G.C.E. (A/L) Examination
2010 August
Chemistry I / Two hours

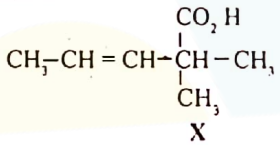
Instructions

* *This paper consists of 09 pages (Periodic Table is provided on page 10)*
* *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 periods in the periodic table that contain elements found in all three physical states (solid, liquid and gas) at room tempera ture and atmospheric pressure are,
(1) 2 and 4 (2) 3 and 4 (3) 3 and 6
(4) 4 and 5 (5) 4 and 6

2. The IUPAC name of the compound **X** is
(1) 1,2 -dimethylpent-3-enoic acid
(2) 3-methylhex-4-en-2-oic acid
(3) 4,5-dimethyl-2-hexenoic acid
(4) 2,3-dimethyl-4-hexenoic acid
(5) 4-methyl-2-hexenoic acid



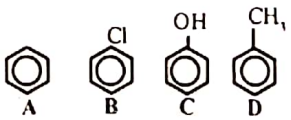
X

3 A certain salt dissolves in water and gives a coloured solution. When dil. NaOH is added to this solution, a pale green precipi tate is formed. When NH_4OH is added to this precipitate, it dissolves forming a blue solution. The cation present in the salt is,
(1) Co^{2+} (2) Ni^{2+} (3) Fe^{2+} (4) Fe^{3+} (5) Cr^{3+}

4. When 100 cm3 of a hydrocarbon was completely burnt in 600 cm^3 of oxygen, 300 cm^3 of carbon dioxide and 400 cm^3 of water vapour were formed. The oxygen remained unreacted after the combustion was 100 cm^3. All volumes were measured at the same temperature and pressure. The formula of the hydrocarbon is.
(1) C_2H_4 (2) C_2H_6 (3) C_3H_6 (4) C_3H_8 (5) C_4H_8

5. Identify the molecule or ion from those given below whose shape is distinctly different from that SO_3^{2-}
(1) ClO_3^- (2) PCl_3 (3) $SOCl_2$ (4) H_3O^+ (5) NO_3^-

6. The increasing order in the rate of reaction of the compounds **A,B,C** and **D** given, when taking part electrophilic substitution reactions is,
(1) **A< B< C<D**
(2) **B < D <A< C**
(3) **B < A <C< D**
(4) **B < A <D< C**
(5) **D < B <A< C**



A B C D

7. $CH_3CH_2CH_2CH_2OH$ (A) $CH_3CH_2CH_2OH$ (B) $CH_3CH_2CH_2CHO$ (C)
$CH_3CH_2CH_2CH_2Cl$ (D)

The increasing order of the solubility of the above compounds in water is,
(1) **C< D < A< B** (2) **D < C < A< B**
(3) **D < C < B< A** (4) **C< D < B < A**
(5) **A< D < C< B**

8. An aqueous solution of $Ca(NO_3)_2$ contains 20 mg of Ca^{2+} ions in 0.500 dm^3. The concentration of NO_3^- in the solution (in mol dm^{-3}) is, (Ca = 40)
(1) 5.0×10^{-4} (2) 1.0×10^{-3} (3) 2.0×10^{-3} (4) 4.0×10^{-3}
(5) 1.0×10^{-2}

9. Which molecule or ion from those given below has the highest dipole moment?
(1) O_3 (2) NH_3 (3) NO_2^- (4) $AlCl_3$
(5) ICl_4^-

10. The increasing order of boiling points of CO_2, SO_2, N_2, He and Ne is
(1) He< Ne < N_2< CO_2< SO_2
(2) He< Ne<CO_2 <N_2 <SO_2
(3) He< Ne< N_2< SO_2< CO_2
(4) Ne< He< N_2< CO_2< SO_2
(5) Ne< He< CO_2< SO_2< N_2

11. **A, B** and **C** are three metals. Under standard conditions, when **B** is placed in a solution of either A^{2+}(aq), C^{2+} (aq) is oxidized. However, when **C** is placed in a solution A^{2+} (aq), **C** is **not** oxidized.

$E^{\ominus}$ $(pb^{2+} / pb) = -0.13V$; $E^{\ominus}$ $(Zn^{2+}/Zn) = -0.76V$
$E^{\ominus}(Cu^{2+}/Cu) = +0.34V$

According to the standard reduction potentials given above, the metals **A, B** and **C** respectively are,
(1) pb, Zn and Cu (2) Zn, Cu and pb
(3) Zn, and Cu (4) pb, Cu and Zn
(5) Cu, Zn and pb

12. The compound $CH_3CH_2-\overset{\overset{O}{\|}}{C}-OCH_3$ was reacted with aqueous NaOH. The products in the flask at the end of the reaction are.
(1) $CH_3CH_2CO_2H + CH_3OH$
(2) $CH_3CH_2OH + CH_3CH_2CO_2^-\ Na^+$
(3) $CH_3CO_2^-Na^+ + CH_3O^-\ Na^+$
(4) $CH_3CH_2CO_2^-Na^+ + CH_3OH$
(5) $CH_3CH_2CO_2H + CH_3O^-\ Na^+$

13. Consider the enthalpy changes for the three reactions given below

$H_2(g) + O(g) \rightarrow H_2O(g)$; $\Delta H_1 = -a\ kJ\ mol^{-1}$
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$; $\Delta H_2 = -b\ kJ\ mol^{-1}$
$2H(g) + O(g) \rightarrow H_2O(g)$; $\Delta H_3 = -c\ kJ\ mol^{-1}$

The decreasing order of the numerical value of the enthalpy changes is,
(1) c > a> b (2) b > a > c (3) c > b> a
(4) b > c> a (5) a > b> c

14. When a mixture of 4.0g of sodium carbonate and sodium hydrogencarbonate was heated, the loss in mass was 0.31 g. The percentage of mass of sodium carbonate in the mixture is.
(H = 1, C = 12, O = 16, Na = 23)
(1) 95 (2) 90 (3) 83 (4) 79 (5) 63

15. The equilibrium constants at a particular temperature of the reactions,

$A(g) \rightleftharpoons 2B(g)$ and $B(g) \rightleftharpoons C(g) + D(g)$

are K_1 and K_2, respectively. The equilibrium constant of the reaction,

$A(g) \rightleftharpoons 2C(g) + 2D(g)$

at the same temperature is

(1) K_1+K_2 (2) $K_1 K_2$ (3) $K_1K^2_2$
(4) $2K_1K_2$ (5) $K_1 + 2K_2$

16. Which of thje following statements is not true regarding sub-atomic particles?
(1) Electrons show both wave properties and particle properties.
(2) Electrons in an atom are dispersed in 3-dimensional regions of space around the nucleus referred to as orbitals.
(3) The neutron was detected when beryllium was bombarded with high energy α particles (helium nuclei)
(4) The neutron is an uncharged particle with its mass approxi mately equal to that of the proton.
(5) The numbers of protons in isotopes of an element are differ ent from each other.

17. Consider the statements given below regarding 1- butyne.
(a) All carbon atoms of this molecule lie on the same straight line.
(b) It reacts with $NaNH_2$ and evolves H_2.
(c) It decolourizes bromine water.
(d) It reacts with Ag^+ and forms a silver mirror.

Which of the above statements is/are true?
(1) (a), (b) and (c) only. (2) (b), (c) and (d) only
(3) (c) and (d) only. (4) (c) only.
(5) (d) only.

18. Solubility product of Hg_2Cl_2 at 25°C is 1.2×10^{-18} mol^3 dm^{-9} The concentration Hg_2^{2+} ions (in mol dm^{-3}) in a 0.040 mol dm^{-3} aqueous NaCl solution saturated with Hg_2Cl_2 at 25°C is.
(1) 1.1×10^{-9} (2) 7.5×10^{-15} (3) 7.5×10^{-16}
(4) 3.0×10^{-17} (5) 3.6×10^{-20}

19 $\overset{a}{CH_3} - C \equiv C - \overset{b}{H}$ $\overset{c}{CH_3} - \overset{O}{\overset{\|}{C}} - H$

The increasing order of acidity of H atoms marked as **a**,**b** and **c** of the above two compounds is,
(1) **a < b < c** (2) **b < a < c** (3) **a < c < b**
(4) **c < a < b** (5) **c < b < a**

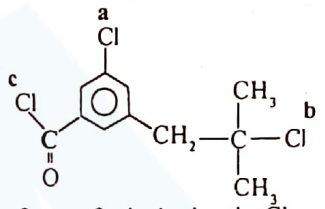
20. Which of the following statements is true regarding patterns shown in the s and p block elements in the periodic table?
(1) Atomic size decreases down a group.
(2) Atomic size increases across a period from left to right.
(3) Ionic radius decreases down a group.
(4) Metallic nature increases across a period form left to right.
(5) The basic nature of oxides and hydroxides decreases across a period from left to right.

21 A 0.331 g sample of $Pb(NO_3)_2$ contaminated with $NaNO_3$ was dissolved in 100.0 cm^3 of water Excess H_2S gas was then bubbled through this solution until the precipitation was com plete. The mass of the dried precipitate was 0.200 g. The per cent purity (w/w) of the sample is approximately.
(N=14, O=16, S=32, Pb=207)
(1) 16 (2) 47 (3) 68 (4) 79 (5) 84

22 The pH of a monobasic weak acid solution is 3.0. The pH of the same solution upon dilution of 100 times (at the same tempera ture) could be,
(1) 2.0 (2) 3.0 (3) 4.0 (4) 5.0 (5) 6.0

23. Which of the following statements is not true for a sample of an ideal gas according to the kinetic molecular theory of gases?
(1) The total energy of molecules does not change during colli sions at constant temperature.
(2) The root mean square velocity depends on the type of the gas.
(3) The mean kinetic energy of a gas molecule is proportional to the absolute temperature.
(4) The size of a gas molecule is considered as negligible com pared to the volume of the container.
(5) The mean kinetic energy of a gas molecule increases with increasing pressure at constant temperature.

24. Consider the following compound



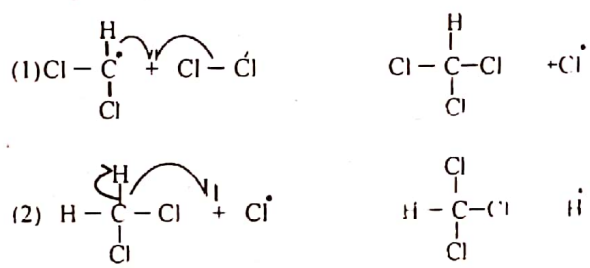
The order of ease of substituting the Cl atoms marked **a**,**b** and **c** in the above compound with OH by reacting the compound with hydroxyl ions is,
(1) **b>a>c** (2) **b>c>a** (3) **a>b>c** (4) **c>b>a** (5) **c>a>b**

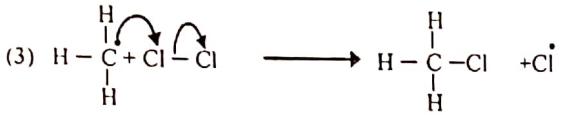
25. Which one of the following statements is true regarding the kinetics of chemical reactions?
(1) The unit of the rate of a reaction depends on the overall order of the reaction.
(2) A mathematical expression for the rate of any reaction can be written using the balanced overall chemical equation.
(3) Rates of all reactions increase with increasing temperature
(4) The overall rate of a multi-step reaction depends on the rates of all steps.
(5) The activation energy of a reaction changes when the initial concentrations of the reactants are changed

26. The correct chemical formula of pentaamminehydroxocobalt(III) nitrate is,
(1) $[Co(OH)(NH_3)_5]NO_3$ (2) $[Co(NH_3)_5(OH)(NO_3)]$
(3) $[Co(OH)(NH_3)_5](NO_3)_2$ (4) $[Co(NH_3)_4(OH)]_2(NO_3)$
(5) $[Co(OH)(NH_3)_5](NO_3)_3$

27. Which of the following statements is true regarding the element lithium?
(1) Lithium burns in air to form Li_2O and LiN_3.
(2) Lithium forms a solid hydrogen carbonate, $LiHCO_3$
(3) Among group I metals, lithium reacts less vigourously with water.
(4) Lithium carbonate is stable to heat.
(5) Lithium nitrate on heating gives O_2 as the only gas

28 Which of the following correctly represents a step in the mecha nism of the chlorination of methane.?



(3) 

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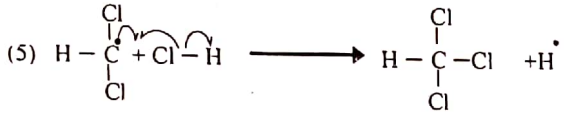
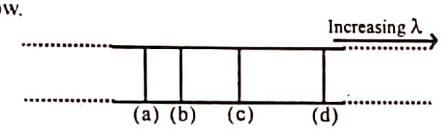
(5) 

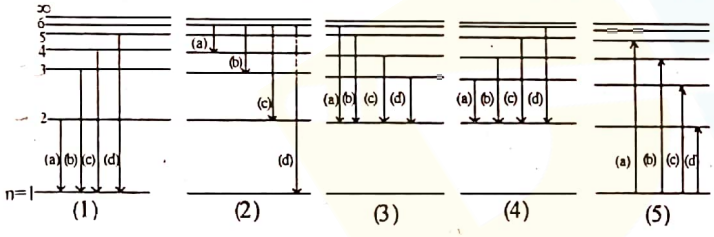
29. Consider the solubility product of $Fe(OH)_2$ in aqueous medium at constant temperature. If the pH of the solution is increased from 8.0 to 9.0. the solubility of $Fe(OH)_2$ is,

(1) unchanged (2) increased by a factor of 100
(3) decreased by a factor of 10 (4) decreased by a factor of 100
(5) decreased by a factor of 1000

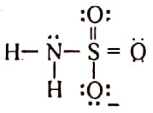
30. A part of the emission spectrum of atomic hydrogen is given below.



Which of the following diagrams represents the electronic transitions corresponding to the lines labelled as (a), (b), (c) and (d)?

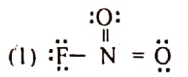
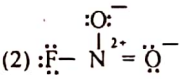


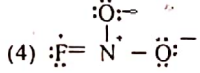
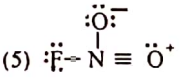
31. The oxidation numbers of nitrogen and sulphur atoms in the following ion are respectively.



(1) -3 and +2 (2) -3 and +6 (3) -3 and +4
(4) +3 and +4 (5) +3 and +6

32. The correct structural formula of NO_2F is

(1)  (2)  (3)

(4)  (5) 

33. 1.0 dm^3 of an aqueous solution of H_2O_2 was heated to complete dissociation. The volume of oxygen evolved was 8.0 dm^3 at S.T.P. The concentration of the H_2O_2 solution (in mol dm^{-3}) is. (Volume of 1 mole of O_2 at S.T.P. = 22. 4 dm^3)

(1) 0.31 (2) 0.35 (3) 0.62 (4) 0.71 (5) 3.2

34 The two volatile solvents **A** and **B** mix in all proportions forming ideal solutions. At a given temperature, the vapour pressures of pure solvents of **A** and **B** are P^0_A and P^0_B respectively, and at the same temperature, the mole fractions of **A** and **B** in solution are X_A and X_B, respectively. The partial pressures of **A** and **B** in the vapour phase at equilibrium with the solution are P_A and P_B respectively. Which one of the following mathematical expressions is correct for the above system?

(1) $\frac{P^0_A - P_A}{P^0_B} = X_B$ (2) $\frac{P^0_B - P_B}{P^0_B} = X_A$

(3) $\frac{P^0_A - P_A}{P_A} = X_B$ (4) $\frac{P^0_A - P_A}{P^0_A} = X_A$

(5) $\frac{P^0_B - P_B}{P^0_B} = 1 - X_A$

35. A salt containing only one type of an anion, gives a colourless gas when reacted with dil. HCl. This gas decolourizes a piece of filter paper dipped in acidified $KMnO_4$. Which one of the following could not be the anion?

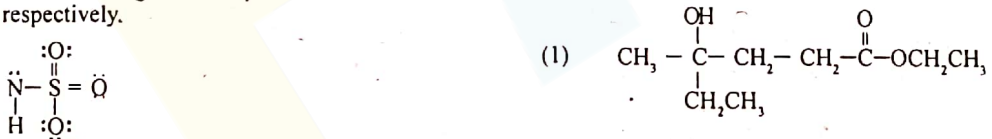
(1) SO_3^{2-} (2) SO_4^{2-} (3) HSO_3^- (4) S^{2-} (5) $S_2O_3^{2-}$

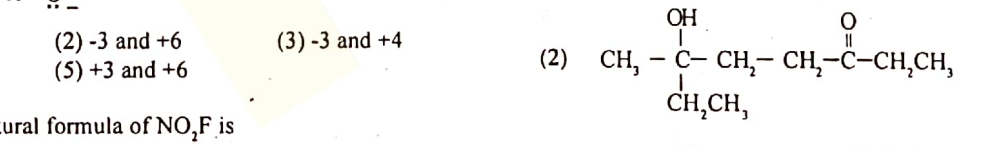
36. A well water sample was found to contain Ca^{2+}, NO_3^-, HCO_3^- and Cl^- ions. A 25.0 cm^3 portion of the water sample was titrated with 0.010 mol dm^{-3} H_2SO_4 using methyl orange as the indicator. The colour of the solution changed from yellow to pink when the burette reading was 5.00 cm^3. The temporary hardness of the well water expressed as $CaCO_3$ (mg dm^{-3}) is. (Ca = 40, O= 16, C = 12)

(1) 200 (2) 100 (3) 75 (4) 50 (5) 25

37. 

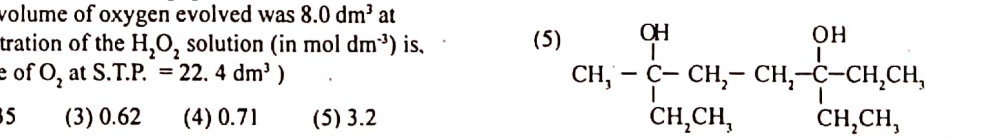
The structure of **X** in the reaction given above is.

(1) 

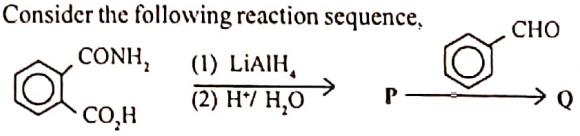
(2) 

(3)

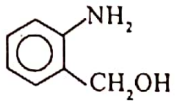
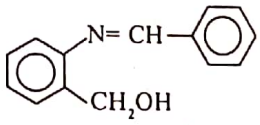
(4)

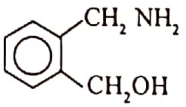
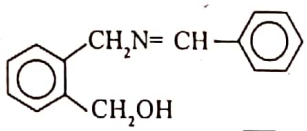
(5) 

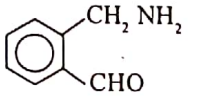
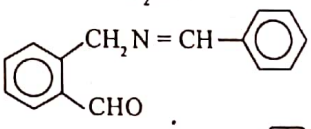
38. Consider the following reaction sequence,

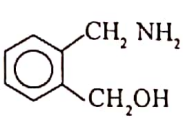
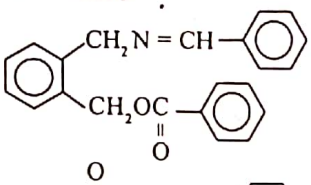


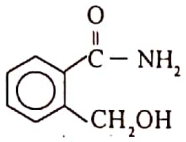
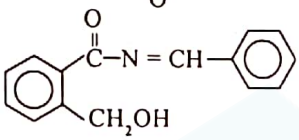
P and **Q** respectively are,

(1)  'and 

(2)  'and 

(3)  'and 

(4)  'and 

(5)  'and 

- Questions **39** and **40** are based on the following experiment

A series of solutions of different concentrations of a substance, **S**, was prepared in water. Each solution was then thoroughly shaken with chloroform and allowed to reach equilibrium. Substance **S** is more soluble in chloroform than in water, and it does not undergo any chemical reaction with water or chloroform.

39. For each of the above equilibria, the concentration of **S** in the organic phase (**Y** - axis) versus the concentration of **S** in the aqueous phase (**X** - axis)was plotted in order to investigate the distribution of **S** between two phases.
Which of the following statements is true regarding the above graph?
(1) The graph is not a straight line.
(2) The slope of the graph is temperature dependent.
(3) The slope of the graph increases with increasing the concentrations of **S** in the aqueous phase.
(4) The slope of the graph decreases when the volume of the aqueous layer is decreased.
(5) The graph does not go through the origin.

40. The partition coefficent of **S** between the two phases is **P** and P>1. In any of the above equilibria the volumes of aqueous and chloroform phases used are V_{aq} and V_{or} respectively, and the masses of **S** initially present (before equilibration) in aqueous phase and that remained after equilibration in aqueous phase are m and x respectively. Which one of the following expressions represents x correctly?

(1) $\frac{mPV_{or}V_{aq}}{PV_{or}+V_{aq}}$ (2) $\frac{mV_{aq}}{PV_{or}+V_{aq}}$ (3) $\frac{PV_{or}+V_{aq}}{mV_{aq}}$

(4) $\frac{V_{aq}}{PV_{or}+V_{aq}}$ (5) $\frac{mV_{or}}{PV_{or}+V_{aq}}$

- **Instructions for questions No. 41 to 50.**
For each of the questions **41** to **50**, four responses (a), (b), (c) and (d) are given; out of which, 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.

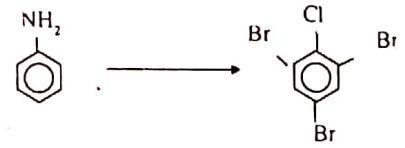
Summary of above Instructions

(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.

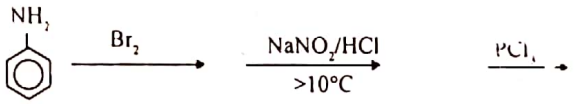
41. Which of the following statements regarding a catalyst is/are valid?
(a) It changes the enthalpy of a chemical reaction.
(b) It decreases the activation energy of a chemical reaction
(c) It is not consumed during a chemical reaction.
(d) It increases both the rates of forward and reverse reactions of a chemical reaction at equilibrium by the same factor

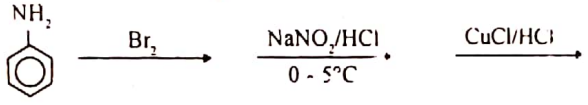
42. Which of the following statements is/are true regarding electronegativity of elements?
(a) Electronegativity is defined as the tendency of an atom to attract electrons to itself.
(b) Electronegativity values of the elements within a group increases in going down the group.
(c) Electronegativity of atoms with nearly filled outer most shell of electrons generally has higher values than those with sparsely filled outer most shell of electrons.
(d) The ionic character of a covalent bond increases when the difference between the Electronegativities of the two atoms forming the bond increases.

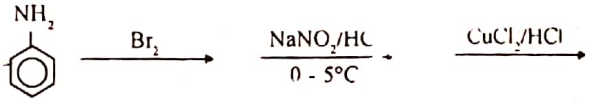
43 Which of the following statements is/are true regarding polymers?
(a) Phenol-formaldehyde is a thermosetting polymer.
(b) $CH_2=CH_2$ undergoes addition polymerization to form polyethylene (polythene).
(c) In natural rubber, there are two carbon-carbon double bonds in each repeating unit.
(d) Polystyrene decolourizes bromine water

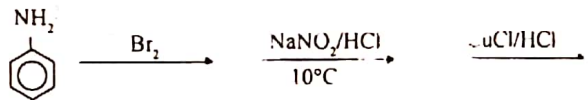
44 

The conversion gives above could be done by

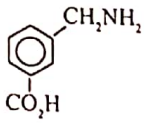
(a) 

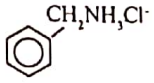
(b) 

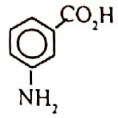
(c) 

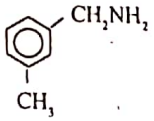
(d) 

45. Consider the following compounds

(a) 

(b) 

(c) 

(d) 

What compounds show all of the following observations?

(i) Liberates CO_2 with Na_2CO_3 solution.

(ii) Liberates a gas with $NaNO_2$ and dil. HCl at 25°C.

(iii) Gives a green coloured solution, when the solution from test (ii) above is warmed with a small amount of $K_2Cr_2O_7$.

46. Corrosion of an underground iron pipeline can be prevented by welding a metal **M** to the pipeline. Which of the following state ments is/are true regarding this process?

(a) The metal **M** can be Mg.

(b) The metal **M** undergoes oxidation.

(c) The matal **M** can be Cu.

(d) An anodic reaction can occur on the surface of the pipeline.

47 At 300 **K**, a closed, rigid vessel contains equal masses of He and Ne gases. Which of the following statements is/are true regarding this system? (He = 4, Ne = 20)

(a) $\frac{\text{Number of moles of He}}{\text{Number of moles of Ne}} = 5$

(b) The partial pressures of the two gases are equal.

(c) $\frac{\text{Density of He}}{\text{Density of Ne}} = \frac{\text{atomic mass of He}}{\text{atomic mass of Ne}}$

(d) $\frac{\text{Mean kinetic energy of a He atom}}{\text{Mean kinetic energy of a Ne atom}} = \frac{\text{atomic mass of He}}{\text{atomic mass of Ne}}$

48 Which of the following statements is/are correct relevant to the extraction of essential oils by steam distillation?

(a) The essential oil must be completely miscible with water.

(b) The essential oil should have a boiling point lower than that of water.

(c) The essential oil must be immiscible in water.

(d) The mixture will boil at a temperature lower than 100°C at atmospheric pressure.

49. Which of the following statements is/are correct regarding $FeSO_4.7H_2O$?

(a) It is used as a primary standard in volumetric analysis.

(b) Cystals of $FeSO_4.7H_2O$ turns brown on exposure to air.

(c) It gives a blus precipitate with $K_3[Fe(CN)_6]$

(d) Its aqueous solution reacts with **KI** to give iodine.

50 Which of the following statements is/are true regarding positive rays which have been detected during experiments with dis charge tubes in determining atomic structure?

(a) They are found toghether with cathode rays and responsible for the glow observed in the region behind a perforated cathode.

(b) They are formed by loss of electrons from atoms or molecules.

(c) They consist of particles whose mass is independent of the residual gas.

(d) They are not affected by electric and magnetic fields.

Instruction 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 and mark appropriately 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

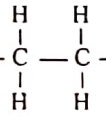
	First Statement	Second Statement
51	Diamond is an allotrope of carbon which does not conduct electricity.	Diamond has a giant structure where each carbon atom is covalently bonded to four other carbon atoms.
52	Addition of a few drops of H_2SO_4 increases the electrical conductance of water.	Benzene has six π electrons which due to cyclic conjugation gives benzene a high stability.
53	The first ionization energy of oxygen is lower than that of nitrogen.	Less energy required to form $O^{2-}(g)$ from O(g) than N^{3-} (g) from N(g).
54	The equilibrium constant, Kp of the reaction $2A(l) + 3B(g) \rightleftharpoons C(s) + 2D(g)$ is directly proportional to the concentration of **D**.	At constant temperature and volume the pressure of an ideal gas is directly proportional to its concentration.
55	The standard enthalpy of formation of any compound is equal to the standard enthalpy of combustion of that compound.	The standard enthalpy of formation of any element at its most stable state is zero.
56	HF(aq) is a stronger acid than other hydrogen halides.	The H-F bond is weaker than the other hydrogen halogen bonds.
57	Boiling point of butane is higher than that of acetone.	Only σ bonds are present in butane while σ bonds and one π bond are present in acetone.
58	A solution of $Na_2S_2O_3.5H_2O$ may be standardized using KIO_3 in the presence of dil. H_2SO_4 and excess KI.	KIO_3 reacts with KI in the presence of dil. H_2SO_4 to liberate iodine.
59	$Ca(OCl)_2$ is an oxidizing agent present as a constituent in bleaching powder and is used as a disinfectant.	All bleaching agents possess oxidizing properties
60	When NaCl is heated with conc. H_2SO_4 in the presence of MnO_2, Cl_2 is produced.	MnO_2 is a stronger oxidizing agent than conc H_2SO_4

G.C.E. (A/L) Examination
2010 August
Chemistry II / Three hours

- Periodic Table is provided on page 13.
- Use of calculators is not allowed.

PART A - Structured Essay (Pages 2-7)

- Answer **all** the questions on this paper itself.
- Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive answers are not expected.
- **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 8-13)

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.

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

PART A - STRUCTURED ESSAY

Answer **all four** questions on this paper itself. Each question carries **10 marks.**

1 (a) The following questions are based on the first 18 elements in the periodic table.

(i) Identify the **two** elements that form the bond with the highest ionic character. ..... and .....

(ii) Identify the element that forms the most stable diatomic molecule. .....

(iii) Identify the element that has the highest first ionization energy. .....

(iv) Identify two elements that form electron-deficient com pounds. ..... and .....

(v) Identify the element that has the highest melting point .....

(vi) Identify the gaseous element that can be used as a fuel

(vii) There are seven consecutive elements where the maxi mum oxidation number of each element increases by one, when moving sequentially from the first to the seventh elements. Identify the first and the seventh elements in this sequence of elements.

First ..... **Seventh** .....

(viii) Identify one metallic element that is responsible for hardness in water .....

(3.3 marks)

(b) **X** and **Y** are two elements in the same period of the periodic table where the atomic number of **X** is less than the atomic number of **Y**. The chlorides that are formed by **X** and **Y** with the maximum number of chlorine atoms are XCl_3 and YCl_3.

(i) Write the chemical symbols of **X** and **Y**.

X = ... **Y** = ...

(ii) Name the shapes of XCl_3 and YCl_3 molecules.

XCl_3 : ..... YCl_3 : .....

(iii) XCl_3 reacts with YH_3 forming the compound **Z**. Draw the structure of **Z** in the box given below showing all the bonds.

(iv) Name the shapes (spatial arrangement of bonds) around **X** and **Y** in the molecule **Z**.

X : ..... **Y** : .....

(3.5 marks)

(c) Write the type of bond if any, and the type of intermolecular force if any (from those given in the table), present in each of the substances indicated in the table below.

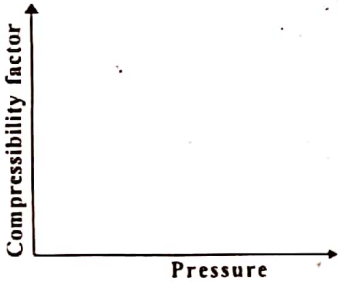
	Substance	Type of bond (ionic, polar covalent, nonpolar covalent)	Type of bintermolecular force (dipole-dipole, hydrogen bonding, London forces)
(i)	Iodine (solid)		
(ii)	Carbon tetracholoride (liquid)		
(iii)	Argon (liquid)		
(iv)	Sodium hydride (solid)		
(v)	Sulphur dioxide (gas)		

(3.5 marks)

2. (a) An alloy contains elements Mg and Al. The minimum volume of 3.60 mol dm^{-3} HCl that is required to completely dissolve a sample of the alloy of mass 0.396 g is 10.0 cm^3. Calculate the mass percentage of Mg in the alloy. (Mg = 24, Al = 27)

(4.0 marks)

(b) (i) I Sketch below, the variation of the compressibility factor with pressure for an ideal gas. Indicate on the same diagram, the expected variation for a real gas



II. State two reasons for the difference in the sketches you drew for the two types of gases.

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(ii) At 300 K and at 3.0×10^5 Nm^{-2}, gas **A** exists in a vessel with a volume of 2.0 m^3. At 300 K and at 5.0×10^5 Nm^{-2}, gas **B** exists in a vessel with a volume of 3.0 m^3. The vessels are connected allowing the two gases to mix completely. During the mixing, no chemical reactions occur. Further, the temperature and the total volume of the two gases remain unchanged. Assuming the ideal gas behaviour, Calculate the following :

I. the total pressure in the connected vessels.

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II. the mole fraction of gas **B** in the mixture.

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III. the partial pressure of gas **B** in the connected vessels when the temperature of the gas mixture is increased to 350 K maintaining the total volume of the two vessels the same.

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(6.0 marks)

3 (a) (i) Draw the structure of 2-methylpropene

(ii) Draw in the boxes **P** and **Q** respectively, the structures of the major product and the minor product formed when HBr is added to 2-methylpropene

P:Major product

Q: Minor product

(iii) Propose a mechanism for the addition of HBr to 2-methylpropene, explaining why the structure drawn in box **P** is the major product. [***Hint** : In answering this, part utilize your knowledge of the mechanism of addition of HBr to praopene, and the stability of carbocations.]*

(3.5 marks)

(b) Compound **A** (molecular formula, $C_6H_{14}O$). exhibits optical isomerism. It reacts with acidic $K_2Cr_2O_7$ at room temperature and gives a carboxylic acid.

(i) Draw possible structures for **A** in the boxes given below

(ii) Compound **A** when heated with conc. H_2SO_4 gives com pound **B** (molecular formula, C_6H_{12}).

Compound **B** also exhibits optical isomerism. Draw the structures of **A** and **B** in the relevant boxes.

A **B**

(iii) When **B** is reacted with HBr,compound **C** is obtained as the major product. Compound **C** when reacted with alcoholic KOH gives compounds **D** and **E**. Compounds **D** and **E** are structural isomers of **B**. Draw the structures of **C**, **D** and **E** in the boxes given below.

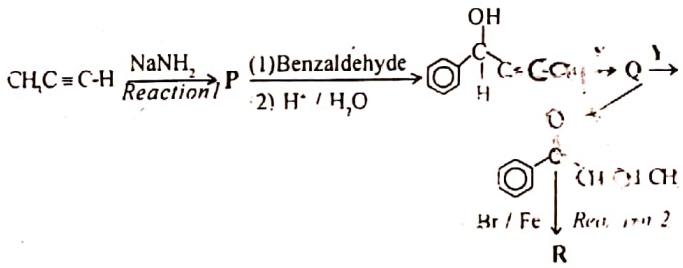
C **D** **E**

(iv) Both compounds **D** and **E** when reacted separately with dil. H_2SO_4 give the same compound **F**. Compound **F** is a structural isomer of **A**. Draw the structure of **F** in the box given below.

F

(6.5 marks)

4 (a) Consider the reaction scheme given below



(i) Draw the structures of compounds **P, Q** and **R** in the boxes given below.

P	Q	R

(ii) Write the reagents. **X** and **Y** in the boxes given below.

X	Y

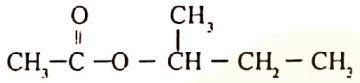
(iii) Classify the reactions labelled as *Reaction 1* and *Reaction 2*, as nucleophilic substitution (S_N), electrophilic substitution (S_E), nucleophilic addition (A_N), electrophilic addition (A_E), or acid-base reaction (A_B).

Reaction 1		*Reaction 2*	

(iv) Recalling the reaction of alkylhalides with KCN, write the structure of the product obtained when compound **P** reacts with CH_3Br.

(2.5 marks)

(b) Using only the chemicals and reagents given in the list propose a synthesis of the following compound.

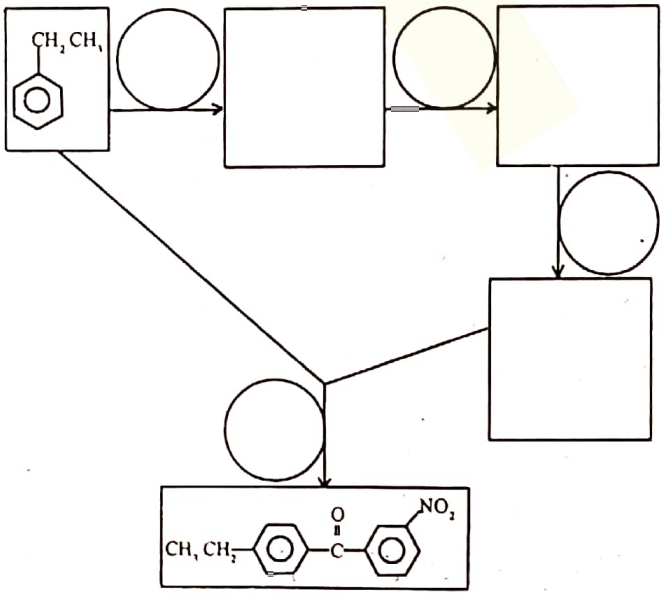


List of chemicals and reagents :

CH_3CHO, PBr_3, Mg, ether, dil H_2SO_4, $NaBH_4$, $K_2Cr_2O_7$, conc.H_2SO_4

(4.7 marks)

(c) Complete the following reaction scheme, by writing the structures of compounds in the boxes and the reagents in circles.



(4.7 marks)

PART B - ESSAY

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

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

5. (a) Calculate the enthalpy change for the reaction.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

at 25°C , using the thermochemical data given below At 25°C,

Bond dissociation enthalpy of $O_2(g)$	=	498 kJ mol^{-1}
First electron affinity of O(g)	=	-149 kJ mol^{-1}
Second electron affinity of O(g)	=	798 kJ mol^{-1}
Enthalpy of sublimation of Mg (s)	=	148 kJ mol^{-1}
First ionization energy of Mg(g)	=	738 kJ mol^{-1}
Second ionization energy of Mg(g)	=	1451 kJ mol^{-1}
Lattice energy of MgO(s)	=	-3791 kJ mol^{-1}

(6.0 marks)

(b) The following equilibrium exists between **A**(g) and **B**(g) at temperatures above 300°C.

$$A(g) \rightleftharpoons 2B(g)$$

Both **A**(g) and **B**(g) behave ideally.

(i) 0.45 mol of **A**(g) were initially placed in a rigid, closed vessel of volume 4.157 dm^3. The vessel was then heated to 327°C to achieve the above equilibrium. The total pressure of the contents of the vessel was then found to be $9.00 \times 10^5\ Nm^{-2}$.

Calculate the following .

I. the total number of moles of the two gases **A**(g) and **B**(g) at equilibrium

II. the number of moles of each gas **A**(g) and **B**(g) at equilibrium.

III. the equilibrium constants K_p and K_c for the above equilibrium.

(ii) Then 0.30 mol of **B**(g) were added to the vessel and the system was allowed to reach equilibrium at the same temperature. The amount of **A**(g) after equilibrium is reached, is x mol more than the amount of **A**(g) that was present in the vessel before the addition of **B**(g). Derive a mathematical expression for the new partial pressure, P_A of **A**(g) in the vessel in terms of x. (This expression should not contain symbols other than x.)

(9.0 marks)

6. (a) Consider the raction, **X**(aq) + **Y**(aq) → **Z**(aq). Kinetic data obtained for different initial concentrations of **X**(aq) and **Y**(aq) in the reaction mixture are given in the table below.

Experiment number	Temperature / °C	Initial concentration/ mol dm^{-3}			Initial rate mol dm^{-3} s^{-1}
		X(aq)	Y(aq)	D(aq)	
1	30	1.0	0.50	-	0.0020
2	30	0.50	0.50	-	0.0010
3	30	0.50	1.0	-	0.0040
4	30	0.50	1.0	0.50	0.020
5	30	0.50	1.0	1.0	0.020
6	50	0.50	1.0	-	0.016

Experiments number 4 and 5 were conducted in the presence of substance **D**.

(i) Write a mathematical expression for the rate of the above reaction in terms of the concentrations of X(aq) and Y(aq)

(ii) Calculate the order of the above reaction with respect with respect to each reactant X(aq) and Y(aq) at 30 °C.

(iii) Calculate the initial rate of the above reaction at 30 °C, when the initial concentration of X(aq) is 0.50 mol dm^{-3} and the initial concentration of Y(aq) is 2.0 mol dm^{-3}.

(iv) What is the role of D(aq) in the reaction,

$X(aq) + Y(aq) \rightarrow Z(aq)$?

(v) Sketch the energy versus reaction coordinate curve for the rate determining step of the reaction in the absence of D. On the same diagram, sketch the curve for the reaction that occurs in the presence of D. Label the axes and both curves clearly in your diagram.

(vi) How would you explain the result of the initial rate of experiment number 6 in comparison with that of the initial rate of experiment number 3 ?

(6.0 marks)

(b) (i) Consider the solutions P,Q.R and S given below, that have been prepared at 25°C.

P : 100.0 cm3 of 0.056 mol dm^{-3} CH_3COOH.

Q : Mixture of 50.0 cm^3 of 0.056 mol dm^{-3} CH_3COOH and 50.0 cm^3 of 0.200 mol dm^{-3} HCl

R: Mixture of 50.0 cm^3 of 0.020 mol dm^{-3} HCl and 50.0 cm^3 of 0.022 mol dm^{-3} NaOH

S : 100.0 cm^3 of 0.056 mol dm^{-3} NaOH.

The dissociation constant, K_a of CH_3COOH and the ionic product of water, K_w at 25 °C are 1.8×10^{-5} mol dm^{-3} and 1.0×10^{-14} mol^2dm^{-6}, respectively.

I. Calculate the pH of solution P, solution Q and solu tion R.

Stare assumptions, if any, you used in each of the calculations.

II. Indicate how you could prepare a buffer solution by using two of the solutions from among P, Q, R and S.

(ii) I. You are provided with a very dilute aqueous solution of an acid-base colour indicator. Very dilute aqueous solutions of HCl and NaOH together with facilities to measure pH of a solution are also provided. Briefly describe how you would determine the colour changing pH range of this indicator.

II. Figures 1 and 2 show pH - titration curves for titra tions of two acid/base pairs. A list of indicators with their colour changing pH rangges is provided in the table below. Select from the table, one suitable indicator each to be used in each of the titrations shown in Figres 1 and 2

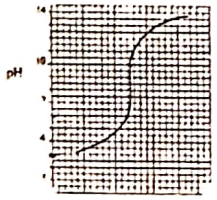


Figure 1

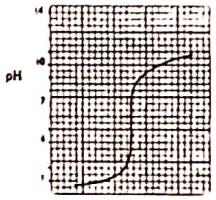


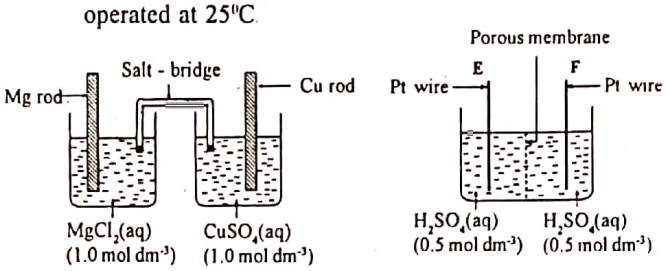
Figure 2

Table : Indicators and their pH ranges

Indicator	Colour changing pH
K	1.5 - 3.4
L	4.8 - 6.4
M	6.0 - 7.8
N	8.3 - 9.8
U	9.0 - 11.0

(9.0 marks)

7. (a) Consider the following two electrochemical cells. Which are operated at 25°C



Cell A Cell B

At 25 °C $E^{\theta}_{Mg^{2+}(aq)/Mg(s)} = -2.37$ V

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

Questions (i) to (iii) relate to electrochemical cell A

(i) Calculate the electromotive force (e.m.f.) of the cell.

(ii) State whether teh cell e.m.f. would change, if a 1.0 mol dm^{-3} $MgSO_4$ solution was used instead of 1.0 mol dm^{-3} $MgCl_2$ solution in the cell. Explain your answer, briefly.

(iii) What is the function of the salt bridge?
Give an example of a compound that can be used to prepare the salt-bridge.

Questions (iv) and (v) relate to the electrochemical cell A in which the two electrodes are connected by a Cu wire.

(iv) State which electrode would function as the cathode.

(v) Write balanced equations for the following.
I. Cathodic reaction
II. anodic reaction
III. overall cell reaction

Questions (vi) to (viii) relate to the cell arrangement where the Cu rod and the Mg rod in cell A are connected respectively to electrode E and electrode F in cell B, using Cu wires.

(vi) Which electrode would behave as the cathode in cell B?

(vii) Write balanced equations for the reactions taking place at the following electrodes.
I. electrode E
II. electrode F

(viii) If the current circulating in the cell arrangement remains constant, state the change you would expect in the amount of product formed at electrode F in a given time interval, when
I. the areas of both electrodes E and F are increased.
II. the concentration of H_2SO_4 in cell B is increased.

(7.5 marks)

(b) At 25 °C, an aqueous solution of $AgNO_3$ of concentration 0.050 mol dm^{-3} was slowly added to a 100.0 cm^3 aqueous solution that contained Cl^- at a concentration of 0.0020 mol dm^{-3} and Br^- at a concentration of 0.0010 mol dm^{-3}

(i) Calculate the minimum concentration of Ag^+ ions required in solution to initiate the precipitation of AgBr.

(ii) Calculate the maximum concentration of Br^- ions that could remain in the solution when AgCl begins to precipitate

(iii) State assumptions, if any, you used in the above calculations.

(iv) In qualitative analysis, once Cl^- ions are precipitated as AgCl, its solubility is tested using aqueous ammonia. Briefly explain the chemistry behind this process using suitable chemical equations.

At this temperature,

solubility product of AgCl = 1.7×10^{-10} $mol^2 dm^{-6}$
solubility product of AgBr = 5.0×10^{-13} $mol^2 dm^{-6}$

(7.5 marks)

PART C - ESSAY

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

8. (a) The following questions are based on the oxides of nitrogen.

(i) Write the chemical formulae and common names of **five** oxides of nitrogen where the oxidation numbers of nitrogen are different from one another.
Give the oxidation number of nitrogen in each oxide you identified.
Indicate whether each oxide is acidic, basic or neutral.

(ii) Indicate how any three of the oxides listed in (i) above can be prepared in the laboratory.

(iii) Draw the resonance structures of the oxide of nitrogen where the oxidation number of nitrogen is +1.

(iv) Give **two** oxides of nitrogen which have unpaired electrons at room temperature and atmospheric pressure. State the chemical change that would take place when these oxides are cooled.

(6.0 marks)

(b) The 3d block element M forms a compound A, which has the formula $2MXO_3.M(OH)_2$. Here, the element **X** belongs to the p block. The compound A reacts with conc. HCl to give a colourless, odourless gas **B** and a yellow coloured solution **C**. When **A** reacts with dil. Hcl, it gives the same (colourless, odourless) gas **B** and a green coloured solution **D** containing two complex ions of **M**. When solution **D** is diluted with water, a light blue coloured solution E is formed. When a small amount of NH_4OH is added to **E**, a blue coloured gelatinous precipitate **F** is formed. **F** dissolves in excess NH_4OH to give a dark blue coloured solution **G**. When solution **E** is treated with excess **KI**, the precipitate **MI** and iodine are formed as the only products.

(i) Identify the elements **M** and **X**.

(ii) Give the electronic configuration of **M**.

(iii) Give the common oxidation numbers of **M**.

(iv) Write the formulae of the ionic species responsible for the colours of the following solutions and give their IUPAC names.

I. solution **C**
II. solution **D**
III. solution **E**
IV. solution **G**

(v) Identify the gas **B** and the precipitate **F**.

(vi) Give the balanced chemical equation for the reaction of solution **E** with excess **KI**.

(vii) Using the reaction of **E** with **KI**, state the steps involved in the experimental determination of the mass percentage of **M** in a sample of **A** provided.

Indicate how you would calculate the mass percentage of **M** from your experimental data.

(viii) Write separate balanced chemical equations for the reactions of **M** and **X** with hot conc. H_2SO_4.

(ix) When common salts of **M** are heated with certain easily oxidizable compounds under **basic** conditions, M_2O is precipitated. Write a balanced **half reaction** for this process and give **one** important use of this reaction.

(x) Give **two** important commercial uses of **M**.

(9.0 marks)

9. (a) The colourless aqueous solution **P** contains **three** metal ions as their nitrates. The tests performed with solution **P** together with their observations are given below.

Test	Observation
(1) Excess NH_4OH was added to solution **P.**	A white precipitate (soluble in dil. **NaOH**) was formed.
(2) The filtrate from test (1) was acidified with dil **HCl.**	A white precipitate (insoluble in dil. HNO_3) was formed.
(3) NH_4OH was addeddropwise to the filtrate from test (2).	A white precipitate was formed which dissolved on further addition of NH_4OH.

(i) Identify the metal ions in solution **P.**

(ii) Identify the white precipitates formed in tests (1), (2) and (3).

(iii) Give the observations that are expected when the precipitates of tests (1) and (3) are subjected to charcoal block test in the presence of cobalt nitrate.

(iv) Give the balanced chemical equation for the reaction of the white precipitate formed in test (1) with dil. NaOH

(b) An aqueous solution **Q** contains **two** anions as their sodium salts. The tests performed with solution **Q** together with their observations are given below.

Test	Observation
(4) A solution of $BaCl_2$ was added to solution **Q.**	A white precipitate (soluble in dil. HNO_3) was formed.
(5) Acidified $KMnO_4$ was added to solution **Q.**	$KMnO_4$ solution was decolourized.
(6) A solution of $BaCl_2$ was added to the solution obtained after performing test (5).	A White precipitate (insoluble in dil HNO_3)
(7) (7.1) $Pb(NO_3)_2$ solution was added to solution **Q.**	A White precipitate was formed.
(7.2) The solution containing the white precipitate was boiled.	A portion of the precipitate dissolved.
(7.3) The mixture from (7.2) was filtered while hot.	A White precipitate in the form of needles was formed in the filtrate on cooling.

(i) Identify the **two** anions in solution **Q.**

(ii) Identify the white precipitates formed in tests (4) and (6).

(iii) Identify the white precipitate formed in the form of needles in test (7.3).

(iv) Give the balanced chemical equation for the reaction in test (5).

(3.5 marks)

(c) A sample of haematite are (Fe_2O_3) containing some amount of Fe_3O_4 and inert material was analysed to determine its purity using the following procedure.

An **8.00** g sample of the ore was treated with excess of aqueous **KI**(**50** cm^3) in an acidic medium to convert all iron in the ore to Fe^{2+}. The solution was then diluted to **100.00** cm^3. When a **25.00** cm^3 portion of the diluted solution was titrated with 1.00 mol dm^{-3} $Na_2S_2O_3$, a volume of **24.00** cm^3 was required to reach the end point. Another **25.00** cm^3 portion of the diluted solution was shaken thoroughly with CCl_4 to completely remove the iodine and the resulting solution then titrated with a **1.00** mol dm^{-3} $KMnO_4$ solution. The end point was reached upon the addition of **5.20** cm^3 of the $KMnO_4$ solution.

(i) Write balanced chemical equations for the reactions of the following with aqueous potassium iodide in acidic medium.

(I) Fe_2O_3 (II) Fe_3O_4

(ii) Calculate the mass percentage of Fe_2O_3 in the ore. (Fe = 56, O = 16)

(7.0 marks)

10. (a) Gases emitted from motor vehicles is one of the major sources of air pollution.

(i) List **six** pollutants present in motor vehicle emissions.

(ii) Name **two** pollutants given in answer to (i) above responsible for acid rain.

(iii) Indicate briefly how the **two** pollutants stated in (ii) above are formed during the combustion process.

(iv) Name **two** pollutants among the answers given in (i) above, responsible for the greenhouse effect.

(v) Indicate briefly how the pollutants given in (iv) above brings about the greenhouse effect?

(vi) Give **two** consequences of the greenhouse effect.

(vii) Name **two** methods used to minimize environmental pollution that occurs from motor vehicle emission.

(7.5 marks)

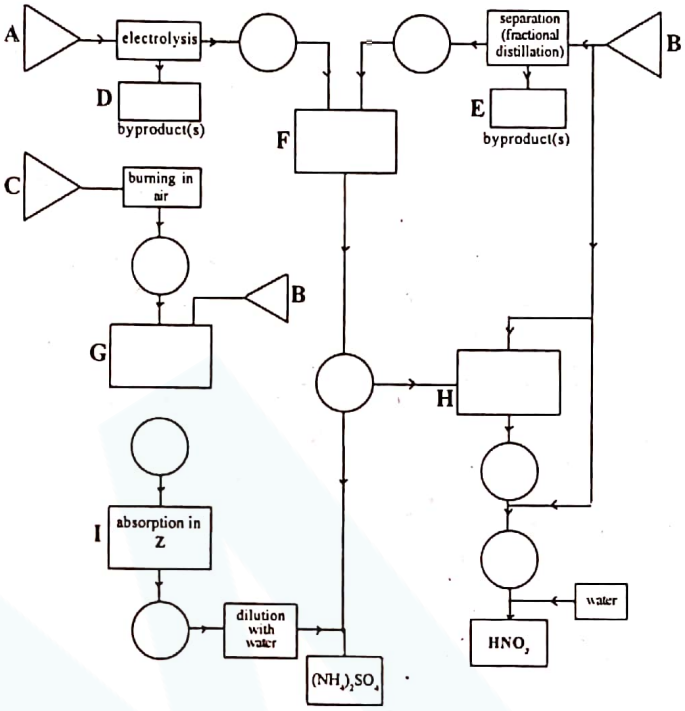
(b) Consider the flow chart given on **page 14** (See last page of **PART A**) for the manufacture of HNO_3 and $(NH_4)_2SO_4$ from the starting materials **A**,**B** and **C**. Complete the flow chart according to the instructions (•) given below and answer the questions given on page 14, relating to flow chart.

- Write in the triangles the names of the naturally available starting materials, **A**,**B** and **C**.
- Write in the circles the chemical formulae of the substances encountered in the process.
- Write in the boxes **F**,**G** and **H**, the conditions employed for the relevant reactions.
- Write in the boxes **D** and **E**, the byproducts of the relevant reactions/ processes.

(7.5 marks)

- **Only Use this page to answer question Number 10 of PART C. (Question Number 10 is not compulsory).**

10. (b)



(i) Identify **Z** : .....

(ii) Write balanced equations for the chemical reactions taking place at **F**,**G**, and **H**.

F : .....

G : .....

H : .....

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 - 2010

M.C.Q. Answers

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

PART A - STRUCTURED ESSAY

Answer all four questions on this paper it self (Each question carries **10 marks)**

01.(a) (i) Na (Sodium) and F (Fluorine) (3+3)

(ii) N (Nitrogen) (3)

(iii) He (Helium) (3)

(iv)Any two out of B (Boron), Be (Beryllium). Al (Aluminium) (3+3)

(v) C (Carbon) (3)

(Vi)H (Hydrogen) (3)

(vii) First Na (Sodium) Seventh Cl (Chlorine) (3+ 3)

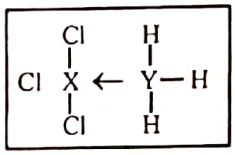
(Viii)Mg (Magnesium) (3)

(33 marks)

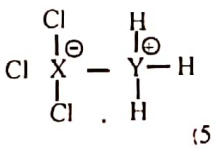
(b) (i) X = B Y = N (5+5)

(ii) XCl_3 : Trigonal planar YCl_3 : Pyramidal (5+5)

(iii)



or



(5)

(iv) X . Tetrahedral Y · Tetrahedral (5 + 5) ·

35 marks

(c)

	Substance	Type of bond (ionic, polar covalent, nonpolar covalent	Type of intermolecular force (dipole - dipole. hydrogen bonding. london forces)
(i)	Iodine (solid)	nonpolar covalent (3)	London forces (3)
(ii)	Carbon tetra Chloride (liquidc)	polar covalent (3)	London forces (3)
(iii)	Argon(liquide)	——	London forces (3)
(iv)	Sodium hydride (solid)	Ionic (3)	—— (3)
(v)	Sulphur dioxide (gas)	polar covalent (3)	dipole - dipole and London forces (3+2)

(32 marks)
(Total 100)

02.(a) Let the weight of Mg in the alloy be x g (2)

∴ weight of Al in the alloy is (0.396 - x) g (2)

$2 Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$ (3)

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$ (3)

moles of HCl required to react with xg of Mg = $\frac{X \times 2}{24}$ (5)

moles of HCl required to react with (0.396-X)g of Al (5)

$= \frac{(0.396 - X) \times 3}{27}$

number of moles of HCl in 10.0 cm^3 of 3.60 mol dm^{-3} HCl (5)

$= \frac{3.60 \times 10}{1000}$

(5)

$\therefore \frac{X \times 2}{24} + \frac{(0.396 - X) \times 3}{27} = \frac{3.60 \times 10}{1000}$

$\frac{X}{12} + \frac{(0.396 - X)}{9} = \frac{3.60 \times 10}{1000}$

$\frac{X}{12} - \frac{X}{9} = \frac{36.0}{1000} - \frac{0.396}{9} = \frac{36.0}{1000} - 0.044$

$\frac{3X - 4X}{36} = \frac{36.0}{1000} - \frac{44}{1000}$

$\frac{X}{36} = \frac{8}{1000}$ (3)

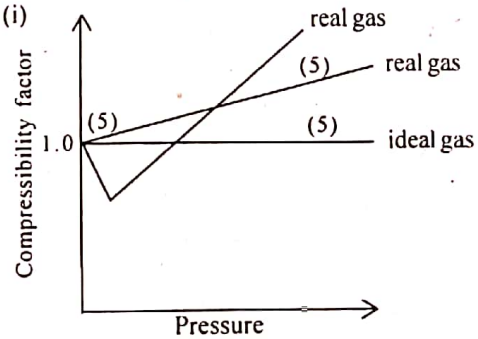
$X = 0.288$ g (2)

$\therefore$ % Mg $= \frac{0.288 \times 100}{0.396}$ (5)

$= 72.7$ %

(40 marks)

(b) (i)



(15)

Note : Any one line / curve for a real gas is accepted.
Lines / curve should start at 1.0

(ii) (1) Presence of inter molecular attractions among real gaseous molecules (5)

(2) Real gas molecules : have volumes / are not point masses / take space (5)

(ii) I P_A = partial pressure of A after mixing

P_B = partial pressure of B after mixing

$2.0\ m^3 \times (3.0 \times 10^5\ Nm^{-2}) = 5.0\ m^3 \times P_A$ (1+1)

$P_A = 1.2 \times 10^5\ Nm^{-2}$ (2+1)

$3.0\ m^3 \times (5.0 \times 10^5\ Nm^{-2}) = 5.0\ m^3 \times P_B$ (1+1)

$P_B = 3.0 \times 10^5\ Nm^{-2}$ (2+1)

$P_{tot} = 1.2 \times 10^5\ Nm^{-2} + 3.0 \times 10^5\ Nm^{-2}$ (1+1)

$= 4.2 \times 10^5\ Nm^{-2}$ (2+1)

II.

Mole fraction of B $= \frac{n_B}{n_A + n_B}$ (3)

$= \frac{P_B}{P_A + P_B}$ (3)

$= \frac{3.0 \times 10^5\ Nm^{-2}}{4.2 \times 10^5\ Nm^{-2}}$ (1) + (1)

$= \frac{5}{7}$ or 0.71 (2)

(III) $\frac{P_B^{T_2}}{P_B^{T_1}} = \frac{T_2}{T_1}$ (3)

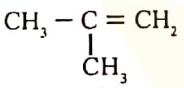
$P_B^{T_2} = \frac{350\ K \times 3.0 \times 10^5\ Nm^{-2}}{300K}$ (3 + 1)

$= 3.5 \times 10^5\ Nm^{-2}$ (2 + 1)

Note : Nm^{-2} or Pa is acceptable

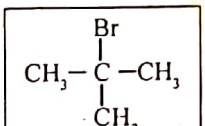
(60 marks)

3. (a)(i)



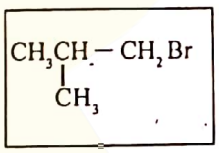
(5)

(iii)



(3)

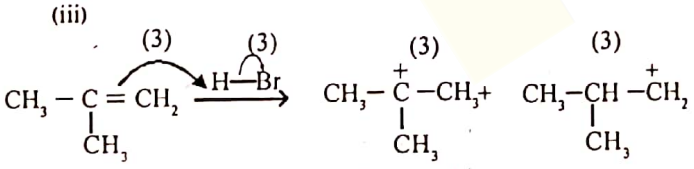
P : Major product



(3)

Q : Minor product

(iii)

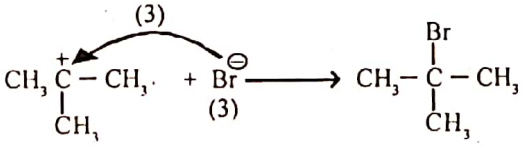


(3) (3) (3) (3)

More stable carbocation (3)

a reason for the stability of the carbocation (3)

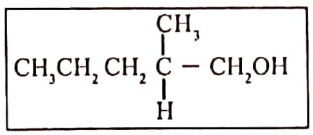
The reaction proceed via the more stable carbocation



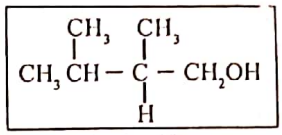
(3) (3)

(35 marks)

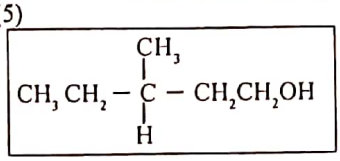
(b) (i)



(5)

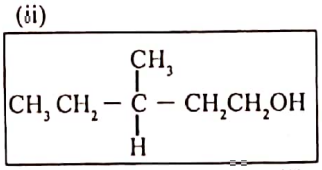


(5)

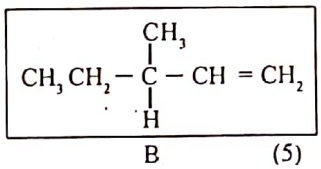


(5)

(ii)

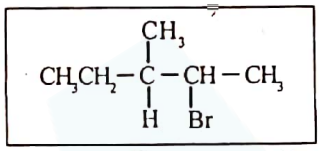


A (5)

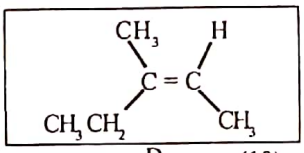


B (5)

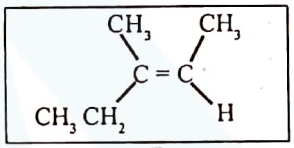
(iii)



C (10)



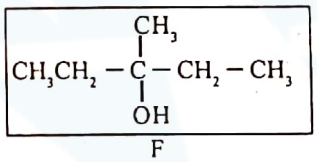
D (10)



E (10)

For one structure without stereochemistry for D/E (10)

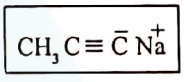
(iv)



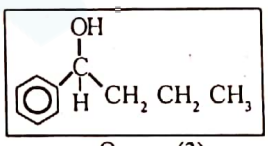
(10)

F

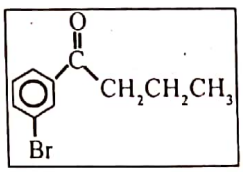
04. (a) (i)



P (3)



Q (3)



R (3)

(ii) H_2 / Ni (Pd or Pt)

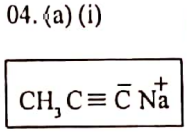
X (3)

$K_2Cr_2O_7$ /H+ or $KMnO_4$ / H^+ or pyridinium chlorachromate

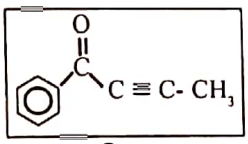
Y(3)

Alternative acceptable answer :

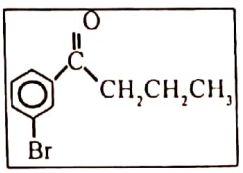
04. (a) (i)



P



Q



R

(ii) $K_2Cr_2O_7$ /H+

X

H_2 / Ni (Pd or Pt)

Y

Note : $KMnO_4$ cannot be used in this alternative answer

(iii) Reaction 1 AB (3)

Reaction 2 S_E (3)

(iv) $CH_3C \equiv C\ CH_3$ (4)

(b) Preparation of Grinard Reagent : '18 marks

$$CH_3CHO\ (3) \xrightarrow[(2)]{NaBH_4} CH_3CH_2OH\ (3) \xrightarrow[(2)]{PBr_3} CH_3CH_2Br\ (3) \xrightarrow[dry\ Et_2O]{Mg} (2)\ CH_3CH_2MgBr\ (3)$$

Preparation of alcohol : 10 marks

$$CH_3CHO\ (3) \xrightarrow[(2)\ dil\ H_2SO_4\ (2)]{(1) CH_3CH_2MgBr\ (2)} CH_3\overset{OH}{CH} - CH_2CH_3\ (3)$$

Preparation of the acid : 08 marks

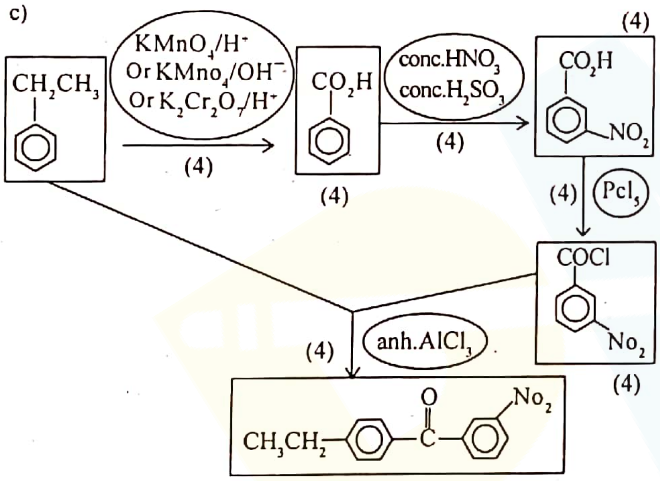
$$CH_3CHO\ (3) \xrightarrow[dil\ H_2SO_4]{K_2Cr_2O_7\ (2)} CH_3COOH\ (3)$$

Using correct acid and alcohol to prepare the desired product : 11 marks

$$CH_3COOH\ (4) + CH_3\overset{OH}{CH} - CH_2CH_3\ (4) \xrightarrow[(3)]{Conc\ H_2SO_4} CH_3\overset{O}{C}-O\underset{CH_2CH_3}{CH}CH_3$$

(47 marks)

c)



(28 marks)

5. (a)

$O_2(g) \longrightarrow 2O(g)$	$\Delta H_1 = 498\ kJ\ mol^{-1}$	(1)	(4 +1)
$O(g) + e \longrightarrow O^-(g)$	$\Delta H_2 = -149\ kJ\ mol^{-1}$	(2)	(4 +1)
$O^-(g) + e \longrightarrow O^{2-}(g)$	$\Delta H_3 = 798\ kJ\ mol^{-1}$	(3)	(4 +1)
$Mg(s) \longrightarrow Mg(g)$	$\Delta H_4 = 148\ kJ\ mol^{-1}$	(4)	(4 +1)
$Mg(g) \longrightarrow Mg^+(g) + e$	$\Delta H_5 = 738\ kJ\ mol^{-1}$	(5)	(4 +1)
$Mg^+(g) \longrightarrow Mg^{2+}(g) + e$	$\Delta H_6 = 1451\ kJ\ mol^{-1}$	(6)	(4 +1)
$Mg^{2+} + O^{2-}(g) \longrightarrow MgO(s)$	$\Delta H_7 = -3791\ kJ\ mol^{-1}$	(7)	(4 +1)

(05) (+) (05) (+) (03)

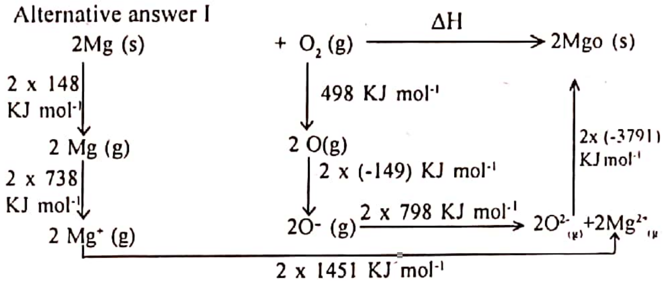
[(1) + [2 x (2)] + [2 + (3)]] + [[2x(4)] + [2 x (5)] + [2x(6)]] + [2 x (7)]

$$2\ Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

$\Delta H = 498 + 2(-149) + 2(798) + 2(148) + 2(738) + 2(1451) +$
$2(-3791)\ KJ\ mol^{-1}$ (5 +2)
$= -1112\ KJ\ mol^{-1}$ (3 +2)

Total for 5 (a) = 60 marks

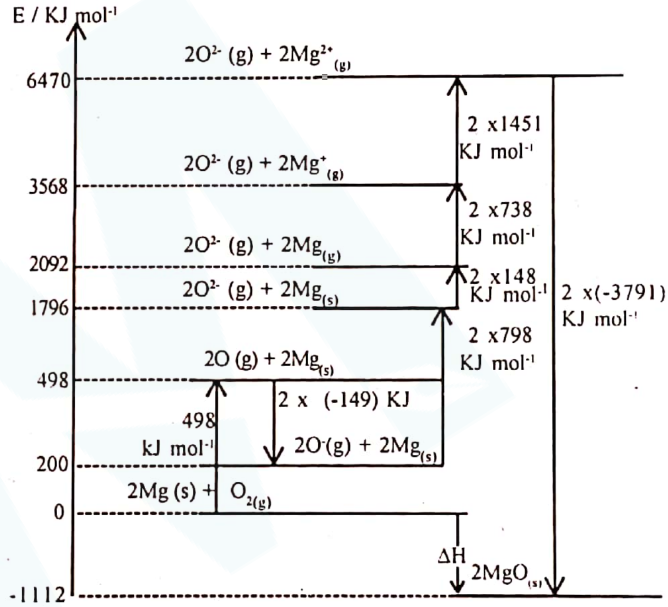
Alternative answer I



7 steps x (04) + 7 values & units x (01) = (35)
correct stoichiometry : Oxygen involving reactions (5) + Mg involving reactions (5) + Combination of $[Mg^{2+}(g) + O^{2-}(g)]$ (3) = (13)

$\Delta H = 498 + 2(-149) + 2(798) + 2(148) + 2(738) + 2(1451)$
$+ 2(-3791)\ KJ\ mol^{-1}$ (5 + 2)
$= -1112\ KJ\ mol^{-1}$ (3 + 2)

Alternative answer II



7 steps x (04) + 7 values & units (on the energy axis or on arrows) x (01) = (35)
Correct stoichiometry : Oxygen involving reactions (05) + Mg involving reactions (05) + Combination of $[Mg^{2+}(g) + O^{2-}(g)]$ (03) = (13)

$\Delta H = 498 + 2(-149) + 2(798) + 2(148) + 2(738) + 2(1451)$
$+ 2(-3791)\ kJ\ mol^{-1}$ (5+2)
$= -1112\ kJ\ mol^{-1}$ (3+2)

b) $A(g) \rightleftharpoons 2B(g)$

(i) I $PV = nRT$ or $n = PV / RT$ (03)

$n = \dfrac{(9.00 \times 10^5\ Nm^{-2}) \times (4.157 \times 10^{-3}\ m^3)}{(8.314\ J\ mol^{-1}\ K^{-1}) \times 600\ K}$ 4 terms x (2 + 1) = 12

0.750 ml (2 + 1)

5b (i) I - 18 marks

II. $A(g) \rightleftharpoons 2B(g)$

	A(g)	2B (g)	
Initially	0. 45	.... mol	(2+1)
At eqm..,	0.45 - X	2X mol	(2+1)

0. 45 - X + 2X = 0.750 (3)
X = 0.750 - 0.45 = 0.30 (3)
number of mol of A at equilibrium = 0 45 - 0.30 0 15 (3)
number of mol of B at equilibrium = 2 x 0.30 = 0 6 (3)

5b (i) II 18 marks

(iii) $K_P = \frac{P_B^2}{P_A}$ (3)

$= \frac{(X_B P)^2}{X_A P}$ (3)

Where X is the mole fraction and P is the total pressure.

$= \frac{X_B^2 P}{X_A}$

$X_A = \frac{0.15}{0.75} = \frac{1}{5}$; $X_B = \frac{0.60}{0.75} = \frac{4}{5}$

$P = 9.00 \times 10^5\ Nm^{-2}$ 2 x (3) = (6)

$\therefore K_P = \frac{\left(\frac{4}{5}\right)^2 \times (9.00 \times 10^5\ Nm^{-2})}{(1/5)}$ (3)

$= 2.88 \times 10^6\ Nm^{-2}$ (2 + 1)

To calculate K_C,

$K_P = K_C (RT)^{\Delta n}$ or $K_P = K_C RT$ or $K_C = \frac{K_P}{RT}$ (3)

$\therefore K_C = \frac{2.88 \times 10^6\ Nm^{-2}}{(8.314\ J\ mol^{-1}\ K^{-1}) \times 600K}$ 3terms x (2 + 1) = (9)

$= 577\ mol\ m^{-3}$ or $0.577\ mol\ dm^{-3}$ (2 + 1)

Alternative answer for part III

$K_C = \frac{C_B^2}{C_A}$ (3)

$= \frac{(n_B/v)^2}{(n_A/v)}$ (3)

where n is the number of moles and v is the volume

$= \frac{n_B^2}{n_A^v}$ (3)

$K_C = \frac{(0.60\ mol)^2}{(0.15\ mol) \times (4.157 dm^3)}$ 3terms x (2 + 1) = (9)

$0.577\ dm^3$ or $577\ m^3$ (2+1)

To calculate K_C,

$K_p = K_c (RT)^{\Delta n}$ or $K_p = K_C RT$ (3)

$K_p = (577\ m^3)(8.314\ J\ mol^{-1}\ k^{-1})(600\ k)$ 3terms x (2 +1) = (9)

$= 2.88 \times 10^6\ Nm^{-2}$ (2+1)

5 b (i) III = 36 marks

5 b (i) = 72 marks

(ii)

	A (g)	⇌	2 B (g)
Initial eqm..	0.15		0.60 mol
Added			0.30 mol
New condition	0.15		0.90 mol
At eqm..	0.15 + X		0.90- 2X mol

(2 + 1)

$P_A = \frac{n_A RT}{V}$

$= \frac{(0.15 + X)\ mol \times (8.314\ J\ mol^{-1}\ k^{-1}) \times 600\ K}{4.157 \times 10^{-3}\ m^3}$ 4 terms x (2+1)= (12)

$= 1.2 \times 10^6 \times (0.15 + X)\ Nm^{-2}$ (02 + 01)

Alternative answer

Total number of mol of A and B = (0.15+X) + (0. 90 - 2X) = 1.05-X (03)

Mole fraction of A $= \frac{0.15+X}{1.05 - X}$ (02)

Partial pressure of A (P_A) = mole fraction x total pressure (P)

$P = \frac{nRT}{V}$

$\therefore P = \frac{[(1.05 - X)\ mol](8.314\ J\ mol^{-1}\ K^{-1})(600\ K)}{4.157 \times 10^{-3}\ m^3}$ (4+4) OR

$P \propto (1.05 - x)\ mol$

$9 \times 10^5\ Nm^{-2} \propto 0.75\ mol$ } (2+2)

$P = \frac{[(1.05 - X)\ (9.00 \times 10^5)\ Nm^{-2}]}{0.75}$ (2+2)

OR

$P_A = \frac{0.15 + X}{1.05 - X} \times \frac{[(1.05 - X)\ mol](8.314\ J\ mol^{-1}K^{-1})(600\ K)}{4.157 \times 10^{-3}\ m^3}$

OR

$P_A = \frac{0.15 + X}{1.05 - X} \times \frac{[(1.05 - X)\ (9.00 \times 10^5) Nm^{-2}]}{0.75}$ (02)

$\therefore P_A = 1.2 \times 10^6 \times (0.15 + X)\ Nm^{-2}$ (02 +01)

5 b (ii) = 18 marks

Total for 5b = 90 marks

6 (a) (i) Rate $\propto [X]^{\alpha}[Y]^{\beta}$ or Rate = $K [X]^{\alpha}[Y]^{\beta}$ (06)

α = order of reaction with respect to X

β = order of reaction with respect to Y

Note : Any other symbols can be used to represent order with respect to each reactant.

6a (i) = 6 marks

(ii) Substitute the data given in Experiments 1,2 and 3 in the above rate expresion.

Expt. 1 : $0.0020 mol\ dm^{-3}s^{-1} \propto [1.0\ mol\ dm^{-3}]^{\alpha} [0.5\ mol\ dm^{-3}]^{\beta}$ —(01)(2 +1)

Expt. 2: $0.0010 mol\ dm^{-3}s^{-1} \propto [0.5\ mol\ dm^{-3}]^{\alpha} [0.5\ mol\ dm^{-3}]^{\beta}$— (02) (2+1)

Expt. 3 : $0.0040 mol\ dm^{-3}s^{-1} \propto [0.50\ mol\ dm^{-3}]^{\alpha} [1.0\ mol\ dm^{-3}]^{\beta}$— (03)(2 +1)

(1) / (2), $2 = 2^{\alpha}$

$\alpha = 1$ OR order of reaction with respect to X = 1 (3)

(3) / (2), $4 = 2^{\beta}$

$\beta = 2$ OR order of reaction with respect to Y = 2 (3)

OR valid qualitative arguments to show

that $\alpha = 1$ (05) and $\beta = 2$ (05)

Example : Compare Experiment 1 and Experiment 2

The concentration of X is decreased by a factor of two, while keeping the concetration of Y constant, the rate of the reaction decreases by a factor of 2 (2)

$\therefore$ Order of reaction with respect to X = 1 (3)

6a (ii) = 15 marks

(iii) rate (r) $\propto [0.5\ mol\ dm^{-3}]^{\alpha} [2.0\ mol\ dm^{-3}]^{\beta}$ ..... (04) (2+1)

(04) / (03) $\frac{r}{0.0040\ mol\ dm^{-3}s^{-1}} = 2^{\beta}$ (3)

$r = 2^2 \times 0.0040\ mol\ dm^{-3}S^{-1}$

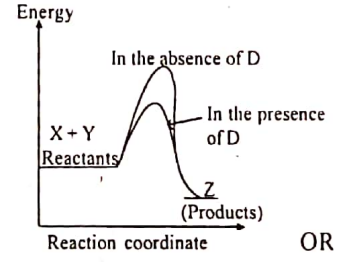
$= 0.016\ mol\ dm^{-3}S^{-1}$ (2+1)

6a (iii) = 09 marks

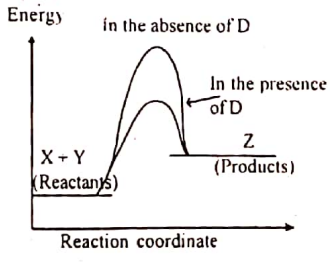
Note : Equation (4) can be divided by any of the three equations (1), (2) or (3)

(iv) It acts as a catalyst. 6a (iv) = 06 marks

(v) (06)



OR



Curve with D	(2)	Curve with no D	(2)
Labelling reactants	(2)	Labelling products	(2)
Labelling X-axis	(2)	Labelling Y-axis	(2)

6 a (v) = 12 marks

(vi) Rate in increased (3) when the temperature is increased from 30°C to 50°C (3)

When the temperature is increased.

Kinetic energy (or speed or velocity) of reactants increases (3)

Fraction of reactant molecules having the energy greater than activation energy increases

Number of collisions per unit time increases (3)

∴ Rate increases.

6 a (vi) = 12 marks

Total for 6a = 60 marks

b (i) Solution P

$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$ (3)

Initially	0.056	.....	.....moldm^{-3}
At eqm..	0.056 - X	X	X moldm^{-3}

(2+1)

$$Ka = \frac{[CH_3COO^-aq][H_3O^+ aq]}{[CH_3COOH(aq)]} \quad (3)$$

$$= \frac{X^2}{0.056 - X} \quad (3)$$

$$\therefore \frac{X^2}{0.056 - X} = 1.8 \times 10^{-5}$$

$0.056 - X \cong 0.056$

$X^2 = 0.056 \times 1.8 \times 10^{-5}$ or $X^2 = 1.0 \times 10^{-6}$ (3)

$X = 1.0 \times 10^{-3}$ (3)

$pH = -\log (1.0 \times 10^{-3}) = 3.00$ (3)

Solution Q

$$[H_3O^+] = \frac{50.0\ cm^3 \times 0.200\ mol\ dm^{-3}}{(50.0 + 50.0)\ cm^3} = 0.100\ mol\ dm^{-3} \quad (5 + 1)$$

$pH = -\log (0.100)$

$= 1.000$ (3)

Solution R

$$[OH^-] = \frac{50.0cm^3 \times 0.022mol\ dm^{-3} - 50.0cm^3 \times 0.020mol\ dm^{-3}}{(50.0 + 50.0)\ cm^3} \quad (2)$$

$= 0.0010\ mol\ dm^{-3}$ (3 + 1)

$POH = -\log (0.0010)$ (03)

$= 3.0$

$PH = 14.0 - 3.0 = 11.00$

Alternative answer

$[H_3O^+] = 1.0 \times 10^{-11}\ mol\ dm^{-3}$ (03)

$PH = -\log (1.0 \times 10^{-11})$

$= 11.00$ (03)

6b(i) I = 42 marks

Assumptions

Solution P

- Amount of CH_3COOH ionized is negligible compared to the initial concentration (3)

  OR fraction of CH_3COOH ionized is very small
- Contribution from the ionization of H_2O to the overall H_3O^+ concentration is negligible. (no marks)

Solution Q

- Contribution from hte ionization of CH_3COOH to the overall H_3O^+ concentration is negligible. (3)
- Contribution from the ionization of H_2O to the overall H_3O^+ concentration is neglible (no marks)

Solution R

- Contritibution from the ionization of H_2O to the overall H_3O^+ concentration is neglibible (3)

6b(i) II = 09 marks

III Use solutions P and S (3)

Mix a larger volume of P and a smaller volume of S (3)

After mixing, the solution has a mixture of CH_3COOH and CH_3COONa and the solution acts as a buffer (3)

6 b (i) III = 9 marks

6 b (i) = 60 marks

(ii) I

- Take a small volume of the indicator into a test tube. Add the HCl acid solution dropwise until a colour change of the solution occurs. (4)
- Measure the pH of the solution at this point (4)
- Place another portion of the indicator in a test tube.

  Add the NaOH solution dropwise until a colour change of the solution occurs (04)
- Measure the pH of the solution at this point (4)
- The two pH values obtained represent the colour changing pH range of the indicator. (4)

6b(ii) I = 20 marks

(ii) Figure 1 : M or N (5)

Figure 2 : L (5)

6b (ii) II = 10 marks

6b (ii) = 30 marks

Total for 6b = 90 marks

(7) (a) (i) $E_{Cell} = 0.34V - (-2.37V)$ (2)

$= 2.71\ V$ (3)

(ii) No Change (5)

Only the cations are involved in the electrode reactions (5)

Although the anion is replaced, the concenration of the cation is not changed. (5)

(iii) To maintain electrical neutrality throughout the cell (5)

(OR to facilitate migration of ions-award only 2 marks)

KCl. KNO_3, NH_4Cl OR NH_4NO_3 (5)

(iv) Cu electrode (5)

(v) I Cathode reaction : $Cu^{2+}(aq) + 2e \longrightarrow Cu(s)$ (5)

II Anode reaction : $Mg(s) \Longrightarrow Mg^{2+}(s) + 2e$ (5)

III Overall reaction : $Mg(s) + Cu^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Cu(s)$ (5)

(vi) F (5)

(vii) I E : $2H_2O(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e$ (5)

II F : $2H^+(aq) + 2e \longrightarrow H_2(g)$ (5)

(viii) I No Change (5)

II No Change (5)

Total for 7a = 75 marks

b (i) $Ag^+(aq) + Br^-(aq) \longrightarrow AgBr(s)$

$K_{sp}(AgBr) = [Ag^+aq)]\ [Br^-(aq)]$ (5)

$$[Ag^+(aq)] = \frac{K_{sp}(AgBr)}{[Br^-(aq)]}$$

$$= \frac{5.0 \times 10^{-13}\ mol^2\ dm^{-6}}{0.0010\ mol\ dm^{-3}} \quad (3+2)$$

$= 5.0 \times 10^{-10}\ mol\ dm$ (3 + 2)

7b (i) = 15 marks

(ii) For AgCl precipitation,

$Ag^+ (aq) + Cl^- (aq) \longrightarrow AgCl(s)$ (5)

$K_{sp} (AgCl) = [Ag^+(aq)] [Cl^- (aq)]$

Concentration of Ag^+ required for AgCl precipitation,

$$[Ag^+ aq] = \frac{K_{sp} (AgCl)}{[Cl^- aq]}$$

$$= \frac{1.7 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}}{0.0020 \text{ mol dm}^{-3}} \quad (3+2)$$

$$= 8.5 \times 10^{-8} \text{ mol dm}^{-3} \quad (3+2)$$

Maximum concentration of Br- remaining in solution when AgCl precipitation occurs,

$$[Br^-(aq)] = \frac{Ksp(AgBr)}{[Ag^+ (aq)]} \quad (5)$$

$$= \frac{5.0 \times 10^{-13} \text{ mol}^2 \text{ dm}^{-6}}{8.5 \times 10^{-8} \text{ moldm}^{-3}} \quad (3+2)$$

$$= 5.9 \times 10^{-6} \text{ mol dm}^{-3} \quad (3+2)$$

7b (ii) = 30 marks

(iii) 1. Addition of the $AgNO_3$ solution does not change the volume of the solution. (5)

2. Temperature of the solution is not changed during the addition of the $AgNO_3$ solution. (5)

7b (ii) = 10 marks

(iv) $Ag^+(aq) + Cl^- (aq) \overset{or}{\rightleftharpoons} AgCl(s)$ (5)

$AgCl (s) + 2NH_3(aq) \rightleftharpoons Ag (NH_3)_2^+ (aq) + Cl^-_{(aq)}$ (5)

Equilibrium constant (Formation constant) of the latter reaction is very high due to the stability of the silver - ammine (Ag-NH_3) complex. (5)

∴ AgCl precipitate readily dissolves in aqueous ammonia (5)

7b (iv) = 20 marks

Total for 7b = 75 marks

PART C

(08) (a) (i)

Formula	Oxidation State	Common name	acidic/ basic/ neutral character
1. N_2O	+ 1	nitrous Oxide	neutral
2. NO	+ 2	nitric Oxide	neutral
3. N_2O_3	+ 3	dinitrogen trioxide/ nitrogen trioxide/ nitrogen sesquioxide	acidic
4. N_2O_4 / NO_2	+ 4	dinitrogen tetraoxide/ nitrogen dioxide/	acidic
5. N_2O_5	+5	dinitrogen pentoxide/ nitrogen pentoxide	acidic

(01 x 20)

(ii) • N_2O

gentle heating of NH_4NO_3

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$ / $NH_4NO_3 \xrightarrow{\Delta} N_2O$

• NO

reacting Cu with dil HNO_3 /

$3 Cu + \text{dil } 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$/

$Cu + \text{dil } HNO_3 \longrightarrow NO$

• N_2O_3

$NO + NO_2 \xrightarrow[\text{low temp}]{\text{-20°C or}} N_2O_3$

• NO_2

reacting Cu with conc. HNO_3

$Cu + \text{conc. } 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$ /

$Cu + \text{conc. } HNO_3 \longrightarrow NO_2$/

$Pb(NO_3)_2 \xrightarrow{\Delta} NO_2$

$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

• N_2O_4

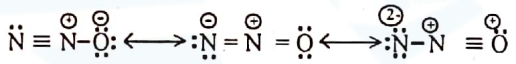
$NO_2 \xrightarrow[\text{temp}]{\text{low}} N_2O_4$ (NO_2 preparation must be given)

• N_2O_5

conc. $HNO_3 \xrightarrow{P_4O_{10}} N_2O_5$

Any three (4 x 3)

(iii)



(4 x3)

(iv) NO, NO_2

$NO \xrightarrow{\text{Cooled}} N_2O_2$ (4)

$NO_2 \xrightarrow{\text{Cooled}} N_2O_4$ (4)

$NO + NO_2 \xrightarrow{\text{Cooled}} N_2O_3 / N_2O_4 / N_2O_2$ (4)

(b) (i) M = Cu (Copper) X = C (Carbon) (5 + 5)

(ii) $1S^2\ 2S^2\ 2p^6\ 3S^2\ 3p^6\ 3d^{10}\ 4S^1$

(iii) + 1, +2 (3 + 3)

(iv) C - $[CuCl_4]^{2-}$

D - $[Cu(H_2O)_6]^{2+}$ and any one of $[CuCl_4]^{2-}$, $[CuCl(H_2O)_5]^+$, $CuCl_2(H_2O)_4$ (5)

E - $[Cu(H_2O)_6]^{2+}$

G - $[Cu(NH_3)_4]^{2+}$, ($[Cu(NH_3)_4(H_2O)_2]^{2+}$ is also acceptable) (2 x 5)

* $[CuCl_4]^{2-}$ - Tetrachlorocuprate (II) ion
* $[Cu(H_2O)_6]^{2+}$ - Tetraaquacopper (II) ion

$[CuCl(H_2O)_5]^+$ - Pentaaquachlorocopper (II) ion

$[CuCl_2(H_2O)_4]$ - Tetraaquadichlorocopper (II)

* $[Cu(NH_3)_4]^{2+}$ - Tetrammine copper (II) ion

$[Cu(NH_3)_4(H_2O)_2]^{2+}$ - Tetraamminediaquacopper (II) ion (2 x 3)

IUPAC names are expected of the compounds marked with an *

(v) B - CO_2 , F - $Cu(OH)_2$ (4 +4)

(vi) $2Cu^{2+} + 4I^- \rightarrow 2CuI\downarrow + I_2$ (3)

(vii) Weight a known amount of A (Wg) (1)

Dissolve in dil. HCl (minimum quantity)

Dilute with H_2O (1)

Add excess KI (1)

Titrate the liberated I_2 with $Na_2S_2O_3$ of known concentration (C mol dm^{-3}) (2)

$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$

$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ (1)

$2I^- + 2Cu^{2+} + 2S_2O_3^{2-} \rightarrow 2CuI + S_4O_6^{2-}$ (2)

$2\ Cu^{2+} \equiv 2\ S_2O_3^{2-}$

$Cu^{2+} \equiv S_2O_3^{2-}$ (2)

Let the volume of $Na_2S_2O_3$ = $V cm^3$ (1)

$\therefore$ moles of $Na_2S_2O_3$ = $(V / 1000) \times C$ (2)

Hence moles of Cu^{2+} = $(V/1000) \times C$ (2)

(Since $Cu^{2+} \equiv S_2O_3^{2-}$)

$\therefore$ Weight of Cu = $(V / 1000) \times C \times M_g$ (2)

(relative atomic mass at Cu = M)

$\therefore$ % Cu in A = $\left[\{(C/100) \times V \times M\}/W\right] \times 100$ (3)

= $CVM / 10\ W$

(Viii) $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$ (4)

$C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$ (4)

(ix) $2Cu^{2+} + 2OH^- + 2e \rightarrow Cu_2O + H_2O$ (5)

This reaction is used to test the presence of reducing agents such as glucose in urine in the diagnosis of diabetes (3)

(x) electrical conductors / to make alloys (2+2)

(09) (a) (90 marks)

(i) Al^{3+}, Ag^+, Zn^{2+} (5 + 5+ 5)

(ii) (1) $Al(OH)_3$ (5)

(2) AgCl (5)

(3) $Zn(OH)_2$ (5)

(iii) (1) blue mass (5)

(3) green mass (5)

(ii) $Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$ (5)

$Al(OH_3) + NaOH \rightarrow Na[Al(OH)_4]$ (also acceptable)

N.B. However, in place of Al^{3+} - Pb^{2+}, Sn^{2+}, Sn^{4+}, Be^{2+} are also acceptable

in place of Zn^{2-} - Cd^{2+} is also acceptable.

(45 marks)

b) (i) SO_3^{2-} . Cl^- (5 + 5)

(ii) (04) $BaSO_3$ (5)

(06) $BaSO_4$ (5)

(iii) $PbCl_2$ (5)

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

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

$5SO_3^{2-} + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$ (10)

(35 marks)

c) (i) $Fe_2O_3 + 6H^+ + 2I^- \rightarrow 2Fe^{2+} + I_2 + 3H_2O$ (7)

$Fe_3O_4 + 8H^+ + 2I^- \rightarrow 3Fe^{2+} + I_2 + 4H_2O$ (7)

$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$ (3)

Let there be X moles of Fe_2O_3 and Y moles of Fe_3O_4 in the ore

Moles of $Na_2S_2O_3$ required to titrate the I_2 in

$25.0 cm^3$ of the diluted solution = 1/1000 x 24 (4)

$\therefore$ moles of I_2 = (1/2) x (1/ 1000) x 24 (4)

$\therefore$ Therefore moles I_2 in $100.0 cm^3$ solution = 0.012 x 4

= 0.048 x 4 (4)

Hene X + Y = 0.048 $\rightarrow$ (1) (10)

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow 5Fe^{3+} + 4H_2O + Mn^{2+}$ (5)

Moles of $KMnO_4$ = (1 / 1000) x 5.2 (4)

Assuming I^- interference negligible (since end point has been reached) (2)

Moles of Fe^{2+} = 5 x (1 / 1000) x 5.2 x 4 (2)

= 0.104 (2)

Hene 2X + 3Y = 0.104 $\rightarrow$ (2) (05)

solving for x using eqations (1) and (2)

X = 0.004 (2)

$\therefore$ Weight of Fe_2O_3 = 0.004 x 160 = 6.4 g (2)

% Fe_2O_3 = $\left(\frac{6.4}{8.0}\right) \times 100$

= 80% (3)

(70 marks)

(10) (a)

(i) CO, CO_2, NO, NO_2, SO_2, C_xH_y (unburnt hydrocarbons), Carbon particles (4 x 6)

(ii) NO_2, SO_2 (4 + 4)

(iii) N_2 (air) + $O_2 \rightarrow 2NO$, $2NO + O_2 \rightarrow 2NO_2$ (4x 3)

Sulpher (in fuel) + $O_2 \rightarrow SO_2$

(Can be given in words)

(iv) CO_2, NO_2, SO_2 (any two) (4 + 4)

(v) These gases absorb heat from the sun that is reflected from the earth surface and prevent heat from being readiated back to space (4)

(vi) Green house effect leads to temperature increase in the atmosphere (3)

- Ice melts and water levels in ocean will increase which will threaten low lying lands
- Fresh water system can evoporate to from desserts (4+4)

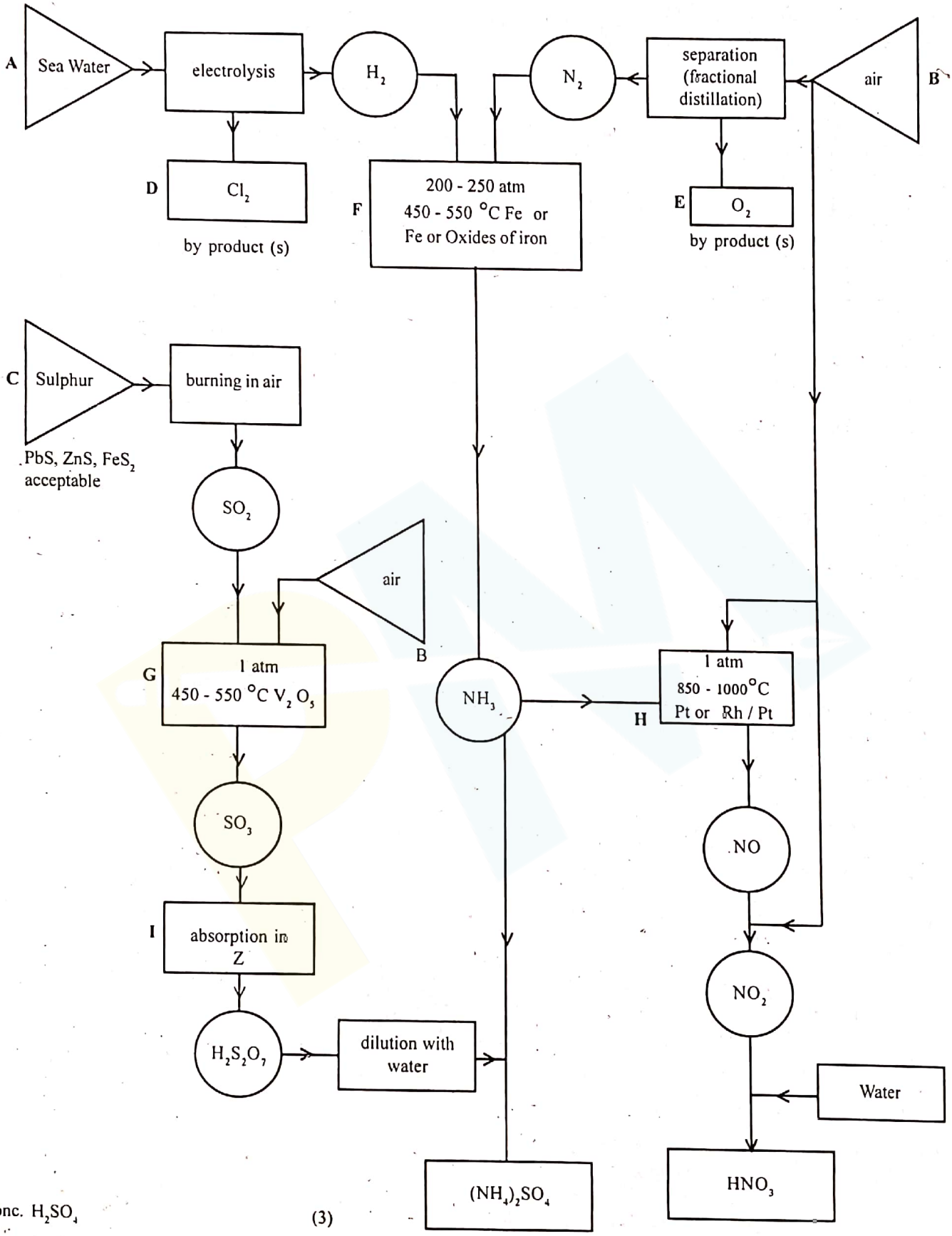
(vii) • Use of catalytic convertors

- Controlling the quantity of air mixed with fuel (engine tuning)
- Use of Oxygenated fuels (4+4)

(any two, accept other suitable answers)

(75 marks)

10. (b). Only use this page to answer question number 10 of PART C.
(Question Number 10 is not compulsory)



(i) Conc. H_2SO_4 (3)

(ii) F : $N_2 + 3H_2 \rightarrow 2NH_3$ (5)

G : $2SO_2 + O_2 \rightarrow 2SO_3$ (5)

H : $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ (5)

Marks :

Circles	= 3 x 8 = 24
Triangles	= 3 x 3 = 9
Rectangular boxes (small) D and E	= 3 x 2 = 6
Rectangular boxes (G, F, H)	= 6 x 3 = 18