMnO4 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 H2 and ZnSO4 when added to H2SO4 are: (a) Magnesium and Zinc (b) Magnesium and CuO (c) Sodium and NaOH (d) iron and copper

**THEORY**

1. State what would observe on
2. mixing Zinc dust with CuSO4 solution
3. adding concentrated HNO3 to freshly prepared FeSO4 solution
4. A salt sample was suspected to be either Na2CO3 or NaHCO3. A student who was required to identify it, tested a portion for solubility in water and for effects on litmus paper.
5. What was the observation in each case?
6. State the reason why the student’s procedure was unsuitable.
7. Describe briefly how you would have identified the salt.