L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2024 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	29th August 2024
TIME:	9:00 a.m. to 12:05 p.m.

Required Data: Relative atomic masses (RAM): H = 1, C = 12, O = 16, Br = 80
Molar Gas Constant, R = 8.31 J mol^{-1} K^{-1}
Faraday's Constant = 96500 C mol^{-1}

Answer ALL questions

1. a) i) Using the VSEPR theory, draw and name the shapes of the following species.

PF_4^+	Name of shape: _____
PF_4^-	Name of shape: _____
NH_3	Name of shape: _____

(3)

Question continues on the next page.

ii) Give approximate values for the angles in PF_4^+ and NH_3 and explain why they differ.

_____

_____

_____

_____

_____ (3)

b) i) Give the coordination number for the sodium and chloride ions in the sodium chloride unit cell.

_____ (1)

ii) Suggest whether caesium chloride is expected to have a larger or smaller coordination number than sodium chloride. Explain your answer.

_____

_____

_____

_____ (2)

(Total: 9 marks)

2. a) Explain the trend in thermal stability of the Group 2 carbonates.

_____

_____

_____

_____

_____

_____

_____ (3)

b) Explain the change in reactivity of the Group 2 metals with cold water down the group. Use chemical equations to back up your answers.

_____

_____

_____

_____

_____

_____

_____

_____ (4)

c) Lithium is a Group 1 metal, however, its compounds tend to exhibit chemical properties similar to those of magnesium. Explain this statement and list **TWO** properties to demonstrate this.

_____

_____

_____

_____

_____ (3)

(Total: 10 marks)

3. This question is about periodicity.

a) F^- and Na^+ are said to be isoelectronic.

i) Give the electronic configuration of these ions.

_____ (1)

ii) Use your knowledge of the nuclear charge and electronic configuration of these ions to suggest and explain which one has the smallest radius.

_____

_____

_____

_____

_____

_____ (3)

Question continues on the next page.

b) i) Describe the ionic/covalent character of sodium, magnesium and aluminium chlorides.

_____

_____

_____

_____ (4)

ii) Explain why a solution of aluminium sulfate is acidic.

_____

_____

_____

_____

_____

_____

_____

_____ (3)

(Total: 11 marks)

4. a) State Dalton's law of partial pressures.

_____

_____

_____ (1)

b) A gaseous mixture composed of 110 g of carbon dioxide and 112 g of oxygen has a total pressure of 5.95 atm. What is the partial pressure of each gas?

_____

_____

_____

_____

_____

_____ (4)

c) i) An emptied 100 cm^3 gas syringe was mounted in a thermostated oven. Some volatile liquid was transferred into a fine hypodermic syringe, and the syringe was weighed. The liquid was quickly injected into the gas syringe via a self-sealing rubber cap. The hypodermic syringe was re-weighed immediately.

Experimental data:

- Mass of the hypodermic syringe and the volatile liquid was 10.6403 g.
- Mass of hypodermic syringe after injection of the volatile liquid was 10.4227 g.
- Volume of volatilised liquid in the gas syringe was 67.3 cm^3.
- Oven temperature was at 82 ^oC.
- Pressure was 100260 Pa.

Calculate the relative molecular mass of the liquid.

_____

_____

_____

_____

_____

_____ (4)

ii) Suggest a possible molecular formula for the volatile liquid if it was formed from the reaction of bromine and a hydrocarbon.

_____

_____ (1)

(Total: 10 marks)

5. a) The reduction half equations for copper and silver, and their respective standard electrode potentials are:

Cu^{2+} (aq) + $2e^-$ → Cu (s) $E^\ominus$ = + 0.34 V

Ag^+ (aq) + e^- → Ag (s) $E^\ominus$ = + 0.80 V

i) Indicate which electrode acts as an anode and which electrode acts as the cathode. Show your reasoning.

_____

_____

_____

_____ (2)

Question continues on the next page.

ii) Write the cell diagram of the copper-silver galvanic cell.

_____

_____

_____ (1)

b) i) Write the overall redox reaction taking place in the galvanic cell and calculate the standard electrode potential for the reaction.

_____

_____

_____

_____ (3)

ii) Find the value of $\Delta G^{\ominus}$ for this redox reaction and explain why this is a spontaneous reaction.

_____

_____

_____ (3)

c) The effect of changes in temperature and ion concentration on the potential of a cell can be deduced using the Nernst equation. For a half-cell at 298 K, the Nernst equation reduces to:

$$E = E^{\ominus} + \frac{0.059}{z} \log_{10} \frac{[\text{oxidised species}]}{[\text{reduced species}]}$$

Calculate the electrode potential at 298 K of a Cu^{2+}/Cu half cell where the concentration of $Cu^{2+}(aq)$ is 0.0010 mol dm^{-3}.

_____

_____

_____

_____

_____

_____ (2)

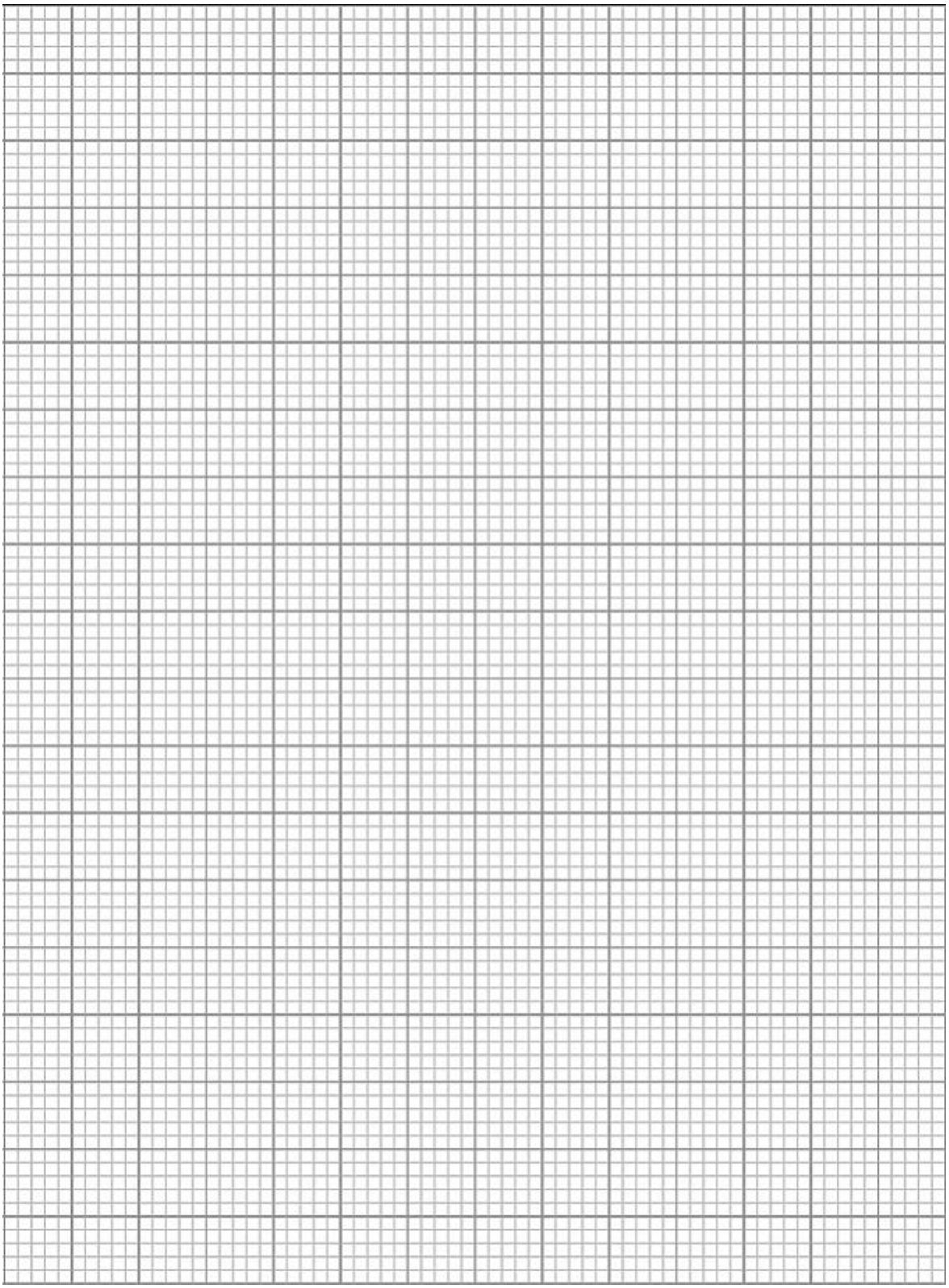
(Total: 11 marks)

6. A student investigated the rise in temperature when sulfuric(VI) acid solution was added to a 1.00 mol dm^{-3} sodium hydroxide solution. Both solutions were at 25.0 °C. The procedure was as follows:
   - 20.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution was poured into a beaker.
   - Then, 5.0 cm^3 of sulfuric(VI) acid solution from the burette was added to the aqueous sodium hydroxide. The reaction mixture was stirred gently, and the maximum temperature was recorded.
   - Immediately after the maximum temperature was recorded, another 5.0 cm^3 of sulfuric(VI) acid solution was added from the burette, and the maximum temperature was recorded. This was repeated until 35 cm^3 of sulfuric(VI) acid solution was added in total. The data is reported in the Table below.

Volume of sulfuric(VI) acid added (cm^3)	**Maximum Temperature (°C)**
5.0	27.0
10.0	29.0
15.0	31.0
20.0	33.0
25.0	32.0
30.0	29.0
35.0	26.0

a) Plot the maximum temperature against volume of sulfuric(VI) acid solution added. (4)

Question continues on the next page.



b) Use the graph to answer the following questions.

i) Extrapolate the two sections of the graph and deduce the maximum temperature reached at the equivalence point.

Maximum temperature at equivalence point: _____ (2)

ii) What volume of sulfuric(VI) acid produces this temperature?

_____ (1)

iii) Calculate the concentration of the sulfuric(VI)acid solution.

_____

_____

_____

_____ (3)

iv) Calculate the enthalpy change of this reaction. Assume that the density of the solution is 1.0 g cm^{-3} and that the specific heat capacity of water is 4.18 J g^{-1} K^{-1}.

_____

_____

_____

_____ (3)

(Total: 13 marks)

7. a) Fill in the following table giving the compound, reagent, conditions, or main product required for the preparation of these halogenocompounds.

Compound	Reagent	Conditions	Main product
$CH_3CH_2CH_3$			$CH_3CH_2CH_2Br$
$CH_3CH=CH_2$	HBr (g)	Room temperature	
$CH_3CH=CH_2$			$CH_3CHBrCH_2Br$
	HCl (g)	$HgCl_2$, heat	$CH_3CCl=CH_2$
$CH_3C\equiv CH$	HCl (g)	Excess HCl (g), heat	

(7)

b) Give an equation, including reagents and conditions, for the conversion of 1,2-dibromopropane into the corresponding diol.

_____ (2)

c) i) Give the reagent(s) for the reaction of the diol prepared in (b) above with a mild oxidising agent and immediate distillation at a controlled temperature.

_____ (1)

Question continues on the next page.

ii) Give the structure of the dicarbonyl compound mentioned in part (c)(i) above.

_____ (1)

(Total: 11 marks)

8) This question is about aromatic chemistry.

a) Benzene and methylbenzene are both hydrocarbons. Benzene has a melting point of 6 °C whilst that of methylbenzene is -95 °C. Explain.

_____

_____

_____

_____ (3)

b) Give the reagent and conditions needed to change:

i) methylbenzene to (chloromethyl)benzene;

_____ (1)

ii) methylbenzene to chloro-4-methylbenzene.

_____ (1)

c) Benzene can be nitrated at a temperature of 60 °C, whilst methylbenzene can undergo nitration at a lower temperature.

i) Give the reagents needed for the nitration of benzene.

_____ (1)

ii) State why methylbenzene undergoes nitration at a lower temperature.

_____ (1)

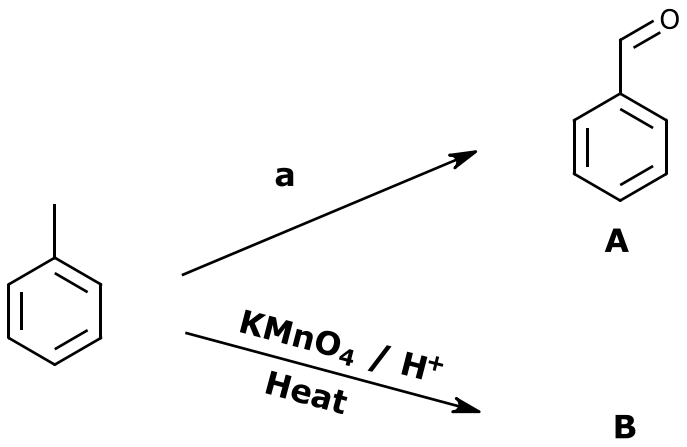
iii) State what happens if a higher temperature is used.

_____ (1)

iv) Draw the structure of the main organic product formed when benzene is nitrated at 100 °C.

_____ (1)

d) The diagram below shows two oxidation reactions for methylbenzene.



i) Give the name of structure **A**.

_____ (1)

ii) Give reagent **a**.

_____ (1)

iii) Draw the structure of compound **B**.

_____ (1)

(Total: 12 marks)

9) This question is about the identification of organic molecules.

a) An organic compound, **J** is a colourless liquid used for flavouring, as a solvent, and in making paints and varnishes. The mass spectrum of **J** shows a molecular ion peak with an m/z value of 88. **J** gives the ^{1}H NMR spectrum shown in Figure 1. The peak integration data is shown in brackets. Chemical shifts are given in the table below the spectrum.

Question continues on the next page.

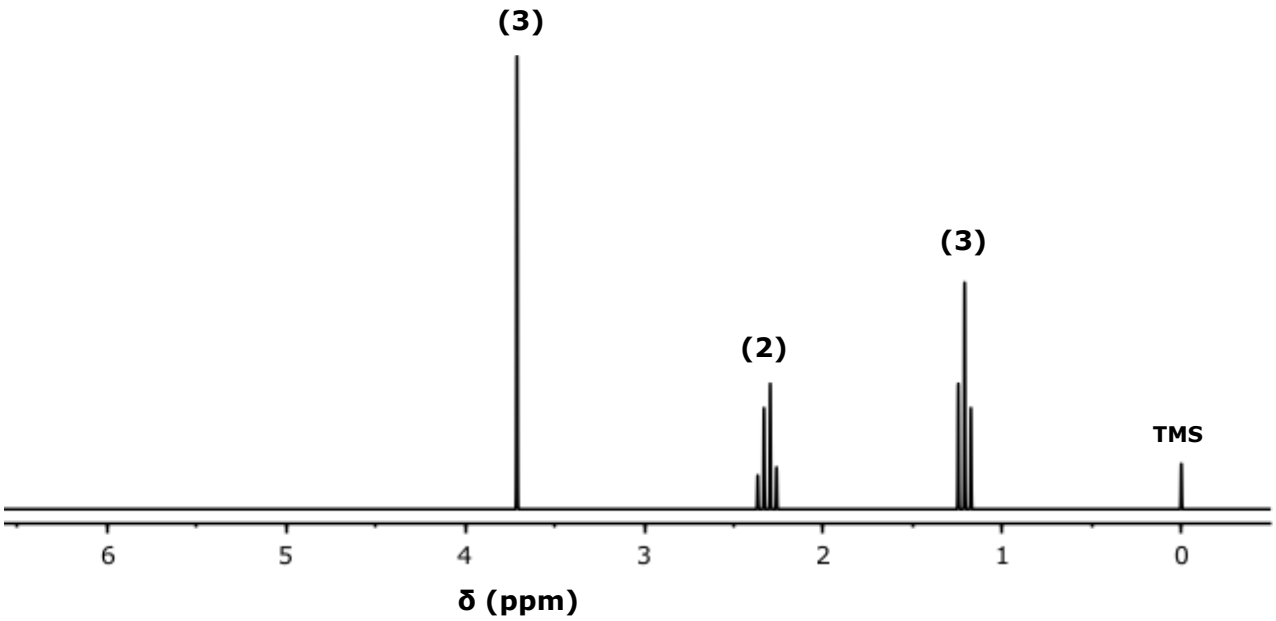


Figure 1**:** High-resolution ^{1}H NMR spectrum of compound **J**

Type of Proton	Chemical shift, δ (ppm)
R-O**H**	0.5 – 5.0
R-C**H₃,** R-C**H₂**-R	0.7 – 1.4
R-C**H₂**-CO	2.0 - 2.4
R-C**H₂**-O, C**H₃**-O	3.3 – 4.3
R-C**H**O	9.0 – 10.0
R-COO**H**	10.0 – 12.0

i) What does the m/z value of 88 mentioned above indicate?

_____ (1)

ii) Explain the information about compound **J**'s structure that can be obtained from Figure 1 and the chemical shift data.

_____

_____

_____

_____

_____ (4)

b) Hydrolysis of **J** gives two different products, **K** and **L**. The IR spectrum of compound **L** is given in Figure 2. The absorption data is also given below.

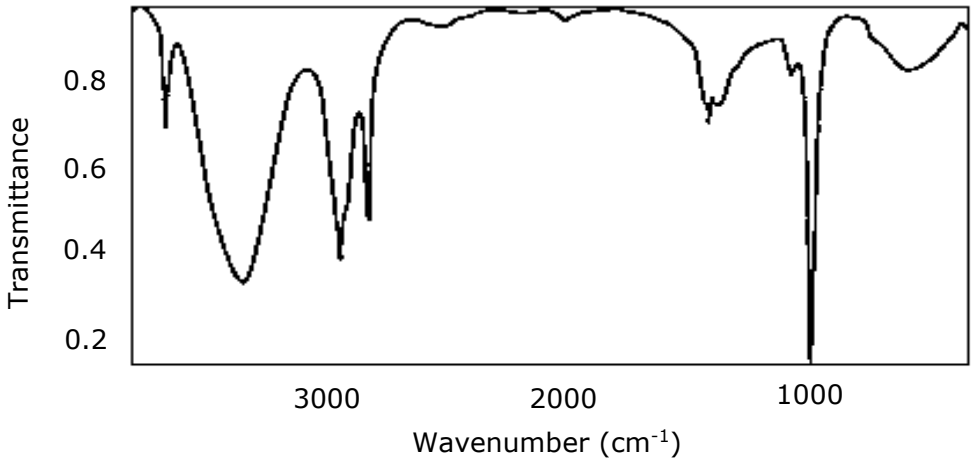


Figure 2**:** IR spectrum of compound **L**

Wavenumber (cm^{-1})	**Bond**	**Compound**
3200 – 3500 (broad)	O–H	alcohols/phenol
2500 – 3500 (very broad)	O–H	carboxylic acid
3300	C–H	aromatic
2845 – 2975	C–H	alkane (aliphatic)
2650 – 2880	C–H	aldehyde
1650 – 1750	C=O	aldehyde/ketone/carboxylic acid
1050 – 1210	C-O	alcohol/ether/ester

Use this information to identify the homologous series to which compound **L** belongs. Explain your answer.

_____

_____

_____

_____ (3)

Question continues on the next page.

c) **K** is a liquid at room temperature with a pungent and unpleasant smell. It can be converted to other compounds by reaction with PCl_5, metals, carbonates, alcohols, and other reagents. When heated with soda lime, it produces a two-carbon hydrocarbon.

i) Give the condensed structural formula of compound **K**.

_____ (1)

ii) State the class of compounds obtained when **K** reacts with PCl_5.

_____ (1)

iii) Give the structure of the product of the reaction of **K** with the metal potassium.

_____ (1)

iv) The compounds obtained in parts (ii) and (iii) above can react together. Give the name of the product obtained in this specific reaction.

_____ (1)

d) From the information obtained in this question, give the name of compound **J.**

_____ (1)

(Total: 13 marks)

Blank Page

Blank Page

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2024 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	II
DATE:	30th August 2024
TIME:	9:00 a.m. to 12:05 p.m.

A Periodic Table is provided.

Answer TWO questions from each section and ANY other question.

SECTION A

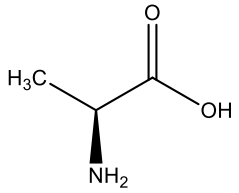
1. This question is about the pH of several solutions. Give all pH values to two decimal places.
   a) i) Calculate the pH of a 0.154 mol dm^{-3} hydrochloric acid solution. (2)
   ii) Calculate the pH of the solution formed when 10.0 cm^3 of 0.154 mol dm^{-3} hydrochloric acid is diluted to 1.0 dm^3 of solution. (2)

   b) The weak acid HX has an acid dissociation constant K_a of 4.83×10^{-5} mol dm^{-3} at 25 °C. If the pH of a solution of HX is 2.48, calculate the concentration of the HX solution. (4)

   c) The acid dissociation constant of another weak acid, HY, is 1.35×10^{-5} mol dm^{-3} at 25 °C. A quantity of 0.0236 moles of the salt NaY, was dissolved in 50.0 cm^3 of 0.428 mol dm^{-3} solution of HY to form solution A.
   i) Describe the function of solution A. (2)
   ii) Calculate the pH of this solution. Indicate any assumptions adopted in the calculation. (5)
   iii) Calculate the pH of solution A, on addition of 5.00×10^{-4} moles of sodium hydroxide. Assume no change in total volume. (5)

(Total: 20 marks)

2. This question is about organic chemistry. The amino acid alanine has the following structure:



   a) i) Give the systematic name of the amino acid. (1)
   ii) Give **TWO** repeating units of the polymer formed from this amino acid. (2)

   b) Discuss the melting point and solubility of amino acids such as alanine in water. (4)

   c) Alanine can react with ethanol in the presence of acid to form **B**, with PCl_5 to form **C**, and with propanoyl chloride to form **D**. Identify organic compounds **B, C,** and **D** by clearly showing the structures. (4)

Question continues on the next page.

d) Explain how 3-aminobutanamide can be converted to:
   i) propane-1,2-diol;
   ii) 3-aminobutanenitrile.

   Equations are **not** required, but the answer should show the reagents, conditions, and structures of 3-aminobutanamide, 3-aminobutanenitrile and any intermediate compounds formed. The conversions may involve more than one step. (5)

e) Compare the conditions needed for the hydrolysis of acid chlorides, acid anhydrides, esters and amides. (4)

(Total: 20 marks)

3. This question is about kinetics.
   a) Describe the mechanism for the reaction of 2-bromo-2-methylbutane with potassium cyanide. (5)
   b) Give the systematic name of the product formed**.** (1)
   c) Write a rate equation for this reaction. (1)
   d) Define the molecularity of a reaction and give the molecularity of this reaction. (2)
   e) Explain why 2-bromo-2-methylbutane reacts via the mechanism described in part (a).(3)
   f) Alkenes react with hydrogen in the presence of a heterogeneous catalyst. Describe the underlined term and explain the action of such a catalyst in this reaction. (5)
   g) Alkynes can also react with hydrogen in the presence of the same catalyst as in (f) or a poisoned catalyst. Explain this statement indicating what determines the choice of catalyst. (3)

(Total: 20 marks)

4. This question is about the chemistry of sulfur and oxygen and titrimetry.
   a) i) The concentration of sulfur dioxide in the atmosphere can be determined by reacting a sample of air with acidified manganate(VII). In an experiment, 25 m^3 of air was bubbled through 50 cm^3 of a 0.010 mol dm^{-3} acidified potassium manganate(VII) solution. SO_2 is oxidised to sulfate(VI) ions in this reaction. Assume that only SO_2 molecules in the air sample react with manganate(VII) ions.
   The resulting solution required 20 cm^3 of a 0.0050 mol dm^{-3} iron(II) sulfate to completely neutralise the excess manganate(VII) ions. Calculate the concentration of SO_2 in mg per m^3 of air. (8)
   ii) Using equations, explain how sulfur dioxide in the atmosphere results in the formation of acid rain. (4)

   b) Using chemical equations, describe the use of potassium superoxide in rebreathers. (4)

   c) Treatment of aqueous acidified dichromate(VII) ions with hydrogen peroxide, results in the formation of a colourless gas and a green solution. Explain what is happening in this reaction, including ionic equations in your answer. (4)

(Total: 20 marks)

SECTION B

5. This question is about transition metals.
   a) Manganese can exist in several oxidation states.
      i) Determine the oxidation state of manganese in the following compounds: K_2MnO_4, MnO_3F and $(NH_4)_3[Mn(CN)_6]$. (3)
      ii) Give the electronic configuration for manganese that gives rise to the following oxidation states: +2 and +4. (2)
      iii) Suggest why the +7 state is the maximum value for oxidation in manganese. (2)

   b) Describe how the haem molecule in blood acts as a polydentate ligand. (3)

   c) Complexes of hydrates of chromium(III) chloride may exhibit geometrical isomerism.
      i) Draw the complex ion of the two isomers. In your answer, include the name of the complex ions. (4)
      ii) Suggest why the exchange of water and chloride ions leads to a colour change of the complex ion. (2)
      iii) Describe, using chemical equations, the effect of pH on the equilibrium between chromate(VI) and dichromate(VI) ions. Your answer should include what is observed as the pH is changed. (4)

(Total: 20 marks)

6. This question is about the chemistry of nitrogen and hydrogen.
   a) Nitrogen can form different oxides.
      i) Draw the Lewis structures of NO, NO_2 and N_2O. (3)
      ii) NO_2 undergoes disproportionation when dissolved in water. Explain this statement with the aid of a chemical equation. (2)
      iii) NO is a toxic pollutant that forms when combustion occurs in car engines. Explain how catalytic converters can be used to help reduce its emissions. (3)
      iv) Nitric(V) acid is a compound of nitrogen that can be used in multiple reactions. Explain how a small sample of anhydrous nitric(V) acid can be prepared in the laboratory starting from potassium nitrate(V). (2)

   b) Hydrogen is another important chemical used in several industrial processes.
      i) Describe the industrial manufacture of hydrogen from natural gas. (6)
      ii) Give chemical equations to describe two ways to prepare hydrogen in the laboratory, one using sulfuric acid and the other using methanol. (4)

(Total: 20 marks)

7. This question is about chemical equilibria.
   a) A solution containing 1.00 g of X in 100 cm^3 of water was shaken with 10 cm^3 of ether. A portion of X, 0.80 g, transferred to the ether layer.
      i) Calculate the partition coefficient of X between ether and water. (3)
      ii) Calculate the amount of X extracted if the solution containing 1.00 g of X in 100 cm^3 of water was shaken with two successive 5 cm^3 portions of ether. (9)
      iii) Find the difference, if any, in the total amount of X extracted with a single 10 cm^3 portion and two successive 5 cm^3 portions of ether. (1)

Question continues on the next page.

b) Consider a covalent substance AB_2 that undergoes dissociation according to the following equation:

$$AB_2\ (g) \rightleftharpoons A\ (g) + B_2\ (g)$$

i) Derive an expression for K_c in terms of the degree of dissociation α and the initial concentration of AB_2, C. (5)

ii) State the units for K_c, if any. Explain your answer. (2)

(Total: 20 marks)

8. This question is about organic chemistry.

a) Benzene can react with ethanoyl chloride under appropriate conditions to give the ketone phenylethanone. Give the mechanism for this reaction clearly indicating any conditions required. (5)

b) Sodium phenoxide can form phenyl benzoate and ethoxybenzene in two separate reactions. Give equations, including the structures of any reagents required. (4)

c) Compound **S** burns, giving a sooty flame. It can be reduced to a compound **T,** which reacts with a mixture of cold $NaNO_2$ and HCl to give an unstable compound **U**. **U** can be converted to a compound **V,** which gives a purple complex when treated with neutral iron(III) chloride. **U** and **V** react together in the cold to give a yellow/brown solid.

i) Suggest structures for organic compounds **S, T, U,** and **V** which fit the information provided in the question. (4)

ii) Give the reagents required to reduce **S** to **T**. (2)

iii) Explain why cold conditions are required in the preparation of **U** from **T**. Describe what happens if the reaction is **not** carried out in the cold. (2)

iv) **T** and **V** react with bromine water to give a visible change. Discuss. (3)

(Total: 20 marks)

Index No.:_____ AM06/III.24s

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2024 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	III – *Practical*
DATE:	28th August 2024
TIME:	3 hours 5 minutes

1. You are provided with four solutions as follows:

   i) a solution of potassium manganate(VII) labelled **K_n**;
   ii) a solution of ethanedioic acid of concentration 0.05 mol dm^{-3} labelled **O**;
   iii) a solution of an ethanedioate salt of formula $M_2(C_2O_4).2H_2O$, where M is a Group 1 metal. This solution is labelled **A** and was prepared by dissolving 9.78 g of the salt per litre of solution;
   iv) 2M sulfuric acid.

In this experiment, you are required to:

   i) determine the molarity of solution **K_n**;
   ii) determine the relative molecular mass of the ethanedioate salt and, hence, the relative atomic mass of M.

a) Record the value of your laboratory number, n (found on solution **K**), on your answer book in the following box.

CANDIDATE LABORATORY NUMBER, n:.....

Determination of the molar concentration of solution K_n

b) Fill the burette with solution **K_n**. Into each of the three conical flasks, transfer a 25.0 cm^3 aliquot of solution **O** and add approximately 20 cm^3 of the 2M sulfuric acid. Heat the resulting solution to approximately 60 °C and titrate until the first permanent pink colour is obtained. Repeat the titration for concordant results and record your results in the table below.

	1st Titration	2nd Titration	3rd Titration
Final burette reading			
Initial burette reading			
Titre (cm^3)			

Mean titre: _____ cm^3 of solution **K_n**.

(20)

c) Manganate(VII) ions and ethanedioic acid react as follows:

$$2MnO_4^- + 5(COOH)_2 + 6H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Calculate the molar concentration of solution **K_n**.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Determination of the relative atomic mass of M

d) Fill your burette with solution $\mathbf{K_n}$. To each of the three conical flasks, transfer a 25.0 cm^3 aliquot of solution **A** followed by approximately 20 cm^3 of the 2M sulfuric acid. Heat the resulting solution to approximately 60 °C and titrate until the first permanent pink colour is obtained. Repeat the titration for concordant results and record your results in the table below.

	1st Titration	2nd Titration	3rd Titration
Final burette reading			
Initial burette reading			
Titre (cm^3)			

Mean titre: _____ cm^3 of solution $\mathbf{K_n}$.

(20)

e) Manganate(VII) and ethanedioate ions react as follows:

$$2MnO_4^- + 5(COO)_2^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Use your data to calculate the concentration of solution **A** and determine the relative atomic mass of metal M.

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total: 50 marks)

Please turn the page.

2. You are provided with an inorganic double salt labelled **X**. Carry out the tests described below and attempt to identify the inorganic salt **X**.

a) Dissolve approximately half your sample of **X** in 10 cm^3 of water. ***Retain this solution for subsequent tests***.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(4)

b) To around 1 cm^3 of the solution from test (a), add ammonia solution, first dropwise, followed by an excess.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(4)

c) To around 1 cm^3 of the solution from test (a), add sodium hydroxide solution, first dropwise, followed by an excess. ***Retain this solution for the next test.***

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(4)

d) Carefully heat the reaction mixture from test (c) over a Bunsen flame and test any vapours released with moist litmus paper.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(4)

e) To 1 cm^3 of the solution from test (a), add 2 cm^3 of sodium hydroxide solution, followed by **2 drops** of hydrogen peroxide solution. Boil the solution for one minute and cool. ***Retain this solution for the next test.***

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

f) To 1 cm^3 of the solution from test (e), add 1 cm^3 of dilute sulfuric acid.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Question continues on the next page.

g) Acidify 1 cm^3 of the solution from test (a) with 1 cm^3 of dilute nitric acid and add 1 cm^3 of barium chloride solution.

Observation	*Inference*
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(5)

Conclusion

Suggest a possible identity for substance **X**: _____ (3)

(Total: 30 marks)

3. Substance **C** is an organic solid. Carry out the tests described below and suggest a plausible chemical structure for this compound.

a) Transfer a tip of a spatula of solid **C** to a crucible lid and burn the solid.

Observation *Inference*

(4)

b) Add approximately half your sample of **C** to 15 cm^3 of water and shake. If the substance does not dissolve, warm gently. ***Retain this solution for subsequent tests.***

Observation *Inference*

(3)

c) Test the pH of the solution from test (b) with litmus paper.

Observation *Inference*

(3)

Question continues on the next page.

d) In a test tube, add a tip of a spatula of 2-naphthol followed by 2 cm^3 of dilute sodium hydroxide solution. Shake the contents and cool for 2 minutes in an ice bath. In another test tube, cool 2 cm^3 of dilute hydrochloric acid in the ice bath for 2 minutes. To the cold dilute hydrochloric acid, add a tip of a spatula of sodium nitrate(III), followed by a few crystals of **C** and shake. Mix the contents of the two test tubes.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(5)

e) To the 1 cm^3 of the solution from test (b), add 5 drops of dilute hydrochloric acid solution followed by 10 drops of neutral iron(III) chloride.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Conclusion

A possible structure for **C** is: _____ (2)

(Total: 20 marks)