P525/2
Chemistry
Paper 2
July - August 2019
2 ½ 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=8.314J mol^{-1}K^{-1}.

Molar volume at s.t.p = 22.4dm^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 $Ag(s)/Ag^{+}(aq)$ electrode. (4 marks)

(c) The standard electrode potential of $Ag(s)/Ag^{+}(aq)$ and $Fe^{2+}(s)/Fe^{3+}(aq)$ 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.

$Li^{+}(aq) + e \rightarrow Li(s) \quad E^{\ominus} = -3.04V$

$K^{+}(aq) + e \rightarrow K(s) \quad E^{\ominus} = -2.92\ V$

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:

$MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$

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 $CH_4 > SiH_4 > GeH_4 > PbH_4$ 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^3. 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.

(2½ marks)

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

Temp (^{0}C)	92	94	96	98	100
VP of X (Nm^{-2})	6000	8000	12000	15000	17000
VP of water (Nm^{-2})	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)

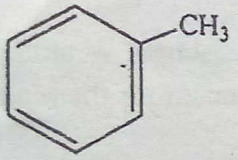
(ii)State any **two** advantages of steam distillation. (02 marks)

SECTION B

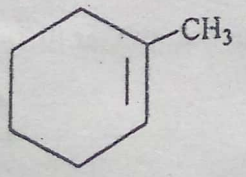
Answer any **TWO** questions.

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

a) $CH_3\overset{\overset{O}{\|}}{C}\text{-}OCH_3 \xrightarrow[\text{Warm}]{OH^-}$

b)  $+ Cl_2 \xrightarrow{U.V}$

c) $(CH_3)_2NH + CH_3\overset{\overset{O}{\|}}{C}\text{-}Cl \longrightarrow$.

d)  $\xrightarrow{Cl_2/H_2O}$.

e) $CH_3\overset{\overset{O}{\|}}{C}CH_3 \xrightarrow{Na_2SO_3/H^+}$

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

(b)Silver oxalate, $Ag_2C_2O_4$ is a sparingly soluble salt.

(i) Write equation for solubility of silver oxalate in water. (01 mark)

(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 3.34×10^{-2} gdm^3.

(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: '

(i) resemble each other.

(ii) 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.

(i)State what was observed. (01 mark)

(ii)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.

(i) 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

Guide.
P 52512

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 (02)

(b) (i) - Standard hydrogen electrode
- Standard calomel electrode
ie Standard mercury(I) electrode. (01)

(ii) The standard electrode potential of the $Ag_{(s)}|Ag^+_{(aq)}$ 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 across a platinum electrode dipped in a unit concentration of hydrochloric acid. (or of hydrogen ions). The $Ag_{(s)}|Ag^+_{(aq)}$ 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 $Ag_{(s)}|Ag^+_{(aq)}$ electrode. The observed electrode potential has a positive value since silver is below hydrogen in the electrochemical series. (04)

which has a potential of 0.00V and + potential

measured relative to the SHE

(c) (i)

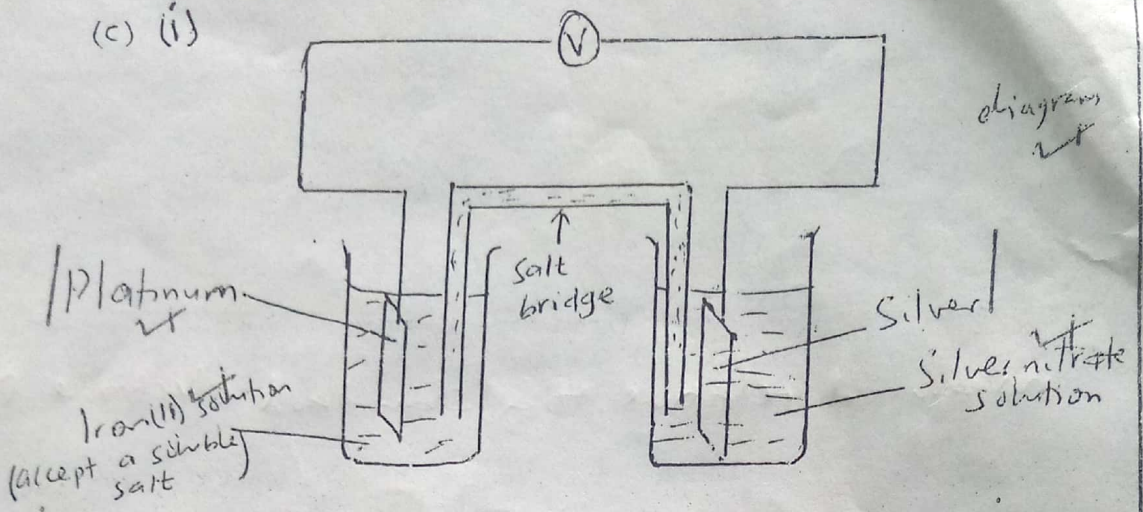


diagram ✓ ↓

(02)

(ii) - Positive electrode

$Ag^{+}_{(aq)} + e \longrightarrow Ag_{(s)}$ ✓ ↓

- Negative electrode

$Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)} + e$ ✓ ↓

(05)

(iii) $E^{\circ}_{cell} = E^{\circ}_{\text{right hand electrode}} - E^{\circ}_{\text{left hand electrode}}$ ✓ ↓

$= 0.81 - 0.75 = +0.06\,V$ ✓

(02)

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

Due 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 is strongly attracts ↓ water molecules. The high hydration energy ↓ indicates that the overall oxidation process of lithium more 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.

(02)

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.

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 grong.

- Cationic radius decreases
- Charge density & polarizing power decreases
- large chloride ion radius
- less easily polarised by cations down the group

06

(b) Bromocyclohexane does not posses 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.

05

However, bromobenzene posses 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

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(I) iodide which is an insoluble salt that appears as a dirty white precipitate stained by the brown solution of iodine. (04)

$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow Cu_2I_2(s) + I_2(aq)$

or $2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$

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

20

NUMBER THREE

(a) Percentage of bromine = 100 − (51.90 + 4.86)
= 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	$\frac{4.325}{0.5405} = 8$	$\frac{4.86}{0.5405} = 9$	$\frac{0.5405}{0.5405} = 1$ ✓

02½

Empirical formula of Z is C_8H_9Br ✓

(b) Using $PV = nRT$

$M_r = \frac{WRT}{PV}$ ✓

where w is the mass = 0.8g

R is gas constant = $8.314\ JK^{-1}mol^{-1}$

T = 80°C = 353K

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

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

03½

$M_r = \frac{0.8 \times 8.314 \times 353 \times 760}{700 \times 101325 \times 136 \times 10^{-6}} = 184.98g$ ✓

$\simeq 185g$ ✓

$Mr = \frac{0.8 \times 8.314 \times 353}{\left(\frac{101325}{760} \times 700\right) \times (136 \times 10^{-6})}$ ✓

93325 · 658 Nm^{-2}

(c) $(C_8H_9Br)_n = 184.98$ ✓

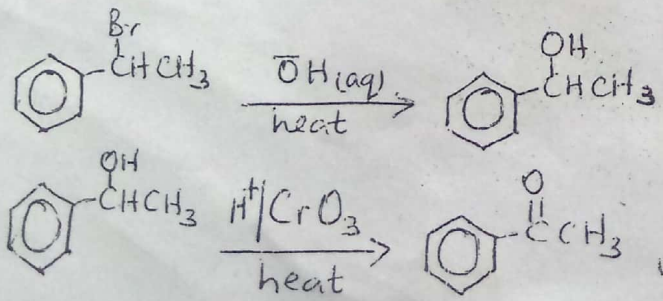
$(12 \times 8)n + (1 \times 9)n + (80 \times 1)n = 184.98$ ✓

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

01½

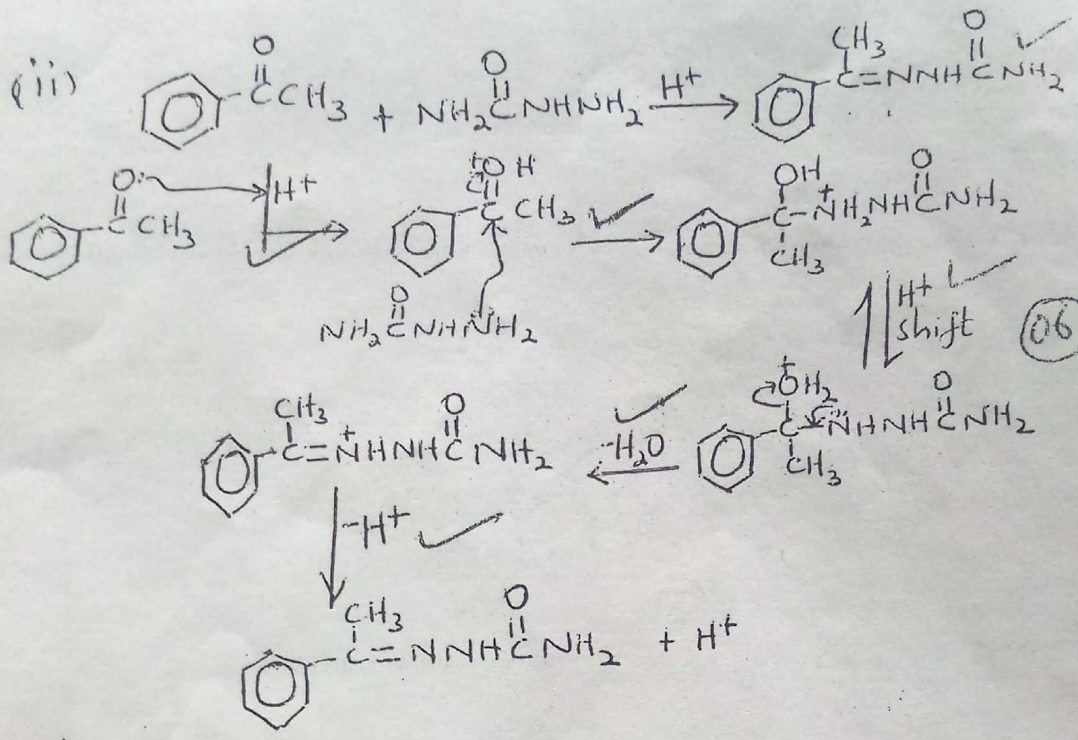
Molecular formula of Z is C_8H_9Br ✓

(d) (i)



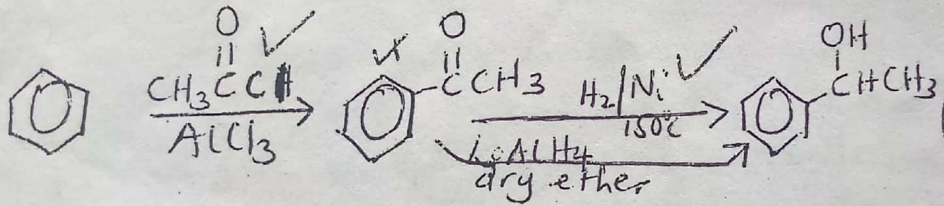
04

(ii)



06

(iii)



02½

20

- 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°C.

(03)

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

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

(02)

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	100,000	109000	118000

✓✓ (02)

(ii) See graph paper

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

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

V.P of X = $12000Nm^{-2}$ ✓ ± 1000

V.P of water = $89000Nm^{-2}$ ✓ ± 1000

From $\frac{P^o_x}{P^o_{H_2O}} = \frac{W_x M_{H_2O}}{M_x W_{H_2O}}$ $\quad \frac{W_x}{W_{H_2O}} = \frac{P^o_x M_x}{P^o_{H_2O} M_{H_2O}}$ ✓✓

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

$P^o_x = 12000Nm^{-2}$ $\quad P^o_{H_2O} = 89000Nm^{-2}$

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

(05)

$$M_x = \frac{W_x P^o_{H_2O} M_{H_2O}}{P^o_x W_{H_2O}} = \frac{1.1 \times 89000 \times 18}{12000 \times 1.6} \checkmark$$

$= 91.78$ ✓ $\pm 100cc$ 92. Being ½ if 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 pure liquids

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

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(To be fastened together with other answers to paper)

UACE

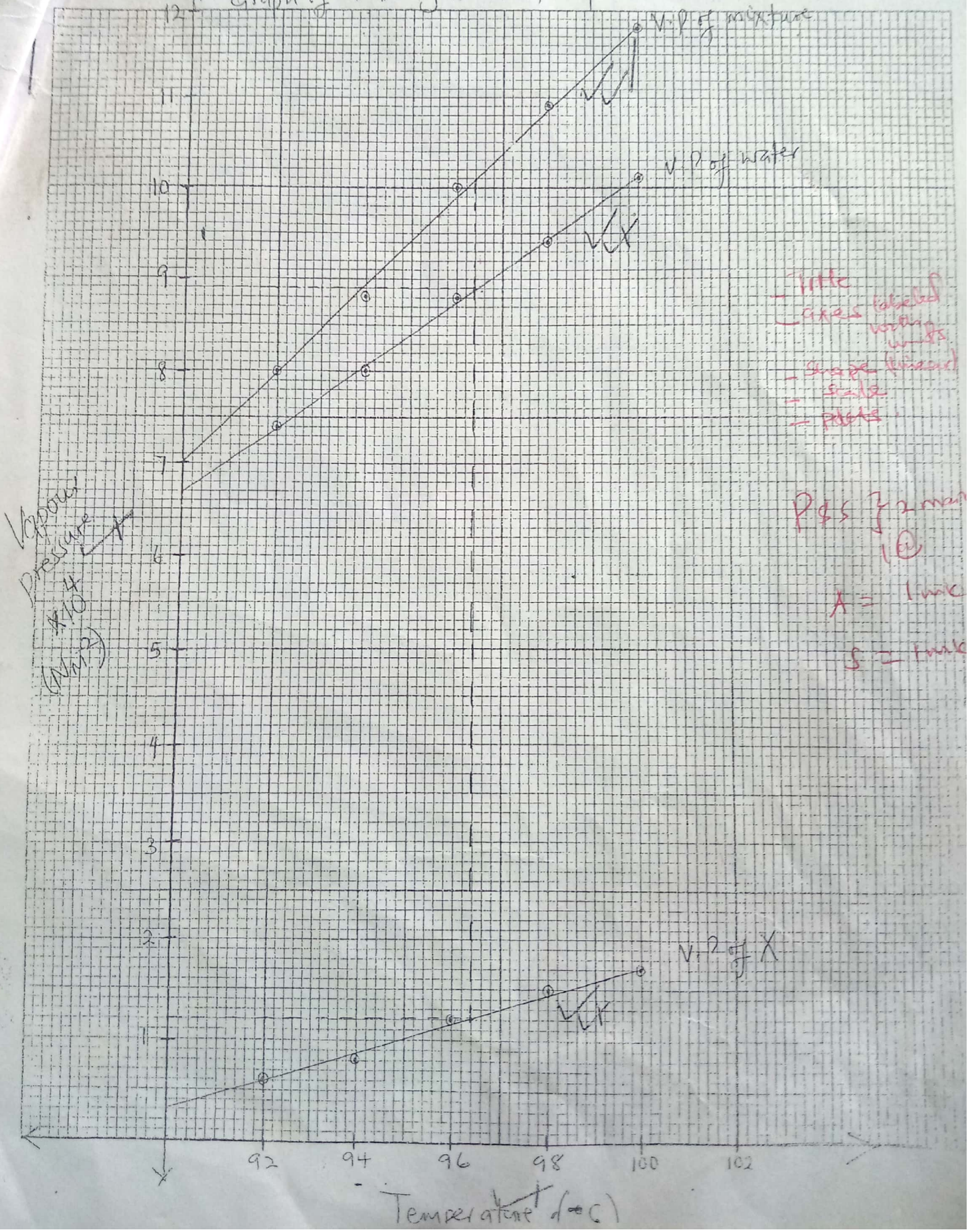
Candidate's Name .....

Signature .....

Random No.

Personal Number

Subject Name Graph of V.P against temperature



- Title
- Axes labeled with units
- Graph titled
- Scale
- Points

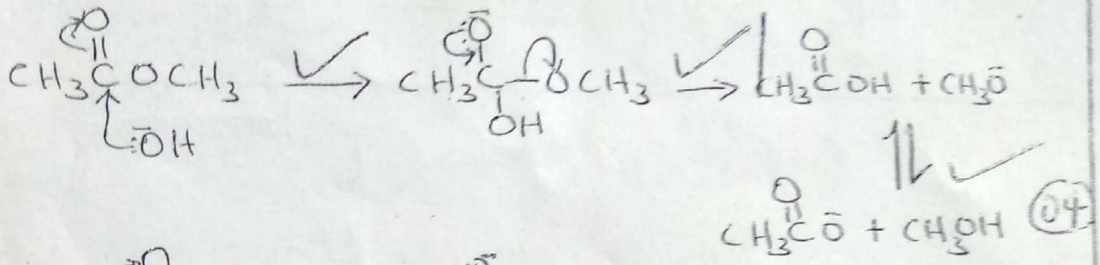
P&S } 2 mar
10

A = 1 mar

S = 1 mar

NUMBER FIVE

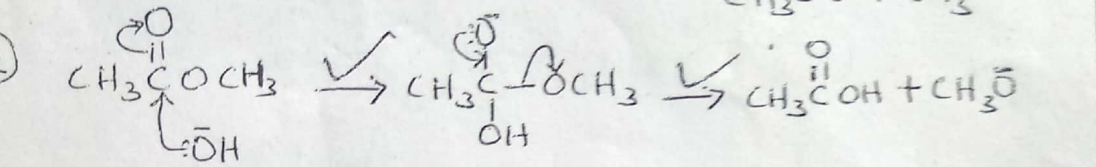
(a) $CH_3COCH_3 \xrightarrow[\text{warm}]{\bar{O}H} CH_3C(=O)\bar{O} + CH_3OH$



Arrow originate from the bond being heyd. drawn

$CH_3C(=O)\bar{O} + CH_3OH$ (04)

OR



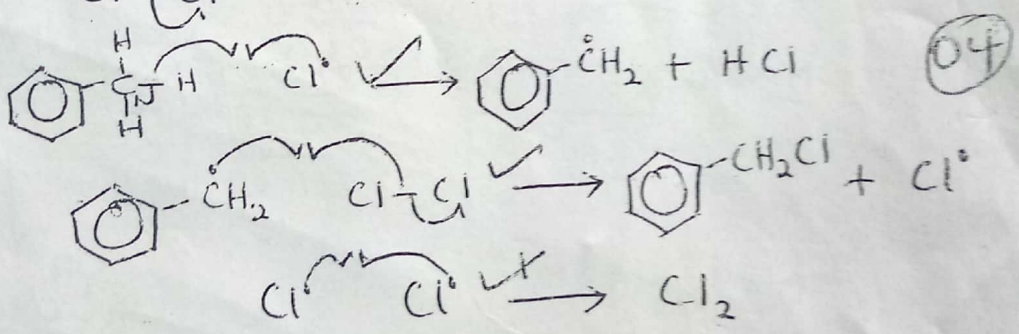
$CH_3\bar{O}: + H{-}OH \longrightarrow CH_3OH + \bar{O}H$

$CH_3C(=O)OH + \bar{O}H \longrightarrow CH_3C(=O)\bar{O} + H_2O$

(b) $C_6H_5CH_3 + Cl_2 \xrightarrow{UV} C_6H_5CH_2Cl + HCl$

Repeat full arrow.

$Cl{-}Cl \xrightarrow{UV} 2Cl^{\bullet}$



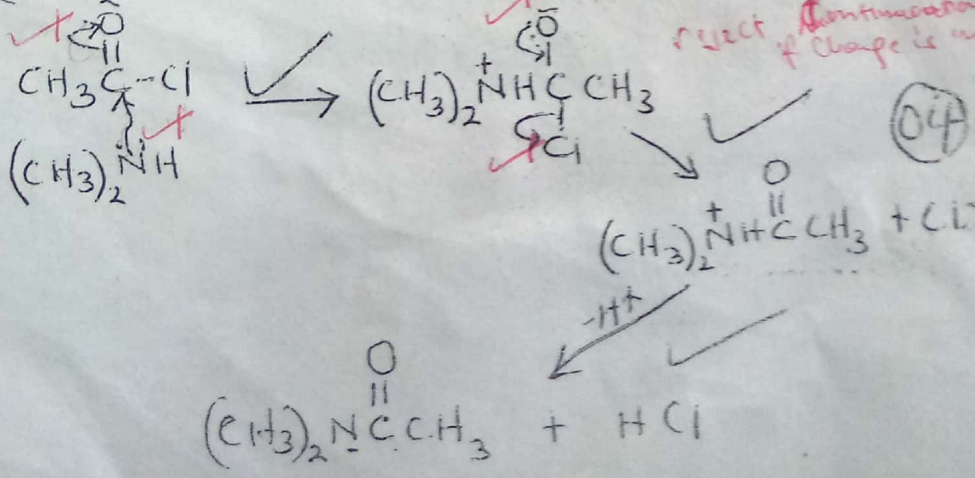
(04)

No recovery

$C_6H_5CH_2^{\bullet} + Cl{-}Cl \longrightarrow C_6H_5CH_2Cl + Cl^{\bullet}$

$Cl^{\bullet} + Cl^{\bullet} \longrightarrow Cl_2$

(c) $(CH_3)_2NH + CH_3C(=O)Cl \longrightarrow (CH_3)_2NC(=O)CH_3 + HCl$



reject discontinuation of charge is must

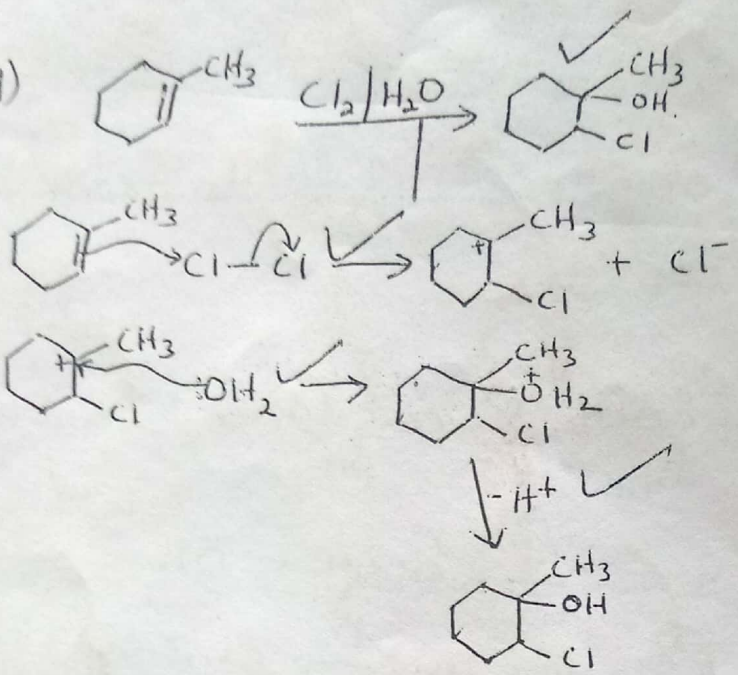
(04)

$(CH_3)_2\overset{+}{N}HC(=O)CH_3 + Cl^-$

$-H^+$

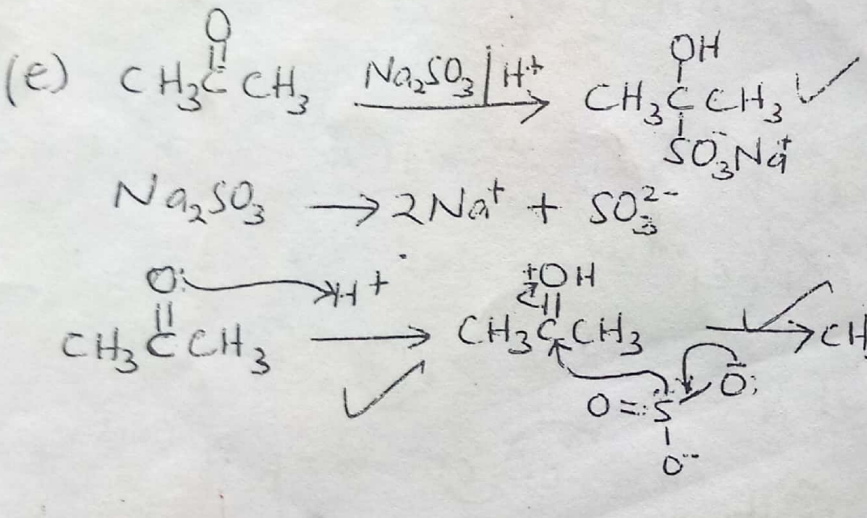
$(CH_3)_2NC(=O)CH_3 + HCl$

(d)



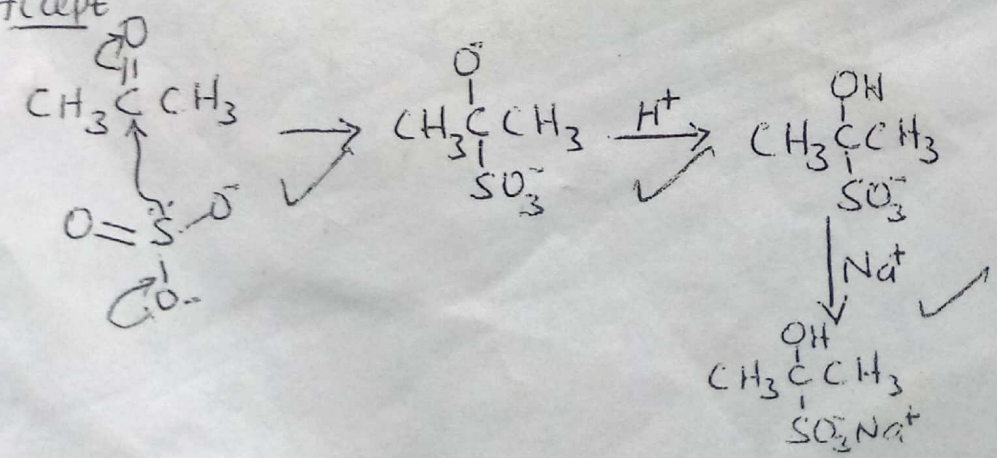
04

(e)

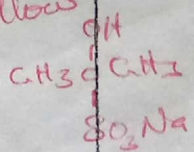


04

Accept



Allow



c(i) RMM of $Ag_2C_2O_4$ = (108×2)+(12×2)+(16×4)
= 304

solubility of $Ag_2C_2O_4$ in $moldm^{-3}$
$= \frac{3.34\times10^{-2}}{304} = 1.099\times10^{-4}$ $moldm^{-3}$

$[Ag^+] = (2\times1.099\times10^{-4}) = 2.197\times10^{-4}$ $moldm^{-3}$ (0.5)
$[C_2O_4^{2-}] = 1.099\times10^{-4}$ $moldm^{-3}$
4 sf ignore

$K_{sp} = (2.197\times10^{-4})^2 \times (1.099\times10^{-4})$
$= 5.304\times10^{-12}$ mol^3dm^{-9}

Deny ½ for wrong unit.

(ii) RMM of $K_2C_2O_4$ = (39×2)+(12×2)+(16×4)
= 166

Moles of $K_2C_2O_4 = \frac{3.04}{166} = 0.0183$ moles

Thus $[C_2O_4^{2-}]$ from $K_2C_2O_4$ = 0.0183 $moldm^{-3}$

Let solubility of $Ag_2C_2O_4$ in presence of $K_2C_2O_4$ be s

$[Ag^+] = 2s$

$[C_2O_4^{2-}] = (s + 0.0183)$ but s is very small (03)

such that $(s+0.0183) \simeq 0.0183$

hence $[C_2O_4^{2-}] = 0.0183$ $moldm^{-3}$

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

$s = \sqrt{\frac{K_{sp}}{4\times0.0183}} = \sqrt{\frac{5.304\times10^{-12}}{4\times0.0183}}$

$= 8.512\times10^{-6}$ $moldm^{-3}$

(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 (02) 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)

(b) (i) $Ag_2C_2O_{4(s)} + (aq) \rightleftharpoons 2Ag^+_{(aq)} + C_2O_4^{2-}{}_{(aq)}$ (01)

Being for wrong state symbols.

(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. 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 (06 maximum)

$2MnO_4^-{}_{(aq)} + 5C_2O_4^{2-}{}_{(aq)} + 16H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 10(O_2)$

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)

$K_{sp} = [Ag^+]^2 [C_2O_4^{2-}]$

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

$Ag^+_{(aq)} + \bar{O}H_{(aq)} \longrightarrow AgOH_{(s)}$

$2AgOH_{(s)} \longrightarrow Ag_2O_{(s)} + H_2O_{(l)}$

$Ag_2O_{(s)} + H_2O_{(l)} + 4NH_{3(aq)} \longrightarrow 2Ag(NH_3)^+_{2(aq)} + 2\bar{O}H_{(aq)}$

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NUMBER SEVEN

(a) +2 ✓ and +4 ✓ (01)

(b)

(i) Similarities in chemical properties

- Their dioxides react with cold and concentrated hydrochloric acid

Manganese(IV) oxide reacts to form manganese(II) chloride and water. Any 2 (02½ each)

$MnO_{2(s)} + 4HCl_{(aq)} \rightarrow MnCl_{4(aq)} + 2H_2O_{(l)}$

Lead(IV) oxide reacts to form lead(II) chloride and water.

$PbO_{2(s)} + 4HCl_{(aq)} \rightarrow PbCl_{4(l)} + 2H_2O_{(l)}$ ✓

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

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

$Pb^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Pb(OH)_{2(s)}$

Manganese(II) salt solutions react with aqueous ammonia to form manganese(II) hydroxide. (05)

$Mn^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mn(OH)_{2(s)}$

- Both lead and manganese form their trilead tetra oxide and trimanganesetetraoxide respectively when heated strongly for a long time.

$3Mn_{(s)} + 2O_{2(g)} \longrightarrow Mn_3O_{4(s)}$

$3Pb_{(s)} + 2O_{2(g)} \longrightarrow Pb_3O_{4(s)}$

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

$MnO_{2(s)} + 4HCl_{(aq)} \rightarrow MnCl_{2(aq)} + 2H_2O_{(l)} + Cl_{2(g)}$

$PbO_{2(s)} + 4HCl_{(aq)} \rightarrow PbCl_{2(s)} + 2H_2O_{(l)} + Cl_{2(g)}$

- Both manganese and lead directly combine with halogens when strongly heated to form their dihalides $M_{(s)} + X_{2(g)} \rightarrow MX_{2(s)}$

where - M is Pb or Mn and X is Cl, Br or I

except their trihalides

(ii) Differences in chemical properties.

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

$PbCO_{3(s)} \longrightarrow PbO_{(s)} + CO_{2(g)}$

Manganese(II) carbonate when heated is decomposed and is oxidised by air to form Manganese(IV) oxide and carbondioxide gas.

$MnCO_{3(s)} + \frac{1}{2}O_{2(g)} \longrightarrow MnO_{2(s)} + CO_{2(g)}$

Any two 02½ each

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

$2PbO_{2(s)} \rightarrow 2PbO_{(s)} + O_{2(g)}$

Manganese(IV) oxide does not decompose on heating.

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

$2Pb(NO_3)_{2(s)} \longrightarrow 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

Manganese(II) nitrate decomposes on heating to form manganese(IV) oxide and nitrogendioxide 05

$Mn(NO_3)_{2(s)} \longrightarrow MnO_{2(s)} + 2NO_{2(g)}$

- 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.

$Mn_{(s)} + 2HCl_{(aq)} \longrightarrow MnCl_{2(aq)} + H_{2(g)}$

$Mn_{(s)} + H_2SO_{4(aq)} \longrightarrow MnSO_{4(aq)} + H_{2(g)}$

Lead is inert to both dilute hydrochloric and sulphuric acid.

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

$MnO_{(s)} + 2H^+_{(aq)} \longrightarrow Mn^{2+}_{(aq)} + H_2O_{(l)}$

while for lead

$PbO_{(s)} + 2H^+_{(aq)} \longrightarrow Pb^{2+}_{(aq)} + H_2O_{(l)}$

$PbO_{(s)} + 2OH^-_{(aq)} + H_2O_{(l)} \longrightarrow Pb(OH)^{2-}_{4(aq)}$

(c) (i) A purple solution is formed. (01)

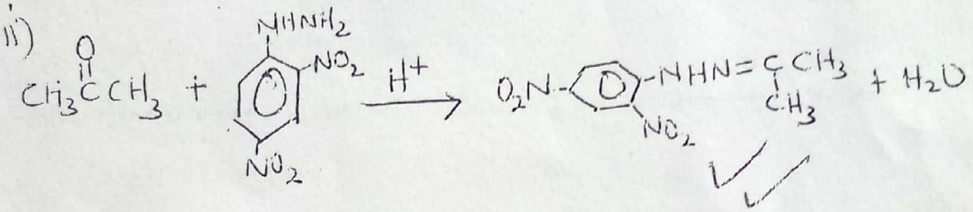
(ii) $5PbO_{2(s)} + 2Mn^{2+}_{(aq)} + 4H^{+}_{(aq)} \rightarrow 5Pb^{2+}_{(aq)} + 2MnO^{-}_{4(aq)} + 2H_2O_{(l)}$ (02)

(d)

(i) $(CH_3COO)_2Pb$ lead(ii) ethanoate (02)

(ii) $(CH_3COO)_2Pb_{(s)} \rightarrow PbO_{(s)} + CO_{2(g)} + CH_3\overset{O}{\overset{\|}{C}}CH_3$ (02)

(iii)



(02)

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NUMBER EIGHT

(a) This is an element that forms atleast one of its ions with partially (incompletely) filled d-orbitals. (S1)

(OR) 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. Any two (C2)
eg. Chromium(II) oxide, chromium(III) oxide, chromium(VI) oxide
- Chromium forms complex ions
eg $Cr(OH)_6^{3-}$, $Cr(H_2O)_6^{3+}$
- 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.

$Cr^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Cr(OH)_{3(s)}$

Accept $Cr(H_2O)_6^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Cr(OH)_{3(s)} + 6H_2O_{(l)}$ (C1)

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

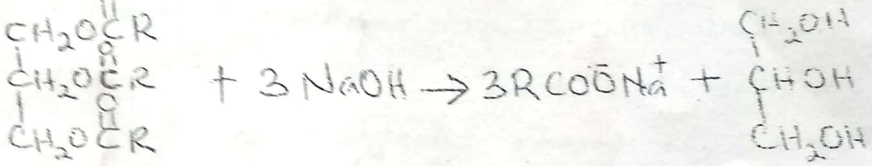
$Cr(OH)_{3(s)} + 3OH^-_{(aq)} \rightarrow Cr(OH)_6^{3-}_{(aq)}$

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

$2Cr(OH)_6^{3-}_{(aq)} + 3H_2O_{2(aq)} \rightarrow 2CrO_4^{2-}_{(aq)} + 8H_2O_{(l)} + 2OH^-_{(aq)}$

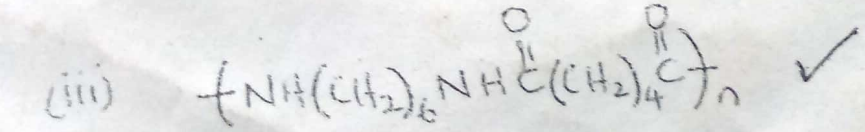
(d) (i) – Fats or oils ✓
– Sodium hydroxide ✓ or potassium hydroxide solution. ✓ (01)

(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)

(iii)  ✓✓ (01½)

(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-dioylchloride ✓ (02)
(or Hexane-1,6-dioic acid)

(iii)  ✓ (01)

(20)