

සියලු ම හිමිකම් ඇවිරිණි / முழுப் பதிப்புரிமையுடையது / All Rights Reserved

නව නිර්දේශය/புதிய பாடத்திட்டம் / New Syllabus

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව  
 திணைக்களம் இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம்  
 Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka  
 இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம்

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

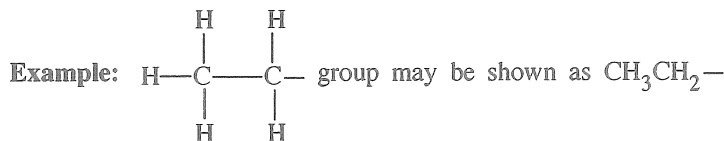
පැය තුනයි  
 மூன்று மணித்தியாலம்  
 Three hours

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.



□ 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 :	

## 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  $\text{Na}^+$ ,  $\text{Mg}^{2+}$  and  $\text{F}^-$ , 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  $\text{H}_2\text{O}$ ,  $\text{HOCl}$  and  $\text{OF}_2$ , 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 [ $\text{Y}(\text{g}) + \text{e} \rightarrow \text{Y}^-(\text{g})$ ;  $\text{Y} = \text{Be}, \text{C}, \text{N}$ ] in the gaseous state? .....

(v) Of the three ionic compounds  $\text{NaF}$ ,  $\text{KF}$  and  $\text{KBr}$ , which one has the **highest** solubility in water? .....

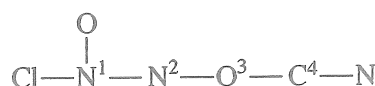
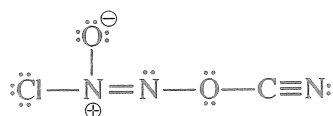
(vi) Of the three compounds  $\text{HCHO}$ ,  $\text{CH}_3\text{F}$  and  $\text{H}_2\text{O}_2$ , which one has the **strongest** intermolecular forces? ..... (24 marks)

(b) (i) Draw the most acceptable Lewis dot-dash structure for the ion,  $\text{N}_2\text{O}_3^{2-}$ . 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.



	$\text{N}^1$	$\text{N}^2$	$\text{O}^3$	$\text{C}^4$
VSEPR pairs around the atom				
electron pair geometry around the atom				
shape around the atom				
hybridization of the atom				

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- 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  $\sigma$  bonds between the two atoms given below.

- I.  $\text{Cl}-\text{N}^1$     Cl .....  $\text{N}^1$  .....
- II.  $\text{N}^1-\text{O}$      $\text{N}^1$  ..... O .....
- III.  $\text{N}^1-\text{N}^2$      $\text{N}^1$  .....  $\text{N}^2$  .....
- IV.  $\text{N}^2-\text{O}^3$      $\text{N}^2$  .....  $\text{O}^3$  .....
- V.  $\text{O}^3-\text{C}^4$      $\text{O}^3$  .....  $\text{C}^4$  .....
- VI.  $\text{C}^4-\text{N}$      $\text{C}^4$  ..... N .....

(v) Identify the atomic orbitals involved in the formation of  $\pi$  bonds between the two atoms given below.

- I.  $\text{N}^1-\text{N}^2$      $\text{N}^1$  .....  $\text{N}^2$  .....
- II.  $\text{C}^4-\text{N}$      $\text{C}^4$  ..... N .....
- $\text{C}^4$  ..... N .....

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

$\text{N}^1$ .....,     $\text{N}^2$  .....,     $\text{O}^3$  .....,     $\text{C}^4$ .....

(vii) Arrange the atoms  $\text{N}^1$ ,  $\text{N}^2$ ,  $\text{O}^3$  and  $\text{C}^4$  in the **increasing** order of electronegativity.

..... < ..... < ..... < ..... (56 marks)

(c) Consider the following information.

I. The atoms **A** and **B** combine to form a heterodiatomic molecule **AB** that has a  $\sigma$  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 ( $d_{\text{A-B}}$ ) of the **AB** molecule is given by the following equation.

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

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  $\sigma$  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 ( $\mu$ ) of molecule **AB** and show its direction.

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

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(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  $P_9$ .

.....

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

I.  $P_1$  with  $\text{NaOH(aq)}$ 

.....

II.  $P_3$  with  $\text{Mg}$ 

.....

III.  $P_7$  with acidic  $\text{K}_2\text{Cr}_2\text{O}_7$ 

.....

(50 marks)

(b) A student is provided with bottles labelled P, Q, R, S, T and U containing aqueous solutions of  $\text{Al}_2(\text{SO}_4)_3$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{Na}_2\text{S}_2\text{O}_3$ ,  $\text{BaCl}_2$ ,  $\text{Pb}(\text{Ac})_2$  and  $\text{KOH}$  (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	T + R	a clear colourless solution
II	P + R	a white precipitate
III	T + S	a gelatinous white precipitate
IV	U + R	a white precipitate
V	P + Q	a white precipitate, turns black on heating
VI	P + U	a white precipitate, dissolves on heating

(i) Identify P to U.

P: ..... Q: ..... R: .....

S: ..... T: ..... 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)

3. (a) A saturated aqueous solution of a sparingly soluble salt  $\text{AB}_2(\text{s})$  was prepared by stirring an excess amount of  $\text{AB}_2(\text{s})$  in  $1.0 \text{ dm}^3$  of distilled water at  $25^\circ\text{C}$ . The amount of  $\text{A}^{2+}(\text{aq})$  ions present in this saturated aqueous solution was found to be  $2.0 \times 10^{-3} \text{ mol}$ .

(i) Write the equilibrium related to the dissolution of  $\text{AB}_2(\text{s})$  in the above system at  $25^\circ\text{C}$ .

.....

(ii) Write the expression for the equilibrium constant for the equilibrium written in (i) above at  $25^\circ\text{C}$ .

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

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.....

(iv) Another saturated aqueous solution of AB<sub>2</sub> was prepared by stirring an excess amount of AB<sub>2</sub>(s) in 2.0 dm<sup>3</sup> 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<sub>2</sub> at 25 °C. Giving reasons, predict whether the concentration of A<sup>2+</sup>(aq) is increased or decreased.

.....

.....

.....

(60 marks)

(b) In an aqueous solution, propanoic acid (C<sub>2</sub>H<sub>5</sub>COOH) ionizes as given below.



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

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

.....

.....

(ii) 100.0 cm<sup>3</sup> of an aqueous solution of C<sub>2</sub>H<sub>5</sub>COOH(aq) was prepared by dissolving 0.74 cm<sup>3</sup> of C<sub>2</sub>H<sub>5</sub>COOH 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<sub>2</sub>H<sub>5</sub>COOH as 1.0 g cm<sup>-3</sup>)

(40 marks)

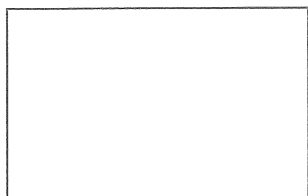


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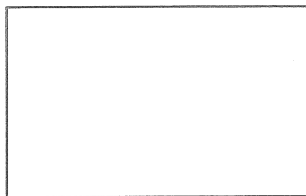
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4. (a) A, B, C and D are structural isomers having the molecular formula  $C_6H_{10}$ . None of them show optical isomerism. All four isomers, A, B, C and D when treated with  $HgSO_4/dil. H_2SO_4$  give products which react with 2,4-dinitrophenylhydrazine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

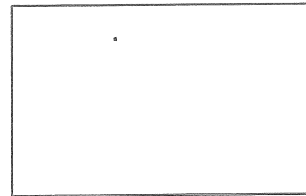
(i) Draw the structures of A, B, C, D, E and F in the boxes given below.



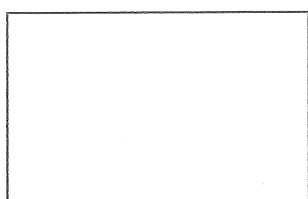
A



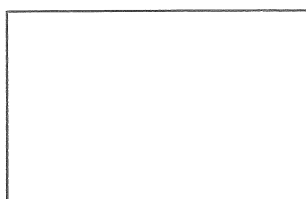
B



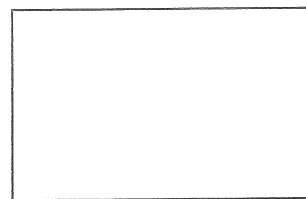
C



D



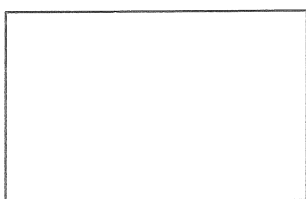
E



F

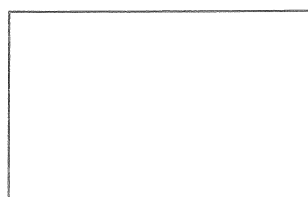
- (ii) Which of the compounds A, B, C and D gives a product that does not show diastereoisomerism when reacted separately with  $H_2 / Pd-BaSO_4 / quinoline$ ?

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

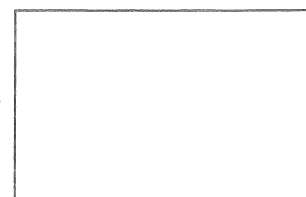
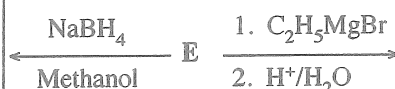


G

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



X



Y

Name a test to distinguish between X and Y.

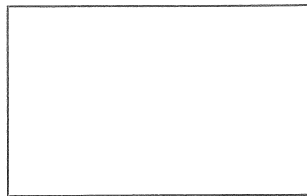
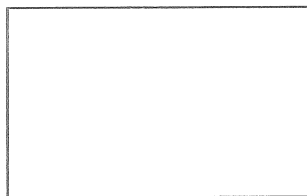
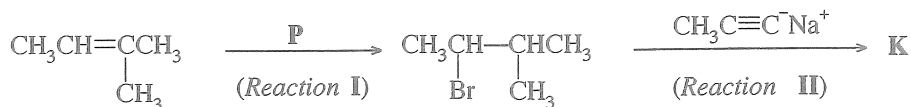
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(60 marks)

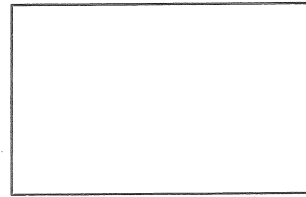
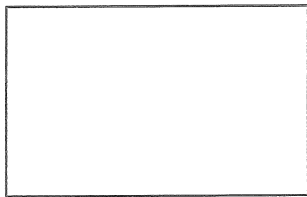
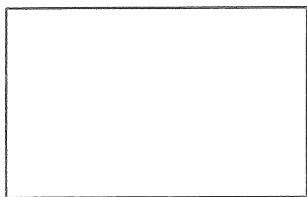
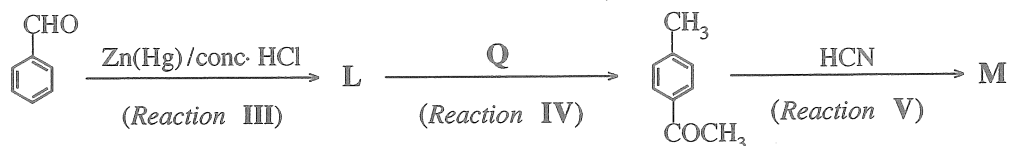
- (b) (i) Complete the following three reaction sequences by drawing structures of compounds K, L and M and giving the reagents/catalysts P, Q and R in the boxes given below.

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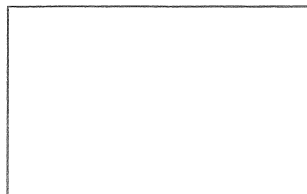
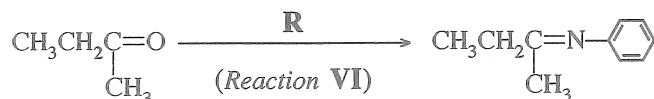
Sequence 1:



Sequence 2:



Sequence 3:



(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