St Henry's college Kitovu
Aisu D-n
Chemistry seminar 2024

1. a) Define the following terms;
    i)   Complex ion
    ii) Co-ordination number
    iii) Oxidation number

    b) For each of the following compounds, state their name, oxidation number and their coordination number.
    i) $[Cu(H_2NCH_2CH_2NH_2)_2]Cl_2$
    ii) $K_2Ni(CN)_4$
    iii) $[Fe(CN)_5NO]^{2-}$
    iv) $[Co(NH_3)_5Cl]^{2+}$
    v) $[CrCl(NH_3)_5]Cl_2$
    vi) $[Mn(C_2O_4)_3]^{3-}$

    c) Explain why;
    (i)   The oxidation state of zinc is not stated in the names of its compounds while for chromium it is always stated in the names of its compounds, yet the two elements are d-block elements.
    (ii)   Copper (i) salts are unstable than copper (ii) salts despite of copper (i) ion having a fully filled d sub energy level.
    (iii) Manganese (ii) chloride can be attracted by the magnet yet scandium chloride is not attracted by a magnet.

    (iv)   Iron is used to speed up the rate of formation of ammonia from nitrogen and hydrogen.

                                                  St. Aloysius Bwanda

2. Describe the importance of each of the following reagent in organic chemistry. Clearly state the nature of the reaction involved and the conditions under which it is carried out.
    a) zinc-copper couple
    b) Sodium nitrite
    c) Finely divided nickel

d) Nitric acid
c) Magnesium
d) Thionyl chloride
c) Lithium aluminium tetrahydride
f) Sulphuric acid

3. Name the reagent which;
   a) Gives a similar observation when treated with each member of the following pairs of compounds and in each case state what is observed and write the equation of the reaction that leads to the observation.
      i) Phenylethanone and propan-2-ol
      ii) Propan-1-ol and propanoic acid
      iii) Ethanol and propanal
      iv) Amino benzene and hydroxybenzene
   b) Can distinguish between the following pairs and in each case state what is observed when treated with each member following pairs of compounds
      i) 1-phenyl, 1- bromomethane and benzene bromide
      ii) ethane-1, 2- dioc acid and methanioc acid
      iii) Ethanal and propanal
      iv) Phenol and cyclohexene

Isaac Newton High School

4. a) Define the following
      i) Order of reaction
      ii) Activation energy of a reaction
   b) Describe an experiment to determine the order of the reaction of hydrogen peroxide.
   c) The following kinetic data in the table below were obtained for the decomposition of hydrogen peroxide.

Log of concentration of H_2O_2 (moldm^{-3})	-2.889	-3.119	-3.444	-3.854	-4.000
Time (minutes)	5	12	20	35	40

   i) Represent the above data on the graph.

d) Use your graph to determine the time take for;

    i) The concentration of hydrogen peroxide to reduce by half.

    ii) Hydrogen peroxide to decompose to a concentration of 2.5×10^{-6} $moldm^{-3}$

5. Explain the following;

    a) Ethanal undergoes neucleophilic addition reaction whereas ethene does not.

    b) Chlorohexane forms a white precipitate with silver nitrate solution in presence of sodium hydroxide solution while chlorobenzene does not.

    c) Ethene reacts with bromine to form 1,2-dibromoethane. But when the reaction carried out in the presence of sodium chloride, 1-bromo-2-chloroethane is formed.

    d) Dimethylamine is a stronger base than phenyl amine.

    e) Nitrogen only forms one chloride (NCl_3) whereas phosphorus forms two chlorides PCl_3 and PCl_5

6. A mixture of nickel (ii) sulphate and chromium (iii) chloride was dissolved in water to form a solution X. solution X was divided into two portions and to first portion add sodium hydroxide solution till in excess and the resultant solution was filtered.

    a) To the filtrate, hydrogen peroxide was added followed by;

        (i) Dilute sulphuric acid. State what was observed and write equations for reaction that took place.

        (ii) Silver nitrate solution. State what was observed and write equations for reaction that took place.

    b) To the residue, ammonia solution was added drop wise until no further change. Suggest a suitable explanation for your observations.

c)   To the resultant solution in (b) dilute hydrochloric acid drop wise till the solution is just acidic. State what is obse. write the equation for the reaction that took place.

d)   (i)   To the second portion of solution X, barium nitrate was ad. State Suggest a suitable explanation for your observations.

(ii) The resultant mixture was filtered, and to the filtrate, silver nitrate solution was added followed by ammonia solution drop wise till in excess. Suggest a suitable explanation for your observations.

KABUKUNGE S.S

7.   a)   Beryllium is chemically different from other group (ii) members but its chemical properties are similar to those of aluminium.

(i)   Give reasons why beryllium is chemically different from other group (ii) members.
(ii)   State different ways in which beryllium is chemically different from other group (ii) members.
(iii) State the name of the relationship shown by beryllium and aluminium and state other elements that exhibit the same relationship.

b)   Describe the reactions of beryllium and barium with;

(i)   Sodium hydroxide solution
(ii)   Sulphuric acid
(iii) Water

c)   Explain why beryllium chloride solutions form a white precipitate which dissolves in excess to form a colourless solution with sodium hydroxide soluble but with magnesium chloride forms a white precipitate insoluble in excess.

NGANDO S.S

8.   Carbon, silicon, germanium and tin and some of the elements in group (iv) of the periodic table.

(i)   Metallic character
(ii)   Melting point

b)   Describe the reaction of elements with;
    (i)   Air
    (ii)   Nitric acid
    (iii) Hydrochloric acid

c)   Explain the following observation
    (i)   Carbon dioxide is gas at room temperature whereas silicon (iv) oxide is a solid.
    (ii)   Tin (iv) chloride exist but tin (iv) bromide does not exist.

La mennais S.S Kyotera

9.   a)   Explain what is meant by the terms
    i)   Neucleophilic bimolecular reaction
    ii)   Activated complex

b)   Bromo-ethane reacts with sodium hydroxide according to the equation.

$$CH_3CH_2Br\ (l) + OH^-\ (aq) \longrightarrow CH_3CH_2OH\ (aq) + \ Br^-(aq)$$

If the enthalpy of formation of sodium hydroxide, bromomethane, ethanol and sodium bromide are $-$ 469.8, -112.2, -277.69 and -394.4kJ/mol respectively;
    i)   Draw a fully labelled diagram of energy versus reaction path for the reaction
    ii)   Write the rate equation for the reaction.
    iii) Outline the mechanism for the reaction.

St. Stephen's College Bajja

10. a)   Explain what is meant by:
    (i)   Rate equation
    (ii)   Order of reaction
    (iii) Rate constant

b)   The kinetic data for the reaction between substances X and Y are shown below.

[X] (moldm^{-3})	[Y] (moldm^{-3})	Rate (moldm^{-3}s^{-1})
5.0×10^{-3}	5.0×10^{-3}	3.0×10^{-3}
1.0×10^{-2}	1.0×10^{-2}	6.0×10^{-3}
5.0×10^{-3}	1.0×10^{-2}	6.0×10^{-3}

Determine the

(i) Rate equation for the reaction and deduce its effect on the initial rate of reaction.

(ii) Value of rate constant and state its units

(iii) Initial rate of the reaction when the concentration of X and Y are 1.5×10^{-2} and 7.5×10^{-3} moldm-3 respectively.

c) (i) Derive the expression for half life of the reaction.

(ii) Determine the half life of the reaction.

d). Explain how temperature affects the rate constant of the reaction

Isaac Newton

11. (a) What is meant by the azeotropic mixture.

(b) The diagram below shows the boiling point – composition curve of benzene and ethanol.
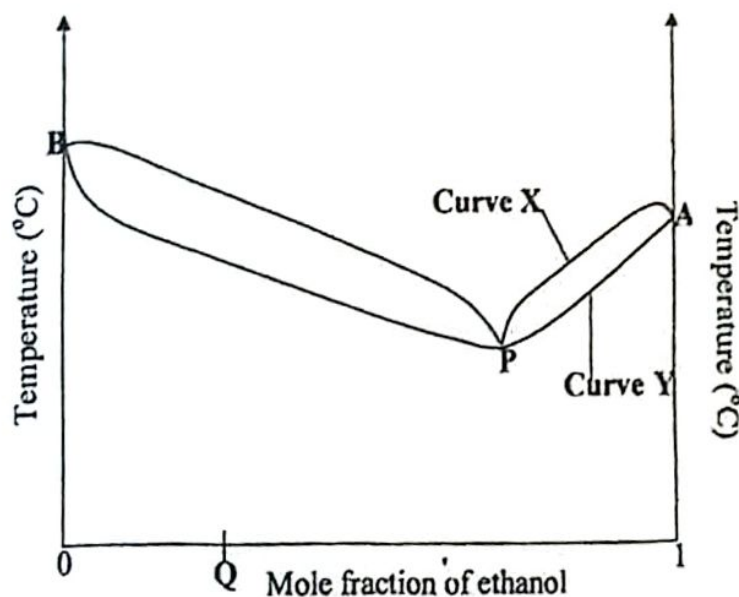
(i) Identify curve labeled X and Y and points A, B and P

(ii)   Suggest a reason as to why the mixture of ethanol and benzene shows the above boiling point- composition diagram.

(iii) Describe what happens when a mixture of mole fraction Q is fractionally distilled

(iv)   Draw the vapour pressure -composition diagram for the above system.

<div align="right">St. Henry's College Kitovu</div>

12.   a)   (i)   What is meant by the term equilibrium constant?

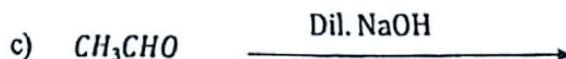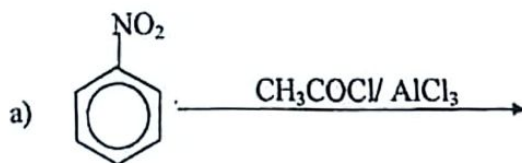   (ii)   State 3 characteristics of chemical equilibrium.   14

Phosphorus pentachloride decomposes when heated at 190°C according to the following equation.
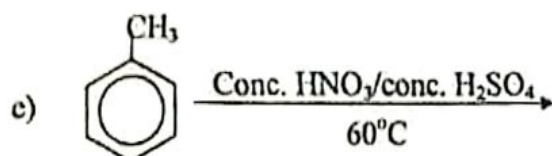
$$PCl_5(s) \longrightarrow PCl_3(s) + Cl_2 (g)$$

b)   Describe an experiment to determine the equilibrium constant Kc for the reaction.

c)   The degree of dissociation of 3.6 moles of phosphorus pentachloride in 2 litre vessel was found to be 40%. Calculate the equilibrium constant Kc for the reaction.

d)   State with a reason, what would happen to the value of the equilibrium constant and position of the equilibrium if;

      (i)   Pressure of the system is increased

      (ii)   Argon is added to the system at constant volume.

<div align="right">St. Charles S.S. Kasasa</div>

13.   Complete the following equations and write the accepted mechanism.

a)   NO₂ benzene ring $\xrightarrow{CH_3COCl/ AlCl_3}$

b) $CH_3CH_2CHO \xrightarrow{H^+/H_2NNHCONH_2}$

c) $CH_3CHO \xrightarrow{Dil. NaOH}$

d) $CH_3COCH_2CH_3$ $\xrightarrow{\text{KCN/H}^+}$

e)

CH_3

$\xrightarrow[\text{60}^{\circ}\text{C}]{\text{Conc. HNO}_3\text{/conc. H}_2\text{SO}_4}$

14. When 7.05g of an organic compound T, on complete combustion yielded $10.08dm^3$ of carbon dioxide and 4.05g of water at s.t.p. 0.225g of T on vaporization at $273^{\circ}C$ and at $56.287kNm^{-2}$ occupied a volume of $193.04cm^3$.

a) (i) Calculate the empirical formula of T
   (ii) Determine the molecular formula of T

b) T burns with a sooty flame. Identify T

c) Write equation and suggest a mechanism for the reaction to show how the following compounds can be synthesized from T
   (i) Methoxy benzene
   (ii) Phenyl propanoate
   (iii) 4- hydroxyphenylethanone

(e) State what was observed and write equation for the reaction when aqueous bromine solution was added to T.

15. a) State what is meant by the following terms;
      (i) Eutectic mixture
      (ii) Eutectic point

   b) Table 1 below shows how the melting points of mixtures of bismuth and cadmium vary with composition.

Percentage of bismuth in the mixture	20	40	70	80	95
Melting point	83	70	95	100	117

   (i) Draw a fully labelled diagram for the bismuth- cadmium system
   (ii) Determine the eutectic temperature and the composition of the eutectic mixture.

       (iii)   Determine the melting point of pure bismuth and pure cadmium.

c)   (i)   Describe the changes that would take place when a liquid mixture of the above system containing 50% bismuth is cooled from $100^{\circ}C$ to $70^{\circ}C$.

    (ii)   Calculate the mass of cadmium that precipitated if 200g of the liquid mixture containing 10% bismuth was cooled from $100^{\circ}C$ to $80^{\circ}C$.

<div align="right">

Kabale Ssanje

</div>

16.   a)   Describe an experiment that is carried out to determine the solubility product of silver ethanedioate.

    b)   The solubility product, Ksp, of Silver ethanedioate in 5.3×10^{-3} $mol^{-3}l^{-3}$ at $25^{\circ}C$. Calculate the concentration of the following ions in a saturated solution of silvers ethanedioate
    (i)   Silver ions.
    (ii)   Ethanedioate ions.

    c)   Calculate the mass of silver nitrate that should be added to the saturated solution in (b) in order to reduce the concentration of ethanedioate ions to a third of its original values.

<div align="right">

St. Henry's College Kitovu

</div>

17.   a)   Explain the meaning of the following terms;
    (i)   Standard electrode potential.
    (ii)   Standard hydrogen electrode.

    b)   With the aid of a diagram, briefly describe how the standard electrode potential of copper can be determined.

    c)   The standard electrode potentials of copper and zinc are given below;

$$Fe^{2+} (aq) \longrightarrow Fe^{3+} (aq) + e \qquad\qquad E^{\ominus} = -0.77V$$
$$2Cr^{3+} (aq) + 7H_2O (l) \longrightarrow Cr_2O_7^{2-}(aq) + 14H^{+}(aq) + 6e \quad E^{\ominus} = -1.33V$$

    (i)   Write the cell notation and the equation for the overall cell reaction.
    (ii)   Calculate the $E^{\circ}cell$ in (d)(i).
    (iii)   Calculate the Gibb's free energy of the cell and state whether the reaction is feasible or not. Give a reason for your answer.

d) State two ways in which an electrolytic cell differs from an e.m.f cell.

e) A current of 2A was passed for 30 minutes through a cell containing dilute sulphuric acid and the hydrogen produced at the cathode collected. Calculate the volume of the hydrogen in cm^3 that was produced at 23°C and 100kPa.

f) State two applications of standard electrode potentials.

<div align="right">St. Victors S.S Kitaasa</div>

18. Fluorine is in group (VII) of the Periodic Table but it behaves differently from the rest of the group members.

    (a) (i) explain why fluorine behaves anomalously from the rest of group members.

          (ii) Describe **three** chemical properties of fluorine which are different from the rest of the group members. (Illustrate your answer with equations)

    (b) Fluorine and chlorine are separately bubbled through aqueous silver nitrate solution.

          (i) State what was observed in each case.

          (ii) Explain your observation is (i) above.

    (c) Describe briefly how potassium chlorate(V) crystals can be prepared from chlorine. (Diagrams **not** required.)

19. a) Define the following terms

      (i) A salt

      (ii) Buffer solution

      (iii) Degree of dissociation

    b) (i) write the equation for ionization of an acid RCOOH in water.

      (ii) Write the expression for the acid dissociation constant.

    c) The ionization constant (K_a) for RCOOH is 1.8×10^{-3} $moldm^{-3}$. Calculate the;

    (i) pKa value of the acid.

    (ii) Percentage ionization of the acid in 1M aqueous solution

    d) Explain why titrations involving solutions of ammonium chloride cannot be carried out using phenolphthalein indicator.

c) Sketch and explain the pH-volume curve for titrations of ammonia against hydrochloric acid solution

PRACTICAL CHEMISTRY

You are provided with the following;

FA1; which is a solution containing 0.72g of iodate ions in 500cm³

FA2; which is sodium thiosulphate solution

FA3; which is solution of iodine in 0.3M potassium iodide

FA4; which is carbon tetrachloride

10% potassium iodide solution

1M sulphuric acid solution

Starch indicator

You are required to determine the;

a) The molar concentration of sodium thiosulphate in FA2

b) The equilibrium constant Kc, for the reaction between iodine and potassium iodide

Theory:

Acidified potassium iodate reacts with potassium iodide to liberate iodine according to the equation

$$IO_3^-(aq) + 6H^+(aq) + 5I^-(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$$
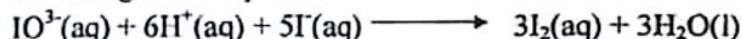
The iodine liberated reacts with thiosulphate ions according to the equation

$$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

When some iodine is added to excess iodide ions, triiodide complex is formed according to the equation

$$I_2(aq) + I^-(aq) \longrightarrow I_3^-(aq)$$
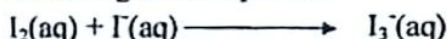
Procedure:

Pipette 20cm³ of FA1 into a clean conical flask followed by about 20cm³ of sulphuric acid and accurately add 10cm³ of potassium iodide solution. Titrate the mixture with FA2 until the solution turns yellow. Add about 5 drops of starch indicator and continue the titration until end point. Repeat the titration 2-3 times and record your results in the table below.

Volume of pipette used...................cm³

Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of FA2 used (cm³)			

Titre values used to calculate the average volume of FA2 used

....

Average volume of FA2 used

....

....

(a) Determine the molar concentration of FA2

(b) Using the measuring cylinder, transfer $50cm^3$ of FA3 into a clean conical flask followed by $50cm^3$ of carbon tetrachloride liquid and shake vigorously for 2-3 minutes. Carefully decant off the upper (organic) layer into a $50cm^3$ beaker.

(c) Using another measuring cylinder, transfer $10cm^3$ of the organic layer into a clean conical flask and then titrate with FA2 using starch indicator.

(d) Repeat procedure (b) using the aqueous layer remaining in the conical flask in (c)

Record your results in the table below

Layer	Organic	Aqueous
Final burette reading (cm^3)		
Initial burette reading (cm^3)		
Volume of FA2 used (cm^3)		

(e) Calculate the molar concentration of;

(i) Iodine in organic layer

(ii) Iodine in aqueous layer

(iii) Free iodine in aqueous layer (partition coefficient of iodine between the carbon tetrachloride and water is 85.5)

(f) Determine the equilibrium constant, Kc for the reaction

You are provided with substance Q which contains 2 cations and 2 anions. Carryout the following tests on Q to identify the cations and anions in Q. identify any gases evolved. Record your observations and deductions in the table below.

TESTS	OBSERVATIONS	DEDUCTIONS
a) heat a spatula endful of Q gently then strongly until no further change		
b) to a spatula endful of Q carefully add 3 drops of Concentrated sulphuric acid and warm	.	
c) Dissolve 2 spatula endfuls of Q in about		

5cm³ of distilled water; add sodium hydroxide drop wise until in excess. Filter and keep both the filtrate and residue.		
d) Dissolve the residue in a minimum dilute nitric acid. Divide the resultant solution into 5 portions		
i) to the first portion, add sodium carbonate solution		
ii) To the second portion, add Concentrated hydrochloric acid drop wise until no further change.		
iii) To the third portion, add potassium hexacyanoferrate (ii) solution.		
iv) to the fourth portion, add potassium iodide solution followed by sodium thiosulphate solution		
v) use the fifth portion to carry out a test of your choice to identify one of the cations in Q		
e) To the filtrate, add dilute nitric acid until the solution is slightly acidic. Divide the resultant solution into 6 portions.		
i) To the first portion, add iron (iii) chloride solution and boil.		
ii) To the second portion, add sodium hydroxide		

drops of Concentrated sulphuric acid and pass any vapour through lime water.		
d) dissolve a spatula endful of P in about 4cm^3 of water and divide the solution into 3 parts i) To the first part, add an equal volume of ethanol followed by 3 drops of Concentrated sulphuric acid and heat, pour the mixture in a beaker of cold water.		
ii) heat the second part of the solution then add a few drops of acidified potassium manganate (VII) solution		
iii) To the third part of the solution, add a saturated solution of Calcium chloride followed by Ethanoic acid.		

Comment on the nature of P

drops ...
sulphur ...
vapour t...
d) dissolv...
of P in abo...
and divide th...
3 parts
i) T...

drop wise until n excess.		
iii) To the third portion, add ammonia solution drop wise until in excess.		
iv) To the fourth portion, add potassium chromate solution.		
v) To the fifth portion, add lead (ii) acetate solution.		
vi) use the sixth portion to carry out a test of your choice to identify one of the anions in Q		

Identify the cations and anions in Q

You are provided with an organic substance P. carry out the following tests on P in order to identify its chemical nature. Record your observations and deductions in the table below.

TESTS	OBSERVATIONS	DEDUCTIONS
a) burn a spatula endful of P on crucible or spatula		
b) Shake a spatula endful of P with about 6cm3 of water. Test the mixture with litmus paper and divide the resultant mixture into 3 portions.		
i) to the first portion, add 4 drops of Brady's reagent		
ii) To the second portion, add an equal volume of neutral iron (iii) chloride solution and heat.		
iii) To the third portion, add ½ a spatula endful of solid sodium hydrogen carbonate.		
c) To a spatula endful of P in a boiling tube, add 4		