# SACE Board Logo2023 Chemistry Subject Assessment Advice

Overview

Subject assessment advice, based on the 2023 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. They provide information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

Teachers should refer to the subject outline for specifications on content and learning requirements, and to the subject operational information for operational matters and key dates.

School Assessment

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 had several possible avenues to explore and allowed opportunities for individual design and investigation of an uncertain outcome
* provided a broad range of considerations for the deconstruction and design represented through visual organisers such as concepts maps, lotus diagrams, and tables to deconstruct and arrange ideas
* included detailed evidence of explored procedures to clearly justify those that could be pursued or were not viable
* clearly separated the four pages of deconstruction and design from the report
* considered a range of possible variables, measurement techniques, and equipment, and justified all selections made in relation to the student’s own design
* summarised variables to be controlled, and explained how and why they would be controlled
* 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 used their data to explain the effect of errors on the outcome and discuss the level of impact
* focused on sources of error that significantly impacted the outcomes
* discussed a range of relevant sources of random and systematic that were often unique to the procedures undertaken and the data obtained
* presented data clearly in labelled tables and constructed graphs using appropriate conventions
* used the qualitative and quantitative 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
* ensured that introductory chemistry supported the SHE concepts
* focussed on highlighting the links between science and society, rather than purely the chemical background
* 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
* utilised statistical data or referenced quotes to provide justification and reasoning
* provided well-substantiated opinions and justified conclusions
* referenced 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
* identified 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 in 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
* 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
* 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

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.

Question 1

(a) (i) Generally answered correctly but a significant number of responses presented an alkane or other incorrect structure with no alkene group.

 (ii) Very few responses scored full marks, with the majority failing to refer to the relevant parts of the structures; the non-polar bonds in polystyrene and the polar bonds in the ester group of polycarbonate. This led to poor descriptions of the secondary interactions between polymer chains, with many stating that hydrogen bonding was involved. Many responses discussed melting point differences rather than structural differences. A large number of responses suggested that the size of the polymer influenced the properties, not considering that both plastics consist of extremely long-chain molecules. The few responses that did refer to the difference in density generally realised that the polystyrene structure had a bulky side group that caused the polymer chains to stack less closely than in polycarbonate. Some also reasoned that polycarbonate chains are able to pack more closely due to the stronger dipole-dipole interactions between chains. Some stated that cross-links were present in polycarbonate, despite being told that both plastics were thermoplastics.

(b) (i) Well done. Some responses incorrectly referred to retention time instead of Rf. Some poor use of ‘adsorb’ for the stationary phase and ‘absorb’ for the mobile phase.

 (ii) Generally, well done but some lost a mark for not referring to evidence on the chromatogram, particularly for the Rf of Z.

Question 2

(a) Most responses correctly identified the relative reactivity of the two metals, but most did not compare the strength of the two reducing methods and that electrolysis provides more energy. Many responses stated that the metal was reduced rather than metal ions. A common irrelevant discussion was about the relative reactivity of the metals with water.

(b) (i) There were usually errors in most responses, including use of capital letters, subscript instead of superscript, and giving the incorrect number of electrons. Failing to remove the 4s electrons (…4s2d6) was the most common error.

 (ii) Many correct responses but several responses could not identify the silicate anion.

(c) (i) Many responses included incorrect formulae of reactants and/or products and so were unable to balance the equation.

 (ii) Many responses answered only the first part of the question and did not discuss the meaning of a waste product. Some suggested that a waste product is wasted rather than goes to waste or is discarded and some suggested that a waste product is harmful in some way. Many responses stated that a by-product is ‘reused’ rather than is used somewhere else.

(d) (i) (1) Many responses simply restated the information given in the question and so gained no marks. Others included extraneous information about the lamp and very few discussed the unique electron configurations of elements and their energy levels. Most did not relate the wavelength to the energy absorbed/emitted.

 (2) Most responses could not explain the function of a monochromator in selecting a single wavelength unique to nickel. Many responses were poorly worded, using terms such as focus, absorb, measure, and detect rather than filter or select one wavelength.

 (ii) (1) Many responses could state the application of the scientific research to the problem with wastewater from nickel extraction. Most were unable to clearly communicate the benefit to society effectively. Many stated that bioremediation prevented leakage from the ponds rather than less nickel would therefore leak into the surrounding environment. Many responses used vague statements about nickel affecting human health or the environment without being specific and some thought that tailings ponds could now be able to grow more plants or provide drinking water to animals or people without considering what else might be in the water.

1. (2) Many of the low achieving responses were made using vague statements about the environment. Many responses did not use the information provided to consider an appropriate limitation and simply fabricated consequences of the issue.

Question 3

(a) (i) The benefit was often correct, but the description was often poorly communicated. The benefit of using renewable resources was sometimes not described, and the benefit of conserving fossil fuels was given as a vague statement about ‘better for the environment’ or ‘less pollution’. Many responses mentioned more than one benefit, which gained no credit. There were several potential worthy answers that were rarely seen, such as some countries with an abundant water supply could benefit economically because less reliance on fossil fuels.

 (ii) (1) Most responses were correct, but a disappointing number could not produce a balanced half-equation.

1. (2) Mostly correct responses were given. Several responses attempted to show electron flow in the external circuit, even though the question clearly asked for the movement of one, circled H+. Some responses drew a vague upwards arrow in the left-hand side that followed the bubbles rather than go straight to the electrode.

(b) (i) Most responses gained full marks.

 (ii) (1) Most responses gained full marks. The most common errors were indicating the exponent correctly or using addition signs.

 (2) Most answers were correct, but a few were incorrectly calculated.

 (3) Most responses were correct, although a concerning number of students interpreted 7.63 x 10-3  as a value larger than one. Some responses incorrectly stated that the position was shifting left rather than lies towards the left.

 (iii) Most responses displayed a good understanding of LCP. Some did not state that the equilibrium was disturbed, which prompted the shift towards production of products to restore equilibrium. The final mark for stating that an increased yield leads to more profit was sometimes not mentioned.

 (iv) Many responses did not recognise that production and use of e-fuel is carbon neutral.

Question 4

(a) (i) Most responses ignored that alkaline hydrolysis was required and used water to produce the acid rather than the ion. Many candidates attempted to write equation for transesterification using methanol.

 (ii) There were many incorrect diagrams presented for this question. Many had an oxide anion replacing the hydroxyl group(s). A common error was neglecting to adjust the number of hydrogen atoms on the three C atoms.

(b) (i) Well done.

 (ii) (1) Only a few responses gave correct formulae and were balanced. Some answers incorrectly showed both the acid and OH group ionised.

 (2) This question was generally well answered but there was frequent mention of ion-dipole ‘bonds’ rather than interactions or forces.

(c) This question was either answered well or very poorly. Many responses did not appreciate that highly saline water has a high concentration of Na+. Most mentioned cation exchange but many could not explain what would happen. Some incorrectly reasoned charge density was the cause of a shift in equilibrium.

Question 5

(a) Generally answered well by the student cohort. Failure to mention uptake or assimilation by roots was the most common omission.

(b) (i) Students could usually perform this calculation. Some lost a mark for incorrect rounding off. Many students lost a mark for not writing appropriate units.

 (ii) Most students protonated the amino group correctly as expected. Some students mistook low pH for an alkaline environment.

 (iii) Generally answered well by the student cohort.

(c) As expected, students generally discussed both slowing of the increase in global warming (and its consequences) due to the decrease in N2O emissions and decreased eutrophication of water bodies (and its consequences) due to less nutrient run-off entering. Note that the positive effect of each of the two on the environment needed to be specified.

Students are not awarded marks for simply restating points given in the question. Nitrous oxide is not one of the NOx known to contribute to photochemical smog, so responses that went down this pathway were not rewarded.

Students lost a mark if they implied, through lack of use of comparative language, that the environmental problems they discussed would be entirely solved by the use of these amino acid fertilisers.

Question 6

(a) Generally well known by students, but some did not carefully read that this was the fermentation equation.

(b) Use of controlled heating to maintain a temperature at or above 78oC but below 100 oC was rarely mentioned by students.

Not all students seemed to realise that far less water than ethanol would then vaporise at the same temperature.

Reason for use of condenser was usually appropriately included.

(Understanding of thermal distillation is required by the ‘water’ topic)

(c) (i) Generally answered well by the student cohort. A small, but significant number of students were unable to rearrange the equation n = cV correctly.

 (ii) Generally answered well by the student cohort.

 (iii) Generally answered well by the student cohort.

 (iv) Generally answered well by the student cohort.

 (v) Generally answered well by the student cohort.

 (vi) This part of the calculation was not performed well at all. Students were largely unable to correctly recognize and reverse the dilution factor. Some students did not recognise that this part followed on from the previous.

 (vii) This manipulation was quite well known. [No penalty is attracted if the method is correct, but the answer is incorrect simply because of a mistake in an earlier part question.]

 (viii) A pleasing number of students were able to write two correct statements that flowed logically to the conclusion that the volume of iron (II) solution used would be decreased.

 (ix) (1) Generally answered well by the student cohort.

 (2) Generally answered well by the student cohort.

Question 7

(a) (i) Students were frequently unable to correctly identify the number of carbon and hydrogen atoms in this structure. They also did not always write their answer as a molecular formula as directed.

 (ii) Generally answered well by the student cohort.

(b) (i) Generally answered well by the student cohort.

 (ii) Many students struggled with this question by failing to refer to temperature. Most students failed to link temperature and rate of GABA production rather than simply ‘GABA concentration’.

 (iii) Generally answered well by the student cohort, but a significant number are not recognising that the increased proportion of molecules with activation energy (or greater) at the higher temperature has a much greater contribution to increasing the rate of reaction than simply increased molecular movement and hence more particle collisions per unit time.

 (iv) Students were not awarded the mark if they implied that enzymes were ‘killed’ by the high temperature. It is the microbes that may be killed, or their enzymes may lose their function. Apart from this flaw, this part question was generally well answered.

 (v) Again, lack of comparative language cost students this mark. ‘Steepest’ or ’greatest slope’ was expected, not simply ‘steep’.

Question 8

(a) (i) Generally answered well by the student cohort. Most stuck to the often-touted competition for arable land and hence decrease in food supply or consequent increase in cost of food if plants are grown to use as feedstock for production of polymers rather than solely as a food source. Some students did not elaborate the consequence sufficiently for 2 marks.

 (ii) (1) Well answered.

 (2) Generally answered well by the student cohort.

 (iii) The reason is still not well recognised by students. The primary structural chain in the polymer is carbon-carbon covalent bonds which are strong, and this main chain contains no functional groups that can be hydrolysed. Microbes in the environment have not evolved enzymes to be able to break down PMMA.

(b) (i) Many students neglected to respond to this part question despite it being numbered (i) and clearly having a (1 mark) allocation.

 (ii) Students are encouraged to mention the different component substances that make up the composite material as well as the difficulty in separating these.

 (iii) Students should identify which key concept of SHE they are using in their response and support their choice with relevant information from the passage, subsequently extending this to how it is of benefit to society or the human condition. There is no evidence for communication/collaboration here.