GISAGARA DISTRICT

GS ST PHILIPPE NERI

Names: .....

School name: .....

CHEMISTRY II

HOLIDAY PACKAGE 2025 – 2026

SUBJECT: CHEMISTRY (THEORY)

COMBINATIONS:

- **MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)**
- **PHYSICS-CHEMISTRY- MATHEMATICS (PCM)**

DURATION: 2 WEEKS

INSTRUCTIONS:

1) Write your names properly on the answer booklet.
2) This paper consists of **ONE** section.
   Answer **ALL** questions. **USE ONLY THIS BOOKLET.**
3) Use **blue** or **black** pen.

Total marks...../100

FOR EXAMINER'S USE ONLY

Questions	Marks	Questions	Marks
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

Attempt all questions

1.

a) What is a hydrogen bond?

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..... **(1mark)**

b) Explain the origin of hydrogen bond in different molecules.

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..... **(2marks)**

2. A certain saturated Hydrocarbon has the ratio of carbon to hydrogen of **X:10**. Find:

a) The value of X .....

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... **(1mark)**

b) Name the Hydrocarbon above.

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..... **(1mark)**

c) Write its molecular formula. **(1mark)**

d) Draw its structural formula.

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..... **(1mark)**

e) Write the combustion reaction of the Hydrocarbon above.

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..... **(2marks)**

3. Fill the gaps by using the following: **Pig iron, $CaSiO_3$ (Slag), reducing agent, Decomposition, CO, acidic impurity, carbon dioxide, carbon.**

During the extraction of iron in the blast furnace, Coke acts as .....**.... (i)** in the lower zone and ..... **(ii)** acts as reducing agent in upper zone. Haematite Fe_2O_3 is primary reduced by CO below 710°C and ..... **(iii)** of SiO_2 is removed is the form of ..... **(iv).**

In blast furnace, the following two endothermic reactions occur: (1) Reaction between **....** **(v)** and ..... **(vi)** to form carbon monoxide. (2). ..... **(vii)** of calcium carbonate to form calcium oxide and carbon dioxide. The iron formed in the blast furnace is called ..... **(viii)**, which consists of impurities like Mn, Si, C and S.

4. You are provided with the following chemical compounds KNO_3, Li_2CO_3, $LiNO_3$, and K_2CO_3. Identify which one is described as follows:

a) A soluble compound which does not decompose on heat

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..... **(1mark)**

b) A soluble compound that may decompose on heat releasing a gas that relights a glowing splint.

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..... **(1mark)**

c) A soluble compound that decomposes on heat releasing brown fumes and a colorless gas that supports combustion.

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..... **(1mark)**

d) A slightly soluble compound which decomposes on heat and releases a colorless gas that turns lime water milky.

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..... **(1mark)**

5. (a) The ion $C_2O_4^{2-}$ can act as a bidentate ligand.

(i) Explain the meaning of the term bidentate ligand. .....

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..... **(1mark)**

(ii) Sketch the structure of the octahedral complex ion formed by Fe^{3+} ions which contains $C_2O_4^{2-}$ as the only ligand. Include the overall charge on the complex ion. .....

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..... **(1mark)**

(b) The chloride ion can act as a monodentate ligand.

(i) Deduce the formula of the linear complex formed when an excess of concentrated hydrochloric acid is added to silver chloride. .....

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..... **(1mark)**

(ii) Explain why metal(II) ions do not usually form octahedral complexes when

chloride ions are the only
ligands. .....
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..... **(1mark)**

6. The conductivity of a 0.20M solution of KCl at 298K is 0.0248 $S.cm^{-1}$. Calculate its molar conductivity.
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(2marks)

7. A naturally occurring sample of the element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes, ^{10}B and ^{11}B
(i) Calculate the percentage abundance of ^{10}B in this naturally occurring sample of boron.
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..... **(2marks)**
(ii) State, in terms of fundamental particles, why the isotopes ^{10}B and ^{11}B have similar chemical reactions.
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(1mark)

8. A chemical bond the force that acts between two or more atoms to hold them together as a stable molecule.
a. Which of LiCl and KCl is more ionic? Explain.
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..... **(3marks)**
b. What are the factors which favour the formation of ionic bond.
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(3marks)

9. Explain the following
   a. Unlike phenols, alcohols are easily protanated.

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      ..... **(2marks)**

   b. Formaldehyde gives Cannizarro reaction but acetaldehyde cannot.

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      ..... **(2marks)**

10. Aqueous copper (II) sulphate contains the copper species **W**. On treatment with an excess of concentrated hydrochloric acid, it turns into a yellow-green solution of copper containing species **X**. When copper metal is added to this solution and boiled, a new copper species **Y** is produced. When solution of **Y** is poured into distilled water, a white precipitate of **Z** is obtained. When **Z** was filtered off and allowed to stand in the air,it slowly turned green.
    a. Identify the copper species **W, X, Y, Z**.

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       (4marks)

    b. Explain the action of copper in the conversion of **X** into **Y**.

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       ..... **(1mark)**

    c. Write the equation for the conversions **W** into **X** and **X** into **Y**.

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       ..... **(2marks)**

    d. Explain why Z turns green on standing in air.

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       ..... **(1mark) N**

11. What is meant by the term "*colligative property*"?

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    ..... **(2marks)**

A pure liquid has vapour pressure 5.2 × 104 Pa at 298 K. When a solute is dissolved, the mole fraction of it is 0.02 in the solution. Find the vapour pressure of the solution.

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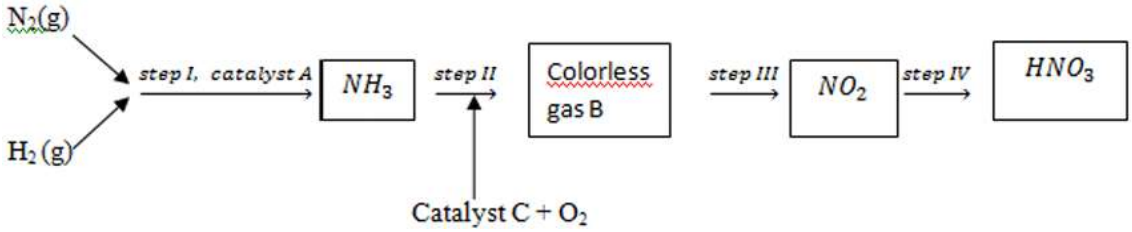
(4marks)

12.Study the flow chart below and answer the questions that follow.



a) Name catalysts A, C and colorless gas B

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..... **(3 marks)**

b) Write the equations for the reactions in step (IV).

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..... **(2 marks)**

c) State two industrial uses of nitric acid.

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..... **(2 marks)**

13.An element X has a relative atomic mass of 88. When a current of 0.5A is passed through the molten chloride of X for 32 minutes and 10 seconds, 0.44g of X deposited at the electrode.

a) Calculate the number of Faradays needed to liberate 1 mol of X.

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..... **(2marks)**

b) Write the formula of the ion of X (1F= 96500C).

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..... **(2marks)**

14.Given the following ΔH_f° **(4marks)**

chemical	$CO_2(g)$	$H_2O(g)$	$C_8H_{18}(l)$
ΔH_f	-393.5 kJ·mol^{-1}	-241.8 kJ·mol^{-1}	**???** kJ·mol^{-1}

If the $\Delta H\ ^\circ_{combusion}$ of octane, C_8H_{18}, is -5508.9 kJ·mol^{-1} calculate the ΔH_f of octane.

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15. Based on metallic bonding, explain why metals are: **(6marks)**

a. Good conductor of electricity.

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b. Good conductor of heat.

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16. Although Chlorine is an electron withdrawing group yet it is ortho para directing in electrophilic aromatic substitution reactions. Why?

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..... **(3marks)**

17. (a) State the Kchlrausch's law of migration of ions.

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..... **(2marks)**

(b) The molar conductivity at infinite dilution at 18^0C of HNO_3, $NaNO_3$ and CH_3CH_2COONa are 413, 108 and 87 Ωcm^2mol^{-1} respectively. The molar conductivity of 0.0025M solutions of propionic acid is 48.6 Ωcm^2mol^{-1}. Calculate the molar conductivity at infinite dilution of propionic acid.

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(3marks)

18.The table below shows the melting points of the period 3 elements except for silicon.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting point /K	371	923	933		317	392	172	84

a) Explain in terms of bonding why the melting point of magnesium is higher than that of sodium

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..... **(2marks)**

b) State the type of bonding between atoms in the element silicon and name the type of structure which silicon forms.

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..... **(2marks)**

c) Predict the approximate melting point of silicon.

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..... **(2marks)**

d) Explain why chlorine has a lower melting point than sulphur.

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..... **(2marks)**

e) Predict the approximate melting point of potassium and give one reason why it is different from that of sodium.

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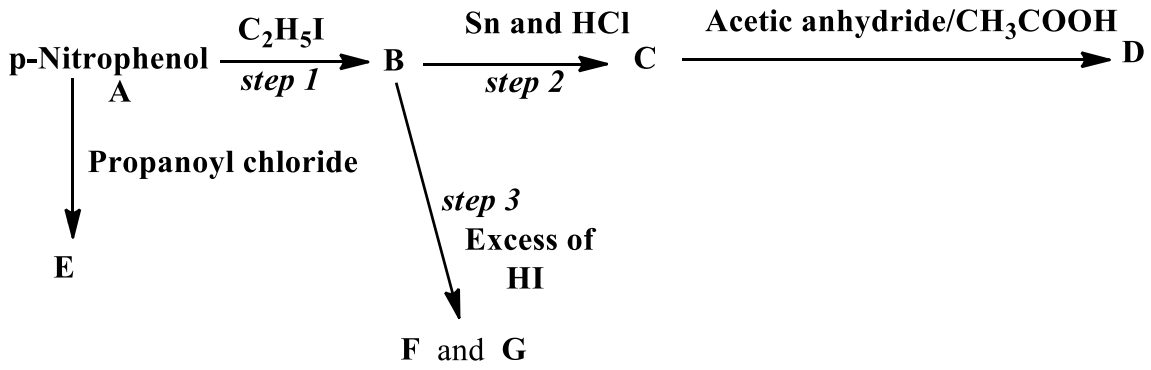
..... **(2marks)**

19.Given the flow-chart



(a) Determine the compounds presented by letters **A, B, C ... G.**

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(7marks)

(b) What are the conditions for reaction in step 3

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..... **(1mark)**

(c) Name the type of the mechanism of reaction in step 1

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..... **(1mark)**

(d) What is the role of concentrated NaOH under heating added in step 2?

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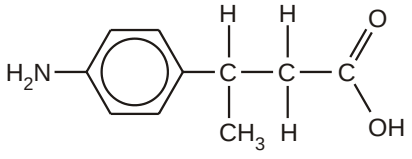
..... **(1mark)**

20. Compound **A**, shown below, is an amino acid that is being used in the development of a new anti-inflammatory drug.



compound **A**

(a) (i) Explain why this molecule is described as an *amino acid*.

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..... **(2marks)**

(ii) State the general formula of an amino acid.

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..... **(1mark)**

Explain whether or not compound **A** fits this general formula.

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..... **(2marks)**

(b) Compound **A** exists as a zwitterion in aqueous solution.

(i) Draw the structure of this zwitterion. .....
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..... **(1mark)**

(ii) Show how the structure of the zwitterion would change if the solution was acidified with dilute hydrochloric acid. .....
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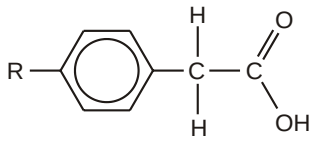
..... **(2marks)**

(c) The anti-inflammatory drug is made by combining compound **A** with compound **B**, shown below. R represents a side chain.



compound **B**

Show the structure of the anti-inflammatory drug formed from compound **A** and compound **B**.

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..... **(2marks)**

21. 0.987 g of impure potassium permanganate $KMnO_4$ was dissolved in 250 cm^3 of aqueous solution. 20 cm^3 of acidified solution of $KMnO_4$ required 24.4 cm^3 of sodium ethanedioate (sodium oxalate $Na_2C_2O_4$) in titration. Given that 1.675 g of $Na_2C_2O_4$ had been dissolved in 250 cm^3 of aqueous solution:

a. State the colour change (s) at the end of titration.

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..... **(1 mark)**

b. Work out the oxidation states of **Mn** in MnO_4^- and **C** in $C_2O_4^{2-}$

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..... **(2 marks)**

c. Write a redox equation between acidified MnO_4^- and $C_2O_4^{2-}$

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..... **(2 marks)**

d. Calculate the percentage purity of $KMnO_4$ in the sample.

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..... **(5 marks)**

22. The table lists the equations for five processes. **(2marks)**

For each process, predict the sign of ΔS.

Process	**sign of ΔS**
$NaBr(s) + (aq) \rightarrow NaBr(aq)$	
$H_2O(l) \rightarrow H_2O(g)$	
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	
$CoCl_2(s) + 6H_2O(l) \rightarrow CoCl_2.6H_2O(s)$	

(b) Ethanol can be combusted as shown in the equation.

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

Standard entropies are shown in the table.

substance	$CH_3CH_2OH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
S^e, J K^{-1} mol^{-1}	161	205	214	70

Calculate the standard entropy change, ΔS^e, for this reaction

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..... **(3marks)**

(c) The combustion of ethanol is an exothermic reaction. This reaction occurs spontaneously at low temperatures but does **not** occur at very high temperatures. Explain why.

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..... **(2marks)**

(d) The decomposition of calcium carbonate is an endothermic reaction.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

ΔH = +178 kJ mol^{-1} and ΔS = +159 J K^{-1} mol^{-1}

Calculate the **minimum** temperature at which this reaction becomes feasible. Show all your working.

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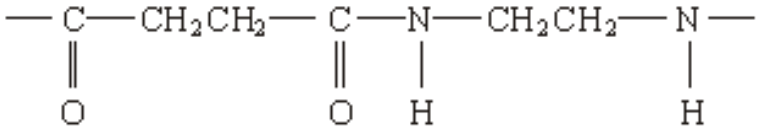
..... **(3 marks)**

23. (a) The structure below shows the repeating unit of a polymer.



By considering the functional group formed during polymerization, name this type of polymer and the type of polymerization involved in its formation.

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..... **(2marks)**

(b) Draw the structure of the species present in solid aminoethanoic acid, $H_2N\text{-}CH_2\text{-}COOH$

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..... **(1mark)**

(c) Explain why the melting point of aminoethanoic acid is much higher than that of hydroxyethanoic acid, $HO\text{-}CH_2\text{-}COOH$

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..... **(2marks)**

24. Three electrolytic cells **A,B,C** containing solutions of Zinc sulphate, Silver nitrate and Copper sulphate respectively, are connected in series. A steady current of 1.5 amperes were passed through them until 1.45g of Silver deposited at the cathode of cell B.

(a) Draw a well labeled diagram for this electrolytic cell (electrolysis setup)

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..... **(3marks)**

(b) How long did the current flow?

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..... **(3marks)**

(c) What mass of copper and zinc were deposited?

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(4marks)

(Atomic masses: Ag=107.9, Cu=63.55, Zn=65.38)

25. In the extraction of Aluminium;

(i) Name the process of concentration of bauxite.

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(1mark)

(ii) Write the cathode reaction in electrolytic reduction of alumina.

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(1mark)

(iii) Write the function and chemical formula of cryolite.

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(2marks)

(iv) Write a chemical equation for the action of heat on Aluminium hydroxide.

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(1mark)

(v) Why is it necessary to replace anodes time to time?

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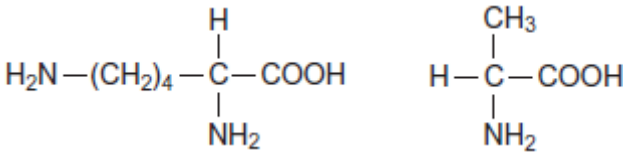
(2marks)

26. Lysine and alanine are two amino acids.



lysine alanine

(a) Give the IUPAC name of lysine.

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(1mark)

(b) Draw structures to show the product formed in each case when lysine reacts with:

(i) an excess of aqueous HCl

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(1mark)

(ii) an excess of aqueous NaOH

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(1mark)

(iii) methanol in the presence of a small amount of concentrated H_2SO_4 **(1mark)**

(c) Draw a dipeptide formed from one molecule of lysine and one molecule of alanine.

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(1mark)

28. Determine the degree of dissociation (in %) of 0.05 M NH_3 at 298 K in a solution of pH=11.

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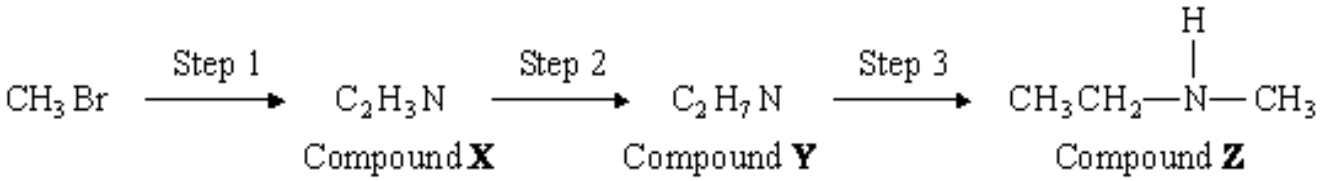
(3marks)

28. Compound **Z** can be formed via compounds **X** and **Y** in the three step synthesis shown below.



(a) Identify compounds **X** and **Y** and give reagents and conditions for Steps 1 and 2.

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(1mark)

(b) State the **type** of compound of which **Z** is an example.

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... **(1mark)**

(c) Compound **Z** reacts with a large excess of bromomethane to form a solid product. Draw the structure of this product and name the type of mechanism for this reaction.

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..... **(2marks)**

29. Oxidation and reduction can be defined in terms of electron transfer.

(a) Define the term *reduction* in terms of electrons.

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..... **(1mark)**

(b) The oxide of nitrogen formed when copper reacts with nitric acid depends upon the concentration and the temperature of the acid. The reaction of copper with cold, dilute acid produces NO as indicated by the following equation.

$$3Cu + 8H^+ + 2NO_3^- \rightarrow 3Cu^{2+} + 4H_2O + 2NO$$

In warm, concentrated acid, NO_2 is formed.

Oxidation states can be used to understand electron transfer in these reactions.

(i) Give the oxidation states of nitrogen in NO_3^-, NO and NO

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..... **(1mark)**

(ii) Identify, as oxidation or reduction, the formation of NO from NO_3^- ions in the presence of H^+ ions. Deduce the half-equation for the reaction.

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..... **(2marks)**

(iii) Deduce the half-equation for the formation of NO_2 from NO_3^- ions in the presence of H^+ ions.

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..... **(1mark)**

(iv) Deduce the overall equation for the reaction of copper with NO_3^- ions and H^+ ions to produce Cu^{2+} ions, NO_2 and water.

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..... **(2marks)**

30. Ethyl ethanoate can be prepared by the reactions shown below.

Reaction 1

$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$ $\quad \Delta H^{\ominus} = -2.0$ kJ mol^{-1}

Reaction 2

$CH_3COCl(l) + C_2H_5OH(l) \rightarrow CH_3COOC_2H_5(l) + HCl(g)$ $\quad \Delta H^{\ominus} = -21.6$ kJ mol^{-1}

Use the information given above and the data below to calculate values for the standard entropy change, $\Delta S^{\ominus}$, and the standard free-energy change, $\Delta G^{\ominus}$, for **Reaction 2** at 298 K.

	$CH_3COCl(l)$	$C_2H_5OH(l)$	$CH_3COOC_2H_5(l)$	$HCl(g)$
$S^{\ominus}/JK^{1}mol^{1}$	201	161	259	187

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31. (a) Define the term Relative lowering of vapour pressure.

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..... **(1mark)**

(b) Derive the relationship between relative lowering in vapour pressure and molar mass of the solute.

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..... **(1mark)**

(c) A 10% aqueous solution of cane sugar (molecular mass 342) is isotonic with 1.754% aqueous solution of urea. Find the molecular mass of solution.

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..... **(3marks)**

(d) Calculate boiling point of a solution prepared by dissolving 15.0 g of NaCI in 250.0 g of water (Kb for water = $0.512K.kg.mol^{-1}$), Molar mass of NaCI=$58.44g.mol^{-1}$).

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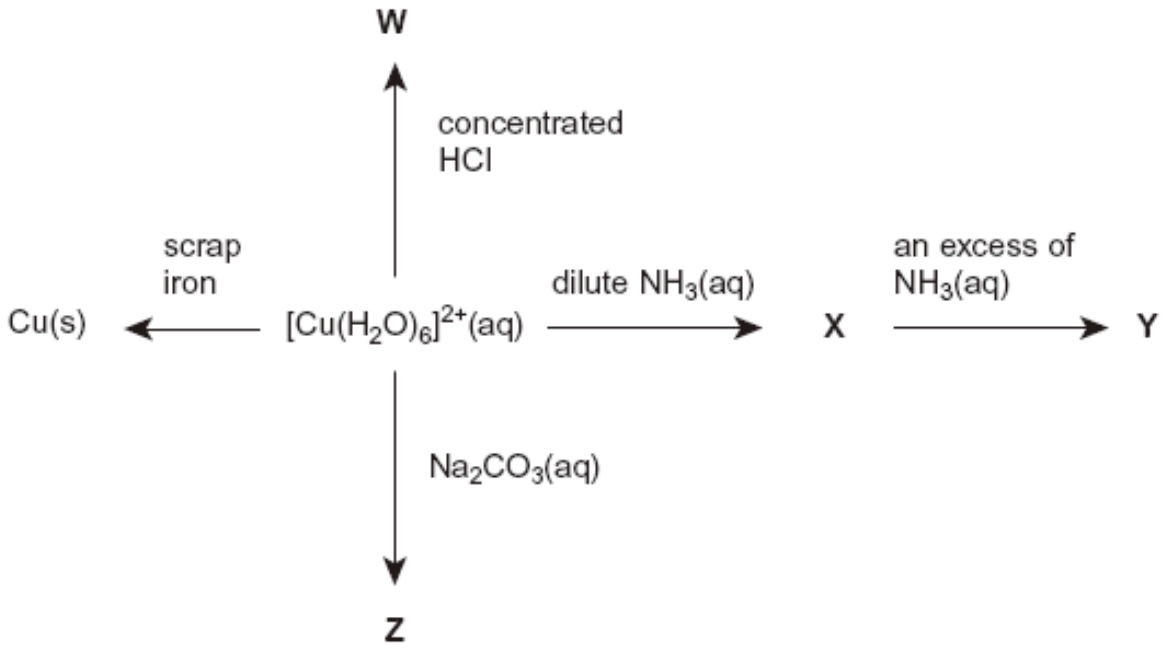
..... **(3marks)**

32. The scheme below shows some reactions of copper(II) ions in aqueous solution. **W**, **X**, **Y** and **Z** are all copper-containing species.



(a) Identify ion **W**. Describe its appearance and write an equation for its formation from $[Cu(H_2O)_6]^{2+}(aq)$ ions.

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(3marks)

(b) Identify compound **X**. Describe its appearance and write an equation for its formation from $[Cu(H_2O)_6]^{2+}(aq)$ ions.

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(3marks)

(c) Identify ion **Y**. Describe its appearance and write an equation for its formation from **X**.

Ion **Y**

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(3marks

(d) Identify compound **Z**. Describe its appearance and write an equation for its formation from $[Cu(H_2O)_6]^{2+}(aq)$ ions.

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(3marks)

(e) Copper metal can be extracted from a dilute aqueous solution containing copper(II) ions using scrap iron.

(i) Write an equation for this reaction and give the colours of the initial and final aqueous solutions.

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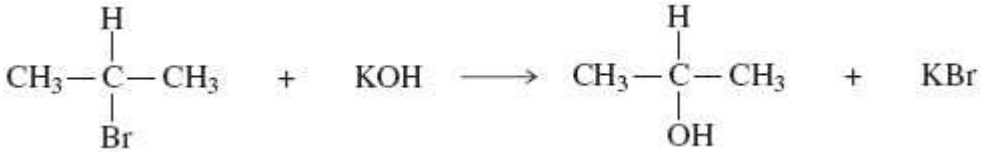
(3marks)

(ii) This method of copper extraction uses scrap iron. Give **two** other reasons why this method of copper extraction is more environmentally friendly than reduction of copper oxide by carbon.

(2marks)

33. (a) Consider the following reaction.



(i) Name and outline a mechanism for this reaction.

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(2marks)

(ii) Name the haloalkane in this reaction.

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(1mark)

(iii) Identify the characteristic of the haloalkane molecule that enables it to undergo this type of reaction.

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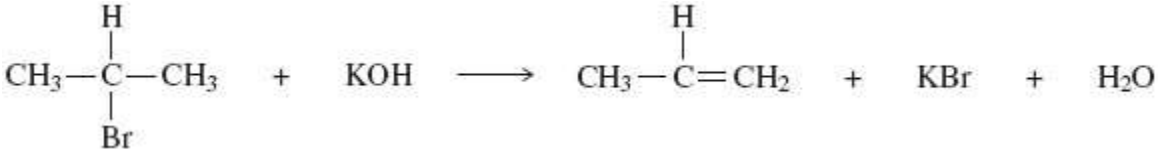
(1mark)

(b) An alternative reaction can occur between this haloalkane and potassium hydroxide as shown by the following equation.



Name and outline a mechanism for this reaction.

(3marks)

(c) Give **one** condition needed to favour the reaction shown in part (b) rather than that shown in part (a).

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(1mark)

(d) Alkenes can be polymerised to produce poly(alkenes).

(i) State the type of polymerisation that alkenes undergo.

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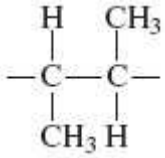
(1mark)

(ii) Name the alkene that gives a polymer with the repeating unit shown below.



(1mark)

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34. (a) Determine the degree of ionization and pH of a 0.05 M ammonia solution. Also calculate ionization constant of its conjugated acid. Given that Kb for NH_3 is 1.77×10^{-5}.

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..... **(4marks)**

(b) What is buffer solution? Write any two properties of buffer solution.

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..... **(2marks)**

(c) A buffer solution contains 0.40 mol of ammonium hydroxide and 0.50 mol of ammonium chloride to make a buffer solution of 1 L. Calculate the pH of the resulting buffer solution. Dissociation constant of ammonium hydroxide at 25°C is 1.81×10^{-5}

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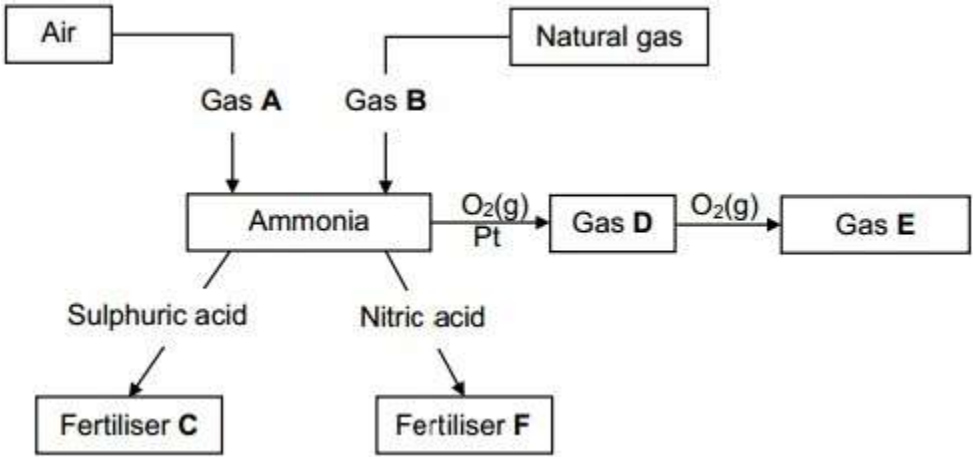
..... **(4marks)**

35. Different processes used in the preparation of fertilisers C and F are represented in the flow diagram below.



1. Write down the NAME or FORMULA of:

1.1 Gas A

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..... **(1mark)**

1.2 Gas B

.....

..... **(1 mark)**

1.3 Fertiliser F

.....

..... **(1 mark)**

2.Sulphuric acid is used to prepare fertiliser C.

Write down:

2.1 The name of the industrial process used to prepare sulphuric acid

..... **(1 mark)**

2.2 A balanced equation for the preparation of fertiliser C (3 marks)

.....

.....

.....

3 Gases D and E are prepared during the Ostwald process. Write down the:

3.1 Name given to the preparation of gas D from ammonia.....

..... **(1 mark)**

3.2 Balanced equation for the preparation of gas D

.....

.....

..... **(3 marks)**

3.3 NAME or FORMULA of gas E

.....

..... **(1 mark)**