L-Università ta' Malta

MATSEC
Examinations Board

Examiners' Report
AM Chemistry

Main Session 2025

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A. STATISTICAL INFORMATION

The examination consisted of three papers: Paper I, comprising nine compulsory, structured questions; Paper II, which consisted of 8 longer-answer questions from which candidates had to choose 5; and Paper III, a practical examination comprising three compulsory questions. Paper I and II each carried 40% of the total mark, while Paper III carried 20%.

Three hundred and forty-nine candidates registered for the first session of the 2025 examination; of these, 323 candidates presented themselves.

Table 1 shows the distribution of grades for the First Session of the 2025 examination.

GRADE	A	B	C	D	E	F	Abs	Total
Number	37	62	81	49	37	57	26	349
% of Total	10.6	17.8	23.2	14.0	10.6	16.3	7.5	100

Table 1: Distribution of the grades awarded for the First Session AM Chemistry Exam 2025

B. GENERAL REMARKS

Candidates generally have an adequate knowledge base in chemistry, although numerous candidates experienced difficulties in answering several questions, especially in Paper 1. Furthermore, questions on inorganic chemistry again scored some of the lowest marks, especially in Papers 1 and 2. Candidates found these questions more challenging to answer, and most of their answers lacked significant detail.

Uncharacteristically, candidates scored a slightly lower average mark in Paper 1 than in Paper 2. The average mark of Paper 1 was 5.5 marks lower than that of May 2024, while that of Paper 2 was nearly two marks higher than that of May 2024. Most candidates found Paper 3 less challenging and obtained higher marks.

C. COMMENTS ON PAPER 1, PAPER 2 AND PAPER 3

Overall Comments

Table 2 gives a summary of the statistical data for the three papers. The highest averages were registered in Paper 3 and the lowest in Paper 1. The average mark obtained in Paper 1 was 3.7 percentage points lower than in Paper 2, and in the practical paper, the average mark was 22.5 percentage points higher than in Paper 1.

Paper	**1**	**2**	**3**
Mean	46.9	50.6	69.4
Median	47.5	56.3	73.0
Highest mark	96.0	93.5	95.5
Number of candidates who attempted the paper	323	320	320

Table 2: Statistical data for Papers 1, 2 and 3

The following sections give specific comments on candidates' performance in each question. The mean, median, and maximum marks scored, together with the Facility Index, are given for each question. The Facility Index indicates how challenging an examination item is for the particular group of candidates taking the examination. A high Facility Index (maximum 1.0) indicates an easy item, while a low Facility Index shows a more challenging item.

General Comments

Paper I

Three hundred twenty-three candidates attempted this paper. A summary of the statistical data for Paper 1 questions is given in Table 3. Question 6 on phase equilibria proved to be one of the most challenging questions. The least challenging question was question 2, which concerned chemical periodicity.

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mean	3.6	6.4	4.1	6.0	4.9	2.9	4.8	4.9	5.5
Median	3.5	6.5	3.5	6.5	4.5	2.5	5.0	5.0	5.5
Highest mark	9.0	11.0	12.0	12.0	13.0	10.0	11.0	10.0	12.0
Facility Index	0.40	0.58	0.34	0.50	0.38	0.29	0.44	0.49	0.46

Table 3: Statistical data for Paper 1 questions

Paper II

Three hundred twenty candidates attempted this paper. Table 4 gives a summary of the statistical data for Paper 2 questions. Question 6, which pertained to inorganic chemistry, proved to be one of the most challenging questions and one of the least attempted. Question 8, which consisted of several calculations on the states of matter and the quantity of matter, was the least challenging question and one of the most frequently attempted. Most candidates attempted questions 4 and 8.

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mean	10.6	9.4	11.3	9.4	8.0	6.9	8.3	12.8
Median	11.5	10.0	12.0	9.0	7.5	6.5	8.3	14.0
Highest mark	19.5	19.5	20.0	19.5	19.0	17.5	18.5	20.0
Facility Index	0.53	0.47	0.57	0.47	0.40	0.35	0.42	0.64
% of candidates who attempted the question	63	42	69	78	67	44	61	76

Table 4: Statistical data for Paper 2 questions

Paper III

Three hundred twenty candidates attempted this paper. Table 5 gives a summary of the statistical data for Paper 3 questions. Candidates performed better in the titrimetric and the inorganic qualitative exercises.

Question	**1**	**2**	**3**
Mean	38.1	21.2	9.2
Median	42.0	21.8	10.0
Highest mark	50.0	29.5	20.0
Facility Index	0.76	0.71	0.46

Table 5: Statistical data for Paper 3 questions

Specific comments about candidates' performance in each question

Paper I

Question 1 tested the candidates' knowledge of chemical bonding. Part (a)(i) was poorly answered. Several candidates attempted to explain the difference in melting points by referring to steric hindrance, inductive effects within the aromatic ring, and repulsion between attached groups. They did not adequately address the key factors of intermolecular and intramolecular hydrogen bonding in the positional isomers of nitrophenol.

Part (a)(ii) was better answered. Most candidates provided a reasonable explanation for the difference in solubility between the nitrophenol isomers. However, many responses omitted discussion of the energy released when the hydroxyl and nitro groups form hydrogen bonds with water.

In part (b)(i), several candidates provided oversimplified representations of the resonance structures of ozone, often omitting partial charges and curved arrows to indicate delocalisation. Part (b)(ii) on bond length was generally well answered.

Question 2, on chemical periodicity, was generally well answered. In part (a), most candidates gave correct answers, although some gave an incorrect chemical formula for silicon dioxide and incorrectly stated its physical state.

In part (b), several candidates showed uncertainty regarding types of bonding. Magnesium oxide was often correctly identified as ionic, but some candidates also mistakenly referred to intermolecular bonding within its ionic structure. Similarly, silicon dioxide was described as macromolecular, but some candidates incorrectly attributed its properties to strong intermolecular forces rather than covalent network bonding. Additionally, a few candidates attempted to explain the gaseous state of sulfur trioxide by suggesting that covalent bonds within the molecules are easily broken.

Part (c) was generally well answered. Most candidates correctly identified magnesium oxide as a basic oxide and sulfur trioxide as an acidic oxide and provided appropriate chemical equations to illustrate their acid–base behaviour. However, many candidates incorrectly classified silicon dioxide as amphoteric and attempted to write incorrect chemical equations.

Question 3 was about the chemistry of transition metals. Part (a) was generally well answered, though numerous candidates only mentioned the general trend and left out the anomalies.

In part (a)(i), most answers contained some form of inaccuracy. Common errors included incorrect naming of the NO ligand, using "tri" instead of "tris," referring to "copper" instead of "cuprate," and assigning the wrong oxidation state to the transition metal cations.

In parts (a)(ii) and (iii), candidates often omitted the square brackets and charges in their diagrams of the stereoisomers, despite correctly identifying the types of stereoisomerism.

In part (b)(i), most candidates correctly wrote the half-equation for the oxidation of iron(II) but struggled with the half-equation for the reduction of nitrate(V).

In part (b)(ii), several candidates incorrectly assigned a negative charge to the nitrosyl ligand and referred to the iron cation in the hexaqua complex as iron(III) instead of iron(II).

Part (b)(iii) was generally well attempted, but some candidates included water in the expression for the stability constant or confused reactants and products.

In part (b)(iv), most candidates understood the greater stability of polydentate ligands compared to monodentate ones. Many referred to the chelate effect or the increase in entropy.

Question 4 was about redox equilibria. Part (a) was generally well answered, though some candidates lost marks due to missing state symbols in the cell diagram. In part (a)(iii), several candidates gave the reverse reaction. Most candidates performed well in the final two sections of part (a).

For part (b), many candidates struggled to write the correct redox equation, which led to subsequent errors in determining oxidation numbers. Few candidates correctly calculated the thermodynamic potential.

Question 5 on energetics was well answered. Many candidates successfully constructed a labelled energy cycle. However, few could explain the discrepancy between theoretical and experimental values of lattice enthalpies for silver halides. In part (a)(iii), most candidates misunderstood the question and compared the lattice energies of different silver halides instead.

In part (b), many candidates correctly wrote the equation. However, in part (ii), few recognised that water was in the liquid state at room temperature. Errors in handling the units of enthalpies of formation and entropy were also common.

Question 6 was about phase equilibria. In part (a)(i), candidates often failed to recognise that the liquids involved were immiscible and incorrectly referred to Raoult's Law.

In part (a)(ii), most candidates correctly identified that steam distillation allows the separation of heat-sensitive compounds.

In part (a)(iii), candidates frequently struggled with algebraic notation.

In parts (b)(i) and (ii), explanations were often incomplete. Many candidates did not describe how positive and negative deviations arise from weaker or stronger interactions compared to pure liquids.

Question 7 was about aliphatic hydrocarbons and halogenoalkanes. In parts (a)(i) and (ii), some candidates omitted necessary reagents and conditions. For example, bromine decolourisation in the dark was often not mentioned in part (a)(i), and the use of ammoniacal $AgNO_3$ or CuCl was omitted in part (a)(ii).

Parts (b) and (c) were generally well answered. In part (d), many candidates did not mention that UV radiation is needed to release chlorine radicals from CFCs. In part (e), candidates often forgot to include both isomers.

Question 8 was about carbonyl chemistry. Part (a) was generally well answered, though some candidates could not name the mechanism. In part (b), Fehling's and Tollen's tests were confused. In part (c), many candidates could not give a balanced equation containing [H] for the reduction of propanal with $[AlH_4]^-$. Part (d) was generally well answered.

Question 9 was about aromatic chemistry. Part (a) was generally well answered. In part (b), most candidates understood the importance of substitution order. In part (c), candidates correctly noted that temperatures below 5 °C prevent decomposition of the diazonium salt, though some mentioned decomposition of HNO_2 instead. Part (d) was well answered.

Paper II

Question 1 tested candidates on ionic equilibria. Parts (a)(i) and (ii) were generally well answered. The formulas pOH = 14 – pH and $[OH^-] = 10^{-pOH}$ were correctly applied. Most candidates correctly related the higher K_b value to a stronger base, linking this to the equilibrium position and OH^- production.

In part (a)(iii), some candidates omitted explanations involving the inductive effect of the alkyl group or the stabilisation of the conjugate acid. Few candidates provided both points.

Part (a)(iv) was often poorly answered. Explanations of buffer solutions lacked chemical equations, which were essential for full marks.

In part (b), the stepwise synthesis was generally understood. However, errors were observed in reagent details and sequencing.

Question 2 tested candidates on various organic and inorganic chemistry topics. In part (a), while most candidates correctly defined a racemic mixture, few identified the chiral carbon in adrenaline.

In part (b)(i), vague or incorrect temperature and pressure values were given. In part (ii), some candidates omitted either “free radical” or “addition” from their response. Part (b)(iii) was often missing the second propagation step.

Part (c) was generally well answered. Candidates described the environmental impacts of sulfur compounds and correctly explained the weak acid dissociation of H_2S.

Part (d)(i) was answered well, but in part (ii), few candidates identified the three-way catalytic converter or described the catalyst as heterogeneous. There was confusion regarding the roles of oxidation and reduction.

Question 3 required candidates to complete a reaction scheme for carboxylic acids and their derivatives. In part (a), most candidates recognised propanamine but did not specify propan-1-amine.

Parts (b), (c), and (d) were generally well answered.

In part (e), many candidates knew that substance B had the lowest boiling point due to a lack of hydrogen bonding. However, few realised that compound C, with two N-H bonds, has more hydrogen bonding than A, which has only one O-H bond. Most incorrectly ranked boiling points as B < C < A..

Parts (f)(i) and (ii) were generally well answered, although many candidates did not know that carboxylic acids do not easily react with phenol.

In part (f)(iii), while most candidates gave correct reactions with Na_2CO_3 for A, they were unaware that phenol reacts without releasing CO_2.

Question 4 tested candidates on rates of reaction. In part (a)(i), most candidates gave correct answers but were unsure about the advantages of homogeneous catalysts.

In part (a)(ii), candidates correctly stated that catalysts increase the rate but incorrectly claimed they affect the yield.

Part (a)(iii) was poorly answered, with many not explaining how Fe^{2+} catalyses the reaction between $S_2O_8^{2-}$ and I^-.

In part (b), Maxwell-Boltzmann distribution sketches were often incorrect and explanations for temperature effects were weak.

Parts (c)(i) and (ii) were generally well answered.

Question 5 tested candidates on chemical equilibria. In part (a)(i), most candidates recognised that forward and backwards reaction rates differ before equilibrium is reached, but a few stated that the forward rate decreases while the backwards rate increases.

In part (a)(ii), several candidates incorrectly stated that reactant and product amounts are equal, rather than constant.

In part (b), candidates were generally familiar with heterogeneous equilibria, though some gave poor examples.

In part (c)(i), candidates attempted to calculate K_p using stoichiometric molar ratios, without using the variable α to represent pressure changes.

Parts (c)(ii) and (iii) were better answered. Candidates related the degree of dissociation and K_p to temperature.

In part (d), many candidates did not explain that solvent extraction relies on two immiscible liquids and solute partitioning based on solubility. Only a few candidates related the distribution coefficient of caffeine in dichloromethane and black tea to its practical application.

In parts (e)(i) and (ii), many candidates wrote the expression for K_d but failed to solve for x, the amount of solute removed. Few candidates showed that two 50 cm^3 extractions are more efficient than one 100 cm^3 extraction.

Question 6 dealt with inorganic chemistry. Part (a) was answered quite well, although this was one of the least chosen questions. Most candidates were able to rank the cations in order of their polarising power correctly. Candidates seemed familiar with the concepts of intermediate bonding, polarising power, and charge density.

In part (b), candidates generally demonstrated a simplistic understanding of the structures of graphite and diamond. Most provided basic diagrams lacking sufficient detail and omitted the explanation of carbon hybridisation. Few stated that each carbon atom is sp^3 hybridised in diamond and sp^2 hybridised in graphite. Although some mentioned free electrons in graphite, very few explained that these originate from unhybridised p orbitals.

Part (c)(i), which focused on the corrosion resistance of aluminium, was well answered. Most candidates mentioned passivation and correctly explained that a protective oxide layer forms a barrier against moisture and oxygen.

In part (c)(ii), many candidates misunderstood the question. Instead of identifying properties such as the non-porous and self-regenerating nature of the oxide layer, they listed general uses of aluminium. This suggests a limited understanding of the specific properties that make aluminium suitable for various applications.

Part (d)(i) and (ii), which focused on the bleaching properties of chlorine and chlorate(I), were generally poorly answered. While some candidates correctly stated that chlorine disproportionates in water to form chlorate(I) ions, few explained why these ions oxidise coloured organic compounds. In part (d)(ii), most candidates could define disproportionation, but only a few provided the correct chemical equation for the disproportionation of chlorate(I).

Question 7 tested polymers and the identification of organic molecules. In the first part, most candidates correctly identified the repeating unit of the polymer. However, responses on the environmental impact of biodegradable and non-biodegradable polymers lacked depth. Few candidates explained that ester linkages in biodegradable polymers are susceptible to hydrolysis.

In the second part, most candidates correctly determined the empirical formulae. However, many incorrectly identified an alkene instead of a cyclic alcohol, overlooking the absence of IR bands for a double bond. Candidates who correctly identified compounds Q and R generally performed well in the final section, where they confirmed the identities using chemical tests.

Question 8 consisted of several calculations on the state and quantity of matter. Parts (a) and (b), which focused on gas laws, were generally well answered. A common error was the failure to convert volume to m^3.

In part (c), many candidates incorrectly used the mass of monoatomic iodine instead of the diatomic form in their calculations.

Part (d) was answered correctly by only a few candidates. Marks were lost for incomplete equations and incorrect mass usage.

In part (e), many candidates confused the values and failed to write a balanced chemical equation. Several assumed a 1:1 molar ratio, which led to errors. Candidates who answered part (e)(i) correctly generally performed well in part (e)(ii).

It is essential that candidates understand the importance of balanced chemical equations in quantitative calculations, as they establish the correct molar ratios.

Paper III

Question 1 required candidates to carry out two sets of titrations. In general, correct titre values were encountered, and the mean titre values for both titrations fell within the acceptable range. The first titration was straightforward, and most candidates performed well. Nearly all candidates used concordant values. However, some calculated the relative formula mass of the iron compound incorrectly or applied the wrong mole ratio (1:8 instead of 1:5), leading to inaccuracies in the final concentration of the manganate(VII) solution.

The second titration required dilution. Once again, the majority achieved concordant values within the expected range. However, marks were frequently lost during calculations, particularly when applying the dilution factor to the final result. Several candidates attempted to determine the original concentration of solution C using a stepwise approach.

Question 2 required candidates to carry out qualitative tests on two inorganic salts. Candidates generally performed well on this practical qualitative analysis question. Most correctly interpreted the observations and linked them to the appropriate ions.

In parts (a) to (d), the identification of Group 2 metal cations was handled reasonably well.

In part (e), many candidates correctly identified the yellow precipitate as sulfur and the gas as sulfur dioxide. However, fewer candidates explicitly stated its effect on dichromate paper, which was required for full marks.

In part (f), the test for NH_4^+ ions was handled well, with most candidates recognising ammonia gas by its characteristic smell and effect on litmus paper.

In part (g), most correctly identified the effervescence as due to CO_2 and linked it to carbonate or hydrogencarbonate ions. The reaction with limewater was also generally described clearly and correctly.

In part (h), candidates were expected to distinguish between CO_3^{2-} and HCO_3^- based on the absence of a precipitate. This deduction created some confusion, and not all candidates correctly identified the anion in substance Q.

Question 3 required candidates to carry out qualitative tests on an organic liquid, and very few candidates deduced the correct structure of compound T. In part (a), answers were generally accurate. In part (b), many candidates missed the 2,4-DNPH precipitate and failed to infer the presence of a carbonyl group. In part (c), failure to eliminate aldehydes based on Tollen’s reagent was common.

Part (d) was well answered, with candidates correctly linking iodoform formation to $CH_3CH(OH)$– or CH_3CO– groups. Part (e) on esterification was well performed.

Chairperson

2025 Examination Panel