අධ්‍යාපන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2018 අගෝස්තු
கல்விப் பொதுத் தராதர்ப் பத்திர (உயர் தர)ப் பரீட்சை, 2018 ஓகஸ்ற்று
General Certificate of Education (Adv. Level) Examination, August 2018

රසායන විද්‍යාව II இரசாயனவியல் II Chemistry II	02 E III	17.08.2018 / 0830 - 1140

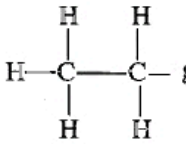
පැය තුනයි
மூன்று மணித்தியாலம்
Three hours

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* 16.
* ***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:  group 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 - 15)

* *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

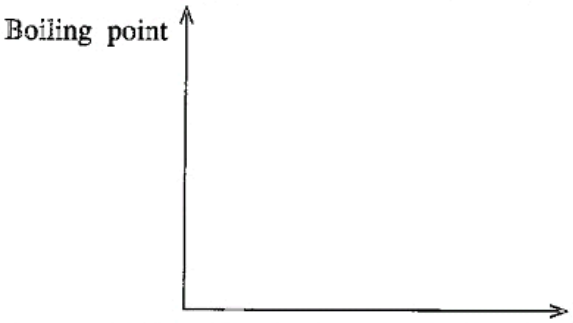
In Numbers	
In Letters	

Code Numbers

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

[see page two

(v) Consider the hydrides of the elements in the group to which X belongs, which are analogous to Y. Sketch the variation in boiling points of these hydrides (including Y) in the graph below. In your sketch indicate the hydrides using their chemical formulae. (Note: Values of boiling points are not required.)



(vi) Give reasons for the variation in boiling points in part (v) above.

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.....

.....

.....

.....

(vii) I. Write what you would observe when an excess of an aqueous solution of Y is added to a solution of $Al_2(SO_4)_3$.

.....

II. Write the chemical formula of the species that gives rise to your observation in part I above.

.....

(viii) Give one chemical test to identify Y.

Test : .....

Observation : .....

(ix) Z is an oxo-acid of X and a strong oxidizing agent.

I. Identify Z. .....

II. State the products obtained when hot concentrated Z reacts with sulphur.

.....

(6.0 marks)

(*b*) A and B are compounds of two *p*-block elements that belong to the same group in the Periodic Table. A exists as a colourless, odourless liquid at room temperature and atmospheric pressure. It is also found in the gaseous and solid states. The solid state of A is less dense than its liquid state. Ionic and polar compounds are readily soluble in A.

B is a colourless gas at room temperature and atmospheric pressure. A filter paper moistened with lead acetate turns black on treatment with B.

(i) Identify A and B.

A = ... B = ...

(ii) Sketch the shapes of A and B showing lone pairs of electrons where necessary.

Do not write in this column.

[see page five

Do not write in this column.

(iii) Giving reasons, state whether A or B has the larger bond angle.

.....

.....

.....

(iv) In each of the following instances, give a balanced chemical equation to indicate the action of A.

I. A as an acid: .....

II. A as a base: .....

(v) Write the balanced chemical equation for the reaction of B with aqueous lead acetate.

.....

(vi) I. Write what you would observe when A and B are added separately to an acidified solution of $BiCl_3$.

with A (excess): ..... with B: .....

II. Write balanced chemical equations for your observations in part I above.

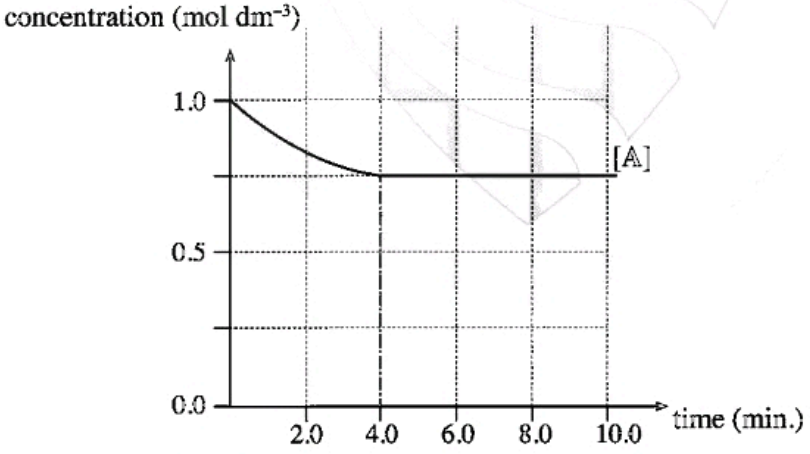
.....

.....

(4.0 marks)

100

3. The reaction $A + B \rightleftharpoons 2C + D$ (elementary in both directions) was carried out at 25 °C. Initially, the reaction mixture was made by dissolving 0.10 mol of A and 0.10 mol of B in distilled water (total volume 100.00 cm^3). Variation in the concentration of A in this solution with time is shown in the graph.



(i) Calculate the amount of A (in moles) reacted during the first 4.0 minutes of the reaction.

.....

.....

.....

(ii) Would the rate of the forward reaction be less than the rate of the reverse reaction after 4.0 minutes? Explain your answer.

.....

.....

.....

[see page six

(c) (i) Give the mechanism of the following reaction.

$$C_2H_5OH + HBr \longrightarrow C_2H_5Br + H_2O$$

(ii) State whether the above reaction is a nucleophilic substitution reaction or an electrophilic substitution reaction. Identify the nucleophile or electrophile as appropriate.

(iii) State giving reasons which of the two compounds, phenol (C_6H_5OH) or ethanol (C_2H_5OH) is more acidic.

(3.0 marks)

PART C — ESSAY

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

8. (a) An aqueous solution ℙ contains two cations and two anions. The following experiments were carried out to identify these cations and anions.

Cations

	Experiment	Observation
①	ℙ was acidified with dilute HCl and H_2S was bubbled through the solution.	A clear solution was obtained.
②	The above solution was boiled till all the H_2S was removed. A few drops of conc. HNO_3 were added and the solution was heated further. The resulting solution was cooled and NH_4Cl/NH_4OH was added.	A brown precipitate (ℚ) was formed.
③	ℚ was removed by filtration and H_2S was bubbled through the filtrate.	A pale pink precipitate (ℝ) was formed.
④	ℝ was removed by filtration and the filtrate was boiled till all the H_2S was removed. $(NH_4)_2CO_3$ was added to the solution.	A clear solution was obtained.
⑤	Dilute NaOH was added to a fresh portion of ℙ.	A dirty-green precipitate and a while precipitate were formed.

Experiments for precipitates ℚ and ℝ:

	Experiment	Observation
⑥	ℚ was dissolved in dil. HNO_3 and a salicylic acid solution was added.	A light purple solution was obtained.
⑦	ℝ was dissolved in dilute acid and dil. NaOH was added to the solution.	A white precipitate was formed. It turned brown on standing.

Anions

		Test	Observation
⑧	I.	$BaCl_2$ solution was added to ℙ.	A white precipitate was formed.
	II.	The white precipitate was separated by filtration and dil. HCl was added to the precipitate.	The white precipitate was not dissolved.
⑨		Cl_2 water and chloroform were added to a portion of the filtrate from ⑧ II, and the mixture was throughly shaken.	Chloroform layer turned yellowish-brown.

[see page thirteen

(i) Identify the two cations and the two anions in solution ℙ. (Reasons are not required.)

(ii) Write the chemical formulae of the precipitates ℚ and ℝ.

(iii) Give reasons for the following:

I. Removal of H_2S in experiment ② for cations.

II. Heating with conc. HNO_3 in experiment ② for cations.

(7.5 marks)

(*b*) The sample 𝕏 contains lead, copper and an inert material. The following procedure was carried out to analyse lead and copper in 𝕏.

Procedure:

A mass of 0.285 g of 𝕏 was dissolved in a slight excess of dil. HNO_3. A clear solution was obtained. A NaCl solution was added to the resulting clear solution. A white precipitate (𝕐) was formed. The precipitate was separated by filtration and the precipitate (𝕐) and filtrate (ℤ) were analysed separately.

Precipitate (𝕐)

The precipitate was dissolved in hot water. A solution of K_2CrO_4 was added in excess. A yellow precipitate was formed. The precipitate was separated by filtration and dissolved in dil. HNO_3. An orange coloured solution was obtained. Excess KI was added to this solution and the liberated I_2 was titrated with 0.100 mol dm^{-3} $Na_2S_2O_3$, with starch as the indicator. The volume of $Na_2S_2O_3$ required to reach the end point was 27.00 cm^3.

(Assume that the NO_3^- ions do not interfere with the titration.)

Filtrate (ℤ)

The filtrate was neutralized and excess KI was added to it. The liberated I_2 was titrated with 0.100 mol dm^{-3} $Na_2S_2O_3$, with starch as the indicator. The volume of $Na_2S_2O_3$ required to reach the end point was 15.00 cm^3.

(Note: Assume that the inert material was soluble in dil. HNO_3 and did not interfere with the experiment.)

(i) Calculate the mass percentages of lead and copper in 𝕏. Write balanced chemical equations where relevant.

(ii) What is the colour change at the end point in the titration carried out in the analysis of precipitate 𝕐?

(Cu = 63.5, Pb = 207)

(7.5 marks)

9. (*a*) The following questions are based on the environment and related issues.

(i) Identify three greenhouse gases that contribute to global warming. State two consequences of global warming.

(ii) Global environmental issues caused by coal power plants are well known. Identify one such issue that contributes significantly to change in certain water quality parameters in rivers and lakes.

(iii) Name the chemical species responsible for the environmental issue identified in (ii) above and state three water quality parameters that are likely to be affected by this issue.

(iv) Identify two environmental issues that change (increase or decrease) the ozone level in the atmosphere and explain briefly how these changes take place with the aid of balanced chemical equations.

(v) I. "Most of the harmful gases in vehicle exhausts are converted to relatively harmless gases by catalytic converters." Briefly explain this statement.

II. Name the harmful gas (except CO_2) that is not converted to a less harmful gas by the catalytic converter. State briefly how this harmful gas is formed in the vehicle engine.

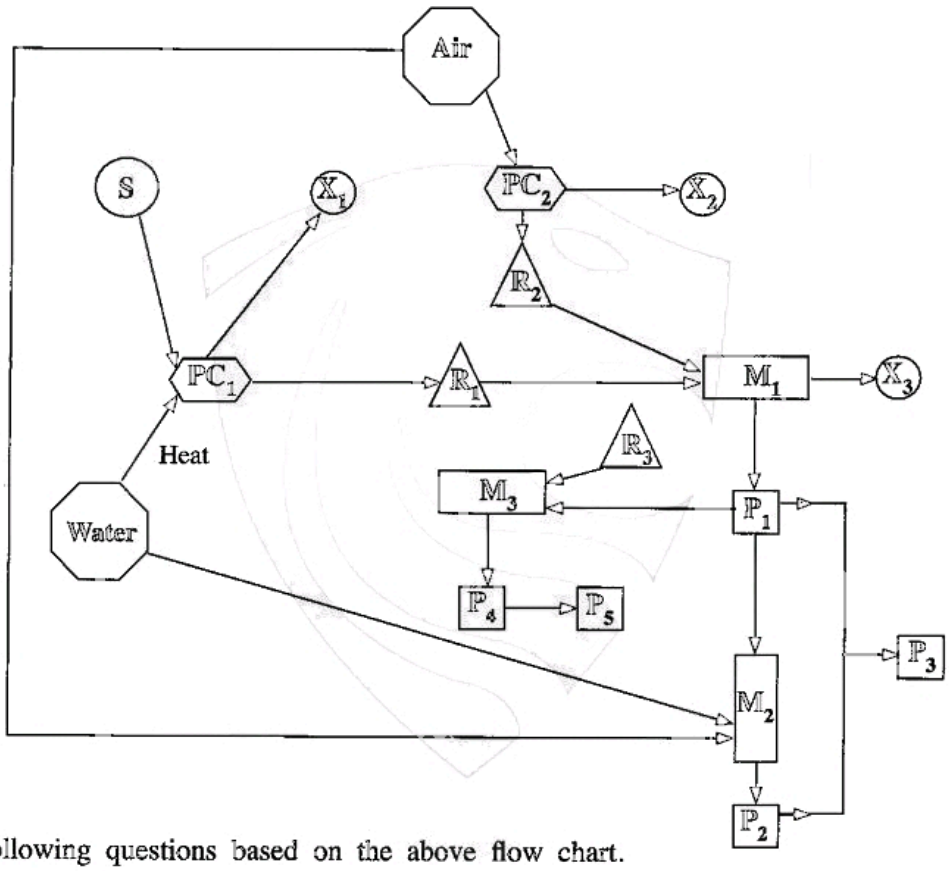
(7.5 marks)

[*see page fourteen*

(*b*) The flow chart given below shows the production of two important compounds $\mathbb{P}_1$ and $\mathbb{P}_2$ and three other important compounds $\mathbb{P}_3$, $\mathbb{P}_4$ and $\mathbb{P}_5$ derived from them. $\mathbb{P}_1$ is used as a raw material in the manufacture of Na_2CO_3. $\mathbb{P}_3$ can be manufactured by the reaction between $\mathbb{P}_1$ and $\mathbb{P}_2$. $\mathbb{P}_3$ is used as a fertilizer and as an explosive. $\mathbb{P}_1$ is also used in the manufacture of $\mathbb{P}_4$ which is a widely used fertilizer. $\mathbb{P}_4$ is used to synthesize an important thermosetting polymer $\mathbb{P}_5$.

$\mathbb{M}$	Manufacturing process	$\mathbb{PC}$	Physical/chemical process to obtain raw material	$\mathbb{R}$	Raw material
$\mathbb{P}$	Product	$\mathbb{S}$	Source of raw material		

$\mathbb{X}$ Unreacted raw material(s) / substance discharged to the atmosphere during physical and/or chemical process



Answer the following questions based on the above flow chart.

(i) Identify $\mathbb{P}_1$, $\mathbb{P}_2$, $\mathbb{P}_3$, $\mathbb{P}_4$ and $\mathbb{P}_5$

(ii) Identify $\mathbb{R}_1$, $\mathbb{R}_2$ and $\mathbb{R}_3$

(iii) Identify $\mathbb{X}_1$, $\mathbb{X}_2$ and $\mathbb{X}_3$

(iv) Identify $\mathbb{S}$.

(v) Briefly state the processes taking place in $\mathbb{PC}_1$ and $\mathbb{PC}_2$ giving balanced chemical equations where applicable.

(vi) Identify manufacturing processes $\mathbb{M}_1$, $\mathbb{M}_2$ and $\mathbb{M}_3$. (e.g. contact process or manufacture of H_2SO_4.)

(vii) Give balanced chemical equations with appropriate conditions, for reactions taking place in $\mathbb{M}_1$, $\mathbb{M}_2$ and $\mathbb{M}_3$.

(viii) I. Give one use of each compound $\mathbb{P}_1$ and $\mathbb{P}_2$ other than those mentioned above.

II. Give one use of $\mathbb{R}_1$ in the manufacturing process $\mathbb{P}_1$ other than being used as a raw material.

(7.5 marks)

[*see page fifteen*

10.(*a*) A and B are complex ions, (i.e. metal ion and ligands coordinated to it) with an octahedral geometry. They have the same atomic composition of $MnC_5H_3N_6$. In each complex ion, two types of ligands are coordinated to the metal ion. When an aqueous solution containing A is treated with a potassium salt, the coordination compound C is formed. C gives four ions in aqueous solution. When an aqueous solution containing B is treated with a potassium salt the coordination compound D is formed. D gives three ions in aqueous solution. Both C and D have an octahedral geometry.

(Note: The oxidation states of manganese in A and B do not change on treatment with the potassium salt).

(i) Identify the ligands coordinated to manganese in A and B.

(ii) Give the structures of A, B, C and D.

(iii) Write the electronic configurations of the manganese ions in A and B.

(iv) Write the IUPAC names of C and D.

(7.5 marks)

(*b*) (i) I. Write the reduction half reaction corresponding to the electrode, $Ag(s)\,|\,AgCl(s)\,|\,Cl^-(aq)$.

II. State whether the electrode potential of $Ag(s)\,|\,AgCl(s)\,|\,Cl^-(aq)$ depends on the Ag^+ concentration in the solution. Explain your answer.

(ii) Consider the following reaction.

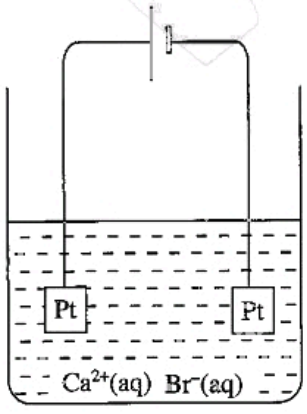
$$Fe(s) + 2H^+(aq) + \frac{1}{2}O_2(g) \longrightarrow Fe^{2+}(aq) + H_2O(l)$$

I. Write the oxidation and reduction half reactions relevant to the above reaction.

II. Given that the above reaction is the cell reaction of an electrochemical cell, determine the standard electromotive force of the cell.

$$E^o_{Fe^{2+}(aq)/Fe(s)} = -0.44\ V \qquad E^o_{H^+(aq)/O_2(g)/H_2O(l)} = 1.23\ V$$

(iii) A constant current of 100 mA was passed through 100.00 cm^3 of a 0.10 mol dm^{-3} aqueous $CaBr_2$ solution as shown in the diagram. The temperature of the system was maintained at 25 °C.



I. Write the oxidation and reduction reactions that take place at the electrodes.

II. Calculate the time taken for the commencement of precipitation of $Ca(OH)_2(s)$. Solubility product of $Ca(OH)_2$ at 25 °C is 1.0×10^{-5} mol^3 dm^{-9}. Neglect the ionization of water. Assume that the volume of the aqueous phase remains constant.

(7.5 marks)

* * *

[*see page sixteen*

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