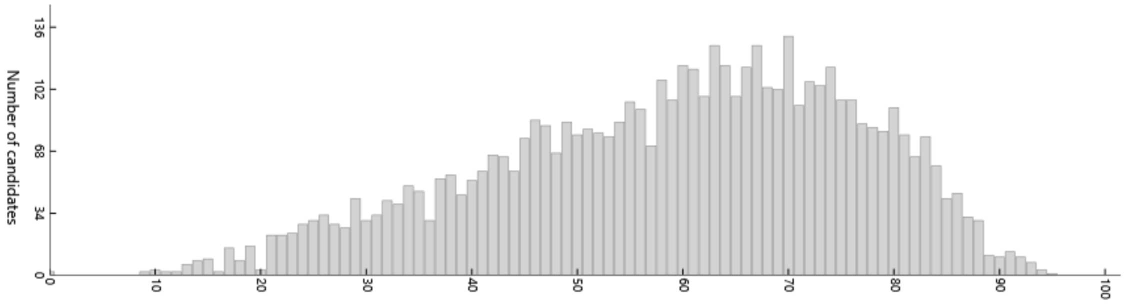
Government of **Western Australia**
School Curriculum and Standards Authority

2018 ATAR Course Examination Report: Chemistry

Year	Number who sat	Number of absentees
2018	4965	50
2017	5007	54
2016	4997	57

Examination score distribution-Written



Summary
Only slightly fewer candidates sat the Chemistry examination in 2018 than in previous years. Overall, the paper was of an appropriate length. There were fewer questions that were not attempted than in previous years; it is uncertain whether this was because of the examination paper itself or because it was the first examination scheduled.

The paper was pitched at an appropriate level of difficulty with individual questions varying in difficulty, allowing candidates to offer a response and gain some marks while stronger candidates could work through questions and gain more marks. There was an appropriate weighting of discriminating questions. Teacher feedback suggests that the examination was well received by candidates. The paper was considered accessible with the discrimination aspect coming from quality questions rather than a long examination. The paper allowed candidates to demonstrate their understanding of the syllabus and included some content that had not been assessed in the previous examinations. Consequently, the examination functioned well to discriminate between candidates and was a fair representation of the course.

Calculations in this examination made up 19.6% and met the design brief requirements of between 15% and 20%. The calculations were deemed to be straightforward with a sufficient number of questions serving to discriminate between the more able candidates.

The contexts used to cover the material were framed in real world contexts that were interesting and original. They gave candidates the opportunity to apply their knowledge to novel situations.

Attempted by 4965 candidates	Mean 58.96%	Max 95.42	Min 0.00

Section means were:

Section One: Multiple-choice	Mean 71.47%		
Attempted by 4965 candidates	Mean 17.87(/25)	Max 25.00	Min 0.00
Section Two: Short answer	Mean 53.34%		
Attempted by 4963 candidates	Mean 18.67(/35)	Max 33.67	Min 0.00
Section Three: Extended answer	Mean 56.18%		
Attempted by 4957 candidates	Mean 22.47(/40)	Max 39.79	Min 0.00

General comments

The examination mean was 58.98%, which is generally consistent with previous years and slightly higher than that of 57.65% in 2016 and 58.73% in 2017.

Advice for candidates

- Examination questions are based on the syllabus not a textbook. Do not expect the examination to contain similar or standard questions from year to year.
- Do not use abbreviations or acronyms.
- Use appropriate units and express numerical answers to the appropriate significant figures.
- Know commonly used reactions (e.g. acid/base indicators and colour changes).
- Some questions require a response drawing on general principles while other questions require a response referring to a specific context, substance or reaction.
- Be conversant with the terms used in the syllabus.
- Understand the differences between related concepts (e.g. intermolecular force and intramolecular force, equivalence point and end point, ionisation and dissociation).
- Practise writing clear, concise and coherent explanations and justifications; incorporating illustrative, labelled diagrams that are clear and relevant.
- Be familiar with the content of, and how to use, the Chemistry Data Booklet.
- Know how to generate, read and apply data from graphs and tables.
- Use the formula given to determine the nature and bonding of a substance and all its intermolecular forces.
- Be familiar with, and how to express clearly, the expected observations and inferences that can be made for the reactions indicated in the syllabus.
- Solutions are clear; some are colourless and some exhibit a colour. Referring to a clear solution is redundant and is not the same as referring to a colourless solution. Copper sulfate solution is blue, while sodium sulfate solution is colourless; both are clear because they are solutions.
- Practise writing equations providing the appropriate formula and state symbols for only those species that are taking part in the reaction, unless otherwise directed.

Advice for teachers

- Ensure coverage of all syllabus dot points and be mindful that the entire syllabus is not necessarily examined in any one examination. Some syllabus points are examined regularly as they are essential for the understanding and communication of chemical concepts and processes.
- Prepare students to expect the examination to contain a range of difficulty and different types of questions often reflecting authentic chemistry contexts.
- Teach efficient and critical reading of information to extract and understand the relevant information.
- Engage students in conducting relevant experiments and problem solving. Candidates often struggle to apply knowledge of common laboratory procedures.
- Insist that students use the appropriate units and express numerical answers to the appropriate significant figures unless otherwise directed.

- Provide students with practise in writing extended answers, justifications and explanations; incorporating illustrative diagrams that are clear, labelled and relevant.
- Encourage students to set out their working and reasoning clearly.
- Teach students to think critically and apply their knowledge of chemistry.
- Teach students to recognise that molecules might exhibit more than one type of intermolecular force and the attraction between molecules is the result of the cumulative effect of all intermolecular forces.

Comments on specific sections and questions

Section One: Multiple-choice (25 Marks)
Attempted by 4965 candidates Mean 17.87(/25) Max 25.00 Min 0.00

Based on the average marks achieved, the easiest questions were 1, 4, 7, 8, 16, 17, 19, 22, 24 and 25. The most challenging questions were 12, 13 and 20.

Question 1 attempted by 4965 candidates Mean 0.93(/1) Max 1.00 Min 0.00

Question 2 attempted by 4965 candidates Mean 0.61(/1) Max 1.00 Min 0.00

Question 3 attempted by 4965 candidates Mean 0.76(/1) Max 1.00 Min 0.00

Question 4 attempted by 4965 candidates Mean 0.82(/1) Max 1.00 Min 0.00

Question 5 attempted by 4965 candidates Mean 0.50(/1) Max 1.00 Min 0.00

Question 6 attempted by 4965 candidates Mean 0.55(/1) Max 1.00 Min 0.00

Question 7 attempted by 4965 candidates Mean 0.83(/1) Max 1.00 Min 0.00

Question 8 attempted by 4965 candidates Mean 0.93(/1) Max 1.00 Min 0.00

Question 9 attempted by 4965 candidates Mean 0.75(/1) Max 1.00 Min 0.00

Question 10 attempted by 4965 candidates Mean 1.00(/1) Max 1.00 Min 0.00
Polytetrafluorthene is used in the manufacture of some parachute canopies and so the question as stated offered no correct answer. All candidates were awarded one mark.

Question 11 attempted by 4965 candidates Mean 0.72(/1) Max 1.00 Min 0.00

Question 12 attempted by 4965 candidates Mean 0.38(/1) Max 1.00 Min 0.00
Candidates skilled in the practice of titration found this a straightforward question.

Question 13 attempted by 4965 candidates Mean 0.25(/1) Max 1.00 Min 0.00
Some candidates who appear to have been taught the over-simplification method of taking three titres and averaging them found this question confusing. The question aimed to assess good scientific practice.

Question 14 attempted by 4965 candidates Mean 0.77(/1) Max 1.00 Min 0.00

Question 15 attempted by 4965 candidates Mean 0.68(/1) Max 1.00 Min 0.00

Question 16 attempted by 4965 candidates Mean 0.82(/1) Max 1.00 Min 0.00
The syllabus places Chemistry in the world of responsible science. It is re-assuring that most candidates performed well with this question.

Question 17 attempted by 4965 candidates Mean 0.81(/1) Max 1.00 Min 0.00

Question 18 attempted by 4965 candidates Mean 0.52(/1) Max 1.00 Min 0.00

Question 19 attempted by 4965 candidates Mean 0.84(/1) Max 1.00 Min 0.00

Question 20 attempted by 4965 candidates Mean 0.46(/1) Max 1.00 Min 0.00
Option (d) was the most frequently selected incorrect answer, followed by option (a) and then option (b).

Question 21 attempted by 4965 candidates Mean 0.71(/1) Max 1.00 Min 0.00

Question 22 attempted by 4965 candidates Mean 0.81(/1) Max 1.00 Min 0.00

Question 23 attempted by 4965 candidates Mean 0.72(/1) Max 1.00 Min 0.00

Question 24 attempted by 4965 candidates Mean 0.84(/1) Max 1.00 Min 0.00

Question 25 attempted by 4965 candidates Mean 0.85(/1) Max 1.00 Min 0.00

Section Two: Short answer (35 Marks)
Attempted by 4963 candidates Mean 18.67(/35) Max 33.67 Min 0.00
The mean for Section Two was 53.34% with marks ranging from 0.00 to 33.67 out of 35 compared to a mean of 50.32% and a range of 0.00 to 34.38 out of 35 in 2017. Questions not well answered in Section Two related to, equilibriums, intermolecular forces, buffering systems and the dissolving processes.

Question 26 attempted by 4932 candidates Mean 5.76(/10) Max 10.00 Min 0.00
Candidates struggled to write correct formula and correctly state symbols in part (a). In parts (b) and (c) many candidates made a reasonable attempt but missed the idea that observations were required during and at the end of the reaction. Most candidates did not know the colour of copper hydroxide. Observations were quite poorly done with many candidates not understanding how to use the Data Booklet in determining colours of solids. The candidates might have checked the table of coloured solids but then failed to recognise that the colour of the ion will determine the colour of the solid. Part (d) sought to assess the knowledge of standard safety precautions and was intended to be a simple question. It was disappointing to observe a mean score of 86% on what should have been a relatively straightforward question.

Question 27 attempted by 4943 candidates Mean 6.00(/12) Max 12.00 Min 0.00
In part (a) candidates did not indicate which was the second ionisation if multiple equations were written. Many candidates did not use double arrows as was required and used H^+ rather than H_3O^+. Many candidates did not read the question carefully in part (b) and simply stated the three products of the reaction. The question clearly required products 'other than water'; however, responses were generally sound although the use of formulae was poor. In part (c) candidates were required to indicate their understanding that the purity of sodium hydroxide cannot be known as it deliquescent (or hygroscopic) and reacts with carbon dioxide in the air. Many candidates only stated that it could not be found in pure form, did not know the meaning of the two terms, deliquescent and hygroscopic, or discussed the reaction with air rather than the components CO_2 and H_2O. Candidates were able to select phenolphthalein in part (d) but were unable to provide clear reasoning behind their choice.

Few candidates identified that the equivalence point was basic, due to the presence of the basic phosphate ion in solution; most just stated that it was a 'weak acid/strong base titration' as their justification.

Question 28 attempted by 4922 candidates Mean 3.70(/8) Max 8.00 Min 0.00
In part (a) many candidates simply remembered the standard oxidation for a half cell and quoted the equation ($H_2 \rightarrow 2H^+ + 2e^-$) in part (a); however, this disregarded the actual question, and therefore, could not attain full marks. In part (b) many candidates attempted to use the question and species to come to the final equation but were unable to complete the task. Candidates answered part (c) in simplistic terms rather than a comparison with the combustion engine. A significant number of candidates said 'produces water as the only by-product'; however, this was only part of the answer.

Question 29 attempted by 4840 candidates Mean 8.27(/15) Max 15.00 Min 0.00
For part (a) many candidates could not write a buffer equation and failed to realise that it is a reversible reaction. Some chose to include all species rather the pertinent ones. Candidates answered part (b) well, although some could not calculate a correct molar mass. Most candidates were able to move from pH or pOH to concentration easily in part (c). Errors occurred when calculating with indices. Part (d) was not well answered. Candidates attempted to use an alternative method rather than answering based on the citric acid buffering components. Candidates were unable to describe why a non-buffer system would have a large increase in pH. Part (e) asked candidates to answer with respect to 'this buffer solution', but many candidates gave a generalised statement about buffer capacity without referring to the components in 'this buffer solution'.

Question 30 attempted by 4862 candidates Mean 3.89(/7) Max 7.00 Min 0.00
Part (a) was either completed very well or very poorly. Common mistakes included terminating the structure, not drawing two repeating units and/or not completing the ester bond correctly. In part (b) some candidates misread the question and attempted to name the polymer rather than the by-product. In part (c) candidates failed to demonstrate their knowledge of reagents which should be in solution form and acidified; most simply wrote ions. Some candidates did not know potassium permanganate and opted for the dioxide (with the permanganate ion). Although part (d) was attempted well by most candidates, some chose to work out and write a full redox equation, showing poor knowledge of the meaning of half-equation as required.

Question 31 attempted by 4894 candidates Mean 3.76(/6) Max 6.00 Min 0.00
A common mistake candidates made in part (a) was adding rather than multiplying the concentration. Many also left out the term 'K ='. Square brackets were not always used as required in equilibrium constant expressions. Part (b)(i) was approached quite well by candidates. Most errors included a lack of balance of charges across equations and missing/incorrect charges on ions. Very few candidates demonstrated an understanding of competing reactions in part (b)(ii).

Question 32 attempted by 4679 candidates Mean 2.68(/4) Max 4.00 Min 0.00
Many candidates failed to reference/use the equations to answer the question as directed. A common mistake was a discussion about carbon dioxide dissolving in water and forming carbonic acid thereby increasing the acidity of the oceans by increasing the concentration of hydronium ions. It appeared that many candidates had simply rote-learned an explanation of ocean acidification and had not read the question. Many talked about the formation of H_2CO_3, which was not one of the given equations.

Question 33 attempted by 4920 candidates Mean 4.13(/11) Max 11.00 Min 0.00
Parts (a) and (b) were answered poorly by most candidates with vague answers. It seems that candidates did not fully understand the requirements for dissolving, nor were they able

to explain the difference in solubilities between compounds, often missing the intent of the question. In part (a) many candidates gave an explanation, rather than a hypothesis. While many candidates performed well, a significant number struggled with understanding basic scientific terminology. Candidates struggled to understand that they were not asked to explain the trend in boiling points. Responses to Part (b) were very disappointing. Candidates were able to identify the intermolecular forces for butane, butanone and butan-1-ol, but some failed to mention the potential intermolecular forces for water. Candidates battled to understand that due to increased H–bonding in butan-1-ol there was greater solubility with water and some did not consider energy requirements when discussing solubility. Far too many gave a 'like dissolves like' response. Many candidates discussed the predominant intermolecular forces rather than the sum of intermolecular forces. In part (c) candidates failed to demonstrate knowledge that reagents should be in solution form and acidified or simply wrote the ions. Several candidates did not understand the intent of the chemical test and chose a different reagent for each substance being tested.

Question 34 attempted by 4735 candidates Mean 4.78(/6) Max 6.00 Min 0.00
This question was answered well generally by most candidates. Not all atoms were consistently shown in molecules or the bonding between atoms was incorrect. For example, carbon atoms did not contain the correct amount of bonds as all 12 hydrogen atoms had already been used. Candidates who attempted to draw primary or tertiary alcohols with a C=C double bond could not draw the alkene part correctly or drew a primary/secondary alcohol rather than the tertiary structure by branching the alkyl chain.

Section Three: Extended answer (40 Marks)
Attempted by 4957 candidates Mean 22.47(/40) Max 39.79 Min 0.00
The mean for Section Three of 56.18% was down from 57.34% in 2017.Marks ranged from 0.00 to 39.79 out of 40 compared with the range of 0.00 to 39.60 out of 40 in 2017. In Section Three candidates struggled to combine the percentage of elements in calculations, needed to be more specific in their answers relating to systematic or random errors, struggled with Collision theory, drawing peptide links and using ions instead of compounds.

Question 35 attempted by 4759 candidates Mean 10.60(/16) Max 16.00 Min 0.00
Candidates struggled to combine the percentage of elements from the various masses or were unable to gain a mass of iodine. Candidates who were able to calculate a correct ratio often rounded 2.65 down to 2.5 rather than triple the ratio.

Question 36 attempted by 4905 candidates Mean 9.04(/17) Max 17.00 Min 0.00
In part (a) many candidates knew the definitions for random and systematic errors but gave examples that were ambiguous. For example, candidates might have said 'depth of water measured incorrectly'. This could be a random error if referring to different scientists using different techniques for measuring depth or by referring to the ruler/tape measure not having the appropriate scale/accuracy. But it could be a systematic error if the tape measure was calibrated incorrectly. Candidates needed to be more specific with their answers. Parts (b)(i) and (b)(ii) were done well with part (b)(i) being a simple introductory question to part (b)(ii). In part (b)(iii) many candidates made a correct prediction but could not justify a reason for the decrease in reliability. In part (c) it appeared that the application of the error margin was unfamiliar and confusing for many candidates. Candidates used mg L^{-1} as mol L^{-1}, did not convert to grams and/or multiply for the volume for the dam. Final answers were not always given to the appropriate number of significant figures.

Question 37 attempted by 4894 candidates Mean 6.16(/12) Max 12.00 Min 0.00
There were many superficial answers for part (a) with candidates talking about number of collisions rather than frequency or more successful collisions rather than a larger proportion of those. Many candidates seemed to not know how to construct or interpret a Maxwell-Boltzmann distribution; many did not know that was the most appropriate diagram for this

question. Candidates discussed equilibrium in part (c) and so assumed that the yield was greater and drew a graph in part (b) accordingly. Some graphs had the correct gradient but had the reaction completed just after three hours, as in the original curve. Candidates had the right idea about part (c) but many still could not use Collision Theory to explain the increase in rate. The word 'frequency' to describe how often collisions occur is not being used. Candidates were unable to link that the increased rate caused the reaction to finish earlier; possibly many thinking the question was about a reaction at equilibrium. Candidates answered part (d) well.

Question 38 attempted by 4924 candidates Mean 12.00(/18) Max 18.00 Min 0.00
Many candidates answered part (a) well. Some candidates either gave the opposite effect on yield for raising pressure or temperature or gave the mechanisms in which the reactions were affected rather than the effect. Not many candidates realised that as part of the lowered temperature and pressure compromise, the catalyst was used for economic benefit. There are many aspects of chemistry that can be asked using such industrial contexts. Some candidates misunderstood this question and attempted to explain the mechanisms of how temperature, pressure and catalysts work rather than why the conditions were considered optimal. This resulted in some candidates spending considerable time providing good chemistry which was superfluous to the question. Parts (b) and (c)(i) were answered well. In part (c)(ii) candidates did not identify the imposed change on a closed system could be in a flexible vessel. Many gave the simplistic answer of increasing the pressure (rather than reducing the vessel volume) or decreased partial pressure of water (rather than remove water). In part (c)(iii) candidates did not draw the graphs as comparative scales and therefore did not show the varying partial pressures due to the stoichiometry of the reaction clearly.

Question 39 attempted by 4823 candidates Mean 6.81(/14) Max 14.00 Min 0.00
Common mistakes by candidates in part (a) included terminating the structure, inability to draw peptide links and/or using incorrect amino acids. If the peptide link was incorrect in part (a) then the peptide bond could not be circled in part (b). Part (c) was completed well. Minor errors included missing hydrogens atom, or placing the charge on the wrong part of the molecule. Some candidates did not draw the R group for leucine. Part (d) was poorly done. Very few candidates identified the groups when discussing the zwitterion in neutral conditions and also did not discuss the proton transfer. In part (e) many candidates did not recognise the disulphide bridge as a covalent bond, nor compared it to weaker intermolecular forces found between the other amino acids.

Question 40 attempted by 4750 candidates Mean 9.44(/17) Max 17.00 Min 0.00
Part (a) was generally well answered. Some candidates did not use the molar masses provided and/or incorrectly calculated their own. Percentage calculations were inverted in some responses. In part (b) candidates used NaOH rather than $OH^-(aq)$ and added Na to the oxygen as a covalent bond. Some candidates removed the wrong hydrogen atom from the salicylic acid. Part (c) was answered well generally. The main error candidates encountered was failing to apply a multiplication factor for the moles of salicylic acid in the 20 mL aliquot to the original 250 mL sample. In part (d) many candidates seemed unfamiliar with incorrect titration techniques and their impact on the results. Many were unable to determine the effect on the concentration with adequate reasoning and candidates chose procedure number six (Rinse down the sides of the conical flask during the titration) as an answer. They argued that the distilled water would dilute the solution (correct) which would affect the calculated concentration from the aliquot used (incorrect), where in fact rinsing down the sides of the flask with distilled water is good titration technique.