QUESTION AND ANSWER

CHEMISTRY, MAY/JUNE 2009

Section B (Essay 100 marks) **Time: 1 hour 40 mins**

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

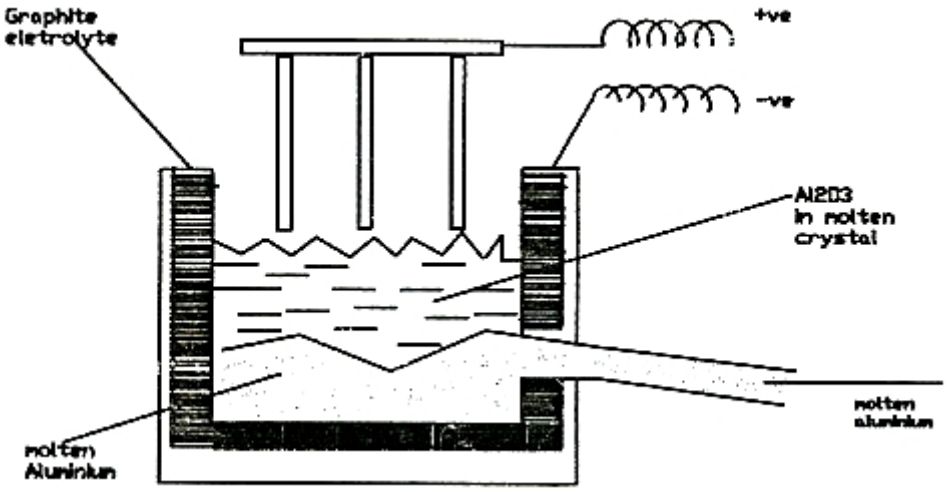
Solution

i. Dissolve the impure bauxite in hot concentrated sodium hydroxide solution/ $2Na\ OH + A1_2\ O_3 + 3H_2\ 0 \rightarrow 2\ NaA1\ (OH)_4$
ii. Filter off the impurities leaving the sodium aluminates solution
iii. Seed the Sodium aluminate solution to obtain pure aluminium hydroxide/$NaA1(OH)_4 \rightarrow Na\ OH + A1\ (OH)_3$
iv. Filter, wash, dry and heat the precipitate of $A1\ (OH)_3$ / to obtain pure aluminium oxide heat/$2A((OH)_3$ heat $A(_2\ 0_3 + 3\ H_20$.
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 or $A1^{3+} + 3e = A1(s)$.

At the anode, oxygen gas is discharged/$20^{2-} = 0_2 + 4^{e-}$



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) $KA1\ (S04)_2\ 12\ H_20$ – (2)
Name: Potassium aluminum III tetra oxosulphate VI duodecahydrate or NH_4
$Fe\ (S04)_2.12H_20$

Ammonium Chromium III tetraoxosulphate VI duodecahydrate

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.

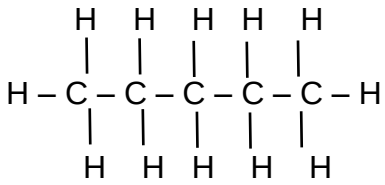
Solution:
Duralumin Composition AL, Mg, Cu, Mn
Use – construction of car, Aeroplane, Railways Coaches, ship.

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

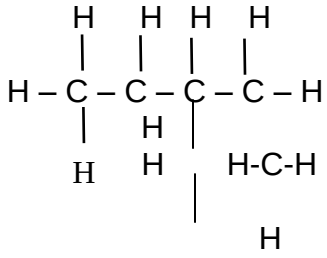
2a. Give correct IUPAC Names and Structures of Isomers of $C_5 H_{,12}$

Solution

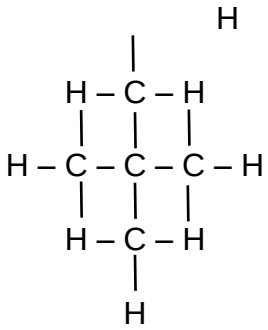
Pentane:



2 methy Butane:



2,2, dimethylpropane



2bi State THREE differences between aliphatic and aromatic hydrocarbons
Give THREE uses of Benzene

Solution

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

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
$C_2 H_5 OH(hq) + 2\{0\} \longrightarrow CH_3 CO_0 H + H_2 0$

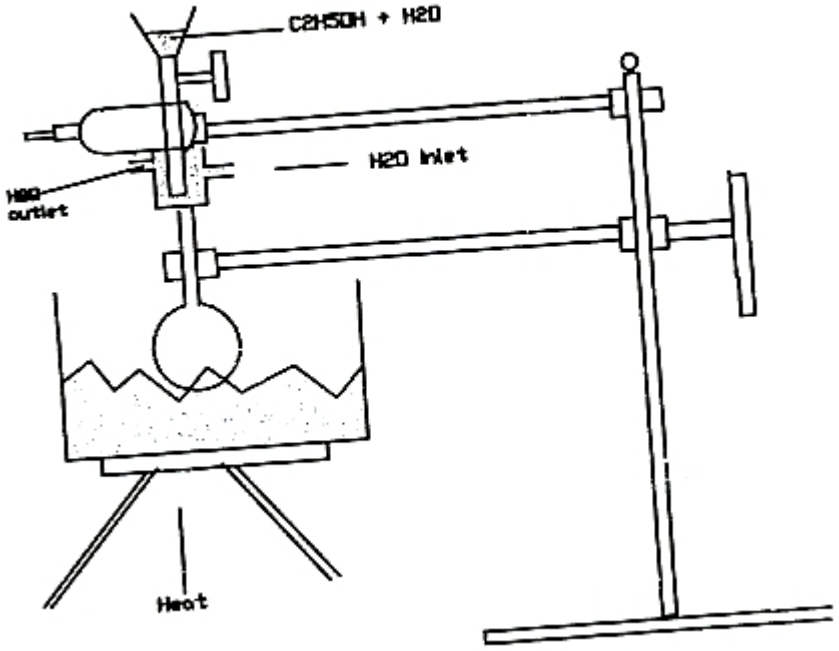
OR

$C_2 H_5 OH + (0) \longrightarrow CH_3 CH0\ [0]\ CH_3 COOH$

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 Ethanonate
ii) Ethyl Ethanonate
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.

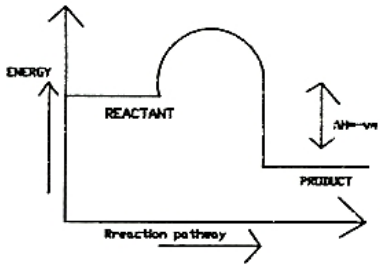
ii) Total entropy change must be positive i.e. ΔS (total) >0 free energy of the system must be negative i.e. $\Delta G < 0$.
Transition Energy complex must be reached.

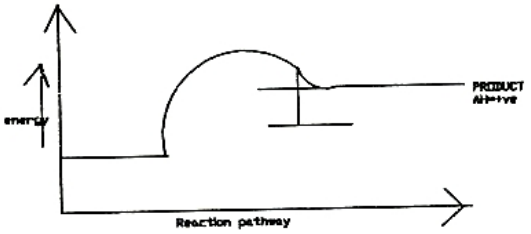
B. With the aid of a diagram state FOUR differences between exothermic and endothermic reactions.

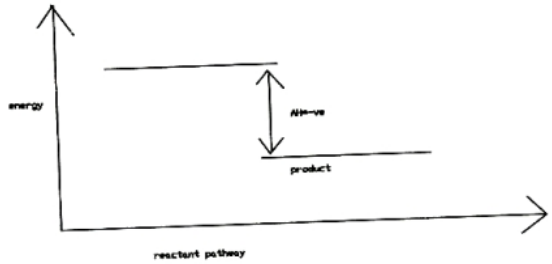
Solutions

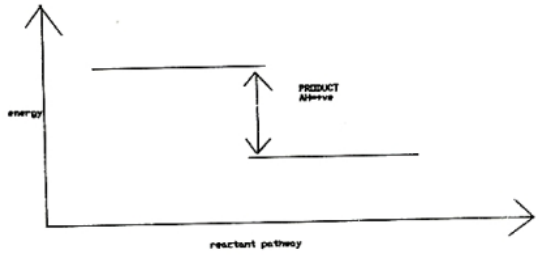
	Exothermic Reaction	Endothermic Reaction
1.	ΔH is negative	ΔH is positive
2.	Heat is liberated from surrounding	Heat is absorbed from surrounding
3.	Preaction vessel is always warm	Reaction vessel is always cold
4.	No external heat supply to system after commencement of reaction	There is an external Heat to the system after commencement of reaction

Profile diagrams









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 partices.

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, 0= 16]

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

$\frac{6.44}{1000} \times 100$ = 0.644 mole of salts

Molar mass of KNO_3
= 39 + 14 + (16 x 3)
= 101 g/mole

Therefore Mass of salt = 0.644 x 101 = 65 . 044
= 65.0g

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 C_2, CS_2, S, C_4 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

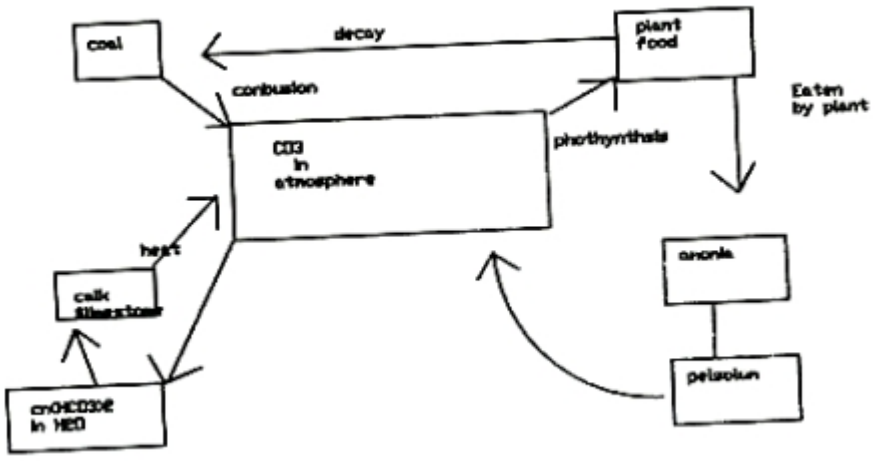
b. Explain the destructive distillation of coal.

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).

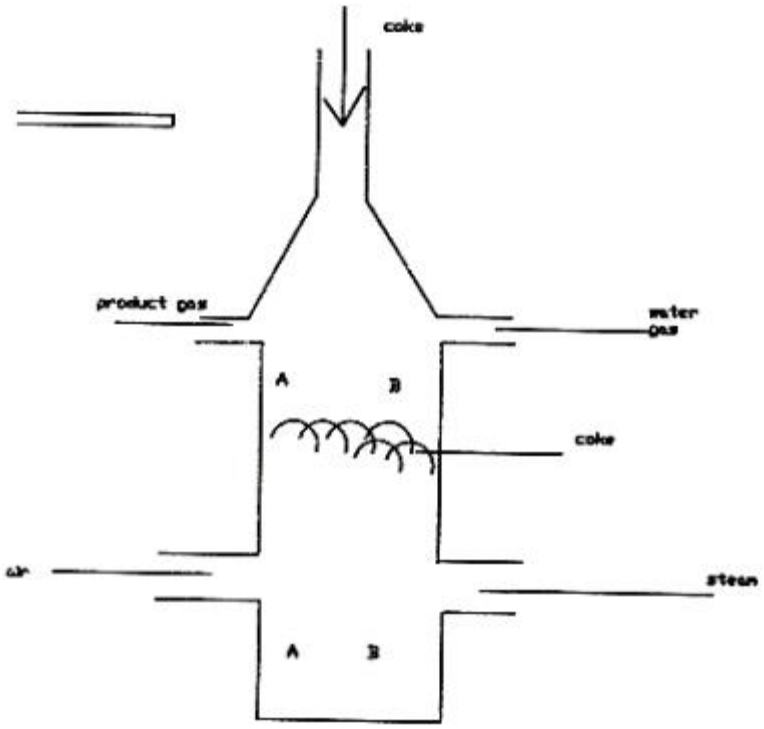
The products of such distillation are coke, ammonical liquor, coal far, coal gas

c. Draw a simple diagram to explain carbon cycle



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, 0 = 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 $2C + 0_2 \rightarrow 2C0$. 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 $C(s) + H_2O(g) \longrightarrow Co(g) + H_2$

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

ii. Molar mass of $C_o = 12 + 16 = 28g$
Molar mass of $C_o = 12 + (16 \times 2) = 44g$ $2\ C_0 + {}^{0}2 \longrightarrow 2\ C\ {}^{0}2$

Therefore 56g Co Producers 58g C_{02}
Therefore 1.54g Co Producers $88/56 \times 1.54$
$= 2.42g \quad C0_2$

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. $3H_2(g) + N_2(g) \rightleftharpoons 2\ NH_{3(g)}\ \Delta H - 49.95\ KTmo1^{-1}$
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 increase
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 shits the quilibrium 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 it's decomposition is endothermic.
A decrease in temperature favours the exothermic process. Thus hydrogen and nitrogen combine to produce more of ammonia shifting equilibrium position to the right.

c. What is the valency of x in the compound $X_3\ Y_2$?

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

Solution:

i. The valency of x 152

ii. $Zn(s) + H_2\,So_4caq \longrightarrow ZnSo_4c(aq) + H_2\,(g)$