PART A — STRUCTURED ESSAY

Answer ***all four*** *questions on this paper itself.* (*Each question carries* **100** *marks.*)

1. (*a*) State whether the following statements are **true** or **false** on the dotted lines. Reasons **not** required.

(i) The pairing of electrons in a particular subshell **does not** take place until all the orbitals of the subshell are singly occupied by electrons with parallel spins. .....

(ii) The atomic orbitals identified by quantum numbers n and l, (I) $n=4$ $l=1$ (II) $n=4$ $l=0$ (III) $n=3$ $l=2$ can be placed in order of increasing energy as (III) < (II) < (I). .....

(iii) The electron pair geometry of the SOF_4 molecule is square pyramidal. .....

(iv) The second ionization energy of Li is less than that of Be. .....

(v) The electron gain energy of fluorine is a negative value. .....

(vi) Among the atoms Be, C, Si and S, the atomic radii increase in the order C < Be < S < Si. .....

(vii) The boiling point of CH_3NH_2 is higher than that of CH_3F. .....

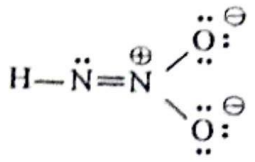
(viii) The ionic radii of Al^{3+}, O^{2-}, F^- and S^{2-} decrease in the order $S^{2-} > F^- > O^{2-} > Al^{3+}$. .....

(*b*) (i) Draw the **most** acceptable Lewis dot-dash structure for the molecule $ClSO_2F$.

(ii) Give the oxidation state of S in the structure drawn in (i) above.

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(iii) A stable Lewis dot-dash structure for the $HN_2O_2^-$ ion is given below. Draw **two** more Lewis dot-dash structures (resonance structures) for this ion. Indicate the stability of each of the structures drawn by you, relative to the structure given, by writing **stable**, **unstable** or **less stable** under the structure.



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



		N^1	N^2	N^3	N^4
I	The number of VSEPR pairs around the atom				
II	electron pair geometry around the atom				
III	Shape around the atom				
IV	Hybridization of the atom				

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- Parts (v) to (viii) are based on the Lewis dot-dash structure given in part (iv). Labelling of atoms is as in part (iv).

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

I.	N^1-F	N^1	F .....
II.	N^1-N^2	N^1	N^2 .....
III.	N^2-N^3	N^2	N^3 .....
IV.	N^3-N^4	N^3	N^4 .....
V.	N^4-H	N^4	H .....

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

I.	N^1-N^2	N^1	N^2 .....
II.	N^2-N^3	N^2	N^3 .....

(vii) State approximate values of bond angles around the N^1, N^2, N^3 and N^4 atoms.

N^1....., N^2 ....., N^3 ....., N^4.....

(viii) Arrange N^1, N^2, N^3 and N^4 atoms in **increasing** order of their electronegativities.

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

(c) (i) Given below are the six successive ionization energies, IE_1–IE_6 (in kJ/mol) of an element in the third period, starting from the first ionization energy (IE_1).

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6
1012	1903	2910	4956	6248	22230

Identify the element and write its electron configuration.

I. element : .....

II. electron configuration : .....

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(ii) A molecule of formula AX_5 has five A—X σ bonds. Here A and X represent symbols of elements and A is the central atom.
Complete the table below by naming the possible molecular shape and giving an example (molecular formula required) for each of the shapes.

	molecular shape	example
I. If AX_5 is polar		
II. If AX_5 is nonpolar		

2. (*a*) (i) **A** is a water soluble white coloured compound. It is composed of three elements in the ratio 4:2:3 (in the increasing order of atomic mass). The atomic number of each element is less than 20. Two of these elements belong to the *p*-block of the Periodic Table. On heating **A**, a colourless, non-toxic, neutral, tri-atomic gas with a linear structure is evolved as one of the products. **A** is used as a fertilizer.

Identify **A** .....

(ii) **B** is also a water soluble white coloured compound. It is composed of the same three elements as **A**. These elements are in the ratio 4:2:2 (in the increasing order of atomic mass). On heating **B**, a colourless, odourless, homo diatomic gas having a high bond dissociation energy is evolved. This gas is obtained industrially by fractional distillation of liquified air.

Identify **B** .....

(iii) **C** is a white coloured ionic compound. It is composed of four elements in the ratio 8:2:4:1 (in the increasing order of atomic mass). The atomic number of each element is less than 20. Three of these elements are found in both **A** and **B**. On heating **C**, a colourless basic gas **X** having a strong smell, and a strong acid are formed. On addition of $BaCl_2$(aq) to an aqueous solution of **C**, a white precipitate that is insoluble in dil. HCl is obtained.

Identify **C** .....

(iv) **D** is a white coloured ionic compound. It is composed of four elements in the ratio 8:1:2:3 (in the increasing order of atomic mass). Three of these elements are found in all three compounds **A**, **B** and **C**. Of the products formed on heating **D**, gas **X** and another gas that turns lime water milky are obtained as two of the products.

Identify **D** .....

(v) **E** is a strong acid. It is composed of the same elements as **A** and **B**. They are in the ratio 3:1:1 (**not** in the increasing order of atomic mass). **E** is a strong oxidizing agent. **E** is manufactured using **X**.

Identify **E** .....

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(b) Give balanced chemical equations for the reactions that take place on heating **A**, **B**, **C** and **D** identified in (*a*) above.

A

B

C

D

(c) (i) Identify **X** based on the information given in part (*a*) above.

.....

(ii) Name the process by which **E**, identified in part (*a*)(v) above, is manufactured using **X**.

.....

(iii) State the other raw material/s used in the above process.

.....

(iv) I. On reacting **X** with excess $Cl_2(g)$ a compound **Y** is formed as one of the products. Write the balanced chemical equation for this reaction.

.....

II. When **Y** reacts with water, a compound that can be used to disinfect water is formed. Write the balanced chemical equation for the reaction of **Y** with water.

.....

(v) Give **one** chemical test to identify **X**, along with its observation.

Test : .....

Observation : .....

3. (*a*) HX(aq) is a weak acid with $pK_a = 4$ at 25 °C.

(i) Write the equation for the ionization of HX(aq) in an aqueous solution.

(ii) Write the expression for the equilibrium constant of (i) above.

(iii) Calculate the pH of a 0.01 mol dm^{-3} solution of HX(aq) at a temperature of 25 °C.

(iv) A volume of 10.00 cm^3 of 0.02 mol dm^{-3} NaOH(aq) solution was added to 25.00 cm^3 of 0.01 mol dm^{-3} HX(aq) solution at a temperature of 25 °C.

I. Write the chemical species present in the solution obtained.

II. What is this type of solution commonly known as?

III. Write the expression for the calculation of pH of this solution.

IV. Calculate the pH of this solution. (log values for 1–10 are given below.)

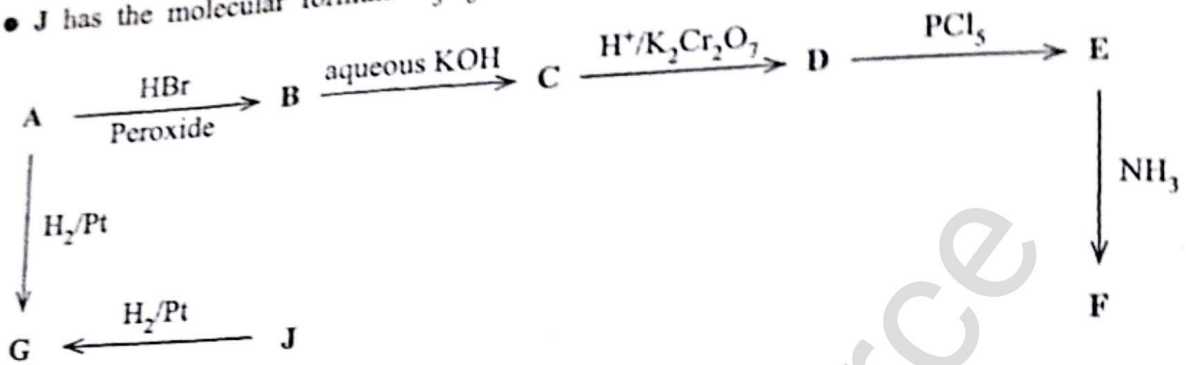
number	1	2	3	4	5	6	7	8	9	10
log value	0.00	0.30	0.48	0.60	0.70	0.78	0.85	0.90	0.95	1.00

V. Calculate the volume of 0.02 mol dm^{-3} NaOH(aq) solution required to be mixed with 100.00 cm^3 of 0.01 mol dm^{-3} HX(aq) to obtain a solution of pH 4.00.

(*b*) At 25 °C, $MgF_2(s)$ is sparingly soluble in water ($K_{sp} = 6.4 \times 10^{-9}$ mol^3 dm^{-9}). Calculate the maximum mass of $MgF_2(s)$ that is completely soluble in 500.00 cm^3 of 0.20 mol dm^{-3} NaF(aq) solution. Assume that there is no change in volume of the solution upon the addition of $MgF_2(s)$. (F = 19, Mg = 24)

4. (a) Consider the reaction scheme given below, in which,

- **A** is a hydrocarbon having the molecular formula C_5H_{10}.
- **D** has the molecular formula $C_5H_{10}O_2$. It exhibits optical isomerism. When **D** is reacted with aqueous Na_2CO_3, CO_2 is liberated.
- **J** has the molecular formula C_5H_8. **J** gives a precipitate with ammonical $AgNO_3$.



(i) Draw the structures of **A**, **B**, **C**, **D**, **E**, **F**, **G** and **J** in the relevant boxes.

A

B

C

D

E

F

G

J

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- When **J** is reacted with $HgSO_4$/dil. H_2SO_4, **K** is formed. **K** can be converted to **G** in one (01) step.

  (ii) Draw the structure of **K** and give the reagent/s that can be used to convert **K** to **G** in the relevant boxes.

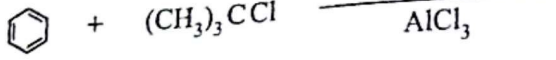
K **Reagent/s**

(*b*) For the reactions given below, write the type of reaction [nucleophilic addition (A_N), electrophilic addition (A_E), nucleophilic substitution (S_N), electrophilic substitution (S_E), elimination (E)] and the major product in the relevant cages in the table.

	Reaction	Reaction type	Major product
(i)			
(ii)			
(iii)			

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(c) Draw the structure of the major product **L** of the reaction given below. Write the mechanism of this reaction.



L

Catal

සියලු ම හිමිකම් ඇවිරිණි /முழுப் பதிப்புரிமையுடையது/All Rights Reserved]

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இலங்கைப் பரீட்சைத் திணைக்களம்
Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2025
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2025
General Certificate of Education (Adv. Level) Examination, 2025

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

02 E II

* 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* **150** ***marks.***)

5. (*a*) At 450 °C, 1.0 mol of $N_2(g)$ and 2.0 mol of $H_2(g)$ were mixed in a 1.0 dm^3 previously evacuated closed-rigid container and allowed to reach the equilibrium given below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

It was found that 1.0 mol of $NH_3(g)$ was present at the equilibrium.

(i) Calculate the total pressure of the equilibrium system at 450 °C ($RT = 6 \times 10^3\ J\ mol^{-1}$ at 450 °C).

(ii) Calculate the partial pressures of $N_2(g)$, $H_2(g)$ and $NH_3(g)$ at 450 °C in the equilibrium system.

(iii) Calculate the equilibrium constant K_P of the system at 450 °C.

(iv) Using the value obtained for K_P in (iii) above, calculate the equilibrium constant K_C of the system at 450 °C.

(v) State what changes, if any, take place in the values of partial pressures of $N_2(g)$, $H_2(g)$ and $NH_3(g)$ and the value of K_P, when 1.0 mol of Ar(g) is added to the above system at 450 °C (calculations are **not** required).

(60 *marks*)

(*b*) Assume that ΔH° and ΔS° of the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ do not change with the temperature.

(i) Predict the effect on the equilibrium concentration of $NH_3(g)$ when the temperature of the system is increased.

(ii) For the above reaction, $\Delta H^\circ = -90\ kJ\ mol^{-1}$ and $\Delta S^\circ = -200\ J\ K^{-1}\ mol^{-1}$.
Show that the prediction you made in (i) above is correct by calculating the ΔG° values of the reaction at 27 °C and 527 °C.

(iii) Consider the reaction $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ occurring in a closed-rigid container at 450 °C.

I. Predict the effect of increasing the temperature on the value of $\left(\dfrac{[NH_3(g)]^2}{[N_2(g)][H_2(g)]^3}\right)$.

II. Comment on the time taken for the reaction above to reach the equilibrium in the presence and absence of a catalyst at 450 °C.

III. Explain your answer in II above.

(60 *marks*)

(*c*) (i) Define the 'normal boiling point' of a pure liquid.

(ii) Write the equilibrium present at the boiling point of pure $CCl_4(l)$.

(iii) Given that, $\Delta H^\circ_{CCl_4(g)} = -95\ kJ\ mol^{-1}$, $\Delta H^\circ_{CCl_4(l)} = -128\ kJ\ mol^{-1}$
$\Delta S^\circ_{CCl_4(g)} = 309\ J\ K^{-1}\ mol^{-1}$, $\Delta S^\circ_{CCl_4(l)} = 214\ J\ K^{-1}\ mol^{-1}$

Calculate the normal boiling point of $CCl_4(l)$.

(30 *marks*)

[*see page ten*

6. (*a*) Consider the reaction $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$ at 25 °C.
The results of an initial-rate experiment carried out at 25 °C for the reaction above are shown below. $[NO(g)]_0$ and $[Cl_2(g)]_0$ are the initial concentrations of NO(g) and $Cl_2(g)$, respectively.

Experiment	$[NO(g)]_0$/mol dm^{-3}	$[Cl_2(g)]_0$/mol dm^{-3}	$\frac{-\Delta[Cl_2(g)]}{\Delta t}$/mol dm^{-3} s^{-1}
1	0.25	0.50	0.75
2	0.25	1.00	3.00
3	0.50	2.00	24.00

(i) Write the expressions for the rate of the reaction with respect to each species appearing in the equation of the reaction.

(ii) Write the rate expression/law for the reaction if the order of the reaction with respect to NO(g) and $Cl_2(g)$ are **a** and **b** respectively, and the rate constant is k.

(iii) Calculate the values of **a** and **b** and overall order of the reaction.

(iv) Calculate the rate constant k of the reaction at 25 °C.

(v) Calculate the rate of disappearance of $Cl_2(g)$ at 25 °C when the initial concentrations of NO(g) and $Cl_2(g)$ are 0.50 and 0.10 mol dm^{-3}, respectively.

(vi) Calculate the rate of formation of NOCl(g) at 25 °C when the rate of disappearance of $Cl_2(g)$ is 4.5 mol dm^{-3} s^{-1} at 25 °C.

(vii) Calculate the rate of formation of NOCl(g) at 25 °C when the initial concentrations of NO(g) and $Cl_2(g)$ are 0.20 and 0.30 mol dm^{-3}, respectively.

(75 *marks*)

(*b*) The reaction of Cu powder with nitric acid results in the formation of a red-brown gas containing N and O. In an experiment carried out at 33 °C, the produced gas was collected to a 150 cm^3 vessel. The pressure and mass of the gas were 831.4 mm Hg and 0.300 g, respectively. Calculate the molar mass of the produced gas and give its chemical formula. State the assumption/s made. (1 mm Hg = 133.3 Pa, N = 14, O = 16)

(35 *marks*)

(*c*) Two identical containers A and B, contain equal volumes of pure water and 3.0 mol dm^{-3} glycerol aqueous solution, respectively, at a given temperature. Giving reasons, compare,

(i) the vapour pressures of the contents in A and B.

(ii) the boiling points of the contents in A and B.

(15 *marks*)

(*d*) At a given temperature, an ideal binary liquid mixture was prepared by mixing liquids C and D in a closed container. At this temperature, vapour pressures of C and D are P_C and P_D respectively, and saturated vapour pressures of C and D are P_C° and P_D° respectively. The mole fractions of C and D in the liquid phase are X_C and X_D respectively.

(i) Derive the expression for the relative lowering of the vapour pressure of C at this temperature.

(ii) A solution was prepared by dissolving 1.0 mol of glycerol in 900 g of water at 25 °C. Calculate

I. the relative lowering of the vapour pressure (mm Hg)

II. the vapour pressure (mm Hg) of the solution.

At 25 °C, saturated vapour pressure of water is 24 mm Hg. (H = 1, O = 16)

At 25 °C, saturated vapour pressure of glycerol is negligible.

(25 *marks*)

[*see page eleven*

7. (*a*) The following electrochemical cell was constructed to study the electrochemical behaviour of the reaction, $3Cu^{+}(aq) + Au^{3+}(aq) \longrightarrow 3Cu^{2+}(aq) + Au(s)$ at 25 °C. The cell consists of an Au(s) electrode in a beaker with 1.0 mol dm^{-3} $Au(NO_3)_3(aq)$ solution and a Pt(s) electrode in another beaker filled with a solution containing 1.0 mol dm^{-3} each of $CuNO_3(aq)$ and $Cu(NO_3)_2(aq)$. The two half-cells were connected *via* a salt-bridge filled with saturated $KNO_3(aq)$ solution and a voltmeter.

$E^{\circ}_{Au^{3+}(aq)/Au(s)} = 1.50$ V and $E^{\circ}_{Cu^{2+}(aq)/Cu^{+}(aq)} = 0.16$ V at 25 °C.

(i) Draw a sketch of the electrochemical cell.

(ii) Identify the anode and the cathode of the cell and write the respective half reactions.

(iii) Identify the positive and negative terminals of this electrochemical cell.

(iv) Calculate E°_{cell} at 25 °C.

(v) Does the mass of the Pt(s) electrode increase, decrease or remain the same as the cell operates? Explain your answer.

(vi) State the ionic species present in the Au(s)-half cell before and after the cell operates.

(vii) After the cell has operated for 30 minutes at 25 °C, 0.197 g of Au(s) was deposited on the Au(s) electrode.

I. Calculate the number of Au moles deposited. (Au = 197 g mol^{-1})

II. Calculate the current (mA) which passed through the cell during the 30 minute period, assuming the current remained constant.

(75 *marks*)

(*b*) (i) **A**, **B**, **C**, **D** and **E** are coordination compounds. They have an octahedral geometry.

I. Give the structural formulae or draw the structures of these coordination compounds, selecting the appropriate species from the list given below.

Na^{+}, Cu^{+}, Cu^{2+}, Br^{-}, NH_3

A : An equal number of two types of ligands are coordinated to the metal ion. Its complex ion has a charge of –1.

B : Two types of ligands are coordinated to the metal ion. On addition of $AgNO_3(aq)$ to an aqueous solution of **B**, a pale yellow precipitate soluble in conc. NH_4OH is formed.

C and **D** : **C** and **D** contain the same elements. However, the complex ion of **C** has a charge of –2, while that of **D** has a charge of –3.

E : Only one type of ligand is coordinated to the metal ion. **E** gives two ions in aqueous solution.

Note : ● A complex ion has one metal ion with multiple ligands coordinated to it.

II. Give the IUPAC name of **E**.

(ii) **X** and **Y** are complex ions of a *d*-block metal ion M(II).

They have a square planar geometry.

X : Only ethylenediamine is coordinated to M(II).

Y : Ethylenediamine and H_2O are coordinated to M(II).

Write the structural formulae of **X** and **Y** and draw their structures.

Note : ● A complex ion has one metal ion with multiple ligands coordinated to it.

● Structure of ethylenediamine $NH_2—CH_2—CH_2—NH_2$.

● Ethylenediamine coordinates to M(II) through both N atoms.

● Use 'en' to denote ethylenediamine in the structural formula.

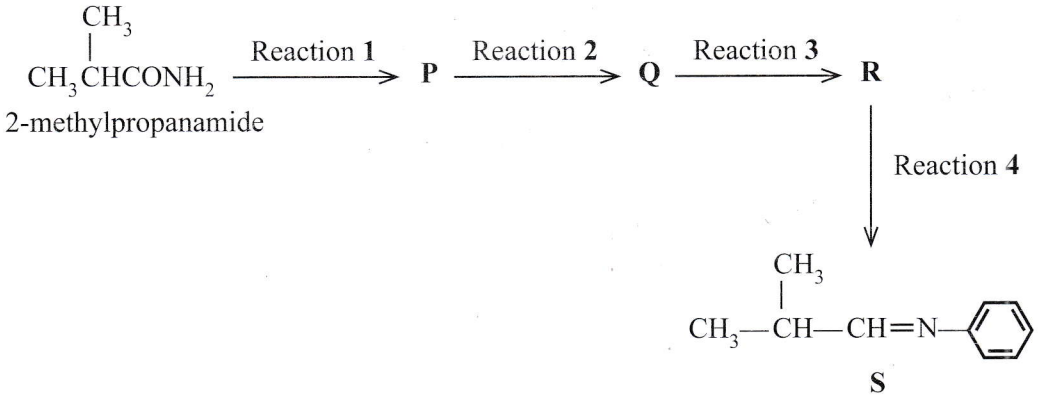
(75 *marks*)

[*see page twelve*

PART C — ESSAY

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

8. (*a*) Given below is a reaction scheme for the preparation of compound **S** using 2-methylpropanamide as the starting compound.



Complete the above reaction scheme by drawing the structures of compounds **P**, **Q** and **R**, and writing the appropriate reagents for reactions **1 – 4**, selecting **only** from the list given below.

List of reagents:
$LiAlH_4$/dry ether, $NaNO_2$, dil. HCl, Pyridinium chlorochromate (PCC), $C_6H_5NH_2$

(35 *marks*)

(*b*) Consider the reaction of 2-methyl-2-butene with HBr.

(i) Give the structures of the two products that could possibly be formed in this reaction.

(ii) Stating the type of the reaction and considering the mechanism of the reaction, explain which of these two products is the major product.

(30 *marks*)

(*c*) Consider the two compounds, phenol and acetic acid.

(i) State which of these two compounds is more acidic.

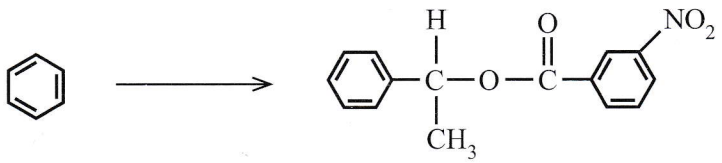
(ii) Write the chemical equations for the equilibria existing in aqueous medium for each of the compounds.

(iii) Draw the resonance structures of the organic chemical species written in the answer to (ii) above.

(iv) Considering the resonance structures, explain your answer to (i) above.

(50 *marks*)

(*d*) Show how you would carry out the following conversion in not more than **five (05)** steps.



(35 *marks*)

[*see page thirteen*

9. (*a*) An aqueous solution **Y** contains four cations **P**, **Q**, **R** and **S**. The following experiments were carried out in sequence to identify these cations.

	Experiment	Observation
1	**Y** was acidified with dil. HCl.	a white precipitate ($\mathbf{P_1}$)
2	$\mathbf{P_1}$ was separated by filtration and H_2S was bubbled through the resulting filtrate.	no precipitate
3	The above filtrate was boiled to completely remove the H_2S. A few drops of conc. HNO_3 were added, the solution was boiled, cooled and NH_4Cl/NH_4OH were added.	a brown precipitate ($\mathbf{Q_1}$)
4	$\mathbf{Q_1}$ was separated by filtration and H_2S was bubbled through the resulting filtrate.	a black precipitate ($\mathbf{R_1}$)
5	$\mathbf{R_1}$ was separated by filtration, the resulting filtrate was boiled to completely remove the H_2S, cooled and NH_4Cl/NH_4OH were added. This solution was warmed and $(NH_4)_2CO_3(aq)$ was added in excess.	a white precipitate ($\mathbf{S_1}$)

The following tests were carried out for the precipitates.

Precipitate	Test	Observation
$\mathbf{P_1}$	dil. NH_4OH was added to $\mathbf{P_1}$.	a colourless solution ($\mathbf{P_2}$)
	The following solutions were added separately to aliquots of $\mathbf{P_2}$.	
	I. KI(aq)	a dark yellow precipitate ($\mathbf{P_3}$)
	II. $Na_2S_2O_3(aq)/\Delta$	a black precipitate ($\mathbf{P_4}$)
$\mathbf{Q_1}$	$\mathbf{Q_1}$ was dissolved in dil. HNO_3. The following solutions were added separately to aliquots of the resulting solution.	
	I. $NH_4SCN(aq)$	a deep red solution ($\mathbf{Q_2}$)
	II. $K_4[Fe(CN)_6](aq)$	a dark blue precipitate ($\mathbf{Q_3}$)
$\mathbf{R_1}$	$\mathbf{R_1}$ was dissolved in warm dil. HCl, the solution was cooled and the following solutions were added separately to aliquots of the resulting solution.	
	I. a few drops of dil. NH_4OH	a green precipitate ($\mathbf{R_2}$)
	II. excess dil. NH_4OH	a deep blue solution ($\mathbf{R_3}$)
	III. a few drops of dil. NH_4OH/ dimethylglyoxime (DMG)	a deep red precipitate ($\mathbf{R_4}$)
$\mathbf{S_1}$	$\mathbf{S_1}$ was dissolved in dil. HCl. The following solutions were added separately to aliquots of the resulting solution.	
	I. dil. H_2SO_4	a white precipitate that was insoluble in dil. HNO_3 ($\mathbf{S_2}$)
	II. $K_2CrO_4(aq)$	a yellow precipitate ($\mathbf{S_3}$)
	$\mathbf{S_1}$ was subject to the flame test.	a pale green flame

Identify the four cations **P**, **Q**, **R** and **S**. Write chemical formulae of the compounds/species $\mathbf{P_1}$–$\mathbf{P_4}$, $\mathbf{Q_1}$–$\mathbf{Q_3}$, $\mathbf{R_1}$–$\mathbf{R_4}$, and $\mathbf{S_1}$–$\mathbf{S_3}$ associated with each cation.

Note : Chemical equations and reasons are **not** required.

(75 *marks*)

[*see page fourteen*

(*b*) The mineral named siderite, contains mainly $FeCO_3$. Siderite is formed when calcium ions (Ca^{2+}) of $CaCO_3$ in limestone are replaced by ferrous ions (Fe^{2+}) over a long period of time. Therefore, $FeCO_3$ in siderite is mixed with $CaCO_3$. In addition, siderite also contains impurities such as silica in small quantities.

8.5 g of such a siderite sample was thermally decomposed at 900 °C under oxygen free conditions until a constant mass was obtained. The mass of the remaining sample was 5.2 g. During thermal decomposition, $CaCO_3$ is converted to CaO and $FeCO_3$ is converted to FeO.

Another 1.7 g of the above siderite sample was dissolved in excess dilute H_2SO_4 acid, filtered, and the resulting solution was diluted to 100.00 cm^3 with distilled water. When 25.00 cm^3 of the resulting solution was titrated with 0.04 mol dm^{-3} $KMnO_4$, the end-point reading of $KMnO_4$ was 12.50 cm^3.

Assume that the quantities of metals other than Fe and Ca in the siderite sample are negligible. (C = 12, O = 16, Ca = 40, Fe = 56)

(i) Calculate the mass percentage of $CaCO_3$ in the siderite sample.

(ii) Calculate the percentage of impurities, other than $CaCO_3$, in the siderite sample.

(iii) When 8.5 g of the siderite sample was thermally decomposed in the presence of oxygen, $FeCO_3$ decomposes giving Fe_2O_3 and Fe_3O_4 in 1:1 molar ratio whereas $CaCO_3$ decomposes to CaO.

Calculate the mass of the remaining residue after this thermal decomposition.

(75 *marks*)

10. (*a*) Consider the industrial manufacture of TiO_2.

(i) Name the process by which TiO_2 is produced from rutile.

(ii) Name the required raw materials (other than rutile) for the above process.

(iii) Name the **two** main steps associated with the above process.

(iv) Give balanced chemical equations for the reactions which take place under each of the above mentioned steps.

(v) Explain how the above process contributes to Global Warming.

(50 *marks*)

(*b*) NO, NO_2, SO_2, CH_4, CF_2Cl_2 and CF_2HCl are among the pollutants that contribute to various environmental problems. Except for the two halogenated compounds, the others are released into the environment through both natural processes and human activities.

(i) State **two** natural processes and **two** human activities that release NO to the environment.

(ii) Acid rain, global warming, ozone layer depletion and photochemical smog are four major atmospheric problems. Briefly describe each of these phenomena and identify **two** gases each from the above list that make a **significant contribution** to each of the phenomena.

(iii) Explain why CF_2HCl was introduced as an alternative to CF_2Cl_2 as an attempt to protect the ozone layer.

(iv) In an industrial zone where sulfur containing coal is used as a fuel, it is reported that fish are dying in nearby lakes. Giving reasons suggest a suitable method to control this environmental problem.

(50 *marks*)

[*see page fifteen*

(*c*) (i) I. Give the classification of polymers according to the type of reaction taking place during the polymerization process.

II. Draw **two** structures each, for each of the classes of polymers you stated in (I) above.

(ii) I. Draw the structure of the repeating unit of natural rubber.

II. Write the name of the process that is used to change the elastic property of natural rubber and name the substance used in the process.

(iii) I. Give a balanced chemical equation to show the synthesis of biodiesel using a triglyceride and methanol.

II. Write the name given to the type of reaction used in the production of biodiesel.

III. Calculate the mass of biodiesel produced from 7.22 g of the triglyceride of $CH_3(CH_2)_{12}COOH$. (H = 1, C = 12, O = 16)

(50 *marks*)

* * *

[*see page sixteen*

The Periodic Table

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