# Government of South Australia LogoSACE Board Logo2024 Chemistry Subject Assessment Advice

Overview

This subject assessment advice, based on the 2024 assessment cycle, gives an overview of how students performed in their school and external assessments in relation to the learning requirements, assessment design criteria, and performance standards set out in the relevant subject outline. It provides information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

1. The Subject Renewal program has introduced changes for many subjects in 2025, these changes are detailed in the change log at the front of each subject outline. When reviewing the 2024 subject assessment advice, it is important to consider any updates to this subject to ensure the feedback in this document remains accurate.

# School Assessment

Teachers can improve the moderation and online process by:

* thoroughly checking that all assessment decisions and features entered into Schools Online against School Assessment types match the features identified in the LAP and decisions submitted for accompanying task sheets
* ensuring that student samples are complete, or adjustments to the assessment are acknowledged using the electronic Variations – Moderation Materials form (VMM).

Assessment Type 1: Investigations Folio

The investigations folio contains at least two practical investigations and one investigation with a focus on science as a human endeavour.

Both assessment design criteria, Investigation, Analysis, and Evaluation, and Knowledge and Application, are used for this assessment type. Student evidence in the investigations folio should focus on the science inquiry skills, explain connections with science as a human endeavour (SHE) and apply science understandings. In at least one practical investigation, students deconstruct a problem and design a method to investigate one aspect of the problem. Students need to know the four key SHE concepts and understand what these concepts mean so that they can discuss scientific research in terms of these key concepts.

*The more successful responses commonly:*

* deconstructed open-ended problems that provided several possible avenues for exploration and allowed opportunities for individual design and investigation of a problem with an uncertain outcome
* deconstructed problems that led to the clear identification of an independent and dependent variable
* provided a broad range of considerations for the deconstruction and design represented through visual organisers such as concepts maps, lotus diagrams, and tables to arrange ideas
* included detailed evidence of explored procedures to clearly justify those that could be pursued or were not viable
* deconstructed problems that led to data that was not exclusively categorical or qualitative in nature
* considered a range of possible variables, measurement techniques, and equipment, and justified the selections made in relation to the student’s individual design
* summarised variables to be controlled, and explained how and why they would be controlled
* clearly separated the four pages of deconstruction and design from the report
* considered relevant safety aspects, including safe use and disposal of chemicals for the quantities and concentrations applied
* clearly identified relevant sources of error in an investigation and established links between the proposed errors and evidence in the collated data
* discussed a range of relevant sources of random and systematic that were often unique to the procedures undertaken and the data obtained
* used data to explain the effect of errors on the outcome and discussed the level of impact, focusing on sources of error that had significant impact
* presented data clearly in labelled tables and constructed graphs using appropriate conventions
* used the data obtained to identify and substantiate trends and conclusions
* justified conclusions and noted their limitations in terms of wider applicability
* clearly identified the SHE concepts that were the focus of the SHE investigation
* chose a contemporary area of investigation for SHE that used a new piece of specific research or technology as the basis for discussion and enabled discussion of Stage 2 Chemistry concepts that helped explain the research
* ensured that introductory chemistry supported the SHE concepts, building from a foundation of chemistry established from the Subject Outline
* clearly established links between science and society, demonstrating human impact
* provided well-substantiated opinions and justified conclusions
* referenced and acknowledged all sources of information consistently using recognised conventions.

*The less successful responses commonly:*

* provided little evidence of individual deconstruction and design opportunities
* unpacked ideas in a deconstruction that were not explored through viable procedures or justified as a selection
* undertook designs with heavily set parameters and defined variables leading to little evidence of individual thinking and unanticipated outcomes
* designed investigations with qualitative-dependent variables, which often limited the quality of the analysis of data
* contained similar ideas and discussion points to reports from other members of their group/class due to excessive scaffolding on the task sheet
* used inappropriate graphs to represent different types of data
* did not establish trends from or use the data obtained to formulate conclusions
* repeated a limited number of generic errors that were nonspecific to the task and applicable to many investigations
* provided lengthy definitions of terms such as random and systematic error at the expense of actually discussing sources and their impact
* used terms such as precision, accuracy, reliability, and validity either incorrectly or without any meaningful discussion of these terms in relation to their data
* presented a report on a topic rather than an investigative exploration of contemporary aspects of SHE
* selected very general topics from the course that were not necessarily contemporary examples
* focussed too heavily on the background chemistry, leaving limited opportunity to explore SHE key concepts and connections
* addressed several SHE key concepts superficially rather one or two in depth
* utilised extensive text and paraphrasing from sources which did not link to SHE and was inconsistently acknowledged by referencing conventions.

Assessment Type 2: Skills and Applications Tasks

Both assessment design criteria, Investigation, Analysis, and Evaluation, and Knowledge and Application, are used for this assessment type. Student evidence in the Skills and Applications Tasks (SATs) should focus on the science understandings, apply science inquiry skills, and explain connections with science as a human endeavour.

Teachers must ensure that questions and task requirements for SATs are based upon content in the current subject outline.

*The more successful responses commonly:*

* included a variety of presentation formats and question types that enabled students to demonstrate varied skills
* provided opportunity to demonstrate depth and breadth of understanding, while still communicating in a clear and concise manner
* used opportunities to present knowledge, understanding, application, and analysis in tasks
* required the application of concepts beyond the contexts that were familiar or rehearsed
* required the construction of responses that drew from a range of topics and concepts, which often demonstrated their interrelated nature
* responded to the question or task presented, rather than recalling information from the course
* effectively utilised terminology and conventions including formulae and chemical equations
* linked evidence provided in a question to the appropriate SHE concepts.

*The less successful responses commonly:*

* responded to questions requiring predominately recall of learned facts and demonstrated little application or analysis
* demonstrated poor use of chemical terms and conventions such as equations and structural formulae
* were hampered by the structure of tasks that did not allow students to provide evidence of deep understanding.

# External Assessment

Assessment Type 3: Examination

General

* Poor handwriting remains an important issue. If writing is not legible, it is assumed to be incorrect.
* Students should not be writing answers in pencil - there is too much scope for smudging here.
* There was a need across the entire paper for more careful checking of question requirements. Phrases such as "using equilibrium principles," were frequently neglected.
* Units should be written for all quantities of measurement. Omission of units will incur a penalty when required units have not been stated as part of the question.
* Teachers should specifically teach how to respond to Science as a Human Endeavour Questions.

Students are expected to use the correct terminology and conventions when explaining chemical concepts such as chromatography, AAS, electron configuration, intermolecular interactions, and equilibrium. Students are expected to use clear, concise communication and to describe specific points that are relevant to the question that is asked.

Examples include:

* Students have poor recall of charges on ions and these charges are frequently not used well by students.
* Students have poor recall of formulae of ions, with the ammonium cation being of particular relevance here.
* Subscripts as to state of matter at room temperature [ (aq), (s) and so on] should be used in chemical equations when it is has impact on the response / is important to the explanation.
* The terms atom, ion, molecule, compound, cation/anion and so on, are not used with accuracy by the majority of students.
* An ion is not a "type of compound", nor is one particular molecule a “type of compound”. For example, a carbohydrate is a type of compound, but fructose is a compound.
* Using the term "ion-dipole attraction" for oppositely charged ions attracting each other is incorrect; Using the term "secondary forces" for covalent cross-links between chains is incorrect. It is incorrect to use the phrase "gallium is more easily reduced than aluminium" rather than "gallium cations are more easily reduced than aluminium cations". It is incorrect to use the term "ionises in water" for an ionic compound dissolving/dissociating in water.
* The term "breaks down" is normally used in conjunction with decomposition. A substance is not "breaking down" when it is melting or dissolving in water without reaction.
* The terms 'absorption' and 'emission' of wavelengths of light are not interchangeable.
* An atom does not "have" a wavelength of light, but it may absorb or emit a wavelength of light.
* A cathode lamp does not detect wavelengths of light, nor does a monochromator.
* The terms anion/cation, anode/cathode cannot be responses to "State the charge on...."
* The energy gap between shells is not a physical distance.
* The phrases "having a specific electron configuration" and "having specific energy levels for orbiting electrons" are not equivalent.
* The expression "as carbon dioxide increases" does not show the same level of understanding as "as the concentration of carbon dioxide increases".
* Secondary interactions should really not be referred to as "bonds", a term reserved for primary forces. This is despite "hydrogen bonding" being a legitimate term for a particular type of secondary force.

If asked to describe the trend in a graph, please use the independent and dependent variables (axis labels) in that order e.g. “When the <independent variable> is increased, the <dependent variable> also increases.”

Having a precise set of data is not the same as having a reliable set of data. A precise set of data may still be inaccurate because of a systematic error that is persistently affecting the data in the same manner.

When drawing repeating unit brackets on a polymer structure, they should be inserted where the monomers linked.

Electron configurations (sub-shell notation) of ions is poorly understood, as are the principles of electron excitation and energy levels (shells, sub-shells). Many students, for example, are under the misapprehension that only valence electrons transition between energy levels.

Question 1

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| (a) | (i) | Most students were able to gain at least 2 marks for recognising that B would be more likely to be a solid and that it was saturated.  Better answers linked the shape of the molecules to the strength of the dispersion forces. Some responses did not mention dispersion forces.  Students should be reminded that in questions comparing two structures, their answer should refer to both structures.  Many students identified ‘carbon-carbon double bonds’ as simply 'double bonds'.  Some students incorrectly thought that carbon-carbon double bonds, being stronger bonds, led to a higher melting point. | | |
|  | (ii) | (1) | Most students correctly named the ester group. The most common unsuccessful response was carboxyl group. | | |
|  |  | (2) | Most students correctly drew the anion. Some incorrectly drew it as a carboxylic acid. Some students drew glycerol by mistake. | | |
| (b) | (i) | (1) | Although many students recognised that this structure was not a polyhydroxy aldehyde or ketone, credit was given for recognising that it was specifically the aldehyde or ketone group that was missing.  The inappropriate response that it does not conform to the general formula of a carbohydrate (rather than referring to the presence/absence of ketone or aldehyde group) persists. | | |
|  |  | (2)A | Most students were able to correctly circle a primary alcohol group. There was no penalty applied if they included the first carbon of the chain here, as this indeed is oxidized and does form part of the new aldehyde group. | | |
|  |  | (2)B | Mainly well done. A common mistake was using acidified dichromate solution which is not specific to aldehyde groups. Credit for correctly identifying the colour change was given. | | |
|  | (ii) | Although many students were able to recognise that the structure contains polar and non-polar regions and identified how they could interact with water and lipid molecules, it was common for students not to identify where those regions were on the molecule. Unfortunately, this means that they have not used the structure of Polysorbate 80 to best effect in the response. | | |
| (c) | (i) | The only carbon that should be included in this group is the one bonded to both nitrogen and oxygen. Despite this being answered reasonably well, many students circled the amino group rather than the entire amide group.  Yet others circled the carboxyl group end of the molecule which does not contain an amide group. | | |
|  | (ii) | Not answered well. Many students protonated the wrong amino group (at the “left” end). This means that they are not able to identify the features of an amino acid correctly.  Others incorrectly drew the acidic form of the amino acid. | | |
|  | (iii) | This question was rarely answered correctly. Responses confused the amide functional group as the amine. Many students did not rotate/reorientate the amino acid for the condensation reaction. Students were unable to properly identify the amino acid structure.  It was common to see an oxygen atom mistakenly within the attempted peptide bond and closed ends to the molecule when the question asked students to draw a section of a protein chain. | | |
| (d) | Generally well answered. However, the term “adsorb” is still persistently replaced with the incorrect “absorb”. Also, adsorption refers to the stationary phase, not the mobile phase. | | |

Question 2

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| (a) | Many students were able to gain full marks for this question with organised and logical calculations. Most students were successful in calculating the Kc value using MICE method. However, a common mistake is that students are not making SPECIFIC reference to the 1.44 value to support their answer. Some students did not take into consideration the coefficients of reactants and products, thus resulting in the wrong ‘change’ values.  Some students did not make the final point that the value calculated was not equal to 1.44 and thus the system was not at equilibrium. Several students incorrectly stated that the system was not at equilibrium because Kc was not = 1. | | |
| (b) | Most students were able to state the trend shown in the graph and correctly state that the forward reaction was exothermic. The quality of the explanation as to why varied. | | |
| (c) | (i) | Many students provided very simple answer like, ‘expensive’, rather than being a bit more specific in terms of how it requires more energy which results in increase cost. | | |
|  | (ii) | Many students answered this question correctly, using collision theory. However, a few students did not specifically link back to the ‘advantage to the manufacturer’. Several students used Le Chatelier’s Principle to answer the question. However, there are an equal number of moles in both sides so there is no effect. | | |
| (d) | Surprisingly, many students are still not understanding the basics of the greenhouse effect. Many students referred to heat or rays from the sun being absorbed, or heat reflected from Earth, rather than referring to heat being re-emitted or re-radiated by the Earth. | |
| (e) | Most students answered this question correctly. However, several students just re-stated information from the question. | |

Question 3

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| (a) | (i) | Generally answered correctly by most students. However, many were not able to give at least one undesirable consequence of NO. A surprising number of students stated that it is a greenhouse gas. | |
|  | (ii) | Many students answered this question correctly. | |
| (b) | (i) | Most students answered this question correctly. The response should focus on CO specifically. A common mistake was mentioning that CO can turn into CO2 which results in global warming. It is also incorrect to identify CO as a lung irritant. | |
|  | (ii) | Many students achieved 2 of the 3 marks available for this question. Students were able to identify that there was a strong triple covalent bond between nitrogen atoms in N2, but the response should have explicitly linked this to particles having less energy to break this bond (less activated molecules) which results in less NO produced. | |
| (c) | (i) | Poorly done. Many students simply guessed two raw materials. Some students did not refer specifically to methanol/ethanol but simply stated “alcohol”. Many students incorrectly stated "water" as a reactant. | |
|  | (ii) | (1) | Mostly answered well. Many students multiplied instead of dividing by the molar mass. | |
|  |  | (2) | Many students did not realise that the density was given in grams per mL and had to be converted to grams per litre. Many students divided instead of multiplying by the density. | |
|  | (iii) | It was surprising how many students did not know the requirements of a thermochemical equation. Many ascribed incorrect states at room temperature to the reactants/products. Some did not record the enthalpy change at the end of the equation or assign its correct sign. | |
|  | (iv) | (1) | The mass used in this calculation should be the mass of water. Some students forgot to convert to kJ as required by the question. | |
|  |  | (2) | Many students were awarded the first mark for correctly identifying a systematic error. Impact of the error on the temperature change needed to be explained well for full marks. Incorrect thermometer calibration is NOT an acceptable response here. It would not make a significant error to the calculation as the temperature change is measured by difference. | |

Question 4

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| (a) | (i) | Mostly answered well, but many students did not refer to equilibrium in their responses or did so in a very general way without specifically relating it to the context of the question. Many explanations correctly identified carbon dioxide dissolving in water to form carbonic acid, but some did not make the next connection to its dissociation to produce H+ ions. | |
|  | (ii) | Many students could antilog the negative pH value correctly but then lost a careless mark as no units were recorded for the calculated concentration. | |
|  | (iii) | (1) | Answered well. Most common error was not using the labels given on the axes (instead making interpretations about being more acidic, etc.) | |
|  |  | (2) | Most students were able to provide an appropriate equation showing the dissolution of calcium carbonate. There were frequent errors with charges on dissociated ions. Many of students who lost the second mark for this explanation did not demonstrate they understood the chemistry behind the shell being weaker and did not directly state that it was the calcium carbonate dissolving, degrading etc. Other students correctly showed that an increase in acidity led to a lower concentration of carbonate ions being available to make the shell and included an appropriate equation. | |
| (b) | (i) | Well answered. | |
|  | (ii) | Many students correctly recognized cross-linking but some were unable to articulate that the type of strong bond formed was “ionic”. Use of terminology proved a weakness for some, incorrectly naming this type of bond “ion-dipole” | |

Question 5

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| (a) | (i) | Many students answered correctly. Incorrect responses could identify there were three repeating units but did not recognise that this polymer would have formed from addition polymerisation and hence brackets could not be positioned at or adjacent to the C=C double bond. | |
|  | (ii) | (1) | Many correct responses. The most common incorrect response did not clearly identify carbon-carbon double bonds, simply stating ‘double bonds’. Some students incorrectly believed that the chlorine atom is involved in cross-linking. | |
|  |  | (2) | Poorly answered. Many students correctly identified that vulcanised polychloroprene was a thermoset plastic but did not link this classification to strong covalent bonds or strong forces between chains. Many could also identify that this would then mean higher melting points but did not elaborate on how that would be leading to charring rather than melting. Some students mistakenly thought that this was a question about composite materials. | |
| (b) | (i) | Responses to this type of SHE QUESTION continue to disappoint. Very rarely were 4 marks awarded.  Most students misinterpreted the term FEEDSTOCK and used the production of Greenhouse gas as the consequence (i.e., Students often incorrectly linked the replacement of fossil fuels as a material in wetsuit to reduced fossil fuels being burnt).  As in the past, the students struggled to clearly link the chosen Key Concept with the text and, in particular when referring to INFLUENCE, stated consequences rather than the influence to or of the process.  Very few outlined the environmental impacts and consequences but focused on the societal or economic consequences. Some of the environmental benefits/consequences that were given were also brief/vague/insufficiently developed.  Better responses were clearly structured, with elaboration about how the SHE concept was relevant and then specific justification about the positive or negative environmental impact. | |
|  | (ii) | (1) | Identification of a specific compound or ion here was an inappropriate response to the question which clearly required a “type of” nitrogen-containing compound. | |
|  |  | (2)A | Many students provided correct answers although a significant number of students gave the formula (correctly) for the **alumino**silicate, indicating that they did not read the question carefully. The overall charge was frequently calculated incorrectly. Some students tried to write a chemical *equation* for the formation of the compound, confusing the terms ‘formula’ and ‘equation.’ | |
|  |  | (2)B | Most students were awarded 1 mark here. While many could state that the ammonium ions were water soluble and thus taken up by the plant roots, most could not discuss the cation exchange and equilibrium principles that led to the release of these water-soluble ions. Some students referred to the nitrogen cycle and nitrifying bacteria as part of their responses, which were not relevant here. | |

Question 6

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| (a) | (i) | Well answered. | |
|  | (ii) | Not very well answered. A number of students gave the electron configuration of the gallium ATOM. If this was correct, they were awarded one mark. Many students did not recognize that electrons are removed from the outermost, 4p and 4s, subshells and NOT the 3d which is of slightly higher energy than the 4s but is closer to the nucleus.  It is not permissible in the SACE exam to use abbreviated electron configurations such as  [Ar]3d10. | |
|  | (iii) | Many answered correctly but this was not as well-known as expected. The response “cathode” does not appropriately respond to the question. | |
|  | (iv) | (1) | Nearly all answered correctly. | |
|  |  | (2) | Most students could identify that aluminium is more active using information from the previous question, but the evidence given was cited poorly. Students discussed the reduction of gallium instead of the gallium cation. Some students correctly described the use of aqueous and not molten electrolysis as the evidence as an alternative. | |
|  | (v) | (1) | “Energy” was considered too broad a response, but most students could provide a commercial use of hydrogen gas. Filling party or hot air balloons is NOT one of them! | |
|  |  | (2) | The majority of students were able to score full marks here, but some explained why hydrogen is a by-product, and did not state why hydrogen is not a waste product. | |
| (b) | (i) | “Reliable” is NOT an appropriate term to describe a data set that has minimal scatter from the line of best fit. Neither are “accurate”, “linear”, or “high correlation”. This word is “Precise”. “High precision” was also accepted. | |
|  | (ii) | Mostly answered well; students that missed the mark often had poorly drawn lines on the graph leading them outside the tolerance of error. Some read the vertical scale incorrectly and hence used 0.9 or 0.805 rather than 0.85. | |
|  | (iii) | Generally poor responses that reflected minimal understanding of the key concept here – electron excitation and energy levels for electrons orbiting in the cloud. Electron configuration is the arrangement of electrons in these shells and sub-shells, so stating “unique electron configuration” to explain specific wavelengths of absorption/emission is incorrect. Some students discussed excited atoms, without explicitly discussing electrons or electron transitions. Some students talked about light emission rather than light absorption. Few students discussed exact energy differences in transitioning from one shell to another.  No discussion of monochromator or cathode lamp is appropriate in this response. | |
|  | (iv) | Poor written expression was the downfall of many students here, as they referred to aluminium “having” a unique wavelength rather than it “not absorbing” the same unique wavelength as gallium. Some students opted to answer with correct refence to the monochromator and then provided sufficient detail around a unique wavelength being selected (this manner of response took up much more time and space). | |
| (c) | (i) | Volumetric analysis is a sub-topic of the Stage 2 Chemistry course, so it is expected that all students will have performed an investigation involving titration as part of their senior years course. They should therefore have an understanding of concordance of titre values and that the average titre is calculated by including only concordant results, of which 3.75 is NOT one here. This value should have been excluded when calculating the average. | |
|  | (ii) | Errors carried forward are not penalised when marking. Most answered this well. mL must be changed to L. There is no data provided about mass in this question, yet some students thought to use n=m/M here. | |
|  | (iii) | Errors carried forward are not penalised when marking. Most answered this well, although some did not correctly use the mole ratio from the equation. | |
|  | (iv) | Errors carried forward are not penalised when marking. Most answered this well. Students must be explicitly taught NOT to round off their calculation answers prior to using them in subsequent steps. An error caused by rounding off will be penalised once. Correct number of significant figures (here THREE) is used when recording answers. Some students seemed not to be able to discriminate between I2 and I-. | |
|  | (v) | Transfer skill. Omission of electrons, or electrons on the wrong side were common errors when balancing the half-equation given. Neither water nor hydrogen ions were required to balance this half-equation. | |

Question 7

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| (a) | (i) | Consistently well answered. Pleasing to see most students showing an understanding of ion-dipole bonds vs hydrogen bonds and effect on solubility. |
|  | (ii) | Most students failed to perform the conversion correctly. However, nearly all students obtained 1 mark for comparing their answer with the 560ngL-1 standard. |
| (b) | (i) | A surprising number of students selected incorrectly here, indicating that ion-exchange is not well understood. |
|  | (ii) | Poorly answered. While quite a few students correctly identified FeCl3 as the most effective solution and obtained 1 mark for this, most were unable to explain why. Justifications were then incorrectly made around the magnitude of iron's positive charge density. A common incorrect answer was that this solution had the highest charge density. Very few responses correctly reasoned that it was because there was a higher concentration of Cl- ions present to undergo ion exchange.  Few students recognised that equilibrium was an applicable concept here.  Chemical terminology was again badly handled here, with students referring (incorrectly) to molecules of FeCl3, to the ionization of FeCl3, to Cl3 ions, to electronegativity and more.  The solution of **highest concentration of chloride ions** will be most effective at replacing PFOA anions on the column, because, **according to Le Chatelier’s Principle, the reversible exchange will be pushed forwards.** |