NATIONAL BUSINESS AND TECHNICAL EXAMINATIONS BOARD

(GENERAL EDUCATION EXAMINATION)

CHEMISTRY (ESSAY)

QUESTION AND ANSWERS

1(a). **What is an Atom?**

Solution:

An atom is the smallest unit/representative/particle of matter made up of electrons, protons and neutrons.

1(b) **Explain briefly the following terms using an example to illustrate each.**

i. Atomic mass number

ii. Nuclear charge

iii. Valency

iv. Isotopy

Solution:

i. Atomic mass number is the sum of protons and neutrons in an atom e.g. chlorine which has 17 protons and 18 neutrons has mass 35.

ii. Nuclear charge is the sum of proton charges in the nucleus. Na has 11 protons; its nuclear charge is (l).

iii. Valency is the combining power of an atom when it reacts with another to from a bond. Valency of oxygen equal 2 because Q^{2-}.

iv. Isotopy is the occurrence of two or more atoms of an element with different numbers of neutrons or atomic mass number. e.g. carbon, oxygen, chlorine.e.t.c.

C → $^{12}_{6}C$ and $^{14}_{6}C$ for Carbon

O → $^{16}_{8}O$ and $^{18}_{8}O$ for Oxygen.

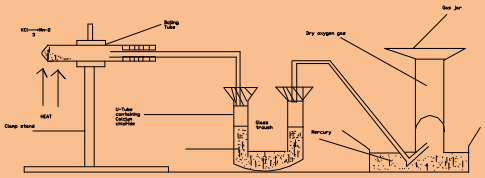
Cl → $^{35.5}_{17}CL$ and $^{17}_{17}CC$ for Chlorine.

1(c) Describe the laboratory preparation of dry oxygen gas.

i. Name THREE uses of oxygen.
i. Respiration of plants and animal
ii. In welding of metals oxy-ethyne flame
iii. Drivers, mountain climbers, and miners use it.
iv. In the steel industry to remove carbon, sulphur and phosphorus.

Solution

Diagram:



1. Heat potassium trixochlorate V and manganese iv oxide in the ratio 4:1 by mass in a hard test tube fitted with a delivery tube.
2. The oxygen gas produced from the mixture is passed through a U tube containing (anhydrous) calcium chloride to dry.
3. The issuing gas is collected over mercury in gas jar or test tube.
4. $2KCLO_3 \xrightarrow[\text{Heat}]{MnO_2} 2KCL+3O_2$.

Cii. Name THREE uses of oxygen.

Uses of oxygen.

1. Respiration of plants and animals
2. Burning of fuels in house hold cooking, motor cars, air planes, space rocket, e.t.c.
3. In welding of metals oxy-ethyne flame.
4. Divers, mountain climbers, and miners use it.
5. In the steel industry to remove carbon, sulphur, and phosphorus.
6. Manufacture of some important compounds.

d. what mass of calcium chloride will be produced when 2.23g of calcium metal reacts with excess chlorine gas.

[H = 1.0, CL = 35.5, Ca = 40.0]

Solution:

$Ca + Cl_2 \rightarrow CaCl_2$

40g 71g 111g

40 of ca produce 111g of C_aCl_2

1g of ca produces 111g/40 of $CaCl_2$

2.23g ca produce 11/40 x 2.23_g/1 of C_aCl_2

= 6.19g (sign figs).

2(a). What do you understand by the following terms using an example to illustrate each?

i. Formula mass
ii. Ionic equation
iii. Allotropes
iv. Covalent bonding.

Solution:

i. Formula mass is the mass of all atoms/ ions and in a formula (of a compound or an ion)
formula mass of Nacl = 23+35.5g
= 58.5g

ii. Ionic equation is the chemical equation of reaction using the ions that are involved in the reaction as reactants and products.
e.g. $NaOH+Hcl \rightarrow Nacl + H_2O$
$Na^+ OH^- + H^+ Cl^- \rightarrow Nacl + H_2O$

iii. Allotropes are the different forms of an element in the same physical state. E.g. Allotropes of carbon are coal, diamond, graphite e.t.c.

iv. Covalent bonding occurs when pairs of electrons are shared between two atoms to form bonds. e.g. bonds between carbon and hydrogen in hydrocarbon molecules.

2b. Give the IUPAC name of these substances

i. H_2SO_3
ii. $KMnO_4$
iii. $K_2Cr_2O_7$
iv. $(NH_4)_2SO_4$

SOLUTION:

i. Trioxosulphate iv acid
ii. Potassium tetraoxomanganate vii
iii. Potassium heptaoxochromate vi

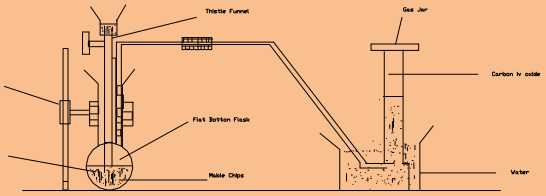
iv. Ammonium tetraoxosulphate vi

2c. Describe the laboratory preparation of carbon iv oxide.

Solution:

Laboratory preparation of carbon iv oxide.

Diagram



Statement of Experiment.

- Pass dilute Hcl or $HN0_3$ through a thistle funnel into a flat bottomed flask containing few chips of marble.
- Pass the gas produced through the water trough in which a beehive shelf is place carrying a gas jar of water.

The gas $C0_2$ is collected in the gas jar over water

$2HCL + CaC0_3 \rightarrow cacl_2 + C0_2 + H_20$

D(i) Give two chemical properties of $C0_2$

ii. **GIVE two uses of carbon IV oxide**.

Solution:

(1) It form trioxocarbon iv acid when dissolved in water

$C0_{2\,(g)} + H_2O_{(i)} \rightarrow H_2\,C0_3\,(aq)$

(2) It reacts with an alkali to form a trioxocarbon v salt and water.

e.g (i) $2NaOH + CO_2 \rightarrow Na_2\,co_3 + H_20$

(ii) $Ca\,(OH)_2 + CO_2 \rightarrow CaC0_3 + H_2O$

(3) Hot magnesium burns in CO_2 to form carbon and oxide of magnesium.

$C0_2 + 2Mg \rightarrow 2M_g0 + C$

4. Red hot carbon burn in Co2 to form carbon ii oxide

$CO_2 + C \xrightarrow{Heat} 2CO$

d(ii)1. Used as fire extinguisher

2. Used to manufacture washing soda in solvary process

3. To manufacture urea and fertilizers.
4. in the manufacture of aerated (soft or mineral) drinks.
5. in the manufacture of health salts.
6. As refrigerant for fruit, ice cream and other perishable goods
7. As coolant in nuclear reactors.

3a. write an appropriate equation showing how the following can be obtained from propan-1-oL in the laboratory

(i). Propene

(ii). Propyl methanoate.

A(ii) State the type of reaction involved in each case

Solution:

- $CH_3CH_2CH_2\ OH \xrightarrow[Heat]{H_2SO_4} CH_3CH_2CH_2+H_20$
- $HCOOH + C_3H_7OH \xrightarrow{dil\ H_2SO_4} HC^{=O}OC_3H_7+H_2O$
- Methanaic acid +tpropane-1-oL--→propyl methanoate + water

A(ii). Dehydration reaction Esterfication.

bi. LIST THREE factors that affect selective discharge of ion during electrolysis.

ii. State faradays second law of electrolysis.

Solution:

bi. Selective discharge is affected by position of the ions in the electrochemical/activity series.

Concentration of the ions in the electrolyte.

Type of electrodes →electrodes used for the electrolysis

ii. Faradays' second law of electrolysis states that when the same quantity of electricity is passed through different electrolytes, the relative number of moles of the elements discharge are inversely proportional to the charges on the ions of the element.

(C) A voltmeter containing silver trioxonitrate v solution was connected in series to another volter containing copper II tetraoxosulphate VI solution. When a current of 0.200 ampere was passed through the solutions, 0.780g of silver was deposited.

Calculate.

i. Quantity of electricity used.
ii. The time of current flow and
iii. Mass of copper deposited
[Cu =63.5, Ag = 108] II = 96,500 coulombs.

Solution:

i. $AgNo_3 \rightarrow Ag^+ + N0^-_3$

1 Faraday will discharge 108g of Ag

I.e. 108g of = 96, 500

1g = 96, 500/108

0.780g $= \frac{96,500 \times 0.780}{108 \quad 1}$

= 696.9 coulombs

= 697 coulombs (3 sign figs)

ii. Q = It
Where Q = quality of electricity (coulombs)
I= current (ampers)
t= time (seconds)
697 =0.200 x t
t = 697 /0.200
= 3485sec (3 sign figs)
= 3490sec. (3 sign figs)

iii. $CUSO_4 \underline{H_2O} \rightarrow Cu^{2+} + SO^{2-}_4$

2 Faraday of electricity = 63.5g of cu

2x 96,500 coulombs = 63.5g of cu

1 coulomb $= \frac{63.5}{2 \times 96,500}$ g of cu

697 coulombs $= \frac{63.5 \times 697}{2 \times 95,500}$ g of cu

= 0.229g of cu (3 sign figs)

iii. Alternative solution.

$CuSO_4$ ---→ Cu^{2+}

No of moles of Ag produced

$\frac{0.780}{108}$ m = 0.00722 moles

But 2 moles of Ag = 1 mole of cu

∴ 1 Moles of cu deposited = 0.00722 ÷ 2

= 0.00362 moles

∴ Mass of cu = 0.00362 x 63.5g

= 0.229g.

(d). Au, Zn, Mg, Na, Sn, Ca

i. Arrange the following metals in the order of increasing reactivity.

ii. Hence state which of them can be extracted by electrolysis.

iii. Why is zinc said to be amphoteric.

Solution:

i. Au, Sn, Zn, Mg, Ca, Na
ii. Na, Ca, Mg
iii. Zn is amphoteric because it reacts/forms an oxide which can react with acid and alkalis to form stable salts.

4(a). What is meant by each of the following terms?

i. Esterification
ii. Saponification.

Solution:

i. Esterification is a chemical reaction between an organic/carboxylic acid and alcohol/alkanol to form ester and water only.
OR

Organic acid + Alcohol----→ester + water.

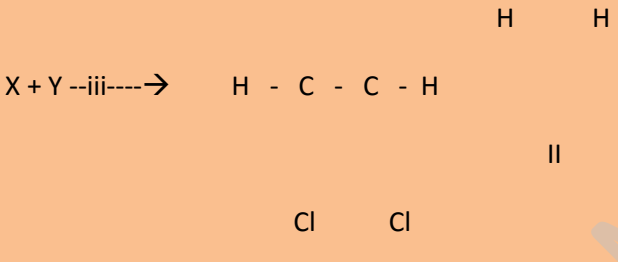
ii. Saponification is a chemical reaction (hydrolysis) of fat or oil with caustic alkali yielding soap and an Alkanol (propane -1,2,3, triol) glycerol
OR

Fats/oil + caustic Alkali ---→ soap + propane- 1, 2, 3, triol. Glycerol.

b. consider the following reaction oaths.

Petroleum 1 → petroleum fraction

Higher petroleum fraction --II---→petrol + X



Nx iv → - $(CH_2 – CH_2 – CH_2 – CH_2 -)_n$

i. State the type of process/reaction involves in each of the path labeled 1 to iv
ii. Identify X and Y
iii. Give the IUPAC name of product obtained in stage III
iv. What are the reaction conditions for stage IV?

Solution:

bi. i = fraction Distillation
ii – cracking
iii = Addition reaction/chlorination.
iv = Polymerization.

4b ii. X is Ethene
Y is chlorine
iii. 1, 2- dichloromethane
iv. Reaction condition of polymerization are high temperature not below 250^{0C}
High pressure not below 1,500 atmosphere suitable Catalysts or chain initiators.

4c. Give ONE reason each why transition metals exhibit the following properties.

Formation of colored ions.
Formation of complex ions.
Variable oxidation state.

Solution:

i. Transition metal form colored ions because they have partially filled 3d orbital. Electron in 3d orbital change from one energy level to another producing / emitting different color of light as they do so.

ii. Complex ions are formed by transition metals because they have positive nuclear charge which permits ligands to attach to their ions through formation of electrovalent or coordinate bonds.

iii. Para magnetism occurs in transition metal because of the presence of one or more unpaired electrons in orbitals.

iv. Variable oxidation states of transition metal are due to the available partially filled 3d orbitals.

d. Distinguish between empirical formula and molecular formula.

Solution:

Molecular formula is the erect combination of atoms which make up a molecule of the substance. While empirical formula is a fraction representive of the molecule, showing the ratio of different atoms which make up the molecule.E.g. mole formula = n [Empirical formula]

5a(i) What are the products of chemical reaction between a solution of sodium hydroxide and hydrogen chloride acid?

ii. Draw a diagram of energy profile to show the path of a chemical reaction in (i) above

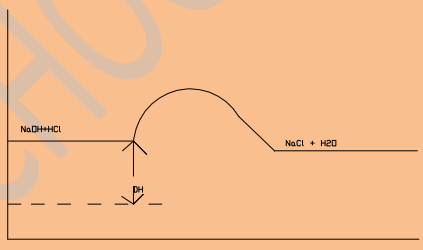
iii. What type of reaction is in (i) above?

Solution:

ai. $NaOH + HCl \longrightarrow Nacl + H^{(i)}_2O + Heat/\Delta H.$

Sodium chloride water

ii. ENERGY PROFILE DIAGRAM



iii. Exothermic reaction

bi. List THREE factors that can affect rates of a chemical reaction.

Ii. Mention THREE chemical reaction this is photo-sensitive

Solution:

bi. Factors affecting rates of a chemical reaction are nature of the reactions
Concentration/ pressure (for gases) of reactants.
Surfaces are of contact (for solids).
Temperature of reaction mixture.
Presence of light
Presences of a catalyst.

ii. Photo-sensitive chemical reactions
Decomposition of Hydrogen peroxide.
Photosynthesis in plants.

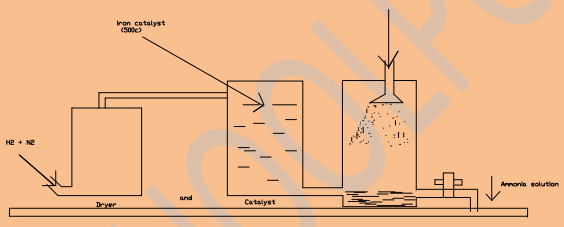
Conversion of silver halides to grey metallic silver (in photosynthesis in plants)

Reaction of hydrocarbons with Halogens (substitution or additive)

ci. Describe the industrial preparation of ammonia through Haber process.

ii. LIST THREE Physical properties of ammonia.

Ci. Haber's process- industrial preparation of ammonia



$3H_2 + N_2 \longleftrightarrow 2NH_3$

Statement of experiment

- Pass a mixture of hydrogen and Nitrogen in the ratio 3:1 into the dryer and condenser
- The mixture is passed into catalyst chamber at 500c, pressure of 200 atmosphere in which finely divided iron catalyst.
- $3H2+N2 \leftrightarrow 2NH3$

Pass the issuing gas (Ammonia) into the absorption tower where water sprinkler wash and dissolve the ammonia.

C(ii) Physical properties of ammonia colorless.

Vapor density is 8.5 for ammonia gas, it is lighter than air

Colorless gas with choking smell.

Boiling point – 77.7^{0C} for liquid ammonia.

Ammonia gas liquefies at – 34.4^{0C}

d. Writes balance equation to show the chemical reaction of ammonia with.

i. Concentrated H_2S0_4

ii. Chlorine gas.

Solution

di. $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2 SO_4$

ii. $2NH_3 + 3Cl_2 \rightarrow 6Hcl + N_2$

OR

$8NH_3 + 3Cl_2 \rightarrow 6NH_4Cl + N_2$