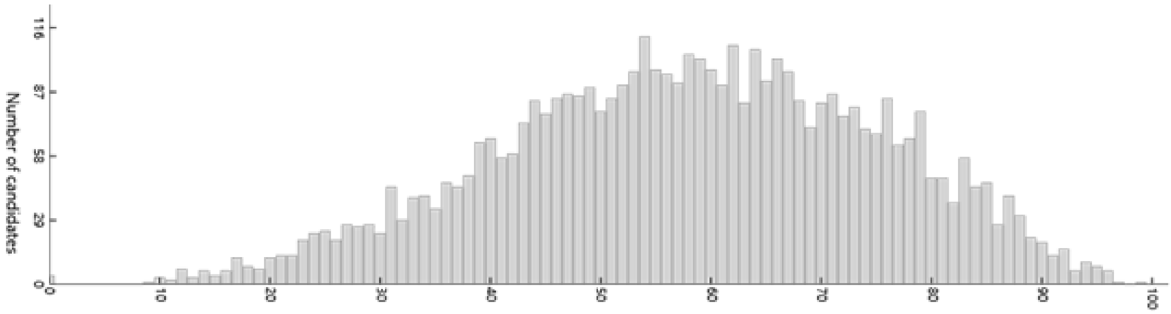
Government of **Western Australia**
School Curriculum and Standards Authority

2019 ATAR course examination report:
Chemistry

Year	Number who sat	Number of absentees
2019	4547	66
2018	4965	50
2017	5007	54
2016	4997	57

Examination score distribution–Written



Summary
All examination questions were answerable by candidates and the paper functioned well to discriminate between the candidate's ability. There was a good mix of application questions and straightforward questions. Individual questions varied in difficulty, allowing weaker candidates to offer a response and gain some marks while stronger candidates could work through questions and gain full marks.

The examination incorporated questions about experimental practice and techniques. Questions were framed in real world contexts that were authentic, interesting and original giving candidates the opportunity to apply their knowledge to novel situations.

Attempted by 4547 candidates	Mean 57.84%	Max 98.51%	Min 0.00%
Section unadjusted means were:			
Section One: Multiple-choice	Mean 67.54%		
Attempted by 4547 candidates	Mean 16.88(/25)	Max 25.00	Min 0.00
Section Two: Short answer	Mean 52.39%		
Attempted by 4538 candidates	Mean 18.34(/35)	Max 32.36	Min 0.00
Section Three: Extended answer	Mean 44.34%		
Attempted by 4527 candidates	Mean 17.74(/40)	Max 37.80	Min 0.00

General comments
Teacher and candidate feedback, together with the lower-than-normal mean, indicated that the examination was too long. While full marks were attained by candidates for Section One, no candidate scored full marks in Sections Two and Three. To address these issue candidates' examination marks were adjusted by the addition of five marks, resulting in an adjusted mean of 57.84 that is consistent with mean marks achieved by candidates in previous years.

Questions 34(b), 37(a), 37(e) and 41(d) seemed to cause some candidates difficulty in achieving full marks. These were non-scaffolded questions, which required a thorough understanding of the concepts and organisation of relevant information to answer the questions satisfactorily.

Candidates tried to explain the effects on systems using Le Châtelier's Principle (LCP). This is a predicting tool and cannot be used as an explanation. Question 36(f) explicitly stated to use LCP to demonstrate the effect of excessively high blood pH. When required to explain aspects of equilibrium in Questions 36(g) and 37(e), candidates were required to use Collision Theory and rates of reaction.

Many candidates demonstrated good numerical skills and generally showed working out in calculations clearly. A common error was the appearance of numbers without specifying what they represented or how they were calculated.

Advice for candidates

- The examination questions are based on the syllabus. Use the syllabus as your check list.
- Do not expect the examination to contain similar or standard questions from year to year. While assessing the same syllabus, expect a range of difficulty and different types of questions, often reflecting authentic chemistry contexts.
- Unless using a key, an examination is not the place for using abbreviations or acronyms.
- Use the appropriate units and express numerical answers to the appropriate significant figures.
- Answer using the terms requested in the question (e.g. if asked for a name, give the name; if asked for a symbol/formula, give the symbol/formula).
- Be conversant with the terms used in the syllabus.
- Understand the differences between related concepts, such as
    - intermolecular force and intramolecular force
    - equivalence point and end point
    - ionisation and dissociation
    - concentrate/dilute and strong/weak.
- Practise writing clear, concise and coherent explanations and justifications. Incorporate equations and labelled diagrams that are clear and relevant.
- Be familiar with the content of the Data Booklet.
- Whenever a colour for a chemical species is provided within the Data Booklet, this is the colour that must be used to describe that species in the examination.
- Use the given formula to determine the nature and bonding of a substance and all its intermolecular forces.
- Be familiar and 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. For example, 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.
- Do not personify chemical species or processes. For example, detergent molecules do not 'swarm around grease' and something that is described as 'hydrophilic' or 'hydrophobic' does not really 'love' or 'hate' water. Instead, describe the relative inter/intra-molecular forces present.
- Practise writing legibly and setting out your work so it is easy to read and follow.

Advice for teachers

- Familiarise students with the general instructions, structure, and requirements of the examination before the examination period.
- Practise reading to identify relevant information and what is required from each question.
- Help students to develop a strategy to answer questions (e.g. firstly attempt questions that can be answered correctly and quickly).
- Guide students about the depth of answer by using the:
    - key word (state, list, outline, explain, illustrate with a diagram etc.)
    - … about this system (specific) or about these systems (general) …
    - number of marks allocated and space provided for the answer.
- Ensure coverage of all syllabus dot points. The entire syllabus is not necessarily examined in any one examination, but should be expected to be assessed in its entirety over the course of a few years. Some syllabus dot points are examined regularly as they are essential for the understanding and communication of chemical concepts and processes.
- Prepare candidates to expect the examination to contain a range of question types, 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; full marks are not awarded unless it is clear how the answer was obtained and the relevant chemical ideas (such as relevant mole ratios) are shown.
- 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. While existing between an atom pair, a hydrogen bond is stronger than a dipole-dipole bond which is stronger than a dispersion force, but, with few exceptions, the cumulative dispersion forces is often the predominant intermolecular force present.
- Whenever a colour for a compound or ion in solution is provided within the Data Booklet, this is the colour that must be used when answering questions in the examination.

Comments on specific sections and questions

Section One: Multiple-choice (25 Marks)

The easiest questions were Questions 4, 17, 19, 20 and 24 with more than 80% of candidates answering these questions correctly. The most challenging questions were Questions 8 and 12. In Question 8, it appears that candidates confused concepts of concentration and strength when referring to solutions of acids. Question 12 also served to discriminate the most capable candidates with most failing to recognise gases other than carbon dioxide as a greenhouse gas.

Question 1 attempted by 4547 candidates	Mean 0.68(/1)	Max 1	Min 0
Question 2 attempted by 4547 candidates	Mean 0.52(/1)	Max 1	Min 0
Question 3 attempted by 4547 candidates	Mean 0.73(/1)	Max 1	Min 0
Question 4 attempted by 4547 candidates	Mean 0.85(/1)	Max 1	Min 0
Question 5 attempted by 4547 candidates	Mean 0.72(/1)	Max 1	Min 0
Question 6 attempted by 4547 candidates	Mean 0.78(/1)	Max 1	Min 0
Question 7 attempted by 4547 candidates	Mean 0.71(/1)	Max 1	Min 0
Question 8 attempted by 4547 candidates	Mean 0.31(/1)	Max 1	Min 0
Question 9 attempted by 4547 candidates	Mean 0.62(/1)	Max 1	Min 0
Question 10 attempted by 4547 candidates	Mean 0.51(/1)	Max 1	Min 0
Question 11 attempted by 4547 candidates	Mean 0.69(/1)	Max 1	Min 0
Question 12 attempted by 4547 candidates	Mean 0.46(/1)	Max 1	Min 0
Question 13 attempted by 4547 candidates	Mean 0.72(/1)	Max 1	Min 0
Question 14 attempted by 4547 candidates	Mean 0.73(/1)	Max 1	Min 0
Question 15 attempted by 4547 candidates	Mean 0.74(/1)	Max 1	Min 0
Question 16 attempted by 4547 candidates	Mean 0.64(/1)	Max 1	Min 0
Question 17 attempted by 4547 candidates	Mean 0.84(/1)	Max 1	Min 0
Question 18 attempted by 4547 candidates	Mean 0.64(/1)	Max 1	Min 0
Question 19 attempted by 4547 candidates	Mean 0.81(/1)	Max 1	Min 0
Question 20 attempted by 4547 candidates	Mean 0.84(/1)	Max 1	Min 0
Question 21 attempted by 4547 candidates	Mean 0.67(/1)	Max 1	Min 0
Question 22 attempted by 4547 candidates	Mean 0.68(/1)	Max 1	Min 0
Question 23 attempted by 4547 candidates	Mean 0.66(/1)	Max 1	Min 0
Question 24 attempted by 4547 candidates	Mean 0.80(/1)	Max 1	Min 0
Question 25 attempted by 4547 candidates	Mean 0.53(/1)	Max 1	Min 0

Section Two: Short answer (106 Marks)
Generally, most candidates did well in this section with the stronger candidates showing a good understanding of chemistry concepts. The mean of 52.39% was similar to 2018.

Question 26 attempted by 4437 candidates Mean 3.36(/9) Max 9 Min 0
In part (a), candidates struggled with the concept of 'once any reactions are complete' and simply wrote observations for the whole reaction. A range of colours for copper were provided (e.g. salmon pink, brown, orange, copper coloured, coppery). Errors included writing equations or inferring products rather than providing observations as requested. A significant number of candidates answered part (b) using a molecular equation and using $CuC\ell$. For part (c), candidates could not answer 'once any reactions are complete'. Other candidates made reference to doing 'the limewater test' to distinguish between the two test tubes which was unnecessary.

Question 27 attempted by 4436 candidates Mean 6.44(/13) Max 13 Min 0
Candidate discussions were poor in part (a). Most discussed the hydrolysis of the $OC\ell^-$ ion, but simply stating OH^- was produced was insufficient. In part (b), most candidates referred to $HC\ell$ dissociating, producing H^+ and did not state 'decrease in pH'. In part (c), the energy profile diagram was generally done well, but labelling was not always clear.

Question 28 attempted by 4458 candidates Mean 3.55(/7) Max 7 Min 0
Most candidates could work out the oxidation numbers in part (a), but many candidates struggled to omit spectator ions or use $Ca(OC\ell)_2$ as a solid when writing the half-equations in part (b).

Question 29 attempted by 4460 candidates Mean 5.56(/8) Max 8 Min 0
Many candidates could not provide an overall equation in part (a), but most were able to list the advantages and disadvantages of using high temperatures and pressures in part (b).

Question 30 attempted by 4336 candidates Mean 7.91(/15) Max 15 Min 0
In part (a), candidates demonstrated a lack of empirical information gathering. The methods were described poorly. Some candidates chose to answer using titration and redox methods rather than in terms expressed and guided by the question. Many candidates omitted calculating the amount of oxygen present in part (b).

Question 31 attempted by 4500 candidates Mean 6.67(/13) Max 13 Min 0
Most candidates were able to complete the diagram in part (a), but some candidates were not always clear in their labelling. In part (b), too many candidates listed the differences rather than explaining the difference. In part (c), candidates did not write about 'why the action took place', only 'what happens if it did not', as stated on the Material Safety Data Sheet (MSDS). Candidates were able to state generic safety measures in part (d), but not why they were required specifically from the MSDS. Many candidates did not make use of the information on the MSDS.

Question 32 attempted by 4209 candidates Mean 5.82(/9) Max 9 Min 0
Many candidates did not show the reagent/product ratio or discuss the limiting reagent as required.

Question 33 attempted by 4462 candidates Mean 9.06(/12) Max 12 Min 0
Generally, this was generally well done by candidates.

Question 34 attempted by 4426 candidates Mean 6.24(/12) Max 12 Min 0
In part (a), many candidates did not draw the curve of best fit. Candidates were not specific enough in their answers in part (b). Not many candidates discussed the rate due to CO_2 being evolved. Recognising that rate of CO_2 evolution is a measure of reaction rate was missed by many candidates. Candidates were not specific in explaining how the reacting reagents caused the change in the shape of the curve. Many candidates answered this as if it were an 'equilibrium question'. In part (c), a good number of candidates were able to show the effect of higher temperature on the graph.

Question 35 attempted by 4431 candidates Mean 2.49(/8) Max 8 Min 0
In part (a)(i), candidates did poorly. Many candidates were not able to give sufficient reasons in part (a)(ii). In part (b), many candidates gave poor justifications. For part (c), candidates were not specific enough when discussing results that were skewed in one direction.

Section Three: Extended answer (109 Marks)
The mean of 44.34% was lower than previous years. Stronger candidates showed a good understanding of chemistry concepts.

Question 36 attempted by 4521 candidates Mean 13.08(/20) Max 20 Min 0
In part (a), a number of candidates were able to identify the two conjugate acid-base pairs. In part (b), many candidates used 'K_w' rather than the required equilibrium constant expression. In part (c), many candidates gave the answer
$H_3O^+ + HCO_3^- \rightleftharpoons H_2CO_3 + H_2O \rightleftharpoons 2H_2O + CO_2$ which is found in text-books. Generally, parts (d) and (e) were done well. In part (f), candidates were not specific in discussing the increase in concentration reducing pH. In part (g), candidates used Le Châtelier's Principle rather than relative rate of reactions. Candidates were not specific in discussing the increase in concentration reducing pH. Many candidates did not realise collision theory had to be applied. For part (h), most candidates answered this question correctly, but many used the wrong word to label the carboxyl/carboxylic acid group.

Question 37 attempted by 4462 candidates Mean 8.55(/24) Max 22 Min 0
In part (a), few candidates referred to the species having similar strength to overcome the dispersion forces that exist between the oil molecules and so will dissolve. Many also did not state that the charged head of the detergent ion exhibits stronger ion-dipole forces of attraction (and hydrogen bonds) with water molecules and so overcoming the hydrogen bonding between the water molecules dissolving preferentially in water. There were few diagrams that attracted full marks. In part (b), candidates were unable to balance the ionic equation and/or did not know how to write the formula for a soap ion. They knew that precipitations occurred in hard water, but could not explain that the cleaning power was reduced. Candidates also struggled in part (c) to draw and work out a basic molecular construction by not counting the number of carbons, adding the COO head, determining the number of bonds and/or adding the appropriate number of H atoms. In part (e), candidates answered in general terms and used Le Châtelier's Principle rather than collision theory. Candidates spent a lot of time discussing pressure and catalyst which were not relevant in this situation.

Question 38 attempted by 4413 candidates Mean 8.81(/18) Max 18 Min 0
In part (a), some candidates struggled to clearly articulate the relationship, property and use of the compound. They failed to justify their choice and simply gave a list of properties. In part (b), candidates were using the given structure as a starting point, but many could not draw the structure of methanol. In part (c), most candidates demonstrated they knew not to terminate the structure, but could not translate the monomer into a polymer structure by rotating the monomer, to give the C=C in a horizontal line. Generally, part (d) was done well by most candidates. Answers to part (e) were too simplistic and expressed poorly.

Question 39 attempted by 4382 candidates Mean 7.53(/13) Max 13 Min 0
Generally, parts (a) and (b) were done well by most candidates. Part (c) challenged some candidates. Setting out was done poorly.

Question 40 attempted by 3600 candidates Mean 7.96(/22) Max 22 Min 0
Parts (a), (b) and (c) were done well by most candidates, however, setting out of their working and reasoning was not always clear. Part (d) was not done well, with setting out done poorly.

Question 41 attempted by 4225 candidates Mean 4.96(/12) Max 12 Min 0
Generally, parts (a) and (b) were done well by most candidates. In part (c), many candidates provided a broad definition of the α-helix and β-pleated sheet, but did not demonstrate an understanding of the significant interactions that produced them. In part (d), many candidates were unable to explain themselves or provide a diagram.