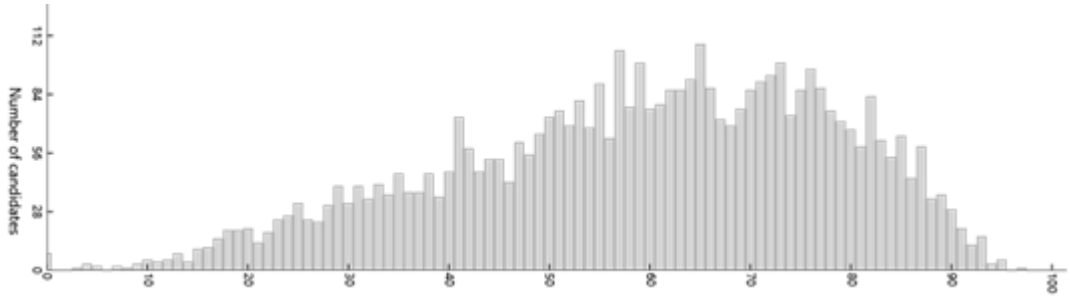
2021 ATAR course examination report: Chemistry

Year	Number who sat	Number of absentees
2021	4451	76
2020	4464	71
2019	4547	66
2018	4965	50

The number of candidates sitting and the number attempting each section of the examination can differ as a result of non-attempts across sections of the examination.

Examination score distribution–Written



Summary

This examination provided good coverage across the syllabus. There were a variety of questions with a range of difficulty and a range of answer types. Many questions referred to real life applications of chemistry. Overall, the questions were accessible to most candidates.

Attempted by 4450 candidates	Mean 58.96%	Max 95.50%	Min 0.00%
Section means were:			
Section One: Multiple-choice	Mean 70.78%		
Attempted by 4450 candidates	Mean 17.70(/25)	Max 25.00	Min 0.00
Section Two: Short answer	Mean 57.87%		
Attempted by 4433 candidates	Mean 20.25(/35)	Max 33.85	Min 0.00
Section Three: Extended answer	Mean 52.54%		
Attempted by 4427 candidates	Mean 21.02(/40)	Max 38.89	Min 0.00

General comments

The means in Sections One and Two were comparable to those in 2020 but were somewhat lower in Section Three. Teacher and candidate feedback indicated that most candidates were able to complete the examination in the three hours allocated.

Advice for candidates

- Respond to the specific question being asked. For example, if a question needs an explanation, writing only a few words is not going to allow you to do this.
- Do not spend time writing answers that digress from the actual question.

- Examine syllabus content points closely, making sure that you can define and explain chemistry terminology contained within them.
- Make sure units are included when appropriate, even if there are no explicit statements saying to do so in the question.
- Become more familiar with the use of significant figures.
- When explaining the choice of indicator for a particular titration reaction, it is not enough to attribute it to acid/base strengths. The nature of the ions in the solution at the end of the titration needs to be considered.
- Do not terminate the ends of polymers.
- Read questions carefully to determine whether collision theory or Le Châtelier's Principle is needed to answer a question. They are different things.
- When adding lines to graphs for Le Châtelier's Principle, take care that the positioning/amount of change reflects the stoichiomentry in the equilibrium equation.
- Practise identifying polar and non-polar organic compounds and the reasons for why they will/will not dissolve in particular types of solvents.
- Be aware that ocean acidification means that it is harder for seashells to form (they are not dissolving).
- Use highlighters/underline key points in questions, to bring into clear focus what each question is asking you to do. It is easy to misread/forget key terms such as 'least likely' etc. if you are in a hurry.

Advice for teachers

- Ensure all students know that all aspects of the syllabus are examinable including the contents of the Scientific Inquiry Skills and Science as a Human Endeavour sections.
- Encourage students to be specific in their answers, and to avoid adding information just to fill up the space allocated for an answer.
- Encourage students to practise drawing and naming organic structures.
- Provide students the opportunity to practise problem-solving by giving calculations that do not follow a straightforward calculation method.
- Teach general concepts from first principles so that students can apply the concepts to unfamiliar situations. Not all answers can be memorised.
- Make sure students are fully aware of the information in the Data Booklet.
- Make students fully aware that Le Châtelier's Principle is a predictive tool and not linked to collision theory.
- Emphasise that ocean acidification does not mean that oceans are acidic/have a pH less than 7 and seashells are not dissolving. Rather, ocean acidification is a decrease in the pH of seawater with this interfering with seashell formation.
- Teach students strategies for answering multiple-choice questions, such as eliminating answers to narrow down the options.

Comments on specific sections and questions

Section One: Multiple-choice (25 Marks)

Questions 3, 6, 7, 12, 16, 17, 18, 20, 21 and 23 proved to be the easiest of the Multiple-choice section, with 75% or more of candidates answering them correctly. Questions 4, 9, 10 and 15 were the most challenging, with 55% or less of candidates answering them correctly. Question 4 emphasised the need for candidates to know more about different polymer characteristics and to identify inconsistencies in answer choices. For example, even if a candidate did not know what cross-linking was, they should have been able to deduce that because hydrogen atoms can only form one bond they will not be able to link with other chains. Question 9 required understanding of the acidity of different ions and hydrolysis. A process of elimination could have been used to narrow down the answer to either (c) or (d), as the neutrality and solubility of group 1 cations should be easily recalled.

Distractor (c) could also be easily eliminated, as it should be commonly known that sulfuric acid is a strong acid. Question 10 required the knowledge of some straightforward definitions, characteristics and common examples of electrochemical cells. This emphasised the need to closely look at the full details of a syllabus content points. The process of elimination could also have been used to answer this question. Question 15 required candidates to recognise that the equilibria involving carbonic acid formation, and associated hydrolysis, result in ocean acidification and interfer with seashell building. Improved skill at answering multiple-choice questions could have increased many candidates' results in Section One.

Question 1 attempted by 4450 candidates	Mean 0.70(/1)	Max 1	Min 0
Question 2 attempted by 4450 candidates	Mean 0.72(/1)	Max 1	Min 0
Question 3 attempted by 4450 candidates	Mean 0.83(/1)	Max 1	Min 0
Question 4 attempted by 4450 candidates	Mean 0.53(/1)	Max 1	Min 0
Question 5 attempted by 4450 candidates	Mean 0.57(/1)	Max 1	Min 0
Question 6 attempted by 4450 candidates	Mean 0.94(/1)	Max 1	Min 0
Question 7 attempted by 4450 candidates	Mean 0.80(/1)	Max 1	Min 0
Question 8 attempted by 4450 candidates	Mean 0.67(/1)	Max 1	Min 0
Question 9 attempted by 4450 candidates	Mean 0.55(/1)	Max 1	Min 0
Question 10 attempted by 4450 candidates	Mean 0.53(/1)	Max 1	Min 0
Question 11 attempted by 4450 candidates	Mean 0.70(/1)	Max 1	Min 0
Question 12 attempted by 4450 candidates	Mean 0.81(/1)	Max 1	Min 0
Question 13 attempted by 4450 candidates	Mean 0.71(/1)	Max 1	Min 0
Question 14 attempted by 4450 candidates	Mean 0.67(/1)	Max 1	Min 0
Question 15 attempted by 4450 candidates	Mean 0.53(/1)	Max 1	Min 0
Question 16 attempted by 4450 candidates	Mean 0.92(/1)	Max 1	Min 0
Question 17 attempted by 4450 candidates	Mean 0.80(/1)	Max 1	Min 0
Question 18 attempted by 4450 candidates	Mean 0.76(/1)	Max 1	Min 0
Question 19 attempted by 4450 candidates	Mean 0.59(/1)	Max 1	Min 0
Question 20 attempted by 4450 candidates	Mean 0.78(/1)	Max 1	Min 0
Question 21 attempted by 4450 candidates	Mean 0.88(/1)	Max 1	Min 0

Question 22 attempted by 4450 candidates Mean 0.71(/1) Max 1 Min 0

Question 23 attempted by 4450 candidates Mean 0.86(/1) Max 1 Min 0

Question 24 attempted by 4450 candidates Mean 0.57(/1) Max 1 Min 0

Question 25 attempted by 4450 candidates Mean 0.56(/1) Max 1 Min 0

Section Two: Short answer (76 Marks)
The mean for this section was 58.48%, which was very similar to the mean of 57.87% in 2020. Candidates performed best in Question 26 (identifying errors in organic compound structural formulae and names), with a mean of 77.5%. Question 31 (the corrosion of iron) was also answered well, with a mean of 70.4%. Question 33 (solubility of ethanol in different solvents) was found to be the most difficult in this section with a mean of 30.7%.

Question 26 attempted by 4420 candidates Mean 6.20(/8) Max 8 Min 0
This question was well answered, indicating that most candidates knew the bonding capacity of different atoms in organic compounds and the main points of the IUPAC naming system.

Question 27 attempted by 4315 candidates Mean 5.91(/11) Max 11 Min 0
The most challenging aspect of this question was writing an ionic equation for the oxidation of an alcohol. The reduction equation was able to be used directly from the Data Booklet. Care needed to be taken when balancing for hydrogen ions and charge (electrons), both when writing the alcohol oxidation equation and when combining it with the reduction equation.

Question 28 attempted by 4408 candidates Mean 4.32(/9) Max 9 Min 0
Part (b) presented difficulty for many candidates, possibly because they had not previously thought about buffering in relation to certain types of acid-base titration. This emphasised the need for candidates to be aware of a concept (e.g. buffering) so that they can apply it to an unfamililar situation. Knowledge of buffering during the titration was not necessary but an understanding of what buffering is, and the flexibility to apply this concept, was essential.

Question 29 attempted by 4321 candidates Mean 4.46(/7) Max 7 Min 0
This question was reasonably well done, indicating that most candidates had the ability to interpret data about pH and calculate hydrogen and hydroxide concentrations.

Question 30 attempted by 4377 candidates Mean 6.12(/10) Max 10 Min 0
The most challenging aspect of this question was part (c), with many candidates finding it hard to provide two specific conditions of the cell to account for the observation. Candidates needed to read this carefully, paying attention to the word ‘specific’. Increased familiarity with the Data Booklet, in particular the conditions for which standard reduction potentials are reported, would have assisted with answering part (c).

Question 31 attempted by 4375 candidates Mean 6.34(/9) Max 9 Min 0
All parts of this question were well answered. Part (a) provided clear scaffolding so that candidates were able to develop oxidation and reduction half equations. Understanding of sacrificial anodes was also well demonstrated.

Question 32 attempted by 4403 candidates Mean 8.17(/14) Max 14 Min 0
Candidates found part (c) the most challenging. They needed to interpret the graph to elucidate the reason for the change, and they needed to adequately explain the consequences of the change using collision theory. Part (d) required care to make sure the ratios in the equilibrium equation were matched in the lines added to the graph.

Question 33 attempted by 4112 candidates Mean 2.46(/8) Max 8 Min 0
Most candidates found this question very challenging. Candidates were required to carefully read the statement and then develop an answer that included all of the specifications, particularly labelled diagrams. Candidates who highlighted/underlined key words, and/or developed an initial plan before providing a more detailed answer, often performed better.

Section Three: Extended answer (90 Marks)
The mean for this section was 52.54%, which was slightly lower than the 2020 mean of 60.14%. Candidates performed best in Questions 34 (polymers/proteins), 35 (titration calculations) and 36 (empirical formula). Question 37, with a mean of 39.5%, proved to be effective in discriminating among candidates, with non-standard methods required in performing calculations. Question 38 (application of collision theory and chemical equilibrium) was also challenging, with a mean of 35.5%

Question 34 attempted by 4414 candidates Mean 7.91(/13) Max 13 Min 0
This question was done well by most candidates, indicating a good understanding of the required aspects of polymer and protein chemistry.

Question 35 attempted by 4370 candidates Mean 7.57(/12) Max 12 Min 0
This question was also done well by most candidates. Candidates achieved marks if they could demonstrate the basics, such as what to rinse titration equipment with and the characteristics of a good primary standard.

Question 36 attempted by 4197 candidates Mean 11.00(/17) Max 17 Min 0
Empirical formula calculations were done well by most candidates, indicating that they had been well-prepared in performing them. Most candidates would have likely practised these types of calculations before the examination, hence the good overall marks.

Question 37 attempted by 4257 candidates Mean 7.11(/18) Max 18 Min 0
This question was also a calculation, but the mean was much lower than for the straightforward empirical formula calculation. A similar situation was encountered in 2019 and again, the lower marks achieved might be attributed to candidates needing more exposure to solving non-standard problems.

Question 38 attempted by 4106 candidates Mean 4.26(/12) Max 12 Min 0
There was no scaffolding in this question, with this possibly contributing to the low mean. Candidates needed to read the question carefully and determine how to approach the answer. Candidates also needed to understand the difference between collision theory and chemical equilibrium, which proved challenging.

Question 39 attempted by 4285 candidates Mean 9.44(/18) Max 18 Min 0
Part (a) was the most challenging part of this question, as candidates needed to develop a series of equations. The other parts of the question, such as constructing and interpreting a graph, were completed quite well.