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Sabaragamuwa Provincial Department of Education

තෙවැනි වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2025

3rd Term Test – Grade 13 – 2025

Chemistry - I	**02**	**E**	**I**	Time : 02 Hours

Instructions:

- Answer all the questions.
- This paper consists of 11 pages.
- Periodic Table is provided.
- Use of calculators is not allowed.
- In each of the questions 1 to 50 pick one the alternatives from (1), (2), (3), (4), (5) which is correct of most appropriate and mark your response on the anser 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	$h = 6.626 \times 10^{-34}\ J\ s$
Velocity of light	$c = 3 \times 10^{8}\ ms^{-1}$
Faraday's constant	$F = 96\ 500\ C\ mol^{-1}$

01. Which of the following statement is incorrect with regard to quantum numbers in an atom.

1. Only the quantum numbers *n, l, ml* are used to describe an orbital.

2. As 'n' increases, the orbital becomes larger and the electron spends more time further from the nucleus.

3. The azimuthal quantum number indicates the shapes and size of the orbital.

4. The total number of orbiral in a shell is n^2, where 'n' is the principal quantum number of the shell.

5. Magnetic quantum number indicates the spatial orientation of the orbital.

02. A pair of elements that includes both an alkaline earth metal and an inner transition metals are,

(a) *Tl, Cl* **(b)** *Te, Po* **(c)** *Se, Pr*

1. Only a and b **2.** Only b and c **3.** All a, b,c

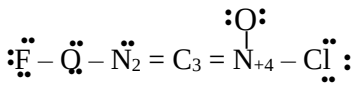
4. Only a **5.** Only c

03. According to the Hund's rule, the set of quantum numbers for an electron in a specially configured electron arrangement of a d-block element is,

1. $(4, 0, 0, -\frac{1}{2})$ **2.** $(3, 0, 0, +\frac{1}{2})$ **3.** $(5, 0, +1, +\frac{1}{2})$

4. $(3, 1, -1, -\frac{1}{2})$ **5.** $(3, 2, -1, -\frac{1}{2})$

04. Consider the following Lewis dot-dash structure and its labelled skeleton.



The correct decending order of eletronegetivity of the labelled atoms is,

1. $C^3 > N^4 > N^2 > O^1 > O^5$ **2.** $O^1 > O^5 > N^2 > N^4 > C^3$ **3.** $O^5 > O^1 > N^2 > N^4 > C^3$

4. $C^3 > N^2 > N^4 > O^5 > O^1$ **5.** $O^1 > O^5 > N^4 > N^2 > C^3$

05. The energy required to remove photoelectron from the surface of Na is 602. 2 kJ mol^{-1}. The wave length of light that can accomplish this process for Ca is,

1. 199 nm **2.** 220 nm **3.** 380 nm **4.** 438 nm **5.** 480 nm

06. At a certain temperature, the value of the equilibrium constant Kc for the following reaction is 5×10^5 mol dm^{-3}

$$MnS_{(s)} + 2H^+_{(aq)} \rightleftharpoons Mn^{+2}_{(aq)} + H_2S_{(aq)}$$

First and second acid dissociation constants (Ka_1 , Ka_2) of H_2S are 1×10^{-7} mol dm^{-3} and 1×10^{-13} mol dm^{-3} respectively. Which is the solubility product (Ksp) of $MnS_{(s)}$

(1) 5×10^{-25} mol^2 dm^{-6} **(2)** 5×10^{-15} mol^2 dm^{-6} **(3)** 2×10^{-16} mol^2 dm^{-6}

(4) 5×10^{-15} mol^2 dm^{-6} **(5)** 2×10^{-16} mol^2 dm^{-6}

07. Consider the following equilibirium,

$$A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} \quad K_1 = 6 \times 10^{-6} \text{ mol}^{-1} \text{ dm}^{-3}$$

$$C_{(g)} + A_{(g)} \rightleftharpoons D_{(g)} \quad K_2 = 6 \times 10^{-4} \text{ mol}^{-1} \text{ dm}^{-3}$$

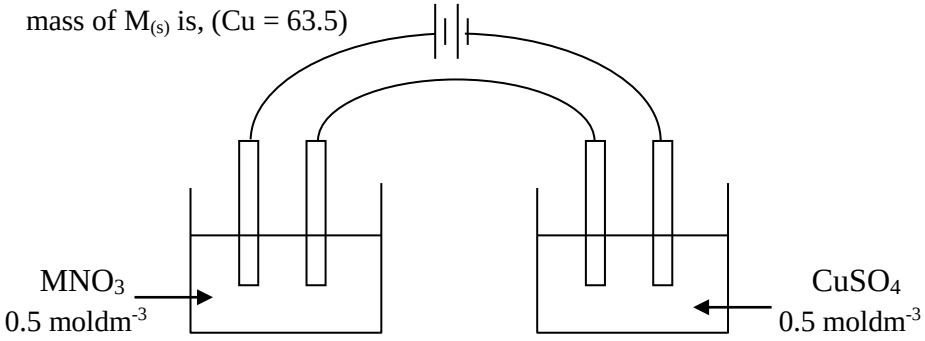
The K_3 for the following reaction is,

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

(1) 6.06×10^{-4} mol^2 dm^{-6} **(2)** 3.6×10^{-9} mol^2 dm^{-6} **(3)** 3.6×10^{-9} mol^{-2} dm^{-6}

(4) 3.6×10^{9} mol^2 dm^{-6} **(5)** 3.6×10^{9} mol^{-2} dm^6

08. Electrolysis was carried out for 772 s using a constant current, based on the given concentratiions in the following diagram. During this time, 0.635 g of Cu and 2.16 g of $M_{(s)}$ were deposited. Relative atomic mass of $M_{(s)}$ is, (Cu = 63.5)

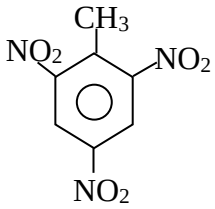


(1) 200
(2) 108
(3) 127
(4) 27
(5) 57

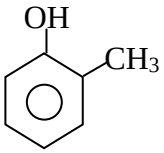
09. Which of the following compound is likely to react with Br_2 water at the slowest rate?

(1) $CH_3 - CH = CH_2$ **(2)** $CH_3 - C \equiv C - H$ **(3)**

(4)



(5)



10. At 25^0C, the solubility product of $Mn(OH)_2$ is 4×10^{-15} $mol^3\ dm^{-9}$ and the base dissociation of NH_4OH (K_b) is 1.6×10^{-5} mol dm^{-3}. Required OH^- concentration is 2×10^{-6} $moldm^{-3}$, to precipitate $Mn(OH)_2$ from Mn^{2+} solution. What is the NH_4OH concentration to do the above precipitation.

(1) 2×10^{-6} $moldm^{-3}$ **(2)** 2.5×10^{-7} $moldm^{-3}$ **(3)** 2.25×10^{-6} $moldm^{-3}$

(4) 1.6×10^{-5} $moldm^{-3}$ **(5)** 3.2×10^{-5} $moldm^{-3}$

11. Which of the following statement is the true regarding the elements in the s, p and d blocks?

(1) H_2O_2 acts as an oxidizing agent only in the acidic medium.

(2) Carbon react with concentrated HNO_3 acid to produce NO_2.

(3) The solubility of alkaline earth metal compounds decreases down the group.

(4) Sc^{3+} aqueous solution is colorless and the percipitates formed maybe coloured.

(5) All the naturally occurring elements in the halogen group react with hot concentrated bases produce the same products.

12. At a certain temperature, the following equilibrium was established in a closed system.

$$H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)} \qquad Kc = 4.00$$

If 2.0 moles of each $H_{2(g)}$ and $CO_{2(g)}$ were initially introduced into the system, the percentage dissociation of $CO_{2(g)}$ would be,

(1) 1.33 **(2)** 0.67 **(3)** 33.25 **(4)** 50.00 **(5)** 66.5

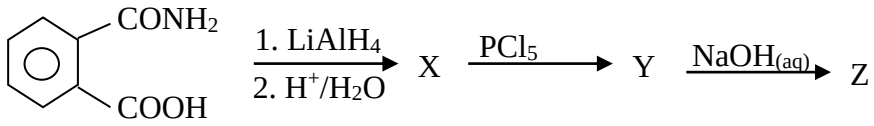
13. The compound that has the least tendency to react with an aqueous NaOH solution among the following compound is,

(1) $CH_3CH_2\,COCl$ **(2)** CH_3Cl **(3)** $CH_3\,CH\,Cl\,CH_3$

(4) $C_6\,H_5\,Cl$ **(5)** $C_6\,H_5\,CH_2\,Cl$

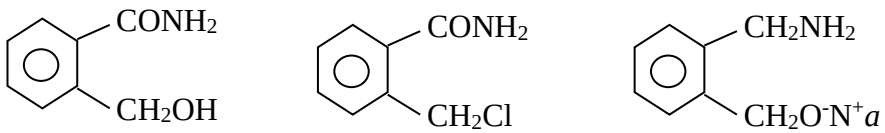
14. Compound P decomposes to form compound $Q_{(s)}$, $R_{(g)}$ and water. When the product formed by the reaction of concentrated HNO_3 with $Q_{(s)}$ is added to $BaCl_{2\,(aq)}$ solution, a white precipitate is formed. Q could be,

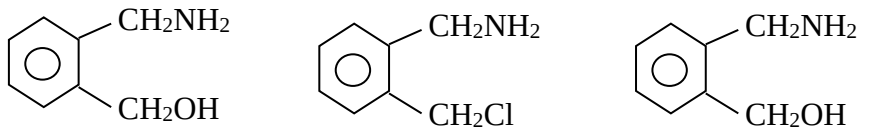
(1) $H_2C_2O_4$ **(2)** $H_2S_2O_3$ **(3)** H_2CO_3 **(4)** H_2S **(5)** H_2COO

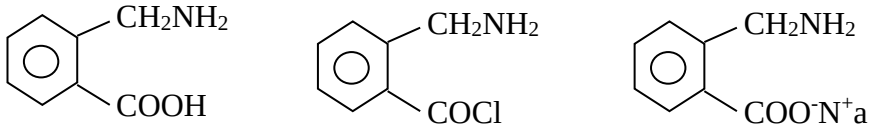
15. 

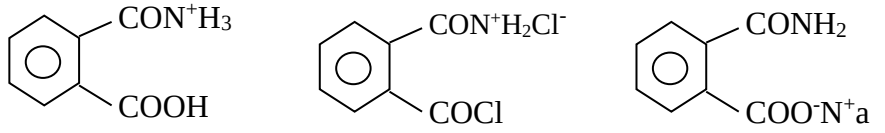
Consider the above reaction sequence.

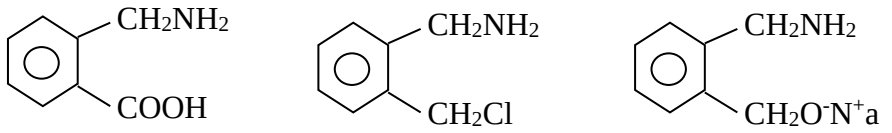
X, Y and Z respectively are,

(1) 

(2) 

(3) 

(4) 

(5) 

16. The elementary reaction $A_{(g)} \rightarrow 2B_{(g)} + C_{(g)}$ occurs in a closed rigid container at constant temperature T. The initial pressure of the container when only 1 mol of $A_{(g)}$ is present, was measured to be P_0. The pressure of the container after 't' time is P. The rate of the reaction after t time is proportional to,

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

17. A buffer solution is prepared by mixing a volume V_1 of 0.2 mol dm^{-3}. HA acid with a volume of V_2 of 0.4 mol dm^{-3} NaOH base. The acid dissociation constant of the weak acid, HA is Ka. If the pH of he buffer solution is to be maintained in pKa – 1, the ratio of the volume of acid to base (HA : NaOH) that should be maintained is,

(1) $\frac{4V_2}{V_1} = 10$ **(2)** $\frac{2V_2}{V_1} = \frac{1}{10}$ **(3)** $\frac{2V_2}{V_1} = 10$

(4) $\frac{2V}{4V_1} = \frac{1}{10}$ **(5)** $\frac{V_2}{10V_1} = 1$

18. ΔH data at temperature, T are provided for the following reactions.

$X_{2(g)} + Y_{2(g)} \rightarrow 2\ XY_{(g)}$ $\quad \Delta H = -x\ KJ\ mol^{-1}$

$2\ XY_{g)} + Y_{2(g)} \rightarrow 2\ XY_{g)}$ $\quad \Delta H = y\ KJ\ mol^{-1}$

Which of the following gives the enthalphy change of formation of $XY_{(g)}$,

(1) $-x - y$ **(2)** $\frac{-x+y}{2}$ **(3)** $-1/2(x+y)$ **(4)** $\frac{y+x}{2}$ **(5)** $\frac{y}{2}+x$

19. Another reaction that corresponds to the enthalphy change of the reaction is $\frac{1}{2}Br_{2(l)} \rightarrow Br_{(g)}$

(1) $\frac{1}{2}Br_{2(g)} \rightarrow Br_{(g)}$ **(2)** $N_{2(g)} \rightarrow 2N_{(g)}$ **(3)** $\frac{1}{2}Hg_{2(l)} \rightarrow Hg_{(g)}$

(4) $\frac{1}{2}Br_{2(l)} \rightarrow Br_{2(g)}$ **(5)** $\frac{1}{2}I_{(g)} \rightarrow I$

20. $A \xrightarrow{P} CH_3CH_2 - CHO \xrightarrow{Q} CH_3CH_2COOH$

Consider the above reaction sequence. The reagent P, Q and the structure of A are respectively,

(1) $H^+/ KMnO_4$, $H^+/ KMnO_4^-$, $(CH_3)_2CHOH$

(2) $LiAlH_4$ then acidify, PCC, $(CH_3)_2$, CHOH

(3) PCC, $H^+/ K_2Cr_2O_7$, $CH_3CH_2CH_2OH$

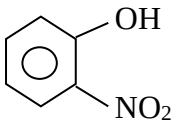
(4) $H^+/ K_2Cr_2O_7$, PCC, $CH_3CH_2CH_2OH$

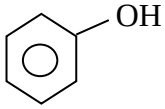
(5) $LiAlH_4$ then acidify, $H^+/ KMnO_4$, $CH_3CH_2CH_2OH$

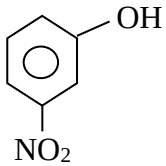
21. A mixture of NO_3^- / NO_2^- ions was oxidized by 50.00 cm^3 of I_2, and the number of moles consumed was 5×10^{-3} mol. The I^- ions were precipitated as AgI, and the filtrate was titrated with 0.25 mol dm^{-3} Fe^{2+} solution. The volume of Fe^{2+} consumed was 100.00 cm^3. The ratio of the initial concentrations of $NO_3^- : NO_2^-$ is,

(1) 1 : 4 **(2)** 3 : 2 **(3)** 2 : 3 **(4)** 4 : 1 **(5)** 1 : 1

22. The correct increasing order of acid strength is,







$CH_3\ CO_2H$

A B C D

(1) D < B < A < C **(2)** D < B < C < A **(3)** A < C < B < D

(4) C < A < B < D **(5)** B < A < C < D

23. The reaction $A_{(g)} + 3B_{(g)} \rightarrow 2C_{(g)}$ is endothermic when calculating the value of ΔG, the value of ΔS must be considered. The requrements for the reaction to be spontaneous is/are,

(1) Temperature should be increased due to Δs positive.

(2) Temperature shloud be decreased due to Δs positive.

(3) Forward reaction can be increased by increasing the pressure.

(4) Accoring to the value of ΔH, increasing the temperature can make the forward reaction more spontaneous.

(5) Temperature should be increased due to ΔS negative.

24. The number of lone pair electrons on the central atom in the $[Cr(CN)_6]^{-4}$ complex ion could be,

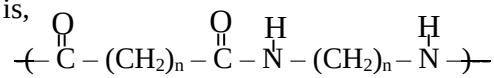
(1) 3 **(2)** 6 **(3)** 5 **(4)** 2 **(5)** 4

25. When metal M is burned in air, it reacts with gas X_2 to form ionic compound Y. Y reacts with water to form a colourless gas Z. When Z is passed through an aqueous $CuSO_4$ solution, a blue solution P is formed. P could be,

(1) $[Cu(H_2O)]^{2+}_{(aq)}$ **(2)** $[Cu(NH_3)]^{2+}_{(aq)}$ **(3)** $CuSO_4 . 2NH_3$

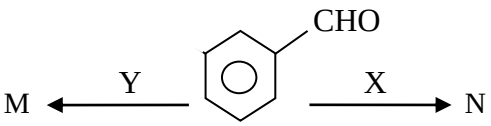
(4) $Cu(OH)_{2(aq)}$ **(5)** $[Cu(NH_3)_4]SO_4$

26. The molar mass of the repeating unit of certain polymer given below is 226 g mol^{-1}. The number of CH_2 groups in one repeating unit is,



(1) 10 **(2)** 6 **(3)** 5 **(4)** 3 **(5)** 4

27.



- N reacts with Na and evolves H_2 gas.
- M - CO_2 gas evolves with the reaction of Na_2CO_3.

The most likely reagent corresponding X and Y respectively are,

(1) $LiAlH_4 / H_3O^+$, $NaBH_4 / CH_3OH$

(2) $H^+ / K_2Cr_2O_7$, $LiAlH_4 / H_3O^+$

(3) $NaBH_4 / CH_3OH$, PCl_3

(4) $NaBH_4 / CH_3OH$, $H^+ / K_2Cr_2O_7$

(5) PCl_3 , $LiAlH_4 / H_3O^+$

28. What mass of $Fe(NO_3)_3$ should be used to prepare a solution with a NO_3^- ion concentration of 200 pm using solid $Fe(NO_3)_3$? (Fe – 56, N – 14, O – 16)

(1) 130 mg **(2)** 156 mg **(3)** 260 mg **(4)** 200 mg **(5)** 500 mg

29. $Cl\,CH_2 - C \equiv C - \overset{\overset{CHO}{|}}{C} - \overset{\overset{O}{||}}{C} - Cl$

What is the IUPAC name of the above compound?

(1) 1,5 – dichloro – 2 – formylpent – 3 – yn – 1 – one

(2) 1,5 – dichloro – 2 – formylpent – 3 yne – 1 - one

(3) 5 – methanoylchloride – 1 – oxopent – 3-yn – 1one

(4) 5 – chloro – 2 – formylpent – 3 – ynoyl chloride

(5) 2 – formyl – 5 chloropent – 3 – ynoyl chloride

30. Buffer solution A has a concentration of 0.45 $moldm^{-3}$ CH_3COOH and A 0.25 mol dm^{-3} CH_3COONa, while buffer solution B has a concentration of 0.045 mol dm^{-3} CH_3COOH and 0.025 mol dm^{-3} CH_3COONa. The dissociation constant of CH_3COOH is K_a. What is the correct relationship between the two buffer solutions? ($Ka = 1.78 \times 10^{-5}$ $moldm^{-3}$)

	Initial pH of A and B solution	Added volume of NaOH solution A and B solution.	The change in pH after addition of NaOH
(1)	pH < 7	5 cm^3	No change in pH
(2)	pH = 4.75	5 cm^3	pH value changes equally
(3)	pH = 4.75	5 cm^3	pH changes unequally
(4)	pH = 4.75	5 cm^3	pH of A changes less and pH of B changes high
(5)	pH = 4.75	5 cm^3	Only A acts a buffer

- For each of the questions 31 to 40, one or more responses out ot the four responses (a), (b), (c) and (d) give is/are correct. Select the correct response/ responses. In accordance with the instuuctins 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 of combination of responses is correct

Summary of above Instruction

(1)	(2)	(3)	(4)	(5)
Only (a) and (b) are correct	Only (b) and (c) are correct	Only (c) and (d) are correct	Only (d) and (a) are correct	**Any other** number of combination of responses is correct

31. Regarding the root mean square velocity (x) of a gas, which of the following statement/s is/are true?

(a) When the absolute temperature of the gas is doubled, x^2 is doubles.
(b) When the pressure of the gas is doubles, x doubles.
(c) When the volume of the gas is doubled, the value of x halves.
(d) At the same temperature, x^2 is independent of the mass of the gas.

32. At temperature T the following equilibrium is establish in a closed rigid container.

$$25O_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

When O_2 (1 mol) and $NO_{(g)}$ (as a catalyst) are added while keeping the temperature constant. Which statement/s about the final equilibrium system is/are **false**?

(a) The partial pressure of $SO_{2(g)}$, $O_{2(g)}$ and $SO_{3(g)}$ remain unchanged, but the total pressure increased by the partial pressure of $NO_{(g)}$.
(b) The partial pressure of $SO_{2(g)}$ decreases and the partial pressure of $SO_{3(g)}$ increases.
(c) After the pressure changes, the equilibrium constant remains unchanged.
(d) The reverse reaction occurs, increasing the pressures of $SO_{2(g)}$ and $O_{2(g)}$.

33. "Water quality parameters are used to measure the quality of water". Which air pollutant/s contribute to significant changes in some water quality parameters when dissolved in water?

(a) CO_2 **(b)** O_2 **(c)** N_2 **(d)** SO_2

34. Compund X reacts with water to form a tribasic acid with the highest oxidation state and another stronger acid as products. The cation of X exists in several polymormhic forms. The cation of X could be,

(a) PCl_3, P^{+3} **(b)** $AsCl_3$, As^{+3} **(c)** $Bi(NO_3)_3$, Bi^{+3} **(d)** PCl_5, P^{+5}

35. According to thermochemical data, which statement/s about the formation of cyclohexane structure is/are ture?

(a) The 'KeKule' structure has higher bond energy.

(b) Although single bonds are present, the cyclic structure is more stable due to the arrangement.

(c) Although double bonds are difficult to break, the presence of delocalized π electrons stabilizes the structure.

(d) The π electron could reflects instability.

36. Which statement/s is/are true regarding the SO_2, SO_3^{-2} and $S_2O_3^{-2}$ molecules/ ions?

(a) The highest bond angle is in SO_3^{-2} among molecule/ ions.

(b) The Sulfur atoms in the above molecule/ ions have the same oxidation number.

(c) The shapes of the above molecules/ ions are not the same.

(d) Electron pair geometry of the Sulfur atom of $S_2O_3^{-2}$ ion and SO_3^{-2} ions are same.

37. Which statement/s about plant-based industries is/are true?

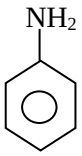
(a) Essential oils are water soluble, non- volatile substances.

(b) In the steam distillation method of essential oil extraction, the steam pressure increases the total pressure, allowing distillation at a lower temperature.

(c) Biodiesel contains methyl esters of fatty acids that are volatile.

(d) In biodiesel production, an excess of the catalyst NaOH is used.

38. Which is/are behave as a buffer solution/s ?

(a) excess CH_3COOH / NaOH **(b)** $NaHCO_3$ **(c)** $KHSO_3$ **(d)** 

, CH_3COOH

39. Which of the following will give a precipitate when dilute HNO_3 acid is added drop wise to a certain ammine solution?

(1) $[Ni(NH_3)_6]Cl_2$ **(2)** $Na_3[Cr(OH)_6]$ **(3)** $[Ag(NH_3)]Cl$ **(4)** $Na_2S_2O_3$

40. "Regarding the increase in $CO_{2(g)}$ levels in the atmosphere", which of the following statement/s is/are false?

(a) It contributes to an increase in the acidity of sea water.

(b) It reduces the hardness of water.

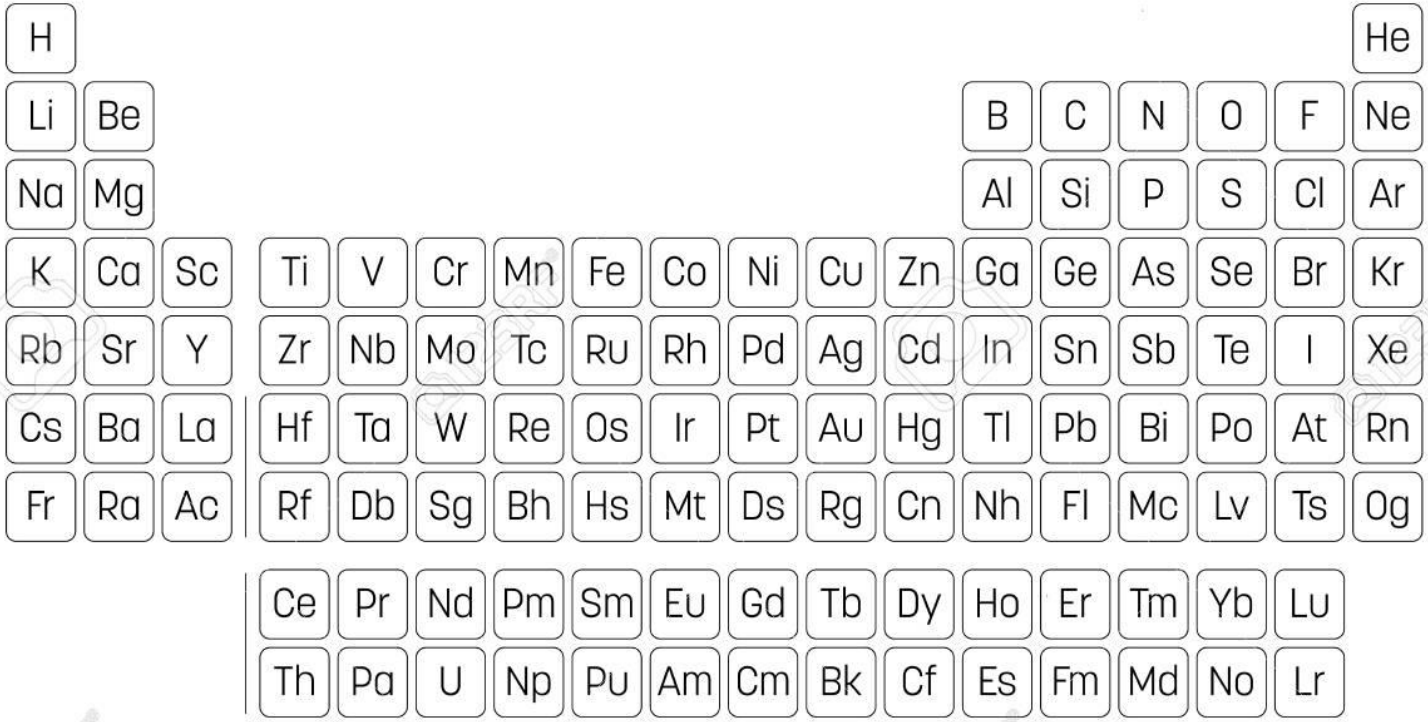
(c) It strongly absorbs UV radiation from the sun.

(d) It does not contribute to acid rain.

- In question Nos. 41 – 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.

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

	First Statement	Second Statement
41.	F has a lower eletron gain enthalpy than other elements in the same group.	As the radius decreases, the nucleus is closer to outershell electron, so it can attract electrons more easily.
42.	When a weak acid solution is diluted, both the degree of dissociation and the pH of the solution increase.	The dissociation of a weak acid occurs in a way that the acid dissociation costant remains constant.
43.	$Na_2S_2O_3$ solution can be used to distinguish $Pb(NO_3)_2$ and $AgNO_3$	The formation of a black precipitate with $Pb(NO_3)_2$ and $Na_2S_2O_3$ occurs slowly at room temperature.
44.	The rate constant of an elementary reaction is directly proportional to the rate of the reaction.	The rate of an elementary reaction depends on the initial concentration, but the rate constant does not.
45.	The reaction type of CH_3NH_2 with CH_3CHO is nucleophilic addition reaction.	It is the opposite of the reaction with a Brady's reagent.
46.	In the addition of bromine to alkenes, a Br^{8+} ion attacks the π bond.	The bromonium ion is stable and is attracted to the Br^+ ion.
47.	$6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq)} + 6O_{2(g)}$ This reaction is spontaneous at room temperature.	It is a chemical cell reaction ($6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq)} + 6O_{2(g)}$) that can be used to generate electricity.
48.	At constant temperature and pressure, the entrapy of the surroundings decreases in a spontaneous endothermic reaction.	If $\Delta H > 0$ and $\Delta S > 0$ for a reaction at constant temperature and pressure, the reaction maybe spontaneous.
49.	The collisions between molecules of a real gas are perfectly elastic.	Since the collisions are perfectly elastic, the momentum of the gas molecules change.
50.	The presence of CO in the atomosphere contributes to global warming.	CO_2 absorbs infrared radiation but cannot persist in the atmosphere for a long time.


H
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Ti
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Sabaragamuwa Provincial Department of Education

තෙවැනි වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2025

3rd Term Test – Grade 13 – 2025

Chemistry - II	**02**	**E**	**II**	Time : 03 Hours

Instructions:

- Periodic Table is provided.
- Use of calculators is not allowed.

Part A – Structured Essay

- Answer all the questions on this paper itself.
- Write you answer in the space provided for each question. Note that the space provided is sufficient for your answers and that extensive answers are not expected.

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	$h = 6.626 \times 10^{-34}\ J\ s$
Velocity of light	$c = 3 \times 10^{8}\ ms^{-1}$
Faraday's constant	$F = 96\ 500\ C\ mol^{-1}$

For the use of the examiner only.

Part	Question No.	Marks
A		
B		
Total		
Precentage		

Paper I	
Paper II	
Final Mark	

Part A – Structured Essay

01. (a) Arrange the following in increasing order of the properly indicated in parentheses.

(i) H_2O, NH_3, HI, HF (dipole moment)

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

(ii) Be, N, He, Mg (positive value of the first electron gain enthalpy)

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

(iii) HF, HCl, HBr, HI (oxidizing power)

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

(iv) H_2O, H_2S, H_2Se, H_2 Te (melting point of hydrides)

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

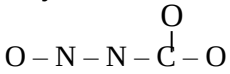
(v) Ultra-violet rays, X-rays, Yellow light, Microwaves (frequency)

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

(vi) H_3C - NC, FNO, FNO_2, F_3C – NC (electronegativity of N atom)

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

(b) The formula of a very weak di-basic acid anion is $[ON_2CO_2]^{-2}$. The skeleton structure of it is



(i) Give one stable Lewis structure for the above anion.

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(ii) Draw any other three resonance structures except the structure drawn in (b) (i).

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(iii) According to the structures in (b) (ii), which is not a resonance structure for a stable acid? Describe the reasons.

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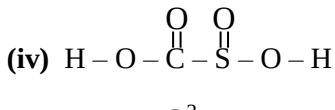
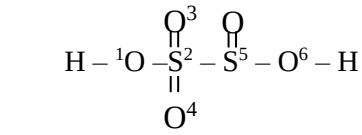
(iv)  The atoms of this acid ($H_2S_2O_5$) is labelled as follows.

 Fill in the table using the above structure.

	Atom	O^1	S^2	S^5	O^6
(i)	Hybridization				
(ii)	Electron pair geometry around the atom				
(iii)	Shape around the atom				
(iv)	Oxidation number				
(v)	Shape				

(v) Identify atomic / hybrid orbitals involved in the formationof σ bonds between the two atoms given below.

$O^1 - S^2$	O^1	.....	S^2	.....
$S^2 - O^3$	S^2	.....	O^3	.....
S^2 - O^4	S^2	.....	O^4	.....
$S^2 - S^5$	S^2	.....	S^5	.....
$S^5 - O^6$	S^5	.....	O^6	.....

(vi) The ascending order of electronegativity of atoms O^1, S^2, S^5 and O^4

.....

(c) Deduce the shape of the molecule/ ion given below.

(i) Shape of AF_2^- ion if AF_4^- is lenear.

……

(ii) Shape of XF_3 ion if the shape of XF_4^- is tetrahedral.

……

(iii) Shape of ZO_4^{-3} ion if the shape of ZCl_5 is tyrgonal bipyramid.

……

02. **(a)** A, B, C are three solid salts with three anions of p block and same cation. When the three salts A, B, C heated with compound D, a gas X evolved that turns red litmus into blue. On heating, only A and B emits gas X while C gives gas Y and water vapour. X gas is evolved when salt C is heated with Al powder in presence of D. When A and B are dissolved in water and $BaCl_2$ added separately, white colour precipitates of E and F were obtained. When diluted HNO_3 was added to E and F, a clear solution was given by E while F, white colour precipitate was insoluble.

(i) Identify the salts A, B and C separately.

A ..... B ..... C .....

(ii) Identify X and Y gases.

X ..... Y .....

(iii) Identify D, E, F compounds.

D ..... E ..... F .....

(iv) Write all the balanced chemical equations for reactions that take place on heating A, B and C.

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(v) Write the balanced equation for the reaction when Al powder added to the salt C and heated presence of D.

.....

(b) Identify the chemical compounds and write the relevant chemical formulae for the following descriptions.

(i) When $Pb(NO_3)_2$ solution is added to a salt 'A', a white colour precipitate 'B' was obtained and when 'B' was heated a black colour precipitate 'C' was obtained. Salt of 'A' gives lilac (purple) for the flame test.

A ..... B ..... C .....

(ii) When the gas X_2 is dissolved in water, it undergoes disproportionation. When cold dilute NaOH added to X_2 gas, a salt 'P' which has bleeching properties and a neutral salt 'Q' is formed. X_2 undergo disprportionation in the above reaction as well.

X_2 ..... P ..... Q .....

(iii) R is a salt formed by a s block element and 2 elements in p block to a ration of 1 : 1 : 3. When a salt 'M' formed by two elements of salt R is added, to salt 'R' in the presence of starch, a blue colour solution was obtained. A yellow flame was obtained by both of the salts for the flame test. The oxidation state of one element of R is +5.

R ..... M .....

(iv) When dilute HNO_3 is added and heated to an aqueous solution of salt 'Y' followed by addition of excess NH_4OH and NH_4Cl, a brown colour precipitate was obtained. The precipitate was filtered and $AgNO_3$ was added to the filtrate and salt 'Z' was obtained which is soluble in concentrated ammonia. When $KMnO_4$ in acidic meium is added t salt Y, the purple colour turned into colourless.

Y ..... Z .....

(v) Consider the reaction between Y and $KMnO_4$ mentioned in (iv) and write;

I. Balanced half reaction for oxidation.

.....

II. Balanced half reaction for reduction.

.....

III. Overall balanced reaction.

.....

03. (a) (i) Write an equation to show that the pressure of gas molecules in a container at a certain temperature is directly proportional to root mean square speed.

.....

(ii) According to the above equation, what could be expected when increasing the speed of gas molecules?

.....

.....

(iii) Graphically represent the change of speed of gases with temperature according to the below data. $T_2 > T_1$

Fraction of molecules

Speed of molecules

(b) X and Y are two completely miscible volatile liquids. When X and Y are mixed with each other, forms an ideal binary liquid mixture. The mole fraction of X is X_x and the partial pressures are P_x and P_y. The total vapour pressure of the mixture is P_{xy}. The saturated vapour pressures are $\overset{\circ}{P}_x$ and $\overset{\circ}{P}_y$.

(i) Write the expression for P_x and P_y.

.....

.....

(ii) Show that $y_y = \dfrac{P_y^\circ - P_y^\circ X_x}{X_x\left(P_x^\circ - P_y^\circ\right) + P_y^\circ}$,

if the mole fraction of X is y_x and mole fraction of y is y_y in terms of moles in the gas phase.

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(iii) A mixture of $CH_3OH_{(aq)}$ and $CH_3CH_2OH_{(aq)}$ act as an ideal solution where the total pressure in the gas phase is 1.6×10^5Pa and the temperature of the system is 600 K. ($V = 8.314\ dm^3$)

If $P^\circ\ CH_3OH_{(l)} = 2 \times 10^5$ Pa and

$P^\circ\ CH_3CH_2OH_{(l)} = 3 \times 10^5$ Pa, show that the mole fraction of the gas phase is 5 :3 when the mole fraction of the solution is 2 : 3.

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(iv) Find the no. of moles in the gas phase of $CH_3OH_{(g)}$ and $CH_3CH_2OH_{(g)}$.

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04. (a) A, B, and C are compounds with molecular formula $C_5H_{13}N$ and are optically inactive. All structures are primary amines and form D, E and F compounds by reacting with $NaNO_2$ and concentrated HCl. Only compound D gives instantaneous turbidity with Lucas reagent D, E and F reacts with concentrated H_2SO_4 and gives G, H and I compound while only compound I shows geometrical isomerism. I consist of 2 geometrical isomers.

Identify compounds A, B, C, D, E, F G, H, I.

A B C

D E F

G H I

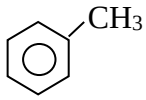
(b) (i) Write the main carbon product of the following reactions.

(I) $CH_2 - C - CH_3$ (with benzene ring) $CH_2 - C \equiv C - H$ $\xrightarrow{C_2H_5^-Mg^+Cl}$

(II) $CH_3CH_2CH = CH_2$ $\xrightarrow{HBr\ /\ Dry\ Ether}$

(III) $CH_3CH_2NH_2$ $\xrightarrow{CH_3COH}$

(IV) $CH_3CH_2CH = CH_2$ $\xrightarrow{\text{Concentrated } H_2SO_4}$

(V)  $\xrightarrow[\text{Concentrated } H_2SO_4 / 35^0C]{\text{Concentrated } HNO_3}$

(ii) Give examples for the following reaction types using the reactions given above from (I) to (V).

I) Neuclophilic addition .....

II) Electrophilic substitution .....

(iii) Write the mechanism corresponding to the (IV) reaction given above.

Essay Paper – Part B

- **Answer two questions only. (Each question carries 150 marks)**

---

05. **(a)** The following reaction happens according to the mechanism given bwlow.

$NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$; $\Delta H = \Delta H < O$

1. Step 1 :- $NO_{(g)}$ + $O_{2(g)}$ $\rightleftharpoons$ $NO_{3(g)}$; fast
2. Step 2 :- $NO_{3(g)}$ + $NO_{(g)}$ $\rightarrow$ $2NO_{2(g)}$; slow

Compound	**Enthalphy of formation / kJ mol^{-1}**	**Molar Entropy / J K^{-1} mol^{-1}**
NO(g)	90.4	210.6
NO_2(g)	33.8	240.5
O_2(g)	0.0	205.1

Using the information from the above table, calculate the following for the reaction.

$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

(i) Change of enthalphy.

(ii) Change of entropy.

(iii) Predict the spontaity of the reaction at 25^0C.

(iv) When $NO_{(g)}$ and $O_{2(g)}$ added to a closed system and increase the temperature gradually, find the temperature at which the system is expected to obtain equilibirium.

(v) If the concentration equilibrium constant is 6.4×10^9 mol^{-1}m^3 of the above system at equilibrium, find the value of K_p.

(b) The following mechanism is suggested for the reaction;

$2\ NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$; $\Delta H < O$

Also the speed expression for the overall reaction is given as; $R = K[NO_{2(g)}]\ [O_{2(g)}]$

1. Step 1 : $NO_{(g)} + O_{2(g)} \rightleftharpoons NO_{3(g)}$ fast
   Concentration equilibrium constant is Kc
2. Step : $NO_{3(g)} + NO_{(g)} \rightarrow 2NO_{2(g)}$ slow
   Rate constant is K_2

(i) Prove that the reaction mechanism agree with the given speed expression. (Obtain the given expression in terms of the mechanism)

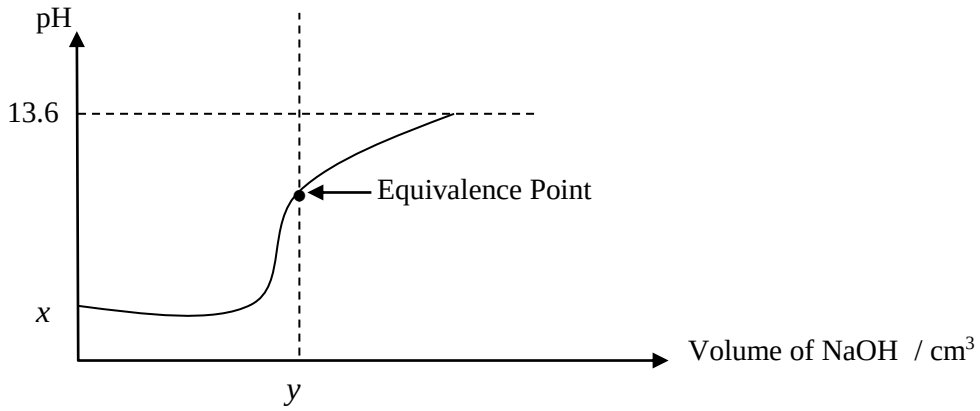
(ii) Draw the energy profile for the above reaction.
Denote the transition states of step 1 and step 2 as TS – I and TS –II respectively.

(iii) Suggest a Lewis structure for the unstable species $NO_{3(g)}$ where bond breaking and bond forming happen in TS – II stage.

(iv) Graphically represent how the concentrations of $[NO_{(g)}]$, $[NO_{3(g)}]$ and $[NO_{2(g)}]$ changes with the time.

(v) At a certain instance, the initial rate of the above reaction is 6.4×10^{-3} mol dm^{-3} s^{-1} and the concentrations of $NO_{(g)}$ and $O_{2(g)}$ are 0.4 mol dm^{-3} and 0.2 moldm^{-3} respectively. Find the rate constant of the reaction.

06. **(a)** The following graph shows the variation of pH value in the tritration flask when 25.00 cm^3 of 0.4 mol dm^{-3} $NaOH_{(aq)}$ titrated with 0.4 mol dm^{-3} H_3CCOOH.



(i) Derive an expression for the pH value at the equivalence point, when concentration of the salt formed at the equivalence point is S, dissociation constant of CH_3COOH is K_a, ionic product of water is K_w.

(ii) Find the pH value at the equivalence point.
(dissociation constant of CH_3COOH is $K_a = 1.78 \times 10^{-5}$ mol dm^{-3} and
$K_w = 1.78 \times 10^{-5}$ mol dm^{-3})

(iii) Mention the values given by *x* and *y* in the above graph

(iv) Initially few drops of phenolphthalene was added to the titration flask in the above titration. When the burette reading is 25.3 cm^3, explain the colour change observation in the titration flask in terms of pH value.

(v) A student suggests to use Cresol Red (pH 7.2 – 8.8) as the indicator for the above titration. Explain the suitability of phenolphthalene relative to Cresol Red as the indicator.

(b) $CaF_{2(g)} \rightleftharpoons Ca^{2+}_{(aq)} + 2F^{-}_{(aq)}$

The above equilibrium can be seen in a saturated $CaF_{2(s)}$ solution. The solubility product of CaF_2 is 3.45×10^{-11} mol^3 dm^{-9}.

(i) When the pH value is decreased in the above equilibrium system, explain whether a change inequilibrium can happen or not?

(ii) Consider an aqueous solution of 100 cm^3 contact with $CaF_{2(s)}$. What is the volume of 0.01 mol dm^{-3} $H^+_{(aq)}$ needed to be added to bring the concentration of $Ca^{2+}_{(aq)}$ upto 6.15 x 10^{-4} mol dm^{-3}.

(Calculate the value to which the pH value of the solution should be brought)

(iii) Find the pH value of the solution when the concentration of $Ca^{+2}_{(aq)}$ is 6.15×10^{-4} mol dm^{-3} in the solution.

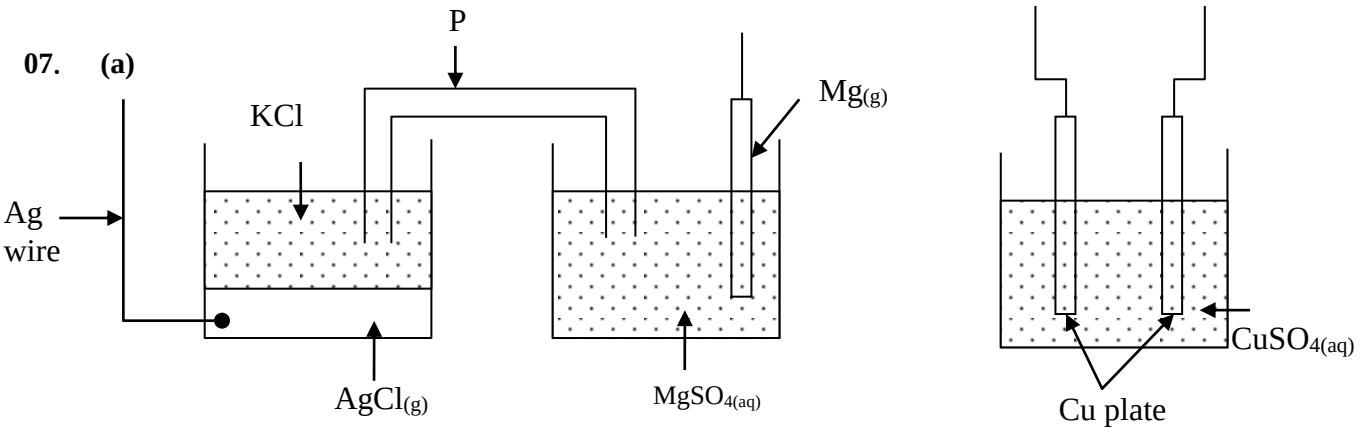
(The dissociation constant of HF at 25^0C $K_a = 3.2 \times 10^{-4}$ mol dm^{-3} , $K_w = 1 \times 10^{-14}$ mol^2 dm^{-6})

(iv) Find the pH value of the solution at an instant where a precipitate is observed when 0.01 mol dm^{-3} NaOH is added dropwise.

(The solubility product of $Ca(OH)_2$ is 1.2×10^{-5} mol dm^{-3} and $K_a = 1 \times 10^{-14}$ mol^2 dm^{-6})

(v) When a precipitate just begins to form during the addition of the above NaOH solution, what is the volume of 0.01 mol dm^{-3} NaOH solution that has been added?

07. (a)



Cell X Cell Y

$Ag_{(s)}$, $AgCl_{(s)}$ | Cl^- E^0 = 0.22 V

Mg^{2+} | $Mg_{(s)}$ E^0 = -2.36 V

(i) Consider the above Cell X and Cell Y given above, write answes for the following questions.

I. Identify the anode and cathode.

II. Write the anodic reaction and cathodic reaction.

III. Write the overall cell reaction.

IV. What is the voltmeter reading, if a voltmeter is connected to A and B terminals?

(ii) What refers to P in Cell X ? Write two chemical substances that can be used for it.

(iii) Write the IUPAC cell notation for Cell X.

(iv) Consider an incident where A and B terminals of Cell X is connected to C and D terminals of Cell Y.

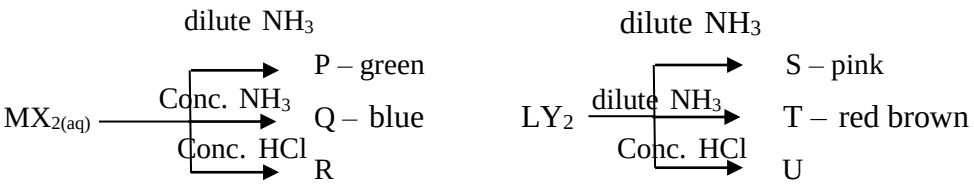
I. Mention the anode and the cathode of Cell Y in terms of C and D.

II. Write the reaction that take place in the cathode and the anode.

III. The initial mass of each Cu plate of Cell Y is 10 g and a current of 9.65 A is passed through the cell for a time period of 100 s. Find the mass of anode and cathode separately at the end of the process.

(IF = 96 500 C mol^{-1} , Cu = 63.5 g mol^{-1})

(b) MX_2 and LY_3 are two salts of 3d transition metals M and L. M and L contains 2 and 3 unpaired electrons respectively in the ground state. When the two salts dissolve in water, they form colorful complex ions with an octahedral geometry. When $AgNO_3$ added to an aqueous solution of MX_2, forms a yellow colour precipitate while insoluble in dilute ammonia. But, when $AgNO_3$ is added to an aqueous soluton of LY_3, a white colour precipitate is formed which is soluble in dilute ammonia. The following reactons aare done for aqueous solutions of MX_2 and LY_3.



(i) Identify M and L elements.

(ii) Write the electronic configurations of ground state of M and L elements.

(iii) Write the chemical formulae of P, Q, R, S, T and U.

(iv) Mention the colours of T and U.

(v) The molecular formulae of A and B which are coordination compounds of M is given below. Consider the following information regarding $MH_{16}N_6O_8$, $MI_2H_{16}N_4O_2$ (not in proper order) When A and B are treated with $Pb(CH_3COO)_{2(aq)}$, the following observations were obtained.

Compound	Observation with $Pb(CH_3COO)_{2(aq)}$
A	Yellow colour precipitate soluble in hot water.
B	No precipitate.

Identify A and B and draw their structures.

(Note : A and B have octahedral geometry while each compound consist of 2 ligand types that are datively bonded to metal ion.)

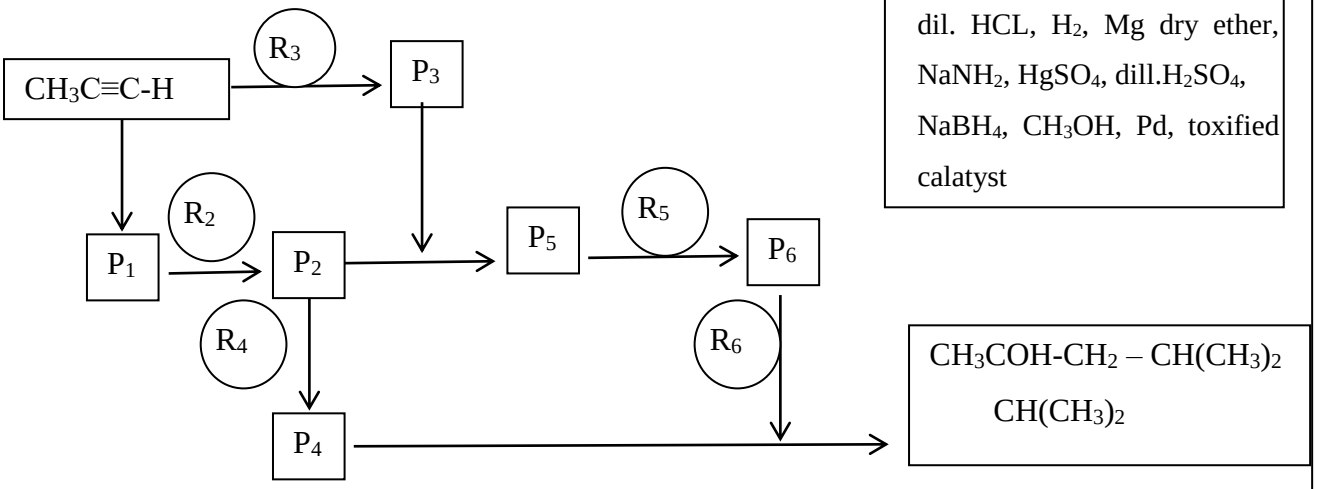
Part C

- **Answer two questions only. (Each question carries 150 marks)**

08. **(a)** Using only the organic compounds and chemical reactants, show how you would carry out the chemical synthesis using the given steps.

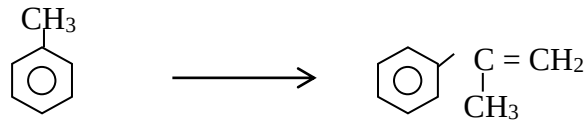
Regeant List

dil. HCL, H_2, Mg dry ether, $NaNH_2$, $HgSO_4$, dill.H_2SO_4, $NaBH_4$, CH_3OH, Pd, toxified calatyst

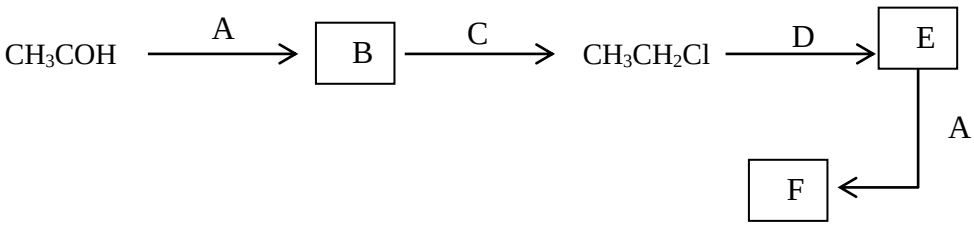


(b) Show how the chemical conversionis done according to the number of steps given infront of the reaction.

(i) $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - NH_2 \longrightarrow CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - NH - \underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle H}{\overset{|}{C}}}} - CH_3$ (3 steps)

(ii)  (4 steps)

(iii) Consider the following reaction series.



I. The relative molecular mass of F has changed by 15 units than that of the initial compound. Identify A, B, C, D, E and F.

(c) Consider the reaction of $CH_3CH_2 - \overset{\overset{O}{\|}}{C} - Cl$ with concentrated NaOH

$$CH_3CH_2 - \overset{\overset{O}{\|}}{C} - Cl \xrightarrow{\text{Conc. NaOH}} P$$

Identify compound 'P' and write the mechanism related to the reaction.

09. (a) The following chemical reactions build up in terms of ions and ion complexes of d block metals named as M and N.

$M(H_2O)_6^{+x}$	Forms green colour precipitate (a) with $NaOH_{(aq)}$. It forms blue purple solution (c) with excess dilute NH_3.
$N(H_2O)^{+y}$	Unstable with atmospheric O_2 in aqueous solution. Forms a yellow colour ion complex (b) with an ion of M. $\left(\left[N(H_2O)_6^{x+}\right]\right)$
$\left[N(H_2O)_6\right]^{x4}$	Forms a yellow brown complex ion (d) with concentrated HCl.
M^{+z}	The ion with the oxidation number (e) reacts with $\left(\left[N(H_2O)_6^{+y}\right]\right)$

(i) Identify the values of X, Y, Z.

(ii) Identify M and N metals and write the electronic configuration of the stable ion of each metal.

(iii) Identify the ions/ complexes a, b, c, d, e.

(iv) Write the IUPAC names of c and b.

(v) Write the chemical tests and observations to identify N^{+y} ion.

(b) Following gives some experimental data obtained in determination of percentages of $S^{-2}, SO_3^{-2}, SO_4^{-2}$ ions in 50 cm^3 of an organic fertilizer, 'X'.

Experiment I

25 cm^3 of X solution was taken and excess amount of hot, concentrated HNO_3 was added to it. No cloudiness was observed and excess amount of $BaCl_2$ was added to the clear solution. The obtained precipitate was dried and measured. The mass was 0.932 g.

Experiment II

40 cm^3 of 0.04 mol dm^{-3} $KMNO_4$ was added to another 25.00 cm^3 of X solutoon. After the reaction took place, it was titrated by 0.04 $moldm^{-3}$ Na_2SO_3. The burette reading was 25.00 cm^3. The mass of the dried precipate obtained by filtering the reaction mixture was 0.032 g.

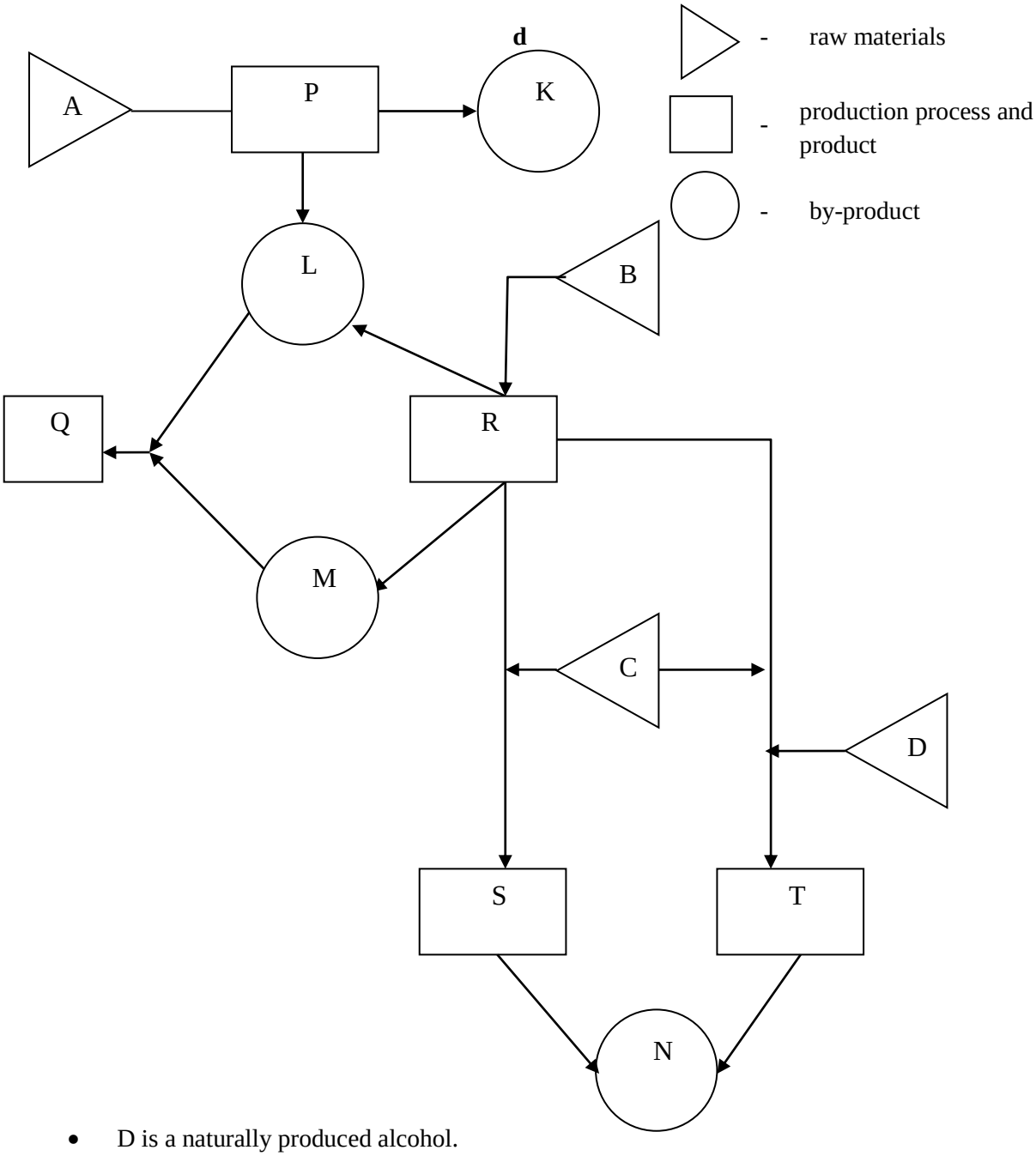
(i) Write the balanced ionic reactions that happened in experiment I.

(ii) Write the balanced ionic reactions that happened in experiment II.

(iii) According to the data of I and II experiments, find the concentrations of $S^{-2}, SO_3^{-2}, SO_4^{-2}$ ions in 50 cm^3 of X soluton.

(iv) Calculate the volume of X solution that should be added to the soil in order to give off 384 ppm of S ions to the soil.

10. **(a)** Consider the following flow chart related to some chemical products.



- D is a naturally produced alcohol.
- T is a renewable power source fuel.
- Q is an acid.
- S is a substance used for good health condition.

(i) Identify the raw materials A, B, C and D.

(ii) Identify the by-products K, L, M and N.

(iii) Identify the production processes P, Q, R, S and T and write the main product that is produced.

(iv) Write the reaction related to production of T.

(v) Write all the reactions for the production process of P.

(vi) Identify the metals used in the anode and cathode in production process of R.

(b) Transportation, Agriculture, Use of refrigerators and A/C machines, Fractional distillation, Lightning, Deforestration, Combustion of coal.

(i) Write three greenhouse gases and one process each, out of the processes given above for each gas emitted.

(ii) When the limit of the amount of greenhouse gases exceed increasing of global warming happen. Write two harmful effects caused by increase of global warming.

(iii) Out of the processes above, name a process that does not occur naturally but influences acid rains and describe how it affects occurrence of acid rains.

(iv) Out of the processes above, which is the main process that affects Ozone layer depletion (OLD) and name a pollutant gas that is emitted from that process.

(v) Briefly describe how the pollutant gas mentioned in (iv) affects the Ozone layer depletion.

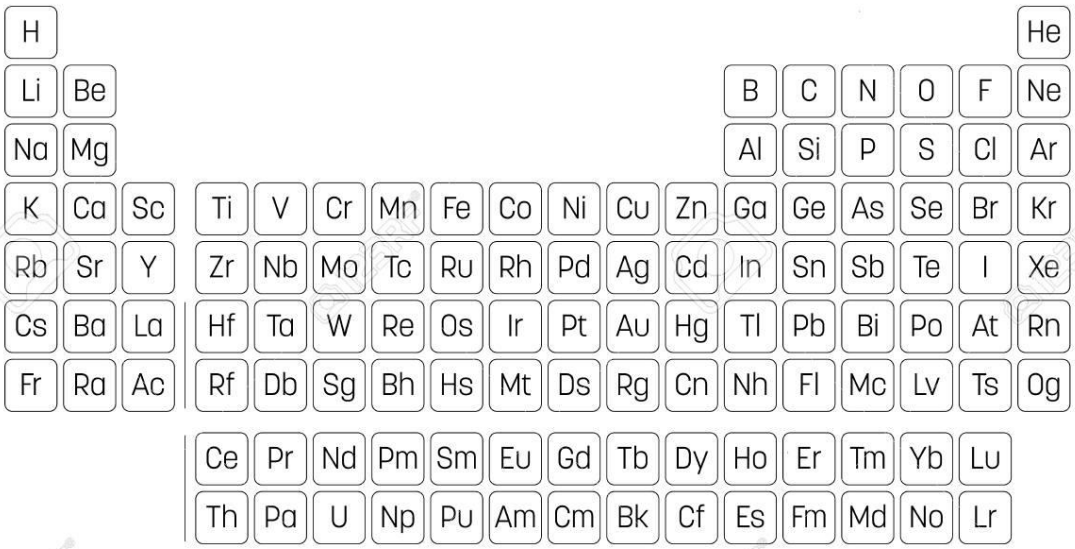
(c) Following questions are related with chemical products based on plant sources and natural rubber.

(i) Name the raw materials needed for the production of biofuels.

(ii) Write the reaction related to transesterification process.

(iii) Write down the repeating unit of natural rubber.

(iv) Name substances each that prevents coagulation of rubber latex and enhances coagulation of latex.



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Sabaragamuwa Provincial Department of Education

අවසාන වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2025

Final term test – Grade 13 – 2025

පිළිතුරු පත්‍රය

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