FWC

Conducted by Field Work Centre, Thondaimanaru

In Collaboration with Provincial Department of Education

Northern Province

Term Examination, November - 2019

Grade – 13 (2020)	**Chemistry - II B**	

Part II B
Essay Questions
Answer any two questions from this part

5) (A)

(i) Calculate the pH of $0.02\ moldm^{-3}\ CH_3COOH_{(aq)}$ at 25^0C.

(At 25^0C, K_a of CH_3COOH is $1.8 \times 10^{-5} moldm^{-3}$)

(ii) $25\ cm^3$ of the above solution was titrated against $0.03\ moldm^{-3}$ NaOH solution. What would be the pH when $12.5\ cm^3$ of $NaOH_{(aq)}$ is added into the solution?

(iii) What is the pH of $0.02\ moldm^{-3}$ HCl solution?

(iv) If $500\ cm^3$ of the above CH_3COOH is added into $500\ cm^3$ of this HCl solution, what would be the pH of the final solution?

(B) (I) (i) Define the terms standard enthalpy of formation and standard enthalpy of combustion

(ii) Consider the following reaction

$$CH_3 - \overset{\overset{O}{\|}}{C} - H_{(g)} + \frac{5}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 2\,H_2O_{(g)}$$

Using the following bond dissociation energy data, calculate the standard enthalpy change of the above reaction

Bond	Standard bond dissociation enthalpy/ $KJmol^{-1}$
$C-C$	348
$C-H$	412
$C=O$	743
$O=O$	496
$O-H$	463

(II) Standard enthalpy changes of two reactions are given below.

$$CO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)} \qquad \Delta H^{\theta} = -284 kJmol^{-1}$$

$$2NO_{(g)} + 2CO_{(g)} \longrightarrow N_{2(g)} + 2CO_{2(g)} \qquad \Delta H^{\theta} = -748 kJmol^{-1}$$

The following thermo chemical data are also given

$\Delta H^{\theta}_{f(H_2O_{(g)})} = -242\ kJmol^{-1}$

$\Delta H^{\theta}_{f(NH_{3(g)})} = -46\ kJmol^{-1}$

$S^{\theta}_{(H_2O_{(g)})} = 189\ Jmol^{-1}K^{-1}$

$S^{\theta}_{(NH_{3(g)})} = 193\ Jmol^{-1}K^{-1}$

$S^{\theta}_{(NO_{(g)})} = 211\ Jmol^{-1}K^{-1}$

$S^{\theta}_{(O_{2(g)})} = 205\ Jmol^{-1}K^{-1}$

Using the above information calculate the following for the reaction

$$4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(g)}$$

I. Standard enthalpy of reaction (ΔH^{θ}_{R})

II. ΔS^{θ}

III. ΔG^{θ}

Hence, predict whether the above reaction is spontaneous at 25^0C.

6) (A) $X + Y + 2Z \longrightarrow$ Products

To investigate the kinetics of the above reaction at 25^0C , four experiments were carried out in which the initial concentrations of X, Y and Z were changed and in each circumstance, the change in concentration of reactant X and the time taken for it were measure. The results of the experiments were tabulated as below.

Experiment	[x]/moldm^{-3}	[Y]/moldm^{-3}	[Z]/moldm^{-3}	Δ[x]/moldm^{-3}	t/s	Initial rate R moldm^{-3}s^{-1}
1	0.2	0.1	0.1	0.040	25	.....
2	0.2	0.2	0.1	0.096	30	.....
3	0.1	0.1	0.2	0.012	30	.....
4	0.1	0.1	0.1	0.012	30	.....

(i) Calculate the initial rates in each of the experiments and complete the relevant column in the table.

(ii) Assuming the rate orders with respect to X, Y and Z to be a, b and c respectively and the rate constant as k, write a mathematical expression for the rate of the reaction (R)

(iii) Using the data given in the table, calculate the volume of a, b, c and k

(iv) Plot the variation of the concentration of Z with time while keeping the concentration of X and Y constant in a graph.

(v) How would the rate change if the concentration of each of X and Y are doubled while keeping the concentration of Z constant?

(B) Consider the reaction $A_{(g)} + 2B_{(g)} \rightleftharpoons 3C_{(g)}$.

The above reaction tales place in a closed vessel of $1\ dm^3$ volume at 400 K. Assume that the reaction was started at t = 0 and the concentration of $A_{(g)}$, $B_{(g)}$ and $C_{(g)}$ at any time t = t s are $0.6\ moldm^{-3}$, $0.3\ moldm^{-3}$, $0.3 moldm^{-3}$ respectively. The reaction attained equilibrium at t = 15 s and the equilibrium concentrations of $A_{(g)}$, $B_{(g)}$ and $C_{(g)}$ were $0.4\ moldm^{-3}$, $0.1\ moldm^{-3}$ and $0.3\ moldm^{-3}$.

At t = 17 s , 0.2 moles of $C_{(g)}$ was introduced to the system and at t = 25 s , the system attained a new equilibrium again.

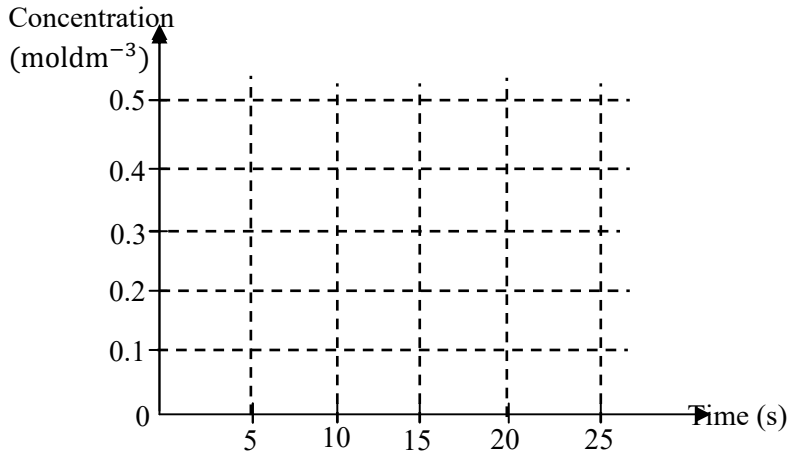
Assuming that the temperature of the system remains unchanged throughout all the above processes, answer the following

(i) Calculate the equilibrium constant k_c for the above reaction at 400 K.

(ii) If there was no $C_{(g)}$ in the system initially, what would be the amounts of A and B in the system at t = 0?

(iii) By calculating the value of Q_c at time t = t s after the reaction has started, predict the direction in which the reaction has proceeded so as to attain equilibrium.

(iv) Indicate the changes in concentrations of the reactants and products in the above process at times t = 0, 15 s, 20 s and 25 s in a graph indicated as below.



7) (A) A transition metal M forms a coloured complex ion P in aqueous medium. It has the general formula $[M(H_2O)_n]^{m+}$

- When a limited amount of concentrated $NH_{3(aq)}$ is added to P, initially a pink coloured precipitate (Q) is formed.
- On further addition of conc. $NH_{3(aq)}$, the above precipitate dissolves to give a yellow coloured solution (R).
- The above yellow coloured solution turned brown after some times.
- When concentrated HCl is added to P, the blue coloured (S) is formed.

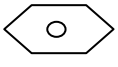
(i) Identify the metal M and mention the oxidation state of M in the complex ion P.
(ii) Give the electronic configuration of M in the complex ion P.
(iii) Give the values of m and n.
(iv) Give the structure of Q, R and S
(v) Write the IUPAC names of the complex ions P, R and S
(vi) Explain the reason for the change in colour from yellow to brown

(B) A and B are two coordination compound with molecular formula $CoN_5H_{12}I_2O_2$. H atom exist only as NH_3 in both compounds and cobalt is in he same oxidation state. Only compound B gives a yellow precipitate with $AgNO_{3(aq)}$ which is insoluble even in concentrated NH_3

(i) In the above compounds, what is the oxidation state of Co?
(ii) Write the complete electronic configuration of Co ion given in above?
(iii) Identify common ligands coordinated in compounds A and B.
(iv) Deduce the structural formulae of compounds A and B (Reasons are required)
(v) Give a chemical test to identify the anion in compound A.

Part – II C

8) (A) Using $CH_2 = CH_2$ as the only organic starting material and as reagents only those given in the list, show how would you synthesis the following compound in not more than eight (8) steps.

$CH_3CH = CHCH_2 -$ 

List of Reagents

Cl_2, dilH_2SO_4, anhydrous $Alcl_3$ conH_2SO_4, H_2O, PCl_5, Mg, dry ether, Pyridinium Chlorochromate PCC.

(B) Show how you would carry out the following conversion not more than eight (8) steps

$$CH \equiv CH \longrightarrow CH_3 - CH = N - CH_2\ CH_2\ CH_2\ CH_3$$

(C) Give the major product of the following reaction

$$CH_3 - CH_2\ CH = CH_2 \xrightarrow{conc.\ H_2SO_4}$$

(i) Write the structure of the major product
(ii) Write the mechanism for the formation of the product in part (i).

9) a) Solution P contains two cations and two anions. Following tests were carried out to identify these cations and anions.

Test for cations

	Test	**Observation**
(i)	Dilute KOH solution was added drop wise into a small portion of P	A grey precipitate (X_1) A brown precipitate (X_2)
(ii)	Dilute NH_3 solution was added into the above obtained precipitates.	A part of precipitate dissolves. The brown precipitate remains.
(iii)	Solution was separated from (ii) by filtration and dilute HNO_3 was added then excess $Na_2S_2O_3$ was added to the solution	White precipitate (X_3) It turns black (X_4) when heated.
(iv)	Dilute HNO_3 was added to the precipitate (X_2) then NH_4SCN added	Red colour complex compound (X_5)

Test for anions

Test	**Observation**
I. Acidified $KMnO_4$ solution was added into P.	$KMnO_4$ colour decolourized gas evolved.
II. $BaCl_2$ solution was added into the solution from (I)	White precipitate (X_6) which is insoluble in dil HNO_3 was obtained.
III. Gas from (I) was passed through clear lime water.	First white precipitate formed (X_7) then a clear solution (X_8) was obtained.
IV. $Ca(NO_3)_2$ was added into solution of P.	A white precipitate (X_9)
V. Dilute HCl was added into P solution	A brown colour gas (X_{10}) evolved.

(i) Identify cations and anions
(ii) Identify $X_1 - X_{10}$.

B) Solution G contains Hg^{2+}, Br^{-} and H^{+}. The following procedures were used to determine their concentrations.

Procedure - I

Excess $AgNO_3$ solution was added to $25.00\ cm^3$ of the solution G forming a precipitate. Dried mass of the precipitate is 3.761 g

Procedure - II

H_2S was bubbled through $25.00\ cm^3$ of solution G to precipitate Hg^{2+} as HgS. The precipitate was filtered and the filtrate was kept to be used in procedure III. The precipitate was transferred into $30.00\ cm^3$ of $0.2\ moldm^{-3}$ acidic $KMnO_4$ to produce Hg^{2+}, Mn^{2+} and SO_2. (Assume there's no reaction between SO_2 and $KMnO_4$) The solution was boiled to remove SO_2, and the excess $KMnO_4$ was titrated with $0.3\ moldm^{-3}$ $Na_2C_2O_4$. The needed volume of $Na_2C_2O_4$ to completely react with $KMnO_4$ is $20.00\ cm^3$

Procedure III

The filtrate from II above was boiled to remove H_2S and cooled to room temperature. The solution was neutralized by $0.4\ moldm^{-3}$ $Ba(OH)_2$. The needed volume of $Ba(OH)_2$ for complete neutralization is $25.00\ cm^3$

According to the procedures above, find the concentrations of Hg^{2+}, Br^{-} and H^{+}

10) a) X is a P – block element. In room temperature, it found as a diatomic molecule. X_1. It has a boiling point of -34.7^0C and melting point of -101^0C. It has high electron affinity. X can take both positive and negative oxidation numbers.

I. Identify X, X_1

II. Write the electronic configuration of X as $1S^2, 2S^2$ ……

III. Give the oxidation numbers of X

IV. Give four oxyacids of X

V. Give the hydrides of the elements (HX) in the group to which X belongs and sketch the variation in boiling points of these hydrides. Explain the variation

VI. In each of the following instances, give balanced chemical equation

i. With excess NH_3

ii. With excess NaOH

VII. Give one use of X.

b) Give the highest oxidation number oxides of third period elements and give their,

I. Oxidation number

II. Bond type.

III. Acidic or basic behaviour

c) Acidic strength of carboxylic acid is greater than acidic strength of phenol . Explain this.

d) Write balanced chemical equation for the following chemical reactions.

I. Thermal decomposition Of $LiNO_3$

II. Hydrolysis of SCl_2

III. Reaction of Br_2 with NaOH

IV. $KMnO_4 + H_2SO_4 + H_2S \longrightarrow$

V. $Cr_2O_7^{2-} + H_2O_2 + H^+ \longrightarrow$

e) Excess KI was added into 2.568 g of KIO_3 solution. Find the minimum volume of $3\ moldm^{-3}$ HCl to completely convert KIO_3 to I_3^-. [K – 39, I – 127, O – 16]