1. Starting from bauxite, explain how to obtain pure aluminium metal

**Solution**

i. Dissolve the impure bauxite in hot concentrated sodium hydroxide solution: 
   \[ 2\text{NaOH} + \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl(OH)}_4 \]

ii. Filter off the impurities leaving the sodium aluminate solution

iii. Seed the Sodium aluminate solution to obtain pure aluminium hydroxide: 
   \[ \text{NaOH} + \text{Al(OH)}_3 \rightarrow \text{NaOH} + \text{Al(OH)}_3 \]

iv. Filter, wash, dry and heat the precipitate of \(\text{Al(OH)}_3\) to obtain pure aluminium oxide: 
   \[ \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O} \]

v. Electrolysis of bauxite

Electrolyte is Alumina (Aluminium Oxide) in molten cryolite. Electrodes are graphite as anode and graphite as cathode.

At the cathode, molten aluminum is discharged: 
\[ \text{Al}^{3+} + 3\text{e}^- = \text{Al} \]

At the anode, oxygen gas is discharged: 
\[ 2\text{O}^2- = \text{O}_2 + 4\text{e}^- \]

**Bi.** Write down the formula and IUPAC name of alum.

**Ii.** Give two uses of alum.

**Iii.** Name THREE metals that can be extracted through electrolysis.

**Solution**

i) \(\text{KA}_1(\text{SO}_4)_2\cdot 12\text{H}_2\text{O} - (2)\)

Name: Potassium aluminum III tetra oxosulphate VI duodecahydrate or \(\text{NH}_4\text{Fe(SO}_4)_2\cdot 12\text{H}_2\text{O}\).
ii) Alum is used for water purification
    Alum is used for mordant in dyeing

iii) Metals that can be extracted through electrolysis-sodium, potassium, calcium, magnesium.

Bi. Name THREE important alloys of aluminium.
    ii. Give two uses of each of the alloys named.
    iii. Give the composition of ONE of the alloys named.

**Solution:**

Duralumin Composition AL, Mg, Cu, Mn
Use – construction of car, Aeroplane, Railways Coaches, ship.

Aluminium Brass – cu, AL uses for casting coins and medals
Alnico – fe, A1, Ni, Co
Uses – for making permanent Magnets

2a. Give correct IUPAC Names and Structures of Isomers of C₅H₁₂

**Solution**

Pentane: \[\text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \]

2 methy Butane: \[\text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \]

2,2, dimethylpropane \[\text{H} - \text{C} - \text{H} \]

For other subjects, go to http://www.myschoolgist.com.ng/NABTEB
2bi State THREE differences between aliphatic and aromatic hydrocarbons
Give THREE uses of Benzene

Solution

<table>
<thead>
<tr>
<th>Aliphatic</th>
<th>Aromatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. C: H ration is low</td>
<td>C: H Ratio is high</td>
</tr>
<tr>
<td>2. Burns without soots or luminous flame</td>
<td>Burns with sooting flame</td>
</tr>
<tr>
<td>3. Not based on benzene</td>
<td>Based on Benzen Structure</td>
</tr>
<tr>
<td>4. Multiple bonds may be included</td>
<td>Multiple bond must be included</td>
</tr>
</tbody>
</table>

ii. Manufacture of synthetic fibers (e.g.) nylon.
Manufacture of pesticides
Manufacture of dyes
Manufacture of drugs

C. Explain using a diagram, how you would prepare ethanoic acid in the laboratory. Write the equation of the reaction solution.

i. Add ethanol from a thistle funnel attached to a reflux flask into a round bottom flask containing concentrated H2 S04 and Na2 Cr2 07.

ii. Put the mixture in a water bath and gently then reflux
\[
C_2H_5OH(haq) + 2 \{0\} \rightarrow CH_3 CO_2H + H_2O
\]

OR
\[
C_2H_5OH + (0) \rightarrow CH_3 CH_0 [0] CH_3 COOH
\]

iii. Distil the solution left to collect the ethanoic acid

D. Give correct IUPAC names of the following compounds

i) \(CH_3 COOCH_3\)

ii) \(CH_3 COOC_2H_5\)

iii) \((CH_3)_2CHCOOH\)

Solutions:

i) Methyl Ethanoneate

ii) Ethyl Ethanoneate

iii) 2 methyl propanoic acid
3ai  State the second law thermodynamics
ii. Give THREE Conditions for a chemical change to occur spontaneously.

Solution
i) The second law of thermodynamics states that a spontaneous process occurs only if there is an increase in entropy of the system and the surroundings.

   ii) Total entropy change must be positive i.e. \( \Delta S \) (total) > 0 free energy of the system must be negative i.e. \( \Delta G < 0 \). Transition Energy complex must be reached.

B. With the aid of a diagram state FOUR differences between exothermic and endothermic reactions.

Solutions

<table>
<thead>
<tr>
<th>Difference</th>
<th>Exothermic Reaction</th>
<th>Endothermic Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ( \Delta H ) is negative</td>
<td>Heat is liberated from surrounding</td>
<td>( \Delta H ) is positive</td>
</tr>
<tr>
<td>2. Heat is liberated from surrounding</td>
<td>Reaction vessel is always warm</td>
<td>Heat is absorbed from surrounding</td>
</tr>
<tr>
<td>3. Preaction vessel is always warm</td>
<td>No external heat supply to system after commencement of reaction</td>
<td>Reaction vessel is always cold</td>
</tr>
<tr>
<td>4. No external heat supply to system after commencement of reaction</td>
<td>Heat is absorbed from surrounding</td>
<td>There is an external Heat to the system after commencement of reaction</td>
</tr>
</tbody>
</table>
C. Define saturated solution, super saturated solution

**Solution:**
A saturated solution is a solution which contains as much solute as it can dissolve at that temperature in the presence of undissolved solute particles.

A supersaturated solution is a solution which has dissolved more solute than it can normally hold/dissolve at that particular temperature.

D. If the concentration in mol/dm$^3$ of potassium trioxonitrate is 6.44, Calculate the mass of salt that will dissolve in 100 cm$^3$ of water [K = 39, N = 14, O= 16]

**Solution**
1000 cm$^3$ of solution contain 6.44 m of salt
Therefore 100 cm$^3$ of solution contains

\[
\frac{6.44 \times 100}{1000} = 0.644 \text{ mole of salts}
\]

Molar mass of KNO$_3$
\[
= 39 + 14 + (16 \times 3)
\]
\[
= 101 \text{ g/mole}
\]
Therefore Mass of salt = 0.644 x 101 = 65.044
\[
= 65.0 \text{ g}
\]

4a. Name THREE allotropic form of carbon and their uses.

**Solutions**

i. diamond (Uses) – Drills and cutting of metals as pivot support, as jewelries.

ii. Graphite (uses) – As lubricants as electrodes, to line crucibles, as lead in pencil a block pigments in Paints as neutron moderator in atomic piles.
iii. Coke (Uses) – As fuel, as reducing agent, for the production of gaseous fuel (i.e. producer gas and water gas) in the manufacture of compounds (e.g.) Ca C₂₆, CS₂, S, C₄ etc.

iv. Coal (Uses) – As a fuel

v. Carbon black (sort), uses – for making rubber tyres, black shoe polish, printer ink, typewriting ribbons, carbon paper.

vi. Charcoal (uses) – As fuel and gas/colour adsorbent

b. Explain the destructive distillation of coal.

**Solutions**

The destructive distillation of Coal is the process of heating coal to a very high temperature in the absence of air (so that volatile components distil over).

The products of such distillation are coke, ammonical liquor, coal far, coal gas

c. Draw a simple diagram to explain carbon cycle

![Carbon Cycle Diagram](image)

di. Describe the production of water gas and producer gas.

ii. What mass of carbon (iv) oxide can be obtained from complete oxidation of 1.54g of carbon (ii) oxide with oxygen (H = 1, C = 12, O = 16)

**Solution**

i.
To produce producer gas, valves B are closed and air is blown in through valve A into the producer which contains Coke $2C + O_2 \rightarrow 2CO$. The mixture of the unchanged nitrogen and CO is called producer gas.

To produce water gas, valves A are closed and steam is passed through valve B into the producer. The steam reacts with the Coke to produce equal volumes of carbon (ii) oxide and hydrogen, referred to as water gas $C(s) + H_2 O(g) \rightarrow Co(g) + H_2$.

The production of producer gas is exothermic while that of water gas is endothermic.

ii. Molar mass of $CO = 12 + 16 = 28g$  
Molar mass of $CO = 12 + (16 \times 2) = 44g$  
$C_0 + O_2 \rightarrow 2 C O_2$

Therefore 56g Co Producers 58g CO
Therefore 1.54g Co Producers 88/56 X 1.54 = 2.42g CO_2

5a. State Le Chateliers principle:  
Le Chatelier’s principle states that if an external constraint is imposed on system. In chemical equilibrium position will adjust so as to reduce the effect of the constraint.

b. $3H_2 (g) + N_2 (g) \rightarrow 2 NH_3(g)$ $\Delta H = -49.95$ KTmo1$^{-1}$
Describe, according to Le Chatelier’s Principle how the equilibrium in the above equation will vary when:
i. More hydrogen is added.
ii. Ammonia is removed
iii. The pressure is increased
iv. The temperature is decreased

**Solution**

i. The hydrogen added will react with the nitrogen to produce more of ammonia – this equilibrium position shifts to the right.

ii. The hydrogen and nitrogen present will react to replace the removed ammonia – this shifts the equilibrium position to the right.

iii. The hydrogen and nitrogen with 4 gaseous volume will react to produce ammonia with 2 gaseous volumes, this equilibrium position shifts to the right.

iv. The temperature is decreased. The production of ammonia is exothermic while its decomposition is endothermic. A decrease in temperature favours the exothermic process. Thus hydrogen and nitrogen combine to produce more of ammonia shifting the equilibrium position to the right.

**c. What is the valency of x in the compound $X_3Y_2$?**

ii. Write a balanced equation for the reaction between zinc and dilute tetraoxosulphate vi) acid.

**Solution:**

i. The valency of x is 152

ii. $\text{Zn(s) + H}_2\text{SO}_4\text{(aq) } \rightarrow \text{ZnSO}_4\text{(aq) + H}_2\text{(g)}$