නව නිර්දේශය / புதிய பாடத்திட்டம் / New Syllabus

NEW

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2020
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2020
General Certificate of Education (Adv. Level) Examination, 2020

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

02 E II

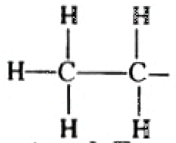
පැය තුනයි
மூன்று மணித்தியாலம்
Three hours

අමතර කියවීම් කාලය - මිනිත්තු 10 යි
மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள்
Additional 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.

Index No. : ....

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

Example:  group may be shown as CH_3CH_2-

❑ PART A — Structured Essay (pages 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 (pages 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 :	

[see page two

PART A — STRUCTURED ESSAY

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

Do not write in this column.

1. (*a*) Write the answers to the questions given below on the dotted lines.

(i) Of the three ions Na^+, Mg^{2+} and F^-, which one has the smallest ionic radius? ....

(ii) Of the three elements C, N and O, which one has the highest second ionization energy? ....

(iii) Of the three compounds H_2O, HOCl and OF_2, which one has the most electronegative oxygen atom? ....

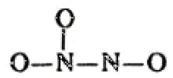
(iv) Of the three elements Be, C and N, which one will liberate energy when an electron is added to its atom $[Y(g) + e \rightarrow Y^-(g); Y = Be, C, N]$ in the gaseous state? ....

(v) Of the three ionic compounds NaF, KF and KBr, which one has the highest solubility in water? ....

(vi) Of the three compounds HCHO, CH_3F and H_2O_2, which one has the strongest intermolecular forces? ....

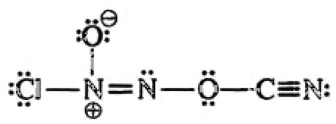
(24 *marks*)

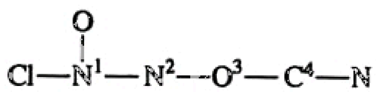
(*b*) (i) Draw the most acceptable Lewis dot-dash structure for the ion, $N_2O_3^{2-}$. Its skeleton is given below.



(ii) Draw three more Lewis dot-dash structures (resonance structures) for this ion. Indicate the relative stabilities of the structures drawn by you, when compared with the most acceptable structure drawn in (i) above, by writing 'less stable' or 'unstable' under these structures.

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





	N^1	N^2	O^3	C^4
VSEPR pairs around the atom				
electron pair geometry around the atom				
shape around the atom				
hybridization of the atom				

[*see page three*

Do not write in this column.

○ Parts (iv) to (vii) are based on the Lewis dot-dash structure given in part (iii) above. Labelling of atoms is as in part (iii).

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

I. $Cl—N^1$ Cl ..... N^1 .....

II. $N^1—O$ N^1 ..... O .....

III. $N^1—N^2$ N^1 ..... N^2 .....

IV. $N^2—O^3$ N^2 ..... O^3 .....

V. $O^3—C^4$ O^3 ..... C^4 .....

VI. $C^4—N$ C^4 ..... N .....

(v) 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. $C^4—N$ C^4 ..... N .....

C^4 ..... N .....

(vi) State the approximate bond angles around N^1, N^2, O^3 and C^4 atoms.

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

(vii) Arrange the atoms N^1, N^2, O^3 and C^4 in the increasing order of electronegativity.

..... < ..... < ..... < ..... *(5½ marks)*

(c) Consider the following information.

I. The atoms A and B combine to form a heterodiatomic molecule AB that has a σ bond. This is represented as A–B.

II. The electronegativity of A is less than that of B ($X_A < X_B$).
X = electronegativity of the atom

III. The inter-nuclear distance between A and B atoms (d_{A-B}) of the AB molecule is given by the following equation.

$$d_{A-B} = r_A + r_B - c(X_B - X_A)$$

r = atomic radius, c = 9 pm

Note: d and r are measured in picometres (pm). (1 pm = 10^{-12} m)

Based on the above information, answer the following questions.

(i) What is the name used to identify the type of σ bond between A and B?

.....

(ii) Show how fractional charges ($\delta+$ and $\delta-$) are located in the molecule AB.

.....

(iii) Write the equation to calculate the dipole moment (μ) of molecule AB and show its direction.

[see page four

Do not write in this column.

(iv) Calculate the percentage of ionic character of the H–F bond in the HF molecule using the data given below.

Inter-nuclear distance of H_2 (d_{H-H}) = 74 pm
Inter-nuclear distance of F_2 (d_{F-F}) = 144 pm
Electronegativity of H = 2.1
Electronegativity of F = 4.0
Dipole moment of HF = 6.0×10^{-30} C m
Charge of an electron = 1.6×10^{-19} C

100

(20 marks)

2. (a) A, B, C and D are chlorides of *p*-block elements. These elements have atomic numbers less than 20. A description of the products ($P_1 - P_9$) formed when A is reacted with a limited amount of water and B, C and D are reacted with excess water are given below.

Compound		Description of products
A	P_1	a compound with a covalent network structure
	P_2	a strong monobasic acid
B	P_3	a gas that turns red litmus blue
	P_4	a compound with bleaching properties
C	P_5	a tribasic acid
	P_6	a strong monobasic acid
D	P_7	a gas that turns acidic $KMnO_4$ solution colourless
	P_8	a colloidal solid
	P_9	a strong monobasic acid

(i) Identify A, B, C and D (give the chemical formulae).

A: .... B: .... C: .... D: ....

(ii) Give balanced chemical equations for the reactions of A, B, C and D with water to give products P_1 to P_9.

....

....

....

....

[see page five

Do not write in this column.

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

I. $\mathbb{P}_1$ with NaOH(aq)

....

II. $\mathbb{P}_3$ with Mg

....

III. $\mathbb{P}_7$ with acidic $K_2Cr_2O_7$

....

(50 marks)

(*b*) A student is provided with bottles labelled $\mathbb{P}$, $\mathbb{Q}$, $\mathbb{R}$, $\mathbb{S}$, $\mathbb{T}$ and $\mathbb{U}$ containing aqueous solutions of $Al_2(SO_4)_3$, H_2SO_4, $Na_2S_2O_3$, $BaCl_2$, $Pb(Ac)_2$ and KOH (not in order). Some useful observations for their identification on mixing two solutions at a time are given below. (Ac - Acetate ion)

	Solutions mixed	Observations
I	$\mathbb{T}$ + $\mathbb{R}$	a clear colourless solution
II	$\mathbb{P}$ + $\mathbb{R}$	a white precipitate
III	$\mathbb{T}$ + $\mathbb{S}$	a gelatinous white precipitate
IV	$\mathbb{U}$ + $\mathbb{R}$	a white precipitate
V	$\mathbb{P}$ + $\mathbb{Q}$	a white precipitate, turns black on heating
VI	$\mathbb{P}$ + $\mathbb{U}$	a white precipitate, dissolves on heating

(i) Identify $\mathbb{P}$ to $\mathbb{U}$.

$\mathbb{P}$: .... $\mathbb{Q}$: .... $\mathbb{R}$: ....

$\mathbb{S}$: .... $\mathbb{T}$: .... $\mathbb{U}$: ....

(ii) Give balanced chemical equations for each of the reactions I to VI.

I: ....

II: ....

III: ....

IV: ....

V: formation of white precipitate: ....

turning black on heating: ....

VI: ....

(Note: indicate precipitates as ⇓) (50 marks)

100

3. (*a*) A saturated aqueous solution of a sparingly soluble salt $AB_2(s)$ was prepared by stirring an excess amount of $AB_2(s)$ in 1.0 dm^3 of distilled water at 25 °C. The amount of $A^{2+}(aq)$ ions present in this saturated aqueous solution was found to be 2.0×10^{-3} mol.

(i) Write the equilibrium related to the dissolution of $AB_2(s)$ in the above system at 25 °C.

....

(ii) Write the expression for the equilibrium constant for the equilibrium written in (i) above at 25 °C.

....

....

[see page six

Do not write in this column.

(iii) Calculate the value of the equilibrium constant stated in (ii) above at 25 °C.

....

....

....

....

....

....

(iv) Another saturated aqueous solution of AB_2 was prepared by stirring an excess amount of $AB_2(s)$ in 2.0 dm^3 of distilled water at 25 °C. Giving reasons, predict the value of the equilibrium constant for this system.

....

....

(v) A small amount of the strong electrolyte NaB(s) is added to a saturated aqueous solution of AB_2 at 25 °C. Giving reasons, predict whether the concentration of $A^{2+}(aq)$ is increased or decreased.

....

....

....

(60 marks)

(*b*) In an aqueous solution, propanoic acid (C_2H_5COOH) ionizes as given below.

$$C_2H_5COOH(aq) + H_2O(l) \rightleftharpoons C_2H_5COO^-(aq) + H_3O^+(aq)$$

At 25 °C, K_a (propanoic acid) = 1.0×10^{-5}

(i) Write the expression for the equilibrium constant for the above reaction at 25 °C.

....

....

(ii) 100.0 cm^3 of an aqueous solution of $C_2H_5COOH(aq)$ was prepared by dissolving 0.74 cm^3 of C_2H_5COOH in distilled water at 25 °C. Calculate the pH of the solution at 25 °C. (C = 12; O = 16; H = 1; consider the density of C_2H_5COOH as 1.0 g cm^{-3})

100

(40 marks)

[see page seven

Do not write in this column.

4\. (*a*) A, B, C and D are structural isomers having the molecular formula C_6H_{10}. None of them show optical isomerism. All four isomers, A, B, C and D when treated with $HgSO_4$/dil. H_2SO_4 give products which react with 2,4-dinitrophenylhydrazine (2,4-DNP) to give coloured precipitates.

Only A gives a precipitate with ammonical $AgNO_3$. A has only one position isomer, which is B. B is a chain isomer of C. C reacts with $HgSO_4$/dil. H_2SO_4 to give two products E and F. D reacts with $HgSO_4$/dil. H_2SO_4 to give only one product, which is E.

(i) Draw the structures of A, B, C, D, E and F in the boxes given below.

A	B	C
D	E	F

(ii) Which of the compounds A, B, C and D gives a product that does not show diastereoisomerism when reacted separately with H_2 / Pd-$BaSO_4$ / quinoline?

(iii) Draw, in the box given below, the structure of the product G obtained when A is reacted with excess HBr.

G

(iv) Draw the structures of products X and Y obtained in the following reactions of E, in the appropriate boxes.

$$X \xleftarrow[\text{Methanol}]{NaBH_4} E \xrightarrow[2.\ H^+/H_2O]{1.\ C_2H_5MgBr} Y$$

X Y

Name a test to distinguish between X and Y.

....

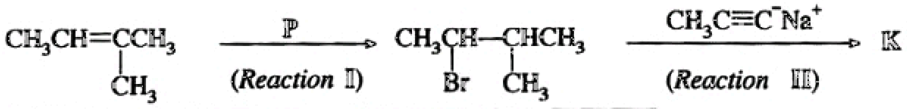
(60 *marks*)

[see page eight

Do not write in this column.

(*b*) (i) Complete the following three reaction sequences by drawing structures of compounds K, L and M and giving the reagents/catalysts P, Q and R in the boxes given below.

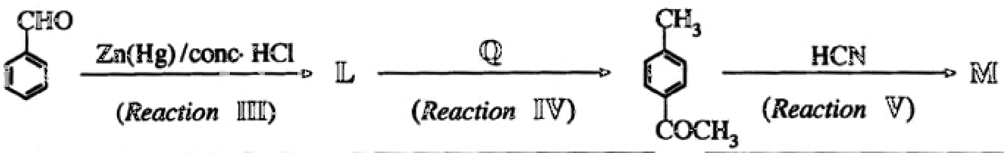
Sequence 1:



P

K

Sequence 2:

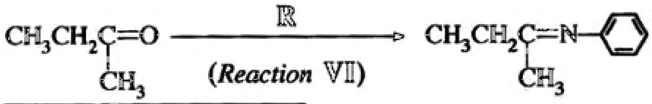


L

Q

M

Sequence 3:



R

(30 marks)

(ii) Selecting from the reactions I – VI, give one (01) example for each of the following types of reactions.

Nucleophilic addition ....

Nucleophilic substitution .... (10 marks)

100

* *

[see page nine

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NEW

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2020
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2020
General Certificate of Education (Adv. Level) Examination, 2020

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 150 marks.)

5. (*a*) A compound $XY_2Z_2(g)$ undergoes dissociation when heated to temperatures above 300 K as given below.

$$XY_2Z_2(g) \overset{\Delta}{\rightleftharpoons} XY_2(g) + Z_2(g)$$

A sample of 7.5 g of $XY_2Z_2(g)$ was placed in an evacuated 1.00 dm^3 rigid-closed container and the temperature was raised to 480 K.
Molar mass of $XY_2Z_2(g)$ is 150 g mol^{-1}. Use the approximate value of 4000 J mol^{-1} for RT at 480 K. Assume ideal gas behaviour for all gases.

(i) Calculate the number of moles of $XY_2Z_2(g)$ in the container before dissociation.

(ii) When the above system reaches equilibrium at 480 K, the total number of moles in the container was found to be 7.5×10^{-2} mol. Calculate the number of moles of $XY_2Z_2(g)$, $XY_2(g)$ and $Z_2(g)$ in the equilibrium mixture at 480 K.

(iii) Calculate the equilibrium constant K_c for the above reaction at 480 K.

(iv) Calculate K_p for the equilibrium at 480 K. *(75 marks)*

(*b*) For the reaction $XY_2Z_2(g) \rightarrow XY_2(g) + Z_2(g)$ described in (a), Gibbs free energies (G) at 480 K for $XY_2Z_2(g)$, $XY_2(g)$ and $Z_2(g)$ are −60 kJ mol^{-1}, −76 kJ mol^{-1} and −30 kJ mol^{-1}, respectively.

(i) Calculate ΔG (in kJ mol^{-1}) for the reaction at 480 K.

(ii) The magnitude of ΔS of the above reaction is 150 J K^{-1} mol^{-1} at 480 K. Calculate ΔH for the reaction at 480 K by using the appropriate sign (− or +) of ΔS.

(iii) By using the sign (− or +) of ΔH obtained in (ii), explain whether this reaction is exothermic or endothermic.

(iv) Deduce the enthalpy difference for the formation of $XY_2Z_2(g)$ from $XY_2(g)$ and $Z_2(g)$ at 480 K.

(v) If the bond enthalpy of the X–Z bond in $XY_2Z_2(g)$ is +250 kJ mol^{-1}, calculate the bond enthalpy of the Z–Z bond.
(Assume that $XY_2Z_2(g)$ has the structure Y, Y, Z—X—Z)

(vi) If liquid XY_2Z_2 is used instead of gaseous XY_2Z_2, giving reasons, explain whether the value of ΔH obtained for the reaction $XY_2Z_2(l) \rightarrow XY_2(g) + Z_2(g)$ is equal to, or higher or lower than ΔH obtained in (ii). *(75 marks)*

[see page ten

6. (a) Consider the reaction given below occurring in a closed container at a given temperature T.

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

(i) Write three expressions for the rate of reaction relevant to each of the compounds appearing in the reaction.

(ii) This reaction was carried out at temperature T with an initial concentration of 0.10 mol dm^{-3} of $N_2O_5(g)$. It was found that 40% of the initial amount was decomposed after a period of 400 s.

I. Calculate the average rate of decomposition of $N_2O_5(g)$ in this time interval.

II. Calculate average rates of formation of $NO_2(g)$ and $O_2(g)$.

(iii) In another experiment, initial rates were measured for this reaction at 300 K and the results are given below.

$[N_2O_5(g)]$ / mol dm^{-3}	0.01	0.02	0.03
Initial rate / mol dm^{-3} s^{-1}	6.930×10^{-5}	1.386×10^{-4}	2.079×10^{-4}

Derive the rate law for the reaction at 300 K.

(iv) Another experiment was carried out at 300 K with an initial concentration of 0.64 mol dm^{-3} of $N_2O_5(g)$. It was found that the concentration of $N_2O_5(g)$ which remained after a period of 500 s was 2.0×10^{-2} mol dm^{-3}.

I. Calculate the half-life ($t_{1/2}$) of the reaction at 300 K.

II. Calculate the rate constant of the reaction at 300 K.

(v) This reaction proceeds through a mechanism involving the following elementary steps.

Step 1 : $N_2O_5(g) \rightleftharpoons NO_3(g) + NO_2(g)$: Fast

Step 2 : $NO_3(g) + NO_2(g) \rightarrow 2NO_2(g) + O(g)$: Slow

Step 3 : $N_2O_5(g) + O(g) \rightarrow 2NO_2(g) + O_2(g)$: Fast

Show that the above mechanism is consistent with the rate law of the reaction. (80 marks)

(b) An ideal binary-liquid mixture was prepared by mixing two liquids of A and B in a closed evacuated container at temperature T. After establishing the equilibrium at temperature T, partial pressures of A and B in the vapour phase are P_A and P_B, respectively. At temperature T, the saturated vapour pressures of A and B are P_A° and P_B°, respectively. Mole fractions of A and B in solution are X_A and X_B, respectively.

(i) Show that $P_A = P_A^\circ X_A$

(Consider that the rates of vaporization and condensation are equal at equilibrium.)

(ii) In the above system at 300 K, the total pressure was 5.0×10^4 Pa. The saturated vapour pressures of pure A and B at 300 K, are 7.0×10^4 Pa and 3.0×10^4 Pa, respectively.

I. Calculate the mole fraction of A in the liquid phase of the equilibrium mixture.

II. Calculate the vapour pressure of A in the equilibrium mixture.

(70 marks)

[see page eleven

7. (*a*) (i) To compare the properties of Electrolytic and Galvanic cells, copy and compiete the following table using the given terms.

Terms: anode, cathode, positive, negative, spontaneous, non-spontaneous.

		Electrolytic cell	Galvanic cell
A.	Oxidation half-reaction takes place at		
B.	Reduction half-reaction takes place at		
C.	Sign of E°_{cell}		
D.	Electron flow	From ..... to	From ..... to .....
E.	Spontaneity of the cell reaction		

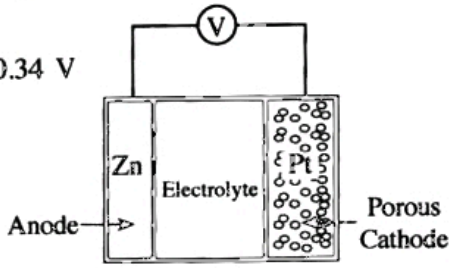
(ii) An electrochemical cell was constructed at 300 K by using a Zn(s) anode, an aqueous alkaline electrolyte and a porous Pt cathode which facilitates the collection of oxygen $O_2(g)$ from air as shown below. As the cell operates ZnO(s) is produced.

You are given that

$E^{\circ}_{ZnO(s)\,|\,Zn(s)\,|\,OH^-(aq)} = -1.31$ V and $E^{\circ}_{O_2(g)\,|\,OH^-(aq)} = +0.34$ V

Zn = 65 g moi^{-1}, O = 16 g mol^{-1} and

1 F = 96,500 C



I. Write the half-reactions occurring at anode and cathode.

II. Write the overall cell reaction.

III. Calculate the cell potential E°_{cell} at 300 K.

IV. State the direction of migration of $OH^-(aq)$ ions between the electrodes.

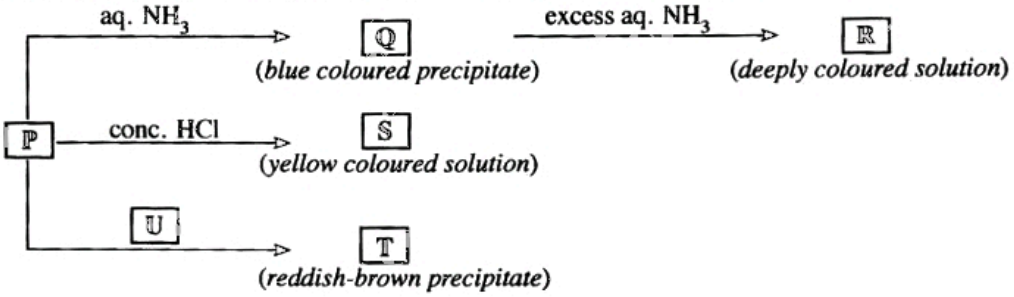
V. When the cell operates for a period of 800 s at 300 K, 2 mol of $O_2(g)$ are consumed.

A. Calculate the number of moles of electrons passing through the cell.

B. Calculate the mass of ZnO(s) formed.

C. Calculate the current passing through the cell. *(75 marks)*

(*b*) A coloured complex ion ℙ is formed when the salt $\mathbb{M}(NO_3)_n$ is dissolved in distilled water. 𝕄 is a transition element belonging to the 3*d* block. ℙ undergoes the following reactions.



𝕋 and 𝕌 are coordination compounds each containing four elements. ℙ, ℝ and 𝕊 are complex ions.

(i) Identify the metal 𝕄. Give the oxidation state of 𝕄 in complex ion ℙ.

(ii) Give the value of n in $\mathbb{M}(NO_3)_n$.

(iii) Write the complete electronic configuration of 𝕄 in complex ion ℙ.

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

(v) Give the IUPAC names of ℙ, ℝ, 𝕊, 𝕋 and 𝕌.

(vi) What is the colour of ℙ?

(vii) What would you expect to observe in I and II given below?

I. When H_2S gas is passed into an acidic solution containing ℙ at room temperature

II. When the mixture obtained in I above is heated with dilute HNO_3 after the removal of dissolved H_2S

(viii) Briefly describe a method with the aid of balanced chemical equations for determining the concentration of M^{n+} present in an aqueous solution, using the following chemicals.

KI, $Na_2S_2O_3$ and starch. *(75 marks)*

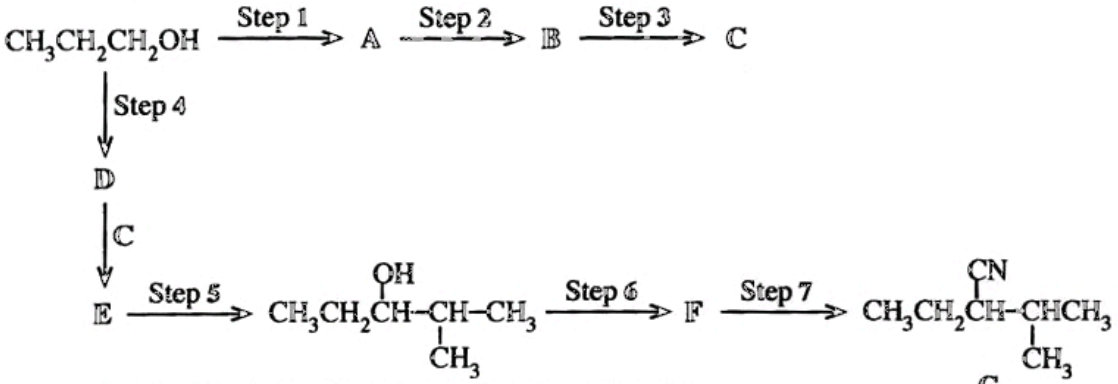
[see page twelve

PART C — ESSAY

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

8. (*a*) (i) Given below is a reaction scheme for the synthesis of compound G using $CH_3CH_2CH_2OH$ as the only organic starting compound.

Complete the reaction scheme by drawing the structures of compounds A, B, C, D, E and F and writing the appropriate reagents for steps 1 – 7, selected only from those given in the list.

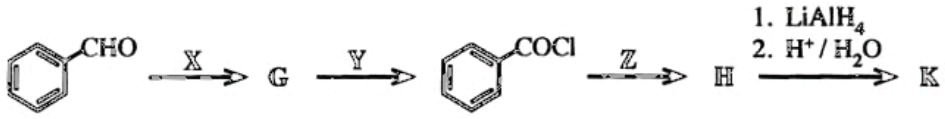


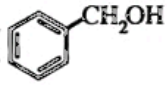
List of Reagents
HBr, PBr_3, pyridiniumchlorochromate (PCC), Mg / dry ether, KCN, conc. H_2SO_4, dil. H_2SO_4

(52 marks)

(ii) Consider the following series of reactions.

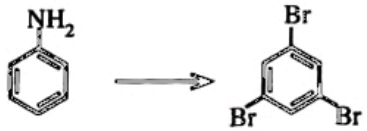
Draw the structures of compounds G, H and K. Give the reagents X, Y and Z.



Note that K gives benzyl alcohol () when reacted with $NaNO_2$/ dil. HCl.

(24 marks)

(*b*) (i) Show how the following conversion could be carried out in not more than three steps.



(20 marks)

(ii) Consider the following reaction.

Identify the chemical substances P and Q necessary to carry out this reaction.
Write the mechanism of this reaction. *(20 marks)*

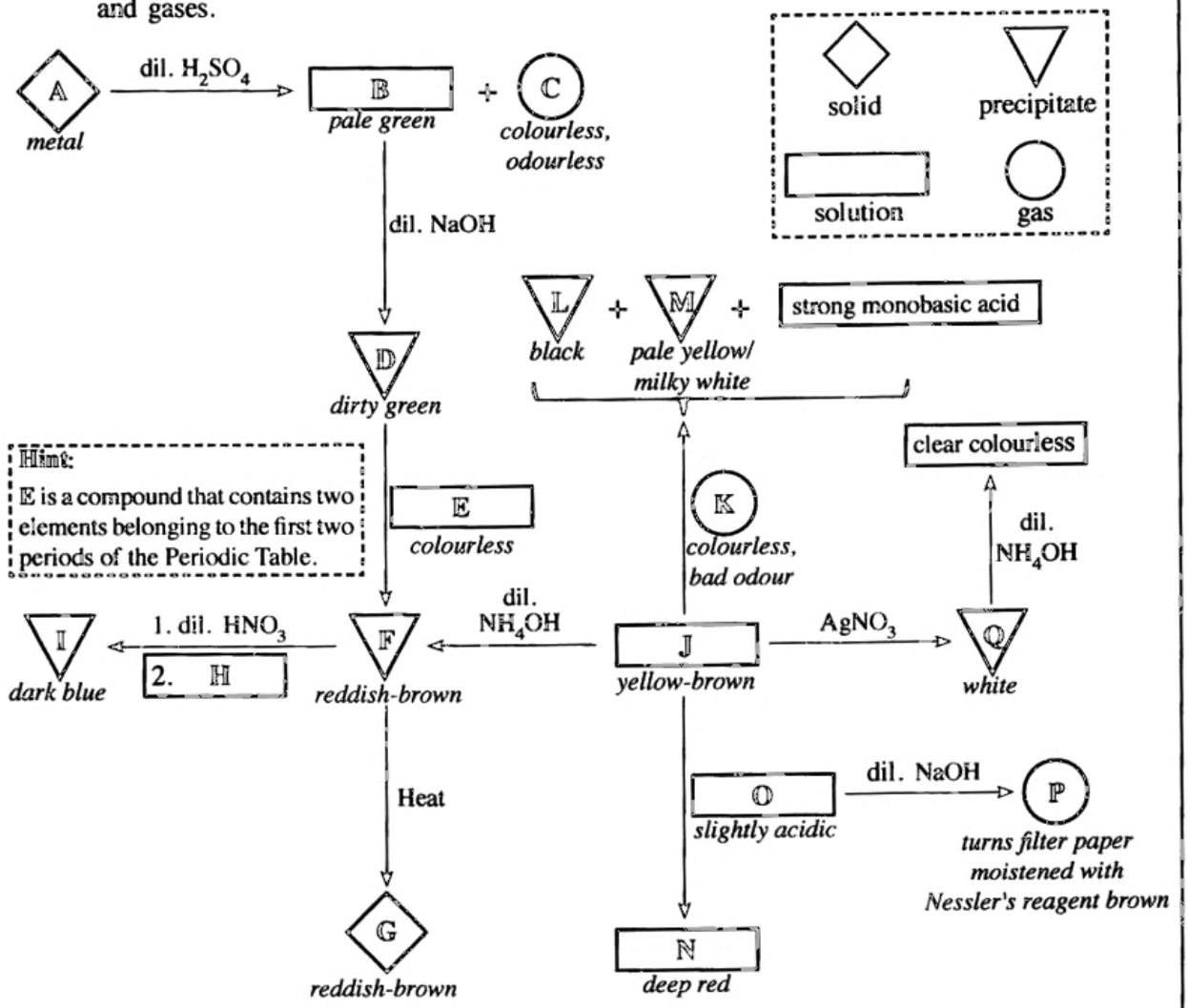
(*c*) (i) Explain why phenol is more reactive in electrophilic substitution reactions than benzene, by considering their resonance hybrids.

(ii) Illustrate the difference in reactivity between phenol and benzene as given in (i) above by means of a suitable reaction.

(iii) Draw the structure(s) of product(s) you described in the reaction in (ii) above. *(30 marks)*

[*see page thirteen*

9. (*a*) (i) Write the chemical formulae of the substances A – Q given in the flow chart below.
(Note: Chemical equations and reasons are not expected for the identification of substances A – Q.)
The symbols given in the box (dash lines) are used to represent solids, precipitates, solutions and gases.



(ii) Write the complete electronic configuration of A.

(iii) State the function of E in the conversion of D to F. Give the relevant balanced chemical equations for the stated function. *(75 marks)*

(*b*) The solid X contains only Cu_2S and CuS. The following procedure was used to determine the percentage of Cu_2S in X.

Procedure

A 1.00 g portion of solid X was treated with 100.00 cm^3 of 0.16 mol dm^{-3} $KMnO_4$ in dilute H_2SO_4 medium. This reaction gave Mn^{2+}, Cu^{2+} and SO_4^{2-} as products. Thereafter, the excess $KMnO_4$ in this solution was titrated with 0.15 mol dm^{-3} Fe^{2+} solution. The volume required for the titration was 35.00 cm^3.

(i) Write the balanced ionic equations for the reactions taking place in the above procedure.

(ii) Based on the answers to (i) above, determine the molar ratio between,

I. Cu_2S and $KMnO_4$
II. CuS and $KMnO_4$
III. Fe^{2+} and $KMnO_4$

(iii) Calculate the percentage by weight of Cu_2S in X. (Cu = 63.5, S = 32) *(75 marks)*

[see page fourteen

10. (*a*) The following questions are based on the properties of titanium dioxide (TiO_2) and its manufacture carried out by the "Chloride Process".

(i) Name the raw materials used in this process.

(ii) Briefly describe the manufacturing process of TiO_2 giving balanced chemical equations where applicable.

(iii) State **three** properties of TiO_2 and give one use each, relevant to each property.

(iv) If you were to consider establishing a TiO_2 manufacturing plant in Sri Lanka, state **three** requirements that need to be fulfilled.

(v) Does the manufacturing process described in (ii) above contribute to global warming? Justify your answer. (*50 marks*)

(*b*) Currently, global warming due to change in greenhouse effect is significantly greater than that before the industrial revolution.

(i) Explain briefly what is meant by greenhouse effect.

(ii) Identify the major environmental problem that occurs due to global warming.

(iii) State **two main** natural gases that contribute to global warming.

(iv) Explain briefly how microorganisms contribute to the release of the gases you stated in (iii).

(v) In addition to the gases you stated in (iii), name **two** classes of synthetic volatile compounds that directly contribute to the global warming, and selecting one compound from each class, draw their structures.

(vi) Select **one** class of compounds from the two classes you stated in (v) that contributes to the catalytic degradation of ozone in the upper atmosphere.

(vii) The slow down of industrial activities due to the Covid-19 pandemic temporarily eased the global environmental issues in many countries. Justify this statement by using **two** main global environmental issues you have learnt. (*50 marks*)

(*c*) The following questions are based on the polymers given below.

Polyvinyl chloride (PVC), Polyethylene (PE), Polystyrene (PS), Bakelite, Nylon 6.6, Polyethylene terephthalate (PET), Gutta percha

(i) Draw the repeating units of **four** of the above polymers.

(ii) Categorize each of the above seven (7) polymers as either,

I. natural or synthetic polymers.

II. addition or condensation polymers.

(iii) Name the **two** monomers used in the formation of bakelite.

(iv) Polymers can be grouped into two categories based on their thermal properties. State these **two** categories. Write to which of these categories PVC and bakelite belong.

(v) Give **one** use each for **three** of the polymers given in the above list. (*50 marks*)

* * *

[see page fifteen

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