MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
SENGEREMA SECONDARY SCHOOL
FORM SIX CHEMISTRY HOME PACKAGE
DECEMBER 2024

ELECTROCHEMISTRY

1. Give brief explanation of the following:
   (i) Silver nitrate does not have solubility product;
   (ii) Impure sodium chloride can be purified by 'common ion' action;
   (iii) Lead (II) chloride can be precipitated from aqueous lead (II) nitrate by dilute hydrochloric acid, but dissolves in concentrated hydrochloric acid
   (iv) Antimony (III) sulphide is precipitated by hydrogen sulphide in the presence of dilute hydrochloric, but not of concentrated hydrochloric acid;
   (v) The pH of molar solution of H_2SO_4 is 0.
2. State one fact in support of each of the following:
   (i) The NH_4^+ ion has acid properties,
   (ii) The NH_3 molecule is amphoteri,
   (iii) Hydrochloric acid is stronger than ethanoic acid,
   (iv) The CL^- ion is a base,
   (v) Water contains both positive and negative ions.
   (vi) Sketch the graph (labeling the axes) to show how the pH of hydrochloric acid varies with concentration between concentration of 1M and 10M
3. The degree of dissociation of M/100 methanoic acid, HCOOH, at 25^0C is 0.14. Use the Ostwald's dilution law to calculate the dissociation constant of the acid
4. What is the degree of dissociation of ethanoic acid is M/20 Solution if Ka of the acid is $1.8x10^{-5}$ $moldm^{-3}$?
5. Calculate the pH of the following aqueous solution at 25^0C:
   (i) 1M/50 C_6H_5COOH (Ka at $25^0C = 6.6X10^{-5}moldm^{-3}$),
   (ii) 1M/100 CH_3NH_2 (K_b at $25^0C= 5.0x10^{-4}moldm^{-3}$)
6. What do you understand by the term solubility product?
7. Write an expression for solubility product of (a) lead (II) sulphide, lead (II) chloride Explain each of the following observation as fully as you can.
8. When hydrogen sulphide is passed into acidified aqueous solution of lead(II) nitrate and zinc nitrate, only lead(II) sulphide is precipitated
9. The solubility of lead(II) chloride in water decrease on addition of dilute hydrochloric acid but increases on addition of concentrated hydrochloric acid
10. When aqueous sodium hydroxide is gradually added to aqueous lead (II) nitrate, a white precipitate is formed initially but this dissolves in an excess of aqueous sodium hydroxide to give colorless solution.
11. Lead(iv) oxide dissolves in cold, concentrated hydrochloric acid to givea deep yellow solution from which a yellow solid separates on additionof saturated aqueous solution of ammonium chloride
12. The solubility of strontium fluoride, SrF_2 in water at 25^0C is $1.0x10^{-3}moldm^{-3}$, what is the solubility product of this salt at this temperature?

13. When one litre of saturated solution of lead chloride, $PbCl_2$ is evaporated to dryness, the residue is found to weight 4.5 g. Calculatethe value of Ksp for $PbCl_2$

13. The solubility product of AgCl in water is 1.5×10^{-10} . Calculate itssolubility in 0.01 M NaCl solution.
14. Calculate the solubility product of AgCl if its solubility at 20 o C is 1.435 × 10–5 g/litre.
15. . Calculate the pH of 0.1 M CH_3COOH. The dissociation constantof acetic acid is 1.8×10^{-5}.
16. Find out the pH of a 0.002 M acetic acid solution if it is 2.3%ionised at this dilution.

20. Find the pH of a buffer solution containing 0.20 mole per litre CH_3COONa and 0.15 mole per litre CH_3COOH. Ka for acetic acid is1.8×10^{-5}.
21. Calculate the pH of a buffer solution that is 0.250 M in formic acid,HCOOH, and 0.100 M in sodium formate, HCOONa. Ka for formic acid is 1.8×10^{-4}.
22. The Ka of propionic acid is 1.34×10^{-5}. What is the pH of a solution containing 0.5 M propionic acid, C_2H_5COOH, and 0.5 sodium propionate, C_2H_5COONa. What happens to the pH of this solution when volume is doubled by the addition of water ?
23. Define or explain the following terms :

25. A buffer solution contains 0.015 mole of ammonium hydroxide and 0.025 mole of ammonium chloride. Calculate the pH value of the solution. Dissociation constant of NH4OH at the room temperature is1.80×10^{-5}.
26. . The pH of a buffer solution containing 0.5 mole/litre of CH_3COOH and 0.5 mole/litre CH_3COONa has been found to be 4.76. What will be the pH of this solution after 0.1 mole/litre HCl has been added to the buffer ? Assume that the volume is unchanged. Ka = 1.75×10^{-5}.
27. . A litre of solution containing 0.1 mole of CH_3COOH and 0.1 moleof CH_3COONa provides a buffer of pH 4.74. Calculate the pH of solution after the addition of 0.02 mole NaOH. Ka = 1.8×10^{-5}

17. A chemist needs a buffered solution of propanoic acid, CH_3CH_2COOH, and its salt, CH_3CH_2COONa. Calculate the ratio $[CH_3CH_2COOH]/[CH_3CH_2COONa]$ required to yield a pH of 4.30. Kafor propanoic acid is 1.3×10^{-5}.
18. Calculate the concentration of sodium formate, HCOONa, that mustbe present in a 0.10 M solution of formic acid to produce a pH of 3.80. Ka for formic acid is 1.8×10^{-4}.
19. A chemistry student desires to prepare one litre of a solution buffered at pH 9.00. How many grams of ammonium chloride have to be added to one litre of 0.20 M NH_3 to make such a buffer. pKb value ofammonia is 4.75 in the equation

(a) Anionic Hydrolysis (b) Cationic Hydrolysis
(c) Hydrolysis constant (d) Degree of Hydrolysis

24. Sodium phenate is hydrolysed to the extent of 0.03% in 0.1 Maqueous solution at 25°C.
Calculate
(i) The hydrolysis constant of the salt; and
(ii) the ionic product of water at 25°C. The dissociation constant ofphenol is 1.3×10^{-10} at 25°C.

28. . A 0.02 M solution of sodium acetate in water at 25°C has a hydrogen ion concentration of 3×10^{-9} M. What is the hydrolysis constant of the salt?

(i) What is hydrolysis constant of salt? Why aqueous solution of sodium carbonate is alkaline? Derive an expression for the hydrolysis constant and pH of thissolution. (b) Calculate the pH of a decinormal solution of ammonium chloride. (pKa = 5.7 and pKw = 14)

28. The dissociation constant of acetic acid is 1.8×10^{-5} at 18°C. The ionic product of water is 10^{-14} at 18°C. What would be the degreeof hydrolysis in a 0.012 N solution of sodium acetate?

CHEMICAL KINETICS

29. Write the differential rate equations of the following reactions:
A + 2B → k P
3A + 2B → k ′ 3C + D + 2E
30. Write the differential rate equations of the following reactions:
(a) A + 3B → 4C (b) A + 2B → C + 3D (c) 3A + B + 2C → D + 3E
31. Express the rate constant k in unit of dm3 mol–1s –1, ifk = 2.50 × 10–9 cm3 molecule–1s –1
k = 2 × 10–6 s –1 atm–1
32. For a certain reaction, the value of rate constant is 5.0 × 10–3 dm3mol–1sec–1. Find the value of rate constant in (i) dm3 molecule–1 sec–1 (ii) cm3 mol–1 sec–1 and (iii) cm3 molecule–1 sec–1.
33. A zero-order reaction is 50% complete in 20 min. How much timewill it take to complete 90%?
34. A reaction is 50% complete in 20 min. How much time will betaken to complete 75% reaction?

35. The specific rotation of sucrose in presence of hydrochloric acid at35°C was measured and is given as follows:

Time (min)	0	20	40	80	180	500	∞
Rotation (°C)	32.4	28.8	25.5	19.6	10.3	6.1	–14.1

36. Calculate the rate constant at various time intervals and show thatthe reaction is first order.
37. A first order reaction is 25% complete in 50 min. What would be concentration at the end of another 50 min if the initial concentration of the reactant is 5.0 × 103 mol dm–3?
38. The kinetics of a reaction was followed by measuring the absorbance due to a reactant at its mix at 25°C. The log (absorbance)versus time (min) plot was a straight line with a negative slope (0.30 ×10–2) and a positive intercept. Find the half-life period of reaction.
39. In a first order reaction the log (concentration of reactant) versustime plot was a straight line with a negative slope 0.50 × 104 sec–1.Find the rate constant and half-life period of reaction
40. A reactant reacts 30% in 30 min. If the reaction follows a second order kinetics, find rate constant and remaining concentration of reactant after 60 min.
41. In a reaction when initial concentration doubles, the half-life is reduced to half. What is the order of reaction?
42. A second-order reaction in which both the reactants were at same initial concentration was 50% completed in 500 sec. How long will it take to complete 75% of the reaction? Determine the rate constant also.
43. A first-order reaction has the rate constant = 1.0 × 10–4 sec–1at 298 K. Calculate the half-life period of the reaction
44. The values of rate constants for reaction $2HI \longrightarrow H_2 + I_2$ were observed as 3.0 × 10–5 mol–1 dm3 s –1 and 2.5 × 10–3 mol–1dm3 s –1 at 357°C and 447°C, respectively. Calculate the E for forward and backward reaction of ΔH = 15.5 kJ mol–1.

45. A first-order reaction at 25°C and 45°C has rate constants equal to 2.5 × 10–4 and 17.0 × 10–4 sec–1, respectively. Calculate Arrhenius factor and Eact for the reaction.
46. The values of the rate constant (k) for the reaction $2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$ were determined at several temperatures. A plot of 1n k versus 1/T gave a straight line of which the slope was found to be – 1.2 × 104 K. What is the activation energy of the reaction?

ORGANIC CHEMISTRY

47. Phenylamine undergoes nitration more readily than benzene carbaldehyde. (ii) Propanone does not give positive iodoform test but propan-1-ol does . (iii) Propanone is less readily attacked by nucleophile than propanal.
48. An organic compound P was boiled with dilute H_2SO_4 to produce an acid Q which was monobasic. Q was esterified with ethanol to give an ester R of molecular mass 150. Compound Q can undergo reductionto form S. Give the structural formular for P, Q, R and S.
    (i) With an example, define the following terms;
    (ii) Aldol-ketol condensation reaction
    (iii) Cannizaro reaction.
49. Give the structure(s) of monomer which gives the following polymer in polymerisation;
    (i) Dacron.
    (ii) Nylon-6,6.
    (iii) Polystyrene.
50. (i) Give the structure of repeating unit in terylene and state the typeof polymerization involved during its formation.
51. Give the structure of repeating unit in poly(phenylethene) and statethe type of polymerisation involved during its formation.
52. Explain why dilute sodium hydroxide will cause holes to appear in clothing made from polymers such as terylene but a poly(phenylethene) container can be used to store sodium hydroxide?
53. With reasons, write down the use of the following polymers:
    (i) Butyl-rubber.
    (ii) Polyhaloalkene.
    (iii) Polyacrylonitriles.
54. Briefly explain the vulcanisation of rubber under the following considerations Meaning.
55. Importance and its application
    (i) (i) By using the chemical equation explain why tertiary halo alkane cannot undergo SN2 reactionmechanism
    (ii) Benzene is more reactive than nitrobenzene while methylbenzene is more reactive than benzene. Explain this observation.
    (a) When 1,2-dibromodecane was treated with potassium hydroxide in aqueous ethanol, it yields a mixture of three isomeric compounds of molecular formula $C_{10}H_{19}Br$. Each of these compounds was converted to dec-1-yne on reaction with sodium amide in dim ethyl sulphoxide. Identify the three compounds.
56. (b) Explain briefly the preparation of acetylene (ethyne) by; -
    i. Pyrolysis of natural gas.
    ii. Action of water on calcium carbide.
57. . a) An aromatic compound D (C8H8O) give a positive result with 2.4 dinitro – phenyl hydrozone but gives yellow precipitate of compound E treatment with iodine and sodium solution. Compound D give negative Tollens or Fehling test. On drastic oxidation with KMnO4 forms a carboxylic acid F (C7H6O2) which is also formed along with the yellow compound in the above reaction. Identify the structure D, E, and F also write all chemical reaction involved.
    (b) A compound A of Molecular formula of C3H7O2N On reaction with iron and concentrated hydrochloric acid give the compound B of molecular formula C3H8O. Compound C Gives Effervescence with sodium on oxidation with CrO3 compound C given saturated aldehyde containing three carbonic atoms deduce the structure of A, B and C
58. A compound (A) with molecular formula C3H6O2 reacts with thionyl chlorideto give compound (B). Compound (B) undergoes Friedel–Crafts acylation with benzene to form compound (C). Compound (C) is then reduced with lithium aluminum hydride to form compound (D). Identify (A), (B), (C), and (D).
59. A compound (A) with molecular formula C4H8O2 undergoes a reaction withbromine in the presence of water to form compound (B). Compound (B) is thentreated with excess ammonia to form compound (C). Identify (A), (B), and (C).
60. A compound (A) with the molecular formula C6H10O2 undergoes reaction with lithium aluminum hydride to form compound (B). Compound (B) undergoes oxidation with potassium permanganate to give compound (C). Identify (A), (B), and (C).
61. A compound (A) with molecular formula C3H6O2 is subjected to a reaction with methylmagnesium bromide to form compound (B). Compound (B) is then hydrolyzed to form compound (C). Identify (A), (B), and (C).
62. A compound (A) with molecular formula C7H6O2 undergoes reduction with sodium borohydride to form compound (B). Compound (B) reacts with an acid to form compound (C). Identify (A), (B), and (C).

63. A compound (A) with molecular formula C8H8O2 undergoes reaction with bromine in presence of light to give compound (B). Compound (B) reacts with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

64. A compound (A) with the molecular formula C9H10O2 reacts with thionyl chloride to give compound (B). Compound (B) undergoes reduction with hydrogen and palladium catalyst to form compound (C). Identify (A), (B), and (C).

65. A compound (A) with molecular formula C6H5COOH undergoes reaction with acetyl chloride to give compound (B). Compound (B) is treated with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

66. A compound (A) with molecular formula C4H6O2 undergoes esterification with ethanol to form compound (B). Compound (B) is then hydrolyzed with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

67. A compound (A) with molecular formula C7H8O2 undergoes a reaction with sodium hydroxide to form compound (B). Compound (B) is then reduced with lithium aluminum hydride to form compound (C). Identify (A), (B), and (C).

68. A compound (A) with molecular formula C3H6O undergoes reaction with sodium metal to give compound (B). Compound (B) is then treated with acetic acid to form compound (C). Identify (A), (B), and (C).

69. A compound (A) with molecular formula C4H10O reacts with a strong oxidizing agent to form compound (B). Compound (B) is reduced by sodium borohydride to form compound (C). Identify (A), (B), and (C).

70. A compound (A) with molecular formula C6H12O undergoes reaction with PCl3 to give compound (B). Compound (B) is then treated with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

71. A compound (A) with molecular formula C5H12O undergoes dehydration with sulfuric acid to give compound (B). Compound (B) reacts with hydrogen in the presence of a palladium catalyst to form compound (C). Identify (A), (B), and (C).

72. A compound (A) with molecular formula C3H6O reacts with sodium to form compound (B). Compound (B) undergoes oxidation with potassium permanganate to form compound (C). Identify (A), (B), and (C).

73. A compound (A) with molecular formula C4H10O is subjected to reaction with sodium metal to form compound (B). Compound (B) reacts with benzene in the presence of AlCl3 to form compound (C). Identify (A), (B), and (C).

74. A compound (A) with molecular formula C7H8O reacts with acetyl chloride in the presence of pyridine to form compound (B). Compound (B) is hydrolyzed to form compound (C). Identify (A), (B), and (C).

75. A compound (A) with molecular formula C5H10O reacts with sodium metal to form compound (B). Compound (B) undergoes oxidation to form compound (C). Identify (A), (B), and (C).

76. A compound (A) with molecular formula C2H6O is oxidized to give compound (B), which is then reduced by hydrogen in the presence of palladium catalyst to give compound (C). Identify (A), (B), and (C).

77. A compound (A) with molecular formula C6H12O reacts with iodine and sodium hydroxide to give compound (B). Compound (B) is then treated with an acid to form compound (C). Identify (A), (B), and (C).

78. A compound (A) with molecular formula C6H5NH2 reacts with nitrous acid to form compound (B). Compound (B) undergoes reaction with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

79. A compound (A) with molecular formula C2H5NH2 undergoes reaction with acetic acid to form compound (B). Compound (B) reacts with sodium nitrite to form compound (C). Identify (A), (B), and (C).

80. A compound (A) with molecular formula C3H7NH2 is reacted with acetic acid to form compound (B). Compound (B) undergoes reduction with lithium aluminum hydride to form compound (C). Identify (A), (B), and (C).

81. A compound (A) with molecular formula C5H11NH2 is treated with chloroform and sodium hydroxide to give compound (B). Compound (B) is then treated with water to form compound (C). Identify (A), (B), and (C).

82. A compound (A) with molecular formula C7H9NH2 reacts with bromine in the presence of sodium hydroxide to form compound (B). Compound (B) undergoes reduction with zinc and hydrochloric acid to give compound (C). Identify (A), (B), and (C).

83. A compound (A) with molecular formula C4H9NH2 is reacted with acetyl chloride to form compound (B). Compound (B) is then treated with water to give compound (C). Identify (A), (B), and (C).

84. A compound (A) with molecular formula C6H4NH2 undergoes acylation with acetyl chloride to form compound (B). Compound (B) is then hydrolyzed to give compound (C). Identify (A), (B), and (C).

85. A compound (A) with molecular formula C3H7NH2 is treated with nitrous acid to form compound (B). Compound (B) undergoes reduction with lithium aluminum hydride to give compound (C). Identify (A), (B), and (C).

86. A compound (A) with molecular formula C9H11NH2 is treated with excess bromine in the presence of sodium hydroxide to form compound (B). Compound (B) undergoes reduction with Zn/HCl to form compound (C). Identify (A), (B), and (C).

87. A compound (A) with molecular formula C6H5NH2 undergoes reaction with formaldehyde to give compound (B), which is then treated with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

Carbonyl Compounds

88. A compound (A) with molecular formula C4H8O undergoes reaction with sodium bisulfite to form compound (B). Compound (B) is then reduced with sodium borohydride to form compound (C). Identify (A), (B), and (C).

89. A compound (A) with molecular formula C6H12O undergoes oxidation to form compound (B). Compound (B) reacts with methylmagnesium bromide to give compound (C). Identify (A), (B), and (C).

90. A compound (A) with molecular formula C3H6O2 undergoes reaction with a Grignard reagent to form compound (B), which is then hydrolyzed to form compound (C). Identify (A), (B), and (C).

91. A compound (A) with molecular formula C7H6O reacts with sodium bisulfite to give compound (B). Compound (B) undergoes reduction with hydrogen to form compound (C). Identify (A), (B), and (C).

92. A compound (A) with molecular formula C6H5COOH undergoes esterification with ethanol to form compound (B). Compound (B) is then hydrolyzed with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

93. A compound (A) with molecular formula C8H8O undergoes reduction with lithium aluminum hydride to form compound (B). Compound (B) is then treated with iodine in the presence of sodium hydroxide to form compound (C). Identify (A), (B), and (C).

94. A compound (A) with molecular formula C4H6O undergoes nucleophilic addition with cyanide to form compound (B), which is then hydrolyzed to form compound (C). Identify (A), (B), and (C).

95. A compound (A) with molecular formula C5H10O reacts with hydrogen cyanide to form compound (B), which undergoes hydrolysis to give compound (C). Identify (A), (B), and (C).

96. A compound (A) with molecular formula C2H6O undergoes oxidation with PCC to form compound (B). Compound (B) is then treated with sodium hydroxide to form compound (C). Identify (A), (B), and (C).

97. A compound (A) with molecular formula C9H10O2 undergoes reaction with bromine to form compound (B). Compound (B) is then reduced with hydrogen in the presence of palladium to form compound (C). Identify (A), (B), and (C).

INORGANIC CHEMISTRY

98. . (a) Aluminium oxide is said to be amphoteric. Explain this fact byaid of chemical equation.
(b) Iron III carbonate never exists. Explain this statement
(c) Explain the following with the aid of chemical reaction if applicable.
i. $MgCl_2.6H2O$ when heated can never give out unhydrous MgCl2
ii. $CuCl_2$ solution is acidic to litmus paper
iii. Fe_3O_4 is called mixed oxide.

99. (i) Generally extraction of metals from their ores involves four stages. Obtaining the ore, concentating the ore, concentrating the compound of interest in the ore, chemical reduction and refining of thecrude metal. Describe how Aluminium is extracted from its ore basingon these stages.
- Show that the properties of aluinium suit its wide range use.

100. Transitional elements show a variety of behaviours. With vivid example explain five (05) properties shown by such metals. (c) Give the IUPAC name of the following i. $[Cr(H2O)4(NH3)_2]Cl_3$ ii. $[CoCl(NO2)\ (en)2]^+$ iii. K4[Fe(CN)6] iv. $[FeBr2(H2O)4]^+$ v. $[CoCl_2(NH_3)_4]3\ [Cr(CN)_6]$

101. (a) What do you understand by the term deliquescence? Explain what makes a hydrated salt to deliquescence.

102. List down at least three useful applications of sulphates. Give at least one example for each.

103. With the help of chemical equation(s), explain the followings;
- Brown ring test.
- A test to distinguish sodium carbonate and sodium bicarbonate.

104. Explain the following observations:
- Oxidizing power of halogens decreases on descending the halogen group.
- Reducing power of hydrogen halides increases on descending the halogen group.
- With help of chemical equations, explain each of the follow.