G.C.E. (A/L) Examination 2006 April
Chemistry I / Two hours

Important :

- *This paper consists of 10 pages (Periodic Table is also provided)*
- *Answer all the questions.*
- *Use of calculators is not allowed.*
- *Write your Index Number in the space provided in the answer sheet.*
- *Instructions are given on the back of the answer sheet. Follow those carefully.*
- *In each of the questions 1 to 60, pick one of the alternatives. from (1), (2), (3), (4), (5) which is **correct or most appropriate** and **mark your response on the answer sheet with a cross (x) on the number of the correct option in accordance with the instructions given on the back of the answer sheet.***

Universal gas constant. $R = 8.314\ JK^{-1}\ mol^{-1}$
Avogadro Constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

1. The oxidation number and valency of the carbon atom in CH_2Cl_2 are respectively,
(1) -2 and 4 (2) +2 and 4 (3) 0 and 4
(4) +4 and 0 (5) 0 and +2

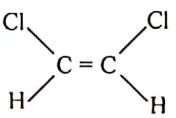
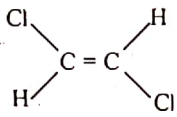
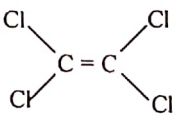
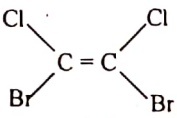
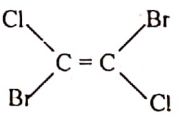
2. Which of the following statements is **incorrect** regarding isotopes of an element?
They have
(1) the same number of electrons.
(2) the same density
(3) similar chemical properties
(4) different numbers of neutrons
(5) the same number of protons

3. Which arrangement of compounds given below, gives the correct increasing order of **boiling points**?
(1) $CH_3CH_2CH_2CH_2CH_3 < CH_3CH_2COCH_3 < CH_3CH_2COOH < CH_3CH_2CH_2CH_2OH$
(2) $CH_3CH_2CH_2CH_2CH_3 < CH_3CH_2COOH < CH_3CH_2COCH_3 < CH_3CH_2CH_2CH_2OH$
(3) $CH_3CH_2COCH_3 < CH_3CH_2CH_2CH_2CH_3 < CH_3CH_2CH_2CH_2OH < CH_3CH_2COOH$
(4) $CH_3CH_2COCH_3 < CH_3CH_2COOH < CH_3CH_2CH_2CH_2OH < CH_3CH_2CH_2CH_2CH_3$
(5) $CH_3CH_2CH_2CH_2CH_3 < CH_3CH_2COCH_3 < CH_3CH_2CH_2CH_2OH < CH_3CH_2COOH$

4. The valence shell electronic configuration of an element showing the valencies 2 and 4 **only** in its compounds
(1) $3d^4 4s^2$ (2) $2s^2 2p^4$ (3) $2s^2 2p^2$
(4) $3s^2 3p^4$ (5) $3s^2 3p^1$

5 Which of the following **will not** colour the CCl_4 layer violet when shaken with CCl_4 and an acidified solution of KI?
(1) CrO_4^{2-} (2) MnO_2 (3) HBr
(4) KO_2 (5) $Ca(OCl)_2$

6 Which one of the following molecules has the **largest** dipole moment?

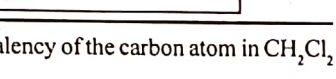
(1) 
(2) 
(3) 
(4) 
(5) 

7. The mass of $K_2SO_4.Cr_2(SO_4)_3.24H_2O$ (relative molar mass = 894) required to prepare 1.00 dm^3 of 10.4 ppm Cr^{3+} solution (1 ppm = 1 mg dm-3 ; Cr = 52.0) is.
(1) 8.940 mg (2) 8.940 g (3) 17.88 mg
(4) 178.8 mg (5) 89.40 mg

8. Which of the following cations
(i) gives a precipitate with NH_4OH, insoluble in excess **and**
(ii) gives a precipitate with dilute NaOH, insoluble in excess?
(1) Fe^{3+} (2) Zn^{2+} (3) Al^{3+} (4) Cu^{2+} (5) Ni^{2+}

9. Which one of the following pairs contains species with different shapes?
(1) CO_2, $BeCl_2$ (2) PO_4^{3-}, $S_2O_3^{2-}$ (3) NO_3^-, SO_3
(4) HOBr, H_2S (5) NCl_3, BCl_3

10. What is IUPAC name of the following compound?



(1) 2-Iodo-3-Pentyn-5-ol
(2) 4-Iodopent-2-yne-1-ol
(3) 1-Hydroxy-4-iodo-2-Pentyne
(4) 2-Iodo-5-hydroxy-3-pentyne
(5) 4-Iodo-2-Pentyn-1-ol

11. The pair of elements forming dioxides, which are solids at room temperature is,
(1) Mn,Cu (2) Mn,S (3) Cu, Ni (4) Ti,Si (5) S, N

12. The cation that forms a hydroxide which readily reacts with oxygen under basic conditions is,
(1) Cr^{3+} (2) Cu^{2+} (3) Co^{2+} (4) Mn^{2+} (5) Fe^{3+}

13. Solubilities of four organic compounds **A,B,C** and **D** in water and in an aqueous solution of 5% HCl are given below

	A	B	C	D
Water	Insoluble	Insoluble	Insoluble	Insoluble
5% HCl	Insoluble	soluble	Insoluble	Insoluble

Which one of the following rows of compounds (1) to (5) is consistent with the above observations?

	A	B	C	D
(1)	CH_3CH_2OH	$CH_3CH_2NH_2$	CH_3COOH	
(2)	CH_3CH_2OH	$CH_3CH_2NH_2$		CH_3COOH
(3)	C_5H_{11}- 	$CH_3CH_2NH_2$	$C_6H_{13}OH$	CH_3COOH
(4)	$C_6H_{13}OH$	$C_6H_{13}NH_2$	C_5H_{11}- 	$C_5H_{11}COOH$
(5)	$C_6H_{13}NH_2$	C_5H_{11}- 	$C_5H_{11}COOH$	$C_6H_{13}OH$

14. A 30.0 mg sample of a volatile liquid is vaporised at 127°C. The volume of the vapour phase measured at 1.00×10^5 Pa is 16.65 cm^3. If the vapour phase behaves ideally, the liquid is most likely to be
(H = 1.0, C = 12.0, O = 16.0, Cl = 35.5)
(1) methanol (2) ethanol (3) acetone
(4) chloroform (5) carbon tetrachloride

15. The energy released in the process
$X(g) + e \rightarrow X^-(g)$ is lowest when X is
(1) Li (2) Be (3) B (4) C (5) F

16. Which one of the following statements is **not true** regarding the ions N^{3-}, O^{2-} and F^-

(1) They have the same electronic configuration
(2) Nuclear charge follows the order $N^{3-} < O^{2-} < F^-$
(3) They have the same number of electrons as Ne.
(4) Their radii follow the order $N^{3-} < O^{2-} < F^-$
(5) Compounds containing these ions are formed when Li reacts with the respective gases, N_2, O_2 and F_2

17. Which arrangement of compounds given below, gives the correct increasing order of **acid strength**?

(1) $C_6H_5OH < CH_3COOH < CH_3CH=CH_2 < CH_3C \equiv CH$
(2) $CH_3CH=CH_2 < C_6H_5OH < CH_3COOH < CH_3C \equiv CH$
(3) $CH_3CH=CH_2 < CH_3C \equiv CH < CH_3COOH < C_6H_5OH$
(4) $CH_3C \equiv CH < CH_3CH=CH_2 < C_6H_5OH < CH_3COOH$
(5) $CH_3CH=CH_2 < CH_3C \equiv CH < C_6H_5OH < CH_3COOH$

18. A 10.0 cm^3 sample of coconut vinegar (density = 1.07 g cm^{-3}) was titrated with a 0.428 mol dm^{-3} NaOH solution, using a suitable indicator. If the end point was 25.00 cm^3, the mass percentage (w/w%) of acetic acid (relative molar mass of CH_3COOH = 60.0) in the vinegar, is

(1) 0.060 (2) 0.60 (3) 3.0 (4) 6.0 (5) 12.0

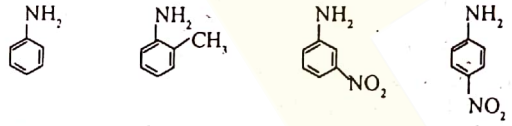
19. Which one of the following statements is not true about hybridisation?

(1) Hybrid orbitals formed from a given hybridisation have the same shape.
(2) Hybrid orbitals may form π bonds.
(3) The angle between sp^2 hybrid orbitals is 120^0.
(4) All carbon atoms in hydrocarbons are hybridised.
(5) Hybrid orbitals formed from a given hybridisation have the same energy.

20. The polymer which reacts most readily with Br_2 is

(1) natural rubber (2) PVC
(3) phenol-formaldehyde polymer (4) poly(styrene)
(5) poly(ethylene)

21. Consider the following compounds



a b c d

Which arrangement of the compounds **a,b, c** and **d** given below, gives the correct increasing order of base strength?

(1) a<b<c<d (2) d<c<b<a (3) d<c<a<b
(3) c<d<a<b (3) b<a<c<d

22 The standard electrode potential of the metal/metal-ion eletrodes $A^{2+}(aq)$ /**A** and $B^{2+}(aq)$/**B** are -0.75 V and -1.0 V respectively. Which of the following statements is **incorrect** regarding a cell constructed by combing the above two standard electrodes, when a current is drawn from the cell?

(1) In the external circuit current flows from **B** to **A**
(2) Anions move towards the $B^{2+}(aq)$ /**B** electrode.
(3) The $A^{2+}(aq)$/**A** electrode is the cathode.
(4) The mass of the metal **B** decreases with time.
(5) Oxidation occurs at the $B^{2+}(aq)$/**B** electrode.

23. Which two aqueous solutions of the following **will not form** a precipitate when mixed together?

(A) $BaCl_2$ (B) $MgSO_4$ (B) $Pb(NO_3)_2$ (D) NH_4OH

(1) A and B (2) A and C (3) B and C
(4) Cand D (5) A and D

24. Average bond energies of C≡ N and C-N bonds are 837 and 347 kJ mol^{-1} respectively. The most reasonable value for the average bond energy (kJ mol^{-1}) of C = N bond is,

(1) 837 - 347 (2) $(837+347)\times\frac{1}{2}$
(3) $837\times\frac{2}{3}$ (4) $347+\frac{(837-347)}{2}$
(5) 347 x 2

25. At 25°C the pressure inside a vessel containing gas **X** is 10 atm. **X** dissociates when exposed to UV light resulting in the following equilibrium.

$$3\,X(g) \rightleftharpoons 3\,Q(g) + 2\,R\,(g)$$

It is found that when equilibrium is reached at 25°C the pressure in the vessel is 13 atm. The percentage of **X** decomposed at equlibrium is

(1) 75 (2) 15 (3) 30 (4) 10 (5) 45

26. Organic compound **A** contains **C,H** and **N** only. The complete combustion of 0.88 g of **A** gave 1.76 g of CO_2 and 1.08 g of H_2O. In a separate experiment, 0.88 g of **A** gave 0.34 g of NH_3. (C=12.0, H= 1.0, N= 14.0, O=16.0)

Which of the following statements is the most appropriate deduction.

(1) **A** is a saturated compound with molecular formula $C_4H_{12}N_2$
(2) **A** is an aliphatic diamine with molecular formula $C_4H_{12}N_2$
(3) **A** is an unsaturated compound with molecular formula $C_5H_{12}N_2$
(4) **A** is an aliphatic diamine with molecular formula $C_5H_{12}N_2$
(5) The data provided above is insufficient to determine the molecular formula of **A**.

27. Solution **S** is prepared by mixing equal volumes of 0.2 mol dm^{-3} aqueous H_2SO_4 and 0.2 mol dm^{-3} aqueous CH_3COOH. 25.0 cm^3 portions of **S** are titrated separately with 0.1 mol dm^{-3} NaOH solution (in burette) using (A) phenolphthalein and (B) methyl orange as indicators. The end - points of the two titrations are respectively

(1) (A) 75.0 cm^3 (B)25.0 cm^3
(2) (A) 25.0 cm^3 (B)25.0 cm^3
(3) (A) 75.0 cm^3 (B)50.0 cm^3
(4) (A) 50.0 cm^3 (B) 75.0 cm^3
(5) (A) 25.0 cm^3 (B)50.0 cm^3

28. Which one of the following observations **cannot** be explained by using the electrochemical series?

(1) Reducing ability of **K** is more than that of Na.
(2) F_2 is more easily reduced than Cl_2.
(3) $Cu^{2+}(aq)$ forms a complex with $Cl^-(aq)$ while $Mg^{2+}(aq)$ does not.
(4) Fe can be oxidized by $H^+(aq)$
(5) Mg can displace Cu from an aqueous solution of $CuSO_4$.

29. Solutions **A** to **D** are prepared as follows

A - 10.0 cm^3 of 0.1 mol dm^{-3} aqueous NH_4OH +10.0 cm^3 of H_2O
B - 10.0 cm^3 of 0.1 mol dm^{-3} aqueous NH_4OH +10.0 cm^3 of 0.15 mol dm^{-3} aqueous NH_4Cl
C - 10.0 cm^3 of 0.1 mol dm^{-3} aqueous NH_4OH +10.0 cm^3 of 0.10 mol dm^{-3} aqueous $(NH_4)_2SO_4$
D - 10.0 cm^3 of 0.1 mol dm^{-3} aqueous NH_4OH +10.0 cm^3 of 0.05 mol dm^{-3} aqueous NH_4OH

The correct order of the pH of the solutions **A** to **D** is

(1) **B<C<A<D** (2) **D < A< C <B** (3) **C<B<A<D**
(4) **B<A<C<D** (5) **A< D <C<B**

30. The colour imparted on the Bunsen flame by metal atoms results from the light energy released when the electrons return to the ground state (energy = ϵ_0) from the 1st excited state (energy = ϵ_1). The flame colours of some atoms are given below

Li - red, Cu - green, Na - yellow, K - violet

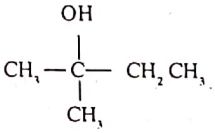
The correct order of $\epsilon_1 - \epsilon_0$, for the atoms is

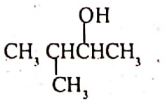
(1) Li>Cu>Na>K (2) Na>Li>K>Cu

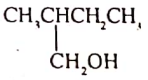
(3) Cu>Li>Na>K (4) K>Cu>Na>Li

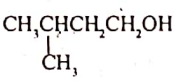
(5) Na>K>Li>Cu

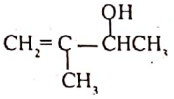
31. Which of the alcohols is the **most difficult** to oxidise with an acidic solution of potassium dichromate?

(1) 

(2) 

(3) 

(4) 

(5) 

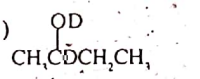
32. The most convenient method to prepare a reasonably pure solution of NaOH at home is

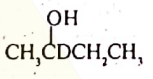
(1) heating a solution of common salt with slaked lime.
(2) heating a solution of baking soda with slaked lime.
(3) heating a solution of washing soda with limestone.
(4) electrolysing a solution of common salt using Fe electrodes.
(5) heating a solution of washing soda with slaked lime.

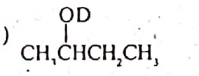
33. Which one of the following statements is true?

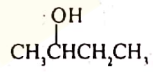
(1) The rate of an expthermic reaction decreases with increasing temperature.
(2) The rate of an endothermic reaction increases with increasing temperature.
(3) Temperature has no effect on solid-state reactions.
(4) A catalyst converts an endothermic reaction to an exothermic one.
(5) A catalyst decreases the enthalpy change of a reaction.

34. The product that results when 2-butanone is first treated with $LiAlH_4$ followed by hydrolysis with duterium oxide (D_2O) is

(1) 

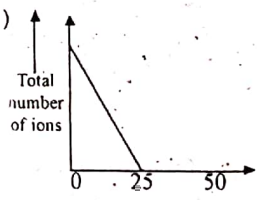
(2) 

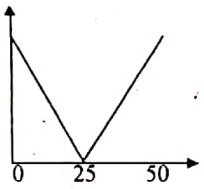
(3) 

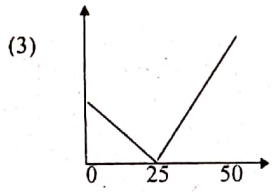
(4) 

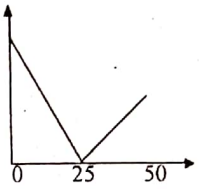
(5) $CH_3CD_2CH_2CH_3$

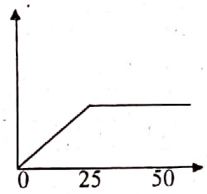
35. When 50.0 cm^3 of 0.1 mol dm^{-3} H_2SO_4 solution is added gradually to 25.0 cm^3 of 0.1 mol dm^{-3} $Ba(OH)_2$ solution, the variation of the total number of ions in the mixture is shown by

(1) 

(2) 

(3) 

(4) 

(5) 

Volume of H_2SO_4 added/ cm^3 ⟶

36. The function of the $FeBr_3$ catalyst in the reaction of bromine and benzene is to

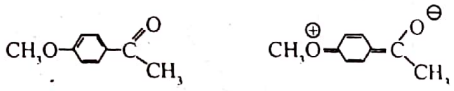
(1) serve as a radical initiator to generate $Br^•$
(2) stabilize the carbocation intermediate.
(3) destabilize the carbocation intermediate.
(4) act as a Lewis acid to activate bromine.
(5) act as a Lewis acid to activate benzene.

37. Which one of the following statements is **not true**? (K_w = 1.0 x 10^{-14} mol^2dm^{-6} at 25°C; K_w = 1.0 x 10^{-12} mol^2dm^{-6} at 80°C: Ignore the effect of dissolved CO_2)

(1) Pure water at 25°C has a pH of 7.
(2) Chlorinated water has a pH less than 7.
(3) When a 0.1 mol dm^{-3} solution of H_2SO_4 is titrated with a 0.2 mol dm^{-3} solution of NaOH at 25°C, the pH rises to 7 at the end point.
(4) When a 0.1 mol dm^{-3} solution of H_2SO_4 is titrated with a 0.2 mol dm^{-3} solution of NaOH at 80°C, the pH rises to 6 at the end point.
(5) The volume of 0.2 mol dm^{-3} NaOH required for the titration of 10.0 cm^3 of 0.1 mol dm^{-3} H_2SO_4 is less at 80°C than that required at 25°C.

38. Which of the following is **not** a pair of resonance structures?

(1) 

(2) 

(3) 

(4) 

(5)

Use the following passage to answer questions **39** and **40**.

A and **B** are two liquids that give ideal solutions. A solution of **A** and B is in equilibrium with its vapour. X_A and X_B are the mole fractions of **A** and **B** respectively in the liquid phase while Y and Y_B are the corresponding values for the vapour phase. P^0_A, the vapour pressure of pure **A**, is larger than P^0_B, the vapour pressure of pure **B**.

39. 3a mol of **A** and 2a mol of **B** are placed in an evacuated vessel and an equilibrium between liquid and vapour phases results. Which one of the following is true for the above system?
(1) X_A=0.6 and X_B=0.4 (2) $Y_A<X_A$ and $Y_B<X_B$.
(3) $X_A<Y_A$ and $X_B<Y_B$ (4) $Y_A<X_A$ and $X_B<Y_B$
(5) $X_A<Y_A$ and $Y_B<X_B$

40. Which one of the following statements is **not true** for any binary solution of **A** and **B**?
(1) The partial vapour pressure of **A** decreases as X_B increases.
(2) The partial vapour pressure of **B** decreases as X_A increases.
(3) For a given X_B, the total vapour pressure is higher than either p^0_A or p^0_B.
(4) The total vapour pressure increases as X_A increases.
(5) The total vapour pressure decreases decreases as X_B increases.

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

For each of the questions **41** to **50**, four responses *(a), (b), (c)* and *(d)* are given; one or more is/ are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark.
(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 **any other** number or combination of responses is correct.

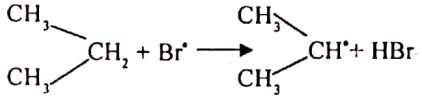
Summary of above Instructions				
(1)	(2)	(3)	(4)	(5)
Only *(a)* and *(b)* are correct.	Only *(b)* and *(c)* are correct.	Only *(c)* and *(d)* are correct.	Only *(d)* and *(a)* are correct.	**Any other** number or combination of responses is correct.

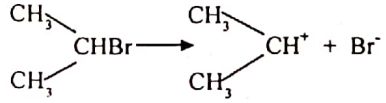
41. Which of the following statements is/are **incorrect**?
(a) All transition elements are metals.
(b) All metals conduct electricity.
(c) No nonmetal conducts electricity.
(d) All metals are solids at room temperature.

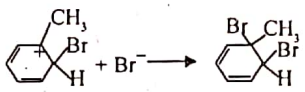
42. Which of the following statements is/are true?
(a) Bohr Theory is a nuclear model of the atom.
(b) Rutherford proposed the first nuclear model of the atom.
(c) Electrons do not behave as waves and particles at one and the same time.
(d) *elm* ratio of cathode rays varies with the gas inside a cathode ray tube.

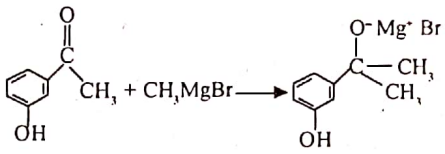
43. Which of the following statements is/are applicable to all three elements Zn, Cu and Ni?
(a) They are d-blook elements.
(b) Solutions containing their ions form precipitates with $(NH_4)_2S$.
(c) They liberate H_2 from dilute acids.
(d) Their oxides dissolve in NH_4OH.

44 Which of the following mechanistic steps is/are feasible?

(a) 

(b) 

(c) 

(d) 

45. Which of the following statements is/are true?
(a) The compressibility of all real gases approaches unity at low pressure.
(b) If the pressure is high enough any real gas can be liquefied at room temperature.
(c) Under identical conditions of temperature and volume, the pressure of an ideal gas is lower than that of a real gas.
(d) At sufficiently low temperatures, any real gas can show a compressibility less than unity.

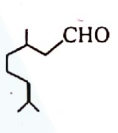
46. Consider the following equilibrium at 150 °C

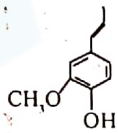
$A(g) + B(g) \rightleftharpoons P(g) + Q(g)$; $\Delta H^0 = -50.0 kJ\ mol^{-1}$

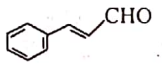
Which of the following statements is/are true for the above system when the temperature is raised to 250 °C?
(a) Initially the rate of the forward reaction rises faster than that of the reverse reaction.
(b) Initially the rate of the reverse reaction rises faster than that of the forward reaction.
(c) Initially both forward and reverse reaction rates increase by the same factor.
(d) At equilibrium.

$$\frac{\text{Rate of the forward reaction at 250°C}}{\text{Rate of the forward reaction at 150°C}} = \frac{\text{Rate of the reverse reaction at 250°C}}{\text{Rate of the reverse reaction at 150°C}}$$

47. Consider the following compounds :


Citronellal


Eugenol


Cinnamaldehyde

Which the following statements is/are correct?
(a) Citronellal, which is present in citronella oil, affects the plane of polarized light.
(b) Eugenol, which is the major compound of clove oil, is used in dentistry.
(c) Eugenol, which is also the major compound of cinnamon bark oil, shows both geometric and optical isomerism.
(d) Cinnamaldehyde, which is used as a flavouring agent in food industry, is the major compound of cinnamon leaf oil.

48. Which of the following statements is/are correct?
(a) There is a rapid change of pH near the end-point of an acid-base titration.
(b) There is a rapid change of pH at the beginning of an acid - base titration.
(c) In MnO_4^- - oxalic acid titration, the colour change at the end-point is due to a rapid change of pH.
(d) Diphenylamine is used as the indicator in the titration between Fe^{2+} and $Cr_2O_7^{2-}$

49. Which of the following statements is/are **not true** regarding the preparation of ethanol (boiling point 78.1°C) from sugar (sucrose, $C_{12}H_{22}O_{11}$) by fermentation using yeast?
(a) One mole of sugar is expected to provide 4 moles of ethanol and 4 moles of carbon dioxide.

(b) High concentrations of ethanol inhibit the fermentation and the concentration of ethanol in the fermentation product will be less than 15%.
(c) More concentrated ethanol can be isolated by distillation of the filtrate of the fermentation broth, and the fraction distilled at 78-80°C would contain 100% ethanol.
(d) The fractions distilled at temperatures over 88°C contain fusel oil which consists of higher alcohols.

50. The kinetic molecular theory equation for an ideal gas is $pV = \frac{1}{3}mN\overline{C^2}$. Which of the following statements is/are true for a sample of an ideal gas?
(a) $\overline{C^2}$ increases with p at constant temperature
(b) $\overline{C^2}$ increases with V at constant temperature.
(c) $\overline{C^2}$ increases with temperature.
(d) $\overline{C^2}$ increases if more molecules of the gas are introduced into the sample at constant temperature.

Instructions for questions No. 51 to 60

- In questions No. **51** to **60**, two statements are given in respect of each question.
From the Table given below, select the response out of the responses (1), (2), (3), (4) and (5) that **best** fits the two statements given for each of the questions and mark appropri ately on your answer sheet.

Response	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
51.	When bromine-water is shaken with hexene and benzene, the colour of the bromine is transferred to the organic layer.	Bromine is more soluble in benzene than in water.
52.	At constant temperature, the rate of hydrogenation of ethylene on Ni catalyst should be the same as that on Pd catalyst.	At constant temperature, rate of hydrogenation depends only on the initial concentration of the reactants.
53.	Fe_3O_4 can. not only be reduced to FeO, but can also be oxidised to Fe_2O_3.	Fe_3O_4 contains both Fe^{2+} and Fe^{3+}.
54.	When a molecule of an ideal gas bounces off the wall of the container, the momentum of the molecule changes.	When a molecule bounces off the wall, its speed as well as the direction of motion changes.
55	No chloride is more soluble in conc HCl than in water	Due to the common ion effect exerted by the large Cl^- concentration in conc. HCl, the solubilities of all chlorides decrease in this acid.
56.	The standard enthalpy of formation of all elements is taken as zero.	As elements are not in a chemically combined state, their enthalpies of formation equal zero.
57.	The rate of the gaseous reaction $A(g) \longrightarrow B(g)$, remains constant as long as the temperature remains constant.	At constant temperature, the number of collisions between reactant molecules as well as the fraction of molecules with sufficient energy for reaction remains constant.
58.	The atomic spectrum of hydrogen is a line spectrum.	The energy associated with each line of the spectrum is equal to the energy of the electronic level corresponding to the line.
59.	When the pH of an aqueous solution changes the pOH also changes by the same number of units.	When the H^+ concentration of a solution changes, the OH^- concentration also changes by the same amount.
60.	Galvanising is a convenient process for making iron corrosion resistant.	Galvanising can be done by immersing a piece of iron in an aqueous solution of $ZnCl_2$

G.C.E. (A/L) Examination 2006 April
Chemistry II / Three hours

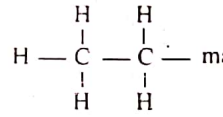
- Periodic Table is provided.
- **Use of calculators is not allowed.**

PART A - Structured Essay (Pages 2-8)

- Answer **all** the questions.
- 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.

N.B. INSTRUCTION BOX

In answering questions 3 and 4, you may represent alkyl groups in a condensed manner.

e.g.  may be shown as CH_3CH_2 -

PART B and PART C - Essay (pages 9-12)

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 answers to 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.

Universal gas constant, R	= 8.314 JK^{-1} mol^{-1}
Avogadro constant N_A	= 6.022 x 10^{23} mol^{-1}

PART A - STRUCTURED ESSAY

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

1 (a) Complete the following statements :

(i) The element with the highest melting point among Li, Na and Mg is .....

(ii) The element that reacts most vigorously with water among Li, Na and K is .....

(iii) The most thermally stable carbonate among Na_2CO_3, $CaCO_3$ and $MgCO_3$ is .....

(iv) The most water soluble hydroxide among $Mg(OH)_2$, $Ca(OH)_2$ and $Ba(OH)_2$ is .....

(v) The two elements that show the **same highest** oxidation state among Cl, Mn, P and Cr are ..... and .....

(3.0 marks)

(b) The element **M** reacts easily with dilute H_2SO_4 as well as with dilute aqueous NaOH solution at room temperature liberating the same gas. The salts of **M** are not electron deficient compounds.

Identify **M** .....

Write balanced chemical equations for the reactions of **M** with (i) dil. H_2SO_4 (ii) aqueous NaOH.

(i) .....

(ii) .....

Give **one** industrial application of **M**.

.....

(2.5 marks)

(c) (i) Write the resonance structures of the N_3^- (azide) ion.

.....

.....

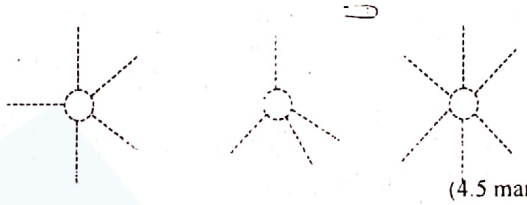
Give **one** application you have read or heard about of sodium azide.

.....

(ii) Three sketches that can be used to show the arrangements of repulsion units (bonds and lone pairs) in molecules are given below. Indicate the arrangement of the repulsion units around the central atom in the molecules.

SiF_4, XeF_4, and SF_4

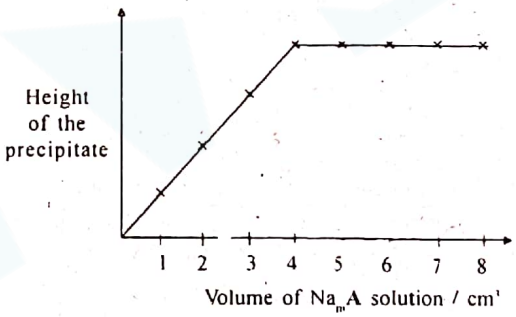
by choosing the appropriate sketch. For this purpose indicate the central atom inside the circle. bonds by solid lines (-) and lone pairs by



(4.5 marks)

2. (a) MCl_n and Na_m **A** are two water soluble salts. Aqueous solutions of these react together forming an immediate precipitate M_mA_n

In an experiment to determine the stoichiometry of this reaction, 9 cm^3 portions of 0.2 mol dm^{-3} MCl_n solution were mixed, in test tubes, with varying volumes of 0.3 mol dm^{-3} Na_mA solution, and the height of the precipitate after the precipitate had settled down, was measured. The results are given in the following graph.



(i) Deduce the stoichiomerty of the reaction.

.....

.....

.....

.....

.....

(ii) Is the above method suitable for determining the stoichiometry of the reaction between $Al_2(SO_4)_3$ and NH_4OH?

Yes / No (Delete the inappropriate word)

Give **two** reasons to support your answer

.....

.....

(5.0 marks)

(b) The ester $R-\overset{O}{\overset{\|}{C}}-OR_2$ is a crystalline solid R_1 and R_2 are hydrocarbon chains. This ester undergoes hydrolysis to give the following equilibrium.

$R_1COOR_2(s) + H_2O(\ell) \rightleftharpoons R_1COOH(aq) + R_2OH(aq)$

The statements given below refer to a procedure for the hydrolysis of the ester. Fill in the blanks in the statemets using **only** siutable words/phrases, selected from the list given below. The same word/phrase may be used more than once. Each blank should be filled with one word **only.**

List of words/ phrases to be used :
activation energy, boiling - point, carboxylic acid, catalysts, concentration, contact, decreases, density, equilibrium, increases, left, mixing, organic compound, rate, right, slowly, sodium salt, solid, yield.

(i) The ester is ground to a fine powder.
Grinding ..... the surface area of the solid. This leads to an increase in the ..... between reactants.

(ii) The rate of hydrolysis can be increased by using acids or bases. Hydrolysis by water alone occurs ..... due to the high .... of the reaction. Acids and bases act as ..... for this reaction.

(iii) Aqueous NaOH is more suitable than aqueous HCl for the above hydrolysis. Acid hydrolysis gives an ..... mixture of products and reactants. Hence the amount of product obtained is limited by the ..... concentrations. When base is used, the carboxylic acid formed on hydrolysis is removed from the ..... mixture as the .... The equilibrium is thus pushed to the ..... and the ..... is increased.

(iv) The powdered ester is stirred with dil. NaOH and heated to 60°C to complete the hydrolysis. Stirring helps to increase ..... between reactants and heating increases the ..... of the reaction.

(v) After complete hydrolysis, when excess NaCl is dissolved in the reaction mixture, a white solid separates and rises to the top.
Dissolved NaCl increases the ..... of ions in solution. Under these conditions the less soluble .... of the carboxylic acid separates. As the dissolved NaCl also increases the ..... of the solution, the solid rises to the top.

(5.0 marks)

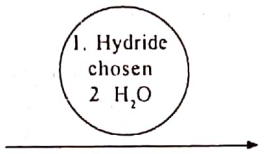
3 Selecting appropriate reagents and solvents for the chemical reactions involved only from the following list, answer parts (a) and (b).

acetone (CH_3COCH_3), aniline ($C_6H_5NH_2$),
bromobenzene(C_6H_5Br), toluene ($C_6H_5CH_3$)
Mg, Fe,Pt
Br_2, PCl_5, NaCN cuprous bromide (Cu_2Br_2), $AlCl_3$, CH_3Cl
$NaBH_4$, $LiAlH_4$ $KMnO_4$, $NaNO_2$
conc.HNO_3, conc. H_2SO_4
aq. NaOH, dil. H_2SO_4
water, ethanol (C_2H_5OH), ether ($C_2H_5OC_2H_5$)

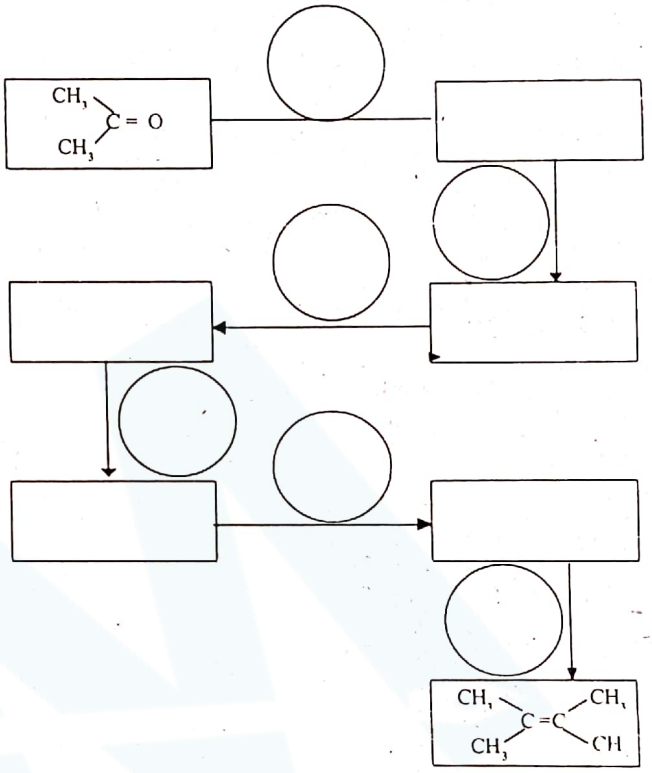
Note :

(I) In the following schemes, write in the boxes the structures of the appropriate compounds and in the circles the appropriate reagents / solvents.

(II) Each arrow indicates a single reaction except in the case of hydride reduction followed by hydrolysis for which the reagents should be given in the same circle as shown below.

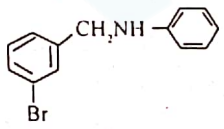


(a) Show how you would prepare 1,1,2, 2- tetramethylethene from acetone by completing trh scheme given below.

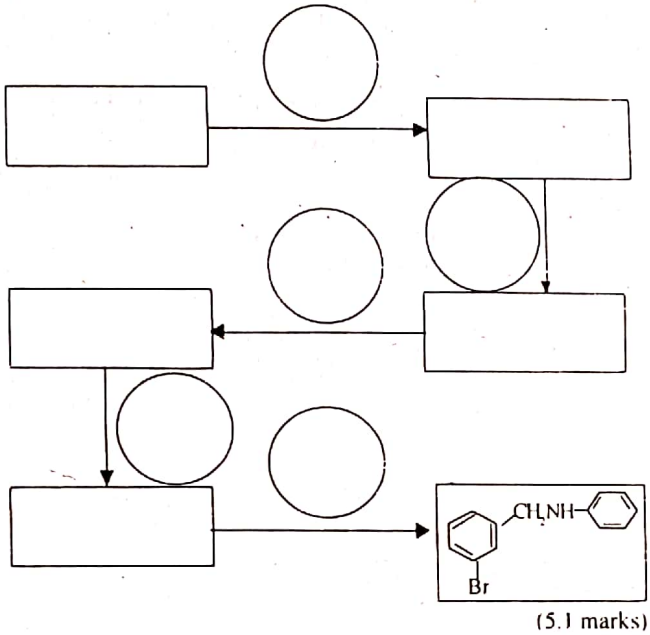


(4.9 marks)

(b) Show how you would synthesise the compound.



by completing the scheme given below



(5.1 marks)

4 (a) **A** and **B** are isomeric hydrocarbons each having **two** sp-hybridised carbon atoms and **two** sp^3 hybridised carbon atoms. Substitution of **one** of the hydrogen atoms in **B** by a chlorine atom gives **C** which shows optical isomerism. **A** and **B** separately react with a mixture of water, mineral acid and catalyst **Y** to give compound **D**. **D** has **three** sp^3 - hybridised carbon atoms. **one** sp^2 - hybridised carbon atom and **one** oxygen atom.

(i) Write the structures of **A, B, C** and **D**.

A B

C D

(ii) What is catalyst **Y**?

Y = ...

(iii) How would you distinguish between **A** and **B** using a chemical test?

(4.0 marks)

(b) Consider the reactions given in column P of the table below.

(i) Write the structure of the major organic product of each of the reactions in the respective cage in column Q of the table.

(ii) Identify the mechanism type of each of the reactions as

electrophilic addition (A_E),
electrophilic substitution (S_E)
nucleophilic addition (A_N)
nucleophilic substitution (S_N)
Elimination (E) or
any other mechanism (M_O)

by writing A_E, S_E, A_N, S_N, E or M_O in the appropriate cages in column R of the table.

(iii) In electrophilic reactions write the electrophiles in the appropriate cages in column S of the table

(iv) In nucleophilic reactions write the nucleophiles in the appropriate cages in column T of the table

(v) In each of the reactions wirte the colour of the main organic product in the appropriate cage in column U of the table

P	Q	R	S	T	U
Reaction	Major organic product	Mecha-nism type	Electrophile	Nucleo-phile	Colour
$CH_3CH_2CH_2I \xrightarrow{aq.NaOH}$					
$(CH_3)_2C=CH_2 \xrightarrow{dil.H_2SO_4}$					
$CH_3CH_2CHI(CH_3) \xrightarrow[KOH]{alcoholic}$					
$C_6H_6 \xrightarrow[AlCl_3]{CH_3COCl}$					
$O_2N-C_6H_3(NO_2)-CHO \xrightarrow{NHNH_2}$					
$CH_3C_6H_4OH \xrightarrow{} N_2^+Cl^-$					

(6.0 marks)

PART B - ESSAY

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

5. (a) Yeast cells obtain their energy requirements by incomplete oxidation of glucose ($C_6H_{12}O_6$) to alcohol (C_2H_5OH) and CO_2, by a process known as fermentation. This process can be represented as follows

$$C_6H_{12}O_{6\,(aq)} \rightleftharpoons 2\,C_2H_5OH\,(aq) + 2\,CO_2\,(g)$$

The standard enthalpies of combustion at 25°C of glucose(s) and alcohol(1) are -2808 kJ mol^{-1} and -1368 kJ mol^{-1} respectively.

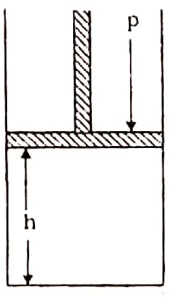
(i) Assuming that the enthalpy changes associated with the dissolution of glucose(s) and alcohol(l) in water are negligible, calculate the amount of energy released when 2.5 mol of glucose is fermented by yeast at 25°C

(ii) What is the ratio between the energy released by fermentation of a certain amount of glucose and the energy released during 'respiration' of the same amount of glucose in man?

Note : In 'respiration' glucose is oxidised completely.

(4.0 marks)

(b) The figure alongside shows a rigid cylindrical vessel fitted with a weightless, frictionless and gas tight piston. 'h' is the height of the piston above the bottom of the vessel when the vessel contains a gas and 'p' is the external pressure acting on the piston. The area of cross section of the piston is 8.314 x 10^{-2} m^2



(i) The vessel is initially filled with a gas **X**. When the temperature of the vessel and contents is 27°C and p is 10^5 Pa, h is 3.0 m. Calculate the number of moles of **X** in the vessel

(ii) **X** dissociates when heated above 80°C, resulting in the following equilibrium.

$2\,X\,(g) \rightleftharpoons Y\,(g) + Z\,(g)$

The vessel in (i) above is heated and the contents allowed to reach equilibrium at 127°C keeping p constant at 10^5 Pa. Under these conditions, the vessel is found to contain 4.0 mol of **X**. Calculate the following :

(A) the value of h

(B) the partial pressures of the gases **X**, **Y** and **Z**.

(C) the equilibrium constant, K_p, for the above equilirium at 127°C.

(iii) 10.0 mol of an inert gas **S** is then introduced to the vessel in (ii) above and the system allowed to reach equilibrium at 127°C, keeping h at the same value as in (ii) (**A**) above. Calculate the values of partial pressures of **X, Y, Z** and **S**. and the value of p under these conditions.

(iv) p is then allowed to change back to 10s Pa, keeping the temperature of the mixture in (iii) above at 127°C. Calculate h, and the partial prssures of the gases **X, Y, Z** and **S** under the new equilibrium conditions.

(v) State any assumptions you made in these calculations.

(11.0 marks)

6. (a) Molecular iodine (I_2) can be partitioned between chloroform ($CHCl_3$) and water.

15.00 cm^3 of a 0.050 mol dm^{-3} solution of I_2 (in $CHCl_3$) is shaken well with 100.0 cm^3 of water and the system is allowed to attain equilibrium at 25°C. 5.00 cm^3 of the equilibrium $CHCl_3$ layer requires 24.00 cm^3 of a 0.020 mol dm^{-3} aqueous solution of $Na_2S_2O_3$ for complete reaction with the I_2 dissolved in the chloroform

Calculate following :

(i) The concentrations of I_2 in the $CHCl_3$ and aqueous layers.

(ii) The partition coefficient for the partitioning of I_2 between $CHCl_3$ and water at 25°C.

(4.0 marks)

(b) I_2 also dissolves in aqueous KI solution to give the following equilibrium.

$I_2\,(aq) + I^-_{(aq)} \rightleftharpoons I_3^-(aq)$

$I_3^-(aq)$ and $I^-(aq)$ are not soluble in $CHCl_3$. Given below is an experimental procedure to determine the equilibrium constant, K_c, of the above equilibrium at 25°C.

The experiment in (a) above is repeated using 100.0 cm^3 of a 0.050 mol dm^{-3} aqueous solution of KI instead of the 100.0 cm^3 of water. 5.00 cm^3 of the $CHCl_3$ layer requires 8.00 cm^3 of 0.020 mol dm^{-3} aqueous $Na_2S_2O_3$ for complete reaction with the I_2 dissolved in $CHCl_3$.

Calculate the following :

(i) The concentrations of I_2 in the $CHCl_3$ and aqueous layers.

(ii) The number of moles of I_2 that reacted with $I^-(aq)$ to give $I_3^-(aq)$

(iii) The concentrations of $I^-(aq)$ and $I_3^-(aq)$

(iv) The equilibrium constant, K_c, at 25°C for the $I_2(aq)$. $I^-(aq)$ and $I_3^-(aq)$ equilibrium

(10.0 marks)

(c) 'Tincture of Iodine' is a solution of I_2 in aqueous KI, used for the disinfection of wounds. Give **two** reasons for the use of this solution, rather than an aqueous solution of I_2 for the above purpose.

(1.0 marks)

7. (a) (i) A 100 cm^3 of 0. 100 mol dm^{-3} aqueous $CuSO_4$ solution containing a small amount of Na_2SO_4 was electrolysed using two clean copper (Cu) electrodes, each with a mass of 10.0 g. During this experiment, a current of 300 mA was passed for 9.65 minutes.
Calculate
(A) the mass of the cathode
(B) the mass of the anode, and
(C) the concentration of Cu^{2+} ions in the solution at the end of this electrolysis experiment.

Note : Charge of 1 mol of electrons is 96500 C Cu = 63.5

(ii) At the end of the experiment described in (i) above, 100 cm^3 of water was added to the electrolyte solution, the solution was stirred, and the electrolysis was continued by passing a current of 300 mA for a further 9.65 minutes

Deduce

(A) the mass of the cathode
(B) the mass of the anode, and
(C) the concentration of Cu^{2+} ions in the solution at the end of this electrolysis experiment.

(iii) Is electrolysis a good method to discharge only Pb^{2+} ions from a solution containing both Pb^{2+} and Cu^{2+} ions? Give reasons for your answer.

$E^{\theta}_{Cu^{2+}(aq)/Cu(s)} = 0.34$ V ; $E^{\theta}_{Pb^{2+}(aq)/Pb(s)} = -0.13$ V

(5.0 marks)

(b) An aqueous solution contains Na_3PO_4 and Na_2SO_4 only. Excess of aqueous $Ba(OH)_2$ solution is added to this solution with stirring until no further precipitation is observed.
In this experiment, it was found that 200 cm^3 of 5.0×10^{-3} mol dm^{-3} $Ba(OH)_2$ solution has been added for 100 cm^3 of the above solution. When the precipitate was filtered, washed and dried, its weight was found to be 0.1435 g. The concentration of SO_4^{2-} (aq) in the filtrate was found to be 1.1×10^{-7} mol dm^{-3}.

(i) Calculate the concentration of Ba^{2+} in the filtrate.

(ii) Hence calculate the number of moles of Ba^{2+} in the precipitate.

(iii) Hence calculate the number of moles of $BaSO_4$ and the number of moles of $Ba_3(PO_4)_2$ in the precipitate.

(iv) Hence calculate the concentrations of PO_4^{3-} and SO_4^{2-} in the initial solution.
(O = 16.0, Na = 23.0, P = 31.0, S = 32.0, Ba = 137.0)

Solubility product of $BaSO_4$ at 25°C = 1.1×10^{-10} $mol^2\ dm^{-6}$

Solubility product of $Ba_3(PO_4)_2$ at 25°C
= 3.4×10^{-23} $mol^5\ dm^{-15}$

(10.0 marks)

PART B - ESSAY

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

8. (a) **L** and **M** are 3d transition elements.
L forms an oxyanion which is tetrahedral in shape
M forms a cation M^{2+}
One mole of the oxyanion of **L** reacts with five moles of M^{2+}, oxidising it to M^{3+} and forming L^{2+}.
An aqueous solution of M^{3+} is yellow-brown in colour and liberates I_2 from KI.

(i) Deduce the oxidation state of **L** in the oxyanion.

(ii) What are the elements **L** and **M**?

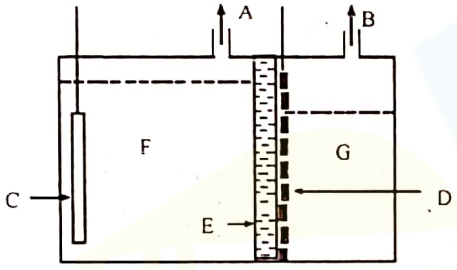
(iii) Write the chemical formula of the oxyanion of **L**.

(iv) Give the reducing agents and the reaction conditions employed in a method used industrially to convert M_2O_3 to the element **M**.

(v) Give one reaction of $L(OH)_2$ useful in quantitative analysis

(7.5 marks)

(b) A diagram of the diaphragm cell used to manufacture NaOH is given below.



(i) Name A, B, C, D and E.

(ii) What are the constituents of solutions F and G?

(iii) Indicate the materials used for the anode and cathode?

(iv) What factors must be taken into consideration in selecting materials for the anode and the cathode?

(v) What is the role of the diaphragm?

(vi) Explain why the solution level of one compartment is usually maintained at a higher level than that of the other compartment.

(vii) Give two reasons for the use of brine but not a dilute solution of NaCl as the electrolyte.

(7.5 marks)

9. (a) Tests carried out with a salt X and the relevant observations are given below.

Test	Observations
(A) Warmed **X** with dil HCl	Colurless solution. No evolution of gases.
(B) Passed H_2S through solution in (A) above.	Orange coloured precipitate.
(C) Diluted a solution of **X** in dil. HCl. with water.	A white precipitate
(D) Warmed **X** with NaOH solution.	No gas evolved.
(E) Warmed **X** with NaOH solution and Al powder.	Ammonia evolved.

(i) State the inferences that you can make from each of the above tests.

(ii) Identity the salt **X**

(iii) Give **one** test to confirm the identity of the anion.

(5.0 marks)

(b) (i) A solution **B** contains SO_3^{2-} and $C_2O_4^{2-}$ ions. 25.0 cm^3 of solution B required 40.0 cm^3 of 0.05 mol dm^{-3} $KMnO_4$ solution for complete reaction under acidic conditions The resulting solution was treated with excess of $BaCl_2$ in the presence of dil. HNO_3. The mass of the white precipitate so obtained after drying was 0.466 g

Calculate the concentrations of SO_3^{2-} nad $C_2O_4^{2-}$ ions in solution **B**.

(Ba = 137.0 ; S = 32.0 O = 16)

(ii) You are provided with a finely powdered mixture containing Fe, Al, Cu and Zn. using **only** the chemicals given below, briefly indicate a chemical method (no experimental details required) to determine the mass percentage of each metal in the mixture.

Chemicals : dilute H_2SO_4, aqueous NaOH, and dilute NH_4OH

(10.0 marks)

10. (a) (i) Write structures of (**A**) P_4 (white phosphorus) molecule and (**B**) three (noncyclic) oxyacids of phosphorus.

Write the names of these three oxyacids and indicate the oxidation number of the phosphorus atom in each case.

(ii) White phosphorus(P_4) reacts with $Ba(OH)_2$ solution forming barium hypophosphite and a gaseous product containing phosphorus.

Write a **balanced** chemical equation for this reaction.

Indicate the oxidation number of each phosphorus atom in the reactant and the products.

Based on these oxidation numbers, name the type of this reaction.

(iii) Nitrogen exists as N_2 molecules with a N ≡ N bond while phosphorus exists as P_4 molecules with P-P bonds.

Explain this using the following bond dissociation energies (kJ mol^{-1})

(N ≡ N 946 ; P ≡ P 490 . N - N 160 ; P - P 200)

10.0 marks

(b) A mixture contains $CaCO_3$, $MgCO_3$ and SiO_2 only. The molar ratio of $CaCO_3$. $MgCO_3$ = 1 . 1 .... 2.00 g of this mixture was heated strongly to a constant mass, the mass of the residue obtained 1.12 g. Calculate the mass percentage of each component in the mixture.

(Ca = 40. 0 ; Mg = 24 . 0; Si = 28 O : 0 = 16. O)

(5.0 marks)

The Periodic Table

1	1 H																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	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
5	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
6	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
7	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	....				

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

G.C.E. (A/L) Examination Chemistry - 2006

M.C.Q. Answers

(1)	3	(16)	4	(31)	1	(46)	5
(2)	2	(17)	5	(32)	5	(47)	1
(3)	5	(18)	4	(33)	2	(48)	4
(4)	3	(19)	2	(34)	3	(49)	5
(5)	3	(20)	1	(35)	2	(50)	5
(6)	1	(21)	3	(36)	4	(51)	4
(7)	5	(22)	1	(37)	5	(52)	5
(8)	1	(23)	5	(38)	4	(53)	1
(9)	5	(24)	(2/4)	(39)	5	(54)	3
(10)	5	(25)	5	(40)	3	(55)	5
(11)	4	(26)	(1/5)	(41)	3	(56)	5
(12)	4	(27)	3	(42)	1	(57)	5
(13)	4	(28)	3	(43)	5	(58)	3
(14)	3	(29)	3	(44)	1	(59)	3
(15)	2	(30)	4	(45)	4	(60)	3

PART A - STRUCTURED ESSAY

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

(01) (a) (i) Mg
(ii) K
(iii) Na_2CO_3
(iv) $Ba(OH)_2$
(v) Cl and Mn (5 x 6 = 30)

(b) Zinc or Zn (10)

(i) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$ (5)

(ii) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$ (5)

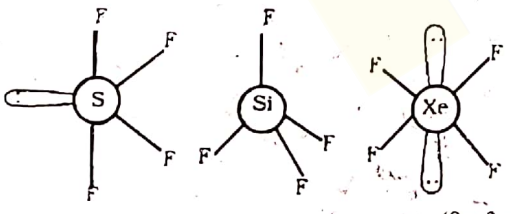
Galvanizing / cathodic protection/ batteries/ alloys (5)

(c) (i) $\overset{\ominus}{N} = \overset{\oplus}{N} - \overset{\ominus}{N} \leftrightarrow N \equiv \overset{\oplus}{N} - \overset{2-}{N} \leftrightarrow \overset{2-}{N} - \overset{\oplus}{N} \equiv N$ (7 x 3)

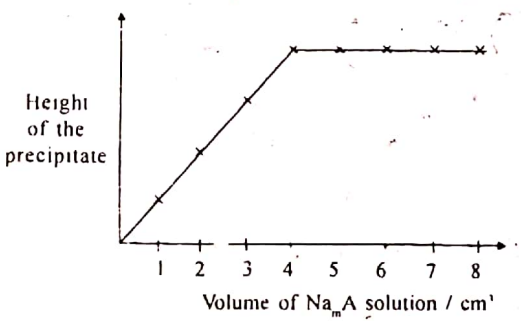
$\overset{\ominus}{N} = N \Rightarrow N$ and $N \equiv N \rightarrow \overset{\ominus}{N}$ also acceptable

Air bags/ detonators/ source of N_2/ toremove O_2 from analytical reagents/ synthesis of drugs/ pesticides (3)

(ii)



(8 x 3 = 24)



02. (a) (i) Moles of MCl_n used $= \frac{0.2}{1000} \times 9$ (5)

Maximum height reacted when volume of Na_mA $= 4.0\ cm^3$ (5)

$\therefore$ maximum number of moles of Na_mA used $= \frac{0.3}{1000} \times 4$ (5)

$\therefore$ Moles of MCl_n : moles of Na_mA $= \frac{0.2}{1000} \times 9 : \frac{0.3}{1000} \times 4$

$= 3 : 2$ (10)

(ii) 1. $Al(OH)_3$ gelatinous or precipitate does not settle. (10)

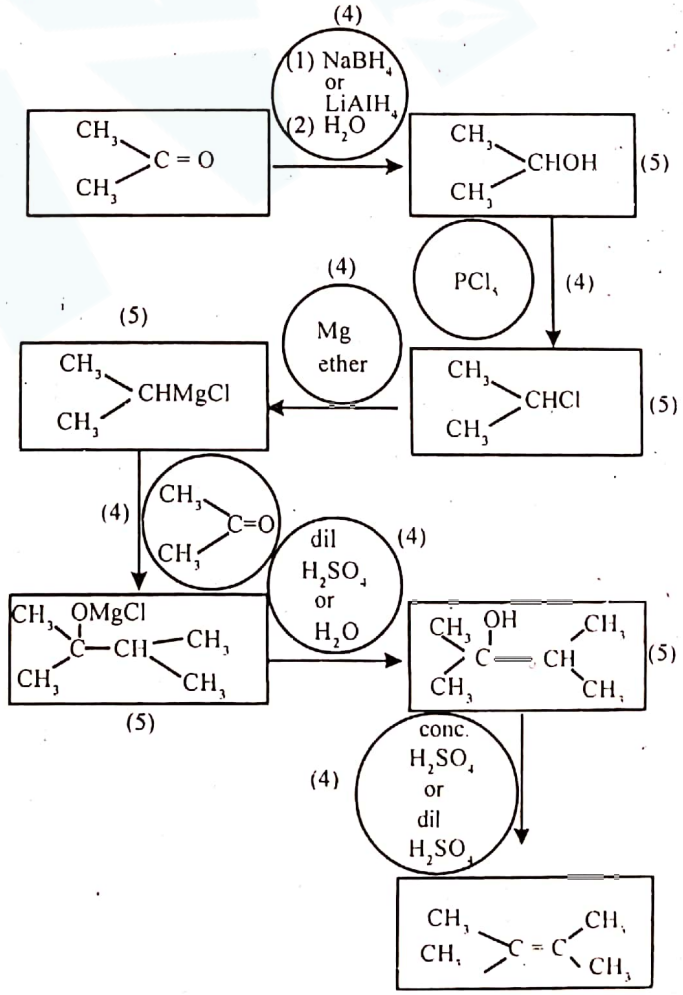
2. Difficult to prepare a standard solution of NH_4OH (10)

(a) (50) marks

(b) (i) increases, contact
(ii) slowly, activation energy, catalysts
(iii) equilibrium, equilibrium, equlibrium, sodium salt, right, yield
(iv) Contact, rate
(v) Concentration, Sodium Salt density

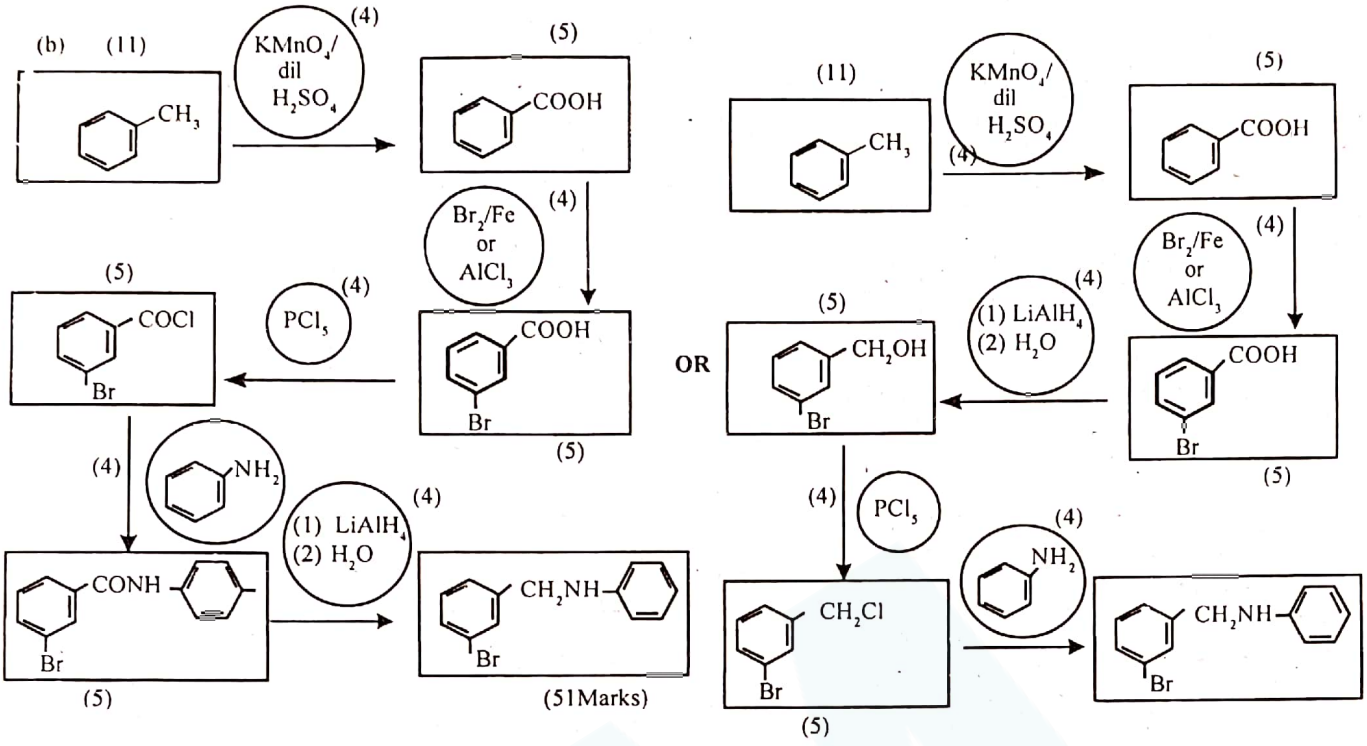
(3 x 16 = (48) +2)
(50 Marks)

03. (a)

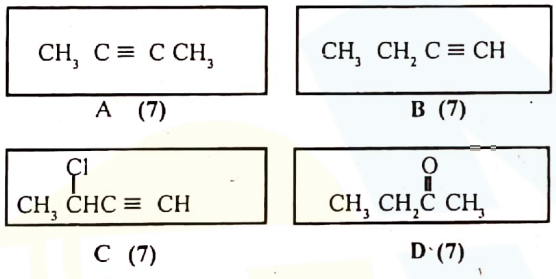


(a) = 49 marks

(b) (11)



04. (a) (i)



(ii) Y = $HgSO_4$ OR Hg^{2+} OR (5)
mercuric sulphate

(iii) For B, Cuprous chloride or Cu_2Cl_2 solution → Brick - red ppt OR
Ammonical $AgNO_3$ → white ppt or Light yellow ppt (2)

For A, No precipitate (2)

P Reaction	Q Major Organic Product	R Mechanism type	S Electrophile	T Nucleophile	U
$CH_3CH_2CH_2I \xrightarrow{aq\ NaOH}$	$CH_3CH_2CH_2OH$ (5)	S_N (2)	–	OH^- (2)	colourless (1)
$(CH_3)_2C=CH_2 \xrightarrow{dil\ H_2SO_4}$	$(CH_3)_3C-OH$ (5)	A_E (2)	H^+ OR H_3O^+ (2)	–	colourless (1)
$CH_3CH_2CH(CH_3)I \xrightarrow[KOH]{alcoholic}$	$CH_3CH=CHCH_3$ (5)	E (2)	–	–	colourless (1)
$C_6H_6 \xrightarrow[AlCl_3]{CH_3COCl}$	$C_6H_5COCH_3$ (5)	S_E (2)	$CH_3C^+=O$ (2)	–	colourless (1)
$C_6H_5CHO + (O_2N)(NO_2)C_6H_3NHNH_2 \rightarrow$	$(O_2N)(NO_2)C_6H_3NHN=CHC_6H_5$ (5)	AN OR AN + E (2)	–	$(O_2N)(NO_2)C_6H_3NHNH_2$ (2)	yellow/ orange (2)
$C_6H_4(CH_3)OH + C_6H_5N^+_2Cl^- \rightarrow$	$C_6H_5N=NC_6H_3(CH_3)OH$ (5)	S_E (2)	$C_6H_5N_2^+$ (2)	–	red/ orange yellow (2)

05. (a) (i) $C_2H_5OH(\ell) \rightarrow C_2H_5OH_{(aq)}$ (03) $\Delta H = 0$ (02)

(ii) $C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_{6(aq)}$ (03) $\Delta H = 0$ (02)

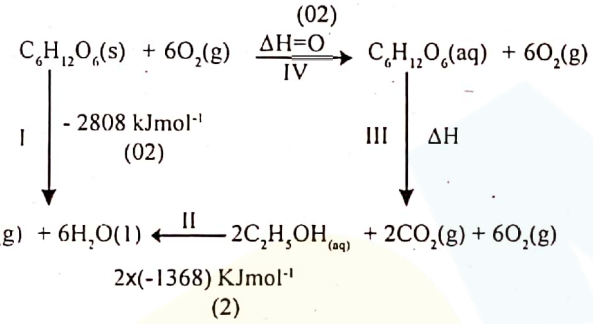
(iii) $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell)$ (03)
$\Delta H^0 = -2808$ KJ mol^{-1} (02)

(iv) $C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$ (03)
$\Delta H^0 = -1368$ KJ mol^{-1} (02)

(iii) -2 x IV + 2 x I - II gives;
$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$
$\Delta H^0 = -2808 - 2(-1368)$ kJmol^{-1} ; (04)
$= -72$ KJmol^{-1} (2 + 2)

Heat released by 2.5 mol = 2.5 mol x 72 kJmol^{-1}
= 180 kJ (2 + 2)

Alternative Calculation



Writing Equations I, II, III and IV (4 x 3 = 12)
ΔH = O for enthalpy of dissolution of $C_2H_5OH(\ell)$ (02)
ΔH = -2808 - 2 (-1368) KJmol^{-1} (04)
= -72KJmol^{-1} (2 + 2)
Heat released by 2.5 mol = 2.5 mol x 72kJmol^{-1}
= 180kJ (2+2)

05. (a) (ii) Ratio = 72 KJmol^{-1}/2808 KJmol^{-1} = 0.0256 (04)
(4)

Part (a) = 40 Marks

(b) (i) P = 10^5Pa, h = 3.0 m, A = 8.314×10^{-2}m^2, T = 300 K
pV = nRT
n = pV/RT (04)

$= \dfrac{(10^5\text{Pa} \times 3.0\text{ m} \times 8.314 \times 10^{-2}\text{m}^2)/}{(8.314\text{J mol}^{-1}\text{K}^{-1} \times 300\text{ K})}$ (2 + 2)

= 10 mol (04)

(ii) $2x(g) \rightleftharpoons Y(g) + Z(g)$

initially	10.0	-	-	mol
At equilibrium	10.0 - 6.0	3.0	3.0	mol

(04)

(A) Total number of moles is not changed ; p is constant

$V_1/T_1 = V_2/T_2 \Rightarrow Ah_1/T_1 = Ah_2/T_2 \Rightarrow h_1/T_1 = h_2/T_2$ (04)

$h_2 = 3.0$ m x 400 K/300 K = 4.0 m (2 + 2)

Alternative approach for part A

pV = nRT n = 10 mol (04)
10^5Pa x h x 8.314 x 10^{-2}m^2
= 10 mol x 8.314 J mol^{-1}K^{-1} x 400 K (2 + 2)
h = 4.0 m (2 + 2)

(B) P_x = (4.0/10.0) x 10^5 Pa
= 4 x 10^4Pa (2 + 2)
Py = (3.0 / 10.0) x 10^5 Pa
= 3.0 x 10^4 Pa (2 + 2)
Pz = (3.0/10.0) x 10^5Pa
= 3.0 x 10^4 Pa (2 + 2)

(C) Kp = Py.Pz/(Px)^2 (04)
= 3.0 x 10^4Pa x 3.0 x 10^4 Pa/(4.0 x 10^4 Pa)^2 (2 + 2)
= 9.0 / 16.0
= 0.56 (2 + 2)

(iii) Addition of the inert gas does not shift the above equilibrium (4)
Partial pressures do not change (2)
the values of Px, Py and Pz are the same as in 5 (b) section (B) (12)

OR

Px = 4.0 x 10^4Pa (2 + 2)
Py = 3.0 x 10^4 Pa (2 + 2)
Pz = 3.0 x 10^4 Pa (2 + 2)
Ps = 1.0 x 10^5 Pa (2 + 2)
New total pressure = 2.0 x 10^5Pa (1 + 1)

(iv) $P_1V_1 = P_2V_2 \Rightarrow P_1h_1A = P_2h_2A \Rightarrow h_2 = P_1h_1/p_2$ (4)
$h_2 = 2 \times 10^5$ Pa x 4.0 m / 1 x 10^5Pa = 8.0 m (2 + 2)

T is constant. $\therefore K_p$ does not change. (2 + 2)
Number of moles at equilibrium does not change (4)

Px = (4.0/20.0) x 1 x 10^5 Pa
= 2 x 10^4 Pa (2 + 2)

Py = (3.0/20.0) x 1 x 10^5 Pa
= 1.5 x 10^4 Pa (2 + 2)

Pz = (3.0 / 20.0) x 1 x 10^5 Pa
= 1.5 x 10^4 Pa (2 + 2)

Ps = (10.0/20.0) x 1 x 10^5 Pa
= 5.0 x 10^4Pa (2 + 2)

Alternative approach

Parameters of this system are similar to those in case (iii), except pressure. (4)
Pressure is halved Volume is doubled. (2)
Partial pressure is halved. (2)

Px = 2.0 x 10^4 Pa (2 + 2)
Py = 1.5 x 10^4 Pa (2 + 2)
Pz = 1.5 x 10^4 Pa (2 + 2)
Ps = 5 x 10^4 Pa (2 + 2)

(V) Assumption = Ideal gas behavior (2)

Total Marks for Part (b) = 110

06. (a) (i) Amount of I_2 in 15.00 cm^3 $CHCl_3$ solution
= 0.050 mol dm^{-3} x (15.00/1000) dm^3
= 0.00075 mol (4)

Amount of $S_2O_3^{2-}$ for titration
= 0.020 mol dm^{-3} x (24.00/1000) dm^3
0.00048 mol (4)

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$ (4)

Amount of I_2 in 5.00 cm^3 of
$CHCl_3$ layer = 0.00024 mol (4)

Concentration of I_2 in $CHCl_3$ layer = $\frac{0.00024 \text{ mol}}{0.005 \text{ dm}^3}$
= 0.048 mol dm^{-3} (2+2)

Amount of I_2 in 15.00 cm^3 of
$CHCl_3$ layer = 0.00072 mol (4)

Amount of I_2 in 100.00 cm^3 water = 0.00075 - 0.00072 mol
= 0.00003 mol (4)

Concentration of I_2 in aqueous layer = $\frac{0.00003 \text{ mol}}{0.100 \text{ dm}^3}$
= 0.0003 mol dm^{-3} (2 + 2)

(ii) partition coefficient = $\frac{[I_2]_{CHCl_3}}{[I_2]_{H_2O}}$ (4)
= $\frac{0.048 \text{ mol dm}^{-3}}{0.0003 \text{ mol dm}^{-3}}$
= 160 (2 + 2)

Total Marks for part (a) = (40)

(b) (i) Amount of $S_2O_3^{2-}$ for titration
= 0.020 mol dm^{-3} x (8.00 / 1000) dm^3
= 0.00016 mol (5)

Amount of I_2 in 5.00 cm^3 of
$CHCl_3$ layer = 0.00016/2 mol
= 0.00008 mol (5)

Concentration of I_2 in $CHCl_3$ layer = $\frac{0.00008 \text{ mol}}{0.005 \text{ dm}^3}$ (5)
= 0.016 mol dm^{-3} (3 + 2)

Concentration of I_2 in aqueous layer = $\frac{0.016 \text{ mol dm}^{-3}}{160}$ (5)
= 0.0001 mol dm^{-3} (3 + 2)

(ii) Amount of I_2 in aqueous layer
= 0.0001 mol dm^{-3} x 0.100 dm^3
= 0.00001 mol (5)

Amount of I_2 in 15.00 cm^3
of $CHCl_3$ layer = 0.00008 mol x 15.00 cm^3/5.00 cm^3 (5)
= 0.00024 mol (5)

Amount of I_2 reacted with I^- to give I_3^- =
= initial mol I_2 in $CHCl_3$ - mol I_2 in $CHCl_3$ at eqm - mol I_2 in aqueous at eqm (10)

OR

= 0.00075 mol [from part (a)] - 0.00024 mol - 0.00001 mol
= 0.0005 mol (5)

OR

No. of moles of I_2 reacted with I^- to give I_3^- = 0.0005

(iii) Amount of I^- = initial amount of I^- - amount of I^- reacted with I^- to give I_3^-
= 0.05 mol dm^{-3} x $\frac{100 \text{ dm}^3}{1000}$ - 0.0005 mol (5)
= 0.0045 mol (5)

Concentration of I^- = 0.0045 mol / 0.100 dm^3
= 0.045 mol dm^{-3} (3+2)

Concentration of I_3^- = 0.0005 mol/0.100 dm^{-3}
= 0.0050 mol dm^{-3} (3+2)

(iv) $K_{eq} = [I_3^-]_{(aq)} / [I_2]_{(aq)} [I^-]_{(aq)}$ (5)
No marks, if 'aq' is not given
= [0.0050 mol dm^{-3} / [0.0001 mol dm^{-3}] [0.045 mol dm^{-3}] (3+2)
= 1111 mol^{-1} dm^3 (3+2)

Total marks for Part b = 100

(c) Higher solubility of I_2 (or more I_2) in aqueous KI solution than in water (5)
Less lost as vaper (5)

Total marks for Part C = (10)

07. (a) Mass of Cu deposited = I x tx molar mass of Cu / 2 x F (4)
Mass of Cu deposited = (300 x 10^{-3} A) x (9.65 x 60 s) x 63.5 $gmol^{-1}$ /(96500 C mol^{-1} x 2)
substitution (0.5 + 0.5) x 4 (4)
= 0.057 g (2 + 2)

(A) Mass of the cathode = 10.0 g + 0.057 g (2)
= 10.057 g (2 + 2)

(B) Mass of the Anode = 10.0 g - 0.057 g (2)
= 9.943 g (2 + 2)

(C) Concentration of Cu^{2+} = 0.1 mol dm^{-3} (2 + 2)

(ii) Same amount of electricity is passed (4)
Change in the masses of electrodes is the same (2)

(A) Mass of the cathode = 10.057g + 0.057 g (2)
= 10.114 g (2)

(B) Mass of the Anode = 9.943 g - 0.057 g (2)
= 9.886 g (2)

(C) Concentration of Cu^{2+} = 0.05 mol dm^{-3} . (2)

(iii) Discharge of only Pb^{2+} is not possible (4)

Reason :- Cu is discharged before Pb or contamination of Pb (4)

Total Marks for Part (a) = (50)

(b) (i) $K_{sp}(BaSO_4) = [Ba^{2+}_{(aq)}][SO_4^{2-}{}_{(aq)}]$ (5)

Note : No marks if 'aq' is not mentioned.

$[Ba^{2+}]_{aq} \times 1.1 \times 10^{-7}$ mol $dm^{-3} = 1.1 \times 10^{-10}$ $mol^2 dm^{-6}$ (3+2)

$[Ba^{2+}]_{aq} = 1.0 \times 10^{-3}$ mol dm^{-3} (3+2)

(ii) Amount of Ba^{2+} in solution
= 1.0×10^{-3} mol $dm^{-3} \times 0.300$ dm^3
= 3.0×10^{-4} mol (5)

Initial Amount of Ba^{2+}
= 5.0×10^{-3} mol $dm^{-3} \times 0.200$ dm^3
= 1.0×10^{-3} mol (5)

No mol of Ba^{2+} precipitated
= $1.0 \times 10^{-3} - 3.0 \times 10^{-4}$ (5)
= 7.0×10^{-4} (5)

(iii) Let a = mol $BaSO_4$ in the precipitate

$3Ba(OH)_2(aq) + 2Na_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(s) + 6NaOH$ (5)

$Ba(OH)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaOH(aq)$ (5)

Molar mass of $BaSO_4$ = 137 + 32 + 4 x 16
= 233 g mol^{-1} (2)

Molar mass of $Ba_3(PO_4)_2$ = 3 x 137 + 2 [31 + 4 x 16]
= 601 g mol^{-1} (3)

No. of moles of $Ba_3(PO_4)_2$ in the precipitate
= (1/3) $(7.0 \times 10^{-4} - a)$ (5)

$233\ a + 1/3\ (7 \times 10^{-4} - a)\ 601 = 0.1435$ (5)

$233\ a + 0.1402 - 200\ a = 0.1435$

$33\ a = 3.3 \times 10^{-3}$ (5)

$a = 1.0 \times 10^{-4}$ (5)

No. of moles of $BaSO_4$ in the precipitate = 1.0×10^{-4}

No. of moles of $Ba_3(PO_4)_2$ in the precipitate
= $(7.0 \times 10^{-4} - 1 \times 10^{-4})/3$
= 2.0×10^{-4} (5)

(iv) Amount of SO_4^{2-} in the initial solution = 1.0×10^{-4} mol (5)

Concentration of SO_4^{2-} in the initial solution

$$= \frac{1.0 \times 10^{-4}\ \text{mol}}{0.100\ \text{dm}^3}$$ (3+2)

= 1×10^{-3} mol dm^{-3} (3+2)

Amount of PO_4^{3-} in the initial solution
= $2.0 \times 10^{-4} \times 2$ mol
= 4.0×10^{-4} mol (3)

Concentration of PO_4^{3-} in the initial solution

$$= \frac{4.0 \times 10^{-4}\ \text{mol}}{0.100\ \text{dm}^3}$$

= 4×10^{-3} mol dm^{-3} (3+2)

Assumption

All SO_4^{2-} and PO_4^{3-} in the solution have been precipitated

OR

Amounts of SO_4^{2-} and PO_4^{3-} remaining in the solution are negligible.

Part (b) = (100) Marks

08. (a) (i) 1 mol of the oxyanion of L reacts with 5 moles of M^{2+}
M^{2+} is converted to M^{3+}. This is a one electron change (5)

(OR $M^{2+} \rightarrow M^{3+} + e$)

L^{2+} is formed from the oxyanion of L.
This therefore involves a 5 electron change ( )
Therefore the oxidation state of L in the oxyanin is + 7 (10)

(ii) L is (Mn) / Manganese, M is Fe/ Iron (10 + 10)

(iii) MnO_4^- , (no marks for LO_4^-) (10)

(iv) C, CO or C only 10)
(CO only) 5)
High temperature (600 to 1600 °C) (5)

(v) Reaction of $Mn(OH)_2$ with O_2 OR

$4Mn(OH)_2 + O_2 \rightarrow 2Mn_2O_3 + 4H_2O$
OR
$2Mn(OH)_2 + O_2 \rightarrow 2MnO_2 + 2H_2O$
OR
$4\ Mn(OH)_2 + O_2 + 2H_2O \rightarrow 4Mn(OH)_4$ (10)

Total for 8 (a) = 75 marks

(b) (i) A - Cl_2 gas (Chlorine) B - H_2 gas (Hydrogen)
C - Anode D - Cathode
E - Diaphragm (4 x 5 20)

(ii) F - Brine/ Conc. NaCl Soln / Na^+Cl^- (5)
G - NaOH + NaCl Soln OR Na^+ Cl^- OH^- (5)

(iii) Anode : Carbon (graphite) or Ti (Titanium) 5)
Cathode : Steel or Iron (Fe) (5)

(iv) Anode material : should not react with Cl_2 (5)
Cathode material : should not react with NaOH 5)

(v) Role of diaphragm :
To prevent reaction between NaOH and Cl_2
To prevent reaction between H_2 and Cl_2
OR To prevent reaction between Fe (cathode) and Cl_2 5)

(vi) Solution level difference . To prevent NaOH (or solution G) from cathode compartment diffusing into the anode compartment (5)

(vii) Reasons for using brine .
(1) Higher concentration of NaCl (or Cl^-) makes the discharge of Cl^- ions C to produce Cl_2 easier

(2) Prevents the discharge of OH^- ions producing O_2
(3) Reduces the resistance of the electrolyte.

Any two points (5 x 2)

Total for 8 (b) - (75) marks

(09) (a) (i)

Test	Inference/s	
A	1. Absence of transition metal ions (Cu^{2+}, Ni^{2+}, etc)	(5)
	2. Absence of HCO_3^-, CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-} $S_2O_3^{2-}$	(1 x 5)
	3. Absence of Gp I cations	(5)
B	Presence of Sb^{3+} (antimony)	(5)
C.	Presence of Sb^{3+} (or Bi^{3+})	(5)
D.	Absence of NH_4^+	(5)
E.	Prensence of NO_3^- (or NO_2^-)	(5)

(ii) Salt X is Antimony nitrate [$Sb(NO_3)_3$] (10)

(iii) Brown ring test (addition of $FeSO_4$ and Conc. H_2SO_4)

Heating X with Conc. H_2SO_4 gives reddish brown fums of NO_2.

Heating X with Conc. H_2SO_4 and Cu turnings gives reddish brown fums of NO_2

Any test (5)

Total for 9 (a) - (50) marks

b (i) When solution B is titrated with $KMNO_4$, SO_3^{2-} is converted to SO_4^{2-}, and $C_2O_4^{2-}$ converted to CO_2

$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O$ (5)

$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e$ (5)

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e$ (5)

$SO_4^{2-} + Ba^{2+} \rightarrow BaSO_4$

Mass of $BaSO_4$ precipitate = 0.466 g

Amount of $BaSO_4$ in 25.0 cm^3 of solution B = $\frac{0.466}{233}$

= 0.002 mol

Amount of SO_4^{2-} in 25.0 cm^3 of solution B = 0.002 mol (5)

Concentration of SO_3^{2-} in Solution B = $0.002 \times \frac{1000}{25}$ mol dm^{-3}

= 0.08 $moldm^{-3}$ (5)

Amount of MnO_4^- in 40.0 cm^3 of solution = $0.05 \times \frac{40}{1000}$ mol

= 0.002 mol (5)

Amount of SO_4^{2-} in 25.0 cm^3 of solution B = 0.002 mol

Amount of SO_3^{2-} of Solution B = 0.002 mol

Amount of MnO_4 reacted with SO_3^{2-} in 25.0cm^3 of solution B = $0.002 \times \frac{2}{5}$ mol

= 0.0008 mol (5)

Amount of MnO_4^- reacted with $C_2O_4^{2-}$ in 25.0cm^3 of solution B = 0.002 - 0.0008 mol

= 0.0012 mol (5)

Amount of $C_2O_4^{2-}$ in 25.0cm^3 of solution B = $0.0012 \times \frac{5}{2}$ mol

= 0.003 mol (5)

The Concentration of $C_2O_4^{2-}$ of Solution B = $0.003 \times \frac{1000}{25}$ $moldm^{-3}$

= 0.12 mol dm^{-3} (05)

Total for 9 (b) (i) - 50 marks

(ii) React a known amount of the mixture with dil. H_2SO_4 (5)
Fe, Zn and Al dissolve, and the residue is Cu (5)
From this, the percentage of Cu can be calculated (5)
React a known amount of the mixture with dil. NaOH (5)
Zn and Al dissolve, and the residue is Fe and Cu. (5)
From these result the percentage of Fe can be calculated. (5)

Acidify the above NaOH solution with dil H_2SO_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated.
Percentage of Zn can be calculated from the difference. (5)

Total for 9 (b) (ii) - (50) marks

Alternative method 9 (b) (ii)

React a known amount of the mixture with dil. NaOH (5)
Zn and Al dissolve, and the residue is Fe and Cu. (5)
Dissolve the residue in dil H_2SO_4 (5)
Fe dissolves, and the residue is Cu (5)
From these results the percentages of Fe and Cu can be calculated. (10)

Acidify the above NaOH solution with dil H_2SO_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated.
Percentage of Zn can be calculated from the difference. (5)

Total for 9 (b) (ii) - 50 marks

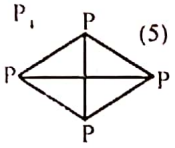
Alternative method 9 (b) (ii)

React a known amount of the mixture with dil. H_2SO_4 (5)
Fe, Zn and Al dissolve, and the residue is Cu. (5)
From this, the percentage of Cu can be calculated. (5)

Add excess dil NaOH to the above acidic solution (5)
Fe precipitates as $Fe(OH)_2$ (5)
Heat the precipitate to a constant mass to get Fe_2O_3 (5)
From this result, the percentage of Fe can be calculated. (5)
Acidify the above NaOH solution with dil H_2SO_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated
Percentage of Zn can be calculated from the difference. (5)

Total for 9 (b) (ii) - 50 marks

(10) (a) (i) P_4

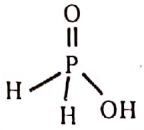


(5)

Phosphoric (I) acid (5)

(Hypophosphorous acid; phosphinic acid) (5)

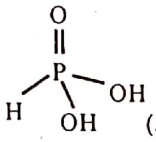
Oxidation state = +1 (5)



Phosphoric (III) acid (5)

(phosphorous acid; phosphinic acid)

Oxidation state = +3 (5)

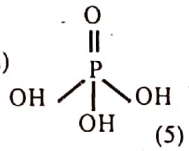


(5)

Phosphoric (V) acid (5)

(phosphoric acid; orthophosphoric acid)

Oxidation state = +5 (5)



(5)

$2P_4 + 3Ba(OH)_2 + 6H_2O \rightarrow 3Ba(H_2PO_2)_2 + 2PH_3$ (20)

Oxidation states : 0 ⟶ +1 -3 (1+2+2)

Disproportionation reaction (5)

(iii) Bond energy of one N ≡ N > Bond energy of three N-N bonds

($964\ KJ\ mol^{-1} > 3 \times 160\ KJ\ mol^{-1}$) (10)

Bond energy of three P-P bonds > Bond energy of one P ≡ P bonds

($3 \times 200\ KJ\ mol^{-1} > 490\ kJ\ mol^{-1}$) (10)

10 (a) - (100) Marks

(b) Mass of the mixture $CaCO_3$, $MgCO_3$, and SiO_2 = 2.00 g

Mass after heating = 1.12 g

Let the mass of $CaCO_3$ be x and mass of SiO_2 be y

$x + \frac{84x}{100} + y = 2.00$ g (for the mixture before heating) (10)

$1.84x + y = 2.00$ g ..... **(1)**

$\frac{56x}{100} + (84x/100) + (40/84) + y = 1.12$ g (after heating) (10)

$0.96x + y = 1.12$ g ..... **(2)**

(1) - (2) gives $0.88x = 0.88$ g

Mass of $CaCO_3$. x = 1.00 g (5)

Mass percentage of $CaCO_3$ $\frac{1.00}{2.00} \times 100 = 50\%$ (5)

Since the molar ratio of $CaCO_3$: $MgCO_3$ = 1:1

Mass of $MgCO_3$ = 1 x 84/100g = 0.84 g (5)

Mass percentage of $MgCO_3$ = $\frac{0.84}{2.00} \times 100 = 42\%$ (5)

Mass of SiO_2 = 2.00 - 1.84 = 0.16 g (5)

Mass percentage of SiO_2 = $\frac{0.16}{2.00} \times 100 = 8\%$ (5)

Total for 10 (b) - 50 Marks

Alternative calculation for 10 (b)

No. of moles of $CaCO_3$ = x

Mass of SiO_2 = y

For the mixture before heating :

$100x + 84x + y = 2.00$ g ..... **(1)** (5)

For the mixture after heating :

$56.x + 40.x + y = 1.12$ g ..... **(2)** (5)

(1) - (2)

$88x = 0.88$ g

$x = 0.01$ mol (5)

No. of moles of $CaCO_3$ = 0.01 (5)

No. of moles of $MgCO_3$ = 0.01 (5)

Mass of $CaCO_3$ = 100 x 0.01

= 1.00 g (5)

Mass of $MgCO_3$ = 84 x 0.01

= 0.84 g (5)

Mass percentage of $CaCO_3$ = $\left(\frac{1.00}{2.00}\right) \times 100 = 50\%$ (5)

Mass percentage of $MgCO_3$ = $\left(\frac{0.84}{2.00}\right) \times 100 = 42\%$ (5)

Mass percentage of SiO_2 = $\left(\frac{0.16}{2.00}\right) \times 100 = 8\%$ (5)

Total for 10 (b) - 50 Marks

Alternative calculation for 10 (b)

Mass of CO_2 avolved = 2.00 - 1.12 g (5)

= 0.88 g

No. of moles of CO_2 avolved = 0.88/44 = 0.02 (5)

Since the ratio of $CaCO_3$: $MgCO_3$ = 1 : 1 (5)

No. of moles of $CaCO_3$ = 0.01 (5)

No. of moles of $MgCO_3$ = 0.01 (5)

Mass of $CaCO_3$ = 100 x 0.01

= 1.00 g (5)

Mass of $MgCO_3$ = 84 x 0.01

= 0.84 g (5)

Mass percentage of $CaCO_3$ = $\left(\frac{1.00}{2.00}\right) \times 100 = 50\%$ (5)

Mass percentage of $MgCO_3$ = $\left(\frac{0.84}{2.00}\right) \times 100 = 42\%$ (5)

Mass percentage of SiO_2 = $\left(\frac{0.16}{2.00}\right) \times 100 = 8\%$ (5)

Total for 10 (b) - 50 Marks