අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 1998 අගෝස්තු (නව නිර්දේශය)
கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர) பரீட்சை, 1998 ஓகஸ்ற் (புதிய பாடத்திட்டம்)
General Certificate of Education (Adv. Level) Examination, August 1998 (New Syllabus)

| රසායන විද්‍යාව I | 02 |
|---|---|
| இரசாயனவியல் I | E \| I |
| **Chemistry I** | |

පැ‍ දෙකයි / இரண்டு மணித்தியாலங்கள் / *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, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

**N.B. The following abbreviations have been used.**

$aq$ = aqueous

C = Celsius or Centigrade or Coulomb

$g$ = gas

$l$ = liquid

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

$s$ = solid

**Other abbreviations also follow standard usage.**

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1. The number of electrons in the last sub-energy level of the +4 cation formed from the element of atomic number 43 is
   (1) 1.　　(2) 2.　　(3) 3.　　(4) 4.　　(5) 5.

2. Which one of the following statements concerning the shape of the $ClO_3^-$ anion is most appropriate?
   (1) It is tetrahedral.
   (2) It is planar.
   (3) It takes the shape of the letter 'T'.
   (4) It is trigonal pyramidal.
   (5) It has the shape of the $SO_3$ molecule.

3. In which one of the following molecules is the dipolar nature least?
   (1) $H_2S$　　(2) $PH_3$　　(3) $AsH_3$　　(4) $H_2Se$　　(5) $BF_3$

4. Which one of the following statements concerning nitrogen is most likely to be **false**?
   (1) $NCl_3$ exists　(2) $NF_3$ exists　(3) $NO_2^+$ exists　(4) $NF_5$ exists　(5) $N_2H_4$ exists

5. The chemical formula of radium manganate(VII) is
   (1) $RA(MnO_4)_2$.　(2) $Ra(MnO_4)_2$.　(3) $RAMnO_4$.　(4) $RaMnO_4$.　(5) $Re(MnO_4)_2$.

[Turn over

6.  Which one of the following is present in apatite?
    - (1) $Ca_2Mg(PO_4)_3Cl$
    - (2) $Ca_2(PO_4)Cl_2$
    - (3) $CaMg_2(PO_4)F$
    - (4) $Ca_3(PO_4)_5Cl$
    - (5) $Ca_5(PO_4)_3Cl$

7.  Which one of the following statements concerning $CH_3OH$ and $(CH_3)_2CHOH$ is most appropriate?
    - (1) These two compounds can be qualitatively distinguished using $PCl_5$.
    - (2) These two compounds can be qualitatively distinguished using $CH_3COCl$.
    - (3) These two compounds can be qualitatively distinguished using $K_2Cr_2O_7/H_2SO_4$ and Brady's reagent.
    - (4) These two compounds can be qualitatively distinguished using aqueous $Ba(OH)_2$ and Fehling's solution.
    - (5) These two compounds cannot be qualitatively distinguished using any of the above.

8.  Consider the equilibrium reaction

    $$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H^\ominus < 0$$
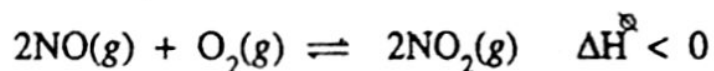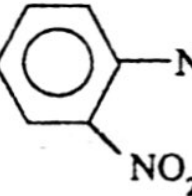
    Which one of the following will decrease the $NO_2$ concentration of the equilibrium mixture?
    - (1) Increasing the NO concentration.
    - (2) Increasing the temperature at constant pressure.
    - (3) Decreasing the volume of the mixture at constant temperature.
    - (4) Increasing the $O_2$ concentration.
    - (5) Increasing the partial pressure of NO at constant temperature.

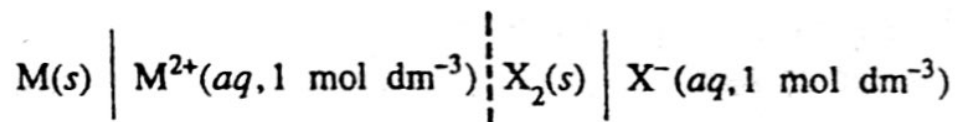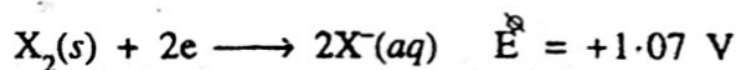9.  Which one of the following statements concerning bromine is most appropriate?
    - (1) Bromine gas reacts with aqueous KOH and gives KBrO.
    - (2) Bromine water reacts with KOH and gives $KBrO_3$.
    - (3) Bromine gas reacts with aqueous KOH and gives KBrO and $KBrO_3$.
    - (4) Bromine gas reacts with aqueous KOH and gives KBrO and KBr.
    - (5) Bromine water reacts with KOH and gives KBr.

10. For the purpose of distinguishing qualitatively between $CH_3CHO$ and $C_6H_5CHO$
    - (1) aqueous HCN can be used.
    - (2) aqueous KOH can be used.
    - (3)  —$NHNH_2$ can be used.
    - (4) $NO_2$——$NHNH_2$ can be used.
    - (5) none of the above can be used.

11.
    $$M^{2+}(aq) + 2e \longrightarrow M(s) \qquad E^\ominus = -0.76 \text{ V}$$

    $$X_2(s) + 2e \longrightarrow 2X^-(aq) \qquad E^\ominus = +1.07 \text{ V}$$

    $$M(s) \mid M^{2+}(aq, 1 \text{ mol dm}^{-3}) \mid X_2(s) \mid X^-(aq, 1 \text{ mol dm}^{-3})$$

    When this electrochemical cell generates electricity,
    - (1) $X^-(aq)$ is oxidized.
    - (2) $M^{2+}(aq)$ is reduced.
    - (3) $M(s)$ bears a negative charge.
    - (4) The emf of the cell is $-0.31$ V.
    - (5) The emf of the cell is $+0.31$ V.

12. Which one of the following statements concerning the $C_2H_2$ molecule is most appropriate?
    (1) In the $C_2H_2$ molecule there is 1 covalent bond.
    (2) In the $C_2H_2$ molecule there are 2 covalent bonds.
    (3) In the $C_2H_2$ molecule there are 3 covalent bonds.
    (4) In the $C_2H_2$ molecule there are 4 covalent bonds.
    (5) In the $C_2H_2$ molecule there are 5 covalent bonds.

13. Which one of the following statements concerning three of the oxy acids of phosphorus is true?
    (1) In the $H_3PO_2$ molecule there is one P-H bond.
    (2) In the $H_3PO_2$ molecule there are three P-H bonds.
    (3) In the $H_3PO_4$ molecule there is one P-H bond.
    (4) In the $H_3PO_4$ molecule there are three O-H bonds.
    (5) In the $H_3PO_3$ molecule there are three O-H bonds.

14. When KCNS solid was added to a portion of an aqueous solution containing cations of a certain element, a red colour was not obtained. To another portion of the original solution, aqueous ammonia was added and set aside for a short time. The product so obtained was made acidic by adding dilute HCl. When KCNS solid was added to this acidic solution, a red colour was obtained. The cation under consideration could be
    (1) $Cr^{3+}$.          (2) $Mn^{2+}$.          (3) $Cu^{2+}$.
    (4) $Fe^{2+}$.          (5) $Fe^{3+}$.

15. Which one of the following is most likely not to react with chlorine?
    (1) Ag metal    (2) P solid    (3) $N_2$ gas
    (4) Ga liquid    (5) Aqueous $Fe^{2+}$

16. Which one of the following statements concerning hot concentrated sulphuric acid is most appropriate?
    (1) It reacts with carbon and gives $CO_2$ and $SO_3$.
    (2) It reacts with carbon and gives $CO_2$ and $SO_2$.
    (3) It reacts with copper and gives $SO_2$ and $SO_3$.
    (4) It does not react with copper.
    (5) It does not react with carbon.

17. Which pair of the following scientists is **most distantly** connected with the Periodic Table?
    (1) Dobereiner and Newlands
    (2) Dobereiner and Mendeleeff
    (3) Avogadro and Dalton
    (4) Mendeleeff and Bohr
    (5) Lothar Meyer and Mendeleeff

18. Which one of the following statements concerning the particles used by Geiger and Marsden, in the experiment that provided the basis for the nuclear model of the atom, is most appropriate?
    (1) Accelerated particles were used by Geiger and Marsden.
    (2) Cathode rays were used by Geiger and Marsden.
    (3) Accelerated cathode ray particles were used by Geiger and Marsden.
    (4) Accelerated neutrons were used by Geiger and Marsden.
    (5) All of the above statements are incorrect.

19. Which one of the following statement concerning ionization energies is true?
    (1) The first ionization energy of Al is greater than the first ionization energy of Mg.
    (2) The third ionization energy of Mg is greater than the second ionization energy of Al.
    (3) The first ionization energy of S is greater than the first ionization energy of P.
    (4) The second ionization energy of Na is greater than the third ionization energy of Mg.
    (5) None of the above statements is true.

[Turn over

20. The IUPAC name of $ClCH_2CH_2\overset{Br}{\underset{|}{C}}=CHCOCH_3$ is

    (1) 1 – chloro – 3 – bromo – 4 – hexen – 2 – one.

    (2) 3 – bromo – 1 – chloro – 3 – hexen – 5 – one.

    (3) 4 – bromo – 6 – chloro – 3 – hexen – 2 – one.

    (4) 5 – chloromethyl – 4 – bromo – 3 – penten – 2 – one.

    (5) 4 – bromo – 5 – chloromethyl – 3 – penten – 2 – one.

21. $C_2O_4^{2-}$ ions are oxidized by $MnO_4^-$ ions in neutral medium. In this reaction the mole ratio, $MnO_4^- : C_2O_4^{2-}$ is

    (1) 2 : 5.        (2) 5 : 2.        (3) 3 : 2.        (4) 2 : 3.

    (5) none of the above.

22. The straight-chain organic compound of molecular formula $C_3Cl_5Br$

    (1) exists as 3 isomers.

    (2) exists as 4 isomers.

    (3) exists as 5 isomers.

    (4) exists as 6 isomers.

    (5) exists as 7 isomers.

23. The gaseous compound, **X** contains boron and hydrogen only. Under $1.013 \times 10^5 Nm^{-2}$ pressure and at 276 K, the volume of 1.00 g of the compound **X**, was 0.82 $dm^3$. The relative atomic masses of boron and hydrogen are respectively, 10.82 and 1.00. Which one of the following could be **X**?

    (1) $BH_3$      (2) $B_2H_6$      (3) $B_2H_2$      (4) $B_3H_8$      (5) $B_3H_6$
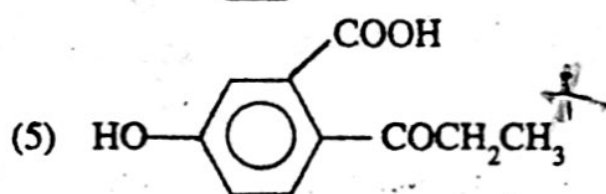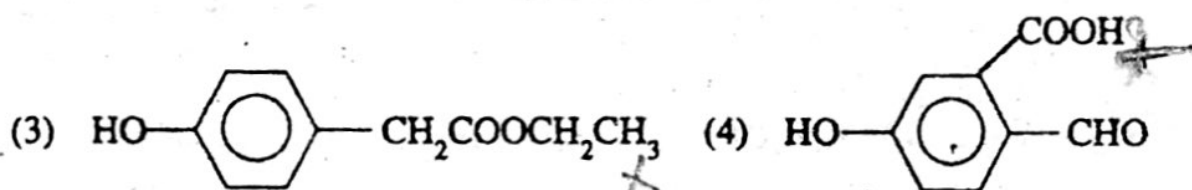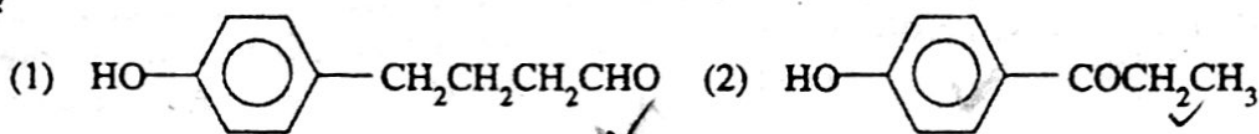
24. Consider the equilibrium,

$$A_2(g) + 2B_2(g) \rightleftharpoons A_2B_4(g).$$
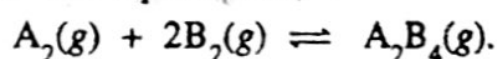
the units of $K_C$ for this reaction are

    (1) $mol^3 dm^{-9}$.    (2) $mol^{-3} dm^9$.    (3) $mol^2 dm^{-6}$.    (4) $mol^{-2} dm^6$.    (5) $mol^{-2} dm^{-6}$.

25. Which one of the following statement is **false**?

    (1) $I_2$ can act as an oxidizing agent.

    (2) $I_2$ can act as a reducing agent.

    (3) HI can act as an oxidizing agent.

    (4) The iodine in HI can be subjected to reduction by NaH.

    (5) The iodine in HOI can be subjected to oxidation.

26. The organic compound, **C** dissolves in aqueous NaOH. However, it does not dissolve in aqueous $NaHCO_3$. **C** gives a precipitate with Brady's reagent. When 1 mol of the product obtained by the reaction of **C** with HCN is heated, 1 mol of water is eliminated very easily. Which one of the following is most likely to be **C**?

    (1) $HO-\bigcirc-CH_2CH_2CH_2CHO$    (2) $HO-\bigcirc-COCH_2CH_3$

    (3) $HO-\bigcirc-CH_2COOCH_2CH_3$    (4) $HO-\bigcirc\begin{smallmatrix}COOH\\ \\CHO\end{smallmatrix}$

    (5) $HO-\bigcirc\begin{smallmatrix}COOH\\ \\COCH_2CH_3\end{smallmatrix}$

27. The inorganic compound, **D**, when treated with dilute $H_2SO_4$ gave a brown gas and a coloured solution. When an excess of ammonia was added to a portion of this solution, a blue solution was obtained. When $H_2S$ gas was passed into another portion of the original coloured solution, a black precipitate was **not** obtained. Which one of the following is most likely to be **D**?

    (1) $Cu(NO_3)_2$    (2) $Cu(NO_2)_2$    (3) $Cd(NO_2)_2$    (4) $Ni(NO_3)_2$    (5) $Ni(NO_2)_2$

28. The molecules, $(CH_3)_3P$ and $AlCl_3$ form a coordination compound in the mole ratio of 1 : 1. In this co the bond between the P atom and the Al atom

    (1)  can be shown as $P=Al$.

    (2)  can be shown as $\overset{+}{P}=\overset{-}{Al}$.

    (3)  can be shown as $\overset{-}{P}=\overset{+}{Al}$.

    (4)  can be shown as $P \leftarrow Al$.

    (5)  can be shown as $P \rightarrow Al$.

29. For the purpose of obtaining a rough idea of the lattice energy of the hypothetical ionic compound, 'N

    (1)  the first ionization energy of sodium is essential.

    (2)  the second ionization energy of sodium is essential.

    (3)  the standard enthalpy change of the process, $Cl_2(g) + e \longrightarrow Cl_2^-(g)$ is essential.

    (4)  the standard enthalpy change of the process, $Cl(g) + 2e \longrightarrow Cl^{2-}(g)$ is essential.

    (5)  none of the above is essential.

30. At constant temperature, the pH of an aqueous solution changed from 8 to 6 as a result of a certain cha being effected. Which one of the following statements is most appropriate in this instance?

    (1)  This change has occurred because $[H^+]$ was increased two-fold.

    (2)  This change has occurred because $[H^+]$ was increased ten-fold.

    (3)  This change has occurred because $[H^+]$ was increased hundred-fold.

    (4)  This change has occurred because $[OH^-]$ was increased hundred-fold.

    (5)  A definite answer cannot be given in this instance because the exact temperature is not specifi

● **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 i correct. Select the correct response/responses. Mark (X) 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 $C_6H_5COCl$?

    (a) $C_6H_5CONH_2$    (b) $(CH_3)_3CNH_2$    (c) $C_6H_5OH$    (d) $CHF_3$

32. Which of the following concerning $K_p$ and $K_C$ of an equilibrium reaction are/is true?

    (a) $K_p = K_C(RT)^{\Delta n}$

    (b) $K_C = K_p(RT)^{\Delta n}$

    (c) $K_p$ depends on the total pressure of the system.

    (d) $K_C$ depends on the temperature of the system.

33. Which of the following are/is true?

    (a) $F_2$ + hot concentrated $KOH \longrightarrow KFO_3$ + other products

    (b) $Ag(s)$ + aqueous $Cu(NO_3)_2 \longrightarrow Cu(s)$ + other products

    (c) $NH_3 + Br_2 \longrightarrow N_2 +$ other products

    (d) $PCl_3 + H_2O \longrightarrow HI +$ other products

[Turn

34. Which of the following statements/statement concerning environmental pollution are/is true?
    (a) $CO_2$ is an important factor.
    (b) $NO_2$ is an important factor.
    (c) Urea is an important factor.
    (d) Super phosphate is an important factor.

35. Which of the following concerning the Avogadro constant L are/is true?
    (a) The numerical value of L = $\dfrac{96490 \text{ C}}{\text{charge on the } ClO_4^- \text{ ion}}$
    (b) The numerical value of L = $\dfrac{192980 \text{ C}}{\text{charge on the } Mg^{2+} \text{ ion}}$
    (c) The numerical value of L = $\dfrac{289470 \text{ C}}{\text{charge on the } NO_3^- \text{ ion}}$
    (d) The value of L = $\dfrac{385960 \text{ C}}{\text{charge on the } BF_4^- \text{ ion}}$

36. Which of the following statements / statement concerning hydrogen bonds are/is true?
    (a) Hydrogen bonds occur in $CH_3CH_2NH_2$.
    (b) Hydrogen bonds occur in $CH_3SiH_2OCH_3$.
    (c) Hydrogen bonds occur in $CH_3CH_2OSiCH_3$.
    (d) Hydrogen bonds occur in liquid $NH_3$.

37. Which of the following statements/statement concerning proteins are/is true?
    (a) The repeating unit occurring in protein chains is $NH_2$—CHCOOH.
       $\overset{|}{R}$
    (b) The repeating unit occurring in protein chains is $NH_2$—CHCH$_2$COOH.
    (c) Sulphur may occur in protein chains.
       $\overset{|}{R}$
    (d) Hydrogen bonds may occur in protein chains.

38. Which of the following contribute/contributes very considerably to acid rain?
    (a) The use of the Contact Process.
    (b) The oxidation of ammonia by catalysts.
    (c) The use of the Haber Process.
    (d) The use of the Ammonia–Soda Process.

39. Originally, the chemists used the term, 'atomic weight' in place of the modern term, 'relative atomic mass'. In the determination of the 'atomic weight' of gaseous elements,
    (a) Charles's studies were useful.
    (b) Mendeleeff's studies were useful.
    (c) Rutherford's studies were useful.
    (d) Avogadro's studies were useful.

40. Cathode ray particles
    (a) are negatively charged.
    (b) travel in straight lines.
    (c) are attracted towards the N - magnetic pole.
    (d) are attracted towards the S – magnetic pole.

**Instructions for questions No. 41 to 50**

In questions No. 41 to 50, two statements are given in respect of each question. From the Table give select the description (1), (2), (3), (4), (5) that **best** fits the two statements given for each of the 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. | CuS dissolves in hot dilute $HNO_3$. | In the presence of hot dilute $HNO_3$, the CuS increases. |
| 42. | An aqueous solution of $Na_2HPO_4$ does not exhibit buffer action. | $Na_2HPO_4$ is not a salt derived from a weak |
| 43. | The electron pair on the N atom of the $CN^-$ anion attacks the C atom of the $\rangle C{=}O$ group in the $CH_3COCH_3$ molecule. | The following electron transition may occur the carbonyl group: $\rangle C \overset{\frown}{=} \overset{\curvearrowleft}{O}$ |
| 44. | $CF_3COOH$ acts as a strong acid. | The electron pair forming the bond in C—attracted towards the F atom. |
| 45. | Nitrogen cannot act as an oxidizing agent. | The nitrogen atom is incapable of acquir electrons from outside. |
| 46. | Aniline is more basic than $C_6H_5CONHCH_3$. | The $—CH_3$ group repels electrons. |
| 47. | Methyl red is a suitable indicator for the titration between $0.1$ mol dm$^{-3}$ aqueous $NH_3$ and $0.1$ mol dm$^{-3}$ aqueous $H_2SO_4$. | Methyl red indicator is yellow in alkali medium, while it is red in acidic medium. |
| 48. | $H_2O_2$ molecule is planar. | In the $H_2O_2$ molecule, the O—O bond and t two O—H bonds are in the same plane. |
| 49. | The $—NHCH_3$, group linked to the benzene is ortho-para directing. | The N atom of the $—NHCH_3$ has a lone p of electrons, and it increases the electron densi in the benzene ring. |
| 50. | Lime water cannot be used to distinguish between $NH_4Cl$ and $(NH_4)_2SO_4$. | Both $NH_4Cl$ and $(NH_4)_2SO_4$ give ammonia wi lime water. |

51. Which type of the following equations will most appropriately represent the behaviour of $CO_2$ gas?

   (1) $(P + x)(V - y) = nRT$    (2) $PV = nRT$    (3) $M = \dfrac{d}{P} \times RT$

   (4) $\left(P + \dfrac{na}{V}\right)(V - n^2b) = nRT$    (5) $\left(P + \dfrac{n^2a}{V}\right)\left(V - \dfrac{b}{n}\right) = nRT$

52. For the purpose of converting the compound, $(CH_3CH_2)_2CHOH$ into $(CH_3CH_2)_2C{=}O$

   (1) Tollen's reagent can be used.    (2) an aqueous solution of $K_2CrO_4$ can be used.
   (3) bromine liquid can be used.    (4) chlorine water can be used.
   (5) none of the above can be used.

[Turn o

53. With which of the following pairs of compounds can you start and proceed to distinguish chemically between

$CH_3$—⟨O⟩—$NH_2$ and ⟨O⟩—$CH_2NH_2$?
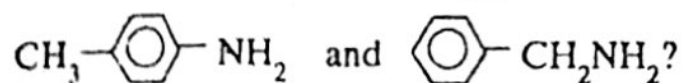
    (1) $C_6H_5COCl$ and anhydrous $AlCl_3$     (2) $CH_3I$ and water
    (3) $NaOH$ and $HNO_3$     (4) $NH_3$ and $HNO_3$
    (5) $H_2SO_4$ and $NaOH$

54. It has become necessary to synthesize $C_6H_5CH_2COOH$ starting from $C_6H_5CONH_2$. Which of the following initial steps is most appropriate for this synthesis?
    (1) $C_6H_5CONH_2 + HCHO + AlCl_3$
    (2) $C_6H_5CONH_2 + KMnO_4 + NaOH$
    (3) $C_6H_5CONH_2 + CH_3MgBr + HCl$
    (4) $C_6H_5CONH_2 + Na + CH_3CH_2OH$
    (5) $C_6H_5CONH_2 + CH_3CHO +$ anhydrous $AlCl_3$

55. Which one of the following sets of values pertaining to the oxidation numbers exhibited by oxygen is most appropriate?
    (1) $-2, -1, 0, +2$ and $+3$     (2) $-2, -1,$ and $+2$
    (3) $-2, -1, 0$ and $+2$     (4) $-2, -1$ and $0$
    (5) $-2, 0$ and $+2$

56. Which one of the following statements pertaining to atomic spectra is **false**?
    (1) Atomic spectra can be studied as emission spectra.
    (2) Atomic spectra can be studied as absorption spectra.
    (3) The spectral lines of an atomic spectrum occur as several clearly distinguishable series of lines.
    (4) The dark lines of an absorption spectrum do not occur as several clearly distinguishable series of lines.
    (5) There is no direct relationship between a given bright line of an atomic spectrum and a certain energy level in the atom under consideration.

57. Which one of the following concerning Raoults' law is most appropriate?

    (1) $\dfrac{P_A - P_A^0}{P_A^0} = x_B$     (2) $\dfrac{P_A^0 - P_A}{P_A^0} = x_A$

    (3) $\dfrac{P_A^0 - P_A}{P_A} = x_B$     (4) $\dfrac{P_A^0 - P_A}{P_A} = x_A$

    (5) None of the above is in agreement with Raoult's law.

58. Which of the following statements concerning the intermolecular forces in a certain binary system is true?
    (1) The forces among $CH_3COCH_3$ molecules are equal to the forces among $CH_3OH$ molecules.
    (2) The forces among $CH_3COCH_3$ molecules are larger than the forces among $CH_3OH$ molecules.
    (3) There are no attractive forces among $CH_3COCH_3$ molecules.
    (4) The $CH_3COCH_3$—$CH_3OH$ intermolecular forces are smaller than the $CH_3OH$—$CH_3OH$ intermolecular forces.
    (5) The $CH_3COCH_3$—$CH_3OH$ intermolecular forces are larger than the $CH_3COCH_3$—$CH_3COCH_3$ intermolecular forces.

59. Which one of the following statements concerning a catalyst is most appropriate?
    (1) A catalyst decreases the activation energy of a reaction.
    (2) A catalyst increases the activation energy of a reaction.
    (3) A catalyst changes the activation energy of a reaction.
    (4) A catalyst decreases the standard enthalpy of formation of products.
    (5) A catalyst changes the enthalpy of formation of reactants.

60. The mole fraction of ethanol in an aqueous solution of ethanol is 0·10. What is the ethanol concentration of this solution, **by weight**? ($H = 1$ ; $O = 16$ ; $C = 12$)
    (1) 11%     (2) 11·06%     (3) 20%     (4) 22·12%     (5) 33·21%

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| රසායන විද්‍යාව II | 02 |
|---|---|
| இரசாயனவியல II | E \| II |

**Chemistry II**

පැ තුනයි / மூன்று மணித்தியாலங்கள் / *Three hours*

Index No.: ..........................

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**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 three hours.*

---

**PART A — Structured Essay**

*Answer all the questions. Write your answer in the space provided below each question. Please that the space provided is sufficient for the answer and that extensive answers are not expected.*

**PART B and PART C—Essay**

*Answer four questions selecting two questions from each part. Use the paper supplied for this purpose. At the end of the time allotted for this paper, tie 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*

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

N.B. 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.

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[Turn

*Answer all four questions. Each question carries 10 marks.*

1. (a) (i) Define the term, 'Avogadro constant'.

(ii) Write the numerical value of the Avogadro constant.

(iii) If there is a unit pertaining to the above value, indicate it below. **If there is no unit, state that fact below, specifically.**

(b) Name the following compounds appropriately.

| compound | name |
|---|---|
| $FeS_2O_3$ | |
| $Cr_2(MnO_4)_3$ | |

(c) (i) Indicate **specifically, in the usual manner,** the arrangement of electrons in **the last two sub-energy levels** of the element, **X** of atomic number 40.

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(ii) Write the chemical formula of the nitride of **X** derived from its highest oxidation

2. (a) (i) Write a balanced chemical equation for the complete precipitation reaction occurring betw
aqueous $H_3PO_4$ and aqueous $Ba(OH)_2$.

(ii) Calculate the volume of $0.2$ mol $dm^{-3}$ aqueous $Ba(OH)_2$ solution required for the comp
precipitation of $PO_4^{3-}$ ions obtainable from $25$ cm$^3$ of $0.12$ mol $dm^{-3}$ aqueous $H_3PO_4$ solut

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[Turn

(b) Indicate briefly how you would use an acidified solution of $K_2Cr_2O_7$ for the purpose of distinguishing between a dilute aqueous solution of HBr and a dilute aqueous solution of HI. N.B. You are not supplied with organic solvents or other reagents. However, you are provided with the normal facilities available in the laboratory.

(c) Name the factors that influence the rate of a chemical reaction.

(d) Assume that you are supplied with only $H_2S$ gas and chlorine water as reagents. Propose a suitable method to distinguish between an ammoniacal solution of $CuSO_4$ and an ammoniacal solution of $NiSO_4$, using the above two substances.

(a) Y is a gaseous hydrocarbon. 15 cm$^3$ of Y was mixed with an excess of oxygen gas. This mixture was ignited by an electrical method, and it was allowed to attain normal temperature and pressure. Then it was observed that the volume of the gaseous mixture decreased by 30 cm$^3$. When this gaseous mixture was treated with a solution of concentrated KOH, the volume of the gaseous mixture decreased further by 45 cm$^3$. Calculate the molecular formula of Y in the usual manner.

N.B. Assume that all of the above volumes were measured at s.t.p.

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(h) Consider the diagram shown below, pertaining to the formation of chemical bonds in the $C_2H_2$ molecule. In this diagram the various atomic orbitals relevant to the $C_2H_2$ molecule are drawn approximately.



atomic orbitals
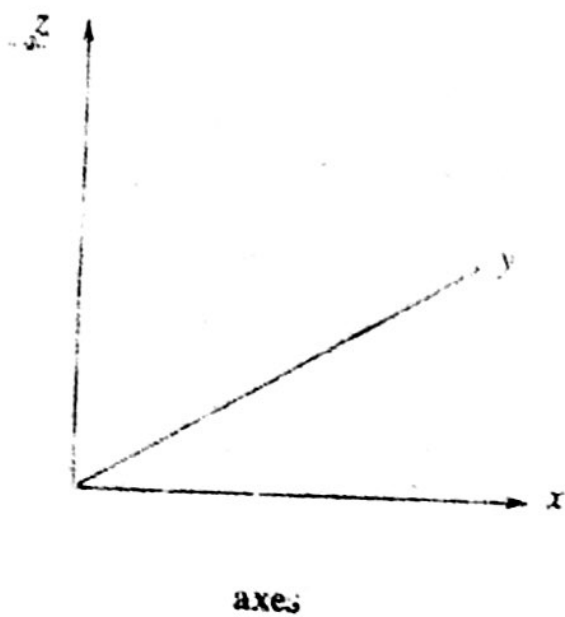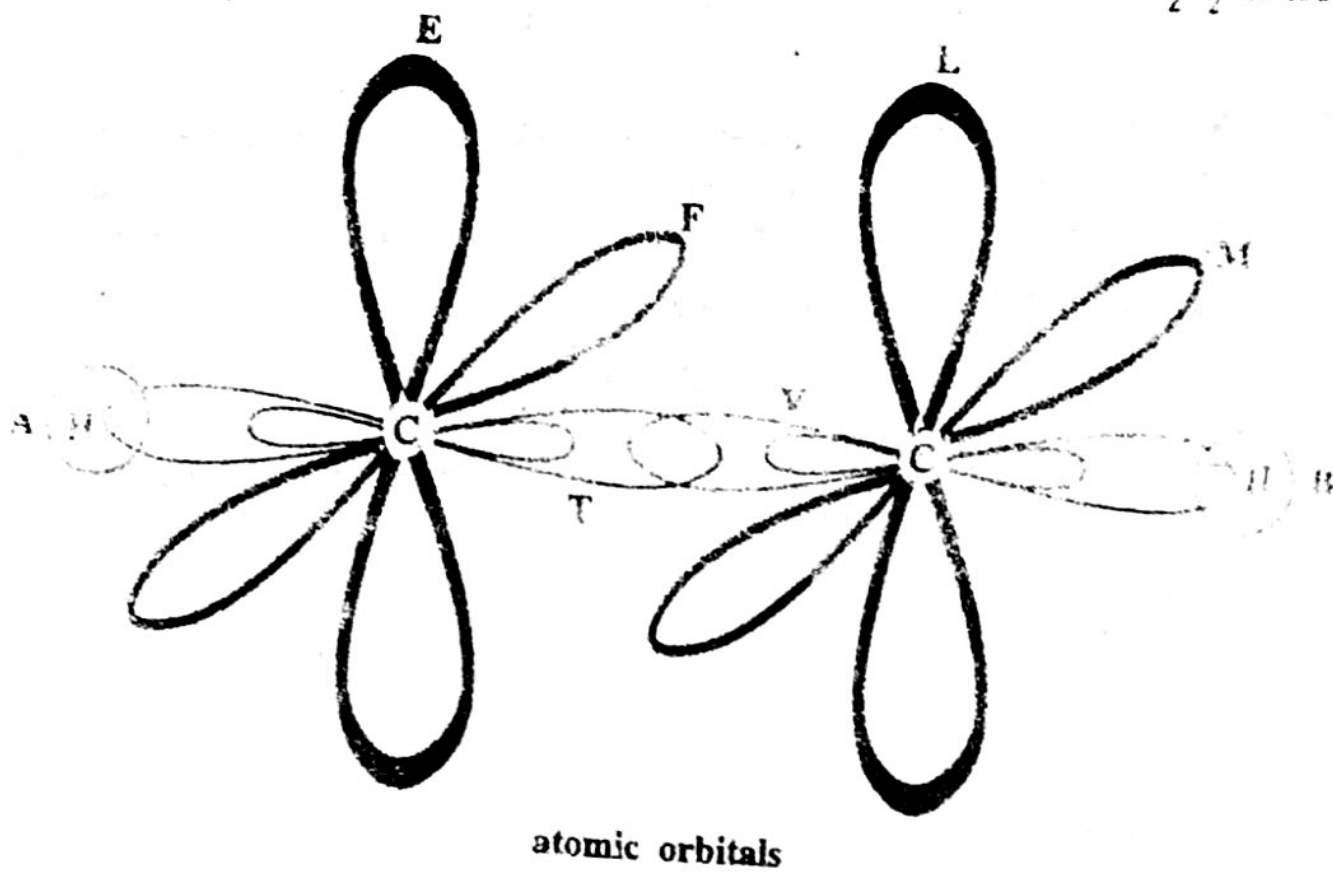


axes

Examine the diagram given above, and fill the blanks in the following sentences appropriately. N.B. You should pay attention to the axes. **In naming the various atomic orbitals specifically, follow the method usually accepted for that purpose.**

(i)   A is ........................ orbital.

(ii)   T is ........................ ........orbital.

(iii)   L is ........................ orbital

(iv)   M is ........................ orbital.

(v)   Between T and V ........................................................................ takes place.

(vi)   Between F and M ........................................................................ takes place.

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(c) **N.B. In the following syntheses, the necessary reagents and reaction conditio**
**shown clearly at the appropriate places. When the method of synthesis prop**
**is unnecessarily long, you will not be awarded maximum marks.**

(i) Indicate how you would attempt to synthesize

$$CH_3CH_2CH_2NHCOCH_2CH_3$$
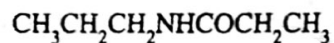
using $CH_3CH_2CONH_2$ as the only carbon-containing starting material.
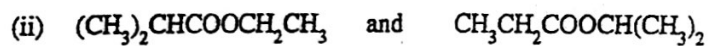
(ii) Indicate how you would attempt to synthesize

$$(CH_3)_2CHCOOCH(CH_3)_2$$

using $CH_3CH_2CH_2OH$ as the only carbon-containing starting material.

4. (a) Name the compound with the following structure, in accordance with IUPAC nomenclature.

$$CH_3-CH_2-CH_2-\overset{\overset{\displaystyle CH-CH_2-Br}{\|}}{C}-\overset{\overset{\displaystyle NO_2}{|}}{CH}-\overset{\overset{\displaystyle O}{\|}}{C}-O-H$$
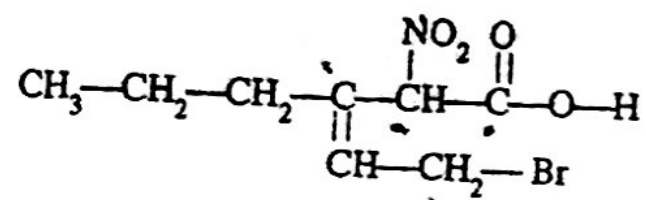
(b) Indicate how you would distinguish between the two compounds in each of the following

(i)

$$HO—\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}—\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}—NH_2 \quad \text{and} \quad HO—\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}—CH_2—NH_2$$

(ii) $(CH_3)_2CHCOOCH_2CH_3$ and $CH_3CH_2COOCH(CH_3)_2$

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[Turn over
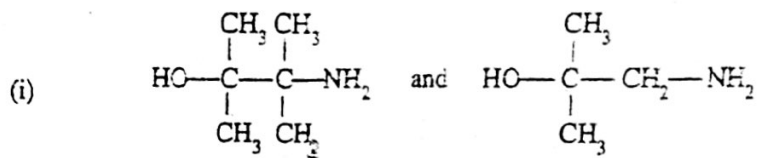
(c) Consider the following acylation reaction.
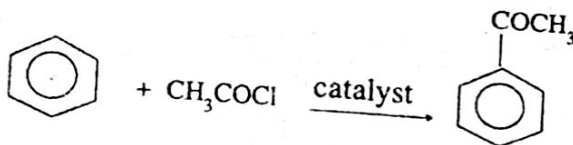


Now, fill the blanks in the following sentences appropriately.

(i) For this reaction, ........................... is a suitable catalyst.

(ii) In this reaction, ........................... is the ionic species that attacks the benzene ring.

(iii) This attack is called ................................................................... reaction.

(d) Indicate how the following conversion could be effected. N.B. The necessary reagents and reaction conditions should be shown clearly at the appropriate places. If the method of conversion proposed by you is unnecessarily long, you will not be awarded maximum marks.
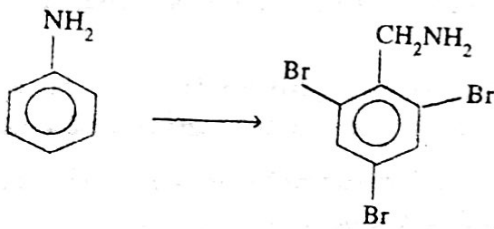
අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 1998 අගෝස්තු (නව නිර්දේශය)
கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர) பரீட்சை, 1998 ஒகஸ்ற் (புதிய பாடத்திட்டம்)
General Certificate of Education (Adv. Level) Examination, August 1998 (New Syllabus)

| රසායන විද්‍යාව II | 02 |
| இரசாயனவியல் II | E \| II |
| **Chemistry II** | |

## PART B — Essay

*Answer two questions only. Each question carries 15 marks.*

5. (a) (i) Assuming the equation $PV = \frac{1}{3} mN\overline{c^2}$, derive the equation $PV = nRT$ pertaining to an ideal gas.

   (ii) Explain how the equation $PV = nRT$ has been modified so as to be appropriate for a gas that does not behave ideally. **N.B. Write clearly the Van der Waals equation obtained after effecting this modification.**

   (b) The molar mass of a certain gas is $16\,g\,mol^{-1}$. Calculate the density of this gas under a pressure of $30.4 \times 10^5\,Nm^{-2}$ at $29.5\,°C$. **N.B. Assume that the gas is behaving ideally under these conditions.**

   (c) You are informed that chlorine in aqueous medium **cannot be directly** titrated with a solution of $Na_2S_2O_3$. You are provided with chlorine gas, $CCl_4$ and a standard solution of $Na_2S_2O_3$. You are also supplied with **other materials** and facilities normally available in the laboratory. Explain, with the essential details, how you would attempt to determine the distribution coefficient of chlorine between $CCl_4$ and water using the above $Na_2S_2O_3$ solution.

6. (a) (i) The two ions $X^{5+}$ and $Y^{2-}$ react together and form the solid, $X_2Y_5$ which is sparingly soluble in water. At a certain temperature, a saturated aqueous solution of $X_2Y_5$ exists in equilibrium with solid $X_2Y_5$. Derive an equation for the equilibrium constant, $K_C$, for this equilibrium.

   (ii) Write an equation for the $K_{sp}$ of $X_2Y_5$. If there are any assumptions that you make in writing this equation, state those assumptions **clearly in words.**

   (iii) Assume that the cation $M^{3+}$ forms the hydroxide, $M(OH)_3$ which is sparingly soluble in water. The pH of a saturated aqueous solution of $M(OH)_3$, in equilibrium with solid $M(OH)_3$ at 25 °C is 9.301. Calculate the $K_{sp}$ of $M(OH)_3$ at 25 °C. $K_w = 1.0 \times 10^{-14}\,mol^2\,dm^{-6}$ at 25 °C.

   (b) (i) Describe clearly how the colour-change pH interval of an acid-base indicator, supplied to you, can be experimentally determined.

   (ii) The colour-change pH intervals of some acid-base indicators are given in the following Table.

| indicator | pH interval |
|-----------|-------------|
| P | 9.0 – 10.0 |
| Q | 4.0 – 5.0 |
| R | 12.0 – 13.0 |
| S | 2.0 – 3.0 |
| T | 6.0 – 8.0 |

Now, consider the following titrations A, B, C and D, carried out between 0.1 mol $dm^{-3}$ aqueous acid and 0.1 mol $dm^{-3}$ aqueous base.

*[Turn over*

| A | The titration between $HClO_4$ and $Ba(OH)_2$. | T |
| B | The titration between HI and $CH_3NH_2$. | Q |
| C | The titration between $CH_3COOH$ and $[(CH_3)_4N]^+OH^-$. | |
| D | The titration between $CH_3CH_2COOH$ and $CH_3CH_2NH_2$. | P |
| | | T |

Select and mention clearly, **the most suitable indicator**, out of **P, Q, R, S and T**, for the purpose of obtaining the correct burette reading in the case of each of the above titrations. **If none of the above indicators is suitable for a particular titration, mention that fact also clearly. N.B. If you mention more than one indicator for a particular titration, you will not be awarded marks for that answer.**

(a) (i) Indicate clearly how the natural occurrence of the metals can be related to the various positions of the metals in the electrochemical series.

(ii) Indicate clearly how the general methods of extraction of the metals can be related to the various positions of the metals in the electrochemical series.

(b) (i) Explain how an aqueous solution of the compound, $HOOCCH_2CH_2COONa$ exhibits buffer action.

(ii) Explain how proteins exhibit buffer action.

(c) (i) Consider the following reaction which is in a state of equilibrium.

$$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$$
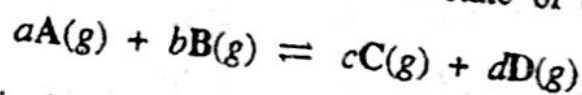
Derive the relationship between $K_P$ and $K_C$ for this equilibrium.

(ii) Consider the following equilibrium

$$QR_3(g) + R_2(g) \rightleftharpoons QR_5(g).$$
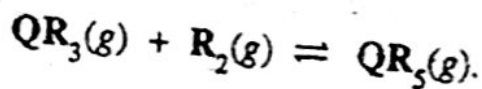
5 mol of $QR_3$ and 3 mol of $R_2$ are kept in a closed vessel. When the temperature was 469 K, the pressure inside the vessel was $10·13 \times 10^5$ Nm$^{-2}$. Under these conditions, 30% of the initial amount of $QR_3(g)$ had taken part in the above reaction. Calculate the $K_P$ for this reaction.

(a) (i) State Hess's Law.

(ii) Explain how the standard enthalpy change for the reaction,

$$3C(s) + 4H_2(g) \longrightarrow C_3H_8(g)$$
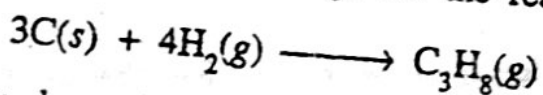
can be experimentally determined.

(b) (i) Describe clearly and briefly an experiment that you have done in the laboratory for the purpose of examining the variation of the rate of the reaction between $S_2O_3^{2-}$ and $H_3O^+$ with the concentration of $S_2O_3^{2-}$.

(ii) Consider the reaction

$$L(g) + M(g) \longrightarrow S(g) + T(g).$$

The rate of decrease of the partial pressure of $L(g)$ in this reaction was studied at 30 °C. Some data obtained in this study are given in the Table below.

| experiment number | initial partial pressure of L(g), mm Hg | initial partial pressure of M(g), mm Hg | rate of decrease of the partial pressure of L(g), mm Hg s$^{-1}$ |
|---|---|---|---|
| 1 | 400 | 375 | 0·762 |
| 2 | 400 | 152 | 0·125 |
| 3 | 291 | 400 | 0·780 |
| 4 | 147 | 400 | 0·395 |

Assume that in this reaction the rate of decrease of the partial pressure of L(g) varies as [...]

$$\text{Rate} \propto \left\{p_{L(g)}\right\}^x \times \left\{p_{M(g)}\right\}^y$$

Using the data supplied to you, calculate the values appropriate for $x$ and $y$.

(iii) Calculate the rate of decrease of the partial pressure of L(g) when the partial pressure [...] and the partial pressure of M(g) are both 300 mm Hg, and the temperature is 30 °C.

## PART C — Essay

*Answer two questions only. Each question carries 15 marks.*

9. (a) Consider the simplest hydrides of the elements, nitrogen, oxygen and phosphorus.

   (i) Indicate clearly and separately whether each one of the above hydrides

        acts as an acid, or
        acts as a base, or
        acts both as an acid and as a base, or
        **does not** act as either an acid or as a base.

   (ii) Indicate clearly and separately whether each one of the above hydrides

        acts as an oxidizing agent, or
        acts as a reducing agent, or
        acts both as an oxidizing agent and as a reducing agent, or
        **does not** act as either an oxidizing agent or as a reducing agent.

   (b) (i) Explain what is meant by the 'hardness of water'.

   (ii) Explain briefly **four** methods used in removing the hardness of water.

   (c) You are supplied with an aqueous solution containing $SO_3^{2-}$ ions and $SO_4^{2-}$ ions. Propose a [...] suitable for the quantitative determination of the concentration of $SO_3^{2-}$ ions and the concentra[...] $SO_4^{2-}$ ions in the solution.

10. (a) Write a brief description of the manufacture of nitric acid by the 'Ostwald Process'.

   (b) How and under what conditions does nitric acid react with the following elements?
        (i) copper
        (ii) carbon
        (iii) sulphur

   **N.B. You should write balanced chemical equations for the above reactions.**

   (c) Draw the structure of the compound, $H_4P_4O_{12}$.

   (d) Propose a suitable method for obtaining zinc and sulphur from zinc sulphide.
   **N.B. It is not necessary to write balanced chemical equations.**

11. (a) Name the compound with the chemical formula, $[Ni(H_2O)_6][CoCl_4]$ in accordance with IU[...] nomenclature.

   (b) (i) Moderately concentrated hydrochloric acid is gradually added to solid $CuCO_3$. Indicate clearly [...] changes that you would expect to see in this instance. **N.B. Disregard the heat cha[...]**

   (ii) Explain the reactions that occur in the above **three** changes. **N.B. You should write bal[...] chemical equations for these changes.**

   (c) Present **five** important facts pertaining to the environmental pollution that occurs in the manufa[...] of sulphuric acid by the 'Contact Process'.

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[Tur[...]

12. (a) "In our march towards progress, we have to burn petroleum fuels. This action damages the environment."

Give **five** reasons pertaining to the above environmental damage.

(b) You are supplied with a mixture consisting of barium carbonate, dolomite, potassium carbonate and silicon dioxide. Explain how you would attempt to determine quantitatively each of the constituents present in this mixture.

(c) You are given a sample of cinnamon oil with some kerosene oil dissolved in it. Propose a method to determine at least approximately the percentage of kerosene oil present in this sample, by volume.

N.B. (i) **You are not provided with facilities for various types of distillation.**
(ii) **Clue: Think of the chemical nature of the principal constituents of cinnamon oil.** Recollect that eugenol is a phenol and that camphor is a ketone.

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