

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය 1997 අගෝස්තු (නව නිර්දේශය)
 கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர)ப் பரீட்சை, 1997 ஓகஸ்த் (புதிய பாடத்திட்டம்)
 General Certificate of Education (Adv. Level) Examination, August 1997 (New Syllabus)

රසායන විද්‍යාව I
 இரசாயனவியல் I
 Chemistry I

02	
E	I

පෑ දෙකයි / இரண்டு மணி / Two hours

Important : This question paper consists of two sheets. Put the sheets together in the correct order of pages before answering.

Enter your *Index Number* in the space provided on the answer sheet.
 Use of calculators is not allowed.

You should attempt all the questions in this paper. For each question there are five responses of which only one is correct. When you have selected the response which you consider to be the best answer to a question, mark your response on the answer sheet. Answer easier questions first and leave aside any questions which you find too difficult and come back to them later.

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

The following abbreviations have been used.

aq = aqueous

C = Celsius or Centigrade or Coulomb

g = gas

l = liquid

mol dm^{-3} = moles per cubic decimetre

s = solid

Other abbreviations also follow standard usage.

- The principal valencies of the element of atomic number 34 are
 (1) 2 and 4. (2) 2 and 6. (3) 1 and 3. (4) 2 and 3. (5) 3 and 5.
- Which one of the following compounds has the highest ionic character?
 (1) LiCl (2) HF (3) LiBr (4) RbCl (5) HI
- The concentration of an aqueous solution of methanol is 10%, by weight. If the relative atomic masses of carbon, hydrogen and oxygen are respectively 12, 1 and 16, the mole fraction of methanol in this solution is
 (1) 0.1111. (2) 0.8889. (3) 0.0588. (4) 0.9412. (5) 0.0625.
- Which one of the following statements concerning the chemistry of phosphorus is true?
 (1) The H_3PO_3 molecule has three O—H bonds.
 (2) The H_3PO_3 molecule has two O—H bonds.
 (3) The H_3PO_2 molecule has two O—H bonds.
 (4) Phosphorus does not react with chlorine.
 (5) Phosphorus reacts with water.
- The straight-chain organic compound of molecular formula $\text{C}_3\text{H}_4\text{Cl}_2$
 (1) exists as 4 isomers. (2) exists as 5 isomers.
 (3) exists as 6 isomers. (4) exists as 7 isomers.
 (5) exists as 8 isomers.

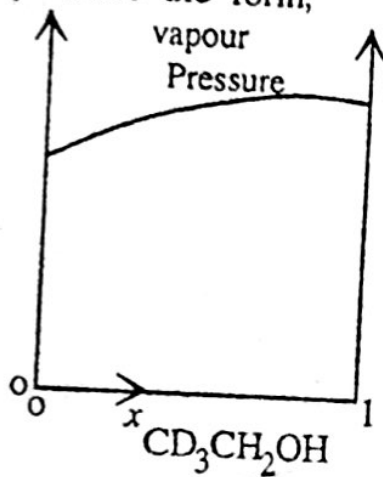
6. 0.80 mol of a gas which behaves ideally, is present in a closed vessel at a temperature of 300 K and under a pressure of $4.157 \times 10^5 \text{ N m}^{-2}$. The volume of this vessel is
- (1) $480 \times 10^{-5} \text{ m}^3$ (2) $480 \times 10^{-3} \text{ dm}^3$ (3) $720 \times 10^{-5} \text{ m}^3$
 (4) $720 \times 10^{-3} \text{ dm}^3$ (5) $960 \times 10^{-5} \text{ m}^3$

7. When the inorganic compound, X was treated with dilute hydrochloric acid, a colourless gas and a coloured solution were obtained. When this gas was passed into an aqueous solution of hydrogen sulphide, a precipitate was obtained. When an excess of aqueous ammonia was added to the coloured solution referred to above, a coloured precipitate was obtained. Which one of the following could be X?
- (1) $\text{Fe}(\text{NO}_2)_3$ (2) $\text{Cr}_2(\text{SO}_3)_3$ (3) $\text{Cr}_2(\text{CO}_3)_3$ (4) CuSO_3 (5) $\text{Cu}(\text{NO}_2)_2^x$

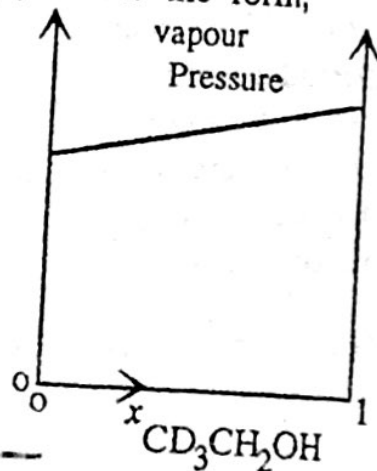
8. Aqueous $\text{Pb}(\text{NO}_3)_2 / \text{HNO}_3$
- (1) gives a precipitate with $\text{ClCH}=\text{CHCH}_2\text{COBr}$.
 (2) gives a precipitate with $\text{BrCH}_2\text{CH}_2\text{COOH}$.
 (3) gives a precipitate with $\text{I}_2\text{CHCH}_2\text{COCH}_2\text{CH}_2\text{Br}$.
 (4) gives a precipitate with $\text{C}_6\text{H}_5\text{I}$
 (5) does not give a precipitate with any of the above.

9. The vapour pressure variation of the binary system consisting of $\text{CD}_3\text{CH}_2\text{OH}$ and $\text{DCH}_2\text{CH}_2\text{CH}_2\text{OH}$

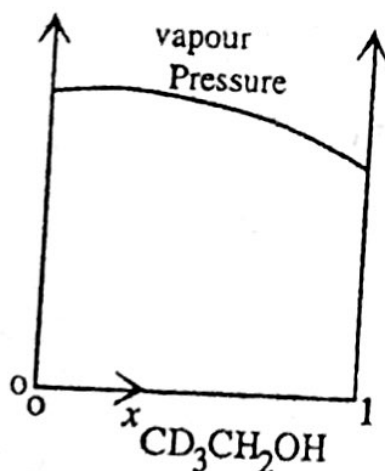
(1) takes the form,



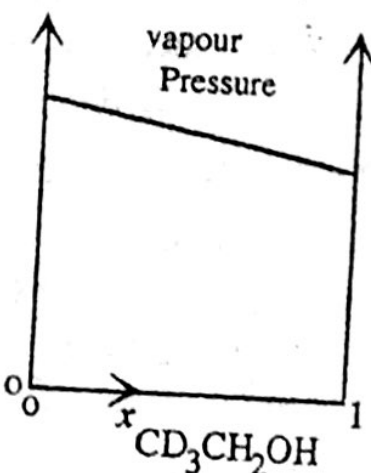
(2) takes the form,



(3) takes the form,



(4) takes the form,



(5) takes none of the forms shown above.

10. Naturally occurring chlorine contains 75% of the $^{35}_{17}\text{Cl}$ isotope and 25% of the $^{37}_{17}\text{Cl}$ isotope. The relative atomic mass of naturally occurring chlorine
- (1) is 36. (2) is 35.51. (3) is 35.47. (4) is 36.5.
 (5) cannot be accurately calculated with the data supplied.

11. For the purpose of calculating the lattice energy of the hypothetical compound 'CaF',
- (1) the second ionization energy of calcium is necessary.
 (2) the first ionization energy of calcium is necessary.
 (3) the first ionization energy of fluorine is necessary.
 (4) the standard enthalpy change pertaining to the process, $\text{F}(\text{g}) + 2\text{e} \longrightarrow \text{F}^{2-}(\text{g})$ is necessary.
 (5) none of the above is necessary.

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12. Which one of the following will **not** undergo a chemical change in the presence of aqueous H_2O_2 ?
- (1) NH_4MnO_4 / dilute HCl (2) $NaMnO_4$ / dilute HNO_3
(3) MnO_2 / dilute H_2SO_4 (4) MnO_2 (5) HI
13. The organic compound, Y dissolves in aqueous sodium hydroxide. It gives a precipitate with Brady's reagent. It reduces Fehling's solution. Which one of the following is most likely to be Y?
- (1) $HOOCCH_2CH_2CH_2COCH_3$ (2) $HO-C_6H_4-CH_2CH_2CHO$
(3) $HO-C_6H_4-COCH_2CH_3$ (4) $CH_3OCH_2-C_6H_4-CH_2CHO$
(5) $HOCH_2CH_2CH_2CH_2CH_2CH_2CHO$
14. Which one of the following has the largest ionic radius?
- (1) S^{2-} (2) Na^+ (3) F^- (4) O^{2-} (5) Mg^{2+}
15. The first seven successive ionization energies of an element are respectively as follows: 1018, 1910, 2910, 4972, 6280, 21276 and 25403 $kJ\ mol^{-1}$. This element
- (1) belongs to group 2 of the periodic table.
(2) belongs to group 3 of the periodic table.
(3) belongs to group 4 of the periodic table.
(4) belongs to group 5 of the periodic table.
(5) belongs to group 6 of the periodic table.
16. Which one of the following statements concerning environmental pollution caused by acidic substances is most appropriate?
- (1) N_2 is an important factor. (2) O_2 is an important factor.
(3) Coal and O_2 are important factors. (4) H_2O is an important factor.
(5) All of the above are important factors.
17. Which one of the following is most closely connected with apatite?
- (1) Ca_2PO_4Cl (2) $Ca_3PO_4F_3$ (3) $Ca_3(PO_4)_3F$ (4) $CaMgPO_4F$ (5) $Ca_2MgPO_4F_2Cl$
18. Which one of the following is **not** necessary for the production of terylene?
- (1) $HOCH_2CH_2OH$ (2) $HOOC-C_6H_4-COOH$
(3) $CH_3-C_6H_4-CH_3$ (4) $CH_2=CH_2$ (5) $HOOC-C_6H_3(COOH)-COOH$
19. The size of the atomic nucleus was first determined by
- (1) making use of α -particle scattering. (2) making use of β -particle scattering.
(3) using high-speed electrons. (4) using neutron beams.
(5) making use of α -particle absorption.
20. Which one of the following statements concerning the nitration of $\text{C}_6\text{H}_5\text{NHCOCH}_3$ is most appropriate?
- (1) A mixture of the 1-nitro derivative and the 3-nitro derivative is obtained.
(2) A mixture of the 2-nitro derivative and the 3-nitro derivative is obtained.
(3) A mixture of the 2-nitro derivative and the 4-nitro derivative is obtained. ✗
(4) The 4-nitro derivative is obtained.
(5) The 2-nitro derivative is obtained.
21. NH_4OH and NH_4CNS were added to an aqueous solution of an inorganic compound, Z, and the reaction mixture was kept aside for a few minutes. Then, this reaction mixture was acidified with dilute sulphuric acid. A red solution was thus produced. Which one of the following is most likely to be Z?
- (1) $NiSO_4$ (2) $Cr_2(SO_4)_3$ (3) $Mn(NO_3)_2$ (4) $K_4Fe(CN)_6$ (5) $FeSO_4$

22. 50.0 cm³ of 0.1 mol dm⁻³ aqueous NaOH solution was mixed with 100.0 cm³ of 0.1 mol dm⁻³ aqueous CH₃COOH solution. The pH of this mixture was 4.75. 1.0 cm³ of aqueous 0.1 mol dm⁻³ KOH was added to the above mixture. The pH of the solution finally obtained
- (1) is likely to increase to 4.90. (2) is likely to decrease to 4.70.
 (3) is likely to decrease to 4.65 (4) is likely to decrease to 4.60
 (5) is likely to remain constant as 4.75.

23. The colour-change pH intervals of four acid-base indicators, P, Q, R, and S are shown in the Table below.

Indicator	Colour-change pH interval
P	3.9 — 5.1
Q	4.0 — 5.4
R	4.7 — 6.3
S	8.3 — 9.1

Which one of the statements concerning the titration between 0.1 mol dm⁻³ aqueous NH₃ solution and 0.1 mol dm⁻³ aqueous HClO₄ solution is most appropriate?

- (1) For this titration, Q is a suitable indicator.
 (2) For this titration, P and Q are suitable indicators.
 (3) For this titration, S is a suitable indicator.
 (4) For this titration, P, Q and R are suitable indicators.
 (5) For this titration, Q, R and S are suitable indicators.
24. When an organic compound, A was boiled with concentrated HCl and allowed to cool, a white crystalline solid, B was obtained. When B was filtered off, separated, washed with water and then treated with NaHCO₃ solution, bubbles of gas were liberated. NaNO₂ was added to the filtrate and it was neutralized with aqueous NH₃. When bromine water was added to this neutral solution, a white precipitate was obtained. Which one of the following could be A?
- (1) C₆H₅NHCOCH₂CH₃ (2) CH₃CH₂CH₂NHCOC₆H₅ (3) C₆H₅NHCOC₆H₅
 (4) (C₆H₅)₂NCOC₂H₅ (5) (CH₃)₃CNHCOCH₂C₆H₅

25. It has become necessary to synthesise H₂NCH₂CH₂CH₂CH₂NH₂ starting from ethene. The most appropriate first step for this purpose is

- (1) reacting ethene with aqueous sulphuric acid.
 (2) reacting ethene with aqueous hydrobromic acid.
 (3) reacting ethene with Cl₂.
 (4) reacting ethene with aqueous KCN.
 (5) reacting ethene with alcoholic ClCH₂CN.

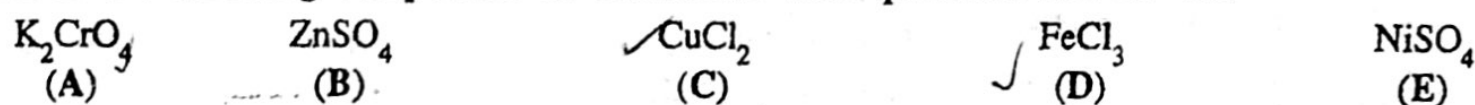
26. The chemical formula of scandium thiosulphate is

- (1) ScS₂O₃ (2) Sc(S₂O₃)₂ (3) Sc₂(S₂O₃)₃
 (4) Sc₃(S₂O₃)₂ (5) none of the above.

27. The shape of the POClBrF molecule

- (1) is planar. (2) takes the form of a square pyramid.
 (3) is octahedral. (4) is tetrahedral
 (5) is trigonal bipyramidal

- Consider the following compounds in connection with questions No. 28—30.



28. Which of the above is/are likely to give a precipitate with dilute HCl saturated with H₂S?
 (1) A only. (2) A and B only. (3) C only.
 (4) A, C and D only. (5) B and E only.
29. Which of the above is/ are likely to liberate I₂ with KI, under certain specific conditions?
 (1) A and B only. (2) A, C and D only. (3) A and D only.
 (4) A and C only. (5) C, D and E only.
30. Which of the above will oxidize CH₃CHO under certain specific conditions?
 (1) A only. (2) B and D only. (3) A and C only.
 (4) C only. (5) A, B and E only.

● Instructions for questions No. 31 to 40

For each of the questions 31 to 40 four responses (a), (b), (c), (d) are given. One or more of these are correct. Select the correct response/responses. Mark × against,

- (1) if only (a) and (b) are correct.
- (2) if only (b) and (c) are correct.
- (3) if only (c) and (d) are correct.
- (4) If only (d) and (a) are correct.
- (5) If only one response or any other number of responses are correct.

Summary of Instructions				
(1)	(2)	(3)	(4)	(5)
Only (a) and (b) correct	Only (b) and (c) correct	Only (c) and (d) correct	Only (d) and (a) correct	Only one response or any other number of responses correct

31. Which of the following will react with phenol?
 (a) RbHCO_3 (b) $\text{C}_6\text{H}_5\text{OCH}_2\text{CH}_3$
 (c) Concentrated nitric acid (d) Ethanoyl chloride
32. Which of the following will assist the corrosion of iron that is taking place in air?
 (a) Mg (b) NaCl (c) CO_2 (d) NO
33. Consider following reaction,

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \quad \Delta H^\ominus = -46 \text{ kJ (per mole of NH}_3 \text{ formed)}$$
 Which of the following statements / statement concerning the above reaction are / is true?
 (a) At all temperatures, $K_p = \frac{(P_{\text{NH}_3})^2}{P_{\text{N}_2} \times (P_{\text{H}_2})^3}$
 (b) At constant temperature, K_p increases when P_{N_2} is increased.
 (c) At constant temperature, K_p decreases when P_{N_2} is increased.
 (d) At constant pressure, the amount of NH_3 in equilibrium reaction mixture increases when the temperature is decreased.
34. Which one of the following relationships / relationship concerning the pH of the aqueous solution of $0.1 \text{ mol dm}^{-3} \text{ Na}_2\text{CO}_3$, $0.1 \text{ mol dm}^{-3} \text{ KHCO}_3$, $0.1 \text{ mol dm}^{-3} \text{ Ba}(\text{ClO}_4)_2$ and $0.1 \text{ mol dm}^{-3} \text{ C}_6\text{H}_5\text{NH}_3^+$ are / is true?
 (a) $\text{C}_6\text{H}_5\text{NH}_3^+ \text{ HSO}_4^- < \text{KHCO}_3 < \text{Na}_2\text{CO}_3$
 (b) $\text{C}_6\text{H}_5\text{NH}_3^+ \text{ HSO}_4^- < \text{Ba}(\text{ClO}_4)_2 < \text{KHCO}_3$
 (c) $\text{Ba}(\text{ClO}_4)_2 < \text{Na}_2\text{CO}_3 < \text{KHCO}_3$
 (d) $\text{Na}_2\text{CO}_3 < \text{KHCO}_3 < \text{Ba}(\text{ClO}_4)_2$
35. Which of the following could be deduced using the equation $PV = \frac{1}{3} mNc^2$?
 (a) Boyle's law (b) Charles' law
 (c) Deviations from gas laws (d) Avogadro constant, L
36. Which of the following statements / statement are / is true?
 (a) Electric fields do not affect the path of cathode rays.
 (b) Magnetic fields do not affect the path of cathode rays.
 (c) Electric fields do not affect the path of fast-moving neutrons.
 (d) Magnetic fields do not affect the path of fast-moving neutrons.
37. Strong hydrogen bonds
 (a) exist in CH_3OH liquid. (b) exist in CH_3COOH liquid.
 (c) exist in liquid NH_3 . (d) exist in liquid HF.

38. Which of the following statements / statement concerning the mechanism of the reaction occurring between C_6H_5CHO and HCN are/is true?
- (a) The initial attack is by the $\bar{C}N$ ion on the C atom of the $>C=O$ group
 (b) The second attack is by the H^+ ion.
 (c) The initial attack is by CN^- on the O atom.
 (d) The initial attack is by one of the lone pairs of electrons present in the $>C=O:$ group.
39. Which of the following statements/statement concerning bleaching powder are/is true?
- (a) Limestone is necessary for manufacturing it.
 (b) Salt is necessary for manufacturing it.
 (c) It changes the colour of $K_2Cr_2O_7$ / hot concentrated H_2SO_4 .
 (d) It removes the colour of $FeCl_3$ in aqueous ammonia medium.
40. Which of the following are/is necessary for the manufacture of caustic soda for commercial applications?
- (a) Carbon (b) Iron (c) Sulphur (d) Thermal energy
- In questions No. 41 to 50, two statements are given in respect of each question. From the Table given below, select the description (1), (2), (3), (4), (5) that best fits the two statements given for each of the questions and mark appropriately.

First Statement	Second Statement
(1) True	True, and correctly explains the first statement.
(2) True	True, but does not explain the first statement correctly.
(3) True	False
(4) False	True
(5) False	False

First Statement	Second Statement
41. The shape of the electron density distribution of the 1s orbital of the hydrogen atom is spherical.	According to the Bohr Theory, the electron in the hydrogen atom moves in a circular path.
42. Propanone reacts with aniline.	An acid-base reaction occurs between aniline and propanone.
43. Citronella oil can be extracted by steam distillation.	Raoult's law can be applied to this distillation.
44. Nitrogen gas cannot act as an oxidizing agent.	The electronegativity of nitrogen is less than the electronegativity of oxygen.
45. The specific heat capacity of liquid water is anomalously high.	In liquid water, strong interactions occur between H_2O molecules.
46. All catalysts increase the rates of the relevant chemical reactions.	All catalysts decrease the activation energies of the relevant chemical reactions.
47. Alkenes are not converted into an oxidized state by alkaline $KMnO_4$.	The MnO_4^- ion does not show oxidizing properties in alkaline solution.
48. The hardness of diamond is very much higher than the hardness of solid carbon dioxide.	The C—C bond strength is very much higher than the C=O bond strength.
49. Optical isomers cannot be obtained by subjecting propene to addition reactions.	Propene does not exist as geometrical isomers.
50. NO_2 cannot act as an oxidizing agent.	NO_2 can be converted easily to HNO_3 .

51. Which one of the following statements concerning the electrolysis of some aqueous solutions is false?
- (1) The mass of Cd liberated during a definite time is proportional to the electric current that is passed through a $\text{Cd}(\text{NO}_3)_2$ solution.
 - (2) The mass of Cu liberated by a definite electric current is proportional to the time during which current is passed through a $\text{Cu}(\text{NO}_3)_2$ solution.
 - (3) The masses of Cd and Cu liberated when a definite quantity of electricity is passed through aqueous CdSO_4 and CuSO_4 solutions are proportional to the molar masses of those elements.
 - (4) The masses of Ag, Hg and Fe liberated when a definite quantity of electricity is passed through aqueous AgNO_3 , HgSO_4 and FeCl_3 solutions are proportional to the molar masses of those elements.
 - (5) The masses of Ag and Cu liberated when a definite quantity of electricity is passed through aqueous Ag_2SO_4 and CuSO_4 solutions are proportional to the chemical equivalents of those elements.

52. SrCrO_4 is dissolved in dilute nitric acid. The colour of this solution is
- (1) purple.
 - (2) green.
 - (3) yellow.
 - (4) orange.
 - (5) red.

53. The relationship among K_b of $\text{NH}_3(\text{aq})$, K_a of $\text{NH}_4^+(\text{aq})$ and K_w at the same temperature is

- (1) $\frac{K_a}{K_b} = K_w$.
- (2) $\frac{K_b}{K_a} = K_w$
- (3) $K_a - K_b = K_w$
- (4) $K_a \times K_b = (K_w)^{\frac{1}{2}}$
- (5) none of the above.

54.
$$\text{Zn}^{2+}(\text{aq}) + 2\text{e} \longrightarrow \text{Zn}(\text{s}) \quad E^\ominus = -0.76 \text{ V}$$

$$\text{Ag}^+(\text{aq}) + \text{e} \longrightarrow \text{Ag}(\text{s}) \quad E^\ominus = +0.80 \text{ V}$$

Which one of the following statements concerning the cell, $\text{Zn}(\text{s}) \mid \text{Zn}^{2+}(\text{aq}, 1 \text{ mol dm}^{-3}) \mid \text{Ag}^+(\text{aq}, 1 \text{ mol dm}^{-3}) \mid \text{Ag}(\text{s})$ is false?

- (1) Oxidation takes place at the Zn electrode.
 - (2) Reduction takes place at the Ag electrode.
 - (3) The E^\ominus of this cell is + 1.56 V.
 - (4) The E^\ominus of this cell is + 0.84 V.
 - (5) In this cell, the Zn electrode has a negative electrical charge.
55. The reactions between $\text{H}_2(\text{g})$ and $\text{Cl}_2(\text{g})$ is catalysed by palladium. Which one of the following statements concerning this reaction is most appropriate?
- (1) The enthalpy change of formation of $\text{HCl}(\text{g})$ is decreased by palladium.
 - (2) The enthalpy change of decomposition of $\text{HCl}(\text{g})$ is decreased by palladium.
 - (3) H_2 is adsorbed on palladium.
 - (4) Cl_2 is adsorbed on palladium.
 - (5) Both hydrogen and chlorine are adsorbed on palladium.

56. The water solubility of $\text{Cu}(\text{OH})_2$ at a certain temperature is $x \text{ mol dm}^{-3}$. The solubility of $\text{Cu}(\text{OH})_2$ in 2.0 mol dm^{-3} aqueous ammonia at the same temperature is

- (1) $x^3 \text{ mol dm}^{-3}$.
- (2) $\frac{x^3}{4} \text{ mol dm}^{-3}$.
- (3) $x^2 \text{ mol dm}^{-3}$.
- (4) $\frac{x^2}{2} \text{ mol dm}^{-3}$.
- (5) none of the above.

57. The straight-chain hydrocarbon of molecular formula, $C_{11}H_{20}$ was subjected to oxidation under vigorous oxidizing conditions. In this reaction, the reactive carbon-carbon bonds were broken, and two carboxylic acids were obtained as products. This hydrocarbon

- (1) is likely to be $CH_3CH = CHCH_2CH_2CH_2CH = CHCH_2CH_2CH_3$.
- (2) is likely to be $CH_3CH_2CH = CHCH_2CH_2CH_2C \equiv CCH_2CH_3$.
- (3) is likely to be $CH_3CH_2CH = C = CHCH_2CH_2CH_2CH_2CH_2CH_3$.
- (4) is likely to be $CH_3CH_2CH_2C \equiv CCH_2CH_2CH_2CH = CHCH_3$.
- (5) is likely to be $CH_3C \equiv CCH_2CH_2CH_2C \equiv CCH_2CH_2CH_3$.

58. Which one of the following concerning halogens is most likely to be false?

- (1) $3Cl_2 + 8NH_3 \longrightarrow N_2 + 6NH_4Cl$
- (2) $3Cl_2 + 2NH_3 \longrightarrow N_2 + 6HCl$
- (3) $I_2 + 2H_2O \longrightarrow H_3O^+ + I^- + HOI$
- (4) $Cl_2 + 2HF \longrightarrow 2HCl + F_2$
- (5) $Br_2 + 2HI \longrightarrow 2HBr + I_2$

59. Which one of the following is true?

- (1) Avogadro constant = $\frac{96490 \text{ C}}{2 \times \text{charge on the alpha particle}}$
- (2) Avogadro constant = $\frac{96500 \text{ C}}{\text{charge on the sodium ion}}$
- (3) Avogadro constant = $\frac{F}{\text{charge on the oxide ion}}$
- (4) Avogadro constant = $\frac{F}{\text{charge on a mole of electrons}}$
- (5) Avogadro constant = $\frac{96490 \text{ C}}{\text{charge on a mole of protons}}$

60. The element Q is a non-metal. It forms stable diatomic molecules. The reaction between Q and hot concentrated caesium hydroxide

- (1) is likely to give CsQ and $CsQO$.
- (2) is likely to give $CsQO_4$ and $CsQO_2$.
- (3) is likely to give $CsQO_3$ and $CsQO$.
- (4) is likely to give CsQ and $CsQO_3$.
- (5) is likely to give $CsQO_3$ and $CsQO_4$.

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

02
E | II

පැය තුනයි / மூன்று மணி / Three hours

Index No. :

Important : This question paper consists of four sheets. Put the sheets together in the correct order of pages before answering

Use of calculators is not allowed.

This question paper consists of three parts A, B and C. The time allotted for all three parts is three hours.

Part A — Structured Essay
Answer all four questions. Each question carries 10 marks

1. (a) (i) Present briefly and clearly a simple experiment to demonstrate that gases are non-continuous.

Do not write anything in this column

(ii) Present briefly and clearly a simple experiment to demonstrate that liquids are non-continuous.

Do not
write
anything
in this
column.

(b) Name the chemical compounds shown below, appropriately.

Compound	Name
Cu_3N	
Li_2O_2	

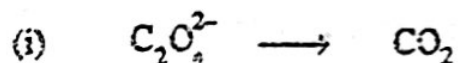
(c) (i) The relative atomic mass of the element, X is between 50 and 70. The hydrated crystals of XSO_4 are colourless, while XS is a white precipitate. A dioxide of X does not exist. Identify X.

(ii) Write the electronic configuration of the element of atomic number 28 in the usual form, $1s^2 2s^2 \dots$ etc.

(iii) Apart from the temperature changes that occur, predict three important changes that could occur when an excess of dilute FeSO_4 is gradually added to an aqueous solution of Br_2/KBr .

(iv) Apart from the temperature changes that occur, predict three important changes that could occur when a small amount of $\text{Fe}(\text{OH})_2$ is added to an aqueous solution of hydroiodic acid.

2. (a) Balance the following chemical changes with respect to the various atoms and electrical charges.



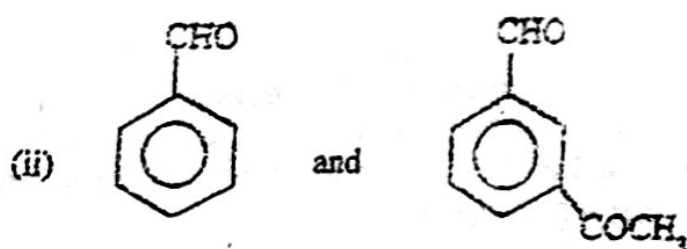


- (b) Using the balanced equations obtained above, or using another method, write a balanced chemical equation for the reaction that could occur when K_2CrO_4 , $\text{K}_2\text{C}_2\text{O}_4$ and aqueous H_2SO_4 are heated together.
- (c) Explain qualitatively the nature of the three physical states of matter on the basis of the motion and arrangement of molecules. N.B. It is sufficient to consider two properties for each of the physical states.
- (d) Indicate how you would show that the equilibrium reaction pertaining to the $\text{Cr}_2\text{C}_7^{2-} / \text{CrO}_4^{2-}$ system in aqueous solution is reversible.
3. (a) The organic compound, P contains 47.4% carbon, 2.63% hydrogen, 18.4% nitrogen and oxygen only. The relative molecular mass of P is about 150. Determine the molecular formula of P. (H = 1; N = 14; O = 16; C = 12)
- (b) Consider the C_2H_4 molecule.
- (i) Name specifically the orbitals that are being used by the carbon atoms for bond formation in this molecule.
- (ii) Indicate in a diagram the orbitals that are being used by a carbon atom for bond formation in this molecule. Indicate clearly in your diagram the angles between the directions of orientation of the above orbitals. N.B. These angles should be specified in degrees.

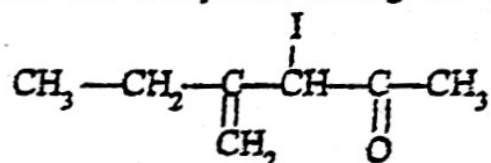
(iii) Describe clearly the nature of the double bond between the two carbon atoms in the C_2H_2 molecule.

(c) Indicate how you would chemically distinguish between the two compounds in the following pairs.

(i) $CH_3CH_2CH=CH_2$ and $CH_3CH=CHCH_3$



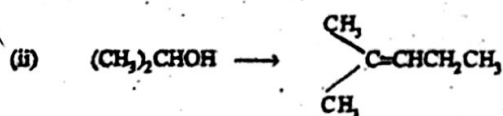
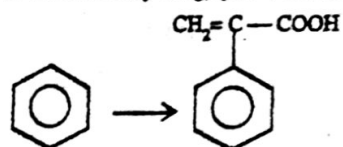
4. (a) Name the compound having the structure



in accordance with IUPAC nomenclature.

(b) Give the mechanism of the addition reaction that occurs between $\text{CH}_2=\text{CH}_2$ and HBr under appropriate conditions.

(c) Indicate how the following conversions could be effected. The necessary reagents and reaction conditions should be clearly given at the appropriate places. N.B. If the method of conversion proposed by you is unnecessarily long, you will not be awarded maximum marks.



N.B. For this conversion, you are supplied with only $(\text{CH}_3)_2\text{CHOH}$ as an starting compound.

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

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 1997 අගෝස්තු (නව නිර්දේශය)
கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர)ப் பரீட்சை, 1997 ஓகஸ்ட் (புதிய பாடத்திட்டம்)
General Certificate of Education (Adv. Level) Examination, August 1997 (New Syllabus)

රසායන විද්‍යාව II

இரசாயனவியல் II

Chemistry II

02

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II

Part B — Essay

Answer two questions only. Each question carries 15 marks.

5. (a) State Boyle's law and Charles' law in words. Using these two laws derive the ideal gas equation.
- (b) A closed vessel of volume 7.76 dm^3 contains a mixture of helium and oxygen. The pressure inside the vessel at 280 K was $1.50 \times 10^5 \text{ N m}^{-2}$. Inside the vessel there is a strip of magnesium which can be ignited by an electrical method. When this strip of magnesium was ignited, the oxygen completely combined chemically with the magnesium. After this reaction, the pressure inside the vessel at 327.5 K was $0.702 \times 10^5 \text{ N m}^{-2}$.
- (i) Assuming that the total volume of magnesium and magnesium oxide is negligible, calculate the mass of helium present in the vessel.
- (ii) Calculate the mass of magnesium oxide formed in the vessel.
(He = 4; O = 16; Mg = 24)
N.B. Assume that under the above conditions helium and oxygen behave as ideal gases, and that the volume of the vessel remains constant.
- (c) Ammonium dichromate(VI) solid undergoes complete thermal decomposition as follows:
 $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{N}_2 + 4\text{H}_2\text{O} + \text{Cr}_2\text{O}_3$
You are supplied with pure ammonium dichromate(VI) solid. Describe clearly how you would attempt to determine experimentally the gas constant, R , using this substance.
- (a) (i) State Hess's law.
- (ii) Explain how the standard enthalpy of formation of the hypothetical ionic compound 'KBr₂' could be determined.
- (b) (i) Assume that Y is a trivalent metal while Z is a non-metal. Assume that the ionic solid YZ₃ is slightly soluble in water. At a certain temperature the concentration of Z⁻ in an aqueous solution saturated with YZ₃ is $C \text{ mol dm}^{-3}$. Derive the relationship between the K_{sp} of YZ₃ and C at this temperature.
N.B. In this derivation, the essential steps should be clearly indicated.
- (ii) The water-solubility of the compound, Y(MnO₄)₃ is small. Assume that this solubility cannot be determined accurately by weighing. However, assume that Y(MnO₄)₃ dissolves slightly in water at $25 \text{ }^\circ\text{C}$ giving a considerably prominent purple colour. Describe clearly how you would attempt to determine experimentally the K_{sp} of Y(MnO₄)₃ at $25 \text{ }^\circ\text{C}$.

7. (a) (i) Derive the equation pertaining to Ostwald's dilution law.
- (ii) The dissociation constant of the weak mono-basic acid, RCOOH is $2.5 \times 10^{-5} \text{ mol dm}^{-3}$ at 25 °C. Calculate the pH value and the OH^- ion concentration of a 0.16 mol dm^{-3} aqueous solution of RCOOH at 25 °C.
 $K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ at 25 °C
- (b) (i) Using a **specific**, simple chemical reaction of your choice, present an experiment to demonstrate clearly that temperature influences the rate of a chemical reaction.
- (ii) Using a **specific**, simple chemical reaction of your choice, present an experiment to demonstrate clearly that light influences the rate of a chemical reaction.
- (c) Assume that a certain water-soluble chloro-compound QCl, undergoes hydrolysis slowly in aqueous medium. Assume also that the rate of this reaction can be expressed as follows:

$$\text{Rate} = k[\text{QCl}]^n$$

Describe clearly an experimental method which might be suitable for the determination of the value of n above.

8. (a) (i) State in words Raoult's law as applicable to a mixture consisting of two liquids A and B which are completely miscible.
- (ii) Give **two specific examples** of instances which show positive deviations from Raoult's law. Explain how these deviations occur.
- (b) Present the theory pertaining to the separation of the constituents of a binary solution consisting of two liquids by fractional distillation.
- (c) (i) A zinc rod is partially immersed in a 1.0 mol dm^{-3} aqueous solution of ZnSO_4 at 25 °C. Explain how an electrical potential difference arises between the zinc rod and the ZnSO_4 solution.
- (ii) The value of the above electrical potential difference cannot be measured simply and directly by a voltmeter. Explain why this is so.

Part C — Essay

Answer two questions only. Each question carries 15 marks.

9. (a) (i) Write the chemical formulae of the oxides derived from the highest oxidation states of boron, magnesium, aluminium, sulphur, chlorine, rubidium and barium.
- (ii) Using **appropriately only one or two** of the terms, 'strongly acidic', 'weakly acidic', 'weakly basic' and 'strongly basic' indicate clearly the acid-base nature of each of those oxides.
- (b) (i) Give **four** reasons that led to the classification of hydrogen along with the alkali metals in the Periodic Table.
- (ii) Give **four** reasons that led to the classification of hydrogen along with the halogens in the Periodic Table.
- (c) You are provided with a mixture consisting of barium carbonate, magnesium carbonate, potassium chloride and silicon dioxide. Explain how you would attempt to determine the mass percentage of each of these constituents in the mixture.

- (a) (i) Indicate clearly and separately the various conditions employed in the manufacture of sulphuric acid by the Contact Process.
- (ii) Explain as fully as you can, appropriately and separately, how each one of the conditions indicated by you, increases the efficiency of the above manufacturing process.
- (b) (i) How and under what conditions will sulphuric acid react with ammonium iodide?
N.B. The relevant balanced chemical equation should also be written.
- (ii) Predict how and under what conditions methanoic acid (HCOOH) is likely to react with sulphuric acid. N.B. The relevant balanced chemical equation should also be written.
- (c) You are provided with an aqueous solution containing Fe^{3+} ions and Fe^{2+} ions. Propose a method to determine the concentration of Fe^{3+} and the concentration of Fe^{2+} in this solution.
- (a) Explain how the environment is polluted by a factory that produces nitric acid using the Ostwald Process.
N.B. It is sufficient to consider four important points.
- (b) Indicate briefly how and under what conditions the following pairs of substances would react.
- $\text{NH}_3(\text{g})$ and $\text{Cl}_2(\text{g})$
 - $\text{NH}_3(\text{g})$ and $\text{K}(\text{s})$
 - $\text{NH}_3(\text{aq})$ and $\text{Cu}(\text{NO}_3)_2(\text{aq})$
 - $\text{NH}_3(\text{aq})$ and $\text{FeSO}_4(\text{aq})$
- (c) Assume that the molecular formula of a certain monobasic acid is $\text{H}_4\text{P}_2\text{O}_4$. If two oxyacids are obtained when this compound is hydrolysed, draw the most likely structural formula that will correspond to $\text{H}_4\text{P}_2\text{O}_4$.
- (a) (i) We can assume that natural rubber is formed by the polymerization of a certain molecule. Draw the structure of this molecule.
- (ii) Draw the structure of natural rubber.
- (iii) Indicate briefly how you would show that sulphur is present in a sample of vulcanized rubber.
- (b) Describe briefly how calcium carbide is manufactured.
- (c) Consider following statement:
- “We can circumvent the fuel crisis in Sri Lanka by producing ethyne from calcium carbide and utilizing that ethyne in large quantities.”**
- Show that the proposal pertaining to the above statement is not an appropriate one.
N.B. It is sufficient to consider five important points.