THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/2 **CHEMISTRY 2**

Time: 3 Hours **ANSWERS** **Mwaka: 2008**

Instructions

1. This paper consists of a total of six questions
2. Answer five questions.

1 (a) Define the following terms
(i) Half-life of a reaction
(ii) Rate law reaction
(iii) Activated complex

(i) Half-life of a reaction is the time required for the concentration of a reactant to decrease to half of its original value during a chemical reaction. It is constant in a first-order reaction and varies in other orders.

(ii) Rate law reaction is an expression that relates the rate of a chemical reaction to the concentration of the reactants. It is usually written in the form: Rate = $k[A]^n[B]^m$, where k is the rate constant and n, m are the reaction orders with respect to each reactant.

(iii) Activated complex is a short-lived, high-energy, unstable arrangement of atoms that forms at the peak of the activation energy barrier during a reaction. It represents the transition state between reactants and products.

1 (b) The decomposition of nitrogen (V) oxide at 45 °C is a first order reaction with a rate constant of 5.1×10^{-3} s^{-1}
$2N_2O_5(g) \text{ ---> } 4NO_2(g) + O_2(g)$

(i) What is the concentration of N_2O_5 after 192 seconds, if the initial concentration is 0.25 mol dm^{-3}?

For first-order reactions:
$[At] = [A_0]e\text{^}(-kt)$
$[At] = 0.25 \times e\text{^}(-(5.1\times10^{-3})\times192)$
$= 0.25 \times e\text{^}(-0.9792)$
$= 0.25 \times 0.3755$
= 0.0939 mol dm^{-3}

(ii) How long will it take for the concentration of N_2O_5 to decrease from 0.25 mol dm^{-3} to 0.15 mol dm^{-3}?

Using first-order formula:
$t = (1/k) \times \ln([A_0]/[At])$
$t = (1/5.1\times10^{-3}) \times \ln(0.25/0.15)$
$= 196.08 \times \ln(1.6667)$
$= 196.08 \times 0.5108$
= 100.22 seconds

(iii) How long will it take to convert 62% of the starting material?

62% decomposed means 38% remains, i.e. $[At] = 0.38 \times [A_0]$
$t = (1/k) \times \ln([A_0]/[At])$
$= (1/5.1\times10^{-3}) \times \ln(1/0.38)$

$= 196.08 \times \ln(2.6316)$
$= 196.08 \times 0.9676$
$= 189.57$ seconds

1 (c) In the hydrolysis of ethylacetate using equal concentrations of ester and sodium hydroxide, the following results were obtained:
$CH_3COOC_2H_5 + NaOH \text{--->} CH_3COONa + C_2H_5OH$

Time (min): 0 5 15 25 33
Volume of HCl (cm^3): 16.00 10.24 6.18 4.32 3.41

To show second order, we use the second order integrated rate law:
$1/[A] = kt + 1/[A_0]$

Since volume of HCl is proportional to concentration of remaining NaOH, we can plot 1/[Volume] against time. If the plot is linear, the reaction is second order. The values of 1/Volume over time are:

$1/16.00 = 0.0625$
$1/10.24 = 0.0977$
$1/6.18 = 0.1618$
$1/4.32 = 0.2315$
$1/3.41 = 0.2932$

As 1/Volume increases linearly with time, the reaction is second order.
2 (a) What is the difference between solubility and solubility product?

Solubility refers to the maximum amount of a solute that can dissolve in a given quantity of solvent at a specific temperature to form a saturated solution. It is usually expressed in g/100 cm^3 or mol/L.

Solubility product (Ksp) is the equilibrium constant for the dissolution of a sparingly soluble ionic compound. It represents the product of the molar concentrations of the ions raised to the power of their stoichiometric coefficients in the dissolution equation. It is used to predict whether a precipitate will form in a solution.

2 (b)
(i) Will a precipitate of CaF_2 form when 50 cm^3 of 5×10^{-4} M $Ca(NO_3)_2$ is mixed with 50 cm^3 of 2×10^{-4} M NaF?
Ksp of CaF_2 is 1.7×10^{-10}

First, calculate final concentrations after mixing:
$[Ca^{2+}] = (50/100) \times 5 \times 10^{-4} = 2.5 \times 10^{-4}$ M
$[F^-] = (50/100) \times 2 \times 10^{-4} = 1.0 \times 10^{-4}$ M

Now calculate ionic product:
$Q = [Ca^{2+}] \times [F^-]^2$
$Q = (2.5 \times 10^{-4}) \times (1.0 \times 10^{-4})^2$
$= 2.5 \times 10^{-12}$

Compare Q with Ksp:
$Q < K_{sp}$ $(2.5 \times 10^{-12} < 1.7 \times 10^{-10})$
Since Q < Ksp, no precipitate of CaF_2 will form.

(ii) Comment on the solubility of $PbCl_2$ in water and in 1 M lead nitrate solution.

$PbCl_2$ is sparingly soluble in water, meaning it dissolves to a small extent, producing Pb^{2+} and Cl^- ions. However, in 1 M $Pb(NO_3)_2$ solution, due to the common ion effect (presence of Pb^{2+} ions from $Pb(NO_3)_2$), the solubility of $PbCl_2$ decreases. The equilibrium shifts backward, reducing the dissolution of $PbCl_2$, leading to lower solubility.

2 (c) Giving an example in each case explain what is meant by
(i) Brønsted–Lowry concept of an acid and base

According to the Brønsted–Lowry concept, an acid is a proton (H^+) donor and a base is a proton acceptor.
Example: In the reaction $HCl + NH_3 \text{--->} NH_4^+ + Cl^-$, HCl donates a proton to NH_3, making HCl a Brønsted–Lowry acid and NH_3 a Brønsted–Lowry base.

(ii) Lewis acid

A Lewis acid is a substance that accepts a pair of electrons to form a covalent bond.
Example: BF_3 acts as a Lewis acid when it accepts a pair of electrons from NH_3 to form a coordinate bond in $BF_3 \cdot NH_3$ complex.

3 (a) Define the following terms
(i) Enthalpy of solution
(ii) Standard heat of vaporisation
(iii) Standard enthalpy of atomisation
(iv) Dissociation energy

(i) Enthalpy of solution is the heat change that occurs when one mole of a solute dissolves in a solvent to form an infinitely dilute solution under standard conditions.

(ii) Standard heat of vaporisation is the enthalpy change required to convert one mole of a liquid into vapour at constant pressure under standard conditions.

(iii) Standard enthalpy of atomisation is the enthalpy change required to produce one mole of gaseous atoms from an element in its standard state.

(iv) Dissociation energy is the amount of energy required to break one mole of bonds in a gaseous molecule to form separate atoms.

3 (b) State Hess's law of heat summation.

Hess's law states that the total enthalpy change in a chemical reaction is the same regardless of the number of steps or the path taken, provided the initial and final conditions are the same.

3 (c) The combustion of carbon disulphide is exothermic and the enthalpy of combustion of the compound is 1108 kJ mol^{-1}. Given that carbon dioxide and sulphur dioxide are exothermic compounds with enthalpies of formation of -405 and -294 kJ mol^{-1} respectively,

(i) Calculate the enthalpy of formation of carbon disulphide.

Combustion reaction: $CS_2 + 3O_2 \text{--->} CO_2 + 2SO_2$
$\Delta Hc = \Delta Hf(\text{products}) - \Delta Hf(\text{reactants})$

$\Delta Hc = [(-405) + 2\times(-294)] - \Delta Hf(CS_2)$
$1108 = -405 - 588 - \Delta Hf(CS_2)$
$1108 = -993 - \Delta Hf(CS_2)$
$\Delta Hf(CS_2) = -993 - 1108 = -2101$ kJ mol^{-1}

(ii) Comment on the stability of this compound at various temperatures considering the result obtained in the light of Le Chatelier's principle.

The combustion is highly exothermic, indicating that CS_2 is thermodynamically unstable and readily releases energy when reacting with oxygen. According to Le Chatelier's principle, increasing temperature would shift equilibrium backward in an exothermic reaction, hence reducing the yield of combustion products. Thus, CS_2 is more stable at lower temperatures and becomes more reactive at higher temperatures, which affects its practical storage and handling conditions.

4 (a)
(i) Define oxidation and reduction in terms of current flow

Oxidation is the loss of electrons by a species and occurs at the anode where current flows away from the substance. Reduction is the gain of electrons and occurs at the cathode where current flows toward the substance.

(ii) Write the oxidation state of sulphur and carbon in the following radicals:
$S_4O_6^{2-}$ and $C_2O_4^{2-}$

In $S_4O_6^{2-}$: Let oxidation state of sulphur be x
$4x + 6(-2) = -2$

$4x - 12 = -2$
$4x = 10 \rightarrow x = +2.5$ (Average oxidation state per sulphur atom)

In $C_2O_4^{2-}$: Let oxidation state of carbon be x
$2x + 4(-2) = -2$
$2x - 8 = -2$
$2x = 6 \rightarrow x = +3$ (Each carbon atom has oxidation state +3)

4 (b) Balance the following reactions which take place in acidic solutions:

(i) $ClO_3^-(aq) + I^-(aq) \text{--->} I_2(aq) + Cl^-(aq)$
Balanced equation:
$ClO_3^- + 6I^- + 6H^+ \text{--->} 3I_2 + Cl^- + 3H_2O$

(ii) $Cr_2O_7^{2-}(aq) + I^-(aq) \text{--->} Cr^{3+}(aq) + I_2(aq)$
Balanced equation:
$Cr_2O_7^{2-} + 6I^- + 14H^+ \text{--->} 2Cr^{3+} + 3I_2 + 7H_2O$

(iii) $S_2O_3^{2-}(aq) + I_2(aq) \text{--->} I^-(aq) + S_4O_6^{2-}(aq)$
Balanced equation:
$2S_2O_3^{2-} + I_2 \text{--->} 2I^- + S_4O_6^{2-}$

4 (c) A standard solution made by dissolving 1.015 g of potassium dichromate (VI) is made up to 250 cm³. A 25.00 cm³ portion is added to an excess of potassium iodide and dilute sulphuric acid. The iodine liberated required 19.20 cm³ of sodium thiosulphate.

Reaction between thiosulphate and iodine:
$2S_2O_3^{2-} + I_2 \text{--->} 2I^- + S_4O_6^{2-}$

First, calculate moles of $K_2Cr_2O_7$ in 250 cm³:
Molar mass $K_2Cr_2O_7 = (2\times39.1) + (2\times52) + (7\times16) = 294.2$ g/mol
Moles = 1.015 / 294.2 = 0.00345 mol
Molarity = 0.00345 mol / 0.25 L = 0.0138 mol/L

Moles in 25 cm³ = $0.0138 \times 0.025 = 3.45 \times 10^{-4}$ mol
Each mole of dichromate liberates 3 moles of I_2:
Moles of $I_2 = 3 \times 3.45 \times 10^{-4} = 1.035 \times 10^{-3}$ mol

From reaction with thiosulphate:
1 mol I_2 reacts with 2 mol $S_2O_3^{2-}$
Moles of $S_2O_3^{2-} = 2 \times 1.035 \times 10^{-3} = 2.07 \times 10^{-3}$ mol

Volume = 19.20 cm³ = 0.0192 L

Concentration = 2.07×10^{-3} mol / 0.0192 L = 0.108 mol/L

5 (a) (i) Give five (5) anomalies (peculiar properties) of nitrogen

- Nitrogen exists as a diatomic gas (N_2) unlike other group 15 elements.
- Nitrogen shows ability to form multiple bonds (triple bonds) which is rare for others in its group.
- Nitrogen has small size and high electronegativity compared to its group members.
- Nitrogen forms stable oxides like N_2O, NO, which are not stable for others.
- Nitrogen forms hydrogen bonding in ammonia (NH_3), enhancing its solubility and boiling point.

(ii) Although NH_3 and phosphine are hydrides of group five, NH_3 is a Lewis base while phosphine is not. Give reasons for such state.

NH_3 has a lone pair on nitrogen in a small and highly electronegative atom, making it easily available for donation, hence acting as a Lewis base. In contrast, the lone pair on phosphorus in PH_3 is held more tightly and is less available for bonding due to lower electronegativity and larger size, making PH_3 a poor Lewis base.

5 (b) Explain the following:

(i) $SiCl_4$ hydrolyses in water but not CCl_4
$SiCl_4$ has empty d-orbitals that can accept electron pairs from water molecules, leading to hydrolysis. CCl_4 has no vacant d-orbitals and thus does not hydrolyze.

(ii) When SO_2 is bubbled through acidified aqueous solution of $K_2Cr_2O_7$, the yellow colour of the latter turns green.
SO_2 is a reducing agent and reduces $Cr_2O_7^{2-}$ (orange/yellow) to Cr^{3+} (green).
Equation: $Cr_2O_7^{2-} + 3SO_2 + 6H^+ \text{--->} 2Cr^{3+} + 3SO_4^{2-} + 3H_2O$

(iii) Hard water forms lather with soapless detergents but not with soapy detergents
Soap forms insoluble precipitates with calcium and magnesium ions in hard water. Soapless detergents do not form such precipitates, hence lather forms easily.

(iv) Silver chloride salt is insoluble in water but readily soluble in aqueous ammonia
AgCl dissolves in ammonia forming a complex ion $[Ag(NH_3)_2]^+$, which increases solubility in ammonia.

(v) The boiling point of water is higher than that of H_2S although the molar mass of H_2S is larger than that of water
Water forms strong hydrogen bonds which require more energy to break, leading to a higher boiling point than H_2S, which lacks strong hydrogen bonding.

(vi) Although HNO_3 is an oxidizing agent, it is transported using containers made of Aluminium

Aluminium forms a protective oxide layer (Al_2O_3) that prevents further reaction with nitric acid, making it safe to store.

6 (a) Explain briefly and concisely the following properties of transition elements, ions or molecules:
(i) Magnetism
Transition elements show magnetism due to unpaired d-electrons. The presence of these unpaired electrons creates magnetic moments, leading to paramagnetic properties.
(ii) Coloured compound formation
Transition metal compounds are often coloured due to d-d electron transitions within the d-orbitals. When light is absorbed to excite an electron, the remaining transmitted light gives the compound its observed colour.

6 (b)(i) Explain the form of the d-orbital splitting diagram for trigonal bipyramidal complexes of formula ML_5 and square pyramidal complexes of formula ML_5
In trigonal bipyramidal geometry, the d-orbitals split into three energy levels due to axial and equatorial ligand interactions. In square pyramidal geometry, splitting occurs differently due to strong interaction in the square plane and one axial ligand, giving a different set of orbital energies.

(ii) What would be the expected magnetic properties of such complexes of Ni(II)?
Ni(II) has a $3d^8$ configuration. Depending on the ligand field strength, it may exhibit either paramagnetic (with unpaired electrons) or diamagnetic behavior (if all electrons are paired in strong field ligands). In most ML_5 geometries, Ni(II) remains paramagnetic with two unpaired electrons.
7 (a) Write the IUPAC names of the following complex compounds:

(i) $[Ag(NH_3)_2]_4[Fe(CN)_6]$
Tetra(diammine silver(I)) hexacyanoferrate(II)

(ii) $[Pt(NH_3)_3(C_2O_4)Cl]Cl$
Triamminechloridooxalato platinum(IV) chloride

(iii) $K[Au(CN)_2]$
Potassium dicyanoaurate(I)

(iv) $NaVO_3$
Sodium metavanadate

7 (b) Give explanations of the following (use chemical equations where necessary):

(i) Aluminium metal does not react with hot water or steam
Aluminium forms a protective oxide layer (Al_2O_3) on its surface which prevents it from further reacting with water or steam, hence appearing unreactive under such conditions.

(ii) F_2 and Cl_2 exist as gases, Br_2 exists in the liquid form while I_2 exists as solid

This is due to increasing molecular size and van der Waals forces. As we go down the group, intermolecular forces increase, making F_2 and Cl_2 gases, Br_2 a liquid, and I_2 a solid at room temperature.

(iii) A solution of ammonium chloride has the pH less than seven
NH_4^+ ion hydrolyses in water releasing H^+ ions:
$NH_4^+ + H_2O \text{ ---> } NH_3 + H_3O^+$
This makes the solution acidic with pH less than 7.

(iv) Lithium carbonate is easily decomposed thermally compared with sodium carbonate
Due to the small size of lithium ion, Li_2CO_3 is less stable and decomposes easily to form Li_2O and CO_2, while Na_2CO_3 is more thermally stable due to less polarizing power of Na^+ ion.

(v) Sodium metal is very soft compared with magnesium metal
Sodium has a larger atomic radius and weaker metallic bonding compared to magnesium, making it softer and easily cut with a knife.

(vi) Silicon tetrachloride ($SiCl_4$) can be hydrolyzed by water, but carbon tetrachloride (CCl_4) cannot
$SiCl_4$ has vacant d-orbitals which allow attack by water molecules, leading to hydrolysis. CCl_4 lacks such d-orbitals and hence is inert to water.

8 (a) Show how ethanol reacts with:

(i) A mixture of amalgamated zinc (Zn/Hg) and concentrated hydrochloric acid
This is a Clemmensen reduction, but ethanol is not a carbonyl compound. Therefore, no significant reaction is expected. Usually used for reducing carbonyl groups to alkanes.

(ii) Hydroxylamine ($H_2N–OH$)
$CH_3CH_2CHO + H_2N–OH \text{ ---> } CH_3CH_2CH=N–OH + H_2O$
(Ethanol does not react; aldehydes or ketones react with hydroxylamine)

(iii) Sodium hydrogen sulphite ($NaHSO_3$)
Ethanol does not form bisulfite addition compounds. This reaction is typically for aldehydes or ketones.

8 (b) Two compounds A and B, all carbonyl compounds, have the same molecular formula C_3H_6O.

(i) Draw possible structural formulae for A and B
A: CH_3CH_2CHO (Propanal - aldehyde)
B: CH_3COCH_3 (Propanone - ketone)

(ii) Describe tests (reagents, conditions and observations with each compound) that would show that A and B are carbonyl compounds.

- 2,4-DNP test:

Both give orange/yellow precipitate indicating presence of carbonyl group.

- Tollens' test:

Aldehyde (propanal) gives silver mirror; ketone (propanone) gives no reaction.

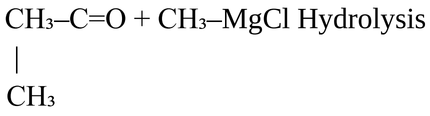
- Fehling’s solution:

Aldehyde gives brick red precipitate; ketone gives no reaction.

(iii) Suggest the class of another compound having the same molecular formula that is not a carbonyl compound. What type of isomerism does it exhibit with respect to A and B?

Class: Alcohol (e.g., $CH_3CH(OH)CH_3$ – Isopropanol)
It exhibits functional group isomerism with propanal and propanone.

8 (c) Complete the following equations by giving the structural formulae of the products of the reaction. Assume that the reaction proceeds to completion.

(i) 

$CH_3-\underset{\underset{CH_3}{|}}{C}=O + CH_3-MgCl$ Hydrolysis

This is a Grignard reaction. The product is a tertiary alcohol:
$CH_3-C(OH)(CH_3)CH_3$ ----> 2-methyl-2-butanol
8 (c) Complete the following equations by giving the structural formulae of the products of the reaction. Assume that the reaction proceeds to completion:

(ii) $CH_3-C\equiv CH + H_2O \rightarrow H_2SO_4/HgSO_4$
Hydration of alkyne leads to formation of ketone via enol intermediate.
$CH_3-C(OH)=CH_2$ (enol) tautomerizes to $CH_3-CO-CH_3$ (propanone)

(iii) $CH_3-CO-CH_3 + H_2N-NH-C_6H_4-NO_2$
This is a condensation reaction between a ketone and substituted hydrazine.
Product: $CH_3-C=N-NH-C_6H_4-NO_2$ (hydrazone derivative)

(iv) $CH_3-CO-CH_2-CH_3 + I_2$ + excess NaOH
This is the iodoform reaction. CH_3CO group reacts to give iodoform.
Products: $CHI_3 + CH_3CH_2COONa$

(v) $CH_3-CO-CH_3 + LiAlH_4$
Reduction of ketone to secondary alcohol.
Product: $CH_3-CH(OH)-CH_3$ (propan-2-ol)

(vi) $CH_3-CHO + [Ag(NH_3)_2]^+ + OH^-$

Tollen’s reagent test. Aldehyde is oxidized to acid and Ag^+ is reduced.
Product: CH_3COOH + silver mirror (Ag)

9 (a)
(i) Define the term dissociation constant of ethanoic acid in aqueous solution.
It is the equilibrium constant (Ka) for the dissociation of ethanoic acid (CH_3COOH) in water to produce CH_3COO^- and H_3O^+ ions.

(ii) Give a detailed account of the effect of substituents on the acidity of aliphatic carboxylic acid.
Electron-withdrawing groups like -Cl, $-NO_2$ increase acidity by stabilizing the conjugate base ($RCOO^-$) via inductive effect. Electron-donating groups like $-CH_3$ decrease acidity by destabilizing the conjugate base.

(iii) Under what conditions is the pH of an aqueous solution of an acid equal to the pKa of the acid?
When concentrations of acid and its conjugate base are equal, that is, during buffer solution formation. At this point, pH = pKa.

9 (b) Show how you would attempt the following transformation:
Toluene ---> 4-nitrobenzoic acid

Step 1: Oxidation of methyl group
$C_6H_5CH_3$ + [O] ----> C_6H_5COOH (benzoic acid) using $KMnO_4$ or $K_2Cr_2O_7$

Step 2: Nitration
C_6H_5COOH + HNO_3 + H_2SO_4 ---> 4-nitrobenzoic acid (para-nitro product favored due to COOH being meta-directing)

9 (c) An aromatic carboxylic acid A (Mr = 166) contains 57.83% C, 3.64% H, 38.53% O by mass.

(i) Calculate the molecular formula of A
C: $57.83 \div 12 = 4.819$ mol
H: $3.64 \div 1 = 3.64$ mol
O: $38.53 \div 16 = 2.408$ mol

Divide by smallest:
$C = 4.819 \div 2.408 \approx 2$
$H = 3.64 \div 2.408 \approx 1.5$
$O = 2.408 \div 2.408 = 1$

Multiply to get whole numbers:
C = 4, H = 3, O = 2 ---> Empirical formula $C_8H_6O_2$
Mr of $C_8H_6O_2$ = 166 ---> molecular formula is $C_8H_6O_4$

(ii) Draw three possible structures of the acid:

1. 1,2-benzenedicarboxylic acid (phthalic acid)
2. 1,3-benzenedicarboxylic acid (isophthalic acid)
3. 1,4-benzenedicarboxylic acid (terephthalic acid)

10 (a) Define the following terms and give one example in each case:

(i) Condensation polymerisation
This is a type of polymerisation where monomer units join together by elimination of small molecules such as water or HCl.
Example: Formation of Nylon 6,6 from hexamethylenediamine and adipic acid.

(ii) Addition polymerisation
This is a polymerisation reaction in which unsaturated monomers (usually containing double bonds) join together without elimination of any molecule.
Example: Formation of polythene from ethene.

10 (b) The structure drawn below represents a polymer:

(i) Name two classes of compounds to which the large molecule could belong.
The polymer belongs to:
- Polyamide (because of the –CONH– link)
- Protein/Peptide type structure (biological polyamide)

(ii) If the compound is hydrolysed by boiling with hydrochloric acid, four smaller molecules would be formed from the structure. Draw the structural formula of each of these molecules:
Hydrolysis breaks amide bonds to form corresponding diamines and dicarboxylic acids or derivatives. Likely products:
- $HOOC–CH(CH_3)–CH_2–COOH$ (dicarboxylic acid)
- $H_2N–(CH_2)_4–NH_2$ (butane-1,4-diamine)
- $HOOC–CH_2–CH(CH_3)–COOH$ (another dicarboxylic acid)
- $H_2N–C_6H_{14}$ (aromatic diamine)

10 (c) Which of the following substituent entered the benzene ring first?

(i) CH_3 and OH (activating and ortho/para directing)
(ii) CH_3 and NO_2 (CH_3 is activating, NO_2 is deactivating meta-directing)
(iii) OH and Cl (OH directs ortho/para, Cl directs ortho/para but is deactivating)
(iv) NO_2 and Cl (NO_2 is meta-directing, Cl is ortho/para directing)

From the positions in structures:
(i) CH_3 entered first
(ii) CH_3 entered first
(iii) OH entered first

(iv) NO_2 entered first

10 (d) Write the complete structures of the monomers used to prepare each of the following polymerization reactions:

(i) Dacron
Monomers:
- Terephthalic acid ($HOOC–C_6H_4–COOH$)
- Ethylene glycol ($HO–CH_2–CH_2–OH$)

(ii) Nylon 6,6
Monomers:
- Adipic acid ($HOOC–(CH_2)_4–COOH$)
- Hexamethylenediamine ($H_2N–(CH_2)_6–NH_2$)

(iii) Polystyrene
Monomer:
- Styrene ($CH_2=CH–C_6H_5$)