2021 Chemistry Subject Assessment Advice

Overview

Subject assessment advice, based on the 2021 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 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 aspects to explore that allowed opportunities for individual design and investigation of an uncertain outcome
* summarised variables to be controlled, and how and why they would be controlled, in table format
* considered a range of possible variables, measurement techniques and equipment, and justified all selections made in relation to the student’s own design
* considered relevant safety aspects including safe disposal of chemicals
* included detailed evidence of deconstruction and justification of the student’s method
* clearly separated the four pages of deconstruction and design from the report
* clearly identified relevant errors in a practical investigation and used their data to explain the effect of errors on the outcome
* justified conclusions and noted their limitations
* clearly identified the SHE concepts that were the focus of the SHE investigation
* chose a topic for the SHE investigation 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.

The less successful responses commonly:

* responded to tasks that provide few opportunities for collection of data that enabled in-depth analysis
* responded to a series of straightforward questions that did not allow students to show evidence at the highest level
* included just a brainstorm or mind map as evidence of a deconstruction with no justification of the chosen procedure
* 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, such as a bar graph to show titration results
* identified only a few general errors that were nonspecific to the task and applicable to many investigations
* had difficulty providing quality evidence for IAE3 and IAE4 in an ester preparation task
* used terms such as precision, accuracy, reliability, and validity either incorrectly or without any meaningful discussion of these terms in relation to their data
* copied information from articles about an application or development related to chemistry without discussing how it relates to any of the SHE concepts in the SHE investigation
* addressed several SHE concepts superficially rather one or two in depth
* selected very general topics, such as plastics, greenhouse effect, ocean acidification and even lithium batteries that did not focus on a piece of current research.

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
* linked evidence provided in a question to an appropriate SHE concept (CC, D, I, or AL).

The less successful responses commonly:

* were hampered in achieving high grades because of too much simple recall and too little application, analysis or in-depth explanation.

External Assessment

Assessment Type 3: Examination

Examination questions are designed to assess students’ understanding and application of all three strands of the subject outline: the science understandings, the science inquiry skills and the key concepts of science as a human endeavour. All specific features of the assessment design criteria for this subject may be assessed in the examination.

Question 1

(a) (i) Generally, well done. The most common mistake was not indicating the activation energy accurately, often from the products to the peak. Some students lost marks due to sloppy arrows that gave a general indication of activation energy and enthalpy changes that did not match the energy levels provided

(ii) Most responses were correct. A few students used rounded brackets, inserted + signs, swapped denominators and numerators, omitted the superscript 3 for the hydrogen concentration, or added numbers.

(iii) Most students lost at least one mark for this question. Students who used RICE table tended to be more successful. Common errors included failing to convert to concentration (÷ by 50), forgetting to use the mole ratio, or dividing instead of multiplying by 3. Most students used the correct number of significant figures.

(iv) There were some excellent responses that referred to both the effect of temperature on equilibrium and rate of reaction. Weaker responses tended to either refer to the effect of equilibrium or the effect on rate of reaction. Others did not connect the increased energy with an increase in successful collisions per unit time due to more collisions having sufficient energy to overcome the activation energy required for the reaction. About half the responses were able to link increased yield to increased profit for the manufacturer.

(b) (i) (1) About half of the responses produced an acceptable equation. Common errors included not balancing the equation, writing an overall equation, adding an oxygen molecule to one side, including water on both sides of the equation, using both H+ and OH– in an equation, not adding electrons, and using incorrect formulae.

(2) Most responses were correct but there were still many arrows drawn in the electrolyte.

(ii) (1) Generally, well done. Some responses simply stated that activation energy was reduced, rather than rate increased.

(2) This question challenged students to think ‘outside the square’ and use their knowledge about how the use of a catalyst may benefit the environment. Acceptable answers included ‘cobalt phosphide is a more abundant resource’ and ‘using an alternative preserves the finite platinum resource for other uses’.

(3) Many responses included errors, such as writing the electron configuration for the element or removing electrons from the 3d subshell. A small number did not use the correct conventions of lower-case letters and superscripts for the number of electrons.

Question 2

(a) Mostly well done, correctly identifying Apamin due to its shorter retention time. Students are reminded to use correct terminology associated with adsorbing (not absorbing) to the stationary phase or dissolving in the mobile phase.

(b) (i) Most responses were correct. Common incorrect responses included amine, ketone and ester.

(ii) A significant number of students drew incorrect amino and carboxyl groups. Students were most successful when they left the structure in skeletal form and did not change its orientation. A few drew the general structure for an amino acid and others drew an incorrect self-protonated form, showing a lack of understanding for the general formula of an amino acid.

(c) (i) (1) Generally, well answered. Some students clearly did not understand the difference between anion and cation exchange columns.

(2) Many students incorrectly identified NaCl exchanging with the protein rather than the sodium ion. Good responses included an equilibrium equation to explain their answer.

(ii) (1) Most answers were correct. A small number approximated the maximum to 50°C, rather than reading correctly to the nearest degree.

(2) Generally, well done by students. Some had very good explanations about loss of function of the enzyme without relating it to the activity on the graph. Others made mistakes, referring to secondary interactions as just bonds or not explaining the disruption of secondary interactions at all.

Question 3

(a) (i) Well done, with responses referring to the scatter around the line of best fit. Common incorrect responses referred to outliers or that the line of best fit did not pass through the origin, or by referring to absorbance not being 0 (indicating misunderstanding of random and systematic errors).

(ii) (1) Most students were able to read the scale appropriately.

(2) Very few students answered this correctly. Most did not recognise the volume unit of ug/mL is the same number in mg/L.

(3) Students really struggled on this question, failing to recognise that AAS monochromators select one unique wavelength of light to detect just one element. Only a few referred to the energy being absorbed by electrons or connecting the specific amount of energy required for an electron to move between energy levels to the specific wavelengths of light that are absorbed by iron. Aluminium oxide was often referred to, rather than aluminium.

(b) (i) Fairly well answered, but some students wrote Fe2 or Fe3+ for the iron product, added extra reactants and products, and sometimes electrons.

(ii) Not well done with only a few students demonstrating a good understanding that the strength of reduction technique is related to the activity of the metal. Instead of referring to the position of iron on the metal activity series, some tried to use rate of reaction or an aqueous vs molten explanation. Several referred to reduction of the metal, rather than the ions, and some referred to C rather than CO.

(c) (i) (1) Most responses received one mark, recognising the need for concordant titres to calculate an average but then not stating that this minimises the effect of random error, or increases reliability. A significant number of students mentioned precision and accuracy in the same sentence suggesting a lack of understanding of these terms.

(2) Generally done well. The most common mistake was using the volumes in the wrong places. Inability to rearrange the c=n/v formulae created issues in calculations for some and there were some rounding errors.

(ii) Generally done well with most common mistake using the molar mass of iron rather than of iron sulfate. Some students also multiplied by 10, rather than dividing, in the calculation of M.

(d) (i) Most could identify the cell as galvanic. Some were confused by the ‘power in/out’ and therefore said it was electrolytic. Some did not link the negative charge on Electrode 1 with the oxidation process occurring at Electrode 1, which was therefore acting as the anode. Many incorrect responses just gave the definition of a galvanic cell with chemical energy being converted into electrical energy rather than referring to this specific cell and equations.

(ii) Many responses identified that flow cells are rechargeable but then needed more detail about the benefit, such as being able to regenerate the fuel rather than having to have fuel continually supplied. Many incorrect responses vaguely discussed resources, size of cells or greenhouse gas emissions.

Question 4

(a) (i) Many responses lost one mark because they wrote a structural or condensed formula rather than the correct molecular formula for this compound, C2H7NO. Some students tried to write the name, not reading the question carefully. A common mistake was an incorrect number of H atoms. Although the formula should be written in alphabetical order, an incorrect order was not penalised.

(ii) Usually answered correctly, with an occasional amide instead of amine.

(b) (i) Most students achieved at least one mark by acknowledging that the amine could accept a proton. Many responses did not achieve the additional mark because they failed to recognise that carbon dioxide forms carbonic acid in solution, producing H+(aq). A significant number of students confused MEA with an amino acid and concluded that the molecule self-ionised.

(ii) Very few responses were awarded the full four marks. Many simply repeated elements of the question. High CO2 levels should have been linked to global warming, or ocean acidification, and then explained some disastrous effects of these. Students failed to elaborate on the impact on society and the reasons *why* governments and companies would be influenced and instead focussed on *how* they would influence. It was concerning to read responses that stated carbon dioxide levels cause respiratory diseases and poor health.

(c) (i) Usually answered correctly. A few incorrectly referred to ion-dipole interaction.

(ii) Some students drew their own diagram when the question clearly said to indicate on the diagram. Dashed lines (rather than dotted lines) were common but not penalised. The most common loss of marks was for using solid lines to depict a secondary interaction, connecting the H-bond between incorrect atoms, mislabelling the polarity on the functional groups, or omitting the partial charges altogether.

Question 5

(a) Many responses stated that availability of sunlight is not continuous whereas steam generation of electricity can occur 24 hours a day. A few stated land requirements being less for a fossil fuelled plant. A very common incorrect answer was that the fossil-fuel method generated more electricity than solar, rather than specifying this on an area of land basis. Other common errors were to suggest it was better for controlling exhaust gases or pollution, or that the supply of water for this system is cheaper.

(b) (i) Most responses did not produce the correct answer of 12.5kg. Many used Q to solve for ‘m’ as the mass for coal, but this is the mass of water. Other errors included incorrect rearrangement of equations, using DH as Q, neglecting to convert kg of water to grams, or grams of coal back to kg.

(ii) Many acceptable fossil fuel variations were accepted. Common errors were a formula instead of a name, simply writing oil instead of crude oil, naming an alcohol, and writing coal even though the question asked for an alternative to coal.

(iii) CO and NO were the most common correct answers. The most common error was to write nitrogen oxides or NOx rather than a specific substance.

(c) (i) Most students gained this mark. Marks were awarded for any clear reference to clean, potable, deionised or other variant of purified water. The most common incorrect response was salt or brine.

(ii) This question tested students’ problem-solving ability. Relatively few students clearly identified that the heat energy recovered from the powerplant would reduce the energy requirements to heat sea water at the desalination plant. Many answers incorrectly assumed that the power produced from the power station was then used to power the desalination plant. Another incorrect response was stating that connection of the plants reduced transport costs for water. Some students tried to explain that selling water would reduce costs which was not awarded marks as this may improve profit but does not directly reduce costs.

(iii) Pressure was commonly correctly stated as the reason, but some responses did not explain correctly why the high pressure is required.

Question 6

(a) (i) Mostly answered well. Common errors including numbering from the wrong end, misnumbering the methyl group, or misnaming the butanal as butanoic acid or butanone.

(ii) (1) Most responses gained this mark, stating acidified dichromate solution or Tollens’ Reagent.

(2) Mostly well answered. A few crossed over observations with the reagents chosen in part (1). Common error was to describe there being no reaction from compound Y rather than no observable change.

(iii) Poor use of terminology resulted in this question not being well answered. Many answers simply compared the size of the two molecules rather than explicitly talking about the length of the non-polar carbon chain. The much larger size of the non-polar hydrocarbon portion in Y leads to Y being much less polar overall. It was common to incorrectly attribute the difference in solubility to aldehyde groups being more polar than ketone groups.

(iv) Usually, the carbon chain was correct but often the carboxylic acid and not the secondary alcohol was given. Students should take care in positioning the hydroxyl group correctly on the bond attached to the carbon chain.

(b) (i) Generally done well. The most common error was drawing the carboxylic acid instead of the carboxylate anion.

(ii) Usually well answered. Water was the most common incorrect answer, and some students simply wrote alcohol, which is too vague to receive a mark.

(iii) The best answers systematically discussed the carboxylate ion’s properties and then went on to discuss interactions with water and compound Y and how this enabled removal from the dog hair. The best responses discussed the role of agitation and the micelle structure in the formation of an emulsion to wash away compound Y. It was extremely common that students incorrectly stated that the ionic head was polar, and this was penalised. It was not uncommon for students to mix up the terms hydrophobic and hydrophilic. Many responses included a diagram, with some incorrectly labelling the hydrophobic and hydrophilic ends.

Question 7

(a) Mostly answered correctly. Marks were lost for not being specific about the kind of interactions between polymer chains. Polyurethane contains polar functional groups that would add to the strength of the interactions between chains through dipole-dipole attraction or even hydrogen-bonding (amide groups) whereas polypropene has only dispersion forces between its chains, which is a weaker force. Some responses lost marks for stating that polyurethane forms crosslinks; sometimes suggesting that H‑bonds were crosslinks. It was common to compare the length of the repeating units and make statements suggesting that this translated to polypropene being a smaller polymer than polyurethane which demonstrated a lack of understanding about polymers being very large molecules that can comprise hundreds or thousands of repeating units. Many were unable to express the difference between weakening the forces between the chains (which happens when melting) and breaking covalent bonds within the chains (which would decompose the polymer).

(b) (i) Relatively few responses discussed the conservation of finite non-renewable resources for other purposes. There was a poor understanding of the difference between recyclable, biodegradable, and renewable. Many incorrect responses focussed on the advantage of recyclable polymers rather than production of polymers from renewable resources. Reducing greenhouse gas emissions was a common incorrect response.

(ii) Generally, well answered. Most common errors were leaving out the *n* to balance the water and glucose, or failing to copy the formula for starch accurately by either not including the brackets, the *n* or both.

(iii) (1) Most students answered this correctly.

(2) Many answers correctly identified the ester group, with ketone being the most common incorrect answer along with a range of other functional groups.

(3) Few responses mentioned that microorganisms or other biological organisms biodegrade materials. The best responses were able to identify that the ester functional groups in PHB were able to be hydrolysed, facilitated by enzymes in micro-organisms.

(iv) (1) Few students were able to transfer the knowledge of triglyceride structure to this scenario. Responses that identified the increase in distance between the chains due to irregular packing were able to recognise that less closely packed molecules lead to weaker dispersion forces and a lower melting point.

Most responses incorrectly stated that the addition of PHV monomers increases molar mass, disregarding that fact that polymer chains are huge anyway. Responses that then associated the increase in mass to increased dispersion forces and therefore increased melting point received two marks. Some compared PHV, and not modified PHB, to PHB.

(2) Few responses were awarded full marks. Most were able to give evidence of where development, application, influence, or communication was found in the article. Very few were able to explain how this benefits society or science, e.g., biodegrades more rapidly, so contributes to less landfill, or a stronger polymer can be used in a range of new ways as it would not break as easily. The most common incorrect answer was trying to explain a limitation of the existing technology rather than of the new development.