L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	31st August 2026
TIME:	9:00 a.m. to 12:05 p.m.

Required Data: Relative atomic masses (RAM): H = 1, O = 16, Cl =35.5, Ag = 107.9 , Ba = 137.3

Answer ALL questions.

1. The question is about atomic structure.
   a) Define the following:
      i) atomic number;

      _____

      _____ (1)

      ii) nucleon number.

      _____

      _____ (1)

   b) Define relative atomic mass.

   _____

   _____

   _____

   _____ (1)

   c) Magnesium exists naturally as three isotopes, ^{24}Mg, ^{25}Mg and ^{26}Mg. The relative abundances of these isotopes are 78.9%, 10.0% and 11.1%, respectively. Calculate the relative atomic mass of magnesium.

   _____

   _____

   _____

   _____

   _____

   _____ (2)

Question continues on the next page.

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d) With the aid of chemical equations, describe **ONE** use of isotopes as tracers in mechanistic studies.

_____

_____

_____

_____

_____

_____

_____

_____

_____ (4)

(Total: 9 marks)

2. This question is about bonding in molecules.

a) Carboxylic acids can form dimers.

i) Explain how such dimers arise. Your answer should include a diagram showing the bonding between monomers.

_____

_____

_____

_____

_____ (3)

ii) Explain how dimer formation influences the boiling point of carboxylic acids.

_____

_____

_____

_____ (2)

b) Complete the following table. For each of the following substances at room temperature and pressure, state the strongest intermolecular attraction present. Explain your answer.

Substance	Intermolecular attraction	Explanation
NH_3		
I_2		
CH_3CHO		
HI		

(6)

(Total: 11 marks)

Please turn the page.

3. a) Transition metal ions commonly form complex ions with ligands of different denticity. Explain why polydentate ligands form more stable complexes than comparable monodentate ligands.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ (4)

b) The complex ion $[Cu(H_2O)_6]^{2+}$ reacts with excess aqueous ammonia.

i) Describe the stepwise changes that occur, including any observations.

_____

_____

_____

_____

_____

_____ (3)

ii) Write an equation for the formation of the final complex ion.

_____ (1)

c) Some transition metal complexes are coloured, whereas others are colourless. Explain why complexes of Cu(II) are coloured but complexes of Cu(I) are colourless.

_____

_____

_____

_____

_____

_____

_____ (3)

d) When excess concentrated hydrochloric acid is added to an aqueous solution of $[Cu(H_2O)_6]^{2+}$, a different complex ion is formed.

i) State the formula and shape of the complex ion formed.

_____

_____ (1)

ii) Explain why the coordination number changes during this ligand exchange reaction.

_____

_____

_____

_____ (2)

(Total: 14 marks)

4. This question is about redox equilibria.

a) In the presence of $H_2SO_4(aq)$, $K_2Cr_2O_7(aq)$ oxidises $K_2C_2O_4(aq)$ to $CO_2(g)$ being itself reduced to $Cr^{3+}(aq)$ salt. Construct the half equations and then the ionic equation of the reaction of dichromate(VI) ions with ethanedioate ions.

_____

_____

_____

_____ (2)

b) Name the standard reference half-cell against which electrode potentials are measured, and for this half-cell, state the conditions to which the term "standard" refers.

_____

_____

_____ (2)

Question continues on the next page.

c) Consider the following standard electrode potentials:

Half-equation	$E^\ominus$ (V)
$S_2O_8^{2-}(aq) + 2e^- \rightarrow 2SO_4^{2-}(aq)$	+2.01 V
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80 V

i) Deduce the equation for the spontaneous reaction in the cell formed when the two half-cells are connected.

_____

_____ (1)

ii) Calculate the cell emf.

_____

_____ (1)

iii) State how, if at all, the electrode potential of the Ag^+/Ag half-cell would change if the concentration of Ag^+ is decreased. Explain your answer.

_____

_____

_____ (2)

(Total: 8 marks)

5. This question concerns chemical energetics.

a) Distinguish between the standard enthalpy of solution and the standard enthalpy of solvation.

_____

_____

_____

_____

_____

_____

_____ (2)

b) The isomers cis-but-2-ene and trans-but-2-ene have standard enthalpies of formation of −5.7 kJ mol^{-1} and −10.1 kJ mol^{-1} and standard entropies of 301 J K^{-1} mol^{-1} and 296 J K^{-1} mol^{-1} respectively. Determine if the cis-to-trans transition is spontaneous at 200 °C.

(4)

c) Explain the statement: "A reaction is thermodynamically feasible but kinetically not feasible."

(2)

d) The standard enthalpy of formation of buta-1,3-diene calculated from the combustion data of carbon, hydrogen and buta-1,3-diene is +108 kJ $mol^{-1,}$ while that calculated from the bond enthalpies of C – H, C – C and C = C and enthalpies of atomisation of carbon and hydrogen is +124 kJ mol^{-1}. Explain why the two values are different.

(2)

Question continues on the next page.

e) The standard enthalpies of neutralisation of HCl (aq) with KOH (aq) and of HCN (aq) with KOH (aq) are −57 kJ mol^{-1} and −11.7 kJ $mol^{-1,}$ respectively. Explain the difference briefly.

_____

_____

_____

_____

_____

_____

_____ (3)

(Total: 13 marks)

6. This question is about quantity of matter.

a) A sample of hydrated metal chloride $MCl_2.2H_2O$, with a mass of 1.23 g, was dissolved in water, and AgCl precipitated by the addition of an excess $AgNO_3$ solution. After purification, AgCl had a mass of 2.40 g.

i) Calculate the number of moles of the chloride in the salt.

_____

_____

_____

_____ (2)

ii) Calculate the number of moles of the hydrated salt used in the experiment.

_____

_____ (1)

iii) Find the relative atomic mass of M.

_____

_____

_____

_____ (3)

b) A sample of 34.26 g of $Ba(OH)_2$ was mixed with 300 mL aqueous hydrochloric acid of concentration 1.00 mol dm^{-3}. After isolating the $BaCl_2$ produced, the dried anhydrous solid was found to have a mass of 29.32 g.

$$Ba(OH)_2\,(s) + 2HCl\,(aq) \rightarrow BaCl_2\,(aq) + 2H_2O\,(l)$$

i) Calculate the expected mass of anhydrous $BaCl_2$ to be produced.

_____

_____

_____

_____

_____

_____ (3)

ii) Calculate the percentage yield of anhydrous $BaCl_2$.

_____

_____ (1)

(Total: 10 marks)

7. a) The compound 1,1-dichlorobutane forms an alkyne when it reacts with a strong base. The alkyne formed can be converted into a dihalogenoalkane.

i) Give the structure of the alkyne formed.

_____ (1)

ii) Give the structure of the dihalogenoalkane formed.

_____ (1)

iii) Give an equation, clearly showing reaction conditions, for the conversion of the alkyne to the dihalogenoalkane.

_____ (2)

b) A drop of 1,1-dichlorobutane in a test tube is warmed with a solution of sodium hydroxide in ethanol. The mixture is acidified with excess HNO_3 and treated with silver nitrate. What would be observed?

_____ (1)

Question continues on the next page.

c) Give the product(s) of the following reactions.

i) Pent-2-ene and cold, dilute, alkaline manganate(VII) ions.

_____ (1)

ii) Reductive ozonolysis of 2-methylbut-1-ene.

_____ (2)

iii) Propene and concentrated H_2SO_4, followed by reflux with water.

_____ (1)

iv) Propene and liquid bromine.

_____ (1)

v) Ethene at 300 ^oC and 1000 atm.

_____ (1)

vi) Ethyne and dilute sulfuric(VI) acid in the presence of $HgSO_4$ at 60 ^oC.

_____ (1)

(Total: 12 marks)

8. This question is about carbonyl compounds.

a) $C_6H_5COCH_2CH_2CH_3$ can be prepared from benzene.

i) What reagents and conditions are used for this preparation?

_____ (2)

ii) What test, indicating reagents and observations, would be used to distinguish between $C_6H_5COCH_2CH_2CH_3$ and its isomer $C_6H_5CH_2CH_2COCH_3$?

_____

_____

_____ (2)

b) Propanal can be converted into pentan-3-ol. Assuming access to ethanol and any inorganic reagents, describe how this synthesis can be carried out. Describe the type of reaction in each step, clearly showing the structures of the molecules involved.

_____

_____

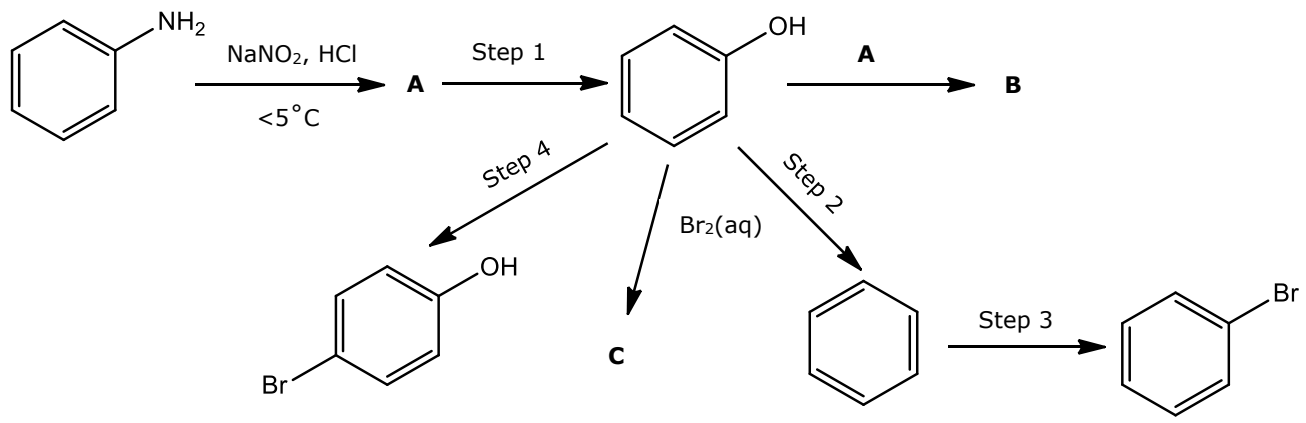
_____

(6)

(Total: 10 marks)

9. This question is about aromatic chemistry.

a) Consider the scheme below. Compounds **A**, **B** and **C** are organic compounds.



i) Give the structures of compounds **A**, **B**, and **C** above.

(3)

ii) Give reagents for steps 1, 2, 3 and 4 above.

(4)

Question continues on the next page.

b) Give the name of a compound that would form $C_6H_5NH_2$ on heating with bromine and a strong base such as NaOH solution.

_____ (1)

c) On adding HCl separately to benzenamine and phenol, one reacts, but the other does not.

i) Which one reacts?

_____ (1)

ii) Why does only one of the compounds react?

_____

_____

_____ (2)

d) Phenol and 2-phenylethanol both have an aromatic ring and a hydroxyl group, yet they differ in certain properties and reactions. Describe the difference when they are added separately to:

i) a solution of neutral iron(III) chloride;

_____

_____ (1)

ii) NaOH(aq).

_____

_____ (1)

(Total: 13 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	II
DATE:	1st September 2026
TIME:	9:00 a.m. to 12:05 p.m.

A Periodic Table is provided.
Molar Gas Constant, R = 8.31 J mol^{-1} K^{-1}
1 atm = 101325 Pa

Answer TWO questions from each section and ANY other question.

SECTION A

1. This question is about chemical periodicity.
   a) i) Define reducing agent. (0.5)
   ii) Explain the relationship between reducing strength and ionisation energy of an element. (1.5)
   iii) Li is a stronger reducing agent than Be. Explain why. (3)

   b) Explain briefly each of the following.
   i) Mg has a higher melting point than Na. (2)
   ii) There is a massive increase from the fourth to the fifth ionisation energies of Si. (2)
   iii) The hydrides of Na and Si have different structures and bonding. (2)
   iv) Although Al is considered to be a metal, its bonding with Cl is predominantly covalent. (2)
   v) Cl_2O is described as the anhydride of chloric(I) acid. (2)

   c) Al_2O_3 is an amphoteric oxide. Give full equations (including spectator ions) for its reactions with KOH and H_2SO_4. (2)

   d) As the metallic character of the elements along the third period of the periodic table decreases, the nature of their chlorides changes.
   i) What change occurs in the type of bonding of the chlorides in period 3? (1)
   ii) Describe, using chemical equations, the action of water on NaCl and PCl_5. (2)

   (Total: 20 marks)

2. a) There are different isomers with molecular formula $C_4H_{10}O$, including a pair of optical isomers.
   i) Draw the pair of optical isomers, labelling the chiral carbon clearly. (2)
   ii) Explain, with reference to the effect on plane-polarised light, why certain mixtures of enantiomers can be optically inactive. (3)

   b) i) Describe the mechanism of the reaction that occurs when bromoethane is heated with aqueous potassium hydroxide. (4)
   ii) Explain how reaction conditions influence whether substitution or elimination is favoured. (2)

Question continues on the next page.

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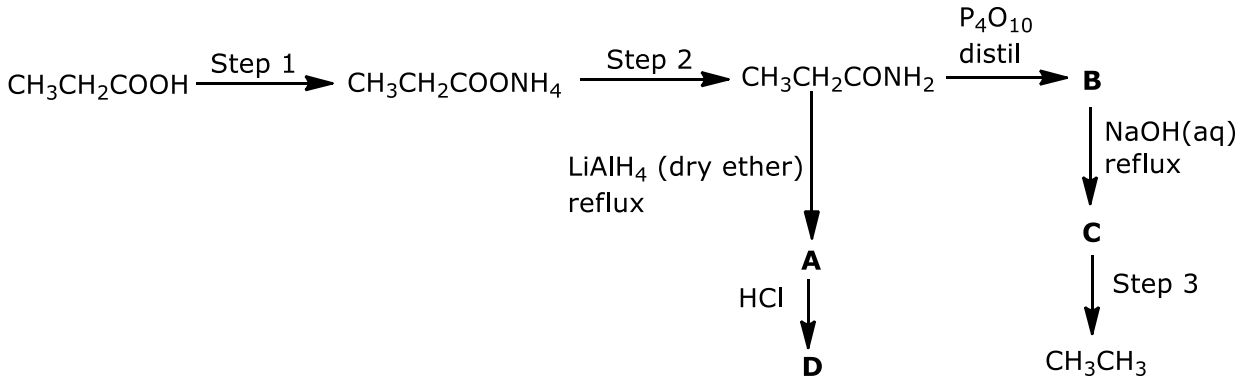
c) i) Use the Lewis structure of the thiosulfate ion to explain why calculating the oxidation state of sulfur using standard rules yields only an average value. (3)

ii) Explain what happens in the reaction of thiosulfate ions with iodine solution, including a balanced chemical equation and the role of this reaction in redox titrimetry. (3)

d) Explain why nitrogen is chemically inert and why reactions which result in the formation of nitrogen are thermodynamically favoured. Explain in terms of orbital overlap, bond enthalpy and entropy considerations. (3)

(Total: 20 marks)

3. This question deals with organic chemistry. Consider the following reaction scheme. Compounds A to D are organic compounds.



a) Give the systematic names of $CH_3CH_2COONH_4$ and $CH_3CH_2CONH_2$**.** (2)

b) Complete the reaction scheme by giving the structures of compounds **A**, **B**, **C** and **D**. (4)

c) Give the reagents and conditions for steps 1, 2 and 3. (4)

d) Give the name of the reaction involved in the conversion of **C** to CH_3CH_3 and explain its use in synthesis. (2)

e) $CH_3CH_2CONH_2$ reacts with cold aqueous $NaNO_2$ and hydrochloric acid, producing effervescence of a gas, and yet, this reaction cannot be used as a test to identify the nature of this compound. Explain with the use of equations. (4)

f) Give **THREE** equations, including reaction conditions, to show different ways of preparing esters from the reaction of carboxylic acids and their derivatives. (4)

(Total: 20 marks)

4. This question is about reaction kinetics.

a) The following equation represents the reaction between carbon monoxide and nitrogen dioxide in the gas phase.

$$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g)$$

A series of experiments using the initial rates method was conducted at the same temperature and the same total pressure to determine the rate equation for the above reaction. The following experimental data were obtained.

Experiment	[CO] (mol dm^{-3})	[NO_2] (mol dm^{-3})	Initial rate (mol dm^{-3} s^{-1})
1	0.10	0.10	1.0×10^{-3}
2	0.20	0.10	1.0×10^{-3}
3	0.10	0.30	9.0×10^{-3}

i) Using the data provided, determine the rate equation for the reaction between CO and NO_2. (2)

ii) Calculate the value of the rate constant k and state its units. (2)

iii) Predict by what factor the initial rate changes if the initial concentration of NO_2 is increased by 50 % while the concentration of CO is halved. (2)

iv) Discuss whether a single-step bimolecular reaction mechanism is consistent with the experimental rate equation. (1)

v) Propose a reaction mechanism which is consistent with the experimental rate equation. (3)

vi) The above experiments are repeated at a higher temperature, while all initial concentrations remain unchanged. Identify the term(s), if any, in the rate equation that is/are temperature dependent. (1)

b) The Arrhenius equation is given by

$$k = A\, e^{\frac{-E_a}{RT}}$$

i) Describe what the pre-exponential factor A and the exponential term $e^{-Ea/RT}$ represent. (3)

ii) Sketch a graph showing a Maxwell–Boltzmann distribution of molecular energies for a sample of molecules. On your graph, use appropriately named axes, mark the activation energy, and show how the exponential fraction in the Arrhenius equation is represented. (3)

iii) A catalyst affects the rate of a chemical reaction. Identify which term in the Arrhenius equation is affected by the presence of a catalyst. (1)

iv) Some reactions proceed faster at high temperature but show almost no increase in rate when a catalyst is added. Referring to the Arrhenius equation, suggest an explanation for this observation. (2)

(Total: 20 marks)

SECTION B

5. This question is on chemical equilibria.

a) The partial oxidation of methane is a process that converts natural gas into synthesis gas, which is used to produce fuels and other chemicals. The partial oxidation is shown by the following equation.

$$2CH_4(g) + O_2(g) \rightleftharpoons 2CO(g) + 4H_2(g)$$

A mixture of 10 moles of CH_4 and 4 moles of O_2 is introduced into an evacuated vessel of volume 5 litres. At equilibrium, 60% of CH_4 is partially oxidised. Calculate K_c. (5)

b) i) Define the degree of decomposition, α, for the endothermic decomposition of dinitrogen tetroxide as represented by the following equation. (1)

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

ii) What happens to α when the temperature is decreased at constant pressure? (1)

iii) What happens to α when pressure is increased at constant temperature? (1)

c) i) Define partial pressure of a gas. (1)

ii) Give the expression and unit of K_p, given that the pressure is in kPa for the industrial production of freon, $CCl_2F_2(g)$, represented by the following equation. (2)

$$CCl_4(g) + 2HF(g) \rightleftharpoons CCl_2F_2(g) + 2HCl(g)$$

Question continues on the next page.

d) If an inert gas is added to the equilibrium in c(ii), keeping the volume of the mixture constant, explain what happens to:
   i) the partial pressures of the components at equilibrium. (2)
   ii) K_p. (1)

e) Explain how K_c for the reaction of ethanol with ethanoic acid is measured in the lab. (6)

(Total: 20 marks)

6. a) Discuss the trends in reactivity of the Group 1 elements down the group. Your response must reference changes in atomic radius, first ionisation energy, and their reactions with water. Include a relevant chemical equation with state symbols. (5)

b) i) Describe **ONE** advantage and **ONE** disadvantage of using magnesium for aircraft construction. (2)
   ii) Suggest a reason why zinc anodes **cannot** be used to protect aluminium structures. (2)

c) i) The boiling points of the group 7 elements increase going down the group. Explain this statement. (3)
   ii) Chlorine can undergo disproportionation reactions. Explain this statement and give an ionic equation to show this. Include oxidation states of chlorine for each species. (3)

d) i) Explain why silicon dioxide has a much higher boiling point than CO_2. Include a diagram in your answer. (4)
   ii) State **ONE** industrial use of silicon dioxide and explain its suitability. (1)

(Total: 20 marks)

7. a) Figures 1 and 2 are the spectra of an organic compound, **P**. **P** does not give off effervescence with sodium metal.

The ^{1}H NMR spectrum of compound **P** shows a peak at 2.9 ppm that disappears upon shaking the compound with D_2O. The integration data of the ^{1}H NMR spectrum are given above each peak in Figure 2.

Use this information to deduce the identity of compound **P,** clearly explaining in detail how you reached your conclusion. (10)

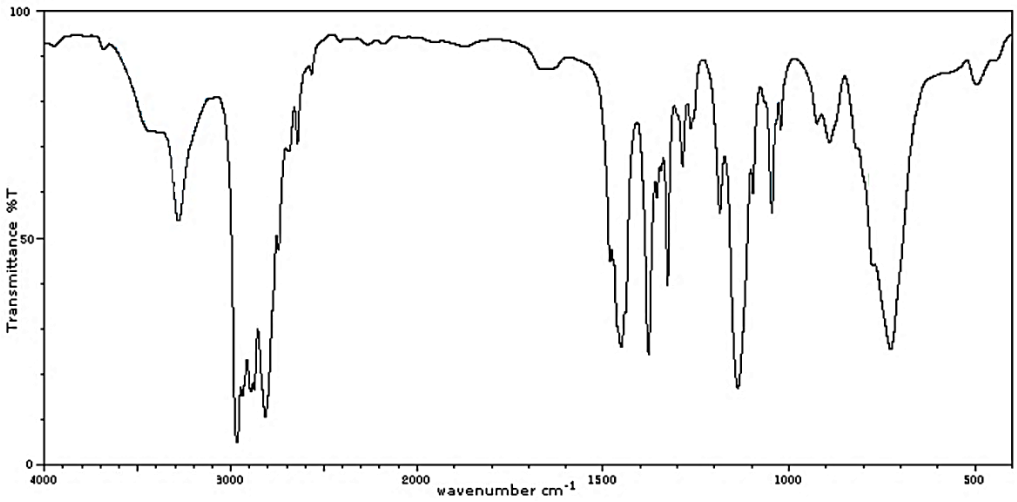


Figure 1

CORRELATION TABLE			
Wavenumber (cm^{-1})	**Bond**	**Wavenumber (cm^{-1})**	**Bond**
3200 – 3500 (broad)	O–H	2845 – 2975 (aliphatic)	C–H
3100 – 3500	N-H	2650 – 2880	C–H
2500 – 3500 (very broad)	O–H	1650 – 1750	C=O
3100 – 3300 (aromatic)	C–H	1500 – 1680	C=C

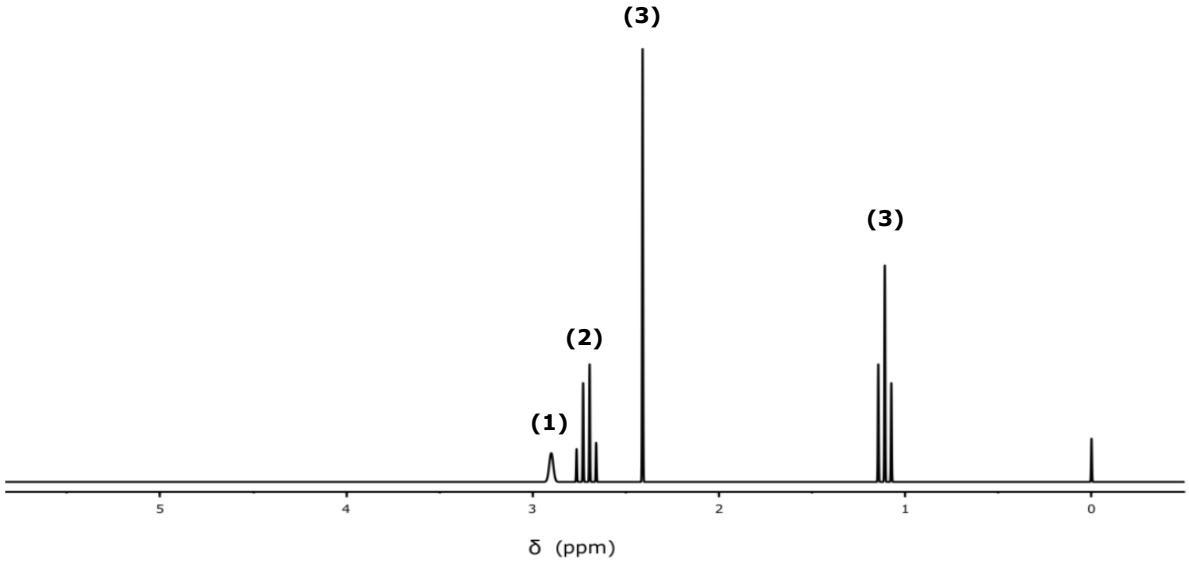


Figure 2

b) Polypeptides and synthetic polyamides like Kevlar are both condensation polymers with similar linkages.
   i) Give the **TWO** monomers used in the formation of Kevlar. (2)
   ii) Write the condensation polymerisation reaction, including the repeating unit of Kevlar. (2)
   iii) Discuss **TWO** uses of Kevlar and how these are related to its properties. (5)
   iv) Explain why one polymer is easily broken down in nature, unlike the other one. (1)

(Total: 20 marks)

8. This question is about gases and osmotic pressures.
   a) A sample of pure liquid trichloromethane, $CHCl_3$, weighing 4.0 g, is placed in an evacuated rigid vessel of volume 1.0 dm^3 at 323 K. At this temperature, the saturated vapour pressure of trichloromethane is 70 kPa. In this question, assume that trichloromethane vapour behaves as an ideal gas.
      i) Calculate the number of moles of trichloromethane vapour present in the vessel at equilibrium. (2)
      ii) Calculate the mass of liquid trichloromethane remaining in the vessel. (1)
      iii) State and explain **TWO** factors which affect the vapour pressure of a pure liquid. (2)
      iv) Explain why trichloromethane does **not** boil at 323 K in an open container, even though it evaporates readily. (2)

   b) At 273 K and 101 kPa, the molar volume of ammonia is 22.1 dm^3, whereas the molar volume of an ideal gas is 22.4 dm^3. Explain qualitatively why the molar volume of ammonia is less than that of an ideal gas under these conditions. (3)

Question continues on the next page.

c) Anisole (C_7H_8O) is an organic liquid used in the perfume industry. It can be purified by steam distillation at atmospheric pressure. At 96 °C, the vapour pressures of anisole and water are 15.3 kPa and 86.0 kPa, respectively.

i) State **TWO** conditions that a compound must satisfy to be suitable for purification by steam distillation. (1)

ii) Using the data provided, show that the mixture of anisole and water boils at 96 °C. (1)

iii) Calculate the mole ratio of anisole to water in the vapour phase at 96 °C. (1)

iv) Calculate the mass of anisole that distils with 100 g of water. (2)

d) Osmotic pressure provides a method for determining the molar masses of polymers. An aqueous solution of polymer **X** is prepared by dissolving 0.80 g of the polymer in water and making up the volume to 200.0 cm^3. The osmotic pressure of this solution at 30 °C is found to be 820 Pa.

i) Calculate the molar mass of polymer **X**. (2)

ii) In addition to determining the molar masses of polymers, osmotic pressure concepts are widely utilised in large-scale industrial separation processes. Identify **ONE** such commercial process and explain how osmotic pressure is counteracted to achieve separation. (3)

(Total: 20 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 SECOND SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	III – *Practical*
DATE:	27th August 2026
TIME:	3 hours 5 minutes

1. You are provided with four solutions as follows:

   i) A solution of potassium manganate(VII), $KMnO_4$, labelled $\mathbf{A_n}$;
   ii) A solution containing 8.04 g dm^{-3} sodium ethanedioate, $Na_2C_2O_4$, labelled **B**;
   iii) A solution of ammonium iron(II) sulfate(VI) of unknown concentration, labelled **C**;
   iv) A solution of 2 mol dm^{-3} sulfuric(VI) acid.

In this experiment, you are required to:

- standardise the potassium manganate(VII) solution, labelled $\mathbf{A_n}$;
- determine the molar concentration of solution **C** using the standardised potassium manganate(VII) solution.

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

CANDIDATE LABORATORY NUMBER, n:.....

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Standardisation of solution A_n

b) Fill the burette with solution **A_n**. Using a suitably rinsed pipette and a pipette filler, transfer a 25.0 cm^3 aliquot of solution **B** to a conical flask, followed by approximately 20 cm^3 of 2 mol dm^{-3} sulfuric(VI) acid.

Warm the contents of the flask to approximately 60 °C. Titrate the hot solution with solution **A_n**, to a permanent pink endpoint and record the 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 **A_n**.

(20)

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

$$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$$

Calculate the concentration of solution **A_n**, using the stoichiometry of this reaction and the data from part (b).

_____

_____

_____

_____

_____

_____

_____

_____

(6)

Determination of the molar concentration of solution C

d) Fill the burette with solution $\mathbf{A_n}$. Using a suitably rinsed pipette and a pipette filler, transfer a 25.0 cm^3 aliquot of solution **C** to a conical flask, followed by approximately 20 cm^3 of 2 mol dm^{-3} sulfuric(VI) acid. Titrate the solution with solution $\mathbf{A_n}$, to a permanent pink endpoint and record the 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 $\mathbf{A_n}$.

(20)

e) Manganate(VII) ions react with iron(II) ions according to the equation:

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

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total: 50 marks)

Please turn the page.

2. You are provided with two inorganic compounds, **P** and **Q**. **P** is provided as an aqueous solution of the salt. Compound **Q** is given as a solid and is a binary inorganic compound. Carry out the tests described below and attempt to identify the compounds **P** and **Q**. Your inferences should include the names of any precipitates or gases which are produced.

a) To about 1 cm^3 of solution **P**, add a few drops of sodium hydroxide solution, followed by excess.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

b) To about 1 cm^3 of solution **P**, add a few drops of aqueous ammonia solution, followed by excess.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

c) To about 1 cm^3 of solution **P**, an equal volume of aqueous sodium sulfate(VI) solution. Allow the solution to stand for a few minutes.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

d) To about 1 cm^3 of solution **P,** add **TWO** drops of a solution of iodine in potassium iodide.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

(3)

e) To about 1 cm^3 of solution **P**, add an equal volume of dilute hydrochloric acid. Perform a test/s to identify the gas, if any, which is produced. Warm the solution if necessary.

Observation *Inference*

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_____ _____

(4)

f) To about a quarter of the sample of solid **Q,** add 2 cm^3 of distilled water in a test tube and shake.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Question continues on the next page.

g) To a tip of a spatula of solid **Q**, add 5 cm^3 of dilute sulfuric(VI) acid in a boiling tube and warm gently for about 5 seconds. Shake the resultant mixture and **allow any residual solid to settle, then use the resulting solution for tests (h) and (i)**.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

h) To about 1 cm^3 of the solution from test (g), add 2 cm^3 of sodium hydroxide solution in a boiling tube, then heat the resultant mixture.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

i) To about 1 cm^3 of the solution from test (g), add drops of aqueous ammonia solution, followed by excess.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Suggest a possible identity for substance **P**: _____ (1)

Suggest a possible identity for substance **Q**: _____ (1)

(Total: 30 marks)

3. Substance **T** is an organic solid with a molecular formula $C_9H_8O_2$. Carry out the following tests and suggest a chemical structure for this compound.

a) Place a full spatula tip (approximately a quarter of your sample) of compound **T** in a test tube and add about 2 cm^3 of distilled water. Shake the mixture.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(2)

b) Transfer a tip of a spatula of solid **T** to a crucible lid and ignite the solid.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Question continues on the next page.

c) Place a spatula tip (a few crystals) of compound **T** in a boiling tube and add 5 cm^3 of distilled water. Warm the mixture for a few seconds and then add 3 drops of bromine water.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(4)

d) Place a full spatula tip (approximately a quarter of your sample) of compound **T** in a boiling tube and add about 4 cm^3 of sodium carbonate solution, followed by 3 drops of potassium manganate(VII) solution. Warm the mixture.

Observation *Inference*

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_____ _____

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_____ _____

(5)

e) Place a full spatula tip (approximately a quarter of your sample) of compound **T** in a test tube and add about 2 cm^3 of ethanol and a few drops of concentrated sulfuric(VI) acid. Warm the mixture in a water bath for about 2 minutes and then transfer the contents of the test tube into a boiling tube containing 10 cm^3 of sodium carbonate solution.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

(3)

Conclusion

Suggest a structure for compound **T** is: _____

(3)

(Total: 20 marks)