

**P525/2**  
**CHEMISTRY**  
**Paper 2**  
**2 $\frac{1}{2}$  hours**

**WAKISSHA**  
**Uganda Advanced Certificate of Education**

**CHEMISTRY**  
**(Principal Subject)**  
**Paper 2**

**2 hours 30 minutes**

**INSTRUCTIONS TO CANDIDATES;**

- Answer **five** questions including **three** questions from section A and any **two** questions from section B.
- Write the answers in the answer booklet/sheets provided.
- **Begin each question on a fresh page.**
- Mathematical tables and graph papers are provided.
- Non programmable, silent scientific electronic calculators may be used.
- Illustrate your answers with equations where applicable.
- Where necessary use (C = 12, O = 16, H = 1, N = 14, Br = 80, IF = 96500C)

## SECTION A

*Attempt only three questions from this section.*

1. (a) What is meant by the term **freezing point depression constant**. (01 mark)
  - (b) (i) Describe how the relative molecular mass of naphthalene can be determined using freezing point depression. (08 marks)
  - (ii) State **four** limitation of the method in (i) above. (02 marks)
  - (c) The freezing points of solutions of various concentrations of naphthalene in cyclohexane at 760mmHg are shown in the table below.
- | Concentration (g/1000g of cyclohexane) | 10   | 20   | 30   | 40   | 50    | 60    |
|--|------|------|------|------|-------|-------|
| Freezing point (°C)                    | 4.93 | 3.36 | 1.79 | 0.22 | -1.35 | -2.92 |
- (i) Plot a graph of freezing point against concentration. (04 marks)
  - (ii) Use the graph to determine freezing point of pure cyclohexane. (01 mark)
  - (iii) Determine the slope of the graph and use it to determine the relative molecular mass of the naphthalene. (4 marks)  
( $K_f$  for cyclohexane = 20.1 °C/mol /1000g of cyclohexane)
2. (a) Define the term **buffer solution**. (01 mark)
  - (b) Describe how a solution containing a mixture of ammonia and ammonium chloride can function as a buffer solution. (05 marks)
  - (c) (i) 50cm<sup>3</sup> of 0.2M ammonia solution were mixed with 30cm<sup>3</sup> of 0.25M ammonium chloride solution. Calculate the pH of the resultant mixture. (04 marks)  
( $K_b$  for ammonia =  $1.78 \times 10^{-5} \text{ mol dm}^{-3}$  and  $K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ )
  - (ii) State and explain what would happen to the pH of the mixture in (c)(i) above if few drops of 2M sodium hydroxide solution were added to it. (03 marks)
  - (d) (i) Sketch a graph of pH changes that take place when ammonia solution is being titrated with dilute hydrochloric acid. (1½ marks)
  - (ii) Explain the shape of the graph (03 marks)
  - (iii) Which of the following indicators would be suitable for the above titration. Give a reason for your answer. (2½ marks)
 

Indicator	pH range
Thymol blue	1.2 – 2.8
Phenolphthalein	8.3 – 10.0
Methyl red	4.2 – 6.3
3. Fluorine , chlorine , bromine and iodine are some of the elements in group(VII) of the Periodic Table.
  - (a) Write the outer most electronic configuration of the elements. (01 mark)
  - (b) Discuss the reactions of the elements with;
    - (i) water (04 marks)
    - (ii) sodium hydroxide solution (5½ marks)
    - (iii) sulphurous acid (02½ marks)

- (c) State what would be observed and write equation for the reaction when chlorine gas was bubbled through the following solution.
- (i) iron(II) chloride solution (2½ marks)
- (ii) sodium thiosulphate solution (2½ marks)
- (iii) potassium manganate(VI) solution. (2½ marks)

4. An organic compound **P** contains 66.4% by mass of carbon, 5.53% by mass of hydrogen and the rest being for chlorine.
- (a) Calculate the empirical formula of **P**. (2½ marks)
- (b) When vaporized, 0.35g of **P** occupied a volume of 75.43cm<sup>3</sup> at 103°C and 860mmHg. Determine the molecular formula of **P**. (03 marks)
- (c) **P** burns with a sooty flame. Write the structural formulae and IUPAC names of the possible isomers of **P**. (02 marks)
- (d) When **P** was refluxed with aqueous sodium hydroxide solution, compound **Q** was formed. **Q** reacted with hot acidified potassium dichromate solution to form compound **R**. **R** formed orange precipitate with 2,4-dinitrophenylhydrazine in acidic medium. Identify **P**, **Q** and **R**. (1½ marks)
- (e) Write equation and suggest a mechanism for the reaction between
- (i) **P** and phenol in the presence of aqueous sodium hydroxide solution. (2½ marks)
- (ii) **R** and 2,4-dinitrophenylhydrazine in acidic medium. (05 marks)
- (f) Using equations only show how **P** can be synthesized from benzene. (3½ marks)

## SECTION B

*Attempt only two questions from this section*

5. Sodium thiosulphate solution reacts with hydrochloric acid according to the following equation.



The kinetic data for the above reaction at 25°C is shown in the table below.

	[ $S_2O_3^{2-}$ ] ( $mol dm^{-3}$ )	[ $H^+$ ] ( $mol dm^{-3}$ )	Initial rate ( $mol dm^{-3} s^{-1}$ )
1	0.40	0.20	$7.00 \times 10^{-4}$
2	0.40	0.60	$6.30 \times 10^{-3}$
3	0.80	0.60	$1.26 \times 10^{-2}$

- (a) (i) Differentiate between **order** and **rate constant** of reaction. (02 marks)
- (ii) Determine the order of reaction with respect to  $S_2O_3^{2-}$  and  $H^+$  ions. (03 marks)
- (iii) Write an expression for the rate law. (01 mark)
- (iv) Calculate the rate constant for the reaction at 25°C and indicate its units. (2½ marks)
- (b) Explain the effect of temperature on the **rate constant** and **activation energy** of the reaction. (04 marks)
- (c) Using the above reaction, describe an experiment that can be carried out to determine the order of reaction with respect  $S_2O_3^{2-}$  ions. (7½ marks)

**Turn Over**

6. Using equations only show how the following conversions can be effected. Indicate the reagents and conditions for the reaction.
- (a) Propan -1- ol from 2- bromopropane. (04 marks)
  - (b) Benzene cyanide ( $C_6H_5CN$ ) from nitrobenzene (04 marks)
  - (c) 2- methylpropanoic acid from propene (04 marks)
  - (d) Phenylethanoate from benzene (05 marks)
  - (e) Aminoethane from propanoic acid. (03 marks)
7. Explain the following observations.
- (a) When lead(IV) oxide is warmed with concentrated hydrochloric acid, effervescence of a greenish yellow gas is evolved. (3½ marks)
  - (b) When hydrogen sulphide gas was bubbled through iron(III) chloride solution, a yellow precipitate was formed. (3½ marks)
  - (c) A mixture of water(Bpt  $100^{\circ}C$ ) and chlorobenzene (Bpt  $136^{\circ}C$ ) boils at  $98^{\circ}C$  at atmospheric pressure. (04 marks)
  - (d) When sodium hydroxide solution was added to chromium(III) sulphate solution drop – wise until in excess, followed by hydrogen peroxide and the mixture warmed, it formed a green precipitate soluble in excess sodium hydroxide to give a green solution which turned yellow on warming with hydrogen peroxide solution. (05 marks)
  - (e) Aluminium chloride sublimes on heating whereas sodium chloride does not. (04 marks)
- 8.
- (a) (i) What is meant by the term **ore**? (01 mark)
  - (ii) Write formulae and names of two ores from which zinc can be extracted. (02 marks)
  - (b) Describe how pure zinc can be extracted from **one** of the ores in (a)(ii) above. (06 marks)
  - (c) Describe the reactions of zinc with
    - (i) sulphuric acid (04 marks)
    - (ii) sodium hydroxide (2½ marks)
  - (d) Ammonia solution was added to zinc sulphate solution drop-wise until in excess.
    - (i) State what would be observed. (1½ marks)
    - (ii) write equation(s) for the reaction(s) that took place. (03 marks)

END

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**2<sup>1</sup>/<sub>2</sub> hours**



**WAKISSHA JOINT MOCK EXAMINATIONS**

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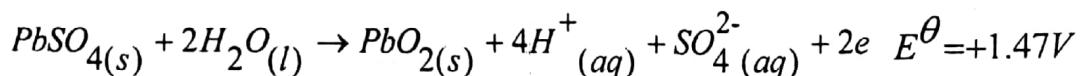
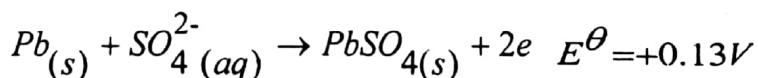
**Paper 2**

**2 hours 30 minutes**

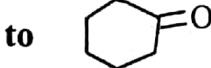
**INSTRUCTIONS TO CANDIDATES;**

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- ☒ Mathematical tables and graph papers are provided.
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- ☒ Where necessary use (C = 12, O = 16, H = 1, N = 14, Br = 80, IF = 96500C)

1. (a) What is meant by the term **voltaic cell**? (01 marks)
- (b) (i) With the aid of a labeled diagram, describe briefly how the standard electrode potential of a voltaic cell made of silver electrode and aluminium electrode can be determined. (08 marks)
- (ii) Write the overall equation for the cell reaction. (1½ marks)
- (iii) If the cell liberated 3892kJ of heat, determine the e.m.f of the cell. (3½ marks)
- (c) Some electrode potentials of the electrode reactions of accumulator cell are shown below;

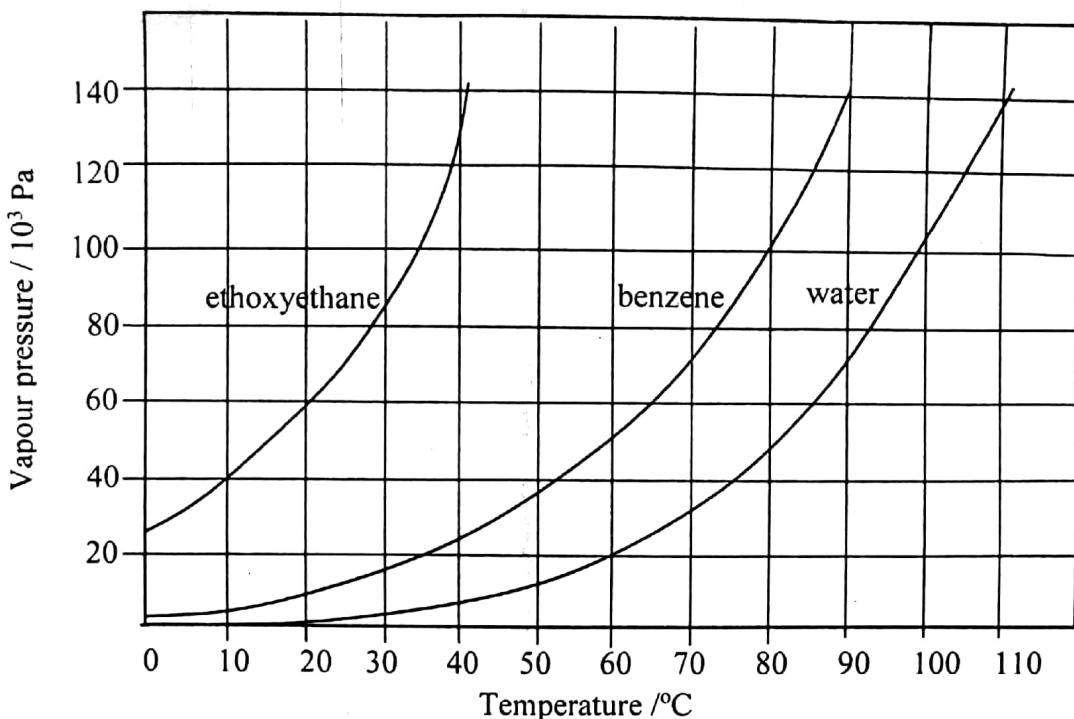


- (i) Write the overall cell reaction and hence determine the e.m.f of the cell. (03 marks)
- (ii) Explain why distilled water is preferred to dilute sulphuric acid when charging an accumulator cell. (03 marks)

2. (a) Using suitable conditions and reagents, show how the following conversions can be carried out.
- (i)  $CH_3CH_2CH_2Cl$  to  $CH_3CH_2CH_2COOH$  (3½ marks)
- (ii)  $BrCH_2CH_2Br$  to  $CH_3C \equiv C CH_2CH_2CH_3$  (05 marks)
- (iii)  to  (3½ marks)
- (b) Name the reagent(s) used to distinguish between the following compounds and in each case state what would be observed if each member of the pair is treated with the named reagent(s)
- (i)  $CH_3CH_2Cl$  and  $CH_3CH_2I$  (03 marks)
- (ii)  $HCOOH$  and  $CH_3C - OH$  (2½ marks)
- (iii)  $HCHO$  and  $CH_3CHO$  (2½ marks)

3. The elements Na, Al, P, Si and Cl all belong to period 3 in the periodic table.
- (a) Write the formulae of the hydride formed by each element and in each case state the type of bonding in the hydride. (05 marks)
- (b) Explain what happens when each of the hydrides in (a) above is added to water and state whether the resultant solution is acidic, alkaline or neutral. Write equations for the reaction in each case. (10 marks)
- (c) State what would be observed and write equation for the reaction when silane is treated with.
- (i) Iron (III) chloride solution. (2½ marks)
- (ii) Chlorine gas. (2½ marks)

- (a) The graph below illustrates how vapour pressure of ethoxyethane, benzene and water change with temperature.



- (i) Using data from the graph, explain the difference in vapour pressures of ethoxyethane, benzene and water at  $30^{\circ}\text{C}$ . (05 marks)
- (ii) Use the graph to determine the boiling points of ethoxyethane, benzene and water at standard pressure of 101kPa. (1½ marks)
- (b) State;
- (i) Raoult's law (01 marks)
- (ii) three properties of an ideal solution (1½ marks)
- (c) (i) An ideal solution of A and B is such that the mole fraction of A is 0.25. If the vapour pressures of pure A and pure B are 8.000kPa and 13.332kPa respectively, Calculate the composition of the vapour above the solution. (04 marks)
- (ii) Sketch a labelled boiling point composition diagram for the mixture in (c) (i) above. (03 marks)
- (d) (i) State the difference between eutectic point and eutectic mixture. (02 marks)
- (ii) State two similarities between a eutectic mixture and pure substance. (02 marks)

## SECTION B

*Attempt only two questions from this section*

5. 8.15g of a saturated alicyclic bromo compound Z,  $\text{C}_n\text{H}_{2n-1}\text{Br}$ , on complete combustion yielded 13.2g of carbon dioxide and 4.95g water. Z has a vapour density of 81.5.
- (a) Calculate the;

- (i) Empirical formula of Z (3½ marks)
- (ii) Molecular formula of Z (02 marks)

- (b) Z burns with a non-sooty flame. Give the IUPAC name and structure of Z. (01 mark)

**Turn Over**

- (c) Discuss the reactions of Z with;
- (i) Sodium hydroxide (05 marks)
  - (ii) Silver ethanoate (2½ marks)
  - (iii) Phenol (03 marks)
- (Your answer should include conditions for the reactions and mechanisms for the reactions.)*
- (d) Using equations only, show how Z can be synthesized from benzene. (03 marks)
6. (a) Explain what is meant by the term **partition coefficient** and state the conditions under which it is valid? (04 marks)
- (b) 25cm<sup>3</sup> of 0.2M Iodine solution in aqueous potassium Iodine was shaken vigorously with 50cm<sup>3</sup> of tetrachloromethane, the colour of tetrachloromethane changed to purple. Explain the;
- (i) role of potassium iodide. (1½ marks)
  - (ii) observed colour change in tetrachloromethane. (02 marks)
- (c) 10cm<sup>3</sup> of tetrachloromethane layer in (b) above required 25cm<sup>3</sup> of 0.3M sodium thiosulphate solution.
- (i) Write the ionic equation for the reaction that took place. (1½ marks)
  - (ii) Determine the partition coefficient of iodine between water and tetrachloromethane. (05 marks)
  - (iii) State one factor that can affect the value of the partition coefficient. (01 mark)
- (d) Briefly describe the application of partition coefficient in analysis of the complex formed between Zinc ions and ammonia. (05 marks)
7. Explain the following observations (illustrate with equations and mechanisms where necessary).
- (a) The melting points of P<sub>4</sub>O<sub>10</sub> and SO<sub>2</sub> are much lower than that of SiO<sub>2</sub>. (03 marks)
  - (b) Fluorine molecule has a short bond length yet its bond dissociation enthalpy is low. (04 marks)
  - (c) Benzene undergoes electrophilic substitution whereas cyclohexene undergoes electrophilic addition. (05 marks)
  - (d) The melting point of aluminium chloride is lower than that of aluminium fluoride. (03 marks)
  - (e) When aqueous sodium hydrogen carbonate is added to an aqueous solution of iron (III) chloride, brown precipitate is formed together with a gas that turns lime water milky. (05 marks)
8. (a) Write the formula and name of the main ore of aluminium. (01 marks)
- (b) Describe how;
- (i) the ore is concentrated. (08 marks)
  - (ii) pure aluminium is obtained from the concentrated ore. (03 marks)
- (c) Describe the reaction of aluminium with
- (i) Sulphuric acid. (04 marks)
  - (ii) Sodium hydroxide. (2½ marks)
- (d) Write the equation for the reaction between aluminium and trimanganese tetraoxide (Mn<sub>3</sub>O<sub>4</sub>). (1½ marks)

END

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## SECTION A

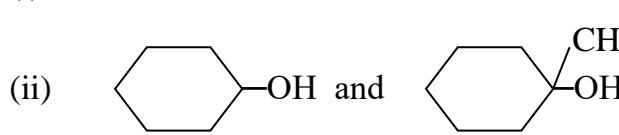
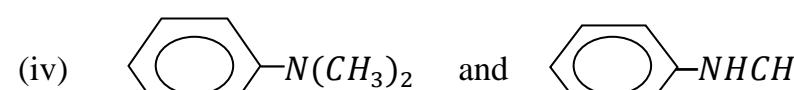
*Answer **three** questions from this section.*

1. (a) Phenolphthalein can be used as an acid- base indicator.
    - (i) What is meant by the term **acid- base indicator**? (01mark)
    - (ii) Describe briefly how phenolphthalein works as an acid- base indicator. (06marks)
    - (iii) The indicator constant,  $K_i$  for phenolphthalein is  $5.012 \times 10^{-10}$  moldm $^{-3}$ . Determine the approximate pH working range for phenolphthalein. (02marks)
  - (b) 25cm $^3$  of 0.12M ethanoic acid was pipetted into a clean conical flask and 2-3 drops of phenolphthalein indicator added and the mixture titrated with 0.2M sodium hydroxide solution until the equivalence point had reached, when 15cm $^3$  of sodium hydroxide had been used.
    - (i) What is meant by the term equivalence point? (01mark)
    - (ii) State the colour change at equivalence point. (01mark)
    - (iii) Calculate the pH of the mixture at equivalence point. (05marks)  
( $K_a$  for ethanoic acid =  $1.75 \times 10^{-5}$  moldm $^{-3}$  and  $K_w$  for water =  $1.0 \times 10^{-14}$  mol $^2$ dm $^{-6}$ )
  - (c) Sketch a graph of pH against volume of sodium hydroxide for the titration in (b) and explain the shape of the graph. (04marks)
- 
2. Carbon, silicon, germanium, tin and lead are elements of Group(IV) of the Periodic Table.
    - (a) (i) Write the outer most electronic configuration of Group(IV) elements. (01mark)
    - (ii) State the oxidation states of Group(IV) elements. (01mark)
    - (iii) State how the stability of the oxidation states vary down the group. (02marks)
  - (b) Describe the reactions of the elements with
    - (i) water (06marks)
    - (ii) concentrated sulphuric acid. (06marks)
  - (c) Write equations for the reactions between
    - (i) silicon (IV)oxide and hot concentrated hydrofluoric acid. (1½marks)
    - (ii) trileadtetraoxide and warm dilute nitric acid. (1½marks)
    - (iii) tin(II) chloride solution and iron(III) sulphate solution. (1½marks)
- 
3. (a) A gaseous alkene **Y** diffuses 0.57735 times faster than nitrogen gas. Determine the molecular formula of **Y**. (03marks)
  - (b) On ozonolysis followed by hydrolysis, **Y** produced propanal and propanone as the major organic products. Identify **Y**. (01mark)
  - (c) Write the equation and suggest a mechanism for the reaction between
    - (i) **Y** and benzene in the presence of an acid. (04marks)
    - (ii) **Y** and bromine water. (04marks)
    - (iii) propanal and phenyl hydrazine in acidic medium. (04marks)
  - (d) Using equations only show how **Y** can be synthesized from propyne. (04marks)

4. (a) (i) Define the term lattice energy. (01mark)  
(ii) State two factors that affect lattice energy. (01mark)
- (b) Thermo dynamic data for aluminium, fluorine and aluminium fluoride are given below.
- |  |                            |
|--|----------------------------|
| The standard enthalpy of formation of aluminium fluoride | = -1301kJmol <sup>-1</sup> |
| The standard enthalpy atomization of aluminium           | = + 314kJmol <sup>-1</sup> |
| The standard enthalpy bond dissociation of fluorine      | = +158kJmol <sup>-1</sup>  |
| First ionization energy of aluminium                     | = +577kJmol <sup>-1</sup>  |
| Second ionization energy of aluminium                    | = +1820kJmol <sup>-1</sup> |
| Third ionization energy of aluminium                     | = +2740kJmol <sup>-1</sup> |
| First electron affinity of fluorine                      | = - 348kJmol <sup>-1</sup> |
- (i) Draw an energy level diagram for formation of aluminium fluoride. (4½marks)
- (ii) Use the diagram you have drawn to determine the lattice energy of aluminium fluoride. (03marks)
- (iii) Given that the hydration energies of aluminium ions and fluoride ions are – 4690 and -364kJmol<sup>-1</sup> respectively. Calculate the enthalpy of solution of aluminium fluoride and comment on the solubility of aluminium fluoride in water. (4½marks)
- (c) The electrode potentials of aluminium and zinc are shown below.
- $$\text{Al}^{3+}(\text{aq}) + 3\text{e} \rightleftharpoons \text{Al(s)} \quad E^\theta = -1.66V$$
- $$\text{Zn}^{2+}(\text{aq}) + 2\text{e} \rightleftharpoons \text{Zn(s)} \quad E^\theta = -0.76V$$
- The two half cells are combined to form a cell
- (i) Write the overall cell reaction (1½marks)  
(ii) Calculate the emf of the cell (1½marks)  
(iii) Calculate the standard free energy for the cell. (02marks)  
(iv) State whether the cell is feasible or not. Give a reason for your answer. (01marks)

## SECTION B

*Answer two questions from this section.*

5. (a) Name a reagent that can be used to distinguish between the following pairs of organic compounds and in each case state what would be observed and write equation for the reaction if any when the reagent is treated with each compound in the pair.
- (i) CH<sub>3</sub>CHO and CH<sub>3</sub>CH<sub>2</sub>CHO (04marks)
- (ii) 
- (iii) H – C – OH and CH<sub>3</sub>C – OH (04marks)
- (iv) 
- (b) Using equations only show how phenylethanoate can be synthesized from benzene. (04marks)

**Turn Over**

6. (a) 2-nitrophenol and 4-nitrophenol can be prepared by reacting phenol with dilute nitric acid.
- (i) write equation for the reaction. (01mark)
- (ii) Which of the two products has a higher melting point. Explain your answer. (06marks)
- (b) 2-nitrophenol and 4- nitrophenol can be separated by steam distillation.
- (i) What is meant by steam distillation? (01marks)
- (ii) With aid of a labeled diagram , describe how a mixture of 2- nitrophenol and 4- nitrophenol can be separated by steam distillation. (06marks)
- (c) When 50g of a mixture of 2-nitrophenol and 4- nitrophenol was steam distilled at 97°C and 750mmHg , a distillate was found to have a mass of 35g. The vapour pressure of water at 97°C is 654mmHg. Determine the percentage by mass of 4-nitrophenol in the mixture. (04marks)
- (d) State two advantages of steam distillation over fractional distillation. (02mark)
7. Explain each of the following observations
- (a) Ethene reacts with bromine to form 1,2- dibromoethane. But when the reaction is carried out in the presence of sodium chloride solution, 1- bromo- 2- chloroethane is formed. (05marks)
- (b) The solution of 0.1M hydrochloric acid has a pH of 1 whereas that of 0.1M hydrofluoric acid is 3.8. (04marks)
- (c) When cold concentrated hydrochloric acid was added to lead (IV) oxide, brown solid dissolves to form a pale yellow liquid. However on slight warming, there was effervescence of a gas. (04marks)
- (d) Hydrogen fluoride can be prepared by reacting calcium fluoride with concentrated sulphuric acid. However hydrogen bromide cannot be prepared from calcium bromide and concentrated sulphuric acid. (04marks)
- (e) When ammonium thiocyanate solution was added to iron (III) chloride solution, a red blood solution was formed. (03marks)
8. (a) What is meant by the term **ore**? (01mark)
- (b) Briefly describe how the following ores can be purified.
- (i) zinc blende (04marks)
- (ii) bauxite (06marks)
- (c) Write equation(s) to show how aluminium metal can be extracted from the purified ore in (b) (ii) above. (1½marks)
- (d) Describe how
- (i) aluminium reacts with sulphuric acid (05marks)
- (ii) zinc reacts with sodium hydroxide. (2½marks)

**END**

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## SECTION A

*Answer three questions from this section*

- 1.** The first six ionization energies of the elements of a given period of the Periodic Table are shown in the table below.

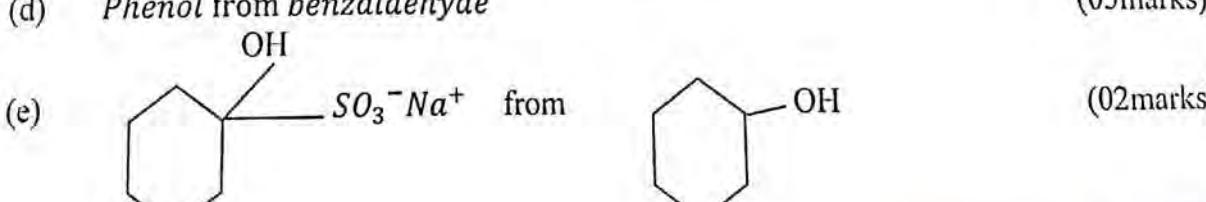
Element	Ionization energy (kJmol <sup>-1</sup> )					
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>
A	1000	2260	3390	4540	6990	8490
B	786	1580	3230	4360	16000	20000
C	1520	2660	3950	5770	7240	8790
D	577	1820	2740	11600	1480	18400
E	1060	1900	2920	4960	6280	21200
F	1260	2300	3850	5150	6540	9330
G	494	4560	6940	9540	13400	16600
H	736	1450	7740	10500	13600	18000

- (a) State and explain the trend in the successive ionization energies. (04marks)
- (b) State with a reason which element represents;
- (i) an alkaline earth metal (02 marks)
  - (ii) A noble gas (02 marks)
- (c) Write equation to show how;
- (i) the third electron is removed from element B (1½marks)
  - (ii) the second electron is removed from element E (1½marks)
- (d) Write formula of;
- (i) oxide of D (01mark)
  - (ii) chloride of E (01mark)
  - (iii) nitride of B (01mark)
- (e) Identify the period to which the elements belong. (01mark)
- (f) Arrange the elements in order of increasing atomic numbers. (02marks)
- (g) Discuss the significance of successive ionization energies. (03marks)
- 2.**
- (a) What is meant by the following terms?
- (i) solubility product. (01mark)
  - (ii) common ion effect. (01mark)
- (b) (i) The solubility of a product of silver chromate at 25°C is  $1.3 \times 10^{-12} \text{ mol}^3 \text{dm}^{-9}$ . When a saturated solution silver chromate was shaken with an aqueous solution of silver nitrate, the solubility of silver chromate reduced by 65% of the solubility in pure water. Determine the molar concentration of silver nitrate solution. (5½marks)
- (ii) Describe how the solubility product of silver chromate can be determined in the laboratory. (06marks)
- (c) Explain the following observations;
- (i) When few drops of dilute hydrochloric acid were added to a saturated solution of lead (II) chloride, a white precipitate was formed. (03marks)

- (ii) When silver nitrate is added to a solution containing potassium chromate, a white ppt is formed rather than a red ppt. (3½marks)
3. (a) Compare the thermal stability of the monoxides and dioxides of Group (IV) elements. (04marks)
- (b) Describe the reactions of the oxides of;  
 (i) carbon and tin with sodium hydroxide. (5½marks)  
 (ii) lead with hydrochloric acid. (4marks)
- (c) Explain the following observation;  
 (i) Carbon (IV) oxide is a gas whereas silicon(IV) oxide is a solid. (04marks)  
 (ii) Silicon (IV) oxide reacts hydrofluoric acid but does not react with hydrochloric acid. (2½marks)
4. An organic compound Y contains carbon, hydrogen and oxygen only. 4.5g of Y yielded 5.6dm<sup>3</sup> of carbon dioxide and 4.5g of water at s.t.p.
- (a) Calculate the empirical formula of Y. (03marks)
- (b) When 0.125g of Y was vaporized at 71.6°C and 65.0kPa, it occupied a volume of 76.52cm<sup>3</sup>. Determine the molecular formula of Y. (03marks)
- (c) Y had no effect on Brady's reagent but gave a yellow precipitate with iodine in the presence of sodium hydroxide solution. Identify Y. (½mark)
- (d) Write the equation and suggest a mechanism for the reaction between Y and  
 (i) Benzoyl chloride.  
 (ii) Bromine water.  
 (iii) Hot concentrated phosphoric acid. (10½marks)
- (e) Y was added to cold acidified potassium manganate (VII) solution.  
 (i) State what would be observed. (01mark)  
 (ii) Write the equation for the reaction. (01mark)  
 (iii) Name the main organic product. (01mark)

## SECTION B

Answer any two questions from this section.

5. Using equations only show how the following conversions can be effected.
- (a) Propyne from but-2-ene (05marks)
- (b)  $(CH_3CH_2)_2N - N = O$  from  $CH_3CH_2COCl$  (04marks)
- (c)  $\begin{array}{c} CH_3 \\ | \\ CH_3CH_2C = N - N = CHCH_3 \end{array}$  from but-2-ene (04marks)
- (d) Phenol from benzaldehyde (05marks)
- (e)  (02marks)

Turn Over

6. (a) (i) Distinguish between activation energy and rate constant. (02marks)  
(ii) Briefly explain how activation energy and rate constant affect the rate of reaction. (04marks)
- (b) Hydrogen reacts with iodine according to the following equation;  
 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}) \quad \Delta\text{H} = + 25.9 \text{ kJ mol}^{-1}$
- The table below shows the rate constant for the reaction varying with temperature.
- | Temperature, T (K)   | 556                   | 629                   | 700                   | 781                   |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| Rate constant, k ( $\text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$ ) | $7.04 \times 10^{-7}$ | $6.04 \times 10^{-5}$ | $2.32 \times 10^{-3}$ | $7.90 \times 10^{-2}$ |
- (i) Plot a graph of  $\log_{10}(k)$  against  $\frac{1}{T}$  (04marks)
- (ii) Use the graph to determine the activation energy of the reaction from Arrhenius equation,  $k = A e^{-E_a/RT}$  ( $R=8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ) (03marks)
- (c) (i) Draw an energy level diagram for the reaction in (b) above and use it to determine the activation energy for the backward reaction. (04marks)
- (iii) Briefly explain how temperature affects the activation of the reaction. (03marks)
7. Explain the following observations.
- (a) When carbon dioxide was bubbled through an aqueous solution of potassium manganate (VI) solution, the green solution turned purple and black precipitate was formed. (04marks)
- (b) An aqueous solution of benzoic acid liberates carbon dioxide from a solution of sodium hydrogen carbonate whereas an aqueous solution of phenol does not. (04marks)
- (c) When iodine crystals are added to cold dilute sodium hydroxide solution, grey solid dissolves to a pale yellow solution which turned colourless on standing. (04marks)
- (d) When bromine liquid was added to benzene, there was no observable change. However on addition of a small amount of anhydrous aluminium chloride, reddish brown solution turned colourless. (04marks)
- (e) When copper (II) hydroxide solid was separately shaken with ammonia solution and sodium hydroxide solution, the blue solid dissolves in ammonia solution but insoluble in aqueous sodium hydroxide solution. (04marks)
8. (a) (i) What is meant by the term ore? (01mark)  
(ii) Write the formula and name of one ore from which copper is extracted. (01mark)
- (b) Describe how;  
(i) the ore in a(ii) can be concentrated. (03marks)  
(ii) pure copper can be extracted from the concentrated ore. (6½marks)
- (c) Discuss the reactions of copper with;  
(i) hydrochloric acid.  
(ii) sulphuric acid. (06marks)
- (d) Few drops of potassium hexacyanoferrate (II) solution were added to copper(II) sulphate solution ;  
(i) State what would be observed. (01mark)  
(ii) Write the equation for the reaction. (1½marks)

END

P525/2  
CHEMISTRY  
Paper 2  
August, 2019  
2½ hrs



## UNNASE MOCK EXAMINATIONS

*Uganda Advanced Certificate of Education*

CHEMISTRY

Paper 2

2 HOURS 30 MINUTES

### INSTRUCTIONS TO CANDIDATES

- Answer **five** questions, including **three** questions from section **A** and any **two** from section **B**.
- Write the answers in the answer booklets provided.
- Begin each question on a fresh page.
- Graph papers are provided.
- Illustrate your answers with equations where applicable.
- Indicate the questions attempted on answer booklets provided.
- Where necessary use  $H = 1$ ,  $C = 12$ ,  $O = 16$ ,  $Cl = 35.5$ ,  $Ca = 40$

Question						Total
Marks						

## SECTION A

*Answer any three questions from this section.*

- 1.** (a) The table below shows the first ionization energies of the elements in third short period of the Periodic Table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
1 <sup>st</sup> I.E(kJmol <sup>-1</sup> )	494	736	577	786	1060	1000	1260	1520
Atomic number	11	12	13	14	15	16	17	18

- (i) What is meant by the term **first ionization energy?** (01mark)
- (ii) Write an equation for the first ionization energy of phosphorus. (01mark)
- (iii) Plot a graph of  $\log_{10}(\text{first ionisation energy})$  against atomic number. (05marks)
- (iv) Explain the shape of the graph. (07marks)
- (b) (i) State how the first ionization energies of group(I) elements vary down the group. (01mark)
- (ii) Show how the first ionization energies of group(I) elements are related to the reactivity of the elements. (Illustrate your answer using the reaction of group(I) elements with water). (01mark)
- 2.** (a) (i) Explain what is meant by the term lattice energy. (05marks)
- (ii) State **two** factors that affect the magnitude of lattice energy. (03marks)
- (iii) Describe how the factors you have stated in(ii) affect the magnitude of the lattice energy. (02marks)
- (b) (i) Draw a Born – haber cycle for the first formation of solid rubidium chloride from its elements. (05marks)
- (ii) Calculate the electron affinity of chlorine from the following data.
- |   |                           |
|---|---------------------------|
| Lattice energy of rubidium chloride                 | = -675kJmol <sup>-1</sup> |
| Bond dissociation energy of chlorine                | = +242kJmol <sup>-1</sup> |
| Atomisation energy of rubidium                      | = +84kJmol <sup>-1</sup>  |
| Ionisation energy of rubidium                       | = +397kJmol <sup>-1</sup> |
| Standard enthalpy of formation of rubidium chloride | = -431kJmol <sup>-1</sup> |
- (iii) Given that the hydration energies of rubidium ions and chloride ions are -301 and -364kJmol<sup>-1</sup> respectively ,determine the enthalpy of solution of rubidium chloride and comment on the solubility of rubidium chloride in water. (04marks)
- 3.** An organic compound **T** , **C<sub>4</sub>H<sub>11</sub>N** when treated with a mixture of concentrated hydrochloric acid and sodium nitrite solution, there was effervescence of a colourless neutral gas **Y** and another organic compound **Z** were formed.
- (a) (i) Identify **Y** (0½mark)
- (ii) Write the structural formulae and IUPAC names of the possible isomers of **T**. (04marks)

- (b) When **Z** was treated with iodine solution and sodium hydroxide solution, a pale yellow precipitate **R** was formed. Identify  
 (i) **T**  
 (ii) **Z**  
 (iii) Pale yellow precipitate **R** (1½marks)
- (c) Write equation and suggest a mechanism for the reaction between  
 (i) **T** and ethanoyl chloride (04marks)  
 (ii) **Z** and hot concentrated phosphoric acid (04marks)
- (d) Using equations only show how **T** can be synthesized from propyne. (06marks)
4. (a) Write equation to show how concentration sodium hydroxide solution reacts with:  
 (i) Aluminium oxide.  
 (ii) Silicon (IV) hydride.  
 (iii) Chlorine heptoxide  
 (iv) Disulphur dichloride (06 marks)
- (b) Compare the properties of Carbon, silicon, and lead by considering the reactions of:  
 (i) Their tetrachlorides with water.  
 (ii) Their dioxides with sodium hydroxide  
 (iii) Elements with concentrated nitric acid. (14 marks)

## SECTION B

Answer **two** questions from this section.

5. (a) A solution containing 20g of a polymer **Q** in a litre of solvent exerts an Osmotic pressure of 1.40 mm Hg at 25°C.  
 (i) Explain what is meant by the terms **osmosis** and **osmotic pressure**. (02marks)  
 (ii) Calculate the relative molecular mass of **Q**. (03 marks)  
 (iii) If the monomer of **Q**, is  $\text{CH}_2=\overset{\text{Cl}}{\underset{\text{C}}{\text{C}}} \text{CH}=\text{CH}_2$ , determine the number of monomer units and hence write the structural formula of **Q** (2½marks)
- (b) (i) Describe how the molecular mass of **Q** can be determined in the laboratory using osmotic pressure method. (06 marks)  
 (ii) State why such a method in b(i) above is preferred. (01 marks)
- (c) (i) The vapour pressure of a solution containing 108.5g of substance **M** in 100g of water at 20°C was reduced by 0.182 mmHg. Calculate the relative molecular mass of substance **M**. Given that the vapour pressure of water at 20°C is 17. 54 mmHg. (2½marks)  
 (ii) Explain why the vapour pressure containing a non-volatile solute is less than the vapour pressure of a pure solvent. (02marks)  
 (iii) State what change would be noted in the relative molecular mass if **M** associated in water. (01mark)

6. Using equations only show how the following conversions can be effected.
- (a) phenol from benzene sulphonic acid (05marks)
- (b) cyclohexanol from aminobenzene. (05marks)
- (c) propanoic acid from 2-bromopropane (05marks)
- (d) Polystyrene from benzene (05marks)
7. (a) Write:
- (i) The electronic configuration of manganese atom (Atomic number 25). (01mark)
- (ii) The possible oxidation states of manganese (2½ marks)
- (b) (i) Write the half equation for the reduction of potassium permanganate in acidic medium (2½ marks)
- (ii) State the change in the oxidation state of the manganese in the reaction in (b)(i) above (01mark)
- (c) Briefly explain why hydrochloric acid and nitric acid are **not** used for acidifying potassium permanganate solution during volumetric analysis. (03marks)
- (d) State **three** advantages of using potassium permanganate in volumetric analysis. (03marks)
- (e) Explain what would be observed if dilute sulphuric acid was added to an aqueous solution of potassium manganate(VI). (04 marks)
- (f) Name a reagent apart from aqueous ammonia and sodium hydroxide that can be used to distinguish between manganese (II) ions and nickel (II) ions. State what would be observed if each of them is separately treated with the reagent you have named. (03 marks)
8. (a) (i) What is meant by the term polymer? (01mark)
- (b) Natural rubber is a natural polymer while nylon6,10 is an artificial polymer.
- (i) Distinguish between natural polymer and artificial polymer. (02marks)
- (ii) Write the structural formulae of the polymers named above. (02marks)
- (iii) Give the names of the monomers of the polymers in (ii) above. (1½marks)
- (c) (i) Describe briefly how natural rubber can be made stronger and more elastic. (3½marks)
- (ii) State **two** uses of the product in c(i) above. (02marks)
- (d) (i) Distinguish between soap and soapless detergents (02marks)
- (ii) Describe how soaps and soapless detergents work. (05marks)
- (i) State **one** advantage and **one** disadvantage of soapless detergents. (01marks)

\*\*\*\*\* END \*\*\*\*\*



**ACEITEKA JOINT MOCK EXAMINATIONS, 2019**  
**UGANDA ADVANCED CERTIFICATE OF EDUCATION**

**CHEMISTRY**  
**PAPER 2**  
**TIME: 2 HOURS 30 MINUTES**

**INSTRUCTIONS TO THE CANDIDATES:**

- Answer five questions including three questions in section A and any two questions in section B.
- Write the answers in the answer booklet provided.
- Mathematical tables and graph papers are provided.
- Begin each question on a fresh page.
- Non-programmable scientific electronic calculators may be used.
- Illustrate your answers with equations where applicable.
- Indicate the questions in the grid below.
- Where necessary use C = 12, O = 16, H = 1, Ca = 40, Ag = 108, P = 31

Question						Total
Marks						

1. An organic compound T on complete combustion yielded 13.2g of carbon dioxide and 2.7g of water. When 4.7g of T was vaporized at 273°C and at 760mmHg, it occupied a volume of  $2.7 \times 10^{-3} m^3$ .
- (a) (i) Calculate empirical formula of T (02 marks)
- (ii) Determine the molecular formula of T (2½ marks)
- (b) T burns with a sooty flame. Identify T. (½ mark)
- (c) Discuss the reactions of T with
- (i) Bromine (4½ marks)
  - (ii) Propene (4½ marks)
  - (iii) Ethanoyl bromide (4½ marks)
- (Your answer should include conditions for the reactions and mechanisms for the reactions where possible)
- (d) Write equation to show how T can be synthesized from benzaldehyde (1½ marks)
2. (a) What is meant by the terms.
- (i) Order of reaction (01 mark)
  - (ii) Half-life of a reaction (01 mark)
- (b) The rate equation for the reaction.
- $$S_2O_3^{2-} (aq) + 2H^+ (aq) \longrightarrow SO_2(g) + S(s) + H_2O(l) \text{ is}$$
- $$\text{Rate} = k [S_2O_3^{2-}][H^+]^2$$
- (i) State how the rate will be affected if the concentrations of the reactants are both doubled. (02 marks)
- (ii) Describe an experiment to determine the order of the reaction with respect to  $S_2O_3^{2-}$  in the laboratory. (06 marks)

- (c) The table below shows the kinetic data for the reaction between hot aqueous potassium hydroxide and alkylbromide( $C_4H_9Br$ )



Experiment	$[C_4H_9Br]$ (mol dm <sup>-3</sup> )	$[KOH(aq)]$ (mol dm <sup>-3</sup> )	Initial rate (mol dm <sup>-3</sup> s <sup>-1</sup> )
1	$1.0 \times 10^{-3}$	$1.0 \times 10^{-3}$	$5.0 \times 10^{-8}$
2	$2.0 \times 10^{-3}$	$1.0 \times 10^{-3}$	$1.0 \times 10^{-7}$
3	$2.0 \times 10^{-3}$	$2.0 \times 10^{-3}$	$2.0 \times 10^{-7}$

- (i) Determine the overall order of reaction. (01 mark)
- (ii) Determine the rate constant for the reaction and state its units. (02 marks)
- (iii) Identify the alkylbromide. (½ mark)
- (d) Write the mechanism for the reaction in (c) above. (3½ marks)
- (e) Draw a well labelled energy level diagram for the reaction mechanism illustrated in (d) above. (03 marks)

3. Carbon, silicon, germanium, tin and lead are elements of Group (IV) of the Periodic Table.

- (a) Write the electronic configuration of the outer most energy level of group (IV) elements. (01 mark)
- (b) Describe how:
- (i) Carbon, silicon and lead react with water. (06 marks)
- (ii) Oxides of the elements in b(i) react with sodium hydroxide. (08 marks)
- (c) Dilute nitric acid was added to trileadtetraoxide ( $Pb_3O_4$ ) and the mixture warmed.

- (i) State what would be observed. (01 mark)
- (ii) Write equation for the reaction that took place. (1½marks)

(d) The resultant mixture in (c) above was filtered and the residue was added to a solution of manganese (II) sulphate followed by few drops of concentrated nitric acid and the mixture warmed.

- (i) State what would be observed. (01 mark)
- (ii) Write equation for the reaction. (1½ marks)

4. (a) What is meant by the term **standard electrode potential?** (01 mark)

(b) (i) State and explain **two** factors that affect electrode potential of a metal. (03 marks)

(ii) Describe how the standard electrode potential of iron can be determined in the laboratory. (07 marks)

(c) The standard reduction potentials of some half- cells are given in the table below.

Half-cell reaction	Standard electrode potential (V)
A: $\text{Fe}^{2+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
B: $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33
C: $\text{MnO}_4^-(\text{aq}) + 5\text{e}^- + 8\text{H}^+(\text{aq}) \rightarrow \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	+1.52
D: $\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36

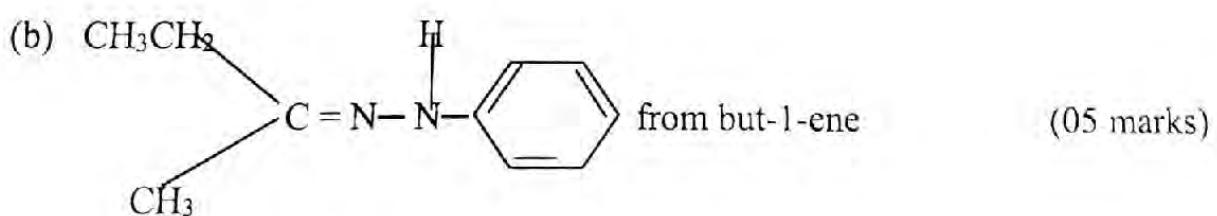
- (i) State which species is the
- strongest reducing agent. (½ mark)
  - strongest oxidizing agent. (½ mark)
- (ii) Write the cell convention for the cell formed by combining the following half-cells:
- A and B (01 mark)
  - C and D (01 mark)
- (iii) State what would be observed at the cathode in each of the cells in (ii) above. (02 marks)
- (iv) Draw a labelled diagram for the cell formed by combining B and C. (03 marks)
- (v) Calculate the standard free energy for the cell in (iv) above. (02 marks)

## SECTION B

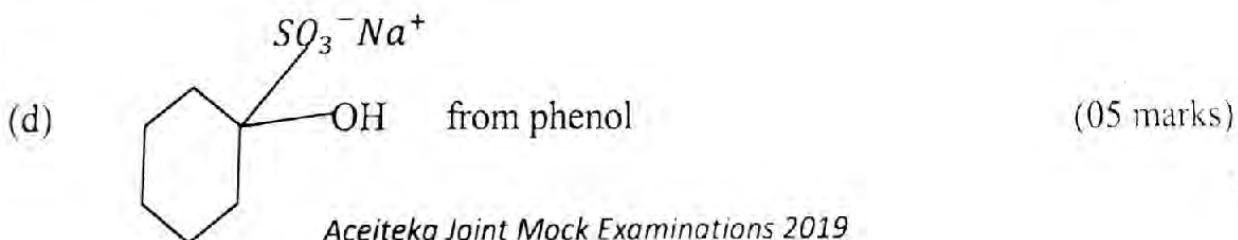
*Attempt any two questions from this section.*

5. Write equations to show how the following conversions can be effected.

(a) Bromobenzene from nitrobenzene (05 marks)



(c) Aminoethane from propanal (05 marks)



6. (a) (i) What is meant by the term standard **enthalpy of combustion**? (01 mark)
- (ii) Describe an experiment that can be carried out to determine the enthalpy of combustion of liquid cyclohexane. (Diagram **not** required) (05 marks)

- (b) The standard enthalpies of combustion of the first five straight chain alkanes and alcohols are shown in the table below.

Number of carbon atoms (n)	0	1	2	3	4	5
Enthalpy of combustion of alkanes , $-\Delta H_c$ (kJmol $^{-1}$ )	286	890	1560	2220	2877	3509

- (i) Plot a graph of the enthalpies of combustion of both alkanes against number of carbon atoms. (03 marks)
- (ii) Use the graph to determine the enthalpy of combustion of hexane. (02 marks)
- (ii) Explain the shape of the graph. (04 marks)

- (d) The enthalpies of combustion of some substances are given in the table below:

Substance	Standard enthalpy of combustion, $\Delta H$ , (kJmol $^{-1}$ )
Hydrogen	-285
Benzene	-3280
Cyclohexene	-3725
Cyclohexane	-3920

- (i) Calculate the enthalpy of hydrogenation of cyclohexene and benzene. (03 marks)

(ii) Comment on your answer in (d)(i) (02 marks)

7. Explain each of the following observations

- (a) When solid iodine crystals were added to a dilute sodium hydroxide solution, the grey solid dissolves to form a pale-yellow solution which turns colourless on standing. (04 marks)
- (b) When ammonium sulphate solution was mixed with sodium sulphite solution and the mixture warmed, there was effervescence of a colourless gas that turns moist red litmus paper blue. (04 marks)
- (c) When a mixture of anhydrous zinc chloride and concentrated hydrochloric acid was added to 2-methylpropan-2-ol, immediate cloudiness was formed but there was no observable change at room temperature if the same reagent was treated with propan-1-ol. (04 marks)
- (d) When aluminium was added to concentrated sodium hydroxide solution, the metal dissolved with effervescence of a colourless gas that burnt with a pop sound. (04 marks)
- (e) When methanoic acid was warmed with Fehling's solution a red precipitate was formed whereas with ethanoic acid, there was no observable change. (04 marks)

8. (a) (i) What is meant by the term **ore**? (01 mark)

(ii) Write the formula and name of **one** ore from which zinc is extracted. (01 mark)

(b) Describe how pure zinc can be extracted from the ore in (a)(ii) above. (07 marks)

- (c) Discuss the reactions of zinc with  
(i) air  
(ii) sulphuric acid  
(iii) sodium hydroxide (7½ marks)
- (d) Ammonia solution was added to zinc sulphate solution drop-wise until in excess.  
(i) State what would be observed. (01 mark)  
(ii) Write equation(s) for the reaction. (2½ marks)

**END**

P525/2  
Chemistry  
Paper 2  
July - August 2019  
2  $\frac{1}{2}$  hours



UGANDA MUSLIM TEACHERS' ASSOCIATION  
UMTA JOINT MOCK EXAMINATIONS 2019  
UGANDA ADVANCED CERTIFICATE OF EDUCATION  
Chemistry  
Paper 2  
2 hours 30minutes

**INSTRUCTIONS TO THE CANDIDATES**

*This paper consists of two sections A and B.*

*Attempt any three questions from section A and any two from section B on the answer sheets provided.*

*Illustrate your answers with equations where possible.*

*Molar volume  $R=8.314 J\ mol^{-1}K^{-1}$ .*

*Molar volume at s.t.p =  $22.4 dm^3$ .*

*Begin each question on a fresh page.*

*Non-programmable scientific electronic calculators may be used.*

*Illustrate your answers with equations where applicable.*

*Indicate the questions in the grid below.*

Where necessary use, Pb=207, Br = 80, Ag = 108, Na = 23, C = 12, O = 16, H = 1

Question						Total
Marks						

## SECTION A

(Answer any **three** questions)

1. (a) Explain the term standard electrode potential. (2 marks)
- (b) (i) Name two reference electrodes. (1 mark)
- (ii) Describe an experiment that can be used to determine the standard electrode potential of  $\text{Ag}(\text{s})/\text{Ag}^+(\text{aq})$  electrode. (4 marks)
- (c) The standard electrode potential of  $\text{Ag}(\text{s})/\text{Ag}^+(\text{aq})$  and  $\text{Fe}^{2+}(\text{s})/\text{Fe}^{3+}(\text{aq})$  are +0.81 and +0.75 volts respectively.
  - (i) Draw a diagram for a cell made up of two electrodes. (2 marks)
  - (ii) Write equations for the reactions that took place at the positive electrode and negative electrode. (3 marks)
  - (iii) Calculate the e.m.f of the cell. (2 marks)
- (d) Lithium has a more negative standard electrode potential than potassium contrary to the overall trend in reactivity of group I elements of the periodic table.



Using appropriate energy changes explain this observation. (4 marks)

- (e) State any two applications of standard electrode potential. (2 marks)
2. Explain briefly each of the following observations. Use equations where necessary to illustrate your answer.

- (a) The melting points of group IIA metal chlorides are in the order:



However, the melting points of their oxides are in the reverse order. (05 marks)

- (b) Bromocyclohexane undergoes nucleophilic substitution reactions whereas bromobenzene does not. (05 marks)

- (c) The bond dissociation energy of the hydrides of group IVB elements are in the order  $\text{CH}_4 > \text{SiH}_4 > \text{GeH}_4 > \text{PbH}_4$  however their boiling points are in the reverse order.

(05 marks)

(d) When potassium iodide solution is added to aqueous solution of copper (II) chloride, a white precipitate in brown solution is formed. On addition of sodium thiosulphate solution only white precipitate remains.

(05 marks)

3.(a) An organic compound Z contains by mass 51.90% Carbon, 4.86% Hydrogen and the rest Bromine. Determine the empirical formula of Z.

(2 ½ marks)

(b) When 0.8g of the compound Z was vapourised at 80°C and at a pressure of 700mmHg, it occupied a volume of 136cm<sup>3</sup>. Determine the molar mass of Z.

(c) Deduce the molecular formula of Z.

(05 marks)

(d) When Z was refluxed with excess sodium hydroxide solution, it formed compound Y. On heating Y with acidified chromium (VI) oxide, it formed substance W. Compound W formed an orange precipitate with 2, 4 dinitrophenyl hydrazine in presence of dilute sulphuric acid but gave no observable change with aqueous ammonia in presence of silver nitrate solution.

(i) Write the chemical equation leading to formation of substances Y and W indicating all the reagents and conditions.

(04 marks)

(ii) Write the chemical equation for the reaction between substance W and semicarbazine in presence of dilute sulphuric acid. Outline the reaction mechanism for the reaction.

(06 marks)

(iii) Write equation(s) to show how compound Y can be synthesized from benzene. Indicate the necessary conditions and reagents.

(2 ½ marks)

4. The vapour pressure (VP) of water and 'of an immiscible liquid X at different temperatures are given in the table below.

Temp (°C)	92	94	96	98	100
VP of X (Nm <sup>-2</sup> )	6000	8000	12000	15000	17000
VP of water (Nm <sup>-2</sup> )	74000	80000	88000	94000	101000

(a) On the same axes, plot graphs of vapour pressure against temperature.

(04 marks)

(b)(i) Determine the vapour pressures of the mixture of X and water at the temperatures given in the table above.

(02 marks)

(ii) On the same axes of the graph in (a), plot a graph of the vapour pressure of the mixture versus the temperature. (02 marks)

(c) The distillate obtained from the mixture at 101kPa contained 1.6g of water and 1.1g of X. Calculate the relative molecular mass of X using the information from the graphs you have drawn. (05 marks)

(d)(i) Explain the principles in the separation of mixtures by steam distillation.

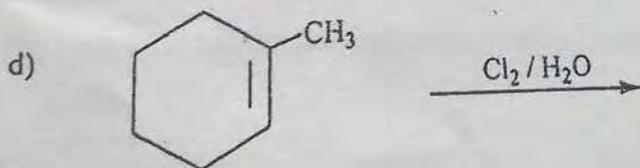
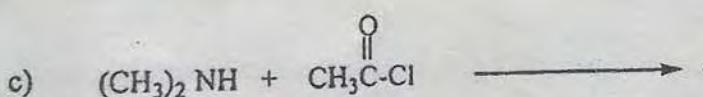
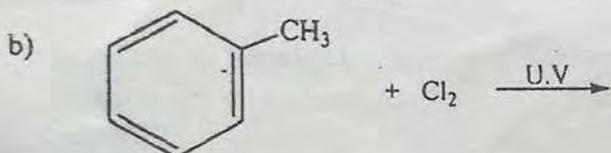
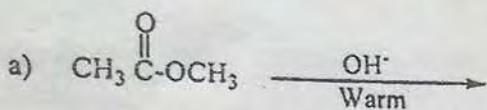
(05 marks)

(ii) State any two advantages of steam distillation. (02 marks)

## SECTION B

Answer any TWO questions.

5. Complete the following organic reactions and write the accepted mechanism.



6. (a) Explain what is meant by the term solubility product. (02 marks)

(b) Silver oxalate,  $\text{Ag}_2\text{C}_2\text{O}_4$  is a sparingly soluble salt.

(01 mark)

(i) Write equation for solubility of silver oxalate in water.

- (ii) Describe an experiment that can be used to determine the solubility product of silver oxalate. (06 marks)
- (c) The solubility of silver oxalate at 25°C is  $3.34 \times 10^{-2}$  gdm<sup>-3</sup>.
- (i) Determine the solubility product of silver oxalate at 25°C. (03 marks)
- (ii) Calculate the solubility of silver oxalate in one litre of a solution containing 3.04g of potassium oxalate. (03 marks)
- (iii) Explain what would happen to the solubility of silver oxalate when a few drops of sodium chloride solution is added. (02 marks)
- (d) State what will be observed and write equation(s) for the reaction(s) that occurs when aqueous ammonia is added dropwise until in excess to aqueous solution of silver nitrate. (03 marks)

- 7.(a) State two oxidation states which exist in both compounds of Lead and Manganese. (01 mark)
- (b) In each case, state two ways and write equations to show how the chemical properties of both Lead and Manganese:
- resemble each other.
  - differ from each other.
- Your answer should include compounds of the two oxidation states mentioned in (a) above. (10 marks)

- (c) Lead(IV) oxide was added to an aqueous solution of manganese(II) nitrate then followed by a few drops of concentrated nitric acid.
- State what was observed. (01 mark)
  - Write equation for the reaction that took place. (02 marks)
- (d) A white solid A with molar mass 325 decomposed on heating forming a red-brown solid which turned yellow on cooling and a colourless vapour. The colourless vapour turned lime water milky and formed yellow precipitate with 2,4-dinitrophenyl hydrazine in presence of sulphuric acid.
- Write the name and structural formula of substance A. (02 marks)

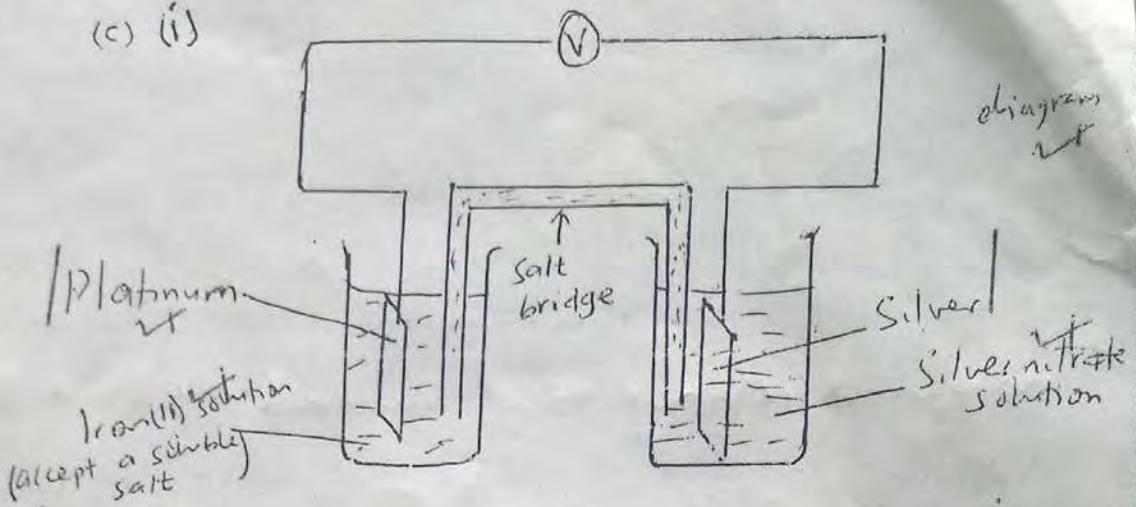
- (ii) Write equation for the reaction that occurred when substance A was heated. (02 marks)
- (iii) Write equation leading to the formation of yellow precipitate. (02 marks)
- 8.(a) Define the term transition metal element. (01 mark)
- (b) Mention any two reasons why chromium is considered as a transition metal. Give one example in each case to illustrate your answer. (02 marks)
- (c) Explain what is observed when sodium hydroxide is added dropwise until in excess to an aqueous solution of chromium(III) sulphate followed by hydrogen peroxide. (7 ½ marks)
- (d) (i) Name any two substances that may be used as raw materials in manufacture of soap. (01 mark)
- (ii) Describe briefly how soap is obtained from the above mentioned raw materials. (02 marks)
- (iii) Write equation leading to the formation of soap described in (c)(ii) above. (1 ½ marks)
- (e) (i) Distinguish between the terms addition polymerization and condensation polymerization. (02 marks)
- (ii) Name the monomers which are used in the processing of nylon -6,6. (02 marks)
- (iii) Write the structural formula of nylon-6, 6. (01 mark)

**END**

## NUMBER ONE

- 1 (a) This is the value of the electrode potential obtained at 298K when the metal electrode is dipped into a solution of an ion at unit (1 molar) concentration measured relative to a standard electrode potential ✓ (Q2)
- (b) (i) Standard hydrogen electrode ✓  
- Standard calomel electrode ✓  
ie standard mercury(I) electrode. ✓ (Q1)
- (ii) The standard electrode potential of the  $\text{Ag}(\text{s}) \mid \text{Ag}^{+}(\text{aq})$  electrode is measured by connecting it to a standard hydrogen electrode via a potassium chloride salt bridge. The standard hydrogen electrode consists of hydrogen gas at one atmosphere and 298K bubbling into across a platinum electrode dipped in a solution of unit concentration of hydrochloric acid. (or of hydrogen ions). The  $\text{Ag}(\text{s}) \mid \text{Ag}^{+}(\text{aq})$  electrode is made up of silver metal dipped into a unit concentration of silver nitrate at 298K and 1 atmosphere. Reactions take place at each electrode and since they take place at different rates, a potential difference is developed which is read from the voltmeter as the electrode potential for the  $\text{Ag}(\text{s}) \mid \text{Ag}^{+}(\text{aq})$  electrode. The observed electrode potential has a positive value since silver is below hydrogen in the electrochemical series. (where there is a potential of 0.7V)

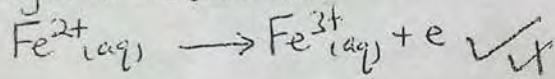
(c) (i)



(ii) - Positive electrode



- Negative electrode



$$\begin{aligned}
 (\text{iii}) \quad E_{\text{cell}}^{\circ} &= E_{\substack{\text{right} \\ \text{hand} \\ \text{electrode}}}^{\circ} - E_{\substack{\text{left hand} \\ \text{electrode}}}^{\circ} \\
 &= 0.81 - 0.75 = +0.06 \text{ V}
 \end{aligned}$$

(65)

(2)

(d) The value of the standard electrode potential is affected by the atomisation energy, ionisation energy and the hydration energy.

Due to the small cationic radius of lithium ion, it has a high charge density and high polarising power. Therefore the lithium ion is easily hydrated such that it strongly attracts water molecules.

The high hydration energy indicates that the overall oxidation process of lithium <sup>more</sup> readily takes place than in potassium.

Hence lithium having a more negative electrode potential.

(04)

- (e) - To predict the feasibility of a reaction.
- To determine the equilibrium constant,  $K_c$ .
- To determine the solubility of a sparingly soluble salt.

(62)

(20)

## NUMBER TWO

(a) There is an increase in cationic radius down the group. Therefore the charge density and hence polarising power decreases. Since the chloride ion is large in radius, it becomes less easily polarised by cations down the group. The chlorides thus become more ionic leading to an increase in the strength of the ionic bond down the group. Hence melting points of group II metal chlorides increase down the group.

- Cationic radius decreases
- Charge density & polarising power decrease
- Large chloride ion radius
- Less easily polarised by cations down the group

(b)

The oxide ion has a small ionic radius and therefore not easily polarised. Thus the oxide ion does not easily approach very closely the cations down the group due to their increasing ionic radii. The oxide ion becomes less strongly attracted to the cations leading to a decrease in the strength of the ionic bond and lattice energy. Hence melting points of group II metal oxides decrease down the group.

(b) Bromocyclohexane does not possess delocalised pie bond electrons. The bromine atom in bromocyclohexane retains its lone pairs of electrons. The bromine atom due to its electronegativity withdraws bonding pair electrons of the carbon to bromine bond more towards itself. The carbon to bromine bond becomes polarised and weakens such that it can easily undergo nucleophilic substitution reactions.

However, bromobenzene possesses delocalised pie bond electrons in the benzene ring. The lone pairs of electrons on the chlorine atom interact with the delocalised pie bond electrons in the ring. This strengthens the carbon to

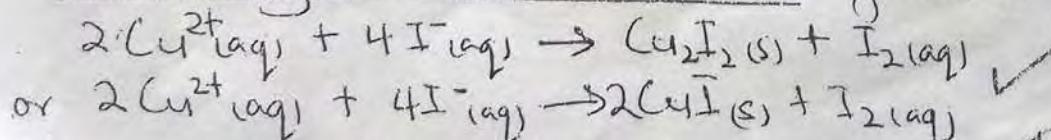
(c)

bromine bond such that the bromine atom in bromobenzene cannot easily be broken. Hence cannot undergo nucleophilic substitution reactions.

(c) There is an increase in atomic radius down group IV elements. The length of the covalent bond increases (the hydrogen atoms become less strongly attracted) leading to a decrease in the bond strength. Hence decrease in the bond dissociation energy. (05)

However, the molecular mass of group IV hydrides increases down the group. The magnitude and strength of the Van der Waals forces of attraction between the molecules increase. More heat energy is required to break the intermolecular forces of attraction hence increase in boiling points.

(d) Copper(II) ions oxidise iodide ions to liberate iodine that forms the brown solution. The copper(II) ions are reduced to copper(II) iodide which is an insoluble salt that appears as a dirty white precipitate stained by the brown solution of iodine. (04)



However, the thiosulphate ions reduce the iodine colourless to iodide ions while the thiosulphate ions are oxidised to tetrathionate ions. Hence the brown colour of iodine turns colourless.

NUMBER THREE

(a) Percentage of bromine =  $100 - (51.90 + 4.8\%)$   
 $= 43.24\%$

Elements	C	H	Br
moles	$\frac{51.90}{12}$ $= 4.325$	$\frac{4.86}{1}$ $= 4.86$	$\frac{43.24}{80}$ $= 0.5405$
Mole ratio	$\frac{4.325}{0.5405}$ $= 8$	$\frac{4.86}{0.5405}$ $= 9$	$\frac{0.5405}{0.5405}$ $= 1$
			(O2)2

Empirical formula of Z is:  $C_8H_9Br$  ✓

(b) Using  $PV = nRT$

$$M_r = \frac{wRT}{PV} \quad \checkmark$$

where w is the mass = 0.8g

R is gas constant =  $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

T =  $80^\circ\text{C} = 353 \text{ K}$

P =  $700 \text{ mHg} = \left( \frac{101325}{760} \times 700 \right) \text{ N m}^{-2}$  ✓

V =  $136 \text{ cm}^3 = 136 \times 10^{-6} \text{ m}^3$  ✓

$$M_r = \frac{0.8 \times 8.314 \times 353 \times 760}{700 \times 101325 \times 136 \times 10^{-6}} = 184.98 \text{ g} \approx 185 \text{ g} \quad \checkmark$$

$$M_r = \frac{0.8 \times 8.314 \times 353}{(101325 \times 700) \times (136 \times 10^{-6})} \quad \checkmark$$

93325.658 Nm<sup>-2</sup>

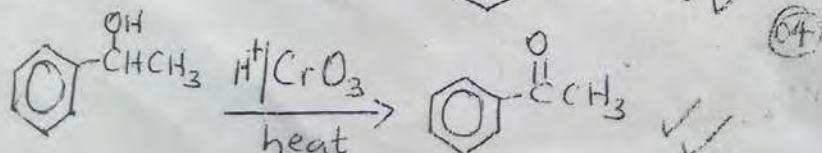
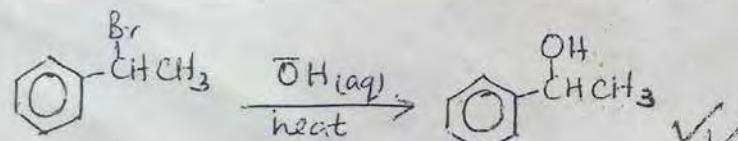
(c)  $(C_8H_9Br)_n = 184.98$  ✓

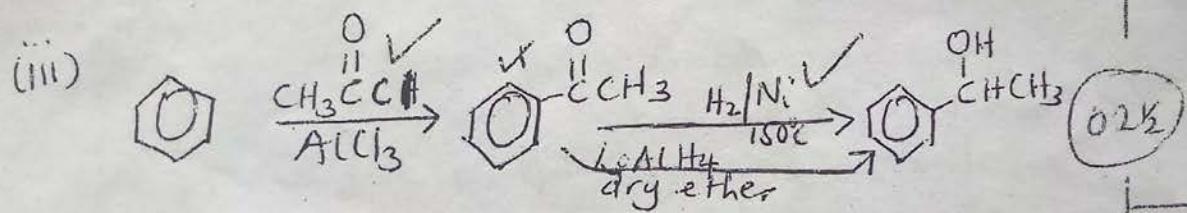
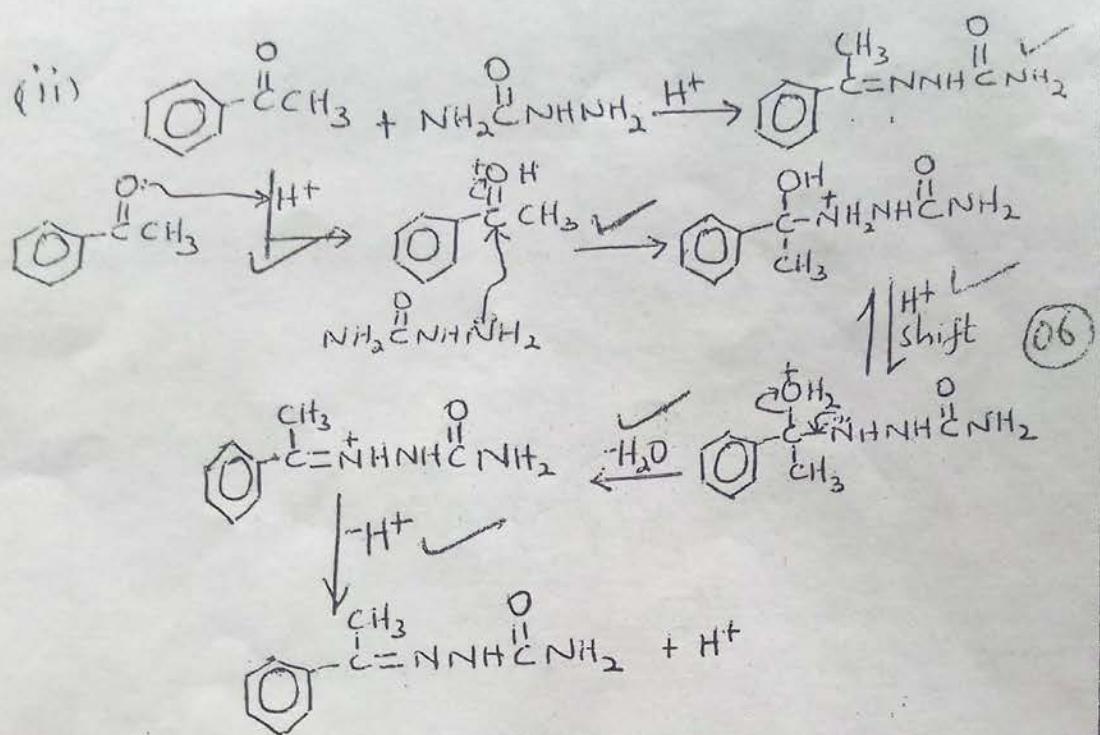
$$(12 \times 8)_n + (1 \times 9)_n + (80 \times 1)_n = 184.98 \quad \checkmark$$

$$185n = 184.98 \quad n = 1$$

Molecular formula of Z is  $C_8H_9Br$  ✓

(d) (i)





- The component to be separated should exert a vapour pressure near the boiling point of water. This is to enable much of it to be obtained in the distillate and also to enable the mixture boil below  $100^{\circ}\text{C}$ .

(iv)

(ii) - Enables to separate components from mixtures which tend to decompose at temperatures close to their boiling points.

(v)

- Enables to separate components that boil at very high temperatures.

20

NUMBER FOUR

4. (a) See graph paper

(b)

(i)

Temp (°C)	92	94	96	98	100
V.P of mixture (Nm⁻²)	80000	88000	100000	109000	118000

② ✓

(ii) See graph paper

$$(c) \quad 101 \text{ kPa} = 101000 \text{ Nm}^{-2}$$

At  $101000 \text{ Nm}^{-2}$  V.P of mixture, from the graph

$$\text{V.P of } X = 12000 \text{ Nm}^{-2} \quad \checkmark \quad \pm 1000$$

$$\text{V.P of water} = 89000 \text{ Nm}^{-2} \quad \checkmark \quad \pm 1000$$

$$\text{From } \frac{P_x^0}{P_{H_2O}^0} = \frac{W_x M_{H_2O}}{M_x W_{H_2O}} \quad \frac{W_x}{W_{H_2O}} = \frac{P_x^0 M_x}{P_{H_2O}^0 M_{H_2O}} \quad \checkmark$$

$$\text{Where } W_x = 1.1 \text{ g} \quad W_{H_2O} = 1.6 \text{ g}$$

$$P_x^0 = 12000 \text{ Nm}^{-2} \quad P_{H_2O}^0 = 89000 \text{ Nm}^{-2}$$

$$M_{H_2O} = 2 + 16 = 18 \quad M_x = ?$$

$$M_x = \frac{W_x P_{H_2O}^0 M_{H_2O}}{P_x^0 W_{H_2O}} = \frac{1.1 \times 89000 \times 18}{12000 \times 1.6} \quad \checkmark$$

$$= 91.78 \quad \checkmark \quad \pm 1000 \text{ Nm}^{-2}$$

being  $\frac{1}{2}$  of units included

(d) (i) - The component to be separated must be immiscible with water. This is because, at a given temperature, water and the component produce a vapour pressure independent of the other.

- Thus the total vapour pressure reaches the external atmospheric pressure faster and boils at a lower temperature than the two <sup>pure</sup> liquids.

- The component to be separated should have a fairly high formula mass in order to obtain much of it in the distillate.

# UGANDA NATIONAL EXAMINATIONS BOARD

(To be fastened together with other answers to paper)

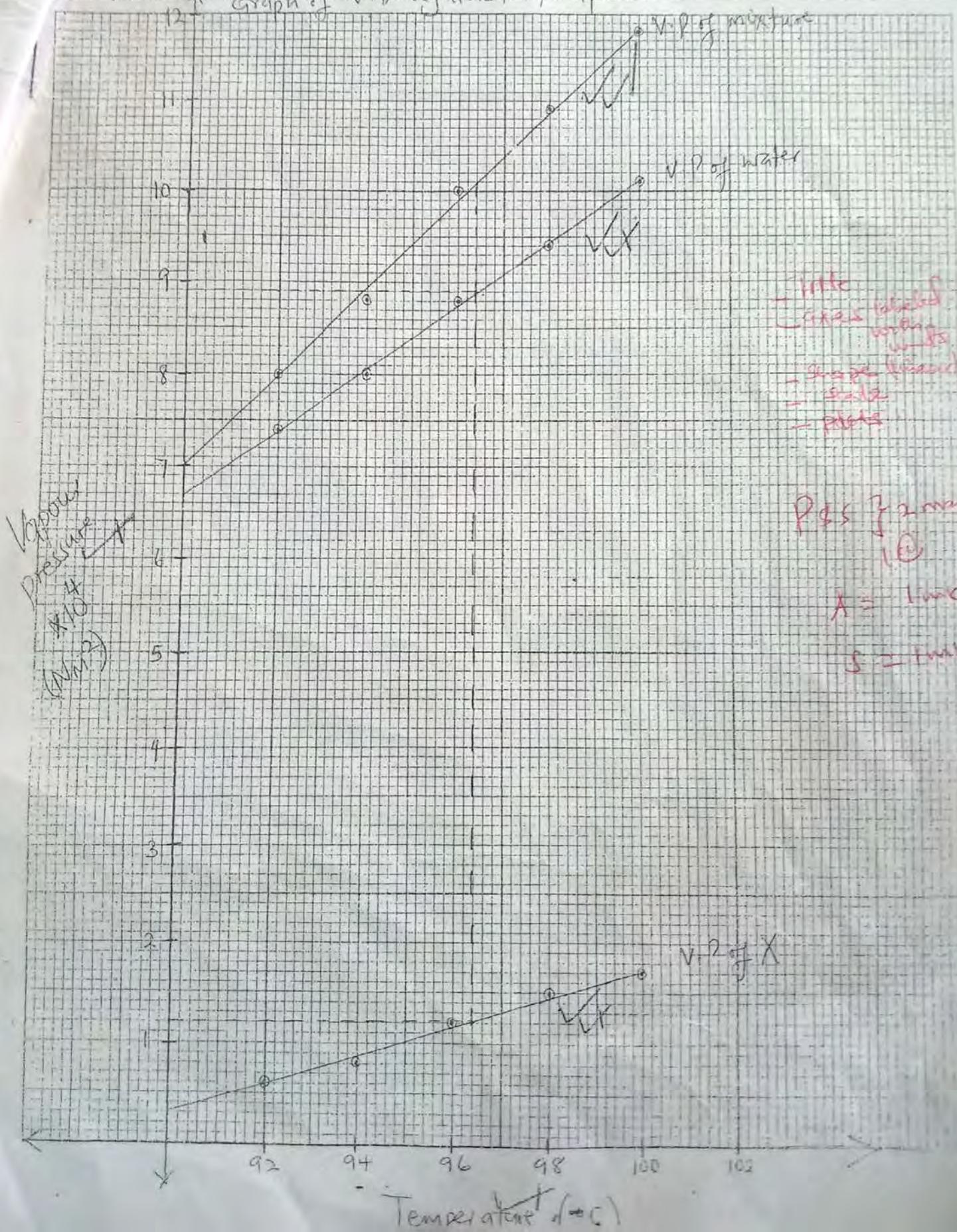
Candidate's Name .....

Signature .....

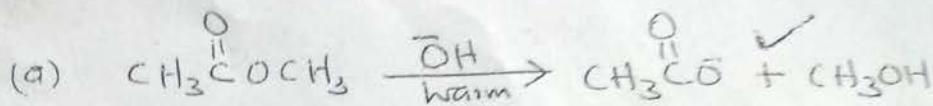
Subject Name: Graph of V.P. of air & water to temperature

UACE

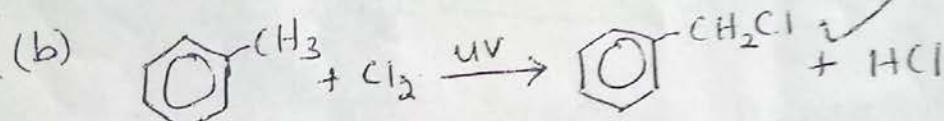
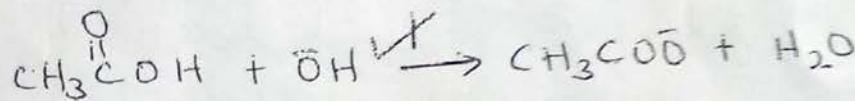
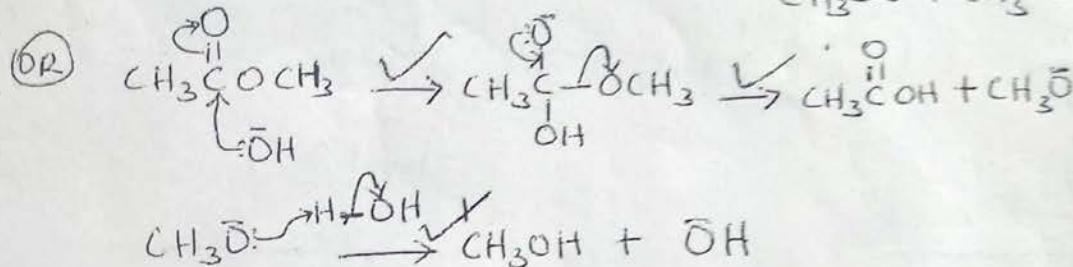
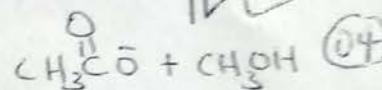
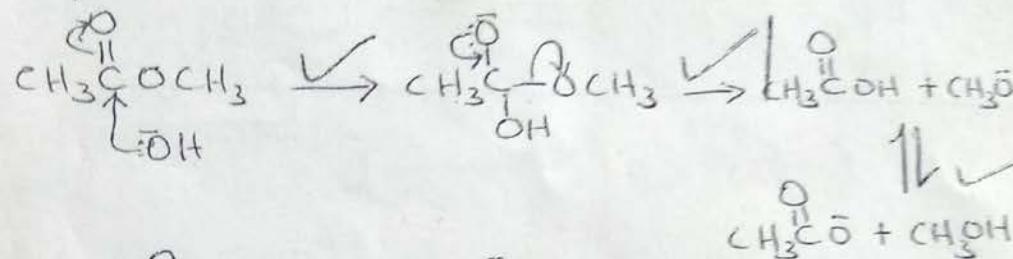
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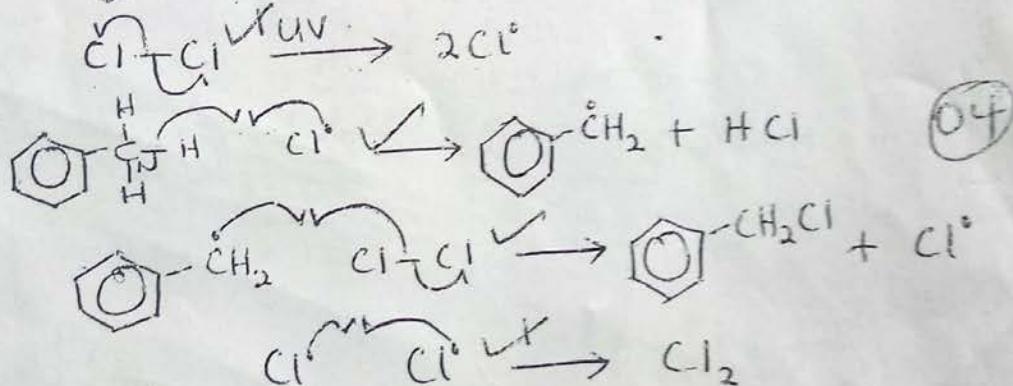
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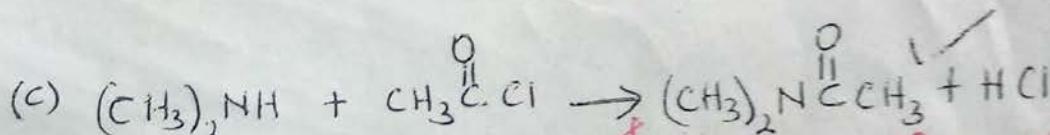
Arrow  
originates  
from the  
bond being  
broken



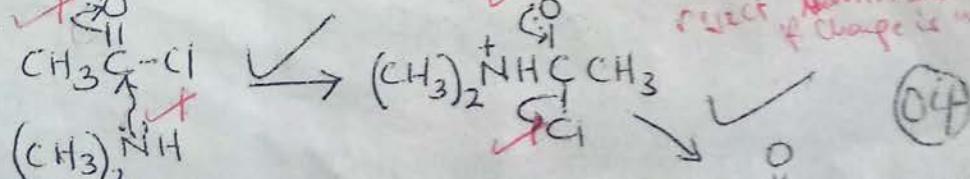
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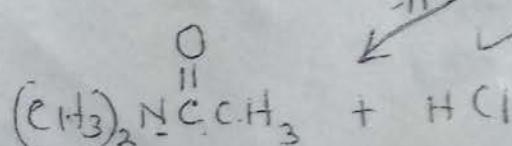
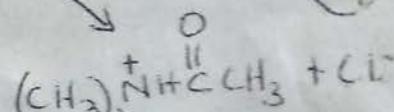
(04)

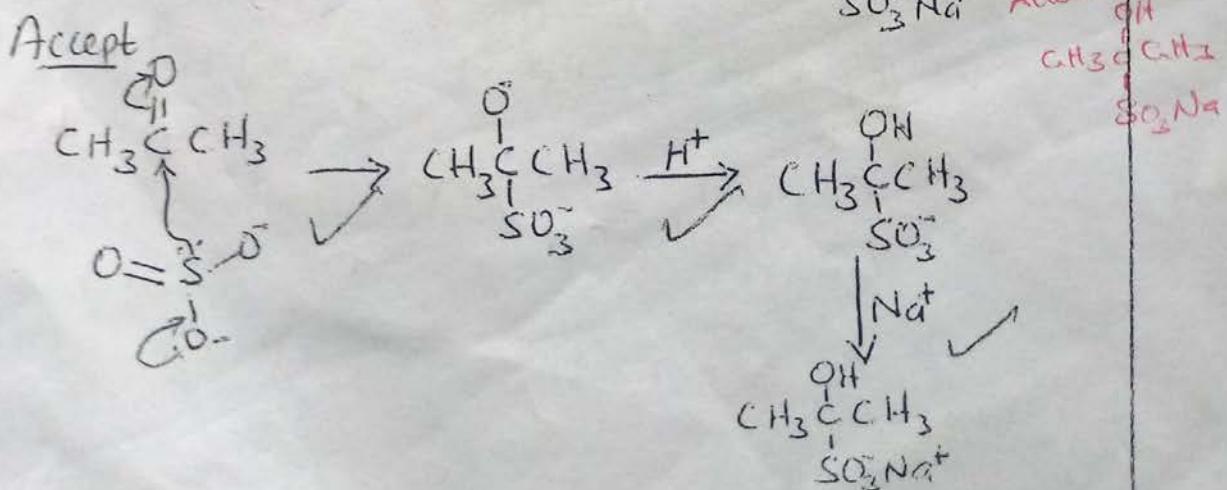
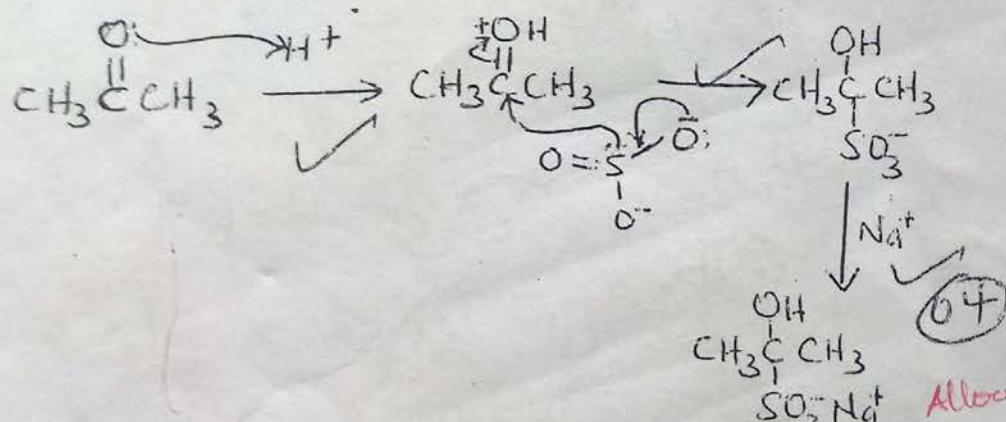
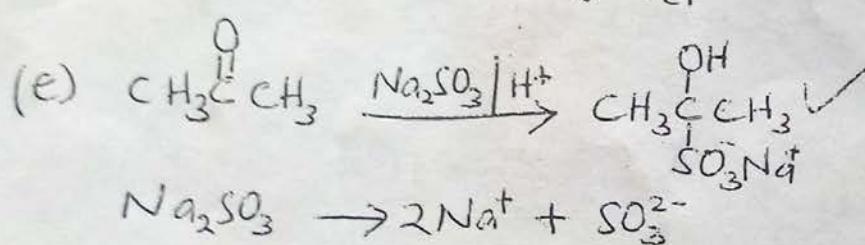
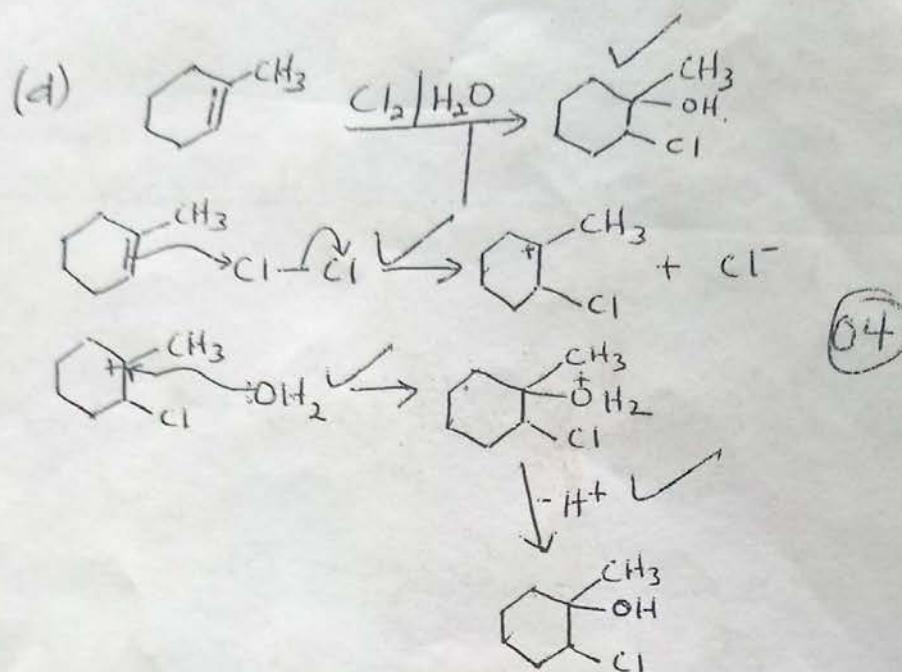


~~CH<sub>3</sub>C<sub>2</sub>O<sub>4</sub>-Cl~~ ~~CH<sub>3</sub>NH<sub>2</sub>~~ ~~select orientation if charge is needed~~



(04)





$$\text{(i) RMM of } \text{Ag}_2\text{C}_2\text{O}_4 = (108 \times 2) + (12 \times 2) + (16 \times 4) \\ = 304$$

solubility of  $\text{Ag}_2\text{C}_2\text{O}_4$  in  $\text{mol dm}^{-3}$

$$= \frac{3.34 \times 10^{-2}}{304} \checkmark = 1.099 \times 10^{-4} \text{ mol dm}^{-3}$$

$$[\text{Ag}^+] = (2 \times 1.099 \times 10^{-4}) \checkmark = 2.197 \times 10^{-4} \text{ mol dm}^{-3} \quad (05)$$

$$[\text{C}_2\text{O}_4^{2-}] = 1.099 \times 10^{-4} \text{ mol dm}^{-3} \checkmark$$

$$K_{\text{sp}} = (2.197 \times 10^{-4})^2 \times (1.099 \times 10^{-4}) \checkmark \\ = 5.304 \times 10^{-12} \text{ mol}^3 \text{ dm}^{-9}$$

+sf  
ignore

using (2) for next step.

$$\text{(ii) RMM of } \text{K}_2\text{C}_2\text{O}_4 = (39 \times 2) + (12 \times 2) + (16 \times 4) \\ = 166$$

$$\text{Moles of } \text{K}_2\text{C}_2\text{O}_4 = \frac{3.04}{166} = 0.0183 \text{ moles}$$

$$\text{Thus } [\text{C}_2\text{O}_4^{2-}] \text{ from } \text{K}_2\text{C}_2\text{O}_4 = 0.0183 \text{ mol dm}^{-3}$$

Let solubility of  $\text{Ag}_2\text{C}_2\text{O}_4$  in presence of  $\text{K}_2\text{C}_2\text{O}_4$  be  $s$

$$[\text{Ag}^+] = 2s \checkmark$$

$$[\text{C}_2\text{O}_4^{2-}] = (s + 0.0183) \checkmark \text{ but } s \text{ is very small} \quad (03)$$

$$\text{such that } (s + 0.0183) \approx 0.0183$$

$$\text{hence } [\text{C}_2\text{O}_4^{2-}] = 0.0183 \text{ mol dm}^{-3} \checkmark$$

$$K_{\text{sp}} = (2s)^2 \times (0.0183) \checkmark = 4s^2 \times 0.0183$$

$$s = \sqrt{\frac{K_{\text{sp}}}{4 \times 0.0183}} = \sqrt{\frac{5.304 \times 10^{-12}}{4 \times 0.0183}}$$

$$= 8.512 \times 10^{-6} \text{ mol dm}^{-3}$$

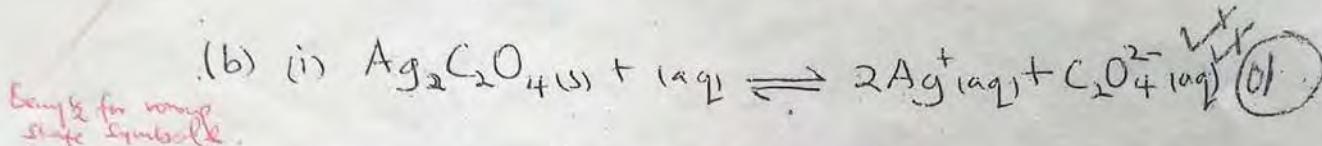
(iii) The solubility of silver oxalate increases.

The silver ions combine with chloride ions to precipitate silver chloride. The concentration of silver ions decrease hence in order to restore equilibrium of silver oxalate, more of it dissolves as the equilibrium shifts to the right.

2

## NUMBER SIX

(a) Solubility product is the product of the molar concentration of ions that exist in a saturated solution of a sparingly soluble salt raised to their coefficients from a solubility equation at a given temperature. 01

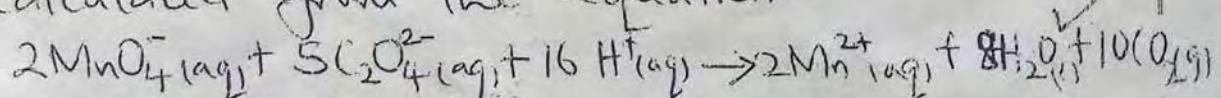


(ii) Excess silver oxalate is added to a little amount of water in a conical flask. The flask is stoppered and shaken vigorously at intervals for a specific period of time. The mixture is left to stand until equilibrium is obtained. The excess undissolved silver oxalate is filtered off. Regent

A known volume of the filtrate is pipetted and acidified with dilute sulphuric acid.

The mixture is warmed and titrated against a standard solution of potassium manganate(VII). The volume of potassium manganate(VII) used is recorded and the number of moles that reacted are calculated.

The number of moles of oxalate ions are also calculated from the equation



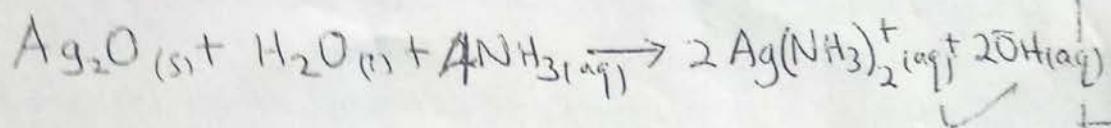
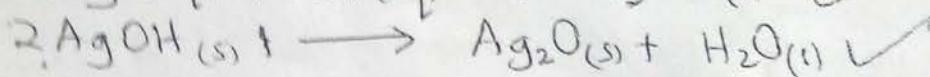
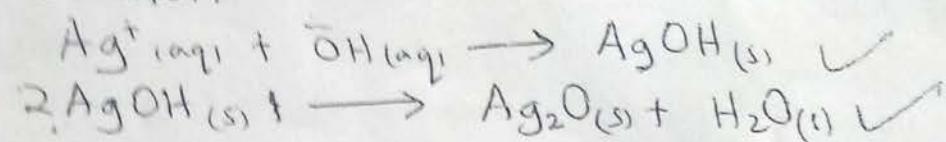
The concentration of oxalate ions is then calculated together with that of the silver ions from the solubility equation.

Hence the solubility product determined from the equation (expression)

$$K_{sp} = [\text{Ag}^+]^2 [\text{C}_2\text{O}_4^{2-}]$$

06
maximum

(d) A white precipitate is formed which rapidly turns brown and dissolves in excess ammonia to form a colorless solution.



20

3

## NUMBER SEVEN

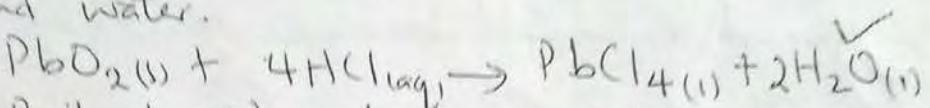
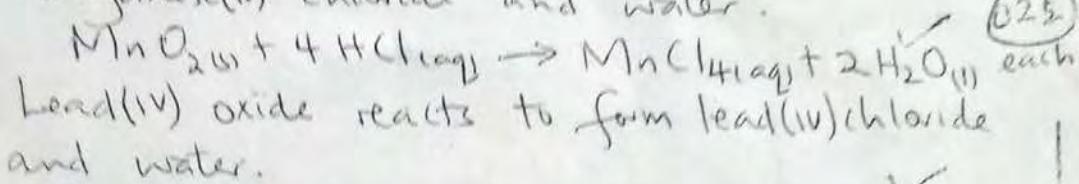
(a) +2✓ and +4✓

(b)

i) Similarities in chemical properties

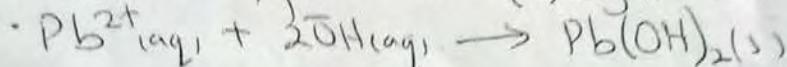
- Their dioxides react with cold and concentrated hydrochloric acid

Manganese(IV) oxide reacts to form manganese(V) chloride and water. Any 2

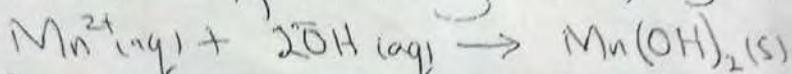


- Both excess lead(II) and manganese(II) salts react with aqueous ammonia to form precipitates which are insoluble in excess.

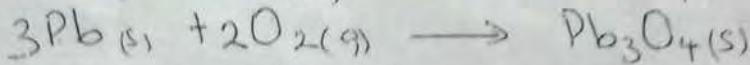
Lead(II) salt solutions react with aqueous ammonia to form lead(II) hydroxide



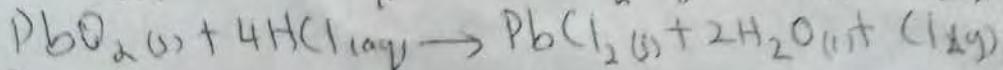
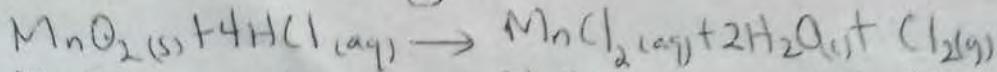
Manganese(II) salt solutions react with aqueous ammonia to form manganese(II) hydroxide.



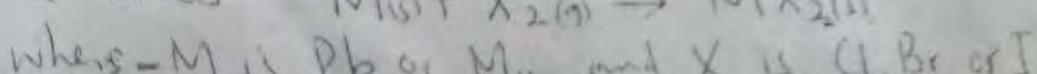
- Both lead and manganese form their trilead tetraoxide and trimanganese tetroxide respectively when heated strongly for a long time.



- Both dioxides liberate chlorine gas from warm concentrated hydrochloric acid.

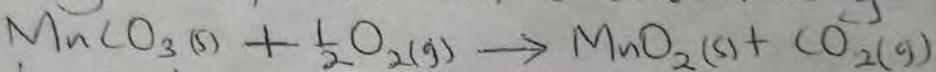
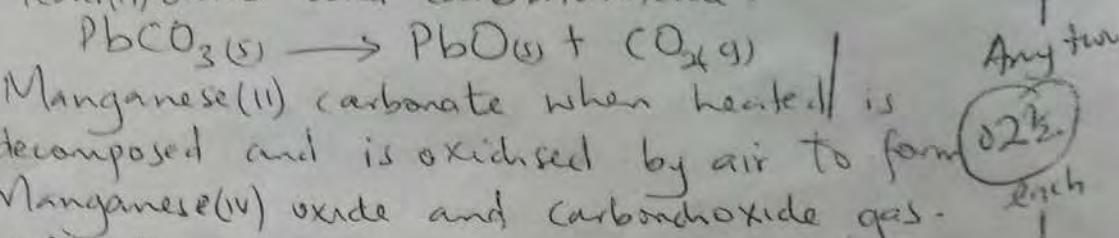


- Both manganese and lead directly combine with halogens when strongly heated to form their dihalides  $\text{MX}_2(s)$

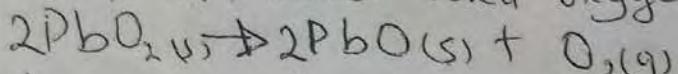


(iii) Differences in chemical properties.

- When lead(II) carbonate is heated, it forms lead(II) oxide and carbon dioxide.

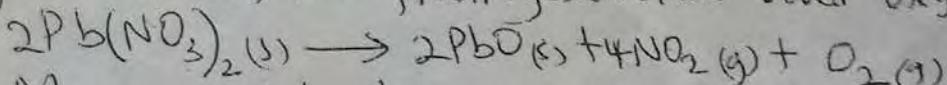


- Lead(IV) oxide decomposes when heated to form lead(II) oxide and oxygen gas.

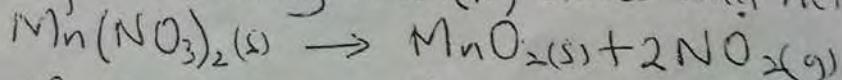


Manganese(IV) oxide does not decompose on heating.

- Lead(II) nitrate decomposes on heating to form lead(II) oxide, nitrogendioxide and oxygen gas.



Manganese(II) nitrate decomposes on heating to form manganese(IV) oxide and nitrogendioxide.



- Manganese rapidly reacts with both dilute hydrochloric and sulphuric acid to form Manganese(II) chloride and manganese(II) sulphate respectively with liberation of hydrogen gas.

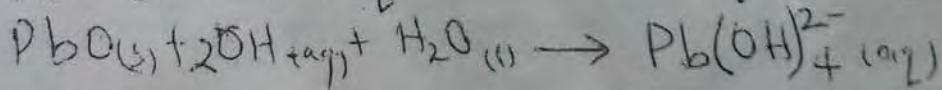


Lead is inert to both dilute hydrochloric and sulphuric acid.

- Manganese(II) oxide is basic while lead(II) oxide is amphoteric.



While for lead



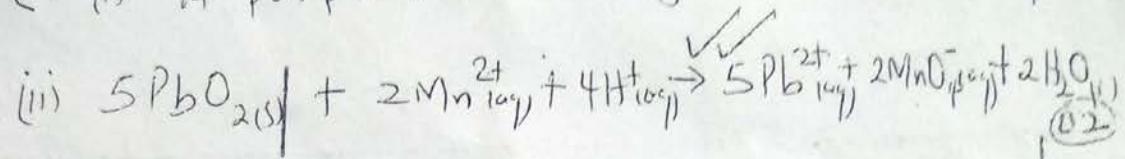
Any two

$\text{O}_2$  &  $\text{CO}_2$

each

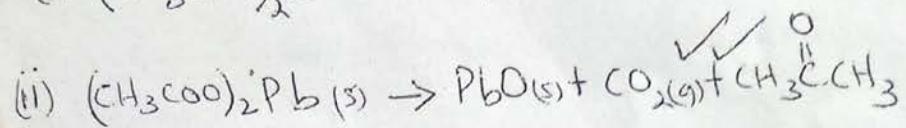
05

(c) (i) A purple solution is formed.



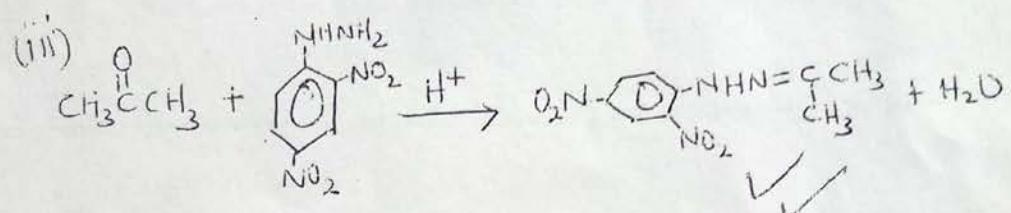
(6)

(d) (i)  $(\text{CH}_3\text{COO})_2\text{Pb}$  Lead(II) ethanoate



(6)

(6)



(6)

20

## NUMBER EIGHT

(a) This is an element that forms atleast one of its ions with partially (incompletely) filled d-orbitals.

(b) It's an element that contains one of its oxidation states with incompletely filled d-orbitals.

(b) - Chromium forms coloured compounds

eg Chromium(III) hydroxide is a green solid.

- chromium has compounds in different (three) oxidation states.

eg. Chromium(II) oxide, chromium(III) oxide, <sup>Am</sup> chromium(IV) oxide

- Chromium forms complex ions

eg  $\text{Cr}(\text{OH})_6^{3-}$ ,  $\text{Cr}(\text{H}_2\text{O})_6^{3+}$

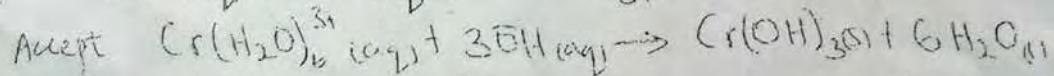
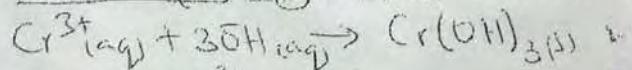
- Chromium has catalytic properties

eg In polymerisation of ethylene

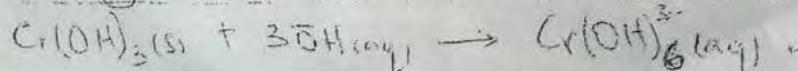
(c) A green precipitate is formed which dissolves in excess to form a green solution.

On addition of hydrogen peroxide, the green solution turns to yellow.

The green precipitate is due to formation of Chromium(III) hydroxide which is an insoluble base.



The precipitate dissolves in excess due to formation of hexahydroxochromate(III) ion which is soluble.



The green solution turns to yellow due to oxidation of the chromium in the complex ion to the chromate(VI) ion that appears yellow.



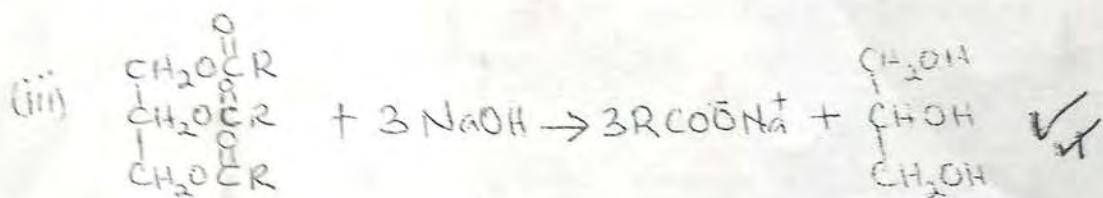
(d) (i) - Fats or oils ✓

→ Sodium hydroxide or potassium hydroxide solution.

01

(ii) The fat or oil is placed in a pan and a concentrated solution of sodium (or potassium) hydroxide is added. The mixture is then steam heated to boiling while stirring until a thick saturated solution (of soap) is formed.

02



01 1/2

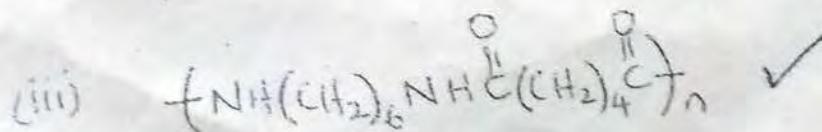
(e) (i) Addition polymerisation is the process of repeated combination of small unsaturated molecules (monomers) to form large saturated molecules that have the same empirical formula as the monomers.

Condensation polymerisation is the process of repeated combination of different small molecules called monomers to form large molecules accompanied by elimination of other smaller molecules.

02

(ii) Hexane-1,6-diamine ✓  
and Hexane-1,6-diyl dichloride ✓  
(or Hexane-1,6-dioic acid)

02



01

20

P525/2

CHEMISTRY

Paper 2

Jul. / Aug. 2017

2  $\frac{1}{2}$  hours



UGANDA TEACHERS' EDUCATION CONSULT (UTEC)

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2

2 hours 30 minutes

**INSTRUCTIONS TO CANDIDATES:**

*Answer five questions including three questions from Section A and one question from Section B.*

**Begin each question on a fresh page.**

*Mathematical tables and graph papers are provided.*

*Non-programmable scientific electronic calculators may be used.*

**Illustrate your answers with equations where applicable.**

[C = 12, H = 1, 1 mol of a gas occupies  $22.4 \text{ dm}^3$  at s.t.p.]

## SECTION A:

Answer three questions from this section.

1. (a) 0.98g of a cyclic organic compound Q on complete combustion yielded 2.64g of carbon dioxide and 0.90g of water. Determine the empirical formula of Q. (03 marks)
- (b) When Q was distilled in steam, the distillation took place at 98.5°C and standard pressure. The distillate was found to contain 0.60g water and 14.88g of Q. [The vapour pressure of water at 98.5°C is 0.18 atm] (04 marks)
- (i) Determine the molecular formula of Q. (01 mark)
- (ii) Q had no effect on ammoniacal silver nitrate solution. Identify Q. (01 mark)
- (c) Write equation for the reaction between Q and semi carbozone in aqueous acidic medium and outline a mechanism for the reaction. (05 marks)
- (d) Write equations to show how nylon 6,6 can be prepared from Q. (07 marks)
2. (a) Describe how you would determine the standard enthalpy of combustion of copper. (07 marks)
- (b) Some thermo chemical data for copper, copper(I)oxide and oxygen is given below:
- | Process                                 | $\Delta H \text{ (kJmol}^{-1}\text{)}$ |
|---|--|
| Sublimation of copper                   | + 339.3                                |
| Enthalpy of formation of copper(I)oxide | - 166.7                                |
| First ionization energy of copper       | + 750.0                                |
| Second ionization energy of copper      | + 1958.0                               |
| Bond dissociation energy of oxygen      | + 498.4                                |
| First electron affinity of oxygen       | - 141.4                                |
| Second electron affinity of oxygen      | + 790.8                                |
- (i) Draw an energy level diagram for the combustion of copper to copper(I) oxide using the enthalpy data given. (03 marks)

- (ii) Calculate the lattice energy for copper(I)oxide. (02 marks)
- (iii) If the enthalpy of formation of copper(II) oxide is  $-155.9 \text{ kJmol}^{-1}$ , determine the lattice energy for copper(II)oxide and comment on the stability of copper(I)oxide and copper(II)oxide. (04 marks)
- (c) (i) Define the term bond energy. (01 mark)
- (ii) The standard enthalpies of atomization of hydrogen, chlorine and graphite are 434.7, 246.6 and  $714.8 \text{ kJmol}^{-1}$  respectively. Calculate the standard enthalpy of formation of chloromethane if the C – Cl and C – H bond energies are 334.4 and 412.6  $\text{kJmol}^{-1}$  respectively. (03 marks)
3. The elements carbon, silicon, tin and lead belong to group IV of the Periodic Table.
- (a) (i) Write the formulae of the oxides of the elements in the +4 oxidation state. (02 marks)
- (ii) State the trend in the acidity of the oxides you have written in (i). (01 mark)
- (b) Discuss the reaction of the oxides in (a) (i) with; (05 marks)
- (i) sodium hydroxide, (05 marks)
- (ii) mineral acids. (05 marks)
- (c) Write equation for the reaction to show how lead(IV)oxide can be prepared from; (1½ marks)
- (i) lead(II) nitrate solution, (1½ marks)
- (ii) trilead tetraoxide. (1½ marks)
- (d) Sulphur dioxide gas was passed over heated lead(IV)oxide. (1½ marks)
- (i) State what was observed. (1½ marks)
- (ii) Explain your observation (1½ marks)
4. (a) Explain the following observations:
- (i) When few drops of sodium hydroxide solution were added to calcium nitrate solution, a white precipitate was formed but when few drops of ammonia solution are added no precipitate was formed. (04 marks)

- (ii) During the titration of ammonia solution with hydrochloric acid methyl orange indicator was used instead of phenolphthalein indicator. (0.3 marks)
- (iii) A mixture of water and carbon tetrachloride boils at a temperature considerably below the boiling point of either liquid. (0.4 marks)
- (b) Chromium sulphate was dissolved in water to form an aqueous solution. To the solution was added sodium hydroxide solution dropwise until in excess followed by hydrogen peroxide. (1½ marks)
- (i) State what was observed.
- (ii) Write equation(s) for the reaction(s) that took place. (3½ marks)
- (c) The resultant solution (b) was gently warmed and then acidified with dilute sulphuric acid. (0.1 mark)
- (i) State what was observed.
- (ii) Write equation(s) for the reaction that took place. (0.3 marks)

## SECTION B:

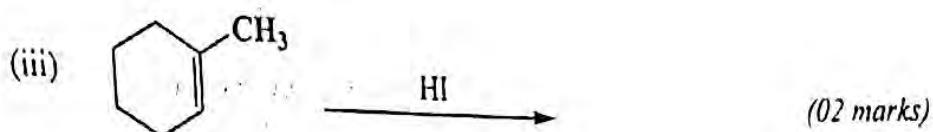
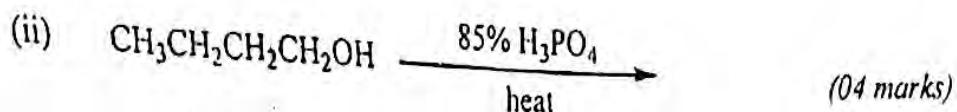
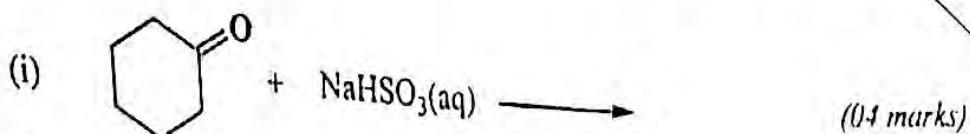
*Answer two questions from this section.*

5. (a) Write equations to show how the following compounds can be synthesized.

Indicate reagents and conditions for the reactions.

- (i) Cyclohexylmethanol from chlorocyclohexane. (0.4 marks)
- (ii) But - 1 - yne from butan - 1 - ol. (0.6 marks)

(b) Complete the following equations and outline a mechanism.



6. (a) The following data was obtained for a mixture of aniline and hydrochloric acid.

Mole fraction of aniline	0.0	0.2	0.4	0.6	0.8	1.0
Partial pressure of aniline (mmHg)	0	35	82	142	219	293
Partial pressure of hydrochloric acid (mmHg)	347	270	185	102	37	0

- (i) Plot a graph of vapour pressure against mole fraction of hydrochloric acid. (05 marks)
- (ii) Draw the boiling point composition diagram for a mixture of aniline and hydrochloric acid and on it indicate a tie line. (04 marks)
- (iii) Describe what would happen if a liquid mixture containing 20% aniline was fractionally distilled. (03 marks)
- (b) To 25.0 cm<sup>3</sup> of 0.2M copper(II)sulphate solution was added 25 cm<sup>3</sup> of 1M ammonia solution. The resultant solution was shaken with trichloromethane and allowed to settle. 25 cm<sup>3</sup> of the aqueous layer required 24.8 cm<sup>3</sup> of 0.5M hydrochloric acid. If the partition coefficient of ammonia between trichloromethane and water is 0.04.

- (i) Calculate the molar concentration of ammonia in the trichloromethane layer. (05 marks)
- (ii) Calculate the concentration of ammonia that formed a complex with copper(II) ions. (03 marks)
- (iii) Determine the coordination number of copper in the complex  $[Cu(NH_3)_n]^{2+}$ . (02 marks)
7. (a) Describe how sodium hydroxide is manufactured in the mercury cell. (07 marks)
- (b) Discuss the reactions of chlorine with potassium hydroxide solution. (06 marks)
- (c) (i) Write the formulae of the oxoacids of chlorine. (02 marks)  
(ii) State the trend of acidity of the oxoacids you have written in (i) above. Explain your answer. (03 marks)
- (d) When an aqueous solution of one of the oxoacids in (c) above was boiled with lead(II) acetate solution, a brown precipitate was formed.  
(i) Identify the oxoacid. (½ mark)  
(ii) Write an equation for the reaction leading to the formation of the oxoacid. (1½ marks)
8. (a) Describe how the solubility product  $K_{sp}$  of silver chromate can be determined by a titrimetric method. (07 marks)
- (b) The solubility of silver chromate at  $25^\circ C$  is  $2.0 \times 10^{-5} \text{ mol dm}^{-3}$ . Calculate the;  
(i) solubility product  $K_{sp}$  of silver chromate and state its units. (03 marks)  
(ii) solubility of silver chromate in 0.1M silver nitrate solution. (03 marks)
- (c) (i) Explain the term buffer solution. (02 marks)  
(ii) Calculate the change in pH when 1.0cm<sup>3</sup> of 1M hydrochloric acid is added to a solution containing 1.07 g of ammonium chloride in 1.0dm<sup>3</sup> of 0.01 M ammonia solution. (05 marks)

END

P530/2  
**BIOLOGY**  
(Theory)  
Paper 2  
**July/August 2019**  
2 ½ hours



**UGANDA TEACHERS' EXAMINATIONS SCHEME**  
**Uganda Advanced Certificate of Education**  
**JOINT MOCK EXAMINATIONS**  
**BIOLOGY**  
**(THEORY)**  
**Paper 2**  
**2 hours 30 minutes**

**INSTRUCTIONS TO CANDIDATES**

*This paper consists of sections A and B.*

*Answer question one in section A plus three others from section B.*

*Candidates are advised to read the questions carefully, organize their answers and present them precisely and logically, illustrating with well labeled diagrams where necessary.*

## SECTION A (40 marks)

1. A. The graph in figure 1 shows the membrane potential of the post synaptic membranes of a neurone after application of acetylcholine to the synapse, thereby producing an excitatory post synaptic potential (EPSP)

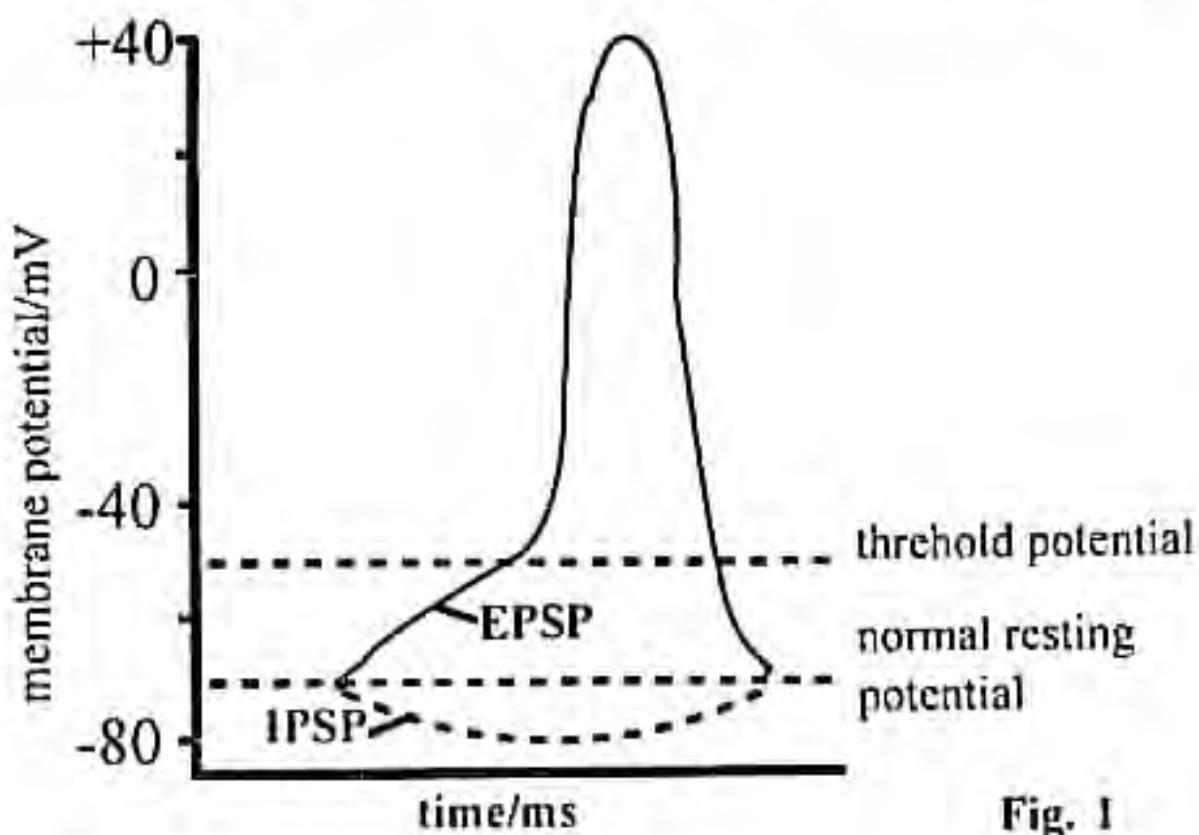


Fig. 1

- (a) (i) What is the cause of the resting potential of -70mV? (03 marks)
- (ii) Describe the molecular events which result in the changes in membrane potential shown on the graph. (10 marks)
- (iii) A different transmitter substance was applied to the synapse. The change in membrane potential of the post-synaptic membrane is illustrated by the curve labeled IPSP. Explain the cause of this. (08 marks)

- B. A theory of colour vision suggests that a photoreceptor has a pigment that exists in three forms namely; blue, red and green according to the colour of the wave length observed by each. The absorption of different wave lengths by the three forms of photoreceptor pigments is given in the table below.

Study the information and answer the questions that follow.

Wave length (nm)	Amount of light observed as a percentage of maximum		
	Red cones	Green cones	Blue cones
660	5	0	0
600	75	15	0
570	100	45	0
550	85	85	0
530	60	100	10
500	35	75	30
460	0	20	75
430	0	0	100
400	0	0	30

- (b) From the data, explain why light of wave length.
- (i) 430nm appears blue (03 marks)
- (ii) 550nm appears yellow (03 marks)
- (iii) 570nm appears orange (04 marks)
- (c) Explain why two closely placed small objects can be easily distinguished by cones that rods. (09 marks)

## **SECTION B (60 MARKS)**

- ✓ 2. (a) Explain the modern concept of evolution by natural selection. (10 marks)
- (b) Explain how features of the embryos in the early stages of development and the possession of vestigial organs support organic evolution. (10 marks)
3. (a) Distinguish between blood circulation of fish and mammals. (06 marks)
- (b) Describe blood circulation in insects. (07 marks)
- (c) Explain cell mediated immune response in humans. (07 marks)
- ✓ 4. (a) Distinguish between primary and secondary succession. (03 marks)
- (b) Describe primary succession on a bare rock. (14 marks)
- (c) Outline the characteristics of a climax community. (03 marks)
- ✓ 5. Describe the location and functions of membranes in eukaryotic cells. (20 marks)
- ✓ 6. (a) Explain why a single base deletion from one DNA molecule usually causes a greater effect than the replacement of one base by another different base. (08 marks)
- (b) Using a named example, describe how gene mutation may affect a genotype of an organism.

**END**