Provincial Department of Education - NWP

02	E	I

First Term Test - Grade 13 - 2019

Index No : .....

Chemistry I

Two Hours

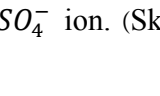
Important

- **Periodic Table is provided.**
- **Answer all the questions.**
- **Use of calculator is not allowed.**
- **Write your Index number in the space provided in the answer sheet.**
- **In each of the questions 1 to 50, pick one of the alternatives form (1), (2), (3), (4), (5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) in accordance with the instructions given on the back of the answer sheet.**

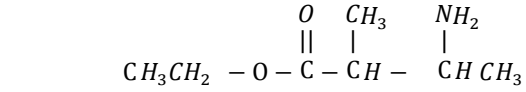
Universal gas constant R = 8.314 J K^{-1} mol^{-1} | Avogadro constant $N_A = 6.022 \times 10^{23}$ mol^{-1}
Planck's constant h = 6.626×10^{-34} J s | Velocity of light C = 3×10^8 m s^{-1}

1. Who observed nature of cathode rays does not depend on the gas taken in the discharge tube or the material of the cathode, during the studies of cathode rays.
   1. J. Stoney 2. J. J. Thomson 3. Sir William Crooks
   4. Robert Millikan 5. Ernerst Rutherford

2. What is the maximum number of electrons could exist in an atom, where principle quantum number $n = 4$ and azimuthal quantum number $l = 2$ with same spin.
   1. 1 2. 3 3. 6 4. 5 5. 10

3. The number of stable resonance structures that can drawn for HSO_4^- ion. (Skelton  is?
   1. 2 2. 3 3. 4 4. 5 5. 6

4. What is the $IUPAC$ name of the following compound ?



   1. ethyl 3-amino-2-methylbutanoic-acid
   2. ethyl 2,3-dimethyl-3-aminopropanoate
   3. ethane 2-methyl-3-aminobutanoate
   4. ethyl 2-methyl-3-aminobutanoate
   5. ethyl 3-amino-2-methylbutanoate

5. The response which contains the most covalent compound and the most ionic compound is?
   1. NO_2 , NaF 2. NO_2 , NaCl 3. NO_2 , KF 4. $NaCl, KCl$ 5. Na_2O , KF

6. The electron pair geometry , shape and hybridization around the three nitrogen atoms (labelled as N^1, N^2, N^3) in the H_3N_3O molecule. (Skelton ) respectively are,

1. Pyramidal, angular , sp^3
2. Trigonal planer, angular, sp^2
3. Tetrahedral, angular, sp^3
4. Linear , linear , sp
5. Trigonal planar , trigonal planar, sp^2

7. Which state of the following statement is incorrect?
1. Polarizing power of metal cations of group I decreases down the group.
2. Polarizability of anions of group 17 decreases down the group.
3. Charge density of cations of group 2 decreases down the group.
4. Water solubility of hydroxides of group 2 increases down the group.
5. Some hydrogen carbonates of group 1, do not exist in solid state.

8. $0.5mol$ of $(NH_4)_2Cr_2O_7\ (s)$ exist in a $8.314\ dm^3$ rigid vessel. It dissociated to $Cr_2O_3(s), N_2(g)$ and $H_2O\ (g)$ when heated to $400K$. If the volume of $Cr_2O_3\ (s)$ is negligible partial pressure of $N_2(g)$ in the vessel is?

1. 4×10^5 pa 2. 1×10^6 pa 3. 2×10^2 pa 4. 2×10^5 pa 5. 1×10^5 pa

9. Which of the following statement is true regarding emission spectrum of hydrogen.

1. Difference of the wave length between first two lines of Bhamer series is lower than the wave length difference of first two lines in Lyman series.
2. Frequency difference between the first two lines of Bhamer series is larger than the frequency difference of first two lines of Lyman Series.
3. Every special line is relevant to a specific energy level .
4. Distance between two consecutive lines increases towards the direction where the wave length increases in every spectral series.
5. Distance between two consecutive lines increases towards the direction where the frequency increases in every spectral series.

10. The increasing order of the electronegativity of the N atom in the species NO_2^- , NO_3^- , NCl_3 and NF_3 is?

1. $NCl_3 < NF_3 < NO_2^- < NO_3^-$
2. $NF_3 < NCl_3 < NO_2^- < NO_3^-$
3. $NF_3 < NCl_3 < NO_3^- < NO_2^-$
4. $NCl_3 < NF_3 < NO_3^- < NO_2^-$
5. $NCl_3 < NO_2^- < NO_3^- < NF_3$

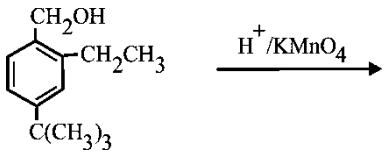
11. $3\ MnO_4^-(aq) + 3H_2O_2\ (aq) \rightarrow 3O_2\ (g) + 2MnO_2(s) + 2OH^-\ (aq) + 2H_2O\ (l)$
True regarding rates of consumption of reactants or formation of products in the above reaction is?

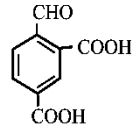
1. $\frac{\Delta[MnO_4^-\ (aq)]}{\Delta t} = \frac{\Delta[O_2\ (g)]}{\Delta t}$
2. $\frac{-\Delta[H_2O_2\ (aq)]}{\Delta t} = 2\frac{\Delta[MnO_2\ (s)]}{\Delta t}$
3. $-\frac{1}{3}\frac{\Delta[H_2O_2\ (aq)]}{\Delta t} = \frac{1}{2}\frac{\Delta[\ OH^-(aq)]}{\Delta t}$
4. $\frac{\Delta\ [H_2O_2\ (aq)]}{\Delta t} = \frac{\Delta[O_2\ (g)]}{\Delta t}$
5. $\frac{1}{3}\frac{\Delta[MnO_4^-\ (aq)]}{\Delta t} = \frac{1}{3}\frac{\Delta[O_2\ (g)]}{\Delta t}$

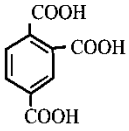
12. $a\ mol\ of\ A_2\ (g)$ and $b\ mol\ of\ B_2\ (g)$ were allowed to reach the equilibrium in a $V\ dm^3$ closed rigid vessel at TK temperature. If $x\ mol$ of gas A_2 (g) was reacted at the equilibrium, find Kc of following reaction at TK.
$A_2(g) + 3\ B_2(g) \rightleftharpoons 2\ AB_3\ (g)$

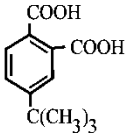
1. $\frac{2x}{(a-x)(b-3x)}\ mol^{-1}dm^3$
2. $\frac{4x}{(a-x)(b-3x)^3}\ mol^{-1}dm^6$
3. $\frac{4x^2}{(a-x)(b-3x)^3}\ mol^{-2}dm^6$
4. $\frac{4xv^2}{(a-x)(b-3x)^3}\ mol^{-2}dm^6$
5. $\frac{4x^2v^2}{(a-x)(6-3x)^3a}\ mol^{-2}dm^6$

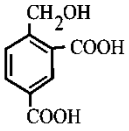
13. What is the Major product of the following reaction?

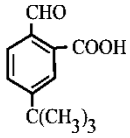


(1) 

(2) 

(3) 

(4) 

(5) 

14. $CH_3-\overset{\overset{O}{\|}}{C}-O-CH_3 \xrightarrow[(ii)\ H^+ / H_2O]{(i)\ LiAlH_4 \text{ / dryether}}$ A + B Products A and B would be?

1. CH_3CH_2OH and CH_3OH 2. CH_3CHO and CH_3OH 3. CH_3CH_2OH and HCOOH
4. CH_3COOH and CH_3OH 5. CH_3CH_2OH and HCHO

15. Standard enthalpy change of vaporization of $H_2O\ (l)$ is $+42$ kJ mol^{-1} and boiling point of water is 100^0C. What is the entropy change of vaporization of $H_2O\ (l)$.
1. 420 J $K^{-1}mol^{-1}$ 2. 112.6 $kJ\ K^{-1}mol^{-1}$ 3. 4200 J$K^{-1}mol^{-1}$
4. 112.6 J $K^{-1}mol^{-1}$ 5. 420 $kJ\ K^{-1}mol^{-1}$

16. **False** regarding the reactions of $C_6H_5N^+ \equiv NCl^-$.
1. Heating of $C_6H_5N^+ \equiv NCl^-$, H_2O gives phenol.
2. $C_6H_5N^+ \equiv NCl^-$, H_3PO_2 gives benzene.
3. Reaction of $C_6H_5N^+ \equiv NCl^-$, $CuCl$ gives C_6H_5Cl.
4. Reaction of $C_6H_5N^+ \equiv NCl^-$, Cu/HBr gives C_6H_5Br.
5. Reaction of $C_6H_5N^+ \equiv NCl^-$, Cu/HI gives C_6H_5I.

17. $X \rightarrow Y + Z$ is a first order reaction. Half-life is 10 seconds. If initial concentration of A is 0.5 $moldm^{-3}$ at given moment, time taken to reach the concentration 0.125 $moldm^{-3}$ is ?
1. 5 s 2. 15 s 3. 20 s 4. 40 s 5. 25 s

18. Organic compound A decolourize Br_2/H_2O. The product obtained when this compound react with $NaOH\ (aq)$ and react further with pcc gives a silver mirror with tollence reagent. The product obtained when A react with alcoholic KOH and then with conc. H_2SO_4 followed by heating with H^+ / H_2O do not react with PCC.

(1) $BrCH_2-\overset{\overset{CH_3}{|}}{CH}-CH_2CH_3$ (2) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{Br}{|}}{C}}-CH=CH_2$ (3) $BrCH_2-CH_2-\overset{\overset{CH_3}{|}}{C}=CH_2$

(4) $BrCH_2-\overset{\overset{CH_3}{|}}{CH}-CH=CH_2$ (5) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{Br}{|}}{C}}-C\equiv C-H$

19. Volume of 0.001 $moldm^{-3}$ $KMnO_4$ in acidic medium required to react completely with 25 cm^3 of 0.01 $moldm^{-3}$ FeC_2O_4 is?

1. 150.0 cm^3 2. 15.0 cm^3 3. 5.0 cm^3 4. 50.0 cm^3 5. 500.0 cm^3

20. What is the concentration of H^+ ions when $100.0\,cm^3$ of $0.01\,mol\,dm^{-3}$ H_2SO_4 solution is mixed with $100.0\,cm^3$ of $0.01\,mol\,dm^{-3}$ $NaOH$ solution.

1. $0.001\,mol\,dm^3$
2. $0.05\,mol\,dm^3$
3. $0.005\,mol\,dm^3$
4. $0.0025\,mol\,dm^3$
5. $0.00125\,mol\,dm^3$

21. Inorganic compound X completely soluble in water and produce a colourless solution. White precipitate is obtained when small amount of $Pb(CH_3COO)_2$ is added to a part of above solution, While, gives a colourless solution when the above participate diluted with water and heat. It gives the white precipitate when cooling. When Na_2SO_4 is added to an aqueous solution of X, white precipitate obtained insoluble in dilute acids, X would be ?

1. $MgCl_2$
2. $ZnCl_2$
3. $BaCl_2$
4. $CuCl_2$
5. $NiCl_2$

22. Consider following reactions exist at TK. temperature.

$2A\,(g) + 3B(g) \rightleftharpoons 2C\,(g)\,;\ K_c = K_1$

$2C\,(g) + B(g) \rightleftharpoons 4D\,(g)\,;\ K_c = K_2$

$A\,(g) + 2B(g) \rightleftharpoons 2D\,(g)\,;\ K_c = K_3$

Value of K_3 using K_1 and K_2,

1. $K_3 = K_1K_2$
2. $K_3 = \frac{K_1}{K_2}$
3. $K_3 = (\frac{K_1}{K_2})^{\frac{1}{2}}$
4. $K_3 = (K_1K_2)^{\frac{1}{2}}$
5. $K_3 = \frac{K_1}{(K_2)^{\frac{1}{2}}}$

23. Inorganic salt A dissolves in water to give a coloured solution. Green precipitate is obtained when dil. NH_4OH added dropwise in to a part of this solution and addition of excess NH_4OH dissolves the precipitate and give dark blue colour solution. Metal cation in A would be ?

1. Cu^{2+}
2. Ni^{2+}
3. Fe^{2+}
4. Cr^{3+}
5. Fe^{3+}

24. Density of aqueous H_2SO_4 solution at $298K$ is $1.0\ gcm^{-3}$. If the H_2SO_4 concentration of the solution is $0.5\,mol\,dm^{-3}$, find H^+ concentration in ppm,

1. 0.1
2. 1
3. 100
4. 1000
5. 10000

25. Which of the following condition / (s) is / are the most suitable to get maximum amount of $NH_3\,(g)$ product from $N_2\,(g)$ and $H_2\,(g)$ according to the equation.

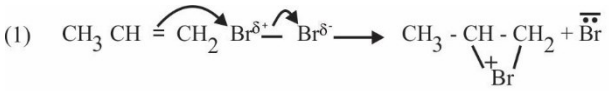
$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)\,;\ \Delta H^\theta = -92\ kJmol^{-1}$

1. Adding an catalyst to the system.
2. Applying high pressure and high temperature conditions.
3. Applying low pressure and high temperature condition.
4. Applying high pressure and low temperature conditions.
5. Applying low pressure and low temperature condition.

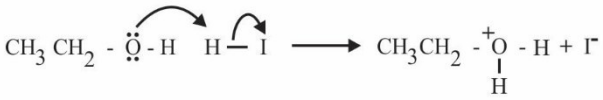
26. $25.0\,cm^3$ of H_2O_2 solution was allowed to react with excess dil. H_2O_4 and KI solution. $20.0\,cm^3$ of $0.025\,moldm^{-3}$ $Na_2S_2O_3$ solution was required to react completely with (I_2) released from above. Concentration of H_2O_2 solution is?

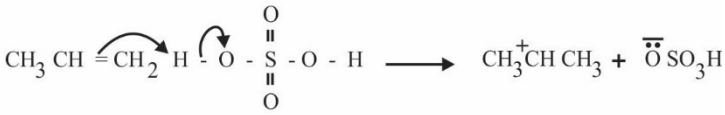
1. $0.01\,mol\,dm^3$
2. $0.001\,mol\,dm^3$
3. $0.002\,mol\,dm^3$
4. $0.0025\,mol\,dm^3$
5. $0.02\,mol\,dm^3$

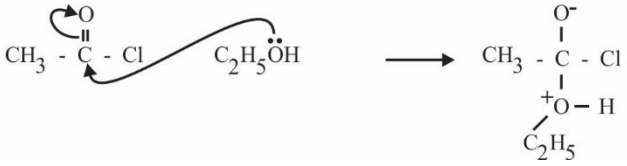
27. Which of the following is not an acceptable mechanism step, among following mechanism steps?

(1) 

(2) 

(3) 

(4) 

(5) 

28. Data obtained during an experiment for the reaction $A_2(g) + B(g) \rightarrow C(g) + D(g)$ at room temperature is given below.

Experiment	$[A_2(g)]/moldm^{-3}$	$[B(g)]/moldm^{-3}$	Initial Rate / $/moldm^{-3}s^{-1}$
1	0.1	0.1	0.005
2	0.1	0.4	0.080
3	0.2	0.1	0.005

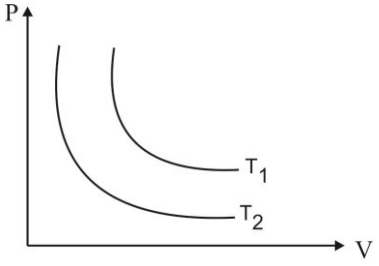
Rate law for the above reaction it.

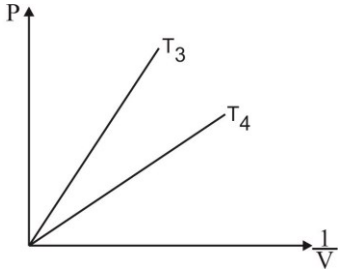
1. $Rate = K\,[A_2(g)][B_2(g)]^2$
2. $Rate = k[A_2(g)]^2\,[B_2(g)]$
3. $Rate = k\,[B_2(g)]^2$
4. $Rate = k\,[A_2(g)]^2$
5. $Rate = k[A_2(g)]\;\;[B_2(g)]$

29. **False** statement among following is.

1. Shape of CO_2 molecule is linear.
2. Two π bonds of CO_2 molecule exist perpendicular to each other.
3. Orientation of two π bonds in the space is linear.
4. C atom of CO_2 exist in sp hybridizatia.
5. Solid CO_2 (dry ice) is used for artificial rains.

30. Following graphs represents change of pressure (p) with volume (v) and $\left(\frac{1}{v}\right)$ with P for sample of an ideal gas.





Which of the following temperature relationship is not true?

1. $T_1 > T_2$ and $T_3 > T_4$ 2. $T_1 > T_2$ and $T_4 > T_3$ 3. $T_1 < T_2$ and $T_3 > T_4$
4. $T_1 < T_2$ and $T_4 > T_3$ 5. $T_1 < T_3$ and $T_2 > T_4$

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

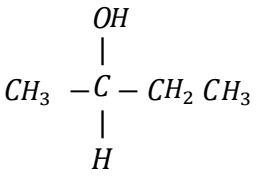
(1) If only (a) and (b) are correct. (2) If only (b) and (c) are correct.
(3) If only (c) and (d) are correct. (4) If only (d) and (a) are correct.
(5) If any other number or combination of responses is correct.

Summary of above Instructions,

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 of responses is correct

31. **True** regarding NH_3 is / are?
(a) Reaction of $NH_3(g)$ with excess $Cl_2(g)$ produce $N_2\ (g)$ and $HCl(g)$.
(b) Reaction of $NH_3(l)$, with $Mg\ (s)$ produce $Mg(NH_2)_{2(s)}$ and $H_2(g)$.
(c) NH_3 can react as an acid as well as a base.
(d) All ammonium salts give $NH_3\ (g)$ with the reaction of $NaOH(aq)$.

32. Which of the following statement / (s) is / are **true** regarding?

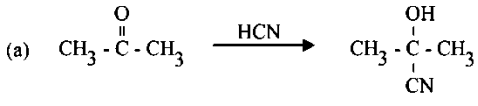


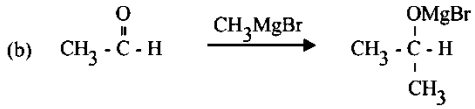
(a) Above compound shows enantiomerism.
(b) Product obtained with the reaction of PCC do not show enantiomerism.
(c) Product obtained when dehydrated with conc. H_2SO_4 do not show diasteriomerism.
(d) Product obtained when react with PCl_3 do not show enantiomerism.

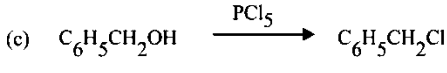
33. Correct $IUPAC$ names are given in?
(a) $FeSO_4$ – iron(II) sulfate (b) H_2S - dihydrogen sulfide.
(c) CO – carban monooxide (d) H_2S - hydrosufuric acid

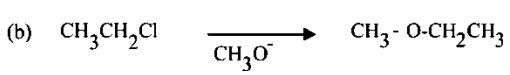
34. Which of the following statement / (s) is/are **true**?
(a) Specific heat capacity is an extensive property while heat capacity is intensive property.
(b) Enthalpy is an intensive property.
(c) The properties that depend on the amount or size of a system are called the extensive property.
(d) The properties that are independent of the amount or size of the system are intensive properties.

35. Which of the following is / are nucleophilic addition reaction?







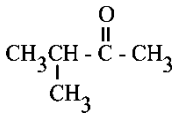


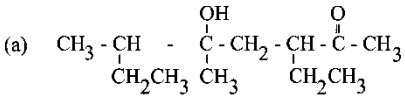
36. Which of the following is / are **true** regarding following enthalpy changes.
    (a) Standard lattice enthalpy of $MgCl_2\,(s)$ is $Mg^{2+}\,(g) + 2Cl^-(g) \rightarrow MgCl_2(s)$
    (b) Standard atomization enthalpy of $Br_2\,(l)$ is $Br_2\,(l) \rightarrow 2\,Br(g)$
    (c) Standard sublimation enthalpy of $I_2\,(s)$ is $I_2(s) \rightarrow I_2\,(g)$
    (d) Standard formation enthalpy of $CaO(s)$ is $2\,Ca(s) + O_2(g) \rightarrow 2\,CaO\,(s)$

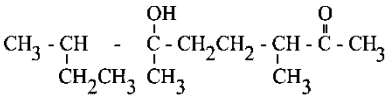
37. Which of the following statement / (s) is / are **true** regarding $3d$ block elements or their ions?
    (a) Among 3d block element Sc and Zn do not categorized under transition elements.
    (b) Fe^{2+}, forms a yellow colour complex with aqueous NH_3.
    (c) Melting point of $3d$ elements are higher than s block elements in the same period.
    (d) All the $3d$ block elements are metals.

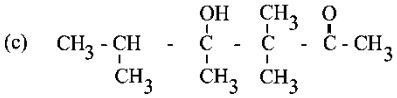
38. True regarding $1.06\,gdm^{-3}\,Na_2CO_3$ solution is / are. $(Na = 23\,, C = 12\,, O = 16)$
    $(\,consider\ 1ppm = 1mgdm^{-3}\,)$
    (a) Na^+ concentration of the solution is $0.01\,moldm^{-3}$
    (b) Na^+ composition of the solution is $460\,ppm$
    (c) Concentration of CO_3^{2-} in the solution is $0.01\,moldm^{-3}$
    (d) Composition of CO_3^{2-} in the solution is $0.6\ ppm$.

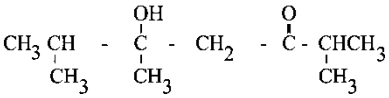
39. True regarding the following reaction which exist in the equilibrium is /are,
    $2A(g) + B(g) \rightleftharpoons 2C(g) + 2D\,(g)\,;\ \Delta H < 0$
    (a) Rate of forward reaction decreases when decreasing the temperature of the system.
    (b) Rate of reverse reaction decreases when increasing the temperature of the system.
    (c) Value of the equilibrium constant K_P decreases when increasing the pressure of the system at constant temperature.
    (d) Equilibrium point of the system shift more towards right when adding $B(g)$ at constant temperature.

40. Product / (s) obtained when self-condensation of  with aqueous $NaOH$.

(a) 

(b) 

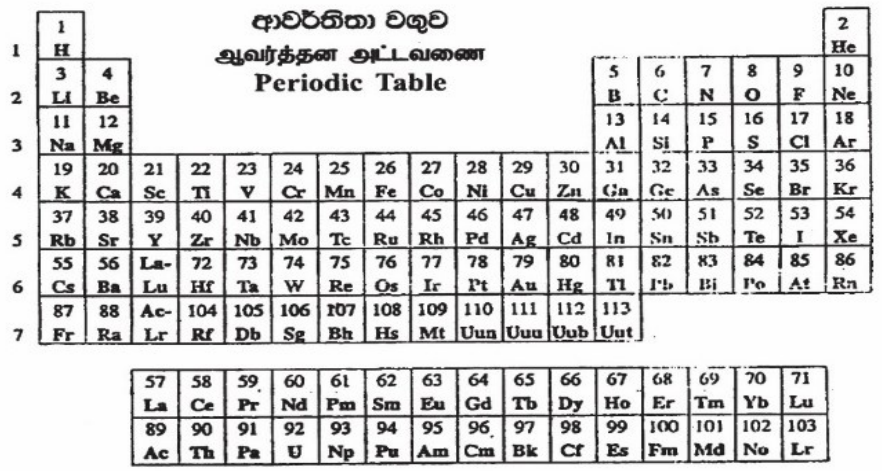
(c) 

(d) 

- **In question numbers 41 to 50, two statements are given in respect of each question. From the table given below, select the response out of the responses (1), (2), (3), (4) and (5) that best fits the two statements and mark appropriately on your answer sheet.**

1st Statement	2nd Statement	Response
True	True and 1st statement is explained correctly	1
True	True and 1st statement is not explained correctly	2
True	False	3
False	True	4
False	False	5

	1st Statement	2nd Statement
41.	All the metals are solids at room temperature.	Metals are bonded through metallic bonds.
42.	$NaCl\ (s)$ is highly soluble in water.	Na^+ ions and Cl^- ions form ion dipole interactions with water molecules.
43.	Mean kinetic energy of an ideal gas depend on the absolute temperature.	Collisions among ideal gaseous molecules are completely elastic.
44.	Acidity of phenol is higher than a alcohol.	Stability of alkoxide ion relative to alcohol is high.
45.	Aldehydes and Ketone with $\alpha - H$ subjected to condensation reactions in the presence of $NaOH\ (aq)$	Here $NaOH$ act as a catalyst.
46.	Under constant pressure conditions, endothermic reactions with positive entropy are not spontaneous always.	Gibbs energy change given by $\Delta G - \Delta H + T\Delta S$
47.	Water solubility of C_2H_5OH is higher than $H - COOH$.	C_2H_5OH as well as $H - COOH$ from $H -$ bonds with water.
48.	Boiling point of propanal is lower than propanone.	Dipole - Dipole interactions exist among propanal molecules.
49.	Plastic cup with a lid is used at the laboratory to determine enthalpy change of the neutralization enthalpy among $NaOH(aq)$ and $HCl\ (aq)$	Plastic is week thermal conductor and has low heat capacity.
50.	H_2S can exist as reducing agent while cannot exist as oxidizing agent.	S in H_2S exist in its minimum oxidation state.



02	E	II

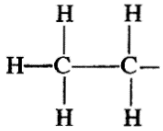
First Term Test - Grade 13 - 2019

Index No : .....

Chemistry II

Three Hours

* *A Periodic Table is provided on page* 16.
* ***Use of calculators is not allowed.***
* *Universal gas constant,* $R = 8.314\ J\ K^{-1}\ mol^{-1}$
* *Avogadro constant,* $N_A = 6.022 \times 10^{23}\ mol^{-1}$
* **In answering this paper, you may represent alkyl groups in a condensed manner.**

Example:  group may be shown as CH_3CH_2-

❑ PART A — Structured Essay (pages 2 - 8)

* *Answer* ***all*** *the questions on the question paper itself.*
* *Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive answers are not expected.*

❑ PART B and PART C — Essay (pages 9 - 15)

* *Answer* ***four*** *questions selecting* ***two*** *questions from each part. Use the papers supplied for this purpose.*
* *At the end of the time allotted for this paper, tie the answers to the three Parts* **A, B** *and* **C** *together so that Part* **A** *is on top and hand them over to the Supervisor.*
* *You are permitted to remove* **only** *Parts* **B** *and* **C** *of the question paper from the Examination Hall.*

For Examiner's Use Only

Part	Question No.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		

Final Mark

In Numbers	
In Letters	

Code Numbers

Marking Examiner 1	
Marking Examiner 2	
Checked by :	
Supervised by :	

Part A - Structured Essay

(01) (a) The following questions are related to the elements of the second row of p block and 2nd α , 3rd row of s block in the periodic table.

i. Identify the metal with highest melting point. .....

ii. Identify the element that has an allotropy fullerene. .....

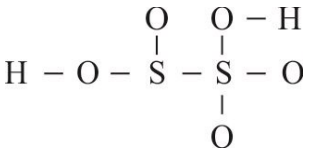
iii. Identify the element that has the highest second ionization energy. .....

iv. Identify the element which forms the unstable oxi acid. .....

v. Identify the element which forms the strongest H bonds. .....

vi. 'First ionization energy increases along a period' Identify p block element which do not obey the above statement. .....

(b) i. Draw the most acceptable Lewis dot - dash structure for the molecule $H_2S_2O_5$ Its Skelton is given below.

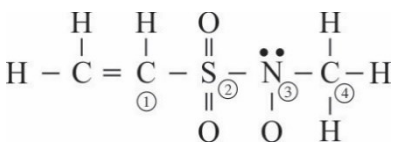


ii. Draw a Lewis dot - dash structures (resonance structures) for OCN^- ions. Write 'unstable' under the most unstable structure drawn by you. Atoms of the ion exist in the order given above.

iii. Base on the Lewis dot dash structure given below, state the following regarding the C, S, N atoms in the table.

1. VSEPR pairs around the atom.
2. Electron pair geometry around the atom.
3. Shape around the atom.
4. Hybridization of the atom.

The atoms are numbered as follows.



	C_1	S_2	N_3	C_4
i. VSEPR pairs				
ii. Electron pair geometry.				
iii. Shape				
iv. Hybridization				

iv. Identify the atomic / hybrid orbitals involved in the formation of the following σ bonds in the Lewis dot - dash structure given in part (iii) above. (Numbering of atoms as in a part (iii))

1. $H - C_{①}$ H ..... $C_{①}$ .....

II. $O - S_{②}$ O ..... $S_{②}$ .....

III. $C_{①} - S_{②}$ $C_{①}$ ..... $S_{②}$ .....

IV. $N_{③} - H$ $N_{③}$ ..... H .....

V. $N_{③} - C_{④}$ $N_{③}$ ..... $C_{④}$ .....

VI. $C_{④} - H$ $C_{④}$ ..... H .....

v. Identify the atomic orbitals involved in the formation of following π bonds in the Lewis dot - dash structure given in part (iii) above. (Numbering of atom as in part (iii))

1. $C - C_{①}$ C ..... $C_{①}$ .....

II. $S_{②} - O$ $S_{②}$ ..... O .....

(C) i. Write the electron configuration of following.

$_{30}$ Zn -

$_{29}$ Cu -

$_{7}$ N -

ii. Complete the following table regarding atomic orbitals of following electrons.

	n	l	m_l	atomic orbital
a. Last electron in Cu^{2+}	.....	.....	-1	.....
b. Last electron in N.	.....	.....	+1	.....
c. Last electron in Zn	.....	.....	.....	.....

iii. Arrange the following in the increasing order of the property indicated in the parenthesis. (Reasons are not required.)

(i) CH_3OH, H_2O , C_6H_5OH , C_2H_5OH (acidity)

..... < ..... < ..... < .....

(ii) $\{n = 3\ ,\ l = 2\}$, $\{n = 4, l = 0\}$, $\{n = 3, l = 0\}$, $\{n = 3\ , l = 1\}$ (energy of electrons)

..... < ..... < ..... < .....

(iii) K^+ , P^{3-} , S^{2-} , Cl^- (radius of the ion)

..... < ..... < ..... < ..... < .....

(02) (a) • Element A belong to the 3rd period of the periodic table. A reacts with $NaOH$ (aq) to produce gas X. X reacts with element B of the same period to produce gas Y. Y change the colour of $H^+ / KMnO_4$ giving a milky solution.

(i) Identify, A,B,X,Y.

A : ..... B : .....

X : ..... Y : .....

(ii) Write the balanced chemical equation for the reaction between A and $NaOH$ (aq) .

.....

.....

(iii) Write the chemical formula, $IUPAC$ name and election configuration of stable ion formed by A in aqueous solutions.

.....

.....

(iv) Write relevant equations when adding,

I. Limited amount of $NaOH$ followed by.

II. Excess amount of $NaOH$ to an aqueous solution containing ion in (iii) above.

(v) Write your observations relevant to (iv) above?

.....

.....

(vi) i. Write the chemical formula of oxide formed by A.

.....

ii. What is the trivial name of organic compound which can be prepared in the laboratory using (i) above.

.....

(vii) Element B form few oxo acids. One of that show two oxidation states of B. Write the chemical formula and draw the structure of that oxo acid.

.....

.....

(viii)Write the balanced ionic equation to show the reducing property of oxo acid in (vii) above.

.....

.....

(ix) i. Write two oxides formed by B.

.....

ii. Write balance chemical equations for the reaction of each of the above with $NaOH\ (aq)$.

.....

.....

(x) Consider the following compounds in given order given compounds and the given boxes, write weather the indicated property increases or decrease.

1. Oxidizing power of $HClO$, $HClO_2$, $HClO_3$, $HClO_4$
2. Rate of evolution of H_2 when alkali metals react with water down the group.
3. Water solubility of metal sulfates.

(b) Test tubes labelled A to D contain compounds Zns, $BiCl_3$, $CaSO_3$, $Mg(NO_3)_2$ (Not in order.) Consider the experiment done and observation relevant to each of the test tube A to D given in the table below.

	Experiment	**Observation**
A	i. Add water. ii. Add dil. HCl	Turbidity Obtained. Dissolves giving colourles solution.
B	i. Add water ii. Add small a amount of dil. HCl.	Insoluble Evolve a gas which turns acidified $KMnO_4$ solution to milky colour.
C	i. Add water ii. Heat small amount of the compound.	soluble Evolve a brown coloured gas.
D	i. Add water ii. Add small amount of $dil.HCl$.	Insoluble Evolve a gas which change the coloured acidified K_2CrO_7 to green.

1. Write balanced chemical equation for each of above experiment.

2. Write one laboratory experiment each to identify gases evolved in B and D above. (Other than experiment given.) i.e. Write your observation.

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(03) (a) (i) Write the definition of the standard enthalpy of neutralization.

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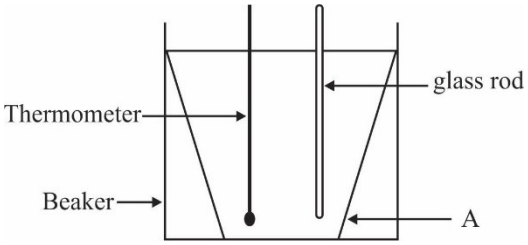
(ii) The set up shown below was used to calculate the heat change associated with the neutralization of $KOH\ (aq)$.



At a given temperature $100cm^3$ of $0.2\ moldm^{-3}\ KOH$ solution was mixed with $50\ cm^3$ of $0.4\ moldm^{-3}\ HCl$ in A. The initial temperature of two solutions was measured to be 22.5^0C. The maximum temperature measured was 24.3^0C. Density and specific heat capacity of water are $1.0\ gcm^{-3}$ and $4.2\ Jg^{-1}C^{-1}$ respectively.

(ii) Calculate the heat change associated with neutralization of KOH in kJ.

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(iii) Write your assumptions in (ii) above.

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(iv) Calculate the enthalpy change associated with above reaction.

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(v) Write a suitable container for (A) in the diagram. Explain why?

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(vi) Gibbs energy change ΔG for the above reaction at 25^0C and $1\ atm$ was calculated to be $-79.89\ kj\ mol^{-1}$. Calculated entropy change ΔS for the reaction at 25^0C using the enthalpy change calculated above.

.....

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.....

(b) Consider the following reversible reaction.

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

Enthalpy changed of the reaction is $+8.9\ kJ$ and activation energy of forward reaction is $180\ KJ$. This is a single step reaction.

(i) Draw an energy profile for the above reaction.

(ii) Mark reactants, products, activated complex (TS), Activation energy of forward reaction (Ea forward) Activation energy of reverse reaction (Ea (reverse)) and Enthalpy (ΔH)

(iii) Find Activation energy of backward reaction.

.....

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.....

(04) (a) Compounds A and B are isomers of the molecular formula C_5H_8 . Only A gives a white precipitate with ammoniac silver nitrate. Both compounds are hydrogenated in presence of pd catalyst deposited on deposited on $BaSO_4$ poisoned by quinolone. Here A gives C and B gives D while C react with HBr to from excess E and limited F. Among the compounds E and F only F shows optical isomerism. B is obtained when D reacted with $Br_2(CCl_4)$ and heated with alcoholic KOH.

(i) Draw the structure of E and F

E F

(ii) Draw the structures of A, B, C and D.

A

B

C

D

(iii) A gives G and B gives H, when A and B react with Hg^{2+} in the presence of $H_2O\ /\ H^+$.
Draw structures of G and H.

G

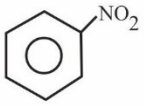
H

(iv) Write the mechanism for the formation of excess product E, in the above reaction C with HBr.

(v) Write the reason for the formation of Excess of E.

(b) Write the correct structures for the following reactions ion the boxes given.

(i) $C_6H_6 + 3H_2 \xrightarrow[150\ ^0C]{\text{Raney. Ni}}$ [ ]

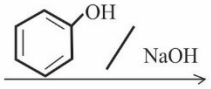
(ii) [ ] $\xrightarrow[50\ ^0C]{\text{Conc. } HNO_3 \text{ / Conc. } H_2SO_4}$ 

(iii) $C_2H_2 \xrightarrow[H^+ / H_2O / \Delta]{Hg^{2+}}$ [ ]

(iv) [ ] $\xrightarrow[H^+ / H_2O / \Delta]{Hg^{2+}}$ CH_3COCH_3

(v) $CH_3\overset{O}{\overset{\|}{C}} - H \xrightarrow[\Delta]{\text{NaOH (aq)}}$ [ ]

(vi) $CH_3COCH_3 \xrightarrow{\text{2, 4-DNP}}$ [ ]

(vii) $C_6H_5N_2^+ Cl^-$ 

[ ]

(viii) $CH_3MgBr + C_6H_5OH \longrightarrow$ [ ] [ ]

(ix) $CH_3 - CH = CH_2 \xrightarrow[\text{Peroxide medium}]{HBr}$ [ ]

First Term Test – 2019
Chemisty 13 – II - PART B

- **Answer two question only (Each question carries 15 mark)**

(05) (a) (i) PV = nRT is the ideal gas equation. Define the word ' ideal gasses' using above.

(ii) $370g$ of $O_2(g)$ trapped inside a cylinder at $25^0\ C$ and $3atm$. This cylinder was stored mistakenly with open valve at at 75^0C. It was found the gas pressure decreased to $1\ atm$ when the tap was closed. Cylinder was stored again under the same temperature $75\ ^0C$. Calculate the mass of $O_2(g)$ leakage to the environment. (1atm = 1x10^5 Pa)

(iii) $1.04\ mol$ of $NO(g)$ and $20\ g$ of $O_2(g)$ was allowed to transformed completely to NO_2 according to the following reaction in a vessel of $20\ dm^3$ 27^0C.

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

Calculate the final pressure in the vessel.

(b) Three reactions to the occurrence of photo chemical smog and some thermodynamic data are given below.

$N_2(g) + O_2(g) \rightarrow 2NO(g)$ ——— (1)

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ ——— (2)

$2NO_2(g) + h\nu \rightarrow NO(g) + O(g)$ ——— (3)

Bond	Enthalpy / $kJ\ mol^{-1}$
N - N	193
N = N	418
N ≡ N	941
O - O	142
O = O	498

Species	$\Delta S^\theta\ /kJ\ mol^{-1}k^{-1}$
$N_2(g)$	191.5
$O_2(g)$	205.0
$NO\ (g)$	210.6
$NO_2(g)$	240.5
$O(g)$	161.0

(i) For the above reaction $\Delta H^\theta = +180.6\ kJ\ mol^{-1}$. Calculate the bond dissociation energy of $NO(g)$.

(ii) Calculate the entropy change for the reaction (1).

(iii) Determine the minimum temperature that the reaction (1) would be spontaneous.

(iv) $\Delta H^\theta = +306\ kJmol^{-1}$ for the reaction (3).

Energy required for this reaction is obtained from sunlight.

I. Determined the required wave length.

II. Mention the region of spectrum it belongs.

(06) (a) $0.8\ mol\ A(g)$ $1.4\ mol\ B(g)$, $0.5\ mol\ C(g)$ and $2.2\ mol\ D(g)$ were added to a closed rigid vessel of 5dm^3 at $400\ K$.

Following equilibrium was obtained,

$A(g) + 2B\ (g) \rightleftharpoons C(g) + D\ (g)$

It was found $0.4\,mol$ of $C(g)$ exist in the vessel at the equilibrium.

(i) Write an expression for Kc relevant to above equilibrium.

(ii) Calculate the Kc value for the first decimal place at $400K$.

(iii) Write an expression for the relationship between Kp and Kc .

(iv) Calculate Kp .

(v) $0.5\,mol$ of He was added to the above equilibrium exist at $400K$. Find following in that equilibrium system.

(a) Total pressure.

(b) Calculate mole fractions of each component.

(vi) When the temperature of the system increased to $500K$, $k\mathrm{p} = 2.5\,\mathrm{x}10^{-6}\mathrm{N}^{-1}\mathrm{m}^{2}$in the equilibrium system. Deduce whether the forward reaction is exothermic or endothermic?

(b) Consider the following reaction.

$H_2O_2(aq) + 3I^-(aq) + 2\,H^+(aq) \rightarrow I_3^-(aq) + 2H_2O(l)$.

Results obtained during an experiment in order to study rate of above reaction at 30^0C given below.

Test	Initial concentration $(moldm^{-3})$			Initial rate of the reaction $moldm^{-3}s^{-1}$
	H_2O_2	I^-	H^+	
1	0.01	0.01	0.0005	1.15×10^{-6}
2	0.02	0.01	0.0005	2.3×10^{-6}
3	0.01	0.02	0.0005	2.3×10^{-6}
4	0.01	0.01	0.001	1.15×10^{-6}

(i) Write an mathematical expression for the rate of above reaction.

(ii) Find order of reaction with respect to $H_2O_2(aq)$, $I^-(aq)$ and $H^+(aq)$.

(iii) Calculate rate constant of the reaction.

(iv) How the rate of reaction change from the initial rate when concentration of H_2O_2 and H^+ kept constant and the concentration of I^- increase by 4.

(07) (a) $1.55g$ of potassium nitrate was dissociated partially by heating the sample. Residue obtained was dissolve in water to prepare $250\,cm^3$ solution. $28.9\,cm^3$ of $0.015\,moldm^{-3}$ $KMnO_4$ in acidic medium was required to react completely with $25\,cm^3$ of above solution.

(i) Write balanced chemical equations for all the reactions in this experiment.

(ii) Calculate the mass of KNO_2 in the residue after the dissociation.

(iii) What is the percentage of initial KNO_3 convert to KNO_2 .

(b) (i) Write the Hess's law.

(ii) $2.76g$ of solid K_2CO_3 was added to $30\,cm^3$ of $2\,moldm^{-3}$ HCl solution under standard conditions. Then the temperature increased by $5.2\,^0C$.

a) Write balanced chemical equation for the above reaction.

b) Calculate enthalpy change of above reaction for $1\,mol$ of K_2CO_3 .

(specific heat capacity is $4200\,J\,Kg^{-1}K^{-1}$ and density is $1000\,kg\,m^{-3}$) of the solution.

(iii) When 2g potassium hydrogen carbonate was added to another $30\,cm^3$ of above HCl solution at standard conditions. Temperature decreases by $3.7\,^0C$.

a) Write balanced chemical equations for all reactions in above (iii)

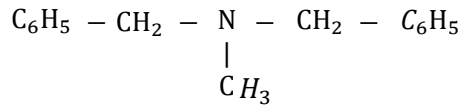
b) Calculate enthalpy change for $1mol$ of $KHCO_3$.

(iv) Use above results and calculate standard enthalpy change relevant to the heat dissociation of $KHCO_3$.

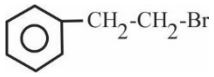
Part - C ESSAY

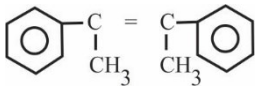
- **Answer two question only (Each question carries 15 marks)**

(08) (a) Using $C_6H_5CONHCH_3$ as the only organic starting material and as regents only those given in the list. Show how you would synthesize the following compound in not more than seven steps.



List of reagents
PCl_3 , $LiAlH_4$, H^+ / H_2O , aq. $NaOH$ / Δ

(b) Using  as only organic starting material, synthesize following compound in not more than seven steps.



(c) (i) Write the mechanism for the reaction $CH_3-\overset{\overset{O}{\|}}{C}-Cl$ with excess aqueous $NaOH$.

(ii) What is the type of above reaction from ,

- nucleophilic addition.
- nucleophilic substitution.
- electrophilic substitution
- electrophilic addition
- Elimination

(iii) What is the leaving group of above reaction.

(09) (a) Two white solid compounds (A and B) were difficult to identified as the labels were lost. Following experiment were done to distinguish two compounds.

Experiment	Observation
1. Add dil. HCl to the compound A.	Obtained brown coloured gas. (X_1)
2. Add water to the compound A.	Obtained clear light blue solution (X_2)
3. Aqueous solution of NH_4OH was added dropwise to the solution obtained in (2) above.	Obtained light blue precipitate. (X_3) Obtained dark blue solution (X_4) when adding excess $NH_4OH\ (aq)$.
4. Add water to the compound B.	Obtained colourless clear solution.
5. Add $Pb(CH_3COOH)_2(aq)$ to the solution obtained in (4) above	Obtain a golden yellow precipitate (X_5). This precipitate dissolves giving coloures solution when heating with water and appear as golden powder when cooling.
6. $Na_2SO_4(aq)$ added to the solution obtained in (4) above.	Obtained a white precipitate (X_6) insoluble in HNO_3 .
7. $Conc.\ HCl$ added to solid compound B and tasted by the flame test.	Produce an apple green (yellowish green) flame.

(i) Identify compounds A and B .
(ii) Identify gases / precipitates / solutions X_1 , X_2, X_3, X_4 , X_5 , X_6 in above.
(iii) Write balanced chemical equations for following.
a. Obtaining X_1 gas.
b. Obtaining X_2 solution.
c. Obtaining X_3 precipitate.
d. Obtaining X_4 solution.
e. Obtaining X_5 precipitate.
f. Obtaining X_6 precipitate.
(iv) Write the $IUPAC$ name of X_4.

(b) **step - I**

$25.0\ cm^3$ of aqueous solution containing Fe^{2+} and Fe^{3+} ions was titrated with $H^+ / KMnO_4$. Volume of $KMnO_4$ consumed at the end point is $20.0\ cm^3$.
Another $25.0\ cm^3$ of above solution was taken and all Fe^{3+} in the solution was converted to Fe^{2+} using a suitable reducing agent.
This solution was titrated with above $KMnO_4$ solution in acidic medium. Volume of $KMnO_4$ consumed was $37.5\ cm^3$.

step- II

$25.0\ cm^3$ of $0.0010\ mol\ dm^{-3}$ $Na_2C_2O_4$ solution was titrated with above $KMnO_4$ solution in acidic medium. Volume of $KMnO_4$ consumed was $20.0\ cm^3$.

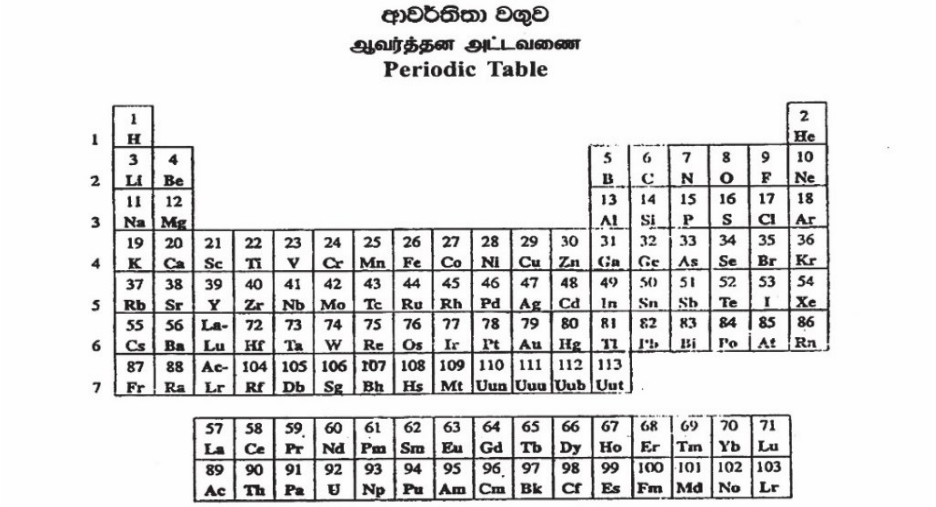
(i) Write balanced ionic / nonionic equations for reactions in step I.
(ii) Write balanced ionic / non ionic equation for reaction in step II.
(iii) Calculate the concentration of $KMnO_4$ solution.
(iv) calculate the concentration of Fe^{2+} in the solution.
(v) Calculate the concentration of Fe^{3+} in the solution.

10. (a) A solution of thiosulfate can be standardized in laboratory using the solutions of KIO_3 and KI. Here, solution of KIO_3 is used as a primary standard. Solutions of sodium thiosulphate are conveniently standardized with starch serving as the indicator by titration of the iodine produced when an excess of potassium iodide is added to a known volume of an acidified standard potassium iodate solution.
    (i) Name two essential characteristics of a compound in order to use it as a primary standard?
    (ii) List two chemical compounds that are commonly used as a primary standard other than KIO_3
    (iii) What is the role of dil.H_2SO_4 in this experiment?
    (iv) Write all the balanced chemical equation for all reactions of the experiment
    (v) Why starch indicator is added close to the end-point?

(b) (i) Which of the three pieces of titration apparatus, the pipette, the burette or the conical flask, should not be rinsed with the solution it is to contain?
    (ii) Why can't you use hydrated KIO_3 for this experiment?
    (iii) Several data obtained during the experimental determination of the order of reaction with respect to Fe^{3+} for the reaction between Fe^{3+} and I^- are given below

Experiment	Distilled water/ cm^3	Acidified 0.1 mol dm^{-3} Fe^{3+}(aq)/ cm^3	3.0 mol dm^{-3} KI(aq)/ cm^3	0.006 mol dm^{-3} $S_2O_3^{2-}$ (aq) + starch/ cm^3	Time taken for the blue colour to appear/ s
1	10.0	15.0	10.0	15.0	27.7
2	15.0	10.0	10.0	15.0	62.5
3	20.0	5.0	10.0	15.0	250

(I) What is the method of determining the rate of this reaction?
(II) What is the function of $S_2O_3^{2-}$ in this reaction?
(III) Can you add Fe^{3+} and $S_2O_3^{2-}$ together? Give reasons
(IV) H_2SO_4 and $S_2O_3^{2-}$ cannot be added together. Give reasons
(V) What is the reason for keeping KI concentration in a higher level than concentration of other solutions in the experiment?
(VI) Why water is added to the mixture?
(VII) Calculate the order of the reaction with respect to Fe^{3+}
(VIII) If the rate constant of the reaction is k and the order of the reaction with respect to I^- is 1, write the rate law for the reaction



(1) – 2	(11) – 3	(21) – 3	(31) – 3	(41) – 4
(2) – 5	(12) – 5	(22) – 4	(32) – 1	(42) – 1
(3) – 2	(13) – 3	(23) – 2	(33) – 4	(43) – 2
(4) – 5	(14) – 1	(24) – 4	(34) – 3	(44) – 3
(5) – 3	(15) – 4	(25) – 4	(35) – 1	(45) – 2
(6) – 2	(16) – 5	(26) – 1	(36) – 5	(46) – 5
(7) – 2	(17) – 3	(27) – 2	(37) – 3	(47) – 4
(8) – 4	(18) – 4	(28) – 3	(38) – 2	(48) – 2
(9) – 4	(19) – 1	(29) – 3	(39) – 4	(49) – 1
(10) – 1	(20) – 3	(30) – 1	(40) – 3	(50) – 4

Part A - Structured Essay

(01) (a) The following questions are related to the elements of the second row of *p* block and 2nd α , 3rd row of *s* block in the periodic table.

i. Identify the metal with highest melting point. ..... Mg .....

ii. Identify the element that has an allotropy fullerene. ..... C .....

iii. Identify the element that has the highest second ionization energy. ..... Li .....

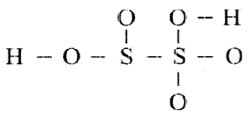
iv. Identify the element which forms the unstable oxi acid. ..... N .....

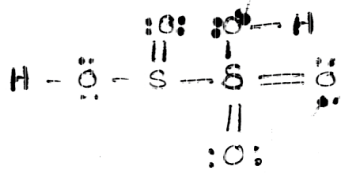
v. Identify the element which forms the strongest *H* bonds. ..... F .....

vi. 'First ionization energy increases along a period' Identify p block element which do not obey the above statement. ..... O .....

(04x6 = 24)

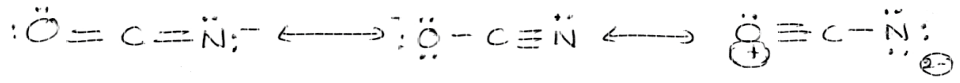
(b) i. Draw the most acceptable Lewis dot - dash structure for the molecule $H_2S_2O_5$ Its Skelton is given below.





(06)

ii. Draw a Lewis dot - dash structures (resonance structures) for OCN^- ions. Write 'unstable' under the most unstable structure drawn by you. Atoms of the ion exist in the order given above.



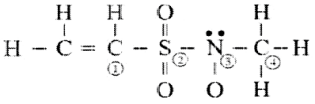
(03x3 = 09)

Unstable (01)

iii. Base on the Lewis dot dash structure given below, state the following regarding the C, S, N atoms in the table.

1. VSEPR pairs around the atom.
2. Electron pair geometry around the atom.
3. Shape around the atom.
4. Hybridization of the atom.

The atoms are numbered as follows.



	C_1	S_2	N_3	C_4
i. VSEPR pairs	03	04	04	04
ii. Electron pair geometry.	Trigonal planer	Tetrahedral	Tetrahedral	Tetrahedral
iii. Shape	,,	,,	Pyramidal	,,
iv. Hybridization	sp^2	sp^3	sp^3	sp^3

(01 × 16 = 16)

iv. Identify the atomic / hybrid orbitals involved in the formation of the following σ bonds in the Lewis dot - dash structure given in part (iii) above. (Numbering of atoms as in a part (iii))

I. $H - C_①$ H S a.o $C_①$ sp^2 h.o

II. $O - S_②$ O p a.o $S_②$ sp^3 h.o

III. $C_① - S_②$ $C_①$ sp^2 h.o $S_②$ sp^3 h.o

IV. $N_③ - H$ $N_③$ sp^3 h.o H S a.o

V. $N_③ - C_④$ $N_③$ sp^3 h.o $C_④$ sp^3 h.o

VI. $C_④ - H$ $C_④$ sp^3 h.o H S a.o

(01 × 12 = 12)

v. Identify the atomic orbitals involved in the formation of following π bonds in the Lewis dot - dash structure given in part (iii) above. (Numbering of atom as in part (iii))

I. $C - C_①$ C p a.o $C_①$ p a.o

II. $S_② - O$ $S_②$ sp^3 h.o O p a.o

(C) i. Write the electron configuration of following.

$_{30}Zn$ - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$

$_{29}Cu$ - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

$_{7}N$ - $1s^2 2s^2 2p^3$

(02 × 3 = 6)

ii. Complete the following table regarding atomic orbitals of following electrons.

	n	l	m_l	atomic orbital
a. Last electron in Cu^{2+}	3	2	-1	3d
b. Last electron in N.	2	1	+1	2p
c. Last electron in Zn	4	0	0	4s

(01 × 10 = 10)

iii. Arrange the following in the increasing order of the property indicated in the parenthesis. (Reasons are not required.)

(i) CH_3OH, H_2O, C_6H_5OH, C_2H_5OH (acidity)

C_2H_5OH < H_2O < CH_3OH < C_6H_5OH

(ii) $\{n = 3, l = 2\}$, $\{n = 4, l = 0\}$, $\{n = 3, l = 0\}$, $\{n = 3, l = 1\}$ (energy of electrons)

$\{n=3, l=0\}$ < $\{n=3, l=1\}$ < $\{n=4, l=0\}$ < $\{n=3, l=2\}$.

(iii) K^+ , P^{3-} , S^{2-} , Cl^- (radius of the ion)

K^+ < Cl^- < S^{2-} < P^{3-} ✓✓ (04 x 3 = 12)

02) (a) • Element *A* belong to the 3rd period of the periodic table. A reacts with *NaOH* (aq) to produce gas *X*. *X* reacts with element B of the same period to produce gas Y. Y change the colour of $H^+ / KMnO_4$ giving a milky solution.

(i) Identify, A,B,X,Y.

A : Al B : S

X : H_2 Y : H_2S (03 x 4 = 12)

(ii) Write the balanced chemical equation for the reaction between *A* and *NaOH* (aq) .

$2Al + 2NaOH + 6H_2O \longrightarrow 2Na[Al(OH)_4] + 3H_2\uparrow$ (04)

(iii) Write the chemical formula, *IUPAC* name and election configuration of stable ion formed by *A* in aqueous solutions.

$1s^2 2s^2 2p^6 3s^2$

$[Al(H_2O)_6]^{3+}$ hexaaqua aluminium ion.

(03 x 3 = 09)

(iv) Write relevant equations when adding.

I. Limited amount of *NaOH* followed by.

$Al^{3+}_{(aq)} + 3OH^-_{(aq)} \longrightarrow Al(OH)_{3(s)}$. (03)

II. Excess amount of *NaOH* to an aqueous solution containing ion in (iii) above.

$Al(OH)_{3(s)} + OH^-_{(aq)} \longrightarrow [Al(OH)_4]^-$ (03)

OR

$AlO_2^-{}_{(aq)} + 2H_2O_{(l)}$

(v) Write your observations relevant to (*iv*) above?

Gives a white gelatinous ppt which dissolves with excess NaOH (03)

(vi) i. Write the chemical formula of oxide formed by A.

Al_2O_3 (02)

ii. What is the trivial name of organic compound which can be prepared in the laboratory using (i) above.

Ethylene (03)

(vii) Element B form few oxo acids. One of that show two oxidation states of B. Write the chemical formula and draw the structure of that oxo acid.

2 s' $H_2S_2O_3$ (03)

(viii) Write the balanced ionic equation to show the reducing property of oxo acid in (vii) above.

thiosulfuric acid. (03)

(ix) i. Write two oxides formed by *B*.

SO_2 SO_3 (

ii. Write balance chemical equations for the reaction of each of the above with *NaOH* (*aq*).

$SO_2 + 2NaOH \longrightarrow Na_2SO_3 + H_2O$

$SO_3 + 2NaOH \longrightarrow Na_2SO_4 + H_2O$

(03 x 2 = 6)

(x) Consider the following compounds in given order given compounds and the given boxes, write weather the indicated property increases or decrease.

1. Oxidizing power of $HClO$, $HClO_2$, $HClO_3$, $HClO_4$ — Decreases
2. Rate of evolution of H_2 when alkali metals react with water down the group. — Increase
3. Water solubility of metal sulfates. — Decrease (02×3 = 6)

(b) Test tubes labelled A to D contain compounds Zns, $BiCl_3$, $CaSO_3$, $Mg(NO_3)_2$ (Not in order.) Consider the experiment done and observation relevant to each of the test tube A to D given in the table below.

	Experiment	Observation
A	i. Add water. ii. Add dil. HCl	Turbidity Obtained. Dissolves giving colourles solution.
B	i. Add water ii. Add small a amount of dil. HCl.	Insoluble Evolve a gas which turns acidified $KMnO_4$ solution to milky colour.
C	i. Add water ii. Heat small amount of the compound.	soluble Evolve a brown coloured gas.
D	i. Add water ii. Add small amount of $dil.HCl$.	Insoluble Evolve a gas which change the coloured acidified K_2CrO_7 to green.

I Identify A, B, C and D A - $BiCl_3$ B - ZnS C - $Mg(NO_3)_2$ D - $CaSO_3$

II. Write balanced chemical equation for each of above experiment. (03×5 = 15)

$BiCl_{3(aq)} + H_2O_{(l)} \rightleftharpoons BiOCl_{(s)} + 2HCl_{(aq)}$

$ZnS + HCl \longrightarrow ZnCl_2 + H_2S$

$Mg(NO_3)_2 \xrightarrow{\Delta} MgO + NO_2 + O_2$

$CaSO_3 + HCl \longrightarrow CaCl_2 + SO_2 + H_2O$ (4×5 = 20)

III Write one laboratory experiment each to identify gases evolved in B and D above. (Other than experiment given.) i.e. Write your observation.

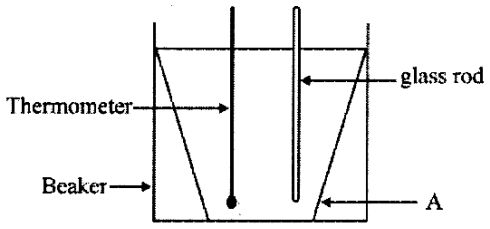
B → Gives black ppt with $Pb(CH_3COO)_2$

D → Change the colour of $H^+/KMnO_4$ purple → colourless
H^+/K_2CrO_7 orange → green
giving clear solution. (06)

(03) (a) (i) Write the definition of the standard enthalpy of neutralization.

It is the enthalpy change when a mole of an aqueous H^+ ions and a mole of an aqueous OH^- ions in the standard state react to form a mole of liquid water. (04)

(ii) The set up shown below was used to calculate the heat change associated with the neutralization of $KOH\,(aq)$.



At a given temperature $100cm^3$ of $0.2\,moldm^{-3}$ KOH solution was mixed with $50\,cm^3$ of $0.4\,moldm^{-3}$ HCl in A. The initial temperature of two solutions was measured to be 22.5^0C. The maximum temperature measured was 24.3^0C. Density and specific heat capacity of water are $1.0\,gcm^{-3}$ and $4.2\,Jg^{-1}C^{-1}$ respectively.

(ii) Calculate the heat change associated with neutralization of KOH in kJ.

Q = mcΔt ✓

= 150.0 cm³ x 1.0 g cm⁻³ x 4.2 J g⁻¹ c⁻¹ x (24.3 - 22.5) C ✓

= 1134 J ✓

= 1.134 kJ ✓

(05 x 6 = 30)

(iii) Write your assumptions in (ii) above.

Density of solution equal to density of water.
Specific heat capacity of water equal to the solution.
No heat flow to the surrounding. (any 2) (02 x 2 = 04)

(iv) Calculate the enthalpy change associated with above reaction.

n KOH = 0.2 mol dm⁻³ x 100 x 10⁻³ dm³

= 0.02 mol ✓

ΔH = 1134 J / 0.02 mol ✓

= 56 700 J mol⁻¹ ✓

= 56.7 kJ mol⁻¹ ✓ (04 x 3 = 12)

(v) Write a suitable container for (A) in the diagram. Explain why?

Plastic cup.
Plastics are poor thermal conductors and have low heat capacity.

(vi) Gibbs energy change ΔG for the above reaction at 25^0C and $1\,atm$ was calculated to be $-79.89\,kj\,mol^{-1}$. Calculated entropy change ΔS for the reaction at 25^0C using the enthalpy change calculated above.

ΔG = ΔH - TΔS ✓

-79.89 kJ mol⁻¹ = -56.7 kJ mol⁻¹ - 298 K ΔS ✓

ΔS = (-56.7 kJ mol⁻¹ + 79.89 kJ mol⁻¹) / 298 K ✓

= 77.81 J K⁻¹ mol⁻¹ ✓

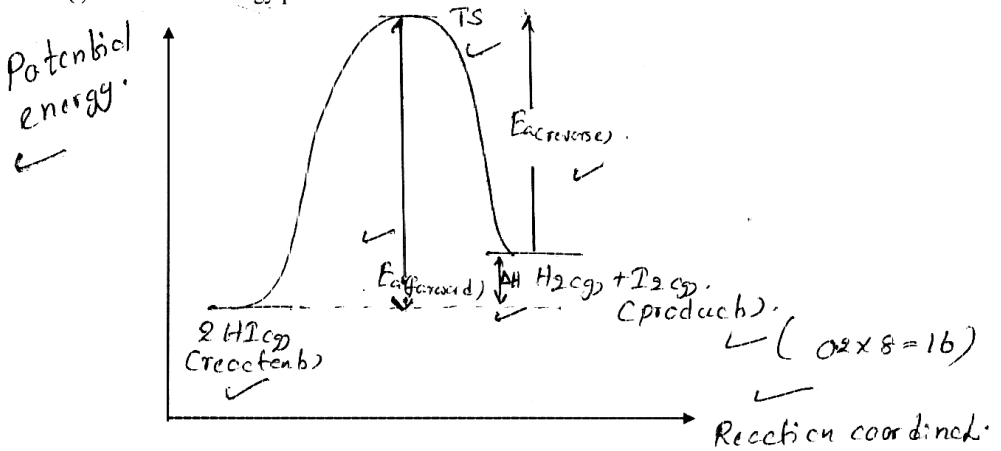
05 x 4 = 20

(b) Consider the following reversible reaction.

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

Enthalpy changed of the reaction is $+8.9\ kJ$ and activation energy of forward reaction is $180\ KJ$. This is a single step reaction.

(i) Draw an energy profile for the above reaction.



(02 × 8 = 16)

(ii) Mark reactants, products, activated complex (TS), Activation energy of forward reaction (Ea forward) Activation energy of reverse reaction (Ea (reverse)) and Enthalpy (ΔH)

(iii) Find Activation energy of backward reaction.

$E_{a(reverse)} = 180\ kJ\ mol^{-1} - 8.9\ kJ\ mol^{-1}$

$= 171.1\ kJ\ mol^{-1}$

(02 × 4 = 08)

(04) (a) Compounds A and B are isomers of the molecular formula C_5H_8. Only A gives a white precipitate with ammoniac silver nitrate. Both compounds are hydrogenated in presence of pd catalyst deposited on deposited on $BaSO_4$ poisoned by quinolone. Here A gives C and B gives D while C react with HBr to from excess E and limited F. Among the compounds E and F only F shows optical isomerism. B is obtained when D reacted with $Br_2(CCl_4)$ and heated with alcoholic KOH.

(i) Draw the structure of E and F

E: $CH_3CH(Br)CH_2CH_2CH_3$

F: $BrCH_2-CH_2CH_2CH_2CH_3$

(05 × 2 = 10)

OR

E: $CH_3CH(Br)-CH(CH_3)-CH_3$

OR

F: $BrCH_2CH_2CH(CH_3)-CH_3$

(ii) Draw the structures of A, B, C and D.

A: $H-C\equiv C-CH_2CH_2CH_3$ OR $H-C\equiv C-CH(CH_3)-CH_3$

B: $CH_3-C\equiv C-CH_2CH_3$

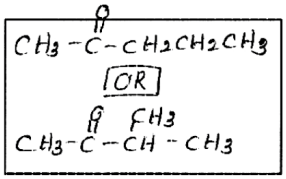
C: $CH_2=CHCH_2CH_2CH_3$ OR $CH_2=CH-CH(CH_3)-CH_3$

D: $CH_3CH=CHCH_2CH_3$

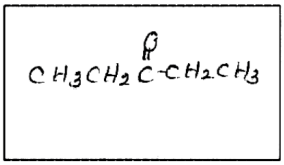
(05 × 4 = 20)

(iii) A gives G and B gives H, when A and B react with Hg^{2+} in the presence of H_2O / H^+.

Draw structures of G and H.



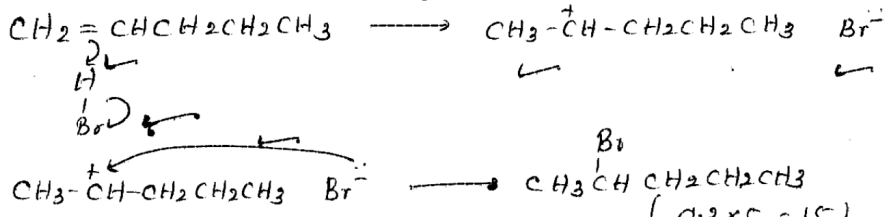
G



H

(05×2 = 10)

(iv) Write the mechanism for the formation of excess product E, in the above reaction C with HBr.



(03×5 = 15)

(v) Write the reason for the formation of Excess of E.

Two intermediate carbocations are possible.

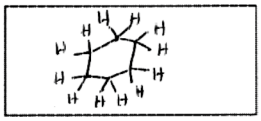
$CH_3\overset{+}{C}HCH_2CH_2CH_3$ Stable. ✓

$\overset{+}{C}H_2CH_2CH_2CH_2CH_3$ Unstable. ✓

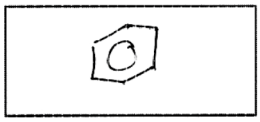
Secondary carbocation is most stable and major product is given by that ✓ (02×4 = 08)

(b) Write the correct structures for the following reactions ion the boxes given.

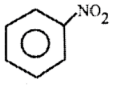
(i) $C_6H_6 + 3H_2 \xrightarrow[150\,^{\circ}C]{\text{Raney. Ni}}$



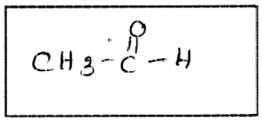
(ii)



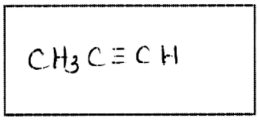
$\xrightarrow[50\,^{\circ}C]{\text{Conc. } HNO_3 \text{ / Conc. } H_2SO_4}$



(iii) $C_2H_2 \xrightarrow[H^+/H_2O/\Delta]{Hg^{2+}}$

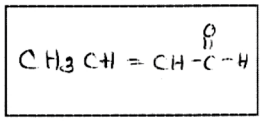


(iv)

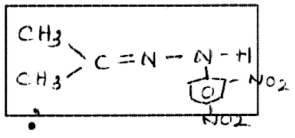


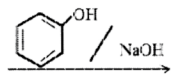
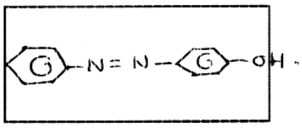
$\xrightarrow[H^+/H_2O/\Delta]{Hg^{2+}}$ CH_3COCH_3

(v) $CH_3\overset{O}{\overset{\|}{C}}-H \xrightarrow[\Delta]{\text{NaOH (aq)}}$



(vi) $CH_3COCH_3 \xrightarrow{\text{2, 4-DNP}}$



(vii) $C_6H_5N_2^+Cl^-$  

(viii) $CH_3MgBr + \xrightarrow{C_6H_5OH}$ CH_4 (02) C_6H_5OMgBr (03)

(ix) $CH_3-CH=CH_2 \xrightarrow[\text{Peroxide medium}]{HBr}$ $CH_3CH_2CH_2Br$.

10 ($04 \times 8 + 5 = 38$)

Part B - Essay.

(05) (i) Gases behave as $PV = nRT$ or $Z = 1$ under any temperature and pressure conditions.

($02 \times 3 = 6$)

(ii) Amount of $O_2 = \frac{370g}{32 g mol^{-1}} = 11.5625$ mol

$P_1 = 30 \times 1 \times 10^5$ Pa $P_2 = 1 \times 1 \times 10^5$ Pa

$T_1 = 298$ K $T_2 = 348$ K.

From $PV = nRT$

$V = \frac{nRT}{P} = \frac{370}{32} \times \frac{1 \times 8.314\ J mol^{-1} K^{-1} \times 298 K}{30 \times 1 \times 10^5 Pa}$ — (1)

$V = \frac{n \times 8.314\ J mol^{-1} K^{-1} \times 348 K}{1 \times 1 \times 10^5 Pa}$ — (2).

(1) = (2).

$\frac{370}{32} \times \frac{8.314 \times 298}{30 \times 1 \times 10^5} = \frac{n \times 8.314 \times 348}{1 \times 10^5}$

$n = 0.33$ mol.

mass of $O_2 = 0.33$ mol $\times 32 g mol^{-1}$

$= 10.56 g$.

Mass of O_2 leakaged $= (370 - 10.56) g$

$= 359.44 g$

(18 × 2 = 36)

(iii) $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$.

	$2NO_{(g)}$	$O_{2(g)}$	$2NO_{2(g)}$
Initial moles	1.04	0.625	-
Reacted moles	1.04	0.52.	
Remaining moles	-	0.625 - 0.52 = 0.105	1.04.

Amount of O_2 = $\frac{20g}{32g\,mol^{-1}}$ = 0.625 mol.

Total moles = 1.145 mol.

Applying $PV = nRT$

$P = \frac{nRT}{V}$

$= \frac{1.145\,mol \times 8.314\,J\,mol^{-1}K^{-1} \times 300K}{20 \times 10^{-3}\,m^3}$

$= 1.48 \times 10^5\,Pa$.

(15 x 2 = 30)

Q - 72.

(b) (i) $\Delta H^\ominus = \sum H_D^\ominus$ (Bonds broken) $- \sum H_D^\ominus$ (Bonds formed)

$180.6\,kJ = 941\,kJ + 498\,kJ - 2 \times H_D^\ominus (NO_{(g)})$

$H_D^\ominus (NO_{(g)}) = 629.2\,kJ\,mol^{-1}$.

(03 x 6 = 18)

(ii) $\Delta S^\ominus = S^\ominus$ products $- S^\ominus$ reactants.

$\Delta S^\ominus = S^\ominus NO_{(g)} \times 2 - (S^\ominus N_{2(g)} + S^\ominus O_{2(g)})$

$= 2 \times 210.6\,J\,mol^{-1}K^{-1} - 191.5 + 205\,J\,mol^{-1}K^{-1}$.

$= 24.7\,J\,mol^{-1}K^{-1}$.

(03 x 6 = 18)

(III) $\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$

at minimum temperature consider $\Delta G = 0$.

$$\Delta H^\ominus = T\Delta S^\ominus$$

$$180.6\ KJ\ mol^{-1} = T \times 24.7 \times 10^{-3}\ KJ\ K^{-1}\ mol^{-1}$$

$$T = \frac{180.6}{0.0247}\ K$$

$$= \underline{7311\ K}$$

$03 \times 6 = 18$.

(IV) Energy for one molecule

$$= \frac{306 \times 10^3\ J\ mol^{-1}}{6.022 \times 10^{23}\ mol^{-1}}$$

$$= \underline{5.08 \times 10^{-19}\ J}$$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{6.626 \times 10^{-34}\ JS \times 3 \times 10^8\ ms^{-1}}{5.08 \times 10^{-19}\ J}$$

$$= 3.91 \times 10^{-7}\ m.$$

$$= 391\ nm.$$

Ultra violet region

$(03 \times 8 = 24)$

b - 78

(07) · @

(i) $2KNO_{3(s)} \longrightarrow 2KNO_{2(s)} + O_{2(g)}$ 07

$2MnO_4^- + 6H^+ + 5NO_2^- \longrightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$

10

17

(II) MnO_4^- consumed $= \frac{0.015}{1000} \times 28.9\ mol$

NO_2^- in $25\ cm^3$ $= \frac{5}{2} \times \frac{0.015}{1000} \times 28.9\ mol.$

amount of NO_2^- in $250\ cm^3$ $= \frac{5}{2} \times \frac{0.015}{1000} \times \frac{28.9 \times 250}{25}\ mol$

KNO_2 residue $= \frac{5}{2} \times \frac{0.015}{1000} \times \frac{28.9 \times 250}{25}$ mol

Mass $= \frac{5}{2} \times \frac{0.015}{1000} \times \frac{28.9}{25} \times 250 \times 85$ g.

$= 0.9212$ g

(03 × 6 = 18)

(III) $KMnO_4$ consumed $= \frac{5}{2} \times \frac{0.015}{1000} \times \frac{28.9}{25} \times 250$ mol

mass $= \frac{5}{2} \times \frac{0.015}{1000} \times \frac{28.9}{25} \times 250 \times 101$ g.

$= 1.094$ g.

KNO_3 percentage consumed $= \frac{1.094}{1.55} \times 100\%$

$= 70.6\%$

(05 × 5 = 25)

a - 150

(b) (i) Enthalpy change of a reaction independent from the path and depend on depend on initial and final state. (15)

(II) (a) $K_2CO_3(aq) + 2HCl(aq) \longrightarrow 2KCl(aq) + CO_2(g) + H_2O(l)$ (05)

(b) Q = mcθ (03)

$= 30 \times 10^{-3}$ kg $\times 4200$ J kg^{-1} K^{-1} $\times 5.2$ K (05)

$= 655.2$ J (03)

Amount of K_2CO_3 $= \frac{2.76 \text{ g}}{138 \text{ g mol}^{-1}}$ (03)

$= 0.02$ mol (03).

HCl added $= \frac{2 \times 30}{1000}$ mol

$= 0.06$ mol (03).

Amount of HCl react with 0.02 mol K_2CO_3 = 0.04 mol. (03)

∴ Excess of HCl and K_2CO_3 react completely (03)

Heat released when 0.02 mol K_2CO_3 reacted = 0.6552 kJ. (03)

∴ Heat released when 1 mol of K_2CO_3 reacted = $\frac{0.6552 \text{ kJ}}{0.02 \text{ mol}}$

∴ ΔH^θ = 32.76 kJ mol^{-1} (03)

III

(a) $KHCO_3(s) + HCl(aq) \longrightarrow KCl(aq) + CO_2(g) + H_2O(l)$. (05)

Q = mcθ

$= 30 \times 10^{-3} \text{ kg} \times 4200 \text{ J kg}^{-1} K^{-1} \times 3.7 \text{ K}$ (05)

$= 466.2 \text{ J}$

$= 0.4662 \text{ kJ}$. (03)

$KHCO_3$ added = $\frac{2 \text{ g}}{100 \text{ g mol}^{-1}}$

= 0.02 mol (03)

Heat absorbed when 1 mol of $KHCO_3$ reacted = $\frac{0.4662 \text{ kJ}}{0.02 \text{ mol}}$ (05)

ΔH^θ = 23.31 kJ mol^{-1}. (03)

IV

$2HCl + 2KHCO_3(s) \xrightarrow{\Delta H^\theta} K_2CO_3(s) + CO_2(g) + H_2O(l) + 2HCl$. (05)

$2KCl(aq) + 2CO_2(g) + 2H_2O(l)$.

23.31×2 kJ mol^{-1} (05)

-32.76 kJ mol^{-1} (05)

From Hess law (03)

$\Delta H^\theta + (-32.76) = 23.31 \times 2$ (03)

$\Delta H^\theta = 23.31 \times 2 + 32.76$

= 79.38 kJ mol^{-1} (03)

b - 100

(06) (a).

$$A_{(g)} + 2B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}.$$

Initial mol	0.8	1.4	0.5	2.2.
reacted mol	–	–	0.1	0.1
Equilibrium	0.9	1.6	0.4	2.1
Concentration.	$\frac{0.9}{5}$	$\frac{1.6}{5}$	$\frac{0.4}{5}$	$\frac{2.1}{5}$.

$01 \times 4 = (04)$

(i) $K_c = \frac{[C_{(g)}][D_{(g)}]}{[A_{(g)}][B_{(g)}]}$ (05)

(ii) $K_c = \frac{\left(\frac{0.4}{5}\right)\left(\frac{2.1}{5}\right)}{\left(\frac{0.9}{5}\right)\left(\frac{1.6}{5}\right)^2}$ $mol^{-1}dm^3$. (05)

$= 1.8 \times mol^{-1}dm^3$ (05)

(iii) $K_p = K_c(RT)^{\Delta n}$ (05) $\Delta n = -1$ (03)

$K_p = \frac{K_c}{RT}$ (03)

$= \frac{1.8 \times 10^{-3}\ mol^{-1}m^3}{8.314\ J\ mol^{-1}K^{-1} \times 400K}$. (05)

$= \frac{1.832 \times 10^{-3}}{6.314 \times 400} = 0.55 \times 10^{-6}$.

$= 5.5 \times 10^{-7}\ N^{-1}m^2$

(02)

(IV) He not reach to equilibrium.
So no chenge in equilibrium constant.
$0.3 \times 2 = 6$

(a) Total moles $= (0.9 + 1.6 + 0.4 + 2.1 + n_{He})$.
$= 10$ mol. ✓ (05)

Total pressure $P = \frac{nRT}{V}$ ✓ (05)

$= \frac{10\,mol \times 8.314\ J\,mol^{-1}K^{-1} \times 400\,K}{5 \times 10^{-3}\ m^3}$ ✓ (04)

$= 6.65 \times 10^6\ Nm^{-2}$

✓ (05)

(b) $X_A = \frac{0.9}{10} = 0.09$ ✓ $X_C = \frac{0.4}{10} = 0.04$. ✓

$X_B = \frac{1.6}{10} = 0.16$ ✓ $X_D = \frac{2.1}{10} = 0.21$ ✓

$X_{He} = \frac{5}{10} = 0.5$ ✓

(02 × 5 = 10)

(VI) at 400 K $K_p = 5.5 \times 10^{-7}\ N^{-1}m^2$ ✓

at 500 K $K_p = 2.5 \times 10^{-6}\ N^{-1}m^2$. ✓

When temperature increases K_p increases. ✓
∴ Equilibrium shifted right. ✓
∴ forword reaction is endothermic.
∴ ✓

(02 × 5 = 10)

a - 80

(6) b (i) Rate = $k[H_2O_2(aq)]^a [I^-(aq)]^b [H^+(aq)]^c$. (05)

order w.r.t $H_2O_2 = a$ order w.r.t. $I^- = b$ Order w.r.t $H^- = c$. (03)

(ii) 1.15×10^{-6} mol dm^{-3} s^{-1} = k (0.01 mol dm^{-3})^a (0.01 mol dm^{-3})^b (5×10^{-4} mol dm^{-3})^c (1)

2.3×10^{-6} = k (0.02)^a (0.01)^b (5×10^{-4})^c (2)

2.3×10^{-6} = k (0.01)^a (0.02)^b (5×10^{-4})^c (3)

1.15×10^{-6} = k (0.01)^a (0.01)^b (1×10^{-3})^c (4)

(05 x 4 = 20)

(3)/(1) $\frac{2.3 \times 10^{-6}}{1.15 \times 10^{-6}} = \left(\frac{0.02}{0.01}\right)^b$

$2^1 = 2^b$

$b = 1$

(4)/(1) $\frac{1.15 \times 10^{-6}}{1.15 \times 10^{-6}} = \left(\frac{1 \times 10^{-3}}{5 \times 10^{-4}}\right)^c$

$1 = 2^c$

$c = 0$

(2)/(1) $\frac{2.3 \times 10^{-6}}{1.15 \times 10^{-6}} = \left(\frac{0.02}{0.01}\right)^a$

$2^1 = 2^a$

$a = 1$ (0.2 x 6 = 12)

(iii) 1.15×10^{-6} mol dm^{-3} s^{-1} = k (0.01 mol dm^{-3}) (0.01 mol dm^{-3})

$k = \frac{1.15 \times 10^{-6} \text{ mol dm}^{-3}\text{s}^{-1}}{1 \times 10^{-4} \text{ mol}^2\text{dm}^{-6}}$ (04)

$= 1.15 \times 10^{-2}$ mol^{-1} dm^3 s^{-1}

(05)

(iv) Rate = $1.15 \times 10^{-2}\ mol^{-1}\ s^{-1}\ dm^3\ (0.01\ mol dm^{-3})(0.04\ mol dm^{-3})$. (10)

$= 1.15 \times 4 \times 10^{-6}$ (05)

= Initial rate increases by four times. (05)

b- 70.

Part c - Essay.

(8) (a)

$C_6H_5CONHCH_3$

I $LiAlH_4$
II H_2O (05)

$C_6H_5CH_2NHCH_3$ (06)

$\downarrow C_6H_5CH_2Cl$ (05)

$C_6H_5CH_2N(CH_3)CH_2C_6H_5$

$NaOH/\Delta$ (05)

C_6H_5COONa (06)

$\downarrow H^+/H_2O$ (05)

C_6H_5COOH (06)

I $LiAlH_4$
II H_2O (05)

$C_6H_5CH_2OH$ (06)

$\downarrow PCl_3$ (05)

$C_6H_5CH_2Cl$. (06)

$5 \times 6 = 30$

$6 \times 5 = 30$

60.

(b) $C_6H_5CH_2CH_2Br \xrightarrow[KOH]{\text{alcoholic}} C_6H_5CH=CH_2$ (5) (5)

$C_6H_5CH=CH_2 \xrightarrow{HBr}$ (5) $C_6H_5CH(Br)CH_3$ (4)

I Conc. H_2SO_4
II $H^+ H_2O$

$C_6H_5CH(OH)CH_3$ (4)

$\downarrow H^+/KMnO_4$ CPCC (5)

$C_6H_5COCH_3$ (4)

$C_6H_5CH(Br)CH_3 \xrightarrow[\text{dry ether}]{Mg}$ (5) $C_6H_5CH(MgBr)CH_3$. (4)

$C_6H_5CH(MgBr)CH_3 + C_6H_5COCH_3 \longrightarrow C_6H_5C(OMgBr)(CH_3)CH(C_6H_5)CH_3$ (3)

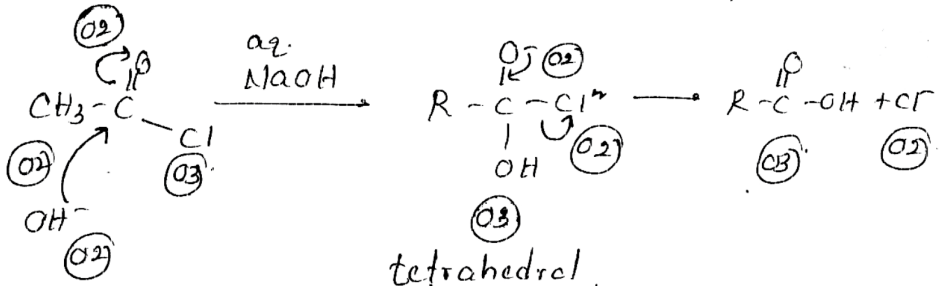
$\xrightarrow[(2)]{H^+/H_2O}$ $C_6H_5C(OH)(CH_3)CH(C_6H_5)CH_3$ (5)

$\xrightarrow[170^\circ C]{Conc.\ H_2SO_4}$ (5) $C_6H_5C(CH_3)=C(C_6H_5)CH_3$.

* Consider grignard reagent and hydrolysis as single step.
Should write as I Grignard reagent
II H^+/H_2O.

$5 \times 7 = 35$
$4 \times 5 = 20$
$5 \times 1 = 5$
$b = \boxed{60}$

(c) (i)



$2 \times 6 = 12$
$3 \times 4 = 12$
24.

(ii) nucleophilic substitution.

(iii) Cl^-

C — 30.

(g) (a) I A $Cu(NO_2)_2$. B: BaI_2 $(12 \times 2 = 24)$

II X_1 NO_2

X_2 $[Cu(H_2O)_6](NO_2)_2(aq)$

X_3 $Cu(OH)_2(s)$

X_4 $[Cu(NH_3)_4]^{2+}(aq)$

or

$[Cu(NH_3)_4](NO_2)_2$.

X_5 $PbI_2(s)$

X_6 $BaSO_4(s)$. $(05 \times 6 = 30)$

III a $Cu(NO_2)_2 + 2HCl \longrightarrow 2NO_2(g) + NO(g) + H_2O(l) + CuCl_2(aq)$
brown.

OR

$CuNO_2 + 2HCl \longrightarrow CuCl_2 + HNO_2$

OR $3Cu(NO_2)_2 + 6HCl \longrightarrow 3CuCl_2 + 2HNO_3 + 4NO + 2H_2O$

OR $3Cu(NO_2)_2 + 6HCl + 2O_2 \longrightarrow 3CuCl_2 + 2HNO_3 + 2H_2O + 4NO_2$

OR $2Cu(NO_2)_2 + 4HCl + O_2 \longrightarrow 2CuCl_2 + 4NO_2 + 2H_2O$

b. $Cu(NO_2)_2 + 6H_2O_{(l)} \longrightarrow [Cu(H_2O)_6](NO_2)_2$

c. $[Cu(H_2O)_6](NO_2)_2 + 2NH_4OH \longrightarrow [Cu(OH)_2(H_2O)_4] + 2NH_4NO_2 + 2H_2O$

OR

$Cu(NO_2)_2 + 2NH_4OH \longrightarrow Cu(OH)_2 + 2NH_4NO_2$

d. $[Cu(H_2O)_6](NO_2)_2 + 4NH_4OH \longrightarrow [Cu(NH_3)_4(H_2O)_2](NO_2)_2 + 2H_2O$

OR

$Cu(NO_2)_2 + 4NH_4OH \longrightarrow [Cu(NH_3)_4](NO_2)_2 + 2H_2O$

e. $Pb(CH_3COO)_2 + BaI_2 \longrightarrow PbI_{2(s)} + Ba(CH_3COO)_2$

f $BaI_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaI$ (05 x 6 = 30)

(iv) tetraamminecopper(II) nitrite (06).

(b) I $Fe^{2+} \longrightarrow Fe^{3+} + e$. (02)

$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$ (02)

$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ (04) } (08)

II $C_2O_4^{2-} \longrightarrow 2CO_2 + 2e$ (02)

$8H^+ + 5e + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O$ (02)

$5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \longrightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$ (04) (08)

(III) $Na_2C_2O_4$ amount added $= 0.0010\ mol\,dm^{-3} \times 25 \times 10^{-3}\ dm^3$

$= 25 \times 10^{-6}$ mol. ✓

$KMnO_4$ in $20cm^3$ $= \frac{2}{5} \times 25 \times 10^{-6}$ mol ✓

$= 1 \times 10^{-5}$ mol.

$[KMnO_4] = \frac{1 \times 10^{-5}\ mol}{20 \times 10^{-3}\ dm^3} = \frac{0.01}{20} = 0.0005\ mol\,dm^{-3}$ ✓ ✓

(iv) $KMnO_4$ consumed $= 0.0005\ mol\,dm^{-3} \times 20 \times 10^{-3}\ dm^3$

$= 1 \times 10^{-5}\ mol$

Fe^{2+} in 25 cm³ $= \frac{5}{1} \times 1 \times 10^{-5}\ mol$

$[Fe^{2+}] = \frac{5 \times 10^{-5}\ mol}{25.0 \times 10^{-3}\ dm^3} = \frac{0.01}{5}$

$= 0.002\ mol\,dm^{-3}$.

(v) $KMnO_4$ volume consumed for Fe^{2+} from Fe^{3+} $= (37.5 - 20.0)\ cm^3 = 17.5\ cm^3$.

∴ No. of Moles of $KMnO_4$ $= 0.0005\ mol\,dm^{-3} \times 17.5 \times 10^{-3}\ dm^3$

$= 8.75 \times 10^{-6}\ mol$

Fe^{2+} exist $= 5 \times 8.75 \times 10^{-6}\ mol$.

Fe^{3+} in 25 cm³ $= 5 \times 8.75 \times 10^{-6}\ mol$.

$[Fe^{3+}] = \frac{5 \times 8.75 \times 10^{-6}\ mol}{25 \times 10^{-3}\ dm^3}$.

$= 1.75 \times 10^{-3}\ mol\,dm^{-3}$.

$(02 \times 15 = 45)$

(10) (i) Highly pure.
Stable.
Not hydrated.
High molecular mass
High water solubility.

2×5 maximum (10).

(ii) Na_2CO_3, $K_2Cr_2O_7$ $(5 \times 2 = 10)$.

(iii) IO_3^- and I^- react in acidic medium. (05)
H_2SO_4 provide H^+ (05).

OR

Provid H^+ to following reaction.

$IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

(iv). $IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$ (10).

$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$ (10).

(v) To identify ~~clear~~ the colour change clearly. (10)

(vi) Titration flask.

(vii) Concentration is not constant when there is hydrated compound (10)

65

(b) (i) Measure the time taken to appear blue colour (5).

(ii) To delay the appearance of blue colour (5).

(iii) Can't (05).
~~What~~ would be occur another reaction ~~what~~ (20).

(iv) $S_2O_3^{2-}$ disproportionate in acidic medium. (10).

(v) Then, change in $[I^-]$ in each step is negligible. (10).

(vi) Keep the volume of each step constant (05)

(vii) $[Fe^{3+}]^m \; t = k$.

$10^m \times 62.5 = 5^m \times 250$.

$\left(\frac{10}{5}\right)^m = \frac{250}{62.5}$.

$2^m = 4$

$m = 2$ (05)

(viii) $R = k[Fe^{3+}]^2[I^-]$. (05)

b - 65.