L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

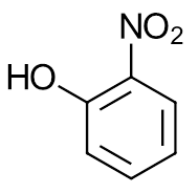
ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	21st May 2025
TIME:	9:00 a.m. to 12:05 p.m.

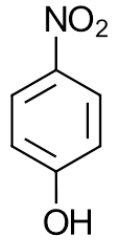
Required Data: Relative atomic masses (RAM): H = 1, C = 12, N = 14, O =16

Answer ALL questions

1. a) Nitrophenol exists as different positional isomers, two of which are shown below.



2-nitrophenol



4-nitrophenol

i) The melting point of 2-nitrophenol is 45 °C, whilst that of 4-nitrophenol is 114 °C. Explain in detail the reasons behind such a discrepancy.

_____

_____

_____

_____

_____

_____

_____

_____

_____ (3)

Question continues on the next page.

ii) The solubility of 4-nitrophenol in water is higher than that of 2-nitrophenol. Suggest an explanation for this.

_____

_____

_____

_____

_____

_____ (2)

b) Ozone is a molecule that exhibits bent geometry and resonance.

i) Draw the resonance structures (canonical forms) of ozone in the space below.

(2)

ii) Explain why the two oxygen-to-oxygen bonds in the ozone molecule are equal in length.

_____

_____

_____

_____ (2)

(Total: 9 marks)

2. This question is about the chemistry of oxides.

a) Write the formula and the physical state for **each** of the following oxides.

i) The oxide of magnesium.

Chemical formula: _____

Physical state at room temperature: _____ (1)

ii) The oxide of silicon.

Chemical formula: _____

Physical state at room temperature: _____ (1)

iii) An oxide of sulfur.

Chemical formula: _____

Physical state at room temperature: _____ (1)

b) Explain the difference in the physical states of the three oxides given in part (a) in terms of their structure and bonding.

_____

_____

_____

_____

_____

_____

_____

_____ (3)

c) Compare the acid-base properties of the three oxides mentioned in part (a). Provide chemical equations to support your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ (5)

(Total: 11 marks)

Please turn the page.

3. This question is about the chemistry of transition metals.

a) Complexes are common in transition metal compounds. Three examples are $[Fe(H_2O)_5(NO)]^{2+}$, $[Cu(C_2O_4)_3]^{4-}$, $[CrCl_2(H_2O)_4]Cl$.

i) Name the above chemical species.

_____

_____

_____ (1.5)

ii) Isomerism is a characteristic feature of some transition metal complexes. Using the examples provided in part (a), identify two types of stereoisomerism, clearly showing the type of isomerism exhibited by the chosen complex ion.

_____

_____ (2)

iii) Choose **ONE** of the complexes mentioned in part (a)(ii) and draw the corresponding stereoisomeric structures in the space provided.

(2)

b) The complex $[Fe(H_2O)_5(NO)]^{2+}$ is formed through an incomplete ligand exchange reaction when an aqueous solution of an iron(II) salt is added to an aqueous solution of nitrate(V) in the presence of an acid.

i) Deduce the full redox equation representing the reaction between the aqueous iron(II) salt and the nitrate solution.

_____

_____

_____

_____ (2)

ii) Write an equation for the ligand exchange reaction resulting in the formation of the complex ion $[Fe(H_2O)_5(NO)]^{2+}$.

_____

_____ (1)

iii) Write an expression for the stability constant, K_{stab}, for the formation of the complex ion $[Fe(H_2O)_5(NO)]^{2+}$.

_____

_____ (1)

iv) The relative stabilities of complexes can be inferred from the values of the overall stability constant K_{stab}. The numerical K_{stab} values for $[Fe(H_2O)_5(NO)]^{2+}$ and $[Fe(C_2O_4)_3]^{4-}$ complexes of iron are $1x10^{13}$ and $1x10^{36}$ respectively.
Explain why the stability constant of the complex $[Fe(C_2O_4)_3]^{4-}$ is much greater than that of the $[Fe(H_2O)_5(NO)]^{2+}$ complex.

_____

_____

_____

_____

_____

_____ (2.5)

(Total: 12 marks)

4. In this question on electrochemistry, consider the following half equations and the corresponding standard electrode potential values.

Half equation	**$E^{\ominus}$ (V)**
$Fe(CN)_6^{3-}(aq) + e^- \rightleftharpoons Fe(CN)_6^{4-}(aq)$	+0.36
$2H_2SO_3(aq) + 2H^+(aq) + 4e^- \rightleftharpoons S_2O_3^{2-}(aq) + 3H_2O$	+0.40
$S_2O_3^{2-}(aq) + 6H^+(aq) + 4e^- \rightleftharpoons 2S(s) + 3H_2O(l)$	+0.52
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$\frac{1}{2}Br_2(l) + e^- \rightleftharpoons Br^-(aq)$	+1.07

Question continues on the next page.

a) A galvanic cell is set up with one half-cell containing liquid bromine and a 1.0 mol dm^{-3} aqueous solution of sodium bromide and with the other half-cell having equimolar aqueous solutions of 1.0 mol dm^{-3} iron(II) salt and iron(III) salt.

i) Write the cell diagram of the galvanic cell.

_____ (1)

ii) Calculate the emf of the cell and indicate the polarities of the half-cells.

_____

_____

_____ (2)

iii) Deduce the chemical equation for the reaction occurring in the galvanic cell.

_____

_____ (1)

iv) Describe the chemical reactions which occur if excess potassium cyanide solution is added to the iron(III)/iron(II) half-cell.

_____

_____

_____ (1)

v) Calculate the new emf of the cell.

_____

_____

_____ (1)

b) Consider the two half equations involving the standard electrode potentials of aqueous thiosulphate and aqueous sulfuric(IV) acid.

i) Write the full equation for the redox reaction which is expected to occur.

_____

_____

_____ (1)

ii) Identify and define the type of redox reaction taking place, specifying the changes in oxidation numbers of the oxidising and reducing agents in the reaction.

_____

_____

_____

_____

_____

_____ (3)

iii) Calculate whether this reaction has the thermodynamic potential to proceed to completion under standard conditions. Explain your answer.

_____

_____

_____

_____ (2)

(Total: 12 marks)

5. This question is about energetics.

a) The following table shows the lattice enthalpies of three silver halides. The values have been determined from experimental data or calculated theoretically.

Compound	**Experimental value (kJ mol^{-1})**	**Theoretical value (kJ mol^{-1})**
AgF	−967	−824
AgCl	−920	−745
AgI	−889	−618

Question continues on the next page.

i) Construct and label an energy cycle that illustrates how the experimental value of the lattice enthalpy of silver chloride is determined, clearly indicating **all** the enthalpies involved.

(3)

ii) Explain why the theoretical values for the lattice enthalpies of the silver halides differ from the experimental values.

_____

_____

_____ (2)

iii) Using silver fluoride and silver iodide as examples, explain why the discrepancy between the values of the experimental and theoretical lattice energies of silver halides increases progressively down Group 7 of the Periodic Table.

_____

_____

_____

_____

_____

_____

_____ (3)

b) The table gives the standard enthalpies of formation and standard entropy values for the following compounds.

Compounds	ΔH^{θ}_{f} (kJ mol^{-1})	ΔS^{θ} (J K^{-1} mol^{-1})
$NaHCO_3$ (s)	-951	102
Na_2CO_3 (s)	-1131	135
CO_2 (g)	-394	214
H_2O (l)	-285	70
H_2O (g)	-241	188

i) Write a balanced equation for the thermal decomposition of sodium hydrogencarbonate.

_____ (1)

ii) Use the values in the above table to show whether the thermal decomposition of sodium hydrogencarbonate is thermodynamically feasible at 25 ^{o}C.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ (4)

(Total: 13 marks)

Please turn the page.

6. This question is about phase equilibria.

a) The boiling points of benzenamine and water are 184 °C and 100 °C, respectively. A mixture of benzenamine and water boils at 98 °C.

i) Explain why the boiling point of the mixture is lower than the boiling points of both liquids.

_____

_____

_____

_____ (2)

ii) Describe why steam distillation and **not** fractional distillation is used to purify benzenamine.

_____

_____

_____ (1)

iii) In the steam distillation of benzenamine, 25 g of distillate, containing a mixture of water and benzenamine, is given off. Calculate the mass of water in the distillate. The saturated vapour pressures of benzenamine, $C_6H_5NH_2$, and water at 98 °C are, respectively, 7.07 kPa and 94.30 kPa.

_____

_____

_____

_____

_____

_____

_____ (3)

b) i) Briefly explain the statement: 'A solution of the liquid mixture benzene and methylbenzene is ideal while the solution of the liquid mixture ethanol and propanone is non-ideal'.

_____

_____

_____

_____

_____

_____ (2)

ii) Explain how a solution with a negative deviation from Raoult's law can be identified when mixing two liquids.

_____

_____

_____

_____

_____

_____ (2)

(Total: 10 marks)

7. This question is about hydrocarbons and halogenoalkanes.

a) Give a chemical test to distinguish between the following compounds. Your answer should include a chemical equation.

i) ethane and ethene

_____

_____

_____

_____ (2)

Question continues on the next page.

ii) but-1-yne and but-2-yne

_____

_____

_____

_____ (2)

b) Give the systematic name of the reactant which, on undergoing reductive ozonolysis, produces octane-2,7-dione.

_____

_____ (1)

c) i) Write an equation for the reaction of 2-bromomethylpropane with magnesium.

_____

_____ (1)

ii) Give the structural formula or systematic name of the organic product produced when the Grignard reagent produced in part (c)(i) reacts with methanal followed by hydrolysis.

_____

_____ (1)

d) Explain the impact of chlorofluorocarbons on the ozone layer.

_____

_____

_____

_____

_____ (2)

e) Different products are formed when 2-chlorobutane reacts with alcoholic KOH and with aqueous KOH. Give the structural formulae of the organic products formed when 2-chlorobutane reacts with:

i) aqueous KOH _____ (1)

ii) alcoholic KOH _____ (1)

(Total: 11 marks)

8. This question is about carbonyl compounds.

a) In the space provided, name and describe the mechanism for the reaction of butanone with HCN.

Name of mechanism: _____ (5)

b) State what would be observed when propanal reacts with Fehling's reagent.

_____ (1)

c) Give an equation, including conditions, for the reaction of propanal with AlH_4^-.

_____

_____ (2)

d) Ethanal and propanal are both aldehydes and yet can be distinguished by reacting with iodine in the presence of alkali. Explain.

_____

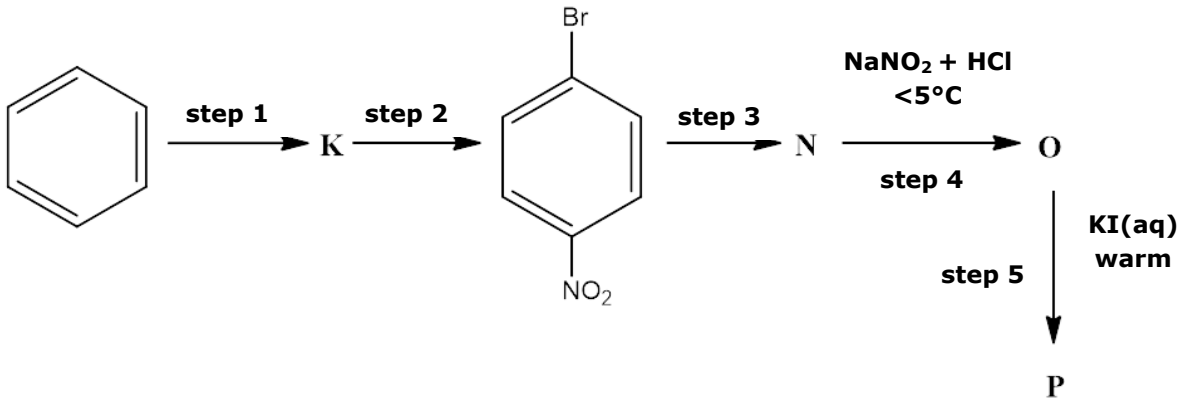
_____

_____ (2)

(Total: 10 marks)

9. This question is about aromatic chemistry.

a) The following is a scheme converting benzene into a disubstituted product, **P**.



i) Suggest reagents and conditions for **Step 1**, **2** and **3**.

Step 1: _____

Step 2: _____

Step 3: _____

(4)

ii) Suggest structures for organic compounds **K**, **N**, **O**, and **P**.

K: **N:**

O: **P:**

(4)

b) The substance 1-bromo-4-nitrobenzene has two functional groups. What was the reason for introducing one before the other when preparing **K**?

_____

_____

_____

_____ (2)

c) Why is a temperature < 5°C used in converting **N** to **O**?

_____ (1)

d) Name the final product **P**.

_____ (1)

(Total: 12 marks)

Blank Page

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	II
DATE:	22nd May 2025
TIME:	9:00 a.m. to 12:05 p.m.

A Periodic Table is provided.
Ionic product of water, K_w = 1.00 x 10^{-14} mol^2 dm^{-6}
Molar Gas Constant, R = 8.31 J mol^{-1} K^{-1}

Answer TWO questions from each section and ANY other question.

SECTION A

1. This question deals with ionic equilibria and organic chemistry.

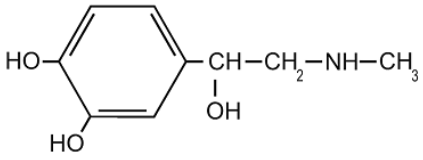
   a) i) Calculate the K_b of butanamine if a 0.10 mol dm^{-3} solution has a pH of 11.56. (5)
   ii) If ethylethanamine has a K_b of 2.95 x 10^{-4} mol dm^{-3}, compare the basic strength of butanamine with that of ethylethanamine based on their K_b values given/calculated in this question. (1)
   iii) Explain the main reasons for the difference in K_b of butanamine and ethylethanamine. (3)
   iv) Explain, including relevant equations, how butanamine can be used to make a solution that resists changes in pH. (5)

   b) Suggest how an amino acid can be prepared from butanal using a hydroxynitrile intermediate. Your answer should include a reaction scheme, showing reagents and conditions for each step. (6)

(Total: 20 marks)

2. This question is about organic and inorganic chemistry.

   a) Adrenaline, whose chemical structure is shown below, is a drug used to treat bronchial asthma and is produced as a racemic mixture.



   Explain what the term racemic mixture means and suggest why adrenaline can exist as a racemic mixture. (3)

   b) Plastics such as low-density poly(ethene) can be produced via polymerisation.
   i) State the conditions required for this polymerisation to occur. (1)
   ii) What is the mechanism through which the reaction proceeds called? (1)
   iii) Describe the mechanism for the polymerisation of poly(ethene). (5)

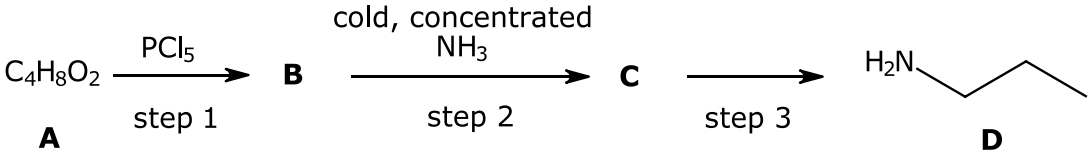
Question continues on the next page.

c) Gaseous sulfur compounds are emitted from various processes.
   i) Explain how atmospheric sulfur(IV) oxide can be harmful to aquatic environments. (2)
   ii) With the aid of equations, explain how hydrogen sulfide acts as a weak dibasic acid. (2)

d) Oxides of nitrogen can be harmful.
   i) Describe the formation of NO from atmospheric nitrogen and explain the conditions under which this reaction occurs. (2)
   ii) With the aid of equations, describe the role of catalytic converters in minimising the harmful impact of unburnt hydrocarbons, CO and nitrogen oxides. (4)

(Total: 20 marks)

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



a) Give the systematic name of compound **D.** (1)
b) Complete the reaction scheme by giving the structures of compounds **A**, **B**, and **C**. (3)
c) Give the reagents and conditions needed in step 3 to convert **C** into **D**. (2)
d) Give balanced equations for the reactions in steps 1 and 2. (2)
e) Place substances **A**, **B**, and **C** in order of increasing boiling point clearly explaining the reason for this order. (5)
f) Compound **B** reacts with phenol.
   i) Give an equation for this reaction and the product's systematic name. (2)
   ii) State whether the same organic product from part (f)(i) would be obtained if **A** is treated with phenol instead. Give **ONE** reason for your answer. (1)
   iii) Explain why a gas that turns lime water milky is released when **A** is added to aqueous sodium carbonate, but no such change is recorded when phenol is added to aqueous sodium carbonate. (4)

(Total: 20 marks)

4. This question is about rates of reactions.

a) Consider the oxidation of I^- ion by $S_2O_8^{2-}$ ion in an aqueous solution. Fe^{2+} ions can be used to act as a homogeneous catalyst in this reaction.
   i) Explain what the term homogeneous catalyst means and highlight the advantages of such catalysts. (2)
   ii) Describe how a catalyst affects the yield and reaction rate. (3)
   iii) With the aid of equations, explain how Fe^{2+} acts as a catalyst in this reaction. (4)

b) Temperature is another factor that influences the rate of a chemical reaction. Sketch the Maxwell-Boltzmann distribution curve and explain this statement. (4)

c) Heterogeneous catalysts are another type of catalyst.
   i) Explain the mode of action of heterogeneous catalysts. (5)
   ii) Catalysts can be poisoned. Explain what this means and give an example. (2)

(Total: 20 marks)

SECTION B

5. This question is about chemical equilibria.

a) State what happens to:
   i) the rates of the forward and backward reactions in a reversible reaction before dynamic equilibrium is reached; (1)
   ii) the quantities of the reagents and products when dynamic equilibrium is reached. (1)

b) Explain the meaning of heterogeneous equilibrium and give an example. (2)

c) When N_2O_4 is allowed to decompose into NO_2, the following equilibrium is reached.

$$N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g) \qquad \Delta H^{\ominus} = +58.0 \text{ kJ mol}^{-1}$$

Gaseous N_2O_4 is introduced into an evacuated vessel at a pressure of 10 atm. When equilibrium is reached, the total pressure in the vessel is found to be 10.61 atm.

   i) Calculate K_p. (5)
   ii) Explain what happens to the degree of dissociation of N_2O_4 when the temperature is increased at constant pressure. (1)
   iii) Explain what happens to K_p when the temperature is increased at constant pressure. (1)

d) Explain the statement: 'The partition coefficient, K_d, of caffeine between dichloromethane and black tea is 4.6 at 25 °C.' (3)

e) A volume of 200 mL of black tea contains 40 mg of caffeine. Using the value of K_d given in part (d), calculate the mass of caffeine which is extracted from the 200 mL of the black tea by 100 mL of dichloromethane used in:
   i) a single portion; (2)
   ii) two successive portions of 50 mL each. (4)

(Total: 20 marks)

6. This question is about inorganic chemistry.

a) Explain the difference in the degree of covalent character in the chlorides of lithium, potassium and beryllium. (5)

b) Graphite is a conductor of electricity, while diamond is one of the hardest substances known to man. Using diagrams, explain how the conductivity of graphite and hardness of diamond arise from their bonding. (5)

c) Aluminium exhibits excellent corrosion resistance.
   i) Describe how aluminium behaves in this manner. (2)
   ii) List and explain **TWO** beneficial properties that result from this behaviour. (3)

d) Chlorine has bleaching properties.
   i) Briefly explain how such bleaching properties arise. (2)
   ii) With the aid of oxidation numbers, explain the disproportionation reaction of chlorate(I) ions in aqueous solutions. Include a balanced equation for the reaction. (3)

(Total: 20 marks)

Please turn the page.

7. This question is about polymers and structure determination.

a) Polymerisation of 2-hydroxypropanoic acid produces a plastic polymer known as PLA.
   i) Give an equation for the polymerisation reaction, clearly showing the repeating unit in this polymer. (2)
   ii) State the type of polymerisation that yields PLA from its monomer. (1)
   iii) Suggest **TWO** reasons why commercial applications for PLA are limited compared to PET or nylon. (1)
   iv) Explain why PLA has a lower environmental impact than addition polymers. (3)

b) A compound **Q** is made up of 72.1% carbon and 12.1% hydrogen, whilst compound **R** consists of 60.0% carbon and 13.3% hydrogen. In both cases, the remaining element is oxygen. The mass spectrum of **Q** gives a molecular ion peak at m/z 100, whilst that of **R** gives a molecular ion peak at m/z 60. The infrared spectrum of **Q** shows a wide prominent band above 3000 cm^{-1}, which is not present in the infrared spectrum of **R**. Both compounds have only one functional group. The IR absorption data is also given below.

Wavenumber (cm^{-1})	**Bond**	**Compound**
3200 – 3500 (broad)	O–H	alcohols/phenols
2500 – 3500 (very broad)	O–H	carboxylic acid
3300	C–H	aromatic

   i) Calculate the empirical formulae for **Q** and **R.** (3)
   ii) Suggest the identity of **Q** and **R,** explaining your reasoning. (5)
   iii) Explain how the identity of **Q** and **R** can be confirmed by using **TWO** separate chemical tests. Identify the reagents required and observations made. (5)

(Total: 20 marks)

8. This question is about states and quantity of matter.

a) i) State **TWO** characteristics of an ideal gas which distinguish it from a real gas. (1)
   ii) Under what conditions does a real gas approach ideal gas behaviour? (1)

b) The volume of 0.20 g of a gaseous hydrocarbon measured at a pressure of 101.3 kPa and a temperature of 25 °C is 174.6 mL. Assuming that the hydrocarbon is an ideal gas, calculate the molar mass of the hydrocarbon. (4)

c) The following redox reaction occurs when 50 mL of 0.60 mol dm^{-3} KI solution is added to 10 mL of 1.0 mol dm^{-3} $CuSO_4$ solution.

$$4KI\ (aq) + 2CuSO_4\ (aq) \rightarrow I_2\ (aq) + 2CuI\ (s) + 2K_2SO_4\ (aq)$$

   i) Determine which of the two reagents is the limiting one. (3)
   ii) Calculate the concentration, in g dm^{-3}, of the I_2 (aq) solution produced. (2)

d) When 120 g of ethanoic acid is mixed with excess ethanol and allowed to reach equilibrium, 117 g of ethyl ethanoate is produced. Calculate the percentage yield of the ester. (3)

e) A 2.50 g sample of impure $FeSO_4.7H_2O$ is dissolved in water and made up to 200 mL solution. A 25.0 mL aliquot of this solution was acidified with H_2SO_4, and an average of 16.40 mL of $KMnO_4$ solution of concentration 0.0100 $moldm^{-3}$ was required for oxidation.
   i) Calculate the number of moles of $FeSO_4.7H_2O$ in 200 mL of solution. (3)
   ii) Calculate the percentage by mass of $FeSO_4.7H_2O$ in the sample. (3)

(Total: 20 marks)

Index No.:_____ AM06/III.25m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	III – *Practical*
DATE:	12th June 2025
TIME:	3 hours 5 minutes

1. You are provided with three solutions as follows:

   i) A solution of potassium manganate(VII), $KMnO_4$, labelled $\mathbf{A_n}$;
   ii) A solution containing 20.0 g dm^{-3} ammonium iron(II) sulfate(VI)-6-water, $Fe(NH_4)_2(SO_4)_2.6H_2O$, labelled **B**;
   iii) A solution of ethanedioic acid, labelled **C**.
   iv) A solution of 1M sulfuric(VI) acid.

In this experiment, you are required to use a titrimetric method to determine the molar concentration of solution **C**.

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

CANDIDATE LABORATORY NUMBER, n:.....

Standardisation of solution A_n

b) Fill the burette with solution $\mathbf{A}_n$. Pipette a 25.0 cm^3 aliquot of solution **B** into a conical flask and add approximately 20 cm^3 of 1M sulfuric acid solution. Titrate 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 $\mathbf{A_n}$.

(18)

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

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

Calculate the concentration of solution $\mathbf{A_n}$ using the stoichiometry of this reaction and the data from part (b).

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Determination of the molar concentration of solution C

d) Transfer 25.0 cm^3 of solution **C** into a 250 cm^3 volumetric flask using a suitably rinsed pipette. Make up the volume to the mark with distilled water and shake the volumetric flask to homogenise the solution. Label the diluted solution, **dC**.

Fill the burette with solution $\mathbf{A_n}$. Using a suitably rinsed pipette, transfer 25.0 cm^3 of solution **dC** into a conical flask and add approximately 20 cm^3 of 1M sulfuric acid solution. Heat the contents of the conical flask to around 60 ^oC. Titrate 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 $\mathbf{A_n}$.

(24)

e) Ethanedioic acid and mangante(VII) ions react as follows:

$$2MnO_4^- (aq) + 6H^+ (aq) + 5H_2C_2O_4 (aq) \rightarrow 2Mn^{2+} (aq) + 8H_2O (l) + 10CO_2 (g)$$

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

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total: 50 marks)

2. You are provided with two inorganic salts **P** and **Q**. **P** is provided as an aqueous solution while **Q** is given as the solid. Carry out the tests described below and identify the salts **P** and **Q**.

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 an equal volume of sodium carbonate solution.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(3)

c) To about 1 cm^3 of solution **P,** add an equal volume of potassium chromate(VI) solution.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

(2)

d) To about 1 cm^3 of solution **P,** add 2 cm^3 of ammonia solution, followed by excess.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(2)

e) To about 1 cm^3 of solution **P**, add a few drops of dilute hydrochloric acid and warm gently. Perform a test/s to identify any gas/es evolved.

Observation *Inference*

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

(5)

f) Dissolve about a quarter of the sample of solid **Q** in 5 cm^3 of distilled water in a boiling tube. Add a few drops of sodium hydroxide solution, followed by excess. Boil the mixture carefully, and perform a test/s to identify any gas/es evolved.

Observation *Inference*

(5)

g) To about a quarter of the sample of solid **Q**, add around 1 cm^3 of dilute hydrochloric acid and perform a test/s to identify any gas/es evolved.

Observation *Inference*

(5)

h) Dissolve another quarter of the sample of solid **Q** in 5 cm^3 of distilled water in a boiling tube, followed by 2 cm^3 of solution **P**.

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

(3)

Conclusion

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 liquid. One molecule of **T** has three carbon atoms. Carry out the following tests and suggest a chemical structure for this compound.

a) Place about 1 cm^3 of potassium dichromate solution in a test tube, followed by 5 drops of concentrated sulfuric acid. To the resulting solution, add 5 drops of compound **T** and warm in a water bath for two minutes.

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

(4)

b) To about 1 cm^3 of 2,4-DNPH solution in a test tube, add 5 drops of compound **T**.

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

(3)

c) Add **two** drops of sodium hydroxide solution to about 1 cm^3 of aqueous silver nitrate in a **clean** test tube, followed by ammonia solution dropwise until the precipitate just dissolves. Add 2 drops of compound **T** to the resultant solution and allow it to rest for 1 minute.

NOTE: After completing this test, clean the test tube immediately and flush it with plenty of water.

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

(3)

d) To about 1 cm^3 of aqueous iodine in potassium iodide, add just enough sodium hydroxide solution to give a clear solution. Add two drops of **T** and warm gently in a water bath if necessary.

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

(3)

e) Place 1 cm^3 of compound **T** in a test tube and add about 1 cm^3 of glacial ethanoic acid and three drops of concentrated sulfuric(VI) acid. Warm the mixture for 2 minutes in a water bath, allow it to cool and then pour the contents of the test tube into a small beaker containing 10 cm^3 of sodium carbonate solution.

NOTE: Dispose of your solution immediately after the test has been carried out, and rinse the glassware with tap water.

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

(4)

Conclusion

The structure of compound **T** is: _____ (3)

(Total: 20 marks)

Blank Page

Blank Page

Blank Page