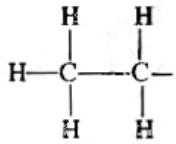
අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2017 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2017 ஒகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2017

රසායන විද්‍යාව II இரசாயனவியல் II Chemistry II	02 E III	පැය තුනයි மூன்று மணித்தியாலம் Three hours

Index No. : .....

* *A Periodic Table is provided on page 15.*
* ***Use of calculators is not allowed.***
* *Universal gas constant, $R = 8.314\ J\ K^{-1}\ mol^{-1}$*
* *Avogadro constant, $N_A = 6.022 \times 10^{23}\ mol^{-1}$*
* **In answering this paper, you may represent alkyl groups in a condensed manner.**

Example:  may be shown as CH_3CH_2-

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

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

❑ PART B and PART C — Essay (pages 9 - 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		
Percentage		

Final Mark

In Numbers	
In Letters	

Code Numbers

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

[see page two

PART A — STRUCTURED ESSAY

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

Do not write in this column.

1. (a) (i) I. Complete the expression given below to determine the charge ($\mathbb{Q}$) of an atom in a Lewis structure by inserting the terms $\mathbb{N}_A$, $\mathbb{N}_{LP}$ and $\mathbb{N}_{BP}$ in the appropriate boxes, where,

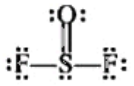
$\mathbb{N}_A$ = number of valence electrons in the atom

$\mathbb{N}_{LP}$ = number of electrons in lone pairs

$\mathbb{N}_{BP}$ = number of electrons in bonding pairs around the atom

$\mathbb{Q}$ = ☐ − ☐ − $\frac{1}{2}$ ☐

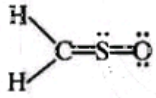
II. Fill in the values for $\mathbb{N}_A$, $\mathbb{N}_{LP}$ and $\mathbb{N}_{BP}$ in the appropriate boxes and calculate the charge on S, $\mathbb{Q}$(sulfur), in the structure SOF_2 given below.



$\mathbb{Q}$(sulfur) = ☐ − ☐ − $\frac{1}{2}$ ☐ = ...

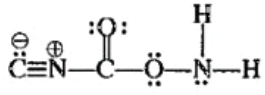
(ii) Draw the most acceptable Lewis structure for the ion, $ClO_2F_2^+$.

(iii) The most stable Lewis structure for the molecule CH_2SO (sulfine) is shown below. Draw another two Lewis structures (resonance structures) for this molecule.

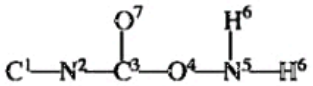


(iv) Based on the hypothetical Lewis structure given below, state the following regarding the C, N and O atoms given in the table below.

I. VSEPR pairs around the atom
II. electron pair geometry around the atom
III. shape around the atom
IV. hybridization of the atom



The atoms are numbered as follows:



		N^2	C^3	O^4	N^5
I.	VSEPR pairs				
II.	electron pair geometry				
III.	shape				
IV.	hybridization				

[see page three

Do not write in this column.

(v) Identify the atomic/hybrid orbitals involved in the formation of the following σ bonds in the Lewis structure given in part (iv) above. (Numbering of atoms is as in part (iv).)

I. N^2—C^3 N^2....., C^3 .....

II. O^4—N^5 O^4....., N^5 .....

III. N^5—H^6 N^5....., H^6 .....

IV. C^3—O^7 C^3....., O^7 .....

(5.5 marks)

(b) (i) Identify the sub-shells (atomic orbitals) along with their azimuthal quantum number (l), and magnetic quantum number/s (m_l) for the energy level with principal quantum number $n=3$ in an atom. What is the maximum number of electrons present in each sub-shell?

Write your answers in the table given below.

Sub-shell	Azimuthal quantum number (l)	Magnetic quantum number/s (m_l)	Maximum number of electrons in each sub-shell
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

(ii) Identify the type/s of intermolecular forces present in I, II and III given below.

I. Ar gas

.....

II. NO gas

.....

III. water sample containing a small amount of dissolved KCl

.....

(iii) "The boiling point of n-butane (C_4H_{10}) is higher than the boiling point of propane (C_3H_8)." Giving reasons, state whether this statement is true or false.

.....

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.....

(iv) Arrange the following in the decreasing order of the property indicated in parentheses. (Reasons are not required.)

I. Li_2CO_3, Na_2CO_3, K_2CO_3 (solubility in water)

..... > ..... > .....

II. NF_3, NH_3, NOCl, NO_2^+ (bond angle)

..... > ..... > ..... > .....

III. $COCl_2$, CO_2, HCN, CH_3Cl (electronegativity of carbon)

..... > ..... > ..... > .....

(4.5 marks)

100

[see page four

Do not write in this column.

2. (a) X, Y and Z are elements that belong to the same group in the Periodic Table. They are in three successive periods respectively on descending the group. Y exists as a non-metallic coloured liquid at room temperature.

(i) Identify X, Y and Z. (Give atomic symbols.)

X = ... Y = ... Z = ...

(ii) Indicate the relative magnitudes of the following with regard to X, Y and Z.

I. Atomic size		>		>	
II. Electron affinity		>		>	
III. First ionization energy		>		>	

(iii) You are provided with aqueous solutions of the anions of X, Y and Z, each in a separate test-tube. Suggest a single reagent that could be used to identify these anions.

[Note: You are required to state the observation for each anion.]

Reagent: .....

Observation: (for the anions)
X: .....
Y: .....
Z: .....

(iv) Give balanced chemical equations for the reactions of $X_2(g)$ with the following.

I. $NH_3(g)$ .....

II. dil. NaOH .....

(v) Draw the structures of two oxoacids of X.

(vi) Name one natural source of X. .....

(vii) I. A monomer that contains X forms an addition polymer that is widely used in the manufacture of water pipes. Draw the structure of the monomer.

II. Write the full name of the polymer. .....

(8.0 marks)

[see page five

Do not write in this column.

(*b*) An aqueous solution Q contains three anions. The following tests were carried out to identify these anions. (Fresh portions of solution Q were used for each test ① to ⑤).

		Test	Observation
①	I	Dilute HCl was added.	A colourless gas was evolved. A clear solution was obtained.
	II	The gas evolved was tested with filter paper moistened with lead acetate.	No colour change
②	I	A $BaCl_2$ solution was added.	A white precipitate was obtained.
	II	The white precipitate was separated by filtration, and dil. HCl was added to it.	The white precipitate dissolved with the evolution of a gas.
	III	The gas evolved was tested with a filter paper moistened with acidified potassium dichromate.	The colour changed from orange to green.
③		Conc. HNO_3 and an excess of ammonium molybdate solution were added and the mixture was warmed.	A yellow precipitate did not form.
④		Devarda's alloy and NaOH solution were added and the mixture was heated.	A gas that turned Nessler's reagent brown was evolved.
⑤		A $FeCl_3$ solution was added.	A blood red coloured solution was obtained.

(i) Identify the three anions in solution Q.

..... , ... and .....

(ii) Write the balanced chemical equation for the reaction taking place in test number ② III.

.....

(5.0 marks)

100

3. (*a*) Methylamine, CH_3NH_2 is a weak base. The following equilibrium exists in an aqueous solution of methylamine.

$$CH_3NH_2(aq) + H_2O(l) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq)$$

(i) Write the expression for K_b of methylamine.

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(ii) At 25 °C, the pH value of a 0.20 mol dm^{-3} aqueous solution of methylamine is 11.00. Calculate K_b.

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see page six

Do not write in this column.

(iii) A volume of 25.00 cm^3 of the solution in (ii) above was titrated with 0.20 mol dm^{-3} HCl at 25 °C. Calculate the pH value of the solution at the equivalence point. ($K_w = 1.0 \times 10^{-14}$ $mol^2\,dm^{-6}$ at 25 °C.)

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(5.0 marks)

(*b*) In an experiment, a limited volume of 1.00 mol dm^{-3} HNO_3 was added to a precipitate MX(s) and the system was allowed to reach equilibrium at 25 °C. This resulted in partial dissolution of the precipitate giving rise to a clear solution. The HX(aq) formed behaves as a weak acid.

(i) Write chemical reactions for the equilibria existing in the above solution.

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(ii) Calculate [X^-(aq)] in the solution assuming that the dissociation of HX(aq) is negligible. (Solubility product of MX at 25 °C, $K_{sp(MX)} = 3.6 \times 10^{-7}$ $mol^2\,dm^{-6}$.)

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[see page seven

Do not write in this column.

(iii) Giving reasons explain whether $[X^-(aq)]$ in a saturated aqueous solution of MX at 25 °C is equal to, smaller than or greater than the value obtained in (*b*)(ii) above.

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(5.0 marks)

100

4. (*a*) The alcohols A, B, C and D are structural isomers of each other having the molecular formula $C_5H_{12}O$. A, B and C show optical isomerism.

(i) Draw possible structures for A, B and C.

When B, C and D are reacted with acidic $K_2Cr_2O_7$, X, Y and Z are formed respectively. The products X, Y and Z can be converted back to B, C and D respectively by reacting with $NaBH_4$.

(ii) What is the structure of A?

A

On heating with conc. H_2SO_4 A and B gave E and F, respectively, while C and D gave the same product G. G shows diastereoisomerism. All three compounds E, F and G have the molecular formula C_5H_{10}. When E and F are reacted with HBr the same product H was formed.

(iii) Draw the structures of B, C, D, E, F and H.

B C D

E F H

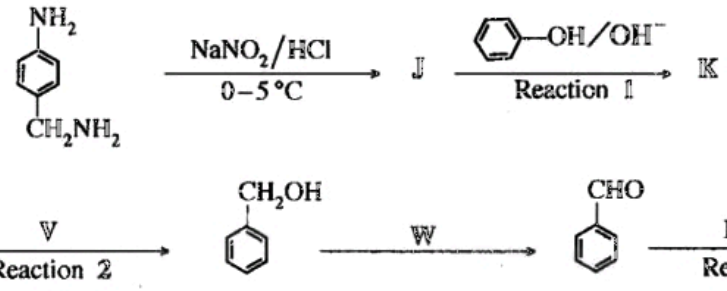
[see page eight

Do not write in this column.

(iv) Draw the structures of the diastereoisomers of G.

(4.8 marks)

(b) Consider the two reaction schemes given below.



(i) Draw the structures of J, K and L in the boxes given below.

J K L

(ii) Write the reagents V and W in the boxes given below.

V = W =

(iii) Writing A_E, A_N, S_E, S_N or E in the appropriate box, classify each of the reactions 1, 2 and 3 as electrophilic addition (A_E), nucleophilic addition (A_N), electrophilic substitution (S_E), nucleophilic substitution (S_N) or elimination (E) reaction.

Reaction 1 Reaction 2 Reaction 3

(4.0 marks)

(c) (i) What is the structure of the major product of the reaction between $CH_3CH{=}CH_2$ and HBr?

(ii) Write the mechanism of the above reaction.

(1.2 marks)

100

* *

[see page nine

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கல்விப் பொதுத் தராதர் பத்திர (உயர் தர)ப் பரீட்சை, 2017 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2017

රසායන විද්‍යාව	II
இரசாயனவியல்	II
Chemistry	II

02 E III

* Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$

* Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

PART B — ESSAY

Answer two questions only. (*Each question carries* 15 *marks.*)

5. (*a*) The following reaction occurs when $NaHCO_3(s)$ is heated to a temperature above 100 °C.

$$2\ NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

A sample of $NaHCO_3(s)$ was placed in an evacuated closed rigid container of 5.00 dm^3 volume and heated to 328 °C. After the equilibrium was reached, a small amount of $NaHCO_3(s)$ still remained in the container. The pressure of the container was found to be 1.0×10^6 Pa. Assume that the volume of the solids remaining in the container is negligible. RT = 5000 J mol^{-1} at 328 °C.

(i) Calculate the number of moles of $H_2O(g)$ in the container when the equilibrium is reached at 328 °C.

(ii) Calculate K_p for the above equilibrium at 328 °C, and hence calculate K_c.

(iii) An extra amount of $CO_2(g)$ was added into the container described above at 328 °C. When the equilibrium is re-established, the partial pressure of $CO_2(g)$ was four (4) times the partial pressure of $H_2O(g)$. Calculate the partial pressures of $CO_2(g)$ and $H_2O(g)$ under this condition.

(7.5 *marks*)

(*b*) In order to determine the standard enthalpy change ($\Delta H°$) of the reaction,

$$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$$

the following experiment consisting of two steps (I and II) was carried out at room temperature.

Step I: 0.08 mol of $NaHCO_3(s)$ was added to 100.00 cm^3 of 1.0 mol dm^{-3} HCl acid solution in a beaker. The maximum temperature fall was found to be 5.0 °C.

[The reaction taking place: $NaHCO_3(s) + HCl(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(l) + CO_2(g)$]

Step II: 0.04 mol of $Na_2CO_3(s)$ was added to 100.00 cm^3 of 1.0 mol dm^{-3} HCl acid solution in a beaker. The maximum temperature rise was found to be 3.5 °C.

[The reaction taking place: $Na_2CO_3(s) + 2\,HCl(aq) \rightarrow 2\,Na^+(aq) + 2\,Cl^-(aq) + H_2O(l) + CO_2(g)$]

Specific heat capacity at constant pressure and density of HCl acid solution are 4.0 J g^{-1} K^{-1} and 1.0 g cm^{-3} respectively. Assume that the changes in volume and density of the solutions after the addition of solids in the above two steps are negligible.

(i) Calculate the enthalpy changes (in kJ mol^{-1}) of the reactions given in steps I and II above.

(ii) Using the values obtained in (i) above and a thermochemical cycle, calculate $\Delta H°$ of the reaction,

$$2\,NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g).$$

(iii) State the condition under which a heat change of a reaction is equal to its enthalpy change.

(iv) Identify two sources of error in the above experimental procedure.

(7.5 *marks*)

[*see page ten*

6. (a) (i) Explain why the rate of a reaction increases when the concentrations of the reactants are increased.

(ii) Give two reasons to explain why in general, the rate of a reaction increases with increasing temperature.

(iii) What is the relationship between order and molecularity of an elementary reaction?

(iv) Sketch the structure of the activated complex of the elementary reaction, $NO + O_2 \rightarrow NO_2 + O$.

Label the bonds that are being formed as 'forming' and the bonds that are being broken as 'breaking'.

(v) Write the rate expression for the elementary reaction, $xA + yB \rightarrow zC$, where the rate constant is k, and stoichiometric coefficients are x, y, z.

(5.0 marks)

(b) The reaction $xA + yB \rightarrow zC$ was studied in a two phase system consisting of an organic solvent and water. The compound A is soluble in both phases while compounds B and C are soluble only in the aqueous phase. The partition coefficient for the distribution of A between phases, $K_D = \frac{[A_{(org)}]}{[A_{(aq)}]} = 4.0$.

The compound A was added to the two phase system and allowed to reach equilibrium. The reaction was started by injecting the compound B to the aqueous phase. Temperature of the system was maintained at a constant value. The results of the experiments carried out are given below.

Experiment No.	Volume of the organic phase (cm^3)	Volume of the aqueous phase (cm^3)	Amount of A added to the system (mol)	Amount of B injected (mol)	Initial rate, $\left(\frac{-\Delta C_A}{\Delta t}\right)$ (mol dm^{-3} s^{-1})
I	–	100.00	1.00×10^{-2}	1.00×10^{-2}	1.20×10^{-5}
II	100.00	100.00	1.25×10^{-1}	1.00×10^{-2}	7.50×10^{-5}
III	50.00	50.00	6.25×10^{-2}	1.00×10^{-2}	1.50×10^{-3}

Note: Experiment I was carried out without the organic phase.

(i) Calculate the initial concentration of A in the aqueous phase in experiments I, II and III above.

(ii) Find the order of the reaction with respect to A.

(iii) Find the order of the reaction with respect to B.

(iv) Calculate the rate constant of the reaction.

(v) In the experiment III above, after adding A and allowing the system to reach equilibrium, if a volume of 10.00 cm^3 was removed from the organic phase, what can be stated about the initial rate of the reaction? Give reason/reasons for your answer.

(5.0 marks)

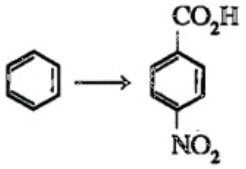
(c) A mixture of liquids X and Y behaves ideally. At a constant temperature, when the liquid phase in equilibrium with the vapour phase in a closed rigid vessel contains 1.2 moles of X and 2.8 moles of Y, the total vapour pressure is 3.4×10^4 Pa. At the same temperature, when the composition of the liquid phase in equilibrium with the vapour phase is 1.2 moles of X and 4.8 moles of Y, the total vapour pressure is 3.6×10^4 Pa. Calculate the saturated vapour pressures of X and Y at this temperature.

(5.0 marks)

[see page eleven

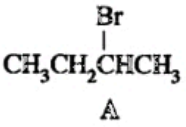
(5.0 marks)

7. (*a*) Show how you would carry out the following conversion in not more than five (5) steps.

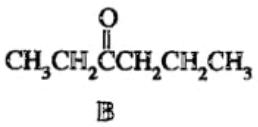


(3.0 *marks*)

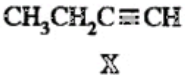
(*b*) Two compounds A and B are required to be prepared in the laboratory.



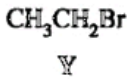
A



B



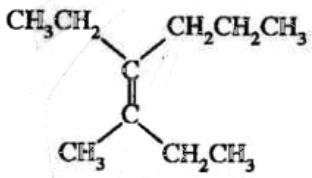
X



Y

(i) Show how you would prepare A and B in not more than five (5) steps in each case, using X and Y as required.

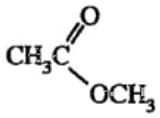
(ii) Show how you would prepare the compound C using A and B given above, in not more than five (5) steps.



C

(9.0 *marks*)

(*c*) Using your knowledge of the mechanism of the reaction between acetyl chloride and NaOH, propose a mechanism for the reaction between



and NaOH.

(3.0 *marks*)

PART C — ESSAY

Answer two questions only. (Each question carries 15 marks.)

8. (*a*) Solution Y contains three cations.

Ⓐ The following tests were carried out to identify these cations.

	Test	Observation
①	Dilute HCl was added to a small portion of Y.	A white precipitate (P_1)
②	P_1 was separated by filtration and H_2S was bubbled through the solution.	A black precipitate (P_2)
③	P_2 was separated by filtration. The filtrate was boiled to remove the H_2S, cooled, and NH_4OH/NH_4Cl was added.	No precipitate
④	H_2S was bubbled through the solution.	A black precipitate (P_3)

[*see page twelve*

Ⓔ The following tests were carried out for precipitates $\mathbb{P}_1$, $\mathbb{P}_2$ and $\mathbb{P}_3$.

Precipitate	Test	Observation
$\mathbb{P}_1$	I. Water was added to $\mathbb{P}_1$ and the mixture was boiled.	Part of $\mathbb{P}_1$ dissolved.
	II. The mixture from I above was filtered while warm and the following tests were carried out on the filtrate ($\mathbb{F}_1$) and residue ($\mathbb{R}_1$).	
	Filtrate ($\mathbb{F}_1$)	
	◦ Dilute H_2SO_4 was added to warm $\mathbb{F}_1$.	A white precipitate
	Residue ($\mathbb{R}_1$)	
	◦ $\mathbb{R}_1$ was washed thoroughly with warm water and dilute NH_4OH was added.	$\mathbb{R}_1$ dissolved.
	◦ Thereafter, a KI solution was added.	A dark yellow precipitate
$\mathbb{P}_2$	$\mathbb{P}_2$ was dissolved in warm dil. HNO_3 and a potassium chromate solution was added.	A yellow precipitate
$\mathbb{P}_3$	I. $\mathbb{P}_3$ was dissolved in warm conc. HNO_3.	A pink coloured solution (solution 1)
	II. The following were added to solution 1 above.	
	◦ conc. HCl	A blue coloured solution (solution 2)
	◦ dil. NH_4OH	A yellow-brown coloured solution (solution 3)

(i) Identify the three cations. (Reasons are not required.)

(ii) Identify,

I. precipitates $\mathbb{P}_1$, $\mathbb{P}_2$ and $\mathbb{P}_3$

II. species responsible for the colours of solutions, 1, 2 and 3.

(Note: Write chemical formulae only.)

(iii) Explain briefly why the cation/s that precipitate/s in Ⓐ ④ above does not/do not precipitate in acidic medium. *(7.5 marks)*

(*b*) A solid sample was found to contain $(NH_4)_2SO_4$, NH_4NO_3 and non-reactive substances. The following procedures were used to determine the amount of ammonium salts present in this sample.

A 1.00 g portion of the solid sample was dissolved in water and diluted to 250.00 cm^3 in a volumetric flask (hereafter referred to as solution S).

Procedure 1

A 50.00 cm^3 portion of solution S was treated with an excess amount of a strong alkali (NaOH) and the gas liberated was passed into 30.00 cm^3 of 0.10 mol dm^{-3} HCl. The volume of 0.10 mol dm^{-3} NaOH required to neutralize the remaining HCl (using phenolphthalein as the indicator) was 10.20 cm^3.

Procedure 2

To a 25.00 cm^3 portion of solution S, Al powder was added followed by an excess of strong alkali, and the mixture was heated. The gas liberated was passed into 30.00 cm^3 of 0.10 mol dm^{-3} HCl. The volume of 0.10 mol dm^{-3} NaOH required to neutralize the remaining HCl (using phenolphthalein as the indicator) was 15.00 cm^3.

(Note: Completion of gas evolution in procedures 1 and 2 was checked using litmus paper.)

(i) Identify the gas liberated in procedure 1.

(ii) Identify the gas liberated in procedure 2.

(iii) Write balanced chemical equations for the reactions taking place in procedures 1 and 2.

(iv) Calculate the mass percentage of each of the compounds $(NH_4)_2SO_4$ and NH_4NO_3 in the solid sample. (H = 1, N = 14, O = 16, S = 32) *(7.5 marks)*

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9. (*a*) Consider the following industrial processes.

I. Manufacture of bleaching powder

II. Manufacture of calcium carbide

III. Manufacture of urea

IV. Manufacture of sulphuric acid (contact process)

(i) State the starting materials used in each process.

(ii) Write balanced chemical equations for the reactions taking place in each process, along with proper conditions wherever necessary.

(iii) State two uses for each of the following:
bleaching powder, calcium carbide, urea and sulphuric acid

(7.5 *marks*)

(*b*) The major environmental problems we are facing at present are ozone layer depletion (OLD), global warming (GW) and acid rain (AR). The questions given below are related to the environment and the problems mentioned above.

(i) The carbon and nitrogen cycles are two important chemical cycles that operate in the environment.

I. With regard to the carbon cycle, state one main form of carbon that is present in each of the following:
atmosphere, plants, water, Earth's crust

II. State briefly how N_2 gas in the atmosphere is removed and replenished in the nitrogen cycle.

III. State two ways by which microorganisms participate in the carbon cycle.

(ii) Identify the two main nitrogen containing compounds present in the atmosphere that contribute to acid rain. With the aid of balanced chemical equations show how these compounds make rain water acidic.

(iii) Identify two contributing industrial processes per environmental problem stated above (OLD, GW, AR). Identify one chemical compound that is liberated to the atmosphere by each of these industrial processes.

(iv) Identify the main industrial process that contributes significantly to the addition of nitrogen compounds to water and soil. Comment on the pathways by which these compounds are added to water and soil.

(v) Inappropriate disposal of solid municipal waste as in the Meethotamulla event contributes significantly to one of the three environmental issues stated above. Identify this environmental issue and state briefly how the disposal of solid municipal waste contributes to it.

(7.5 *marks*)

10. (*a*) (i) $TiCl_3$ is a violet coloured solid. In water, two hydrated species of $TiCl_3$, A and B are formed. A and B are coordination compounds of titanium with an octahedral geometry, containing H_2O and Cl^- as ligands.

A and B were separated and their atomic compositions were determined. The compounds were further analysed using the procedures given below.

Analysis of A

When excess $AgNO_3(aq)$ was added to 50.00 cm^3 of a 0.20 mol dm^{-3} solution of A, a white precipitate that was soluble in dilute ammonia was obtained. The mass of the precipitate after washing and oven drying (to a constant mass) was 4.305 g.

Analysis of B

When excess $AgNO_3(aq)$ was added to 50.00 cm^3 of a 0.30 mol dm^{-3} solution of B, the same white precipitate was obtained as in analysis, A. The mass of the precipitate after washing and oven drying (to a constant mass) was also 4.305 g.

(H = 1, O = 16, Cl = 35.5, Ti = 48, Ag = 108)

I. Write the electronic configuration of titanium in A and B.

II. Deduce the structures of A and B.

III. Give the IUPAC names of A and B.

[*see page fourteen*

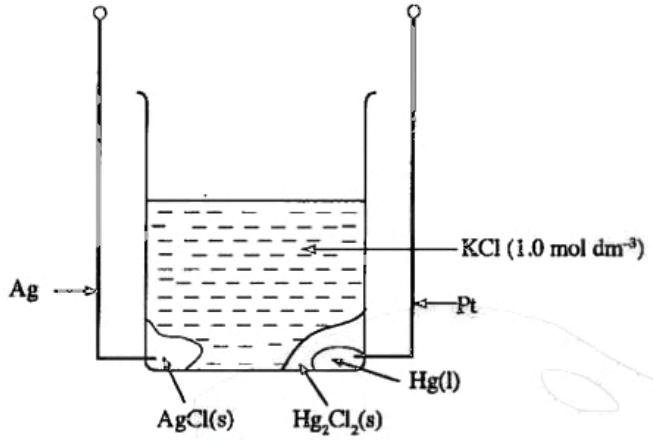
(ii) X, Y and Z are coordination compounds of the metal ion M(II). They have a square planar geometry. X is a neutral compound. On addition of $BaCl_2(aq)$ to an aqueous solution of Y, a white precipitate that is insoluble in dilute acids is obtained. Z gives three ions in aqueous solution.

Write the structural formulae of X, Y and Z selecting the appropriate species from the list given below.

K^+, NH_3, CN^-, SO_4^{2-}

(7.5 marks)

(b)



An electrochemical cell is made as shown in the diagram above.

The following data are provided.

$Ag(s), AgCl(s) \mid Cl^-(aq)$ $\quad E^\circ = 0.22\,V$

$Hg(l) \mid Hg_2Cl_2(s) \mid Cl^-(aq)$ $\quad E^\circ = 0.27\,V$

(i) Write the reduction half reaction of the above cell.

(ii) Write the oxidation half reaction of the above cell.

(iii) Construct the cell reaction.

(iv) Using the E° values given, calculate the electromotive force of the cell.

(v) Give the standard cell notation of the above electrochemical cell.

(vi) Does the electromotive force of the above electrochemical cell depend on the chloride ion concentration? Give reason/s for your answer.

(vii) Calculate the change in the mass of Ag(s) + AgCl(s), when a current of 0.10A was drawn for a period of 60 minutes from the cell.

(viii) What would be the chloride ion concentration in the solution after drawing the current in (vii) above?

(Faraday constant, F = 96,500 C mol^{-1}, Cl = 35.5, Ag = 108)

(7.5 marks)

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The Periodic Table

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

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