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Provincial Department of Education - NWP

02	E	I

Second 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 $R = 8.314\ JK^{-1}\ mol^{-1}$ | Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

Planck's constant $h = 6.626 \times 10^{-34}\ Js$ | Velocity of light $C = 3 \times 10^{8}\ ms^{-1}$

1. Select the element which is having the highest second ionization energy,
   1. C 2. N 3. O 4. F 5. S

2. Select the molecule which is having the largest number of lone pairs in it.
   1. SF_4 2. CCl_4 3. $HClO_4$ 4. H_3PO_4 5. OF_2

3. The Order of increasing bond angle of the species, N^+O_2 , NO_2 , NO_2^- , NO_3^-
   1. $NO_3^- < NO_2 < NO_2^- < N^+O_2$
   2. $NO_2^- < NO_3^- < N^+O_2 < NO_2$
   3. $NO_2^- < NO_2 < NO_3^- < N^+O_2$
   4. $NO_2^- < NO_3^- < NO_2 < N^+O_2$
   5. $NO_2 < NO_2^- < NO_3^- < N^+O_2$

4. IUPAC name of the compound,

```
                O    NH2   CH3  H    O
                ‖    |     |    |    ‖
CH3CH2 - O -    C  - CH -  C  = C -  C - CH3 is,
```

   1. ethyl-2-amino – 3 – methylhex – 3 – en – 5 - oneoate
   2. ethyl 2-amino – 3 – methyl – 5 – oxohex – 3 - enoate
   3. ethyl-3-methyl – 2 – amino – 5 – oxohex – 3 - enoate
   4. ethyl 2-ammine – 3 – methylhex – 3 – en – 5 - onoate
   5. ethyl 2-ammine – 3 – methyl – 5 – oxohex – 3 - enoate

5. Select the statement which is not true?
   1. Temperature, concentration, pressure, physical state and catalysts affect for the reaction rate.
   2. For a given reaction, the rate of removal of each of the reactant is equal to the rate of formation of each of the product.
   3. The rate with respect to a reactant depends on the stoichiometric coefficient of the relevant substance.
   4. The rate of a reaction is the change of concentration occurred within a unit time.
   5. The time taken to occur a given definite change can be used to measure the rate.

6. The product / products obtained when $CH_3 - \overset{\overset{O}{\|}}{C} - CH_2CH_3$ undergoes the self condenzation at the presence of aqueous $NaOH$ is / are ?

A. $CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{CH_2CH_3}{|}}{C}} - CH_2CH_2 - \overset{\overset{O}{\|}}{C} - CH_3$

B. $CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{CH_2CH_3}{|}}{C}} - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - CH_3$

C. $CH_3 - \overset{\overset{O}{\|}}{\underset{\underset{H}{|}}{C}} - CH_2CH_2 - CH_2 - \overset{\overset{O}{\|}}{C} - CH_2CH_3$

D. $CH_3 - \overset{\overset{O\ H}{|}}{\underset{\underset{C\ H_2CH_3}{|}}{C}} - CH_2 - \overset{\overset{O}{\|}}{C} - CH_2CH_3$

1. A only
2. A and B only
3. B and D only
4. C and D only
5. D only

7. Consider the following reaction, taking place at $298\ K$,

   $A_2(g) + 3B_2(g) \rightarrow 2AB_3\ (g)\ ;\ \Delta H^\theta < 0$

   Which of the following statements is true regarding the above reaction?
   1. For all temperatures, ΔG^θ of the reaction takes a negative value.
   2. At the low temperatures the reaction is spontaneous.
   3. When the reaction is taking place, the entropy of the surroundings decreases.
   4. When the reaction is taking place, the entropy of the system increases.
   5. For all the temperatures the reaction is not spontaneous.

8. At 298K the ratio of $\frac{[Pb^{2+}(aq)]}{[Ca^{2+}(aq)]}$ in a saturated solution of $PbCO_3$ and $CaCO_3$ is,

   At 298K $K_{sp}\left(PbCO_3(s)\right) = 6 \times 10^{-14}\ mol^2dm^{-6}$

   $K_{sp}\left(CaCO_3(s)\right) = 3 \times 10^{-9}\ mol^2dm^{-6}$

   1. $\frac{\sqrt{6}}{\sqrt{3}}$
   2. $\frac{1 \times 10^{-2}}{\sqrt{5}}$
   3. 2×10^{-4}
   4. 0.5×10^{-5}
   5. 2×10^{-5}

9. The compound can be used to distinguish both solutions of $MgCl_2$ and $MgSO_4$ is,
   1. $Pb(NO_3)_2(aq)$
   2. $Na_2CO_3(aq)$
   3. $Ba(NO_3)_2(aq)$
   4. $Na_3PO_4(aq)$
   5. NaOH (aq)

10. A mixture of $N_{2(g)}$ and $O_{2(g)}$ is obtained when nitrous oxide $(N_2O)\ (g)$ is undergoing the thermal decomposition. Here 56% of $N_2O\ (g)$ is, under $1.2 \times 10^5 Pa$ pressure. The partial pressure of the $N_2(g)$ formed is, (Consider that the temperature and volume are constants

1. $0.41 \times 10^5 Pa$
2. $0.53 \times 10^5 Pa$
3. $0.26 \times 10^5 Pa$
4. $0.8 \times 10^5 Pa$
5. $0.4 \times 10^5 Pa$

11. The increasing order of melting points of the following substances is,
$H_2O\ ,\ NH_3\ ,\ CH_4\ ,\ HF\ ,\ SbH_3$

1. $CH_4 < NH_3 < HF < H_2O < SbH_3$
2. $CH_4 < SbH_3 < NH_3 < H_2O < HF$
3. $SbH_3 < CH_4 < NH_3 < H_2O < HF$
4. $CH_4 < SbH_3 < NH_3 < HF < H_2O$
5. $SbH_3 < CH_4 < NH_3 < HF < H_2O$

12. Which of the following statements is false regarding the colours of the complex ions, formed by the cations of 3d block?
1. $[CuCl_4]^{2-}(aq)$ is yellow in colour.
2. $[NiCl_4]^{2-}(aq)$ is yellow in colour.
3. $[CoCl_4]^{2-}(aq)$ is blue in colour.
4. $[Ni\ (NH_3)_6]^{2+}(aq)$ is dark blue in colour.
5. $[Co\ (NH_3)_6]^{2+}(aq)$ is dark blue in colour.

13. A and B liquids mix together to form an ideal solution. This solution mixture exists in equilibrium with it's vapour inside a closed vessel at a constant temperature. At that temperature the saturated vapour pressure of A and B are P_A^0 and P_B^0 respectively. If the mole fraction of A in the liquid phase is X_A, then the mole fraction of A in vapour phase is,

1. $\frac{P_A^0 \text{ X } A}{(P_A^0 - P_B^0)X_A + P_B^0}$
2. $\frac{P_B^0\ (1-X_A)}{P_A^0\ (1-X_A) + P_B^0}$
3. $\frac{P_B^0 \text{ X } A}{P_A^0 \text{ X } A + P_B^0(1-X_A)}$
4. $\frac{P_A^0 \text{ X } A}{P_A^0 + P_B^0}$
5. $\frac{P_A^0\ (1-X_A)}{P_A^0 \text{ X } A + P_B^0\ (1-X_A)}$

14. The correct statement from the followings is,
1. In the emission spectrum of atomic hydrogen, the distance between spectral lines is decreasing to the direction of increasing wave Length.
2. Among the species N^+O_2 , NO_3^- and NO_2^- the electronegativity of the central N_1 atiom is highest in NO_2^-.
3. The highest reducing property is shown by K among $Al,\ Na,\ Mg,\ K$
4. The ability of hydrolysis is maximum for $AsCl_3$ among $NCl_3,\ PCl_3,\ AsCl_3$
5. Only H bonds exist among the molecules of CH_3COOH

15. At $298\ K$ Calculate the pH of the buffer solution which is formed by mixing $50\ cm^3$ of $0.2\ mol\ dm^{-3}$ CH_3COOH acid solution and $50\ cm^3$ of $0.1\ mol\ dm^{-3}$ KOH solution.
At $298\ K$ $K_{a_{(CH_3COOH)}} = 1.8 \times 10^{-5}\ mol\ dm^{-3}$

1. 4.74
2. 5.26
3. 4.26
4. 5.74
5. 5.32

16. The standard electrode potentials of two standard electrodes formed by A and B are given below.

$E^{\theta}(A^{+}_{(aq)}/\ A_{(s)})\ =\ +0.52\ V$ $\qquad$ $E^{\theta}_{\left(B^{3+}(aq)\ /B\ (s)\right)}\ =\ -0.74\ V$

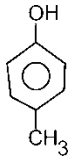
Which is true regarding the electro chemical cell formed using the above half cells? ,

1. Electrode A is the anode and electrode B is the cathode.
2. Electrode A is the cathode and electrode B is the anode and the electromotive force of that cell is to + 0.22 V.
3. When the cell is functioning electrons are following from the electrode A towards the electrode B through the external circuit.
4. Electrode B is the anode and the electro motive force of the cell is + 1.26V.
5. Electrode B is the anode and when the cell is functioning the mass of the electrode B is increasing.

17. Which of the following statements is false?

1. The fractional distillation can be used to obtain distilled water from a salt solution.
2. The fractional distillation can be used to separate the volatile compounds in a liquid mixture.
3. The simple distillation is used to separate the components in a solution, which is formed by dissolving a non volatile substance in a volatile solvent.
4. In order to separate two liquids by the fractional distillation there should be a considerable difference between their boiling points.
5. In the fractional distillation the mole fraction of the substance in the solution which has the high boiling point increases gradually.

18. Which of the following statements is true regarding the given compound ?



1. More acidic than phenol.
2. Less acidic than phenol.
3. reacting with CH_3COOH to form esters.
4. reacting with $Na_2CO_3$to liberate $CO_2(g)$
5. Undergoing nucleophilic substitution reaction with CH_3COCl to form esters.

19. Consider the reaction, $A_{(g)} + B_{(g)}$ + energy $\rightleftharpoons\ C(g)$

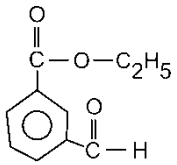
At $298K$ the equal number of moles of $A_{(g)}$ and $B_{(g)}$ are mixed inside a rigid vessel and allowed it to reach the equilibrium. Select the method which can not be used to increase the yield of $C_{(g)}$

1. Increasing the temperature of the system.
2. Addition of a certain amount of $B_{(g)}$ to the system.
3. Removal of $C_{(g)}$ from the system by liquifying.
4. Increasing the pressure of the system by adding an inert gas at constant temperature.
5. Addition of a catalysts.

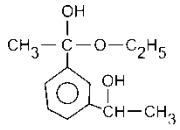
20. A metal mixture in which Na and Cu are mixed, contains 64.25% of Na by mass. When $3.58g$ of that metal mixture is added to $250\ cm^3$ of water. What is the pH value of that solution at $298\ K$. (At $298\ K$ $K_w = 1 \text{ x } 10^{-14}\ mol^2dm^{-6}$ and $Cu = 64\ , Na = 23$)

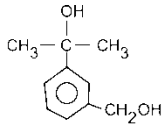
1. 13.4 $\qquad$ 2. 13.6 $\qquad$ 3. 1.6 $\qquad$ 4. 0.6 $\qquad$ 5. 0.4

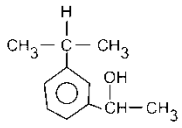
21. The products of the reaction,

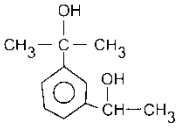


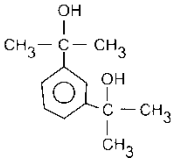
excess
$(i)\ CH_3MgBr$
$\longrightarrow$
$(ii)\ H_2O$

1.  . C_2H_5OH

2.  . C_2H_5OH

3.  . C_2H_5OH

4.  . C_2H_5OH

5.  . C_2H_5OH

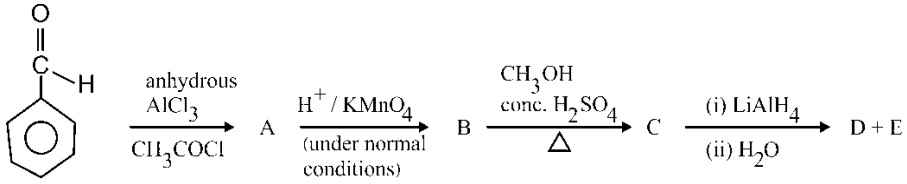
22. At 298 K when 0.1 $moldm^{-3}$ mono basic weak with $pH = 4$ is diluted hundred times, pH value of the resultant solutions is,

1. 4.5 2. 5 3. 6 4. 6.5 5. 5.5

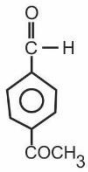
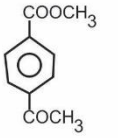
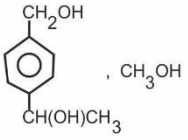
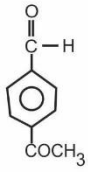
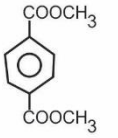
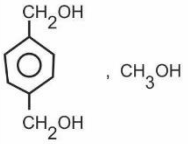
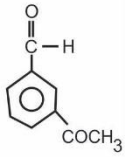
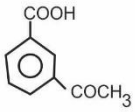
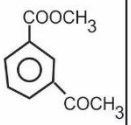
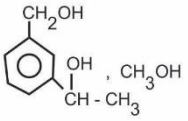
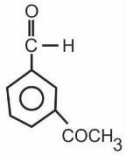
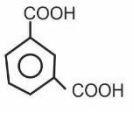
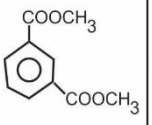
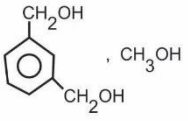
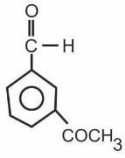
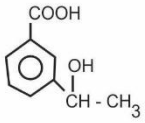
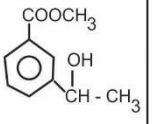
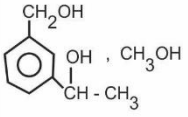
23. For the electroplating of Ni metal $0.5A$ constant current is passed through a $NiCl_2$ solution, during 2 hours. The maximum mass of Ni that can be coated is, $(1F = 96500\ C\ mol^{-1},\ Ni = 58.7)$

1. 2.56 g 2. 5.87 g 3. 1.09 g 4. 58.7 g 5. 1.17 g

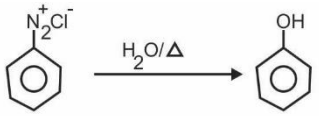
24. Consider the following reaction series.

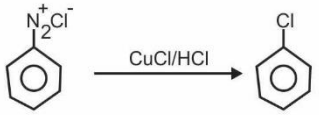


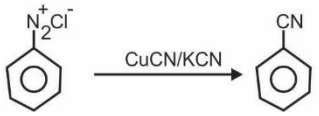
structures obtained for A, B,C, and D respectively.

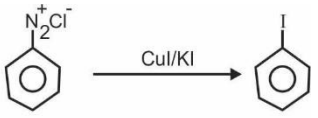
	A	B	C	D + E
(1)				
(2)				
(3)				
(4)				
(5)				

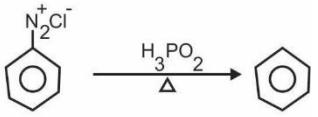
25. Which of the followings is not true regarding the reactions of Diazonium Salt.

(1) 

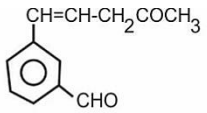
(2) 

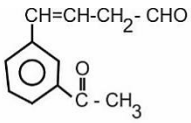
(3) 

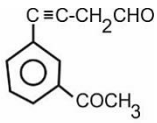
(4) 

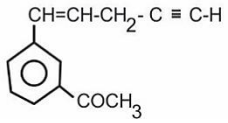
(5) 

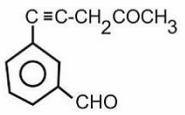
26. Which of the following compounds can be answered for all the following observations?
- Shows the geometrical isomerism.
- The product obtained in the addition of HCN shows enantiomerism.
- Gives a dark yellow colour precipitate with Bready's reagent $(2,4-DNP)$
- Does not give a brick red colour precipitate with Fehling's solution.

(1) 

(2) 

(3) 

(4) 

(5) 

27. The chemical formula of $hexaaquairon(iii)\ sulfate$ is,

1. $[Fe(H_2O)_6]SO_4$
2. $[Fe(H_2O)_6]_2\ (SO_4)_3$
3. $[Fe(OH_2)_6]_2\ (SO_4)_3$
4. $[Fe(OH_2)_6]SO_4$
5. $[Fe(OH_2)_6]\ \ (SO_4)_3$

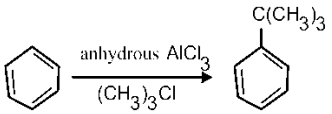
28. Which of the following statements is false regarding S- block elements?

1. Only Li of the first group reacts with N_2 gas.
2. Li forms only $Li_2O\ (s)$ with excess $O_2(g)$.
3. Na reacts with dil. H_2SO_4 and liberates $H_2(g)$ rapidly.
4. All S block elements react with H_2 (g) and form metal hydrides.
5. Except Be rest of all the metals of the second group react with N_2 gas.

29. Which of the following statements is false regarding the d block elements.

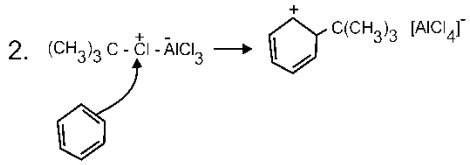
1. Unlike s block elements, d block elements can show variable oxidation states.
2. The electronegativity of d – block elements is less than the electronegativity of s-block elements of the same period.
3. Metallic properties d-block elements is greater than the metallic properties of s-block elements.
4. d - block elements act as catalysts.
5. d – block elements can form acidic / basic / amphoteric oxides.

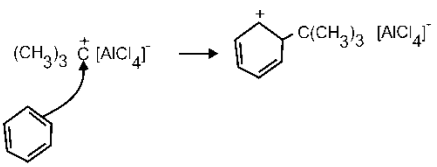
30. Consider the following reactions.

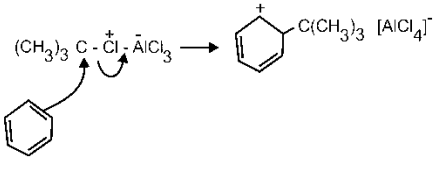


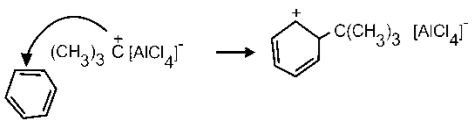
Which of the following responses shows a step of the mechanism of the above reaction correctly?

1. $(CH_3)_3C-Cl\ +\ AlCl_3\ \rightarrow (CH_3)_3C-\ Cl^+-\ \overline{Al}Cl_3$

2. 

3. 

4. 

5. 

- 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. Consider the titration of 0.1 $moldm^{-3}$ HCl in burette and 25 cm^3 of 0.1 $mol\ dm^{-3}$ NH_4OH taken in to a titration flask at 298 K.
    a) pH value at the equivalence point is less than 7.
    b) Consumed volume of HCl at the equivalence point is less than $25cm^3$.
    c) Phenolphthalein is a suitable indicator to determine the equivalence point.
    d) Methyl arrange is a suitable indicator to determine the equivalence point.

32. Select the pairs of ions which show the same colour in the aqueous solution.

    (a) Mn^{2+} , Ni^{2+} (b) V^{3+} , Cr^{3+} (c) Cu^{2+} , Co^{2+} (d) Mn^{2+} , Co^{2+}

33. At 298 K, some amount of $CaCl_2$ is add to a saturated solution of $Ca(OH)_2$. Which of the followings is / are occured in this solution.
    (a) $[Ca^{2+}(aq)]$ increasing (b) $[OH^{-}(aq)]$ increasing
    (c) $[H^{+}(aq)]$ does not change. (d) pH value is decreasing.

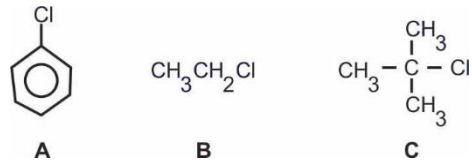
34. At 800 K , for the equilibrium, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the equilibrium constant $K_c = 0.08\ dm^6\ mol^{-2}$ At 800K, 4 mol of $N_2(g)$, 5 mol of $H_2(g)$ and 2.5 mol of $NH_3(g)$ are placed in a rigid vessel of 5 dm^3. Which of the followings is / are true regarding the above equilibrium.
    (a) Initially $Q_C < K_C$ and the reaction shifts to left.
    (b) Initially $Q_C > K_C$ and the reaction shifts to right.
    (c) Initially, $Q_C < K_C$ and the reaction shifts to right by forming excess NH_3.
    (d) Initially $Q_C < K_C$ and the reaction shifts to right consuming $H_2(g)$ and $N_2(g)$.

35. Which is / are true regarding the organic compound, $H-\underset{(p)}{C}\equiv\underset{(q)}{C}-\underset{(r)}{\overset{\overset{H}{|}}{C}}-\underset{(s)}{\overset{\overset{H}{|}}{C}}-\underset{(t)}{CH_2}\underset{(u)}{CH_3}$

    (a) All the C atoms of the molecules exist in the same plane.

(b) p, q and r carbon atoms exist in a same line.
(c) All H atoms of the molecule exist in the same plane.
(d) Above compound shows diasteriomerism.

36. Consider the following two compounds.



The more correct statement /s regarding the above compound is / are.
(a) Rate of nucleophilic substitution reaction of B is less than C.
(b) A undergoes nucleophilic substitution reactions.
(c) Rate of nucleophilic substitution reaction of A is greater than B.
(d) While B undergoes nucleophilic substitution reactions of a single step C undergoes nucleophilic substitution reactions of two steps.

37. Which of the following solutions turns / turn red litmus blue.
(a) NH_4Cl (b) LiF (c) CH_3COOK (d) CH_3COONa

38. Select the factor / factors which affects / affect the electromotive forces of an electro chemical cell.
(a) temperature (b) Cross section area of the electrodes
(c) the distance between the electrodes (d) nature of the electrode used.

39. Which of the followings can be used to distinguish $SO_2(g)$ and $H_2S(g)$.
(a) $H^+ \ / \ KMnO_4(aq)$ (b) $H^+ \ / \ K_2Cr_2O_7$
(c) wet colourful petal of a flower. (d) nature of the electrode used

40. Which of the following statement /s is / are false regarding an aliquot of an ideal gas.
(a) Total energy of the molecules is changed, in the molecular collisions occurred at constant temperature
(b) There are not attraction forces among gas molecules.
(c) At constant temperatures mean kinetic energy of gas molecules is a constant.
(d) Gas molecules travel in all directions in the same speed.

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.	The reaction rate is increased by the catalyzed.	The activation energy of the reaction is decreased by the catalysts.
42.	The basicity of amides is less than that of amine.	The electron pair on nitrogen in the amide group is de localized on to the carbonyl group by the resonance.
43.	The order of an elementary reaction is equal to the molecularity.	The number of molecules participated for the balanced chemical equation is the molecularity.
44.	When the concentration of a monobasic weak acid is decreasing pH value is decreasing.	When the concentration of a monobasic weak acid is decreasing then its degree of dissociation is increasing.
45.	Alkanes are not reactive towards the non polar reagents.	$C-C$ bond of the alkane is non polar and $C-H$ bond is polar.
46.	At high temperature He gas reaches the ideal behaviour.	At higher temperatures the speed of the molecules is increasing, therefore the strength of the attractive forces is decreasing.
47.	In acidic medium when H_2S is passed, not only Cu^{2+} but also Ni^{2+} can be precipitated as its sulphide.	Because of the high H^+ concentration of the acidic medium concentration of S^{2-} ions decreases relatively.
48.	Acidity of the benzoic acid is greater than the acidity of phenol.	The stability of the phenate ion is greater than the stability of the benzoate ion.
49.	The melting point of $MgCO_3$ is less than the melting point of $BaCO_3$.	The polarizing power of Mg^{2+} ion is less than the polarizing power of Ba^{2+} ion.
50.	The conductivity of 0.1 $moldm^{-3}$ $NaCl$ is less than the conductivity of 0.1 $mol\ dm^{-3}$ $NaCl$.	The electric conductivity of the solution depends only on the temperature on the nature of the solute.

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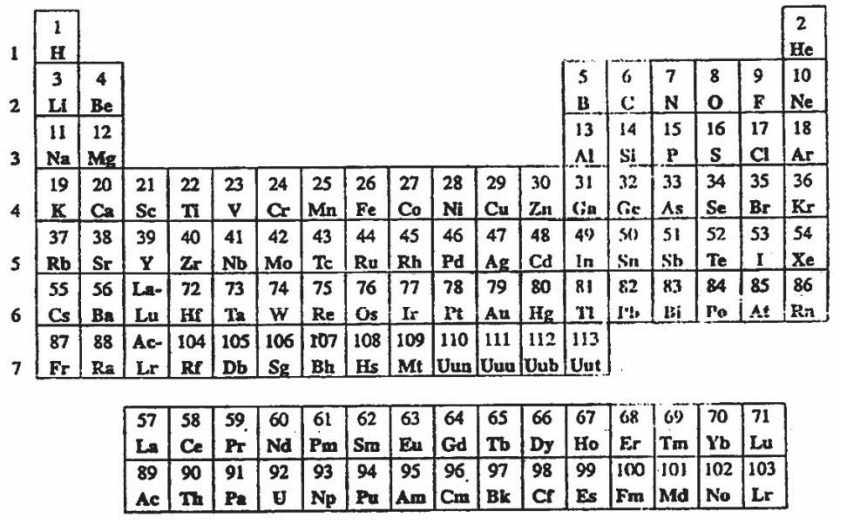
ஆவர்த்தன அட்டவணை

Periodic Table

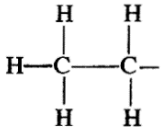


02	E	II

Second 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		
Percentage		

Final Mark

In Numbers	
In Letters	

Code Numbers

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

see page two

Part A - Structured Essay

Answer all four questions on this paper itself. (Each question carries 10 marks)

(01) (a) (i) Mention the oxidation state and hybridization shown by the central N atom in the following compounds and ions.

Compound	NO_2	NO_2F	NH_2OH	N_2O	NH_4^+
1. Oxidation number					
2. Hybridization					

(ii) Draw the acceptable Lewis structure for the molecule N_2O .

(iii) Draw the resonance structures for the above molecules expect the drawn in part II above. Mention the stabilities by giving reasons

(b) KHF_2 is an ionic compound with a cation of one type and an anion of one type.

i. Write IUPAC name of KHF_2.

.....

.....

ii. Write the chemical of the cation and the anion?

cation .....

anion .....

iii. Draw the structure of the anion and name the bond types of it.

.....

.....

iv. Answer the following questions regarding the compounds of H_2S and CS_2 .

1. Mention the secondary interaction type / types existing among each of the species.

H_2S ..... CS_2 .....

....

2. Which of the above molecule has the strongest secondary interactions?

.....

2. Which of the above compounds has the highest boiling point.?

.....

4. Consider the combustion of each of the above compounds at the presence of excess O_2. Write the balanced chemical equations for the above reactions.

.....

.....

(C) Mention whether the following statements are 'True'' or 'False'

i. Unit of the rate constant depends on the order of the reactions. (.....)

ii. All the molecules which are having polar covalent bonds have dipole moments.(.....)

iii. Energy of an electron in a 3d orbital is greater than the energy of an electron in 4s orbital. (.....)

iv. pH value of 10^{-10}mol dm^{-3} aqueous HCl solution at 25^0C is 10 (.....)

v. Heat of the reaction of a chemical reaction depends on the temperature. (.....)

vi. Atomic radius of Cl is greater than that of Li. (.....)

vii. In the order of $NaCl < MgCl_2 < AlCl_3$, their melting points are increasing.(.....)

(02) (a) The element M belongs to s block. Although the sulphate of M is more soluble be in water, the carbonate is insoluble in water. Although M does not react with cold water, it reacts with hot water.

(i) What is the element M? .....

(ii) When the element M is combusted in air it forms two compounds Q_1 and Q_2 . Only Q_2 of them reacts with water. Write the chemical formulae of the compounds Q_1 and Q_2.

Q_1 ..... Q_2 .....

(iii) Write the balanced chemical equations for the followings.

1. Reaction of M with hot water.

.....

2. Reaction of Q_2 with water.

.....

(iv) In a certain experiment the above element M is combusted in air resulting a mixture of Q_1 and Q_2 . 1.0 g of that mixture is allowed to react with excess H_2O. Then a gas is liberated and that gas is allowed react completely with the $0.5\ mol\ dm^{-3}$ HCl. The percentage of Q_2 contained in 1.0g of the above sample is 30.3% Calculate the volume of HCl reacted above.

(b) When 2.48 g of a hydrated inorganic salt X is heated, the anhydrous salt Y and 0.9 g of water is obtained as products. The following observations are given by an aqueous solution of Y.

1. Decolourises the solution of I_2 dissolved in aqueous KI.
2. At the presence of HCl, forms a light yellow colour precipitate, liberating a colourlessgas with a pungent smell.
3. At the presence of aqueous $AgNO_3$,forms a white colour, precipitate and it turns black within a short period of time.
4. A conc. HCl solution of Y imparts yellow colour to the flame in the flame test.

(i) What is the salt of Y?

.....

(ii) Write the balanced equations for the reactions relevant to observations 1, 2 and 3.

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(iii) Derive the chemical formula of the hydrated compound X.

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.....

(c) Write the balanced chemical equations for the following reactions.

(i) $NaNH_2 + NH_4Cl \xrightarrow{\Delta}$

(ii) $H_2S + H_2O_2 \rightarrow$

(iii) $Al + OH^- + NO_3^- \rightarrow$

(iv) $FeCl_3 + H_2S \rightarrow$

(03) (a) At 25^0C p^{K_b} of $NH_3(aq)$ is 4.8 and Kw $= 10^{-14}mol^2dm^{-6}$

(i) What do you mean by p^{K_b} ?

.....

.....

.....

(ii) Write the equilibrium attained when the aqueous NH_3 is decomposed.

.....

.....

(iii) Write an expression for the dissociation constant (K_b) of $NH_{3\,(aq)}$.

(iv) According to the reaction $NH_{4\,(aq)}^{+} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O_{(aq)}^{+}$. Write an expression for (K_a) of $NH_{4\,(aq)}^{+}$.

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(v) Accordingly derive the relationship among k_a, k_b and k_w.

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(vi) At 25^0C Calculate pK_b of $NH_4^+(aq)$.

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(b) An aqueous solution contain $NaOH$ and Na_2CO_3 is provided. Two portions of $50\ cm^3$ from that solution are seperated and labelled as A and B. Those solutions are titrated as follows.

Method 01

Portion A is titrated with $1.0\ mol\ dm^{-3}$ HCl at the presence of phenolphthalein. The consumed volume of the acid at the endpoint is $10.0\ ml$.

Method 02

A few drops of phenolphthalein is added to part B and $CO_2\ (g)$ is bubbled through the solution until the obtained red colour turns colourless. After that at this solution is titrated with $1.0\ mol\ dm^{-3}$ HCl at the presence of methyl orange. The acid volume consumed at the endpoint is $15.0\ ml$.

(i) Write the balanced equations for the reactions taken place in the first titration.

.....

.....

(ii) Write the balanced equations for the reaction taken place, when $CO_2\ (g)$is bubbled through the solution B in the **method 02**.

.....

.....

.....

(iii) Write the balanced equation for the reaction taken place in the second titration?

.....

.....

.....

(iv) If the number of moles of $NaOH$ in the initial mixture is x and the number of moles of Na_2CO_3 in it is y. Calculate the values of x and y.

.....

.....

.....

.....

(04) (a) Write the structures of the major organic products formed by adding of the following reagents to an aqueous solution containing phenol and aniline.

i. $Br_2(l)$

Product formed by Phenol

Product formed by aniline

ii . CH_3COCl

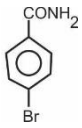
Product formed by Phenol

Product formed by aniline

iii. Nmae the reactions carried out in (i) and (ii) above considering the type of the mechanism.

(i) ..... (ii) .....

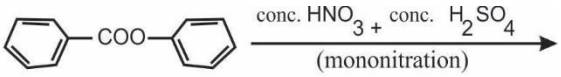
iv. Write the mechanism for the reaction between phenol and CH_3COCl.

(b) Show how would you synthesis the organic compound 

using 

as the starting material in not more than seven steps.

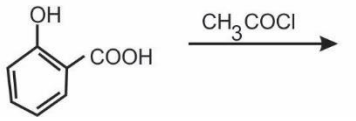
(c) i Write the structures of the major organic products obtained in the following reactions.

1. 

2. $C_6H_5 - CH = CH - CH_3 \xrightarrow{HBr}$

3. $C_6H_5\,COOH \xrightarrow{CH_3MgBr}$

4. $C_6H_5\,CONH_2 \xrightarrow{P_2O_5\,/\Delta}$

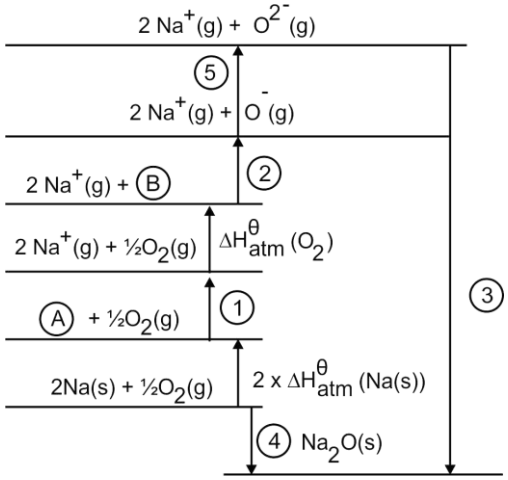
5. 

Second Term Test – 2019

Chemisty 13 – II - PART B

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

((05) (a) (i) The following Born-Harbor cycle of Na_2O can be used to calculate the lattice enthalpy of Na_2O.



1. Write the relevant balanced chemical equation to represent the standard lattice enthalpy of Na_2O .
2. Identify the species A and B by giving the physical states of them.
3. Introduce the enthalpy changes mentioned as (1) - (5).

(ii) Using the Born-Habour cycle mentioned and the following data calculate the lattice enthalpy of Na_2O .
The enthalpy of atomization of $Na(s)$ $= +107\ kJmol^{-1}$
The enthalpy of first electron affinity of Oxygen $= +141\ kJmol^{-1}$
The enthalpy of second electron affinity of oxygen $= +798\ kJmol^{-1}$
The enthalpy of formation of $Na_2O\ (s)$ $= -414\ kJmol^{-1}$
The enthalpy of first ionization energy of Na $= +494\ kJmol^{-1}$
The enthalpy of bond dissociation of O_2 $= +496\ kJmol^{-1}$

(iii) How to compare the lattice enthalpy of $MgO(s)$ relative to the lattice enthalpy of $Na_2O\ (s)$ by giving reasons.

(b) Under certain conditions, partial pressures in equilibrium of N_2 , O_2 and NH_3 are,
$N_{2(g)}$ 44.8 atm , $H_{2(g)}$ 105.6 atm , $NH_{3(g)}$ 37.2 atm

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(i) Write an expression for K_p in the production of NH_3 in the Haber process.
(ii) Using above data calculate the value of K_p with the units.

(c) At a certain temperature the equilibrium constant K_c for the following reaction is 16

$SO_{2(g)} + NO_{2(g)} \rightleftharpoons SO_{3(g)} + NO_{(g)}$

One mole of each of all the above gases are placed inside a closed vessel of $1\ dm^3$ Calculate the equilibrium concentrations in $mol\ dm^{-3}$ of $NO_{(g)}$ and $NO_{2(g)}$ at the equilibrium.

(06) (a) The marble and limestone monuments situated in the places such as Taj Mahal in India are undergoing corrosion due to the acid rain. The carbonate of these monuments is converted to the relatively more soluble sulphate by the acid rain. The relevant reaction is given below.

$CaCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow CaSO_{4(s)} + H_2O_{(l)} + CO_{2(g)}$

(i) Write an expression for the solubility product Ksp of $CaSO_4$. Give the units of K_{sp}.

(ii) At the temperature of occurring the above reaction the value of K_{sp} is 3×10^{-5}. Calculate the concentration of SO_4^{2-} ions in the saturated $CaSO_4$ solution, using the above expression.

(iii) At the above temperature when $100 dm^3$ of the acid rain is fallen on a small monument, calculate the mass loss that occurred. Assume that the monument is made up of pure $CaCO_3$ and the acid rain is saturated with $CaSO_4$ due to the corrosion.
$(Ca - 40,\ S - 32,\ O - 16)$

(b) These monuments are treated with a mixture of urea and $Ba(OH)_2$ to extend the life time. When the mixture is seeping through the small holes of the carbonate stone, urea dissociate in to NH_3 and CO_2. This CO_2 reacts with , $Ba(OH)_2$ to form $BaCO_3$.
The reaction occurred are given below.

$(NH_2)_2CO(aq) + H_2O\ (l) \longrightarrow 2NH_3(g) + CO_2(g)$

$Ba(OH)_2(aq) + CO_2(g) \longrightarrow BaCO_3(s) + H_2O\ (l)$

Then this $BaCO_{3(s)}$ is converted to its sulphate by the acid rain.

$BaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + H_2O_{(l)} + CO_{2(g)}$

The solubility of $CaSO_4$ is too small relative $BaSO_4$. At that temperature in a saturated solution of pure $BaSO_4$,

$[Ba^{2+}] = 9 \times 10^{-6}\ mol\ dm^{-3}$

(i) The solubility of $BaSO_4$ is too smaller than $CaSO_4$

(ii) Write the expression for the K_{sp} of $BaSO_4$. Calculate the value of it. Using above data. Mention the units.

(c) (i) Methonic acid $(HCOOH)$ is a weak acid with $K_a = 1.77 \times 10^{-4} mol\ dm^{-3}$

1. Write an expression for K_a of HCOOH.
2. Calculate $[H^+(aq)]$ of $0.05 mol\ dm^{-3}$ $HCOOH$ solution using the above expression.
3. Calculate the percentage of ionized molecule of $HCOOH$ in the solution.
4. Calculate the pH of the solution.

(ii) Both $HCOOH$ and HCl acid reacts with Mg metal powder.

1. Write the balanced chemical equation for the reaction between $HCOOH$ and Mg reacted.
2. $20\ cm^3$ volumes of $0.05\ mol\ dm^{-3}$ of these two acid solutions are taken and reacted with excess Mg powder. Then the equal volumes of $H_2(g)$ are liberated. But relative to HCl acid, the reaction rate of $HCOOH$ is very low. Calculate the volume of liberated $H_2(g)$.
   (At STP, $V_m = 22.4\ dm^3\ mol^{-1}$)
3. The reaction rate of $HCOOH$ is too low relative to HCl acid. Explain the reasons.
4. Explain the reason for the liberation of the same gas volume as HCl by $HCOOH$, at the end of the reaction.

(07) (a) A low quality sample of an alloy which is used in welding's is analyzed for Pb. A mass of $0.759g$ of that sample is dissolved is an acid to from a solution of Pb^{2+}. An excess K_2CrO_4 solution is added to the above solution to precipitate all Pb^{2+} present in it. After that the precipitate is filtered and washed. Then the precipitate is again dissolved in an acid and treated it with excess KI. The liberated I_2 during the reaction of CrO_4^{2-} with KI is titrated with $0.051 mol\ dm^{-3}$ $Na_2S_2O_3$ solution. The consumed volume of $Na_2S_2O_3$ solution for the titration is $11.22\ cm^3$. ($Pb = 207\ g\ mol^{-1}$)

(i) Write the balanced chemical equations for all the reactions above.
(ii) Calculate the mass percentage of Pb in this alloy.

(b) (i) Explain that "what is referred as standard hydrogen electrode"
(ii) The standard hydrogen electrode is connected to the standard Zn electrode through a salt bridge, to from an electro chemical cell. The following questions are based on the formed cell.

1. Mention the anode and the cathode.
2. When the two terminals are not connected write the balanced chemical equations for the reactions.
3. Write the balanced chemical equation for the cell reaction when a current flows through the cell.
4. Write the standard cell notation for the above cell.
5. If E^θ value of the standard Zn electrode is $Zn\ -0.76\ v$. Calculate the electromotive force of the above cell.
6. Mention a method that can be used to increase the e.m.f. of the above electric cell.

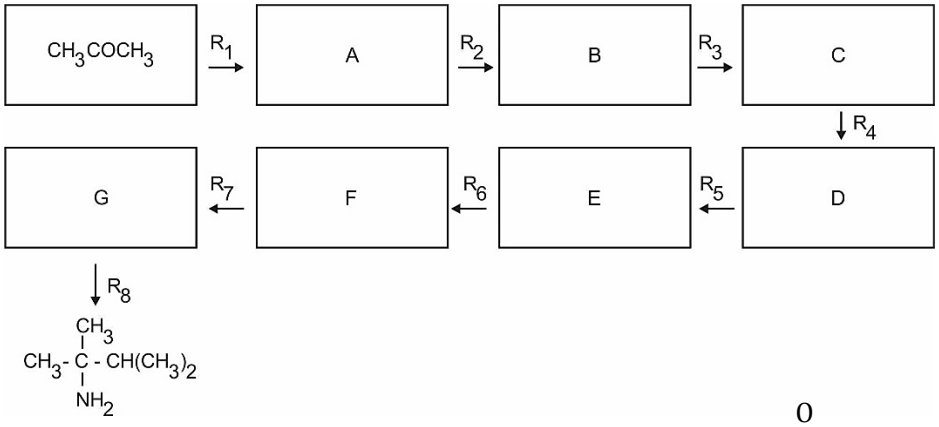
(c) At 27^0C an ideal solution, formed by mixing $A(l)$ and $B(l)$ is in equilibrium with its vapour. At that temperature the standard vapour pressure of A is $4 \times 10^5 Pa$ and the satarated vapour pressure of B is $2.5 \times 10^5 Pa$. The total pressure of the gas phase in $3 \times 10^5 Pa$.

(i) Explain the ideal behaviour of the above solution considering the intermolecular interactions.
(ii) Calculate the composition of A and B in the liquid phase in equilibrium. Mention the used assumptions.
(iii) Calculate the composition of the vapour phase in equilibrium.
(iv) draw the phase diagram of the variation of the temperature and the composition at the constant pressure, relevant to the above ideal solution.
(v) Mention the method that is used to separate a mixture A and B.

Part - C ESSAY

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

(08) (a) Mention the structures of the compounds A to G and the reagents R_1 to R_8 given n the following conversion.



(b) Show how would you synthesis the organic compound $CH_3CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ using C_2H_4 using as the starting matrial, in not more than six steps.

(c) How to distinguish the following compounds.

(i) C_2H_5OH and $CH_3CH_2CH_2OH$ (ii) CH_3NH_2 and CH_3CONH_2

(iii) C_6H_5CHO and $C_6H_5COCH_3$

(09) (a) The compomds A and B are solids and soluble in water. The observations obtained for the experiments carried out to identify the two cations present in those compounds, are given below.

Experiment	Observations
(1) Added a small amount of NaOH to an aqueous solution of A.	A brownish black precipitate is obtained and it is soluble in NH_4OH
(2) Added diluted HCl to a portion of an aqueous solution A	A white precipitate which is insoluble in hot water and soluble in dil. NH_4OH
(3) added a small amount of NaOH to an aq. solution of B	A white precipitate which is soluble in excess NaOH
(4) Added a small amount of NH_4OH to an aqueous solution of B	A white precipitate which is insoluble in excess NH_4OH
(5) Added dil HCl to an aq. solution of B and passed $H_2S(g)$.	No observation.
(6) Boiled the solution obtained in above (5) and added NH_4Cl and NH_4OH.	A gelatinous white precipitate is obtained.

(i) Identify the cations present in A and B.

(ii) Write the chemical formulae of the precipitates obtained in 1 and 3 above.

(b) Write the answers considering the elements P, S and Cl.

(i) Mention the naturally existing molecular type in each of the above elements.

(ii) Arrange the above elements in the order of increasing their melting points.

(iii) Mention the reason for the answer in above (ii).

(iv) Write the chemical formulae of the hydrides formed by the above their elements. Mention their chemical properties in front of them as, weak acidic / weak basic / strong acidic / strong bases.

(v) Write the balanced chemical equations for the reactions of Sulphur with the followings.

1. NaOH (aq) 2. hot concentrated H_2SO_4 (g)

(vi) Write the balanced chemical equations for the reactions of chlorine with the followings.

1. hot concentrated KOH 2. excess NH_3 (g)

(c) (i) Mention the order of decreasing water solubilities of the group II elements. Explain the reasons for that.

(ii) Mention the order of increasing melting points of LiF, LiCl, LiBr, LiI and explain the reasons.

(10) (a) Community of the area complained to the central environmental authority that the waste water drained out from an industry of manufacturing H_2SO_4 is polluted with the acid. To test that waste water $50 cm^3$ of it measured and diluted up to $500\ cm^3$ by adding distilled water. To react with all H^+ present in $25\ cm^3$ of the above prepared solution, 0.2 g of excess KIO_3 and KI was added. To react completely with the formed iodine $20\ cm^3$ of $0.1\ mol\ dm^{-3}$ $Na_2S_2O_3$ solution was required.

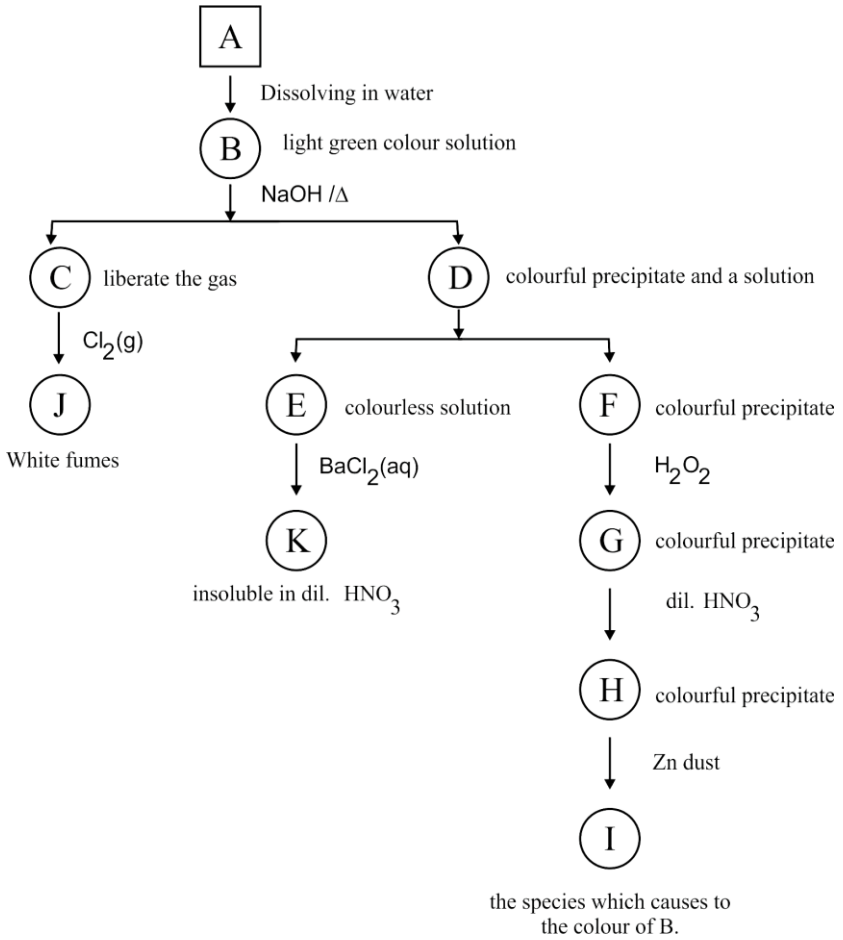
(i) Write the balanced chemical equations for the reactions taken place.

(ii) Calculate the concentration of H^+ present in the waste water.

(b) Mention the chemical formulae of the complex ions formed by the given cations below with the relevant ligand and mention the colours of those complex ions.

cation	ligand	complex ion	colour
(1) Cr^{3+}	Cl^-		
(2) Fe^{3+}	H_2O		
(3) Co^{3+}	NH_3		
(4) Co^{2+}	Cl^-		
(5) Cu^{2+}	NH_3		

(c) A is an inorganic mix salt, of two compounds (a dualsalt) having a single anion and two cations. The tests carried out to identify the anion and two cation and their observations are given below.



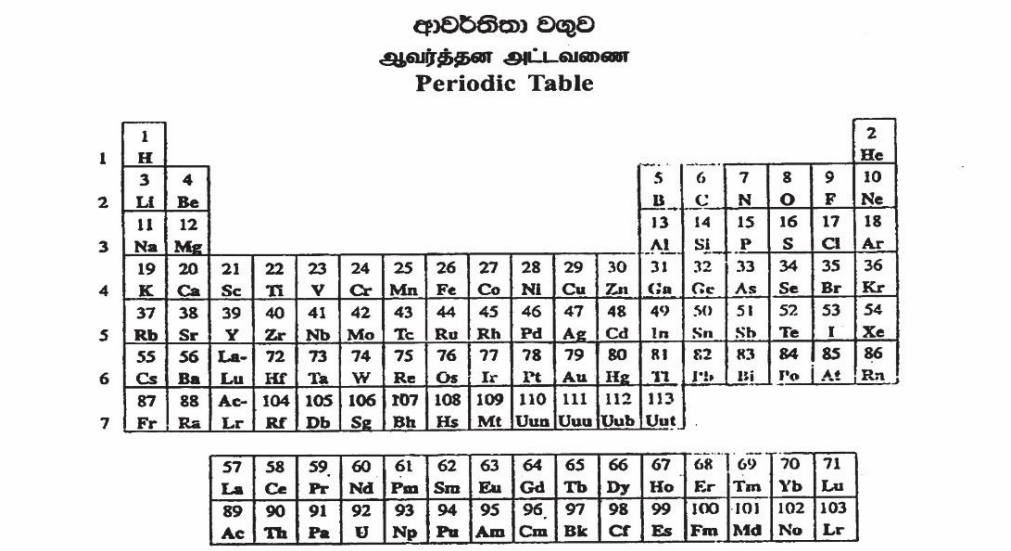
(i) Identify the two cations and the anion contain in A Write the chemical formula.

(ii) Write the chemical formulae of the species C, J and K

(iii) Write the formulae of coordinated complexes which cause to the colour of B and H

(iv) Write the chemical formulae of the precipitates of F and G.

(v) Write the balanced chemical equations for,
the reactions between B and NaOH
the reactions between H and Zn dust.



1	1 H																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	113 Uut					

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Second Term Test Grade 13 - 2019
Chemistry (English) Answers
Part I

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

Part II
Structured Essay - Part II

(01) (a) I

	NO_2	NO_2F	NH_2OH	N_2O	NH_4^+
Oxidation number	+4	+5	−1	+2	−3
Hybridization	sp^2	sp^2	sp^3	sp	sp^3

10 × 1 marks = (10)

II $: N \equiv \overset{+}{N} - \ddot{O}:^-$ (10 marks)

II $:\ddot{\underset{\cdot\cdot}{N}}^- = \overset{+}{N} = \ddot{O}: \longleftrightarrow :\ddot{\underset{\cdot\cdot}{N}}^{2-} - \overset{+}{N} \equiv \ddot{O}:^+$ (marks 5 × 2 = 10)

* not stable.

* (−) charge is on the less electronegative atom. (02 marks)

* not stable.

* charge distribution is high.

* (+) charge is on the oxygen atom (03 marks)

(b) i. potassium hydrogen difluoride (10 marks)

ii. cation K^+

anion HF_2^- (02 × 2 marks)

III. $F^- \cdots H^{\delta+} - F^{\delta-}$ (05 marks)

bond types * hydrogen bonds.

* polar covalent bonds. (02 × 2 marks = 4)

iv. 1. H_2S * dipole - dipole interactions.
* dispersion forces. (02×2 marks = 04)

CS_2 - dispersion forces. (02 marks)

2. CS_2 (05 marks)

3. CS_2. (05 marks)

4. $2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2$

$CS_2 + 3O_2 \longrightarrow CO_2 + 2SO_2$ (05×2 = 10 marks)

(c). i. True. iii. True. v. True.
ii. False iv. False. vi. False.
vii.
(02×8 = 16 marks)

(Q2) (a) i. M = Mg. (10 marks)

ii. $Q_1 = MgO$ $Q_2 = Mg_3N_2$. (10 marks)

iii. 1. $Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$

2. $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$
(10 marks)

Pr. Mass of Q_2 in 1.0 g $= \frac{30.3}{100} \times 1 = 0.303\,g$ ✓

number of moles of Q_2 $= \frac{0.303}{100} = 0.003\,mol$ ✓

$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$

1 : 2 ✓

number of moles of NH_3 liberated $= 0.006\,mol$.

$NH_3 + HCl \longrightarrow NH_4Cl$ ✓

∴ number of moles of HCl reacted $= 0.006\,mol$ ✓

volume of HCl $= \frac{1000\,cm^3 \times 0.006\,mol}{0.5\,mol}$ ✓

$= 12.12\,cm^3$ ✓

(01×8 = 8 marks)

(b). i. $Y = Na_2S_2O_3$ (10 marks)

ii. $2Na_2S_2O_3 + I_2 \longrightarrow 2NaI + Na_2S_4O_6$

$Na_2S_2O_3 + 2HCl \longrightarrow 2NaCl + SO_2 + H_2O + S$

$Na_2S_2O_3 + 2AgNO_3 \longrightarrow Ag_2S_2O_3 + 2NaNO_3$

$Ag_2S_2O_3 + H_2O \longrightarrow Ag_2S + H_2SO_4$

(5 × 4 = 20 marks)

iii. $X \xrightarrow{\Delta} Y + H_2O$

9.48 − 0.9 ✓ 1.58 ✓ 0.9

number of moles $\frac{1.58}{158}$ ✓ $\frac{0.9}{18}$ ✓ to 5

1 ✓ : 5 ✓

$\therefore X = Na_2S_2O_3 \cdot 5H_2O$ ✓ 3

(2 × 6 = 12 marks)

(c) i. $NaNH_2 + NH_4Cl \longrightarrow 2NH_3 + NaCl$

ii. $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$

iii. $8Al + 5OH^- + 3NO_3^- \longrightarrow 8AlO_2^- + 3NH_3$

iv. $2FeCl_3 + H_2S \longrightarrow 2FeCl_2 + 2HCl + S$

(4 × 5 = 20 marks)

(03). (a) i. $pK_b = -\log K_b$ ✓

ii. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_{4(aq)}^+ + OH^-_{(aq)}$ ✓

iii. $K_b = \frac{[NH_4^+{}_{(aq)}][OH^-_{(aq)}]}{[NH_{3(aq)}]}$ ✓

$K_a = \frac{[NH_{3(aq)}][H_3O^+_{(aq)}]}{[NH_4^+{}_{(aq)}]}$ ✓

iv. $K_a \times K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} \times \frac{[NH_3][H_3O^+]}{[NH_4^+]}$ ✓

$= [OH^-][H_3O^+]$

$[H_3O^+][OH^-] = K_w$ ✓

$\therefore K_a \cdot K_b = K_w$ ✓

vi. $K_a = \frac{K_w}{K_b}$ ✓

$-\log_{10} K_a = -\log_{10} \frac{K_w}{K_b}$ ✓ (11 × 5 = 55 marks)

$pK_a = -\log_{10} K_w - \log_{10} K_b = 14 - 4.8 = 9.2$ ✓

03. (b)

i. $NaOH + HCl \longrightarrow NaCl + H_2O$ ✓

$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$ ✓

ii. $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$ ✓

$Na_2CO_3 + CO_2 + H_2O \longrightarrow Na_2CO_3 + H_2O$ ✓

iii. $NaHCO_3 + HCl \longrightarrow NaCl + H_2CO_3$ ✓

iv. In the initial mixture, if there are x moles of NaOH and y mol of Na_2CO_3

$x + y = \frac{1 \times 10}{1000}$ — ① ✓

$x + 2y = \frac{1 \times 15}{1000}$ — ② ✓

② − ① ⇒ $y = 0.015 - 0.01 = 0.005$ mol ✓

$x = 0.01 - 0.005 = 0.005$ mol ✓

(9 × 5 = 45 marks)

(ii) $C_6H_5-O-C(=O)-CH_3$ (6)

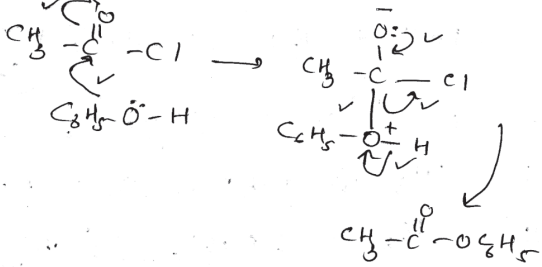
$C_6H_5-N(H)-C(=O)-CH_3$ (5)

iii. 1. Electrophilic substitution

Nucleophilic substitution

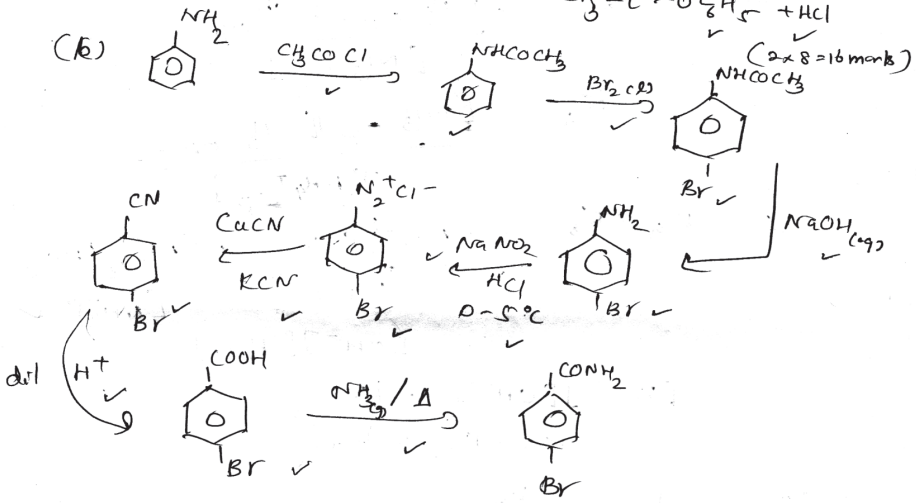
(4 × 2 = 8 marks)

iv:

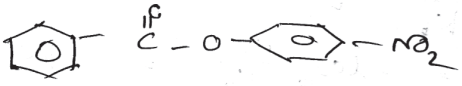


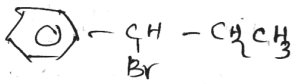
(2 × 8 = 16 marks)

(b)



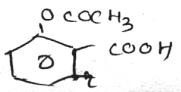
(14 × 2 = 28 marks)

(c) i. 

ii 

iii. $C_6H_5COOMgBr$

iv. C_6H_5CN

v. 

(05 × 5 = 25 marks)

(05) (a).

(i) 1. $2Na^+_{(g)} + O^{2-}_{(g)} \longrightarrow Na_2O_{(s)}$ (10)

ii 2. A = $Na_{(g)}$ (05)

B = $O_{(g)}$ (05)

3. (1) - The first ionisation enthalpy of Na (05)

(2) - The addition of first and second Standard enthalpies of electron affinities of oxygen. (05)

(3) - The standard lattice enthalpy of $Na_2O_{(s)}$ (05)

(4) - The standard enthalpy of formation of $Na_2O_{(s)}$ (05)

(If only the symbols of the enthalpies mentioned, give (2 marks only)

(ii) $\Delta H^\ominus_{f\,(Na_2O_{(s)})} = 2 \times \Delta H^\ominus_{atm\,Na_{(s)}} + 2 \times \Delta H^\ominus_{I_1\,Na_{(s)}}$

$+ \Delta H^\ominus_{atm\,O_{(g)}} + (\Delta H^\ominus_{EA_1} + \Delta H^\ominus_{EA_2})_{O_{(g)}}$

$+ \Delta H^\ominus_{L\,(Na_2O_{(s)})}$

$-414\ kjmol^{-1} = (2 \times 107\ kjmol^{-1}) + (2 \times 494\ kjmol^{-1}) + \left(\frac{1}{2} \times 496\ kjmol^{-1}\right) + (-141 + 798\ kjmol^{-1})$ (10)

$+ \Delta H^\ominus_{L\,(Na_2O_{(s)})}$

$\Delta H^\ominus_{L\,(Na_2O_{(s)})} = -2521\ kjmol^{-1}$ (10)

(iii) The lattice enthalpy of MgO is a ~~smaller~~ lower than the lattice enthalpy of Na_2O. (more negative) (10)

Reason :- Mg^{2+} is ~~double~~ double charged relative to Na^+ and the charge density of Mg^{2+} is high and its radius is small (10)

a → 90

(b) (i) $K_p = \dfrac{P^2_{NH_3(g)}}{P_{N_2(g)} * P^3_{H_2(g)}}$ (10)

(ii) $K_p = \dfrac{(37.2)^2 \text{ atm}^2}{44.8 \times (105.6)^3 \text{ atm}^4}$ (10)

$= 2.62 \times 10^{-5} \text{ atm}^2$ (10)

b → 30

(c)

	$SO_{2(g)}$	+ $NO_{2(g)}$	⇌ $SO_{3(g)}$	+ $NO_{(g)}$
initial moles	1	1	1	1
equilibrium moles	1−x	1−x	1+x	1+x (5)

$K_c = \dfrac{[SO_{3(g)}][NO_{(g)}]}{[SO_{2(g)}][NO_{2(g)}]} = \dfrac{\{(1\text{mol}+x)/1\text{dm}^3\}^2}{\{(1\text{mol}-x)/1\text{dm}^3\}^2} = 16$ (10)

$\dfrac{1\text{mol}+x}{1\text{mol}-x} = 4$

$x = \frac{3}{5} = 0.6 \text{ mol}$

$[NO_{2(g)}] = 0.4 \text{ mol dm}^{-3}$ (05)

$[NO_{(g)}] = 1.6 \text{ mol dm}^{-3}$ (05)

e → 30

Q5 → 150

(6) (a)(i) $CaSO_{4(s)} \rightleftharpoons Ca^{2+}_{(aq)} + SO_4^{2-}_{(aq)}$ (05)

$K_{sp} = [Ca^{2+}_{(aq)}][SO_4^{2-}_{(aq)}] \text{ mol}^2\text{dm}^{-6}$ (05)

(ii) $[CaSO_4] = \sqrt{K_{sp}} = \sqrt{3\times10^{-5}\text{mol}^2\text{dm}^{-6}}$ (05)

$= 5.5 \times 10^{-3} \text{ mol dm}^{-3}$ (05)

(iii) The amount of $CaSO_4$ in $100\text{dm}^3 = 5.5\times10^{-3}\times100$

$= 0.55\text{mol}$ (05)

dissolved amount of $CaCO_3$ = amount of $CaSO_4$ in the solution.

molar mass of $CaCO_3$ = 100 g mol⁻¹

mass loss ($CaCO_3$) = $0.55 \times 100 = 55\text{g}$ (5)

a → 30

(b) (i) When the ionic solids are dissolved in water, to the difference between lattice enthalpy and solution enthalpy, relevent energy should be absorbed. ✓

* When going down the group, the solution enthalpy takes a very low (-) value relative to $CaSO_4$
* Since the cationic radius is large ✓
Therefore the solution enthalpy of $BaSO_4$ takes a more (+) ✓ value than the solution enthalpy of $CaSO_4$.
∴ The solubility of $BaSO_4$ is too low ✓ relative to $CaSO_4$. (.05×6 = 30 marks)

(ii) $K_{sp} = [Ba^{2+}_{(aq)}][SO_4^{2-}{}_{(aq)}]$ (.05)

$= (9 \times 10^{-6}\ mol\,dm^{-3})^2$

$= 8.1 \times 10^{-11}\ mol^2\,dm^{-6}$ (.05)

(c) i. $K_a = \dfrac{[HCOO^-_{(aq)}][H^+_{(aq)}]}{[HCOOH_{(aq)}]}$ $mol\,dm^{-3}$ (.05)

b → 40 (10)

2) $[H^+_{(aq)}] = [HCOO^-_{(aq)}]$ (.05)

$K_a = \dfrac{[H^+_{(aq)}]^2}{[HCOOH_{(aq)}]}$ (.05)

$[H^+_{(aq)}] = \sqrt{K_a \times [HCOOH_{(aq)}]}$ (.05)

Since the dissociation of the acid is too small, it is considered that the equilibrium concentration of the acid is equal to the initial concentration. (.05)

$= \sqrt{1.77 \times 10^{-4} \times 0.05}$

$= 2.97 \times 10^{-3}$ $(\simeq 3 \times 10^{-3})\ mol\,dm^{-3}$ (.05)

(3) $\dfrac{[H^+_{(aq)}]}{[HCOOH_{(aq)}]} \times 100 = \dfrac{2.97 \times 10^{-3} \times 100}{0.05}$

$= 5.94\ \%$ $(\simeq 6\%)$ (.05)

(4) $pH = -\log_{10}[H^+_{(aq)}]$ (05)

$= -\log_{10}(2.97 \times 10^{-3})$

$= 2.52$ (05)

(11) i) $HCOOH_{(aq)} + Mg_{(s)} \longrightarrow (HCOO)_2Mg_{(s)} + H_{2(g)}$

OR $2H^+_{(aq)} + Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + H_{2(g)}$ (05)

2) $H^+_{(aq)}$ amount $= 0.05\ mol\ dm^{-3} \times \frac{20}{10^3}\ dm^3$

$= 1 \times 10^{-3}$ mol (05)

amount of $H_{2(g)}$ $= \frac{1}{2} \times 1 \times 10^{-3}$ mol

$= 0.5 \times 10^{-3}$ mol (05)

Volume of $H_{2(g)}$ $= 0.5 \times 10^{-3} \times 22400$

$= 11.2\ cm^3$ (05)

(3) Rate $\propto [H^+_{(aq)}]$

$HCOOH_{(aq)}$ acid partially decomposes slowly. (05)

(4) The same amount of $H^+_{(aq)}$ is consumed as HCl, because $H^+_{(aq)}$ is consumed to form $H_{2(g)}$. Reason is, the equal volumes of acids are used.

(05)

C → 80

Q.6) = 150

(07) ca). (i) $2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2e^-$ } This step is not essential.

$2e + I_2 \longrightarrow 2I^-$

$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$ (05) (10)

$6I^- + 16H^+ + 2CrO_4^{2-} \longrightarrow 3I_2 + 2Cr^{3+} + 8H_2O$ (10)

$Pb^{2+} + CrO_4^{2-} \longrightarrow PbCrO_4\ (s)$. (10)

(ii). The amount of $Na_2S_2O_3$ $= 0.051\ mol\,dm^{-3} \times \frac{11.22}{1000}\ dm^3$ (05)

The amount of I_2 $= 0.051 \times \frac{11.22}{1000} \times \frac{1}{2}\ mol$ (05)

CrO_4^{2-} amount $= 0.051 \times \frac{11.22}{1000} \times \frac{1}{2} \times \frac{2}{3}\ mol$ (05) (10)

∴ amount of Pb $= 0.051 \times \frac{11.22}{1000} \times \frac{1}{2} \times \frac{2}{3}\ mol$

The mass of Pb $= 0.051 \times \frac{11.22}{1000} \times \frac{1}{2} \times \frac{2}{3} \times 207\ g\,mol^{-1}$ (05) (10)

The mass percentage of Pb $= 0.051 \times \frac{11.22}{1000} \times \frac{1}{2} \times \frac{2}{3} \times \frac{207}{0.759} \times 100$

$= 5.202\ \%$ (From 5 to 5.5) (05) (10)

(05)

9 → ~~80~~ 55

(07) (b)(i). At 298 K

(06)

(2) i. anode Zn (2) cathode – H electrode (2)

At anode $Zn^{2+}_{(aq)} + 2e \rightleftharpoons Zn_{(s)}$ (5)

at the cathode $2H^+_{(aq)} + 2e \rightleftharpoons H_{2(g)}$ (5)

iii $Zn_{(s)} + 2H^+_{(aq)} \longrightarrow H_{2(g)} + Zn^{2+}_{(aq)}$ (5)

iv. $Zn_{(s)} \mid Zn^{2+}_{(aq,\ 1\ mol\,dm^{-3})} \parallel H^+_{(aq,\ 1\ mol\,dm^{-3})} \mid H_{2(g,\ 1\ atm)} \mid Pt_{(s)}$

v. $E^\ominus = E^\ominus_C - E^\ominus_A$ (10)

$= 0 - (-0.76\ V)$

$= +0.76\ V$

(5)

(vi) *. Addition of water to the solution contains Zn metal

*. Addition of con HCl to the solution contains H^+ (05)

(c) i. In the solution

$f_{(A\cdots A)} = f_{(B\cdots B)} = f_{(A\cdots B)}$ ✓

then the ability to vapourize does not depend on each other. ✓ (10)

(ii) By assuming the Ideal nature of the vapour

$P_T = P_A + P_B$ ✓

$3 \times 10^5\ Pa = 4 \times 10^5 x_B + 2.5 \times 10^5 (1 - x_A)$ ✓

$x_A = \frac{1}{3}$ ✓

Then $x_B = 1 - \frac{1}{3} = \frac{2}{3}$ ✓

(02 × 5 = 10 marks)

(iii) $P_A = P_A^\circ \times x_A$ ✓

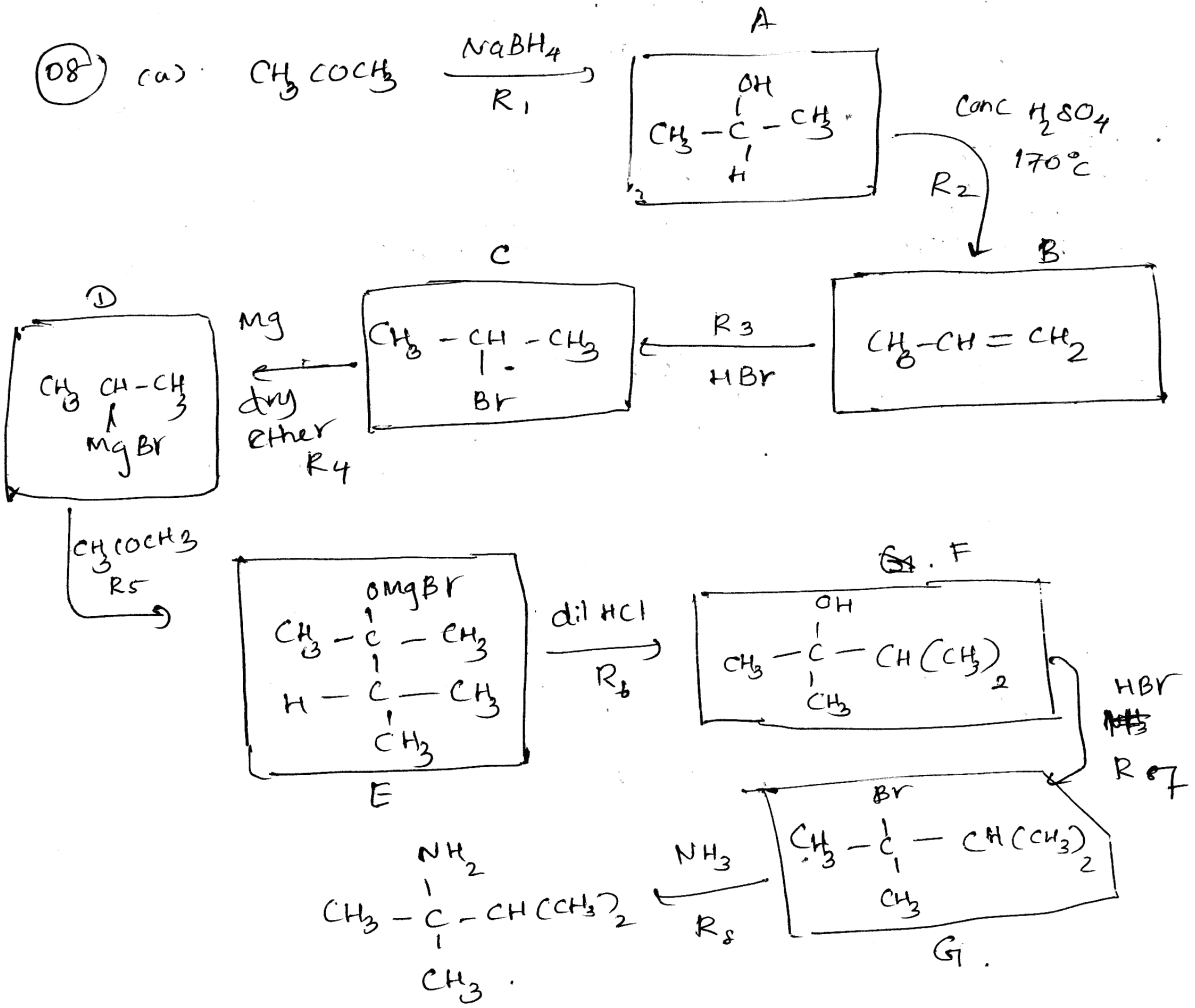
$P_A = 4 \times 10^5 \text{ Pa} \times \frac{1}{3} = \frac{4}{3} \times 10^5 \text{ Pa}$. ✓

$P_A = P_T \times y_A$ ✓

$y_A = \frac{P_A}{P_T}$ ✓ $= \frac{4 \times 10^5}{3 \times 3 \times 10^5} = \frac{4}{9}$ ✓

(2 × 5 = 10)

(08) (a)



A, B, C, D, E, F, G. → (7 × 5 = 35 marks)

$R_1 \rightarrow R_8$ (8 × 3 = 24 marks)

(b). $C_2H_4 \xrightarrow{Br_2(l)} CH_2Br-CH_2Br \xrightarrow{\text{alc. KOH}} C_2H_2$

$C_2H_2 \xrightarrow[\text{controlled conditions}]{Na} H-C\equiv C^-Na^+$

$C_2H_4 \xrightarrow{HBr} CH_3CH_2Br$

$CH_3CH_2Br + H-C\equiv C^-Na^+ \rightarrow CH_3-CH_2-C\equiv C-H$

$CH_3-CH_2-C\equiv C-H \xrightarrow[dil\ H_2SO_4]{Hg^{2+}} CH_3-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

(11 × 5 = 55 marks)

(c) i. $C_2H_5OH \xrightarrow[170^oC]{conc.\ H_2SO_4} C_2H_4 \xrightarrow{dil\ H_2SO_4} C_2H_5OH$

$C_2H_5OH + ZnCl_2 / conc.\ HCl$ ✓

Gives turbidity take about one hour to give the turbidity ✓

OR

$CH_3CH_2CH_2OH \xrightarrow[170^oC]{conc.\ H_2SO_4} CH_3CH=CH_2 \xrightarrow{dil\ H_2SO_4} CH_3-CH(OH)-CH_3$

$CH_3-CH(OH)-CH_3 + ZnCl_2 / conc.\ HCl$ ✓

Turbidity is shown within 5 minutes. ✓

(2 × 9 = 18 marks)

$C_2H_5OH + CH_3CH_2CH_2OH \rightarrow C_2H_4 + CH_3CH=CH_2$

$C_2H_4 \xrightarrow{Br_2(l)} CH_2Br-CH_2Br \xrightarrow{\text{alc. KOH}} C_2H_2$

$C_2H_2 \xrightarrow{Hg^{2+}/dil\ H_2SO_4} CH_3CHO$

$CH_3CHO \xrightarrow{H^+/KMnO_4}$ decolourise

$CH_3CH=CH_2 \xrightarrow{Br_2(l)} CH_3CHBrCH_2Br \xrightarrow{\text{alc. KOH}} CH_3C\equiv CH \xrightarrow{Hg^{2+}/dil\ H_2SO_4} CH_3COCH_3$

ii. CH_3NH_2 ✓ CH_3CONH_2 ✓

$CH_3CONH_2 \xrightarrow{NaOH/\Delta}$ ✓ the liberated gas is tested with Nessler's reagent.

NH_3 gas ✓ filter paper turns brown colour. ✓

(0.3 × 3 = 09 marks)

(d) i.  ✓  ✓

$\xrightarrow{NH_4OH/AgNO_3}$ ✓

Silver mirror ✓ ✗ ✓

(0.3 × 3 = 09 marks)

(13) 09

I. A → Ag^+ B → Al^{3+} (10 marks)

II 1 → Ag_2O 3 → $Al(OH)_3$ (10 marks)

(b). I Phosphorous – P_4 Sulphur S_8 Chlorine Cl_2 (03×3 = 09 marks)

II Melting Point $Cl_2 < P_4 < S_8$ (09 marks)

III The number of electrons present within the molecule is increasing as $Cl_2 < P_4 < S_8$ ✓
Then the ability of forming London forces among the non polar molecules is increasing as $Cl_2 < P_4 < S_8$.
∴ The melting point is increasing as above.

(6×2 = 12 marks)

IV. P → PH_3 weak basic ✓
S → H_2S ✓ weak acidic ✓
Cl → HCl ✓ Strong acid ✓ (06×3 = 18 marks)

V. $6NaOH + 4S \longrightarrow 2Na_2S + Na_2S_2O_3 + 3H_2O$

$2H_2SO_4 + S \rightarrow 3SO_2 + 2H_2O$. (20 marks)

VI. $6KOH + 3Cl_2 \longrightarrow 5KCl + KClO_3 + 3H_2O$

$8NH_3 + 3Cl_2 \longrightarrow N_2 + 6NH_4Cl$ (20 marks)

(c). The order of decreasing the solubility = $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$ (10 marks)

* Down the group, cationic radius is increasing ✓
* The anion is the same ✓ lattice energy is decreasing.
* Down the group, when the cationic radius is increasing, hydration energy is decreasing. ✓
* When going down the group, the hydration energy of ion decreases in a higher amount ✓ than decreasing of lattice energy.
* Down the group, the solution enthalpy of ✓ the sulphates is ~~are~~ (+) ve. (0.2×6 = 12 marks)

II. Melting point LiI < LiBr < LiCl < LiF (10 marks)

* Cation is the same, ✓
* the charge of the anion is the same, ✓
* radius $F^- < Cl^- < Br^- < I^-$ ✓
* Polarizability $F^- < Cl^- < Br^- < I^-$
* Ionic property of the halide. LiI < LiBr < LiCl < LiF ✓
  ∴ melting point is increasing

(5×2 = 10 marks)

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

(10) $I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

(10 × 2 = 20 marks)

ii. $n_{Na_2S_2O_3} = \frac{0.1 \times 20}{1000} = 2 \times 10^{-3}$ mol ✓

$n_{I_2} = 1 \times 10^{-3}$ mol ✓

$n_{H^+} = 2 \times 10^{-3}$ mol ✓

n_{H^+} present in $500 cm^3 = \frac{2 \times 10^{-3} \times 500}{25} = 0.04$ mol ✓

n_{H^+} of $50 cm^3 = 0.04$ mol ✓

$[H^+]$ in waste water $= \frac{0.04 \times 10^3}{50}$ ✓

$= 0.8$ mol dm^{-3} ✓

(05 × 7 = 35 marks)

(b) i. $[CrCl_4]^-$ - blue violet.

ii. $[Fe(H_2O)_6]^{3+}$ → light yellow.

iii $[Co(NH_3)_6]^{3+}$ - dark brown.

iv. $[CoCl_4]^{2-}$ - blue.

v. $[Cu(NH_3)_4]^{2+}$ - blue.

(10 × 5 = 50 marks)

(c). i. Fe^{2+}, NH_4^+, SO_4^{2-} (03 × 3 = 9 marks)

ii. C → NH_3, J → NH_4Cl, K = $BaSO_4$ (03 × 3 = 9)

iii. $[Fe(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{3+}$ (03 × 2 = 06)

iv. F → $Fe(OH)_2$ G = $Fe(OH)_3$ (03 × 2 = 6)

v. $(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 + H_2O$ (5)

$2[Fe(H_2O)_6]^{3+} + Zn \longrightarrow 2[Fe(H_2O)_6]^{2+} + Zn^{2+}$

(10)