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තෙවන වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2024
 Third Term Test - Grade 13 - 2024

Examination No.:

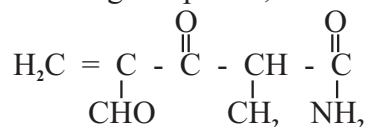
CHEMISTRY - I**Time : 2 hours****Instructions:**

- Periodic Table is provided.
- Answer **all** the questions.
- Write your **Index Number** in the space provided in the answer sheet.
- Follow the instructions given on the back of the answer sheet, carefully.
- In each of the questions **1 to 50**, pick one of the alternatives from (1), (2), (3), (4), (5) which is **correct or most appropriate** and **mark your response on the answer sheet with a cross (x)** with the instructions given on the back of the answer sheet.
- This paper consists of **09** pages.
- **Use of calculators is not allowed.**

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

- (01) Which of the following answer gives the correct electron transitions relevant to the 2 lines in the Lyman series which has equal energy difference as red colour and green - blue colour lines in the Hydrogen emission spectrum,
- (1) $n_i = 3 \rightarrow n_f = 2$ and $n_i = 2 \rightarrow n_f = 1$
 - (2) $n_i = 3 \rightarrow n_f = 1$ and $n_i = 3 \rightarrow n_f = 2$
 - (3) $n_i = 4 \rightarrow n_f = 1$ and $n_i = 3 \rightarrow n_f = 1$
 - (4) $n_i = 4 \rightarrow n_f = 2$ and $n_i = 4 \rightarrow n_f = 1$
 - (5) $n_i = 3 \rightarrow n_f = 1$ and $n_i = 4 \rightarrow n_f = 2$
- (02) Which of the following statement is false regarding Quantum numbers?
- (1) The principal quantum number n never be zero for an atom.
 - (2) The total number of atomic orbitals in a shell is n^2 , where n is the principal quantum number.
 - (3) Each sub shell consists of a specific number of atomic orbitals while it is satisfied by $(2l + 1)$.
 - (4) The shell with principal quantum number n consist of exactly n sub shells.
 - (5) The minimum value for m_l when $n = 2$ is 0.
- (03) Identify the compound which undergoes decomposition presence of heat among the following compounds?
- (1) LiOH
 - (2) NaOH
 - (3) KOH
 - (4) RbOH
 - (5) CSOH
- (04) The correct order of the shape around the central atom in ICl_3 , ICl_4 and IF_5 respectively?
- (1) Trigonal bipyramidal, Square planer, Octahedral.
 - (2) T - shape, Square planer, Square pyramidal
 - (3) Tetrahedral, Octahedral, Octahedral.
 - (4) Square planer, Square pyramidal, Octahedral.
 - (5) T - shape, Square pyramidal, Trigonal pyramidal

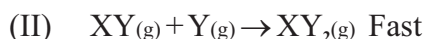
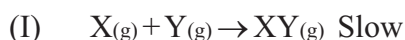
- (05) What is the IUPAC name of the following compound,



- (1) 4 - formyl-2-methyl-3-oxopentenamide
 (2) 4-methyl-1,3-dioxopentanamide
 (3) 4,3-dioxo-2-methylpentenamide
 (4) 4-formyl-2-methyl-3-oxopent-4-enamide
 (5) 1-amine-1,3,dioxopentenal
- (06) Solubility products of Lead chloride and Lead chromate respectively are $3.2 \times 10^{-5} \text{ mol}^3 \text{ dm}^{-9}$ and $1.8 \times 10^{-15} \text{ mol}^2 \text{ dm}^{-6}$ at TK. What is the minimum CrO_4^{2-} concentration required to precipitate PbCrO_4 from saturated PbCl_2 solution in mol dm^{-3} ?
 (1) 8×10^{-14} (2) 9×10^{-14} (3) 10×10^{-5} (4) 18×10^{-2} (5) 22×10^{-15}
- (07) Select the false statement?
 (1) The first ionization energy of He is higher than the second ionization energy of Li.
 (2) The radius of an element depend on the effective nuclear charge.
 (3) The effective nuclear charge of Na is lower than the actual nuclear charge always.
 (4) Radius of K^+ is smaller than the radius of S^{2-} .
 (5) Be has the heighest melting point among the alkaline earth metals.
- (08) The energy of X - rays used for diagnosis is $119 \times 10^8 \text{ kJ mol}^{-1}$. The frequency of a X - ray radiation in Hz is?
 (1) 2×10^8 (2) 2.0×10^{12} (3) 3×10^{22} (4) 5×10^{15} (5) 6×10^{18}
- (09) The correct answer regarding reactions and mechanisms is,

Reaction	Reaction	Electrophile / Nucleophile
(1) Nitrotrion of Benzene	Electrophilic Addition	NO_2^+
(2) Bromination of Alkenes	Electrophilic Addition	Br^+
(3) Chlorimation of Alkenes	Nucleophilic Addition	$\text{Cl}^\bullet$
(4) Condensation of Aldehydes	Nucleophilic Addition	OH^-
(5) Dehydration of alcohols	Electrophilic Addition	H^+

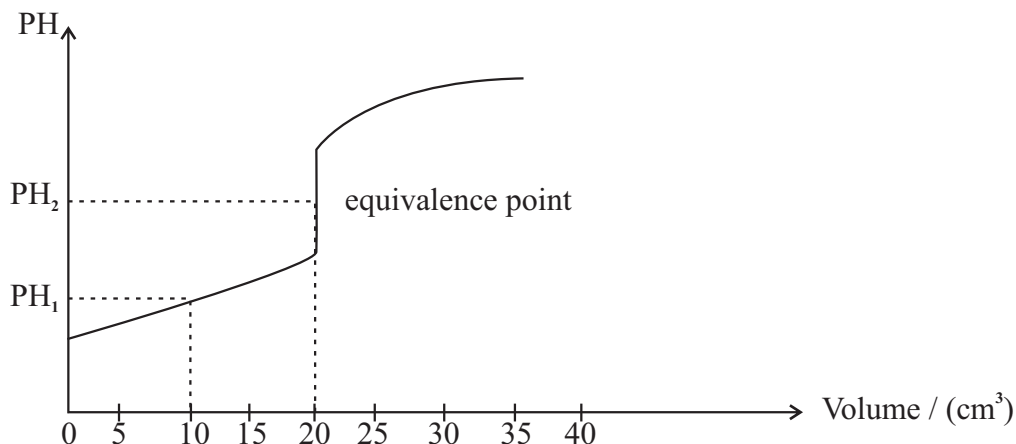
- (10) The correct order of the variation of electro negativity of C in the given species is,
 (1) $\text{CH}_3\text{OH} < \text{CHF}_3 < \text{CHCl}_3 < \text{CCl}_4 < \text{CO} < \text{HCN}$
 (2) $\text{CH}_3\text{OH} < \text{CHCl}_3 < \text{CHF}_3 < \text{CCl}_4 < \text{CO} < \text{HCN}$
 (3) $\text{CHCl}_3 < \text{CH}_3\text{OH} < \text{CHF}_3 < \text{CCl}_4 < \text{HCN} < \text{CO}$
 (4) $\text{HCN} < \text{CO} < \text{CCl}_4 < \text{CHF}_3 < \text{CHCl}_3 < \text{CH}_3\text{OH}$
 (5) $\text{CO} < \text{CH}_3\text{OH} < \text{HCN} < \text{CCl}_4 < \text{CHF}_3 < \text{CHCl}_3$
- (11) The reaction $\text{X}_{(\text{g})} + 2\text{Y}_{(\text{g})} \rightarrow \text{XY}_{(\text{g})}$ occurs inside a closed vessel at constant temperature according to the mechanism given below,



The initial rate of this reaction is R. What is the rate if you twise the volume of this system?

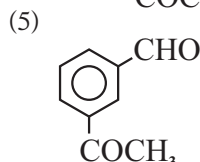
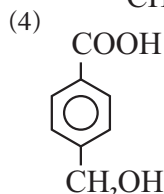
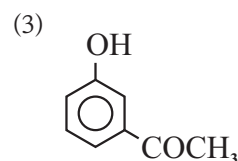
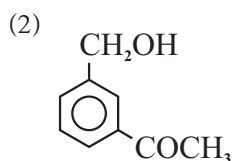
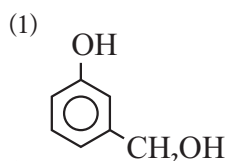
- (1) $\frac{R}{4}$ (2) $\frac{R}{2}$ (3) R (4) 2R (5) 4R

- (12) The following pH curve is relevant to the titration of 20 cm^3 of 1 mol dm^{-3} weak mono basic acid HA and 1 mol dm^{-3} strong base NaOH. At 25°C K_a of HA is $K_a = 1 \times 10^{-5} \text{ Pa}$.

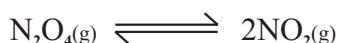


The values of PH_1 and PH_2 respectively are?

- (1) 5 and 4.65 (2) 3 and 7.65 (3) 5 and 7 (4) 5 and 9.35 (5) 5 and 10.70
- (13) The organic compound X reacts with NaOH forming its sodium salt. Further X reacts with Bredy's reagent giving orange colour precipitate. But X does not give dicarboxylic acid during oxidation. X would be?



- (14) What is the volume of acidic $\text{K}_2\text{Cr}_2\text{O}_7$ with concentration 0.25 mol dm^{-3} in cm^3 , required to react completely with 50 cm^3 of 0.1 mol dm^{-3} FeSO_4 solution (Neglect the reduction of SO_3^{2-} in acidic medium)
- (1) 9 (2) 10 (3) 18 (4) 22 (5) 30
- (15) 2.00 m^3 sample of air with the density $1 \times 10^{-3} \text{ g cm}^{-3}$ polluted with SO_2 was passed through a H_2O_2 solution. Excess BaCl_2 was added into a solution obtained above. The dry mass of the precipitate obtained was 2.33 g . The concentration of SO_2 in the air sample in ppm is? (S-32, O-16, Ba-137)
- (1) 320 (2) 480 (3) 4800 (4) 960 (5) 9600
- (16) The following gaseous system exist in the equilibrium at temperature T.



If the total pressure of the equilibrium system is P, and the equilibrium constant is K_p . The amount of dissociation α is?

(1) $\alpha = \sqrt{\frac{4P + kP}{kP}}$

(2) $\alpha = \sqrt{\frac{kP}{4P}}$

(3) $\frac{\sqrt{kP}}{\sqrt{P + kP}}$

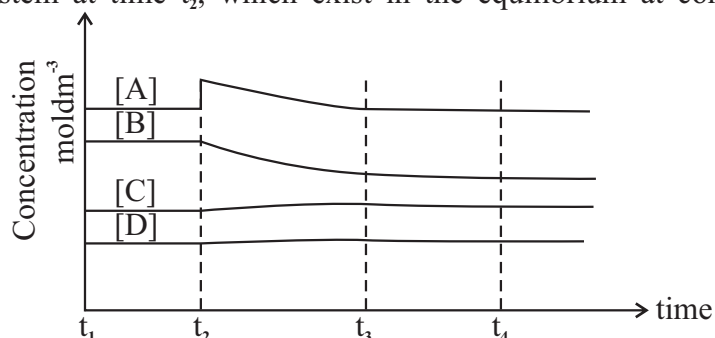
(4) $\alpha = \sqrt{\frac{kP}{2P + kP}}$

(5) $\alpha = \sqrt{\frac{kP}{4P + kP}}$

- (17) 100 cm^3 of $1 \text{ mol dm}^{-3} (\text{NH}_4)_2\text{SO}_4$ solution and 100 cm^3 of $1 \text{ mol dm}^{-3} \text{NaOH}$ solution were reacted at 25°C . What is the pH value of the solution if the gas formed was allowed to release completely by heating the solution? at 25°C $K_b(\text{NH}_3) = 1 \times 10^{-5} \text{ mol dm}^{-3}$
- (1) 3.25 (2) 4.65 (3) 5.65 (4) 6.25 (5) 7.55

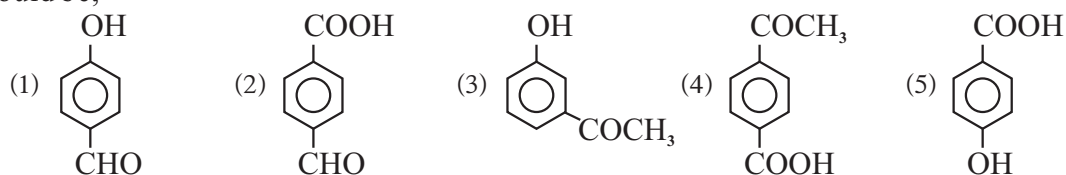
- (18) $a\text{A(g)} + b\text{B(g)} \rightleftharpoons c\text{C(g)} + d\text{D(g)}$

The following graph represents the behaviour of the system at and after when some amount of A(g) added into the above gaseous system at time t_2 , which exist in the equilibrium at constant temperature.



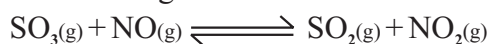
Which of the following represents the relationship between Q_c and K_c in the system during the time periods $t_1 - t_2$, $t_2 - t_3$, $t_3 - t_4$ respectively,

- (1) $Q_c > K_c$, $Q_c < K_c$, $Q_c = K_c$ (2) $Q_c = K_c$, $Q_c < K_c$, $Q_c = K_c$
 (3) $Q_c = K_c$, $Q_c = K_c$, $Q_c = K_c$ (4) $Q_c < K_c$, $Q_c = K_c$, $Q_c > K_c$
 (5) $Q_c = K_c$, $Q_c > K_c$, $Q_c = K_c$
- (19) CO_2 produced during the combustion of cork ($\text{C}_{(s)}$) and Carbon monoxide,
- $$\text{C}_{(s)} + \text{O}_2 \rightarrow \text{CO}_{2(g)} \quad \Delta H^\circ = -394 \text{ kJ mol}^{-1}$$
- $$2\text{CO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{CO}_{2(g)} \quad \Delta H^\circ = -569 \text{ kJ mol}^{-1}$$
- Find the formation enthalpy of $\text{CO}_{(g)}$ in kJ mol^{-1} ?
- (1) -109.5 (2) -219 (3) +109.5 (4) +219 (5) -284.5
- (20) The organic compound P does not react with aqueous Na_2CO_3 while reacts with aqueous KOH. P give a precipitate with Brady's reagent while does not reduce Tollences reagent, P would be,



*

- (21) Consider the following reversible reaction.



The true statement regarding the above reaction which exist in the equilibrium at TK temperature?

- (1) The concentrations of SO_2 and NO_2 are always equal in an equilibrium system relevant to above reaction.
 (2) The equilibrium of the system does not changed when increasing the temperature at constant pressure.
 (3) The equilibrium does not change by adding equal no of moles of $\text{SO}_3(\text{g})$ and $\text{SO}_2(\text{g})$ at constant volume to the system.
 (4) K_p of the system depends on the total pressure.
 (5) The equilibrium does not changed by adding He gas to the system at constant pressure.

- (22) Which of the following statement is false regarding esters.
- (1) Conc. H_2SO_4 act as catalyst to form esters when reacting carboxylic acid with an alcohol.
 - (2) Basic hydrolysis of ester with aqueous NaOH form the sodium salt of carboxylic acid and alcohol.
 - (3) Ketone can not be obtained as a final product by the reaction of Ester with Grignard reagent.
 - (4) Tertiary alcohol is produced always as the final product by the reaction of Ester with Grignard reagent followed by hydrolysis.
 - (5) Primary alcohol can be produced definitely by the reduction of ester using LiAlH_4
- (23) The solution becomes cool by decreasing temperature when dissolving solid $\text{NH}_4\text{Cl}_{(s)}$ in water at 25°C . Which of the following is true regarding this process?
- | ΔH° | ΔS° |
|------------------|------------------|
| (1) (+) ve | (+) ve |
| (2) (+) ve | (-) ve |
| (3) (+) ve | (0) zero |
| (4) (-) ve | (+) ve |
| (5) (-) ve | (-) ve |
- (24) At 27°C and $1 \times 10^5 \text{ Pa}$ pressure 78% of air by volume is N_2 gas. 10m^3 of this air was compressed to 1m^3 at the same temperature. The partial pressure of N_2 in this compressed air in Pa?
- (1) 1×10^5 (2) 7.8×10^4 (3) 1×10^6 (4) 7.8×10^5 (5) 18×10^5
- (25) $4\text{NH}_{3(g)} + 5\text{O}_{2(g)} \longrightarrow 4\text{NO}_{(g)} + 6\text{H}_2\text{O}_{(g)}$
- This reaction occurs above 800°C temperatures, while Pt metal increase the rate of the reaction. Which of the following is the most suitable explanation for the above observation?
- (1) Pt decreases the activation energy of the reaction.
 - (2) Pt provide energy for the reaction.
 - (3) Pt decreases the concentration of products.
 - (4) One product combined with Pt and decrease the concentration of products hence increase the rate of reaction.
 - (5) At least one reactant bind with Pt and the reaction occurs through an alternate path having lower activation energy.
- (26) The total number of electrons exchange during the Oxidation of $\text{CH}_3\text{CH}_2\text{OH}$ from acidic KMnO_4 .
- (1) 4 (2) 5 (3) 9 (4) 10 (5) 20
- (27) The false statement regarding the mechanism of the chlorination of Methane is?
- (1) Energy from diffused sunlight is required only for the chain initiation step.
 - (2) $\text{H}^\bullet$ never formed during chain propagation steps.
 - (3) Diffused sunlight is not required for chain termination steps.
 - (4) Methane chlorination takes place without extra energy.
 - (5) Chain propagation takes place because chlorine free radicals are highly unstable.

- (28) Which of the following gives the IUPAC cell notation and E°_{cell} of a cell formed using standard hydrogen electrode and silver - silver chloride electrode using HCl as the common electrolyte for both electrodes.

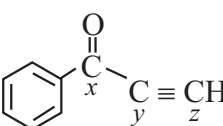
$$E^\circ_{\text{H}^+(\text{aq}) / \text{H}_2(\text{g})} = 0 \text{ V}$$

$$E^\circ_{\text{AgCl(s)} / \text{Ag(s)}} = +0.22 \text{ V}$$

- | | $E^\circ_{\text{cell}} \text{ (V)}$ |
|--|-------------------------------------|
| (1) $\text{Ag(s)} \text{AgCl(s)} \text{Cl}^-(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{H}^+(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{H}_2(\text{g}) \text{Pt(s)}$ | + 0.22 V |
| (2) $\text{Pt(s)} \text{H}_2(\text{g}) \text{H}^+(\text{aq}, 1.00 \text{ mol dm}^{-3}), \text{Cl}^-(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{AgCl(s)} \text{Ag(s)}$ | - 0.22 V |
| (3) $\text{Pt(s)} \text{H}_2(\text{g}) \text{H}^+(\text{aq}, 1.00 \text{ mol dm}^{-3}), \text{Cl}^-(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{AgCl(s)} \text{Ag(s)}$ | + 0.22 V |
| (4) $\text{Ag(s)} \text{AgCl(s)} \text{Cl}^-(\text{aq}, 1.00 \text{ mol dm}^{-3}), \text{H}_2(\text{g}) \text{H}^+(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{Pt(s)}$ | + 0.22 V |
| (5) $\text{Pt(s)} \text{H}_2(\text{g}) \text{H}^+(\text{aq}, 1.00 \text{ mol dm}^{-3}), \text{Cl}^-(\text{aq}, 1.00 \text{ mol dm}^{-3}) \text{AgCl(s)}, \text{Ag(s)}$ | - 0.22 V |
- (29) The concentration of the solution obtained by diluting 100 cm^3 of HCl solution with the composition 30% (w/w) till 500 cm^3 is 2 mol dm^{-3} . The density of the initial HCl solution in g cm^{-3} is? (H-1, Cl-35.5)
- (1) 0.22 (2) 0.35 (3) 0.44 (4) 0.96 (5) 1.22
- (30) What is the initial concentration of NH_3 which should maintain in this solution to precipitate Fe(OH)_2 from 0.4 mol dm^{-3} FeCl_2 solution at 27°C ?
 at 27°C $K_{\text{sp}}(\text{Fe(OH)}_2) = 1.6 \times 10^{-14} \text{ mol}^3 \text{ dm}^{-9}$, $K_{\text{b}}(\text{NH}_3) = 2 \times 10^{-5} \text{ mol dm}^{-3}$
- (1) 2×10^{-10} (2) 3×10^{-10} (3) 2×10^{-9} (4) 3×10^{-9} (5) 4×10^{-9}

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 of combination of responses is correct.
- (31) Which of the following statement/(s) explain the correct reason for increasing the rate of a reaction when increasing the concentration?
- (a) There is direct relationships between the concentration and the activation energy of the reaction.
 (b) Effective collisions increases when increasing the reactant concentrations.
 (c) When increasing the concentration of reactants collision between molecules increases due to increasing the number of molecules in a unit volume.
 (d) The energy of reactant molecules increases when increasing the concentration.

- (32)  Which of the following statement/(s) is/are correct regarding the molecule,

- (a) All the C atoms are sp^2 hybridized.
 (b) Carbon atoms named as x, y and z the oxygen atom lie on the same plane.
 (c) All C - H bond lengths are identical.
 (d) Carbon atoms named as x, y and z lie on a straight line.

- (33) An ideal solution was prepared by mixing pure, two miscible liquids together. Which of the following is/are false?
- The enthalpy change is not zero when mixing.
 - The Raoult's law can be applied for above ideal solution.
 - Vapour pressure of the solution and the mole fraction of each substance change linearly.
 - The vapour pressure of one component in the vapour phase is equal to the product of mole fraction of that component and the saturated vapour pressure.

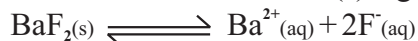
- (34) Which of the following statement / (s) is/are true regarding elements and their compounds in P block?
- The compounds which produced as products when SiCl_4 reacts with less amount of water and excess amount of water respectively are SiO_2 and H_2SiO_3 .
 - POCl_3 is a product when reacting equal moles of PCl_5 and water.
 - SO_2 gas is evolved when reacting S with conc HNO_3 .
 - dil. HNO_3 acid cannot act as an oxidizing agent.

- (35) Which of the following statement/(s) is/are true regarding the molecule given below?



- An alcohol is produced when subjected to reduction with LiAlH_4 followed by hydrolysis.
 - Dibromide is produced as a product when reacting the product in (a) with HBr .
 - Methane is produced when the above carboxylic acid reacts with CH_3MgBr .
 - C=O group in the above molecule can be reduced by NaBH_4 .
- (36) Which of the following statement/(s) is/are true regarding an experiment of the identification of cations of d block?
- Ni^{2+} and Fe^{2+} form green coloured precipitates with aqueous NaOH .
 - The complexes formed by Co^{2+} and Ni^{2+} ions with conc. HCl is yellow colour.
 - Coloured complexes are formed by Fe^{3+} and Mn^{2+} with excess NH_3 .
 - The ammonium complex of Cu^{2+} is blue colour while the ammonium complex of Zn^{2+} is colourless.
- (37) Which of the following statement/(s) is/are true regarding the Green house gases in atmosphere?
- SO_2 and NO_2 are green house gases.
 - O_2 and N_2 are green house gases.
 - N_2O and CO_2 are green house gases.
 - CFC and HCFC act as green house gases.

- (38) The balanced equation of saturated aqueous solution of sparingly soluble compound $\text{BaF}_2(\text{s})$ in water is given below. The false statement/(s) regarding this equilibrium is/are,



At constant temperature,

- The solubility of BaF_2 increases by shifting the equilibrium towards right by adding HCl acid to the solution.
- The solubility of $\text{BaF}_2(\text{s})$ increases by shifting the equilibrium towards the right when adding H_2SO_4 acid to the solution.
- The solubility of BaF_2 increases by shifting the equilibrium towards the right when adding $\text{Ba}(\text{OH})_{2(\text{aq})}$ into the solution.
- The value of K_{sp} changes when twice the volume of the solution by adding water.

- (39) Which of the following statement/(s) is/are true regarding the production of Na_2CO_3 from the Solvay method?
- Bittern solution can be used as a raw material.
 - The both reactions Amonification and carbonificaion which occur inside Solvay towers are endothermic.
 - The main biproduct of the production process is CaCl_2 .
 - Recycling of CaCl_2 taken place during the production process.
- (40) Which of the following statement/(s) is/are true regarding the production process of Bio Diesel.
- Methanol is essential for the production process.
 - 100% renewable bio Diesel can produced using methanol obtained during the productions of petroleum products.
 - This is transesterification reaction.
 - Saphonification can takes place if used excess catalyst.

● **Instruction for questions 41 -50.**

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

1st statement	2nd statement
(41) Cinnamon oil is obtained by the steam distillation of cinnamon leaves.	Cinnamon oil is move volatile than water.
(42) Fe_3O_4 can reduced to FeO while FeO can oxidize to Fe_3O_4	Fe_3O_4 is a combined oxide consist with two states Fe^{2+} and Fe^{3+} .
(43) Weather $\text{C}_6\text{H}_5\text{NH}_2$ is soluble in a queous HCl , $\text{C}_6\text{H}_5\text{CONH}_2$ is not soluble in aqueous HCl .	The basicity of $\text{C}_6\text{H}_5\text{CONH}_2$ is higher than that of $\text{C}_6\text{H}_5\text{NH}_2$.
(44) Real gases deviate more from the ideal behaviour at high pressures and low temperatures.	The volume of real gaseous molecule is lower than the volume of ideal gas molecule.
(45) A salt bridge is essential to join the two electrodes in a Daniel cell.	NaCl can be used as a salt used in a salt bridge.
(46) Diazonium salts of aromatic amines react with water forming phenols.	Diazonium salts can act as electrophiles.
(47) E^0 cell obtained for an electetrochemical cell is positive value while the E^0 cell obtained for an electrolytic cell is always a negative value.	Wheather electricity produced in an electro chemical cell takes place through spontaneous reaction, it is required to provide energy externally for the electrolysis.
(48) The partition coefficient of a solvent depends on the temperature.	Distribution of a solute in a mixture of solvents is constant at constant temperature.
(49) The anode is made by Ti and the cathode is made by Ni in membrane cell used for the production of NaOH .	During the production of NaOH , reduction at the cathode is $\text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2$.
(50) HCFC (hydrocloloroftuorocarban) gas never be contributed for the depletion of Ozone layer.	HCFC is highly volatile compound while alternative for CFC.

The Periodic Table / ආවර්තිත වගුව

1	1																	2		
1	H																	He		
2	3	4													5	6	7	8	9	10
	Li	Be													B	C	N	O	F	Ne
3	11	12													13	14	15	16	17	18
	Na	Mg													Al	Si	P	S	Cl	Ar
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	55	56	La-	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	87	88	Ac-	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118		
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og		

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

The Periodic Table / ආවර්තිත වගුව

1																	2			
1	H																	He		
2	3	4													5	6	7	8	9	10
	Li	Be													B	C	N	O	F	Ne
3	11	12													13	14	15	16	17	18
	Na	Mg													Al	Si	P	S	Cl	Ar
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	55	56	La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	87	88	Ac	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118		
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og		

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

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විශ්ව පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP
 විශ්ව පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP
 විශ්ව පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP
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 විශ්ව පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP

තෙවන වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2024
 Third Term Test - Grade 13 - 2024

Index No.:

CHEMISTRY - II

Time 03 hours

Extra reading time 10 minutes

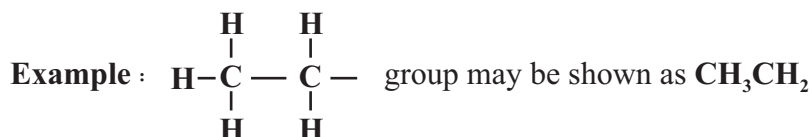
Use **additional reading time** to go through the question paper, select the questions **and** decide on the questions that you give priority in answering.

- A Periodic Table is provided on page 15.

- Use of calculators is not allowed.

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

- In answering this paper, you may represent alkyl groups in a condensed manner.



PART A - Structured Essay (page 02 - 08)

- 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 (page 09 - 14)

- 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		

Total

In Numbers	
In Letters	

Code Numbers

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

Structure Essay**PART - A**

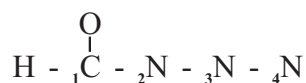
Answer all the questions on this paper itself.

(01) (a) Mention the given statements are true or false. (Reasons are not required)

- (i) Oxidation numbers of both S atoms in $\text{S}_2\text{O}_3^{2-}$ ion is +2 each
- (ii) BCl_3 and NO_3^- are isoelectronic species
- (iii) Both molecules PF_5 and NF_5 are stable.
- (iv) Polarizing power of metal cations increases down the group.
- (v) The Paschen series exist in the Infra-Red region of the atomic spectrum of H
.....
- (vi) The energy released when gaining electrons to gaseous sulfur is higher than the energy released when gaining electrons to gaseous oxygen.

(1a. marks 4 x 6 = 24)

(b) (i) Draw the most acceptable Lewis. Dot Dash structure for the molecule CHON_3 , according to the skeleton and the data given below.



atom	hybridization
${}^1\text{C}$	SP^2
${}^2\text{N}$	SP^2
${}^3\text{N}$	SP

.....

(ii) Draw a rough sketch of the Lewis structure in (i) above, giving the shape and approximate bond angles.

.....

- (iii) The most acceptable stable Lewis structure for the isocyanate compound, molecule CH_2CHNCO is given below. Draw three more Lewis structure for that molecule and comment on their stabilities as stable, unstable, less stable.



.....

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.....

- (iv) Complete the following table based on the Lewis dot - dash structure and its labelled skeleton given below.



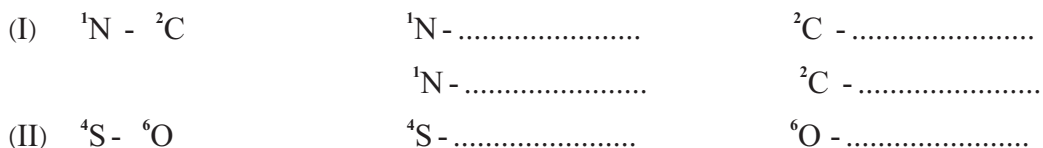
	${}^2\text{C}$	${}^3\text{N}$	${}^4\text{S}$	${}^5\text{O}$
(I) The VSEPR pairs around the atom				
(II) The electron pair geometry around the atom.				
(III) The shape around the atom				
(IV) The hybridization of the atom				

- The questions (v), (vi) and (vii) are based on the Lewis Dot Dosh structure given in (iv) above.

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

(I) ${}^1\text{N} - {}^2\text{C}$	${}^1\text{N} - \dots\dots\dots$	${}^2\text{C} - \dots\dots\dots$
(II) ${}^2\text{C} - {}^3\text{N}$	${}^2\text{C} - \dots\dots\dots$	${}^3\text{N} - \dots\dots\dots$
(III) ${}^2\text{N} - {}^4\text{S}$	${}^3\text{N} - \dots\dots\dots$	${}^4\text{S} - \dots\dots\dots$
(IV) ${}^4\text{S} - {}^5\text{O}$	${}^4\text{C} - \dots\dots\dots$	${}^5\text{O} - \dots\dots\dots$
(V) ${}^5\text{O} - \text{H}$	${}^5\text{O} - \dots\dots\dots$	$\text{H} - \dots\dots\dots$

- (vi) Identify the atomic orbitals involved in the formation of the π bonds between two atoms given below.



- (vii) Arrange the atoms ${}^1\text{N}$, ${}^2\text{C}$, ${}^3\text{N}$, ${}^4\text{S}$, ${}^5\text{O}$ in the increasing order of electro negativity.

.....

(1b. marks 60)

- (c) Arrange the following in the increasing order of the property indicated in parenthesis.

- (i) Na, Mg, Al, K (Melting point)

.....

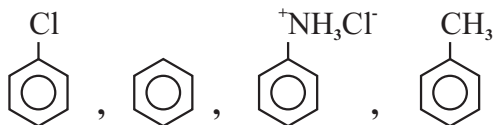
- (ii) SO_3 , Cl_2O_7 , P_4O_{10} , SiO_2 (Acidic Nature)

.....

- (iii) HNO_3 , N_2O , NO_2Cl , NO (N - O bond length)

.....

- (iv) (Possibility electrophilic substitution)



(1c. marks 4 x 4 = 16)

- (02) (a) Test tubes labelled from P to T contain following solid compound (Not in order)

NaNO_3 , $\text{Ca}(\text{NO}_3)_2$, NH_4Cl , NH_4NO_2 , KHCO_3 .

Information regarding the products formed when above solid compounds heated are given below.

Solid Compound	Product
P	• Water vapour • Colourless diatomic gas
Q	• Colourless diatomic gas • Reddish brown gas • White powder which reacts with water forming basic solution
R	• Basic white powder • Water vapour • Colourless, odourless gas which turn lime water milky colour
S	• Acidic gas • Basic gas with pungent smell which turns Nestler reagent brown
T	• Basic white powder • Colourless diatomic gas

(i) Identify solid compound P to T.

P-

R-

T-

Q-

S-

(ii) Write balanced chemical equations for the decomposition of solid substance from P to T.

.....

.....

.....

.....

.....

.....

.....

(2a. marks 30)

(b) (i) Identify the species from A to M based on the information given below.

- A is a solid ionic compound composed of three elements in the ratio 3:1:1, where an aqueous solution of A reacts with Al in basic medium forming basic gas B with a pungent smell and colourless aqueous solution C.

The metallic element contains in A is a component of Silvite which is an iron ore.

- The gas B reacts with excess Cl_2 gas forming gaseous compound D and substance E which can be used as a disinfectant in water.
- F which is an element belongs to the 2nd period of the periodic table reacts with aqueous solutions of strong acids and strong bases. F reacts with a dilute solution of strong acid producing a solution containing salt G and colourless diatomic gas H. When small amount of aqueous BaCl_2 solution is added to this solution gives a white precipitate I insoluble in dilute acids.
- J contains iron which is a stable compound of 3d block element. When J dissolved in conc. HCl solution, form yellow colour solution K.

J reacts with dilute HCl forming an aqueous solution L which is reddish brown in colour. While, form a reddish brown precipitate M when small amount of aqueous KOH solution is added.

A-

F-

K-

B-

G-

L-

C-

H-

M-

D-

I-

E-

J-

- (ii) (I) Write the balanced chemical equation for the reaction of an aqueous solution of A with Al in presence of the base KOH.

.....

- (II) Write an experiment to identify gas H in the laboratory giving observations from it.

.....

- (iii) (I) Write other laboratory experiment to identify the anion in A.

.....

- (II) What is the chemical species which gives the observation in the experiment in (I) above.

.....

(2b. marks 70)

- (03) (a) (i) Write an expression for the equilibrium constant K_a , for the equilibrium occurs in an aqueous solution of weak acid $\text{CH}_3\text{COOH}_{(\text{aq})}$.

.....

- (ii) Write an expression for pH of the equilibrium in (i) above including K_a of the acid.

.....

- (iii) If K_a of $\text{CH}_3\text{COOH}_{(\text{aq})}$ is $1.8 \times 10^{-5} \text{ mol dm}^{-3}$, find the pH value of 0.1 mol dm^{-3} of above acid added in to a titration flask.

.....

- (b) (i) Write the equation relevant to the equilibrium that exists in an aqueous solution of the salt NaA formed by the weak acid HA.

.....

- (ii) If the equilibrium constant for the above equilibrium is K_b , show that,

$$[\text{OH}^-_{\text{aq}}] = K_b \frac{[\text{A}^-_{\text{aq}}]}{[\text{HA}_{\text{aq}}]}$$

.....

- (iii) Obtain the equation $K_b = \frac{K_w}{K_a}$ using above expression.

(K_w = dissociation constant of water, K_a = dissociation constant of HA)

.....

- (vi) What is the pH value when 25 cm³ of NaOH is added to 25 cm³ of 0.1 mol dm⁻³ HA solution.

.....

- (c) (i) Write the two hydrolysis reactions of diacidic base B^{2-} .

.....

- (ii) If the equilibrium constants for above two reactions are K_{b1} and K_{b2} respectively, write expression for equilibrium constants.

.....

- (04) (a) The molecular formula of four compounds A, B, C and D is $C_5H_{11}Br$. All these react with aqueous NaOH solution forming E, F, G, H respectively while they react with Na evolving H_2 . D is a position isomer of B while, only C shows optical isomerism. F, G and H react with PCC forming I, J and K respectively while E does not react with PCC. Only K reacts with ammoniacal $AgNO_3$ producing silver mirror.

(i) Draw the structures of A, B, C, D, E, F, G, H, I, J, K in the boxes given below.

A	B	C
D	E	F
G	H	I
J	K	

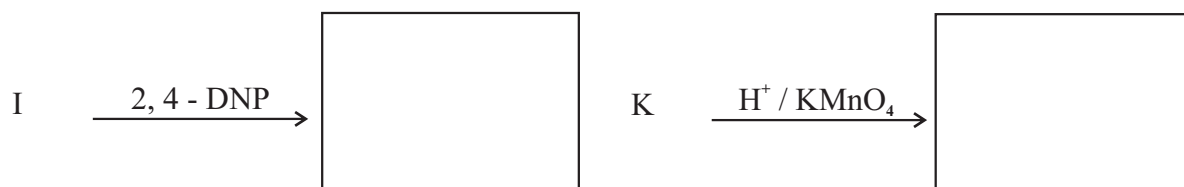
(ii) Write an experiment to distinguish the compounds E and H.

.....

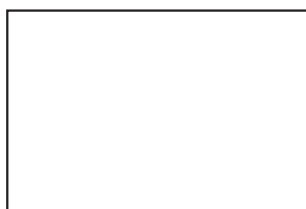
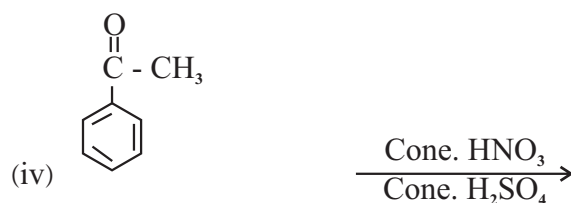
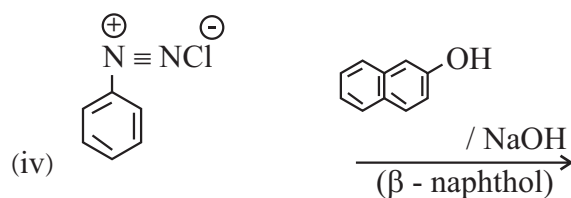
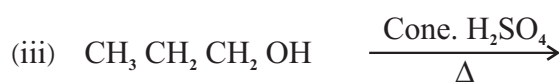
.....

.....

(b) Draw the structures of the products formed by following reactions.



(c) Write the structures of the main products formed by the following reaction.



(d) Give the mechanism and the structure of the product for the reaction between alcohol CH_3OH with HBr .



ESSAY (Part - B)

- Answer two questions only.

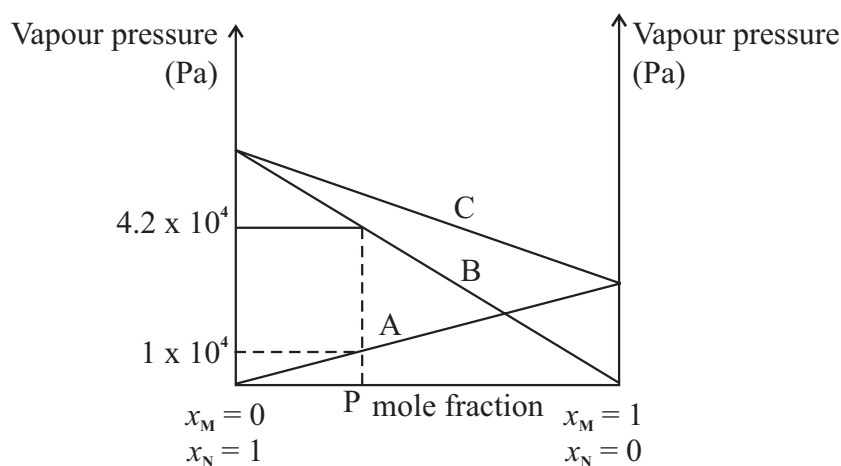


The solid AB_2 decomposed at the temperatures above 360 K.

The volume of the vessel which contains AB_2 solid is 2dm^3 .

0.008 moles of $\text{AB}_{2(s)}$ in the above vessel was allowed to decomposed at 480K. The total pressure inside the vessel at this temperature was $3.2 \times 10^5 \text{ Pa}$.

- Calculate the mole fractions of each gas inside the vessel at this temperature.
 - Calculate the K_c and K_p for the above reaction at 480 K temperature.
- (b) M and N are two volatile liquids. An ideal solution is formed by mixing these solutions. The vapour pressure - composition graph for this solutions at $T^\circ\text{C}$ is given below.



- What is an ideal solution?
 - Name A, B and C line in the above reaction.
 - If the x_M of the solution P is 0.3, Calculate the saturated vapour pressure of M and N at $T^\circ\text{C}$.
 - Calculate the mole ratio of M and N in the vapour phase which exist in the equilibrium with above solution P.
 - Draw the temperature - composition graph for above mixture and mark P and its compositions in the vapour phase.
- (c) The experimental data of an experiment done to determine the distribution coefficient of RCOOH between water and Butanol at 300 K is given below.
- The volume of Butanol layer is 100cm^3 while, 5cm^3 of KOH was consumed to neutralize RCOOH in the 10cm^3 of above solution.
 - The volume of aqueous layer is 50cm^3 while 75cm^3 of KOH was consumed to neutralize RCOOH in the 25cm^3 of this layer.
- Calculate the distribution coefficient between water and Butanol at above temperature.
 - When the above KOH solution is titrated with 25cm^3 0.06 mol dm^{-3} HNO_3 solution, presence of phenolphthalein, the volume of KOH consumed was 12.5cm^3 . What is the total number of moles of RCOOH exist before the distribution among water and Butanol.

- (06) (a) (i) Write the Hess's Law.
- (ii) Use following data to Calculate the standard Lattice dissociation enthalpy of $\text{CuS}_{(s)}$ Using a Born Haber cycle.

The standard sublimation enthalpy of $\text{Cu}_{(s)}$	=	338 KJmol^{-1}
The standard first ionization enthalpy of $\text{Cu}_{(g)}$	=	745 KJmol^{-1}
The standard second ionization enthalpy of $\text{Cu}_{(g)}$	=	1958 KJmol^{-1}
The standard atomization enthalpy of $\text{S}_{(s), \text{Rhombic}}$	=	279 KJmol^{-1}
The standard first electron gain enthalpy of $\text{S}_{(g)}$	=	-200 KJmol^{-1}
The standard second electron gain enthalpy of $\text{S}_{(g)}$	=	$+532 \text{ KJmol}^{-1}$
The standard formation enthalpy of $\text{CuS}_{(s)}$	=	-53 KJmol^{-1}

- (b) Consider the following reaction $\text{A}_{(aq)} + \text{B}_{(aq)} \rightarrow \text{C}_{(aq)}$. The initial rates of reactions obtained for some experiments done at 27°C and 35°C using different initial concentrations of $\text{A}_{(aq)}$ and $\text{B}_{(aq)}$ are given below. The experiment 4 and 5 was done using different amounts of the solution x .

Experiment No.	Temperature $^\circ\text{C}$	Initial concentration / mol dm^{-3}			Initial Rate / $\text{mol dm}^{-3} \text{ s}^{-1}$
		$\text{A}_{(aq)}$	$\text{B}_{(aq)}$	$x_{(aq)}$	
1	27	0.50	0.25	-	0.002
2	27	0.25	0.25	-	0.001
3	27	0.25	0.50	-	0.004
4	27	0.25	0.50	0.5	0.020
5	27	0.25	0.50	1.0	0.020
6	35	0.25	0.50	-	0.016

- (i) Write an expression using the concentrations $\text{A}_{(aq)}$ and $\text{B}_{(aq)}$ for the rate of above reaction.
- (ii) Calculate the order with respect to $\text{A}_{(aq)}$ and $\text{B}_{(aq)}$ and the overall order of the reaction at 27°C .
- (iii) Find the initial rate of the reaction when the concentration of $\text{A}_{(aq)}$ is 0.5 mol dm^{-3} and the concentration of $\text{B}_{(aq)}$ is 1.0 mol dm^{-3} at 27°C .
- (iv) What is the function of $x_{(aq)}$ in the above reaction.
- (v) What is the reason for the difference in initial rates in experiments 3 and 6?
- (vi) If the rate determination step of above reaction is exothermic, draw energy profile in the same diagram when presence of $x_{(aq)}$ and absence of $x_{(aq)}$.
- (07) (a) Consider a situation that current flows through an electro chemical cell formed by using the Standard Oxygen electrode and the standard calamel electrode at 25°C .

$$E^\ominus_{\text{O}_2(g) / \text{OH}^-(aq)} = +0.40 \text{ V}$$

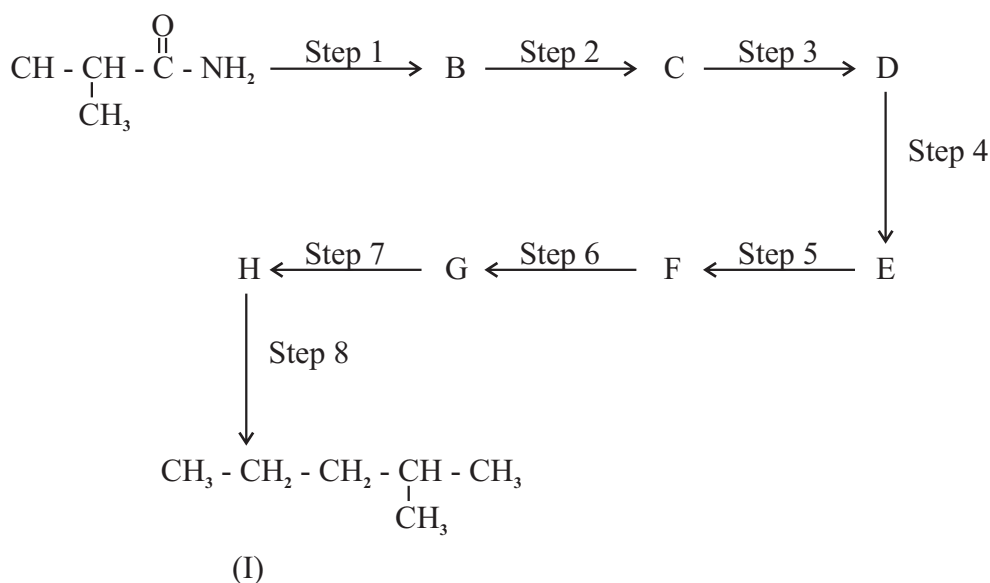
$$E^\ominus_{\text{Hg}_2\text{Cl}_2(s) / \text{Hg}(l)} = +0.27 \text{ V}$$

- (i) Write the half reactions occurs in the Anode and the Cathode.
 - (ii) Write the overall cell reaction.
 - (iii) Calculate the E°_{cell} of this cell at the above temperature.
 - (iv) It is expected to precipitate OH^- ions from $\text{Mg}^{2+}_{(\text{aq})}$ ions just after the completion of current flow of 25 mA during 750 S at above temperature. Thus MgCl_2 was added drop wise. If the volume of electrolyte in the Oxygen electrode is 200 cm^3 and K_{sp} of $\text{Mg}(\text{OH})_2$ at 25°C is $1.5 \times 10^{-11} \text{ mol}^2 \text{ dm}^{-6}$. Find the $[\text{Mg}^{2+}_{(\text{aq})}]$ when it starts to precipitate $\text{Mg}(\text{OH})_2$.
 - (v) Write one advantage and a disadvantage of using the above Calamel electrode over the standard hydrogen electrode as reference electrode in the practical experiments in electrochemistry.
- (b)
- (i) Write the electron configuration of Mn.
 - (ii) Write three stable Oxidation states of Mn.
 - (iii) Write the chemical formula of dioxide formed by Mn.
 - (iv) Write the Oxides of Mn with different Oxidation numbers Mention the Oxidation numbers of Mn and acidic, basic nature of those Oxides.
 - (v) Write the Chemical formulae of complex ions formed with ligands H_2O and Cl^- separately with Mn^{2+} . Write the IUPAC names of them and mention the colour.

(PART - C) - ESSAY

- Answer two questions only.

- (08) (a) The compound A transformed to the compound I using the following reaction sequence. Complete the following giving structures of B, C, D, E, F, G, H and selecting the reagents from the given list for the steps (1) to (8).



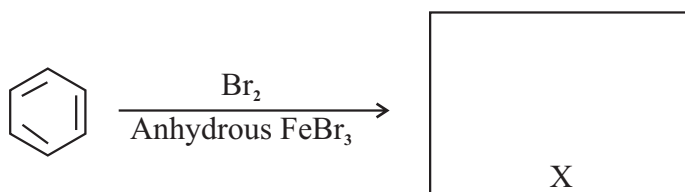
List of Reagents :-

CH_3CHO , $\text{NaNO}_3 / \text{HCl}$, $\text{Mg} / \text{dry ether} / \text{H}^+ / \text{H}_2\text{O}$, PBr_3 , LiAlH_4 , Peridinium chlorochromate (PCC), Zn / Hg , Cane. HCl

- (b) Complete the following translation with 05 steps.

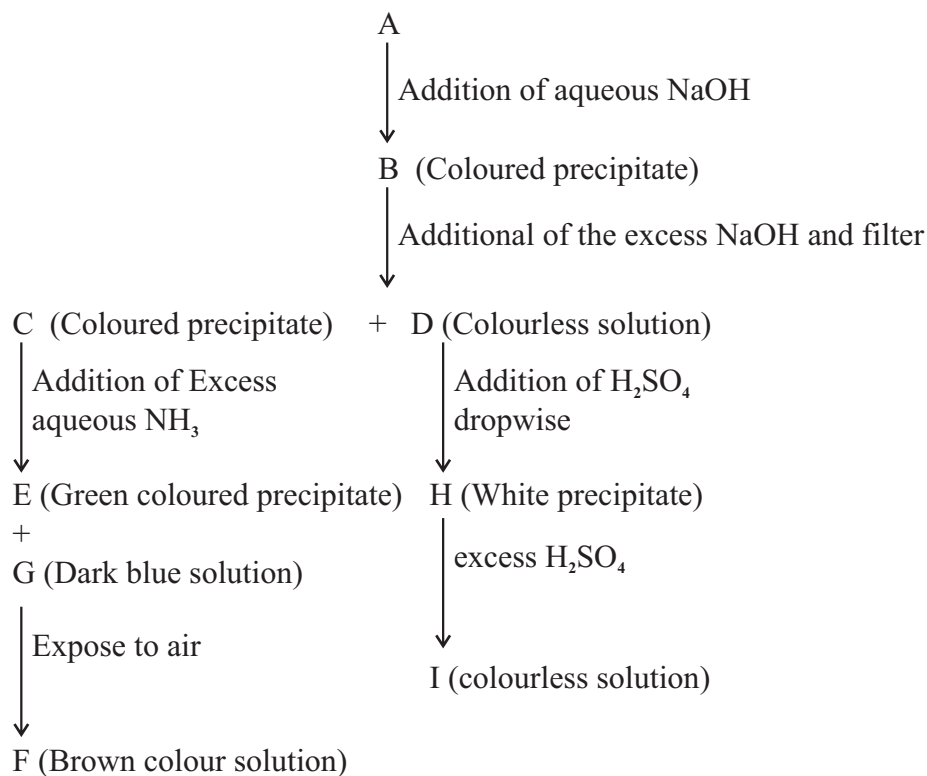


- (c) Give the structure of the Product X in the following Reaction. Write the mechanism of this reaction.



- (d) (i) Carboxylic acids are acidic than alcohols. Explain.
 (ii) Use a suitable reaction to explain the difference in the reactivity in (i) above.
 (iii) Draw structure/(s) product/(s) explain in the reaction in (ii) above.

- (09) (a) A is an aqueous solution containing three metal cations. Following activities were done for this solution A.



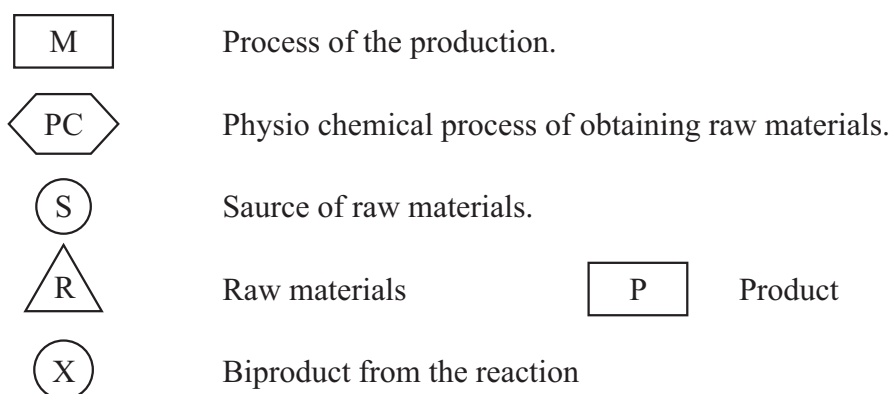
- (i) Identify the metal cations contains in the aqueous solution A.
 (ii) Write the chemical formulae of the species which contains above metal cations from B to I.
 (iii) Write the IUPAC names of the species B to I. Which contains metal cations.

- (b) 1 g of a salt mixture containing Na_2CO_3 , $\text{Na}_2\text{C}_2\text{O}_4$, NaNO_3 is mixed in water forming 25.00 cm^3 solution. Above solution was reacted with excess $\text{Ca}(\text{NO}_3)_2$ and the mass of the precipitate obtained was 0.410 g . This precipitate was dissolved in dil H_2SO_4 and titrated with $0.025 \text{ mol dm}^{-3}$ KMnO_4 solution. The volume of KMnO_4 consumed was 10.00 cm^3 .

- Write the balanced chemical equations for all the reactions above.
- Calculate the mass percentage of each component in the mixture.

- (10) (a) Chemical synthesis of the pair of substances P_6 and P_7 is given in the following flow chart.

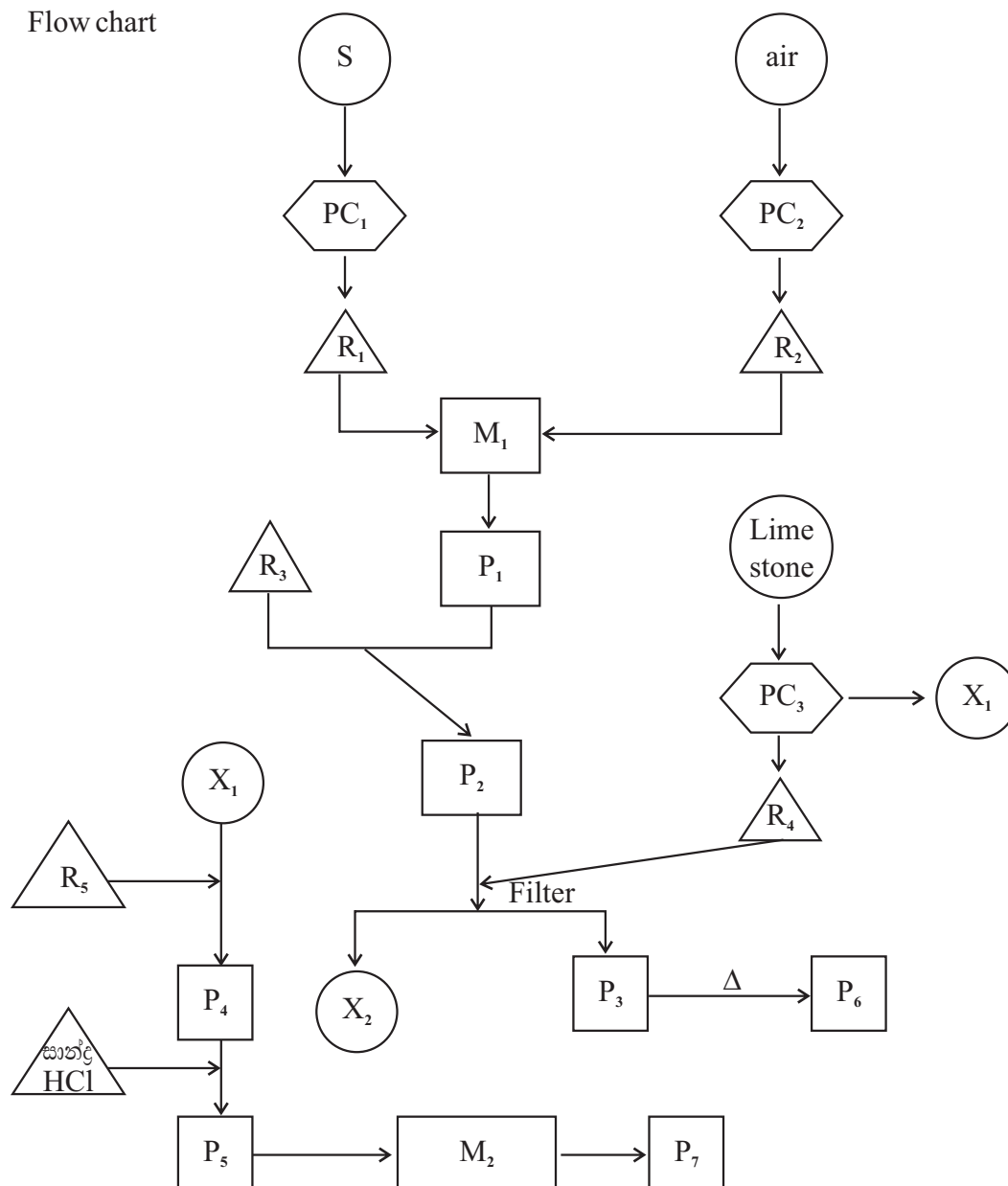
P_1 is used as a raw material in the production of HNO_3 . R_3 is a concentrated solution which removed Ca^{2+} , Mg^{2+} SO_4^{2-} ions. R_5 is solution formed as a byproduct in salt production. P_7 burns with white coloured flame in air.



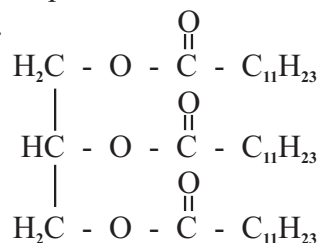
Write the answers for the following using the flow chart given below.

- Identify P_1 , P_2 , P_3 , P_4 , P_5 , P_6 and P_7
- Identify R_1 , R_2 , R_3 , R_4 and R_5
- Identify X_1 and X_2
- Identify S.
- Mention the processes in PC_1 , PC_2 and PC_3 briefly.
- Identify the production process M_1 and M_2 . Mention the conditions used in M_1 .
- Write one use each in P_6 and P_7 .

Flow chart



- (b) Loric acid is a component contains in coconut oil. The structure of the triglyceride of Loric acid is given below.



- What are the other substances required to synthesis bio-diesel from Loric acid.
- Give a chemical reaction for the synthesis of bio diesel.
- Mention the type of reaction occurs in the above synthesis.
- Write two advantages of using bio diesel.
- During the production of bio diesel it may formed a substance we used in our day today life. What is that substance? How you minimize the formation of that substance during the formation of bio diesel.
- Why it is required to minimize it ?

C

- (i) Mention clearly what are considered as acid rains.
- (ii) Name the main gases effect on acid rains.
- (iii) Use balanced chemical equations to shows clearly how the gases mentioned above form acid rains.
- (iv) Mention one gas each from above which effect for the following.
 - (a) Globle warming
 - (b) Green house effect'
 - (c) Depletion of ozone layer.
 - (d) Photo chemical smog.

The Periodic Table / ආවර්තිතා වගුව

1																	2					
	H																	He				
2	3	4															5	6	7	8	9	10
	Li	Be															B	C	N	O	F	Ne
3	11	12															13	14	15	16	17	18
	Na	Mg															Al	Si	P	S	Cl	Ar
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54				
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
6	55	56	La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86				
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
7	87	88	Ac	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118				
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og				
	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71							
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu							
	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103							
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr							

