G.C.E. A/L Examination March - 2019

FWC

Conducted by Field Work Centre, Thondaimanaru

In Collaboration with

Provincial Department of Education Northern Province.

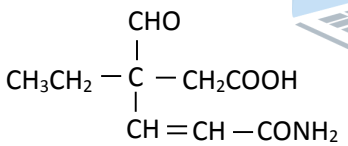
Chemistry I	Grade :- 13 (2019)	Time :- Two hours

Part – I

01. The scientist who is related to the concept that there cannot be more than two electrons in a particular orbital of an atom is
    1) Hund 2) Robert Millikan 3) Pauli
    4) Aufbau 5) Neil Bohr

02. In which of the following ions does the hybridization of the central atom differ form the rest?
    1) CO_3^{2-} 2) NO_3^- 3) IO_3^- 4) BO_3^{3-} 5) NO_2^-

03. The IUPAC name of the compound given below.



    1) $6-amino-3-formyl-3-ethylhex-4-enoic\ acid$
    2) $6-carbamoyl-3-ethyl-3-formyl-4-hexenoic\ acid$
    3) $6-carbamoyl-3-ethyl-3-oxo-4-hexenoic\ acid$
    4) $6-ethyl-4-formyl-5-carboxy-2-hexenamide$
    5) $4-ethyl-4-oxo-5-carboxy-2-hexenamide$

04. The sets of quantum numbers of two electrons of an element belonging to fourth period are (4,0,0,+1/2) (4,0,0,-1/2). Which one of the following cannot be that element?
    1. Ca 2. Sc 3. Br 4. Fe 5. Cr

05. Which of the following is correct for the energy range of a photon of visible light in the wave length range $\lambda_1 to\ \lambda_2 (nm)$ $(\lambda_1 < \lambda_2)$?
    1) $hc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)\times 10^9 J$ 2) $hc\left(\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right)\times 10^9 J$ 3) $hc\left(\frac{\lambda_2-\lambda_1}{\lambda_1\lambda_2}\right)\times 10^{-19} J$
    4) $hc\left(\frac{\lambda_1-\lambda_2}{\lambda_1\lambda_2}\right)\times 10^{-19} J$ 5) $hc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)\times 10^{-9} J$

06. A solution saturated with both AgCl and $AgBr$ at a given temperature is prepared by dissolving $AgCl$ ared $AgBr$ in water. Which of the following is correct regarding the above saturated solution?
(At the given temperature $K_{sp(AgCl)} = K_1, K_{sp(AgBr)} = K_2$)

a) $[Ag^+_{(aq)}] = [Cl^-_{(aq)}] + [Br^-_{(aq)}]$

b) $[Cl^-_{(aq)}][Br^-_{(aq)}] = [Ag^+]^2$

c) $[Ag^+_{(aq)}] = \sqrt{K_1 + K_2}$

d) $\frac{K_1}{K_2} = \frac{[Cl^-_{(aq)}]}{[Br^-_{(aq)}]}$

1) a and b only 2) b, and d only 3) a, and c only
4) b, c, d only 5) a, b, c, and d all.

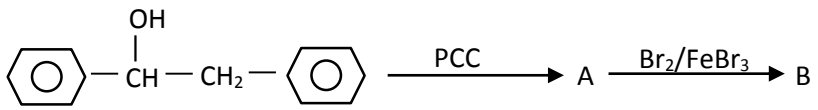
07. Which of the following statements is fales?

1) When heated, aqueous solutions of the bicarbonates of group II elements undergo decomposition before becoming solid.
2) Some of the hydroxides of group II elements do not dissolve in water.
3) The hydrides of Si and S show weakly acidic property.
4) Fluorides of all group I elements dissolve in water
5) Some of the hydroxides of the S–block elements undergo thermal decomposition at high temperatures.

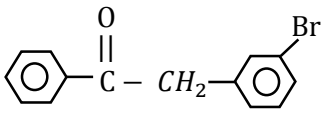
08. At 25^0C , $50\ Cm^3$ a weak acid HA of concentration $0.2moldm^{-3}$ is mixed with 50cm^3 of another weak acid HB of concentration $2moldm^{-3}$. What is the H^+ion concentration in the resulting solution in $moldm^{-3}$?
($At\ 25^0C$ the ionization constants of HA, and HB are $1 \times 10^{-5} moldm^{-3}, and\ 1 \times 10^{-6} moldm^{-3}$ respectively?

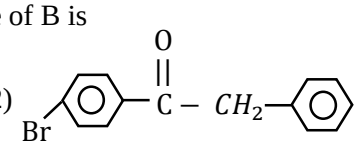
1) 1 x 10^{-3} 2) 1.41 x 10^{-3} 3) 2 x 10^{-3} 4) 1.5 x 10^{-3} 5) 1.2 x 10^{-3}

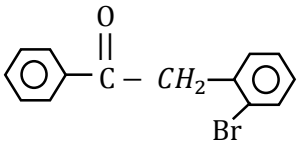
09. Consider the following reaction scheme.

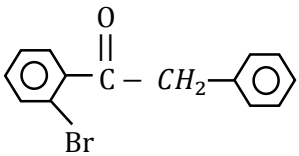


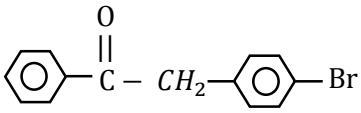
In the above reaction scheme , the possible structure of B is

1) 

2) 

3) 

4) 

5) 

10. If the required volume of a given FeI_2 solution to react completely with $25cm^3$ of a $0.01 moldm^{-3} K_2Cr_2O_7$ solution is $25cm^3$, the concentration of FeI_2 in $moldm^{-3}$

1) 0.02 2) 0.03 3) 0.30 4) 0.025 5) 0.5

11. A gas X decomposes according to the fundamental reaction denoted by $X_{(g)} \longrightarrow Y_{(g)} + 2Z_{(g)}$ at temperature T.

1 mol of gas X is placed in an evacuated rigid container and allowed to decompose as above at temperature T.

If the initial pressure inside the container is P_o and the pressure at a time t is P, which of the following expressions is directly proportional to the rate of reaction at time t?

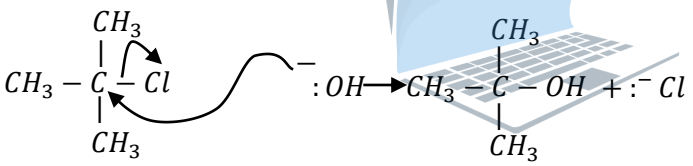
1) $3P_0 - P$ 2) $2P_0 - P$ 3) $P - P_0$ 4) $P_0 - 3P$ 5) $3P_0 - 2P$

12. The mole fraction of NH_4NO_3 is $\frac{5}{6}$ in a solid mixture that consists only NH_4NO_3 and $CaCO_3$. The percentage mass of $CaCO_3$ in the mixture is, $(N = 14,\ O = 16, H = 1, Ca = 40, C = 12)$

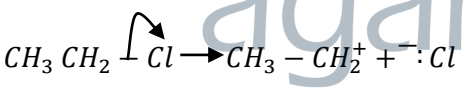
1) 20% 2) 40% 3) 60% 4) 67% 5) 80%

13. Which one of the following represents a possible step of organic reaction mechanism?

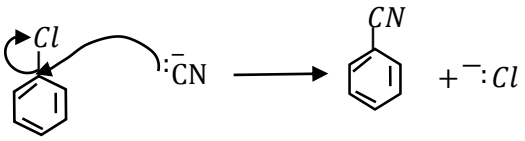
1)



2)



3)



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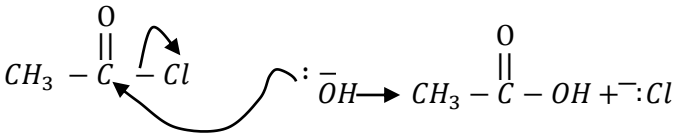
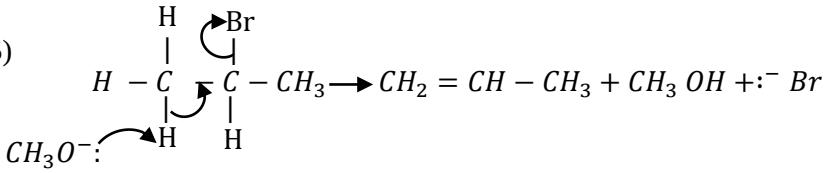


5)



14. Identify the cation

i) Which gives green coloured precipitate with NH_4OH / NH_4Cl

ii) Evolves CO_2 gas with Na_2CO_3 solution

iii) Gives yellow coloured solution with excess NaOH / H_2O_2

1) $Ni^{2+(aq)}$ 2) $Fe^{3+(aq)}$ 3) $Fe^{2+(aq)}$ 4) $Cr^{3+(aq)}$ 5) $Cu^{2+(aq)}$

15. P, Q, and R are three transition metals in the 3d series. Each of them reacts with dry $Cl_2(g)$ to give yellow coloured anhydrous chloride solids. On addition of water to the above chlorides, yellow, green and blue coloured aqueous solutions were obtained respectively. P , Q and R can be

1. Fe, Cr, Cu
2. Ni, Mn, Cr
3. Ni, Cu, Fe
4. Mn, Ni, Cu
5. Fe, Ni, Cu

16. The standard enthalpy and entropy of vaporization of a liquid A are 30 $kJmol^{-1}$,and 75 J $mol^{-1}K^{-1}$ respectively. The boiling point af A under 1 atm atmospheric pressure

1) $400°C$ 2) $627°C$ 3) $127°C$ 4) $673°C$ 5) $173°C$

17. Standard reduction potentials of two electrodes are given below.

$$E^{\theta}_{Al^{3+}_{(aq,\ 1M)}/Al(s)} = -1.66V \quad , \quad E^{\theta}_{Cu^{2+}_{(aq,\ 1M)}/Cu(s)} = 0.34V$$

The correct statement regarding the electrochemical cell constructed with the above electrodes using a salt bridge is

1) The e.m.f will increase if the concentration of $Al^{3+}_{(aq)}$ is increased.
2) The cell reaction for the above cell is $Al_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Al^{3+}_{(aq)} + Cu_{(s)}$
3) To decrease the e.m.f of the cell , temperature should be increased.
4) Ions move from one half cell to the other through salt bridge.
5) When the cell operates , e.m.f will remain constant at 2.00V

18. Pthalic acid $C_6H_4(COOH)_2$ is a dibasic weak acid. The first and second ionization constants of it at $25°C$ are $K_1 = 6.4 \times 10^{-2} moldm^{-3}, K_2 = 6.5 \times 10^{-4} moldm^{-3}$ respectively.

The equilibrium constant for the equilibrium reaction $C_6H_4(COOH)_{2\,(aq)} + 2H_2O_{(l)} \rightleftharpoons$

$C_6H_4(COO)^{2-}_{2(aq)} + 2H_3O^+(aq)$

1) $6.4 \times 10^{-2} mol^2 dm^{-6}$
2) $4.2 \times 10^{-5} mol^2 dm^{-6}$
3) $5.3 \times 10^{-4} mol^2 dm^{-6}$
4) $1 \times 10^{-2} mol^2 dm^{-6}$
5) $9.8 \times 10^{-3} mol^2 dm^{-6}$

19. Consider the following equilibrium reaction

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad \Delta H = (-)$

In a rigid , closed container , certain amounts of $N_{2(g)}, and\ H_{2(g)}$ were mixed and allowed to react and attain the above equilibrium under suitable conditions. When the equilibrium is attained , the following statements were suggested as the ways of increasing the amount of $NH_{3(g)}$ in equilibrium.

A – Increasing the temperature at constant volume

B – Decreasing the volume of the container at constant temperature.

C –Introducing a particular amount of He gas into the container under constant temperature and volume.

The correct statement / statements

1) A only 2) B only 3) B and C only

4) A and C only 5) A, B and C all

20. A hydrocarbon X gives white precipitate with ammonical $AgNO_3$ and it can rotate the plane of the plane polarized light. If the hydrocarbon contains the least possible number of C and H atoms , its molecular formula can be

1) C_6H_{10} 2) C_6H_8 3) C_6H_6 4) C_7H_6 5) C_8H_6

21. The correct increasing order of the second ionization energy of the elements $Na, Mg, Al, S, and\ Cl$ is.

1) $Mg < Al < Cl < S < Na$ 2) $Na < Al < Mg < S < Cl$

3) $Al < Mg < Na < S < Cl$ 4) $S < Mg < Cl < Al < Na$

5) $S < Mg < Na < Al < Cl$

22. An inorganic compound A gives a gas B and a solution C with HCl. The compound in C gives red colour to the flame test. When H_2SO_4 solution is added to solution C, a white precipitate forms. The gas B, when passed into acidified $K_2Cr_2O_7$,orange colour was changed to green. However, it does not give a precipitate with $CuSO_4$ Compound A could be.

1) Li_2S 2) SrS 3) K_2SO_3 4) $Li_2S_2O_3$ 5) $SrSO_3$

23. $CH_3CH_2 - C \equiv CH \xrightarrow{A} X \xrightarrow{B} CH_3CH_2 - \underset{\underset{CH_2CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - OH$

In the above reaction scheme, A, B and X could be

1) $Hg^{2+}/\ dilH_2SO_4,\ (i)CH_3CH_2MgBr\ (ii)\ H_2O\ , CH_3CH_2 - \overset{\overset{O}{||}}{C} - CH_3$

2) $Pd\ /H_2/BaSO_4, Quinolene,\ CH_3CH_2MgBr,\ CH_3CH_2CH = CH_2$

3) $Hg^{2+}/\ dilH_2SO_4\ ,KCN/\ dilH_2SO_4\ , CH_3\ CH_2 - \overset{\overset{O}{||}}{C} - CH_3$

4) $Na/$liq. $NH_3\ , CH_3 - \overset{\overset{O}{||}}{C}\!\!\diagdown_{H} \quad CH_3\ CH_2 - C \equiv C^-Na^+$

5) None of the above

24. A closed container contains $CH_4\ gas\ and\ H_2 gas$ of equal masses at 25^0C. If both gases may behave ideally , the fractional pressure of $H_{2(g)}$ in the above system is.

1) $\frac{1}{2}$ 2) $\frac{8}{9}$ 3) $\frac{1}{9}$ 4) $\frac{16}{17}$ 5) $\frac{1}{8}$

25. At room temperature , vapour pressure of pure A is twice as that of pure B. When a binary ideal solution containing A and B in the molar ration 3:2 respectively is in equilibrium with its vapour , the mole fraction of A in the vapour phase is.

1) 0.25 2) 0.30 3) 0.50 4) 0.75 5) None of the above.

26. What is the pH of the buffer solution prepared by mixing $250cm^3$ of $2.20moldm^{-3}CH_3COOH$ and $250cm^3$ of $2.00moldm^{-3}NaOH$ at 25^0C?
($At\ 25^0C$,$K_a\ of\ CH_3COOH$ is $1 \times 10^{-5}\ moldm^{-3}$)

1) 4 2) 5 3) 6 4) 7 5) 8

27. The incorrect statement regarding $C_2H_5NH_2$ is.

1) it reacts with CH_3COCl and gives an amide.
2) it does not produce NH_3 in the reaction with $NaoH$
3) it reacts with nitrous acid and produces $N_2\ gas$
4) its basicity is greater than that of CH_3CONH_2
5) it undergoes nucleophilic substitution reaction with aldehydes and ketones.

28. Which of the following does not show acidic nature in its aqueous solution?

1) $BiCl_3$ 2) $AlCl_3$ 3) SiH_4 4) $HCOONa$ 5) NH_4Br

29. Which of the following statements regarding secondary interactions is true?

1) I_2 dissolves slightly in water due to ion – induced dipole interaction
2) In certain occasions , London forces may be stronger than dipole – dipole interactions.
3) With the increase in molar mass of ionic compounds , van – der waals forces between the ions will increase.
4) Dissolution of $NaCl$ in water is due to its formation of H – bond with water
5) In general , ion – dipole interaction is not so stronger than dipole – dipole interaction

30. The incorrect statement regarding – $3d$ transition elements is .

1) Of them , $Mn, and\ Cu$ have relatively lower melting points.
2) In general , the oxy anions formed by them are coloured.
3) The atomic radii of these elements are greater than that of the corresponding $4S$ elements.
4) The cations of $Mn\ and\ Fe$ do not form complex ions with NH_3 ligand.
5) Cu has the highest electrical conductivity among these elements.

❖ **For each of the question 31 to 40 one or more response out of four responses (a), (b), (c) and (d) given is / are correct. Select the correct responses / responses. In accordance with the instruction given on your answer sheet mark.**

1	2	3	4	5
only (a) and (b) are correct	only (b) and (c) are correct	only (c) and (d) are correct	only (a) and (d) are correct	any other number or combination is correct

31. The correct statement / statements regarding the kinetics of a chemical reaction is / are .
    a) The unit of the rate of a reaction is determined by the slowest step.
    b) The increase in the concentration of the reactants does not affect the overall order of it.
    c) The unit of the rate constant varies according to the molecularity of the overall reaction.
    d) Zeroth order reaction can never be a single step one.

32. $P, Q, and\ R$ are metals. Some electrodes involving them and their standard electrode potentials are given below.

    $P^{2+}_{(aq)} / P_{(s)}$ $\quad E^{\emptyset} = -0.41V$

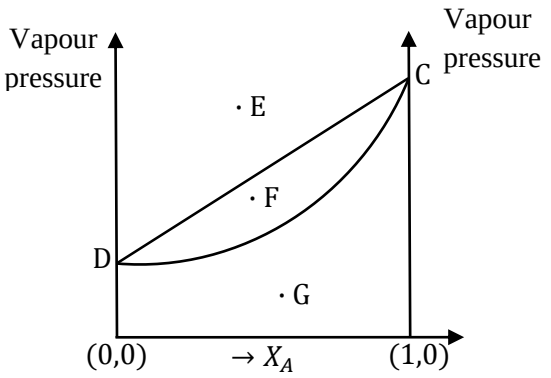
    $Q^{2+}_{(aq)} / Q_{(s)}$ $\quad E^{\emptyset} = -0.76V$

    $R^{2+}_{(aq)} / R_{(s)}$ $\quad E^{\emptyset} = -0.13V$

    Using the above electrodes , three different standard cells are constructed. Which of the statements below is / are true?
    a) The electrode in which R is used always acts as the cathode.
    b) The electrode in which Q is used always acts as the anode
    c) The cell represented by $R_{(s)} / R^{2+}_{(aq,1moldm^{-3})} // Q^{2+}_{(aq,1moldm^{-3})} / Q(s)$ has the greatest e.m.f among them.
    d) Q may be displaced by immersing $P(s)$ in , $Q^{2+}_{(aq)}$

33. The statement / statements which is / are incorrect about the equilibrium constant K of a reversible , equilibrium system .
    a) In an exothermic system , the value of K decreases with the increase in temperature.
    b) The value of K will vary with a change in the concentration of reactants and the pressure of the system.
    c) The ratio between the rate constant of the forward reaction and that of the reverse reaction always gives the value of K for any equilibrium system.
    d) In an endothermic equilibrium, the value of K decreases with the increase in the temperature.

34. Two liquids A and B can form an ideal solution. The variation of vapour pressure with composition in the mixture of A and B is given in the following diagram.



P_A^0 – vapour pressure of pure liquid A

P_B^O – vapour pressure of pure liquid B

The correct statement / statements regarding the above phase diagram is / are

a) In the graph , E – liquid phase , G – vapour phase , F – liquid ⇌ vapour equilibrium; P_A^0, P_B^0 are denoted by C and D respectively.

b) In the graph , E – vapour phase , G – liquid phase, F – liquid ⇌ vapour equilibrium; P_A^0, P_B^0 are denoted by C and D respectively.

c) Boiling point of pure A is greater than that of pure B.

d) The total vapour pressure P of the mixture varies with different compositions accordingly as $P_A^0 < P < P_B^0$

35. The incorrect statement / statements regarding some standard enthalpy changes is / are

a) All forms of allotrops of an element have a standard enthalpy of zero value.

b) The second electron affinity of any element is endothermic.

c) For all diatomic molecules , enthalpy of atomization is half the bond dissociation enthalpy

d) Enthalpies of sublimation , atomization , bond dissociation and lattice energy are always positive quantities.

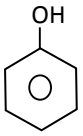
36. At 500K , the value of K_c for the equilibrium reaction $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_3(g)$ is $1.7 \times 10^2 mol^{-2} dm^6$ In a rigid, closed container of $20dm^3$ volume, $1.5 mol\ of\ N_{2(g)}$, $2.0\ mol\ of\ H_{2(g)}$ and $8.0\ mol\ of\ NH_{3(g)}$ were placed and the temperature was established at $500K$. The correct statement / statements regarding the above system is / are.

a) reaction quotient $Q_C < K_C$ and the net reaction proceeds in the forward direction so as to increase the amount of $NH_{3(g)}$

b) reaction quotient $Q_C > K_C$ and the net reaction proceeds in the reverse direction so as to increase the amounts of $N_2\ and\ H_2$

c) reaction quotient $Q_C > K_C$ and the net reaction proceeds in the forward direction so as to increase the amount of NH_3

d) Since the system exists in equilibrium net reaction will not take place in either of the directions.

37. 

(A)

CH_3CH_2OH

(B)

Which of the following statements regarding the compounds A and B given above is / are true?

a) B is more acidic than A

b) rate of the nucleophilic substitution reaction of A is greater than that of A

c) C – O bond in A has a partial double bond character whereas the C- O bond in B has single bond nature.

d) Electron deficiency of the carbon atom attached to oxygen in A is less than the corresponding carbon atom in B.

38. The statement / statements which is / are true regarding ideal gases?

a) Root mean square speed of a gas will increase when its relative molecular mass increases.

b) The distance between gas molecules is negligibly small.

c) The average kinetic energy of the gas molecules is directly proportional it the thermodynamic temperature.

d) At the same temperature, mean square speed of a gas with higher molar mass is greater than that with lower molar mass.

39. Which of the statements below regarding the chemistry of ammonia is / are true?

a) Whenever NH_3 acts as an oxidizing agent, hydrogen will be reduced.

b) When NH_3 reacts with metals, always the amide (NH_2^-) of the metal is formed

c) CaO can be used to dry NH_3 gas

d) In the reaction of NH_3 with an excess of Cl_2 gas, H_2 is produced.

40. The correct statement/ statements with regard to spontaneous processes is / are

a) For all spontaneous processes, $\Delta S > o$

b) For all spontaneous processes, $\Delta H < 0$

c) Exothermic processes with $\Delta S > 0$ are always spontaneous.

d) If the total entropy change of the system and its surrounding is positive, then the process will be spontaneous.

❖ **Instructions for questions 41 to 50**

Response	First statement	Second statement
(1)	True	True and correctly explains the first statement.
(2)	True	True, but not explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	Statement 1	Statement 2
41.	At constant temperature, when a mono – basic acid HA is diluted with distilled water, the H^+ ion concentration in it will increase.	At constant temperature, when a weak acid is diluted, its extent of ionization increases.
42.	The covalent character of AgI is greater than that of AgF	With the increase in the radius of anion, its polarizability increases.
43.	Aqueous solutions of KNO_2, and KNO_3 can be distinguished using dilute HCl	Aqueous solution of KNO_2 is acidic whereas that of KNO_3 is neutral.
44.	Rate of a reaction in general increases with the increase in temperature.	When the temperature increases, negative value of ΔG will increase.
45.	Phenolphthalein indicator may be used for the titration of $1 \times 10^{-3} moldm^{-3} NaOH$ against $1\times 10^{-3} moldm^{-3} HCl$ solution at 25^0C	When $NaOH$ solution is titrated against HCl solution, the pH at the equivalence point is 7 at 25^0C.
46	CuS cannot be precipitated by passing H_2S into an aqueous solution of $Cu^{2+}(aq)$ in alkaline medium	In OH^-/H_2S, the concentration of S^{2-} ion will be high.
47	The boiling point of an ideal solution shows a uniform , linear variation with the change in its composition.	In an ideal solution, attractive forces operating between moclecules of similar species and that between molecules of different species are equal to each other.
48	The $\propto -H$ in the aldehydes is more acidic than the hydrogen attached to triple bond carbon of an alkyne.	Reaction of Grignard's reagent with alkyne is an acid – base reaction whereas the reaction of Grignard's reagent with an aldehyde is nucleophilic addition one.
49	The average speed of $He(g)$ molecules at 80^0C is greater than that of $O_2(g)$ molecules at 40^0C	Average molecular speed is directly proportional to the temperature and it is inversely proportional to the square root of the molar mass.
50	Even when the distance between the two electrodes of an electrochemical cell is increased, the current that flows will not change.	The standard electromotive force (emf) of a cell does not depend on the distance between the two electrodes.

G.C.E. A/L Examination March - 2019

FWC

Conducted by Field Work Centre, Thondaimanaru

In Collaboration with

Provincial Department of Education Northern Province.

Grade – 13 (2019)	Chemistry II A	Time :- Three hours 10 minute

Part II A

Structured Essay

01. (a) Consider the following compounds and answer the questions below.

$$AgNO_3, ZnCO_3, MnCl_2, (COO)_2Fe, CuSO_4.5H_2O, Ag_2CO_3$$

(i) The compound that gives a metal and two colorless gaseous products when heated is

……..

(ii) The compound that gives a black compound and two gases on heating is

……..

(iii) The salt that gives a white precipitate on addition of $Na_2S_2O_{3(aq)}$ to its aqueous solution which turns black on standing is

……..

(iv) Coloured compound that gives a white compound when heated is

……..

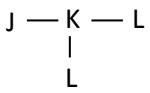
(v) Aqueous solution of the salt which forms a white precipitate on addition of $NaOH_{(aq)}$ and turns brown when exposed to air is

……..

(vi) The compound that gives a yellow product when heated which turns white when allowed to cool is

……..

(b) (I) The skeletal structure of a molecule formed by the elements K,J and L is given below



Some data regarding the above elements is as follows

- J and K are two non – metallic elements placed adjacently in the same group of the p - block
- J forms a triatomic molecule.
- J and K form a compound of molecular formula KJ_2

- J_3 and KJ_2 molecules are similar in shape
- The electro negativity of element L is greater than the electro negativity of J

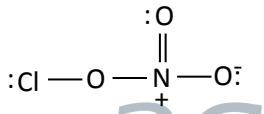
(i) Identity the elements J , K and L according to the given data and draw the most acceptable Lewis structure for the given skeleton structure

(ii) Draw three resonance structures of the molecule

(iii) State the following with regard to the Lewis structure drawn in part (i) above
shape and electron pair geometry around the K atom
Shape……

Electron pair geometry :- ……

(b) (II) Lewis structure of a hypothetical molecule is given below:



Complete the following table regarding the above molecule.

i)

	N atom	O attached to N atom and Cl atom
Electron pair geometry		
Shape		
hybridization		

(C) Arrange the following in the ascending order of the property given in parentheses

(i). The energy liberated during the process $M_{(g)} + e \longrightarrow M^{-}_{(g)}$ $(M \longrightarrow Be, O, Na,\ S\ )$

……..……...<……..…..……<……..……..….<……..……...

(ii). H_2CO, CO, CO_2, $COCl_2$ (electronegativity of carbon)

……..……...<……..…..……<……..……..….<……..……...

(iii) NO_2^+, NO_3^-, NO_2, NO_2^- (bond angle)

…..……...<……..…..……<……..……..….<……..…….....

(iv) $CH_3COO^-, OH^-, NH_2^-, CH_3^-$ (basic nature)

……..……...<……..…..……<……..……..….<…….……..

(v) CH_3CH_2OH, CH_3COOH, CH_3CHO, CH_3-OCH_3 (saturated vapour pressure under STP condition)

……..……...<……..…..……<……..……..….<…….……....

02.

(I) 1 g sample of an alloy containing only Ca and Mg was dissolved completely in excess dilute HCl. The gas evolved occupied a volume of $0.784\ dm^3$ under STP conditions. Find the mass percentage of Mg in the alloy. (Molar volume of a gas under STP conditions is $22.4\ dm^3\ mo1^{-1}$)

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(II) 2g sample of a galvanized iron rod was dissolved in a sufficient volume of concentrated H_2SO_4 and the solution was made up to $200\ cm^3$ by adding distilled water. The resultant solution was kept for 24 hours in a closed beaker and it was found that no solid residue was left over, Gaseous product, it any is assumed to have dissolved in the solution. You are informed that the galvanized iron rod contains only Zn and Fe $(Zn = 64, Fe = 56)$ When $a\ 25\ cm^3$ of the above solution was titrated with $0.15\ mol\ dm^{-3} KMnO_4$, the burette reading was found to be $40.0\ cm^3$.

(i) Write balanced equations for the reactions when galvanized iron dissolves in concentrated H_2SO_4

……..……

.……

……...

(ii) Write the equations for the reactions taking place during the titration

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(iii) What is the indicator in the above titration? and which type of indicator is it?

……

……

……

(iv) Find the percentage of Zn in the galvanized iron

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b) Given below are the solutions labelled from A to E (not in that order)

$Bacl_{2\,(aq)}$, $Na_2S_2O_{3\,(aq)}$, $AgNO_{3\,(aq)}$ $MnCl_{2_{(aq)}}$, $Zn(No_3)_{2\,(aq)}$

The experiments carried out to identity the above compounds and the relevant observations are given below.

Compound	**Adding $NaOH_{(aq)}$**	**Adding $H_2SO_{4\,(aq)}$**
A	Clear solution	Turbid solution with the evolution of gas.
B	White precipitate which dissolved in excess $NaOH$	Clear solution
C	Clear solution	White precipitate
D	White precipitate which turned brown when exposed to air	Clear solution
E	Grey colored precipitate	Clear solution

(i) Identify the solutions from A to E.

A = …… B = ……

C = …… D = ……

E = ……

(ii) Write balanced equations for the reactions in which precipitates are formed

……

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03. a)

(I) Define the following terms :

i) Initial rate

……

……

……

ii) Average rate

……

……

……

iii) Half life

……

……

……

(II) Nitrogen monoxide may be reduced to $N_2 gas$ and steam according to the following equation

$$2\,NO_{(g)} + 2H_{2\,(g)} \longrightarrow N_{2\,(g)} + 2H_2O_{(g)}$$

In an experiment carried out to investigate the kinetics of the above reaction , the change in concentration of $NO_{(g)}$ was measured varying the concentrations of NO and H_2, and the time taken was also measured and tabulated.

Experiment No	Initial concentration		$\Delta[NO]/moldm^{-3}$	Time	Initial rate $(moldm^{-3}\,S^{-1})$
	$[NO]/moldm^{-3}$	$[H_2]/moldm^{-3}$			
1	6.4×10^{-3}	2.2×10^{-3}	20.8×10^{-5}	8S	.....
2	1.28×10^{-2}	2.2×10^{-3}	52.0×10^{-5}	5S	.....
3	6.4×10^{-3}	4.4×10^{-3}	30.6×10^{-5}	6S	.....

(i) Calculate the initial rate in each experiment and complete the relevant column in the above table.

(ii) Assuming the rate orders with respect to NO and H_2 to be x and y respectively and the rate constant as K, write the expression for rate law.

……

……

(iii) Find the values of x and y using the values in the table.

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(iv) Calculate the value of the rate constant , K

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(v) A mechanism suggested for the above reaction is as follows.

$2\,NO_{(g)} \rightleftharpoons N_2\,O_{2(g)}$ (fast, equilibrium step, equilibrium constant K_1)

$N_2O_{2(g)} + H_{2(g)} \longrightarrow N_2O_{(g)} + H_2O_{(g)}$ (slow step, rate constant K_2)

$N_2O_{(g)} + H_{2(g)} \longrightarrow N_{2(g)} + H_2O$ (fast step, rate constant K_3)

(I) State which one of the above steps is the rate determining step for the given reaction

……

(II) Write an expression for the rate of the reaction taking place in the step mentioned above.

……

(III) Hence, derive the rate law for the reaction in the terms of [NO] and $[H_2]$ in accordance to the values x and y you obtained in part (iii) above

……

……

……

b)

(I) Consider the following zeroth order reaction

$A \longrightarrow$ products.

Given that the rate constant for the rate of this reaction is K.

(i) Write the expression for rate law

……

……

(ii) Assuming that the initial concentration of A is $[A]_0$,concentration of A at time t is $[A]_t$ write the relationship between $[A]_0$, $[A]_t$ and K.

……

……

(iii) Using the above relationship , show that the half - life $t_{\frac{1}{2}}$ of the reaction is $t\frac{1}{2} = \frac{[A]_0}{2K}$

……

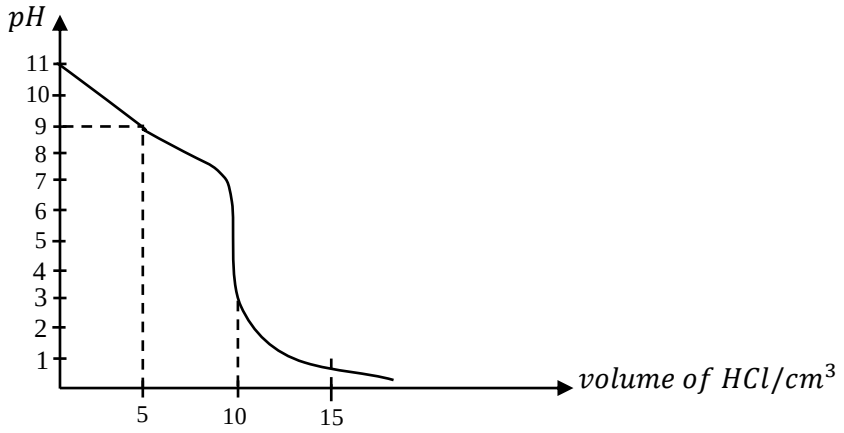
……

……

……

c) The following graph shows the variation of the pH when a given HCl solution is added slowly from a burette into $10.0\ cm^3$ of a NH_4OH solution at $25^\circ C$ Answer the questions given below regarding this graph.

$(At\ 25^\circ C\ ,\ K_w = 1 \times 10^{-14}\ mol^2 dm^{-6})$



(i) What is the ionization constant K_b of NH_4OH at $25^\circ C$?

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……

……

(ii) Calculate the initial concentration of the above NH_4OH solution.

……

……

……

(iii) Find the concentration of Hcl used in this titration.

……

……

……

(iv) Calculate the pH of the resulting solution at equivalence point.

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(v) Explain briefly the difference between the equivalence point and end point in a titration.

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04. a) A, B, C, and D are four structural isomers having the molecular formula $C_5H_{11}Br$. Among them , B, C and D are optically active while A does not show optical activity. The product P formed when A reacts with dilute $NaOH_{(aq)}$ gives immediate turbidity with Lucas reagent. When B, C and D are treated separately with alcoholic KOH , Q , R and S were obtained respectively and of them S showed geometrical isomerism.

(i) Write the structures of A, D, P, and S in the cages below

A	D	P	S

(ii) When B, and C were reacted with $NaOH_{(aq)}$ separately X and Y were obtained respectively. X, Y were treated separately with $H^+/KMno_4$ and when the products were reduced with $NaBH_4$, only Y formed again.

Write the structures of B, C, X, Y, Q and R

B = …… C = ……

Q = …… R = ……

X = …… Y = ……

(iii) Mention a test to distinguish between X and Y

……

……

……

(iv) A $\xrightarrow{NaOH_{(aq)}}$ P

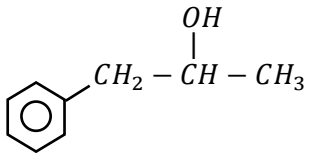
B $\xrightarrow{NaOH_{(aq)}}$ X

What is the type of mechanism for the above two reactions?

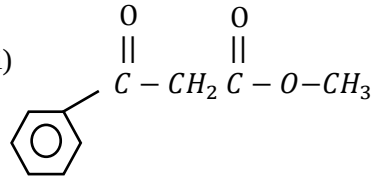
Which one of the above involves 2 steps?

b) Write in the boxes below the major organic product of the reactions given

(i) $CH_3 - C \equiv CH \xrightarrow[\text{(ii) } CH_3CH_2Br]{\text{(i) } NaNH_2}$

(ii) 

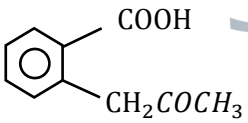
$\xrightarrow[\triangle]{A_2O_3}$

(iii) 

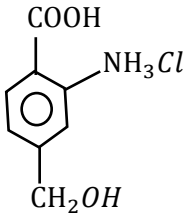
$\xrightarrow[\text{(ii) } H_2O]{\text{(i) (Excess) } CH_3MgBr/\text{ dry ether}}$

(iv) $CH_3 - \underset{\underset{O}{\|}}{C} - CH_2 - \underset{\underset{CN}{|}}{CH} - COOH \xrightarrow{LiAlH_4}$

(v) $C_2H_5COCl \xrightarrow{CH_3NH_2}$

(vi) 

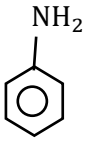
$\xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i)} NaBH_4}$

(vii) 

$\xrightarrow[\triangle]{\text{(excess) aqueous } Na_2CO_3}$

(viii) $C_2H_5OH \xrightarrow{H^+/\,KMnO_4}$

(ix) $CH_2 = CH_2 \xrightarrow[KMnO_4]{\text{(cold) alkaline}}$

(x) 

$\xrightarrow{Br_{2(aq)}}$

c) $CH_3COCH_3 \xrightarrow{2,4-DNPH}$ product

Write the structure of the product above.

Suggest a suitable mechanism for the above reaction and mention the name of the type of mechanism.

G.C.E. A/L Examination March - 2019

Conducted by Field Work Centre, Thondaimanaru

In Collaboration with

Provincial Department of Education Northern Province.

FWC

Grade – 13 (2019)	Chemistry II B	

Essay questions

Part II – B

Answer any two questions from this part

05. (A)

i) At temperature T , a moles of $A_{(g)}$ is placed in a rigid , closed container and allowed to attain the following equilibrium

$$3A_{(g)} \leftrightharpoons 2B_{(g)}$$

When the system attained equilibrium, it was found that 60% $A_{(g)}$,was converted to $B_{(aq)}$ and the total pressure of the system was 2 x 10^5Pa. Calculate the equilibrium constant K_P for the above equilibrium at T.

ii) When the temperature of the system was raised to 2T in addition to the above equilibrium $3A_{(g)} \leftrightharpoons C_{(g)} + 2D_{(g)}$ was also established in the system. When the two equilibria were established , 30% of the initial $A_{(g)}$ was converted to $C_{(g)}$ and $D_{(g)}$ and 40% $A_{(g)}$ remained in the system. Find K_p of the two equilibria at temperature 2T

(B) A monobasic weak acid HA of concentration $Cmoldm^{-3}$ at 25^0C is given.

i) Considering the equilibrium in the aqueous solution of HA , derive an expression for the ionization constant K_a of HA

ii) Derive an expression for the pH of the weak acid HA in terms of c and K_a

iii) If $5cm^3$ of HA is diluted to $500cm^3$ by adding distilled water, what is the difference in pH of the final solution and the initial solution?

iv) Calculate the pH of a $0.02moldm^{-3}$ CH_3COOH solution at 25^0C (At $25^0C, K_a$ of CH_3COOH is 1.8 $\times 10^{-5}moldm^{-3}$)

v) $25cm^3$ of the above CH_3COOH solution was titrated against a $0.02moldm^{-3}$ NaOH solution in a burette

i) When $15cm^3$of NaOH is added what would be the pH of the resulting solution?

ii) What is the volume of NaOH added at the end point of the titration?

iii) Explain with reasons whether the resulting solution at the equivalence point is acidic or basic and calculate its pH value.

($At\ 25^0C\ K_w = 1 \times 10^{-14}mol^2dm^{-6}$)

(C)

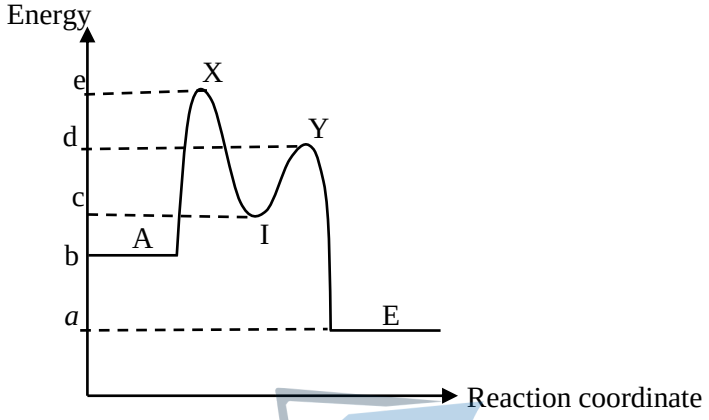
I) Consider the reaction $NO_{(g)} + O_{3(g)} \rightarrow NO_{2(g)} + O_{2(g)}$ $\Delta H < 0$

You are informed that the above reaction is a fundamental reaction.

i. Mention 2 requirements to be satisfied for the above reaction to be possible.

ii. Write the rate law for the above reaction.

II) The reaction $A \rightarrow E$ takes place via two steps. The energy profile for this reaction is given below.



i) Write the names for the species indicated by the letter A, X, I, Y and E

ii) Mention the energy values for the following in terms of a, b, c, d, e

I. enthalpy of reaction

II. first and second activation energies

iii) Alkaline hydrolysis of a tertiary alkyl halide is represented as

$$(CH_3)_3CBr \xrightarrow{NaOH(aq)} (CH_3)_3COH$$

With relevant to the above reaction indicate the species corresponding to the positions X , I and Y of the graph.

06. (a)

i) State Raoult's law pertaining to two completely miscible liquids A and B which form an ideal solution.

ii) By considering the equilibrium that exists in the above liquid system, derive a mathematical expression for Raoult's law. State each term in the expression

iii) When 2 mol of A and 3 mol of B were placed in an evacuated, closed vessel, the liquid – vapor equilibrium was attained at 70^0C in which 10% of A was converted to its vapor whereas 20% of B was converted to vapor, phase. The vapor which was in equilibrium with the liquid, exerted a total pressure of $4.8 \times 10^5 Nm^{-2}$. Assume that the liquids A and B form ideal solution and that there is no interactive forces between A and B molecules in gaseous phase. Calculate pure vapor pressures of A and B at 70^0C

(b) Some experimental results regarding the determination of distribution coefficient $(K_D)$of acetic acid between water and butanol , at 298K are as follows.

- At equilibrium, $25cm^3$of the aqueous layer required $5cm^3$ of a given $NaOH$ solution for complete reaction.
- With $10cm^3$ of butanol layer, the required volume of the same NaoH solution was found to be $40cm^3$

i) At 298 K, find the distribution coefficient of acetic acid between butanol and water.

ii) $50cm^3$ of a $0.05moldm^{-3}$ aqueous solution of CH_3COOH was mixed with $50cm^3$ of butanol and the mixture was shaken well and allowed to attain equilibrium. at 298K, $20cm^3$of the aqueous layer at equilibrium was separated out and was titrated against $0.02moldm^{-3}$ $NaoH_{aq}$. What is the volume of NaoH required at the end point?

(c)

i) $25\ cm^3$ of $2\ mol\ dm^{-3}$ $NaHC_2O_4$ solution was titrated against a $NaOH$ solution of the same concentration. To the resulting solution obtained at the end point, $50\ cm^3$ of $2\ mol\ dm^{-3}$ $Mg(No)_2$ solution was added. Find the mass of MgC_2O_4 which was precipitated. $(Mg = 24, C = 12, 0 = 16,$ At $25^{\circ}C, K_{sp}$ of MgC_2O_4 is $8.1 \times 10^{-5}\ mol^2\ dm^{-6})$

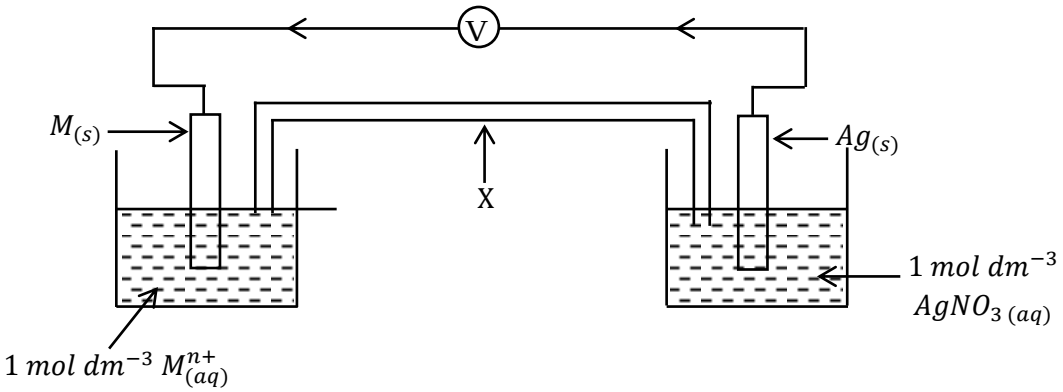
ii) Calculate the pH of a $0.5\ moldm^{-3}$aqueous solution of $NH_4\ Cl$. To what volume should $1\ dm^3$ of the above solution be diluted to prepare a solution of $= 6$?

$(At\ 25^{\circ}C, K_b$ of NH_4OH is $1.8 \times 10^{-5}\ mol\ dm^{-3})$

07.

i) State Faraday's laws of electrolysis.

ii) The diagram below shows an electrochemical cell constructed by connecting an electrode formed by immersing a metal M into $M^{n+}{}_{(aq)}$ of concentration $1moldm^{-3}$to another formed by Ag metal immersed into $AgNO_{3(aq)}$ solution of $1moldm^{-3}$ concentration. The direction in which the current flows is indicated by the arrow.



Standard e.m.f of the cell, $E^{\theta}_{cell} = 1.56V$

Standard electrode potential of $Ag_{(s)}/\ Ag^{+}_{(aq)} electrode$ $E^{\theta}_{Ag^{+}_{(aq)}}/\ Ag_{(s)} = +0.80V$

i) What is the standard equilibrium electrode potential for $M^{n+}_{(aq)} + ne \rightleftharpoons M_{(s)}$,

ii) Identify the anode and cathode and mention their polarities (+ or -)

iii) Write the half ionic equations taking place in anode and cathode

iv) Write the cell reaction

v) What is the function of the part denoted of by X and mention a substance which may be used for it?

vi) When the cell operates, the mass of Ag deposited in Ag electrode is 54 mg. The mass loss in metal M during this time interval is found to be 16.35 mg.

   i. Find the quantity of charge needed to deposit 54 mg of Ag. (Ag = 108, 1F = 96,500 C)

   ii. What is the number of moles of electrons associated with the above charge?

   iii. If the relative atomic mass of M is 65.4, calculate the number of moles of electrons for the dissolution of 1 mol of M and hence deduce the value of n.

b) A and B are two co-ordination compounds with the same molecular formula $Cr\,N_5H_{12}Cl_2O_2$ In both compounds, Cr is in the same oxidation state. and the H atoms in them exist only as NH_3 the net charge of the coordination spheres of the two compounds are the same and are octahedral in shape only the compound A gives a white precipitate with $AgNO_3$ which can dissolve in dilute NH_3 solution.

   i) What is the oxidation state of Cr in the above compounds?

   ii) Write the complete electron configuration of the ionic state of Cr in the above compounds.

   iii) Write the structural formula of A and B giving reasons for your answer.

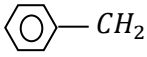
   iv) Give the IUPAC names of the structures mentioned in part (iii) above.

   v) Mention a test to identify the anion found in compound B.

c) A sample of $KMnO_4$ contains MnO_2 as an impurity. To $3.32g$ of the above sample, excess KI and dilute H_2SO_4 were added and after the reaction was completed the liberated iodine was titrated with $2\ mol\ dm^{-3} Na_2S_2O_{3(aq)}$ The required volume of $Na_2S_2O_3$ was $45\ cm^3$ (K=39, Mn = 55, O=16)

   i) Write balanced equations for the reactions involved.

   ii) Find the percentage purity of $KMnO_4$ in the given sample.

08. a) Using  as the starting material, how would you carry out the following conversion using only the list of chemicals given below.

$(CH_3)_2CH - \overset{\overset{O}{||}}{C} - O - CH_2$  $(CH_3)_3C - CH = CH$ 

List of chemicals

H_2O , Con H_2SO_4 , CH_3MgBr / dry ether, alcoholic
KOH , PCC , $NaOH_{(aq)}Br_2/CCl_4$

(b) Consider the compounds A and B given below.

$(CH_3)_2CH - \overset{\overset{O}{||}}{C} - O - CH_2$  $(CH_3)_3 - CH = CH$ 

(A) (B)

Suggest a reaction scheme to synthesize B starting from A without using any other organic substances.

c) methyliodide reacts with ethylamine as follows.

$CH_3I + CH_3CH_2NH_2 \longrightarrow CH_3CH_2NH - CH_3 + HI$

i) To what type does the above mechanism belong?

ii) Write the mechanism of the above reaction using curly arrows where necessary

iii) Methyl iodide does not react with propionamide as given below.

$CH_3I + CH_3CH_2\,CONH_2 \longrightarrow CH_3CH_2CONH - CH_3 + H - I$

Explain briefly the reason as to why the above reaction is not possible.

09. a) A is a coloured solid. When it is boiled with concentrated HCl , a yellow coloured solution B and a colorless gas C are formed. When the solution B is diluted with water and in acidic medium to a portion of it, H_2S gas is bubbled through it, a precipitate is formed. When dilute $NH_{3(aq)}$ is added to another portion of the diluted solution, a precipitate D is formed. Further addition of $NH_{3(aq)}$ dissolves the precipitate and gives a dark blue solution E. When gas C is bubbled through acidic $K_2Cr_2O_7$, a green solution and a light yellow turbid substance F are formed, The above turbid substance may react with dilute $NaOH$ under suitable conditions to give G, H and H_2O as the products. When dilute HCl is added to a mixture containing G and H, the light yellow turbid substance F is formed again with the evolution of gas C and another gas I having an odour.

H can give a white precipitate with $AgNO_{3(aq)}$ which turns black after some time

i) Identify A, B, C, D, E, F, G, H, and I

ii) Write balanced equation for the reaction between F and $NaOH$,mentioned in the question

iii) Explain with the help of the equation the observations when $AgNO_{3(aq)}$ is added to H

iv) Write the balanced equation for the reaction between gas C and gas I in aqueous medium and mention the oxidizing agent and reducing agent in the reaction.

b) A solid mixture X contains the salts of two metals only. Some experiments and the relevant observations with regard to the above mixture are given below.

	Test	Observation
i)	The mixture is dissolved in distilled water	A colored solution is obtained.
ii)	Dilute HCl is added to the aqueous solution of the mixture.	A white precipitate is formed.
iii)	The precipitate obtained in (ii) above was filtere and treated with dilute $NH_{3(aq)}$	The precipitate dissolves and a colorless solution is obtained.
iv)	To the filtrated obtained in (ii) above H_2S gas is bubbled.	No precipitate is formed.
v)	To the filtrate obtained in (iv) above NH_3 solution was added slowly.	A green colored precipitate forms.
vi)	The precipitate obtained in (v) above was heated with $NaOH_{(aq)}$	Green colored solution is obtained.

i) What are the two metal cations in the mixture?

ii) Write the observation and the reaction when $NaOH$, and H_2O_2 are added to the green precipitate obtained in Test (v) above.

10. a) $X, Y,$ and Z are aqueous solutions of the salts of three elements belonging to 3d – series.
To each of the above aqueous solutions, aqueous $NaOH$ was first added slowly followed by an excess amount of it Then excess aqueous NH_3 solution was added to them.
The observations are given below.

X : White precipitate was formed and it dissolved in both excess $NaOH$ and excess NH_3

Y : Green precipitate was formed and it did not dissolve in excess $NaOH$ but it dissolved in excess $NH_{3(aq)}$

Z : Yellow – brown precipitate was formed and it dissolved neither in excess $NaOH$ nor in excess $NH_{3(aq)}$

i) On the basis of the above observations, identify X , Y and Z.

ii) Write the formula of the complex ions and their colors which the ions of X , Y and Z identified above form on addition of concentrated Hcl

b) Write balanced equations for the following reactions.

i) $NO^-_{3\,(aq)} + Al_{(5)} + OH^-_{(aq)} \longrightarrow$

ii) $Cr^{3+}_{(aq)} + OH^-_{(ag)} + H_2O_{2\,(aq)} \longrightarrow$

iii) $H_2O_{2\,(aq)} + Ag_2O_{(5)} \longrightarrow$

iv) $NaOH_{(aq)} + (NH_4)_2Cr_2O_{7\,(aq)} \longrightarrow$

v) $KOH_{(aq)} + NO_{2\,(g)} \longrightarrow$

vi) $Li\,NO_{3\,(5)} \xrightarrow[\Delta]{}$

c) Solution Q contains the ions $Fe^{3+}, Cl^-, and\ H^+$ Concentrations of those ions were determined by following the methods (A, B and C) given below.

A) $25.00cm^3$ of solution Q was treated with excess $AgNO_3$ solution. The dry mass of the precipitate formed was $0.287g$. Calculate the concentration of Cl^- in the solution Q, in $mol\ dm^{-3}$ $(Ag = 108, Cl = 35.5)$

B) $25.00\ cm^3$ portion from the solution Q was taken and bubbled with sufficient amounts of H_2S for the complete precipitation of Fe^{3+} ions as FeS. It was filtered to remove the sulphur containing only two products Fes and S. (The resultant filtrate was kept aside to be used in the method (c))

The precipitate formed above was dried and then roasted in air. The gas, SO_2 liberated was passed into $50.00\ cm^3$ of $0.048\ mol\ dm^{-3}$ acidic $KMnO_4$ solution.

$25.00\ cm^3$ of $0.12\ mol\ dm^{-3} H_2\,C_2O_4$ solution was consumed for the complete reaction with un – reacted $KMnO_4$ solution.

Calculate the concentration of Fe^{3+} in solution Q

C) H_2S was completely removed from the filtrate obtained from method (B) and it was titrated with $0.6\ mol\ dm^{-3}\ NaOH$ solution. The required volume of $NaOH$ was $20.00\ cm^3$. Calculate the concentration of H^+ in the solution Q.