2020 Chemistry Subject Assessment Advice

Overview

Subject assessment advice, based on the previous year’s 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

This year, due to Covid-19 impacts, several schools took the option of removing one summative task, usually a SAT, from the assessment package.

Assessment Type 1: Investigations Folio

The Investigations Folio contains at least 2 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
* clearly separated the 4 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 recent research 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
* 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
* identified only a few general errors that were nonspecific to the task and applicable to many investigations
* copied information from articles about an application or development related to chemistry without discussing how it relates to any SHE concept in the SHE investigation
* addressed several SHE concepts superficially rather one or two in depth
* selected very general topics, such as greenhouse effect or ocean acidification rather than focusing 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 should focus on the science understandings, apply science inquiry skills, and explain connections with science as a human endeavour.

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) Many students made errors in writing the electron configuration of an ion, with most taking the electrons from the 3d instead of the 4s subshell. Others gave the electron configuration of an uncharged manganese atom, used upper case for the letters, did not use superscripts for electron numbers or confused Mn with Mg.

(ii) Many responses were hampered by poor communication of ideas. Many students incorrectly referred to the unique electron configurations rather than correctly referring to the unique set of energy levels or electron transitions for each element. Also the idea that only one wavelength from those emitted from the cathode lamp is selected by a monochromator, and that this specific wavelength is only absorbed by one element, was not often communicated clearly.

(b) This question was well-answered. Many responses correctly stated that caffeine, given it is less polar than the other compound, was more strongly adsorbed to the non-polar stationary phase, or less attracted to the mobile phase. Less successful responses did not link the longer retention time to greater adsorption to the stationary phase.

(c) Mostly responses earned 2 of the 3 marks. Common errors were failing to convert the final answer to mg, dividing by the factor of three instead of multiplying, and dividing by the molar mass instead of multiplying. Where there was unclear or limited working, minimal marks were awarded if the final answer was incorrect.

(d) Generally well-answered. However some students correctly linked the influence to the change in consumption of milk type with tea but did not go on to link this to the beneficial health effect expected as a result. Some instead stated that because tea is widely consumed, this influenced the scientists to undertake the research but it was more difficult for these students to specify the follow-on statement for the second mark. Some students misread the information, inferring that skim milk was the healthier option. Many students outlined the influence of the study as providing health benefits to society. The SHE link should be specific to the text, not just a general link that could be applied to most research.

Question 2

(a) (i) Most answers had at least one error and so failed to gain the mark for this question. Polymer formulae are written with the repeating unit formula inside curved brackets with the subscript n outside the final bracket. Many students incorrectly wrote the formula of glucose or sucrose as the repeating unit.

(ii) Generally correctly answered as condensation polymerisation. The term ‘polymerisation’ has more than one type and so was not an acceptable answer on its own.

(iii) (1) Less successful responses drew bonds that did not clearly connect the correct atoms, omitted some OH groups or left open bonds from the repeating unit unconnected to an atom.

(2) Most responses received only 2 of the 4 marks. Almost all students mentioned the many polar hydroxyl groups and that these could enter into hydrogen-bonding with polar water (hence hydrophilic). However, they could not articulate that the OH groups cause many secondary interactions (hydrogen-bonding again) between the long cellulose chains and that water was unable to separate the chains (and hence dissolve the cellulose).

(b) (i) Approximately half of the cohort responded correctly. The most common mistake was the identification of a group involved in the reaction rather than formed in the reaction.

(ii) Students who simply restated the information provided, that cross-links are formed and so paper is strengthened, received no marks. Students needed to recognise that these cross-links are covalent bonds, and that these require more energy to break than secondary interactions or that molecules now had more restricted movement (giving the paper greater rigidity).

(c) Very few students articulated that the cup was now made of a composite material. Even fewer then went on to state that wax or plastic and paper have different properties and hence require different recycling methods. Few wrote that the wax or plastic would need to be separated from the paper before an attempt to recycle it could be made. Less successful responses stated that expense is a difficulty with no substantiation of why and hence received no marks.

Question 3

(a) (i) Relatively well done although chemical literacy proved challenging for some students. Instead of identifying the greater positive charge of the aluminium ion, compared with the sodium ion, many referred simply to charge rather than positive charge or referred to the whole aluminium sulfate compound instead of just Al3+.

(ii) (1) Only a small percentage of responses achieved full marks for the equation. Although most included the double equilibrium arrow, many could not identify the correct products.

(2) Less successful answers did not identify the increase in pH as a decrease in hydrogen ions and so presented the argument for an increase in these ions. Generic answers such as ‘According to Le Chatelier’s Principle the equilibrium shifts to the right’ were awarded 1 mark whereas an explanation such as ‘In order to counteract the stress on the system the equilibrium shifts to the right’ was awarded 2 marks.

(iii) Many students completed the calculation well, but some students failed to gain the third mark because they did not make the comparison between their calculated answer and 0.9%. Some students were unsure about unit conversions.

(b) (i) Mostly well-answered but some students did not demonstrate a clear understanding of units and formulae nor did they understand correct use of significant figures.

Students who cannot determine an answer to the first part of a calculation should use any number, even ‘x’, in the next parts of the calculation so that they can gain marks for correct working in those parts.

(ii) Some students used the mole ratio of thiosulfate ions to hypochlorite ions incorrectly by multiplying instead of dividing by 2. All figures in the calculator from the answer to part (i) must be used in this calculation rather than a rounded off answer.

(iii) Mostly well-answered. A common error was the use of the incorrect volume of 15.08 x 10-3 L instead of 25.00 x 10-3 L when finding the concentration of ClO-.

Question 4

(a) Answered correctly by the majority of students.

(b) (i) Most students were able to write a correct equilibrium constant expression. Less successful responses used curved brackets or had addition rather than multiplication of concentrations.

(ii) Students were required to interpret the graph to realise that an increase in temperature leads to a higher concentration of products, which is the indication that the forwards reaction is favoured and that endothermic reactions are favoured by increased heat.

(iii) Successful responses indicated that the very small Kc value means this reaction has a very low yield, even at this very high temperature, and that it would be a very costly process for such a small yield.

(c) (i) (1) Most responses gained 2 of the 3 marks for stating that an increase in pressure will shift the equilibrium to the side of the reaction that produces a lower total number of moles of gas. Less successful responses usually did not mention that a new equilibrium position would have to be established in order to counteract the effect of increased pressure on the system.

(2) Most answers to this question were incorrect as they did not recognise that at constant temperature Kc remains constant.

(ii) This question was not well-answered. Most students could identify a statement that related to one of the SHE key concepts but rarely substantiated their choice of concept by showing how it linked to the statement. More successful responses related the decreased need for high temperatures to less combustion of carbon-based fuels and hence less greenhouse gas emission. However, many then failed to mention what the positive outcome for the environment would be. Some less successful responses mentioned the emission of nitrogen oxides into the atmosphere, clearly not understanding that the nitrogen dioxide was the desired product of this stage in nitric acid production.

(d) (i) Generally well-answered. Most students understood the process by which ozone is formed. The most common omission was the necessity of sunlight/UV light for the photolysis of nitrogen dioxide to occur.

(ii) Many students could identify one effect but did not describe this effect. Some responses included incorrect statements such as ‘ozone damages stomata on leaves’, whereas it actually causes damage to the plant tissue inside the leaf.

Question 5

(a) (i) Generally answered very well with most students recognising the tertiary amine. Most incorrect answers stated it was a primary amine.

(ii) Most responses were correct. Less successful answers omitted the 1, 4 or di prefixes. While not penalised, students are encouraged to use commas and hyphens correctly in systematic names.

(b) (i) Many responses gained only 2 of the 3 marks. Many students could identify a form of secondary interaction between molecules and stated little energy is required to break these interactions. However many students did not recognise the three methyl groups attached to the N atom resulting in low overall polarity of the molecule. Most students tried to justify weak dispersion forces simply on the basis of the molecule being small. Small molecules alone are not a justification for weak secondary interactions.

(ii) (1) Generally done well as most students could correctly add the hydrogen and place the positive charge on the nitrogen atom. Common errors included omitting the methyl groups from the structure and replacing them with hydrogens.

(2) Some students recognised that decreased fishy smell was either connected to reduced boiling point or increased solubility in water. Few students successfully connected this change in physical properties to the formation of an ion, enabling stronger ion-dipole interactions.

(iii) (1) Most responses successfully stated a whole number between 125 and 130 h.

(2) Most responses correctly stated the effect of temperature on rate but many did not use values from the graph as evidence. Some led successful responses discussed the time fish remained fresh rather than rate of formation of TMA.

(3) Most responses successfully stated there was no effect.

Question 6

(a) Many students were able to identify a change in enzyme shape and then link this to a change in enzyme function. The most successful responses explained the change in structure to disruption of secondary interactions between protein chains.

(b) (i) Mostly well answered. Less successful responses didn’t link the two variables, instead making half statements such as ‘decreasing’, and so did not gain a mark.

(ii) The vast majority of responses correctly identified C.

(c) (i) Generally answered well. Less successful responses just stated ‘time’, and so did not gain a mark.

(ii) Generally not answered well. Many students could state that concentration of H2O2 affects the rate of reaction but few recognised that concentration would affect the development of the red-brown colour. Some students were able to articulate that the outcome of the experiment couldn’t be attributed to the boiling time if two variables were in play.

(iii) (1) A significant number of students could not balance this half-equation with some students not including electrons and others not attempting an answer.

(2) Very well answered. Less successful responses omitted the increased rate of collisions per unit time, or just referred incorrectly to there being ‘more collisions’ rather than ‘more frequent collisions’.

Question 7

(a) Many students managed to calculate the charge on the aluminosilicate. Less successful responses did not account for a 2+ charge on Mg or did not determine the oxidation state of Si correctly.

(b) Poorly answered with very few responses gaining full marks. Most responses did not acknowledge that because surfaces of aluminosilicates are negatively charged they attract cations and therefore act as reservoirs for mineral nutrients. The more clay in the soil the greater the reservoir of nutrients and since many cations are plant nutrients the more clay in the soil the greater the amount of plant growth.

(c) (i) Generally answered well. However, a significant number of answers did not include correct units.

(ii) Mostly well answered. Less successful responses had carbonic acid or hydrogen carbonate ions as the product or were incorrectly balanced.

Question 8

(a) (i) Generally answered very well with the most common errors being not balancing the equation and incorrectly copying formulae from the diagram.

(ii) Poorly answered. Few students recognised that it must be a reactant added to the process and instead gave vague answers, such as ‘it is needed for step 1’, that could equally apply to other inputs, e.g. heat or recycled by-products.

(iii) (1) Responses were typically awarded 1 of the 2 marks. Common errors were not mentioning that lithium is a very reactive metal/high on the metal activity series and stating that water would be reduced in preference to lithium, rather than lithium ions.

(2) Mostly well answered. Most students connected a molten electrolyte to a higher energy requirement and then increased cost or reduced profit. Others linked the high temperatures to safety concerns for the workers. Less successful responses only stated the issue, without the consequence, and some tried to link it to greenhouse gas emissions with no connection to the manufacturer.

(iv) Mostly well answered. Successful responses stated that there would be less mining, less environmental waste in landfill or that lithium is a rare/finite source. Less successful responses referred to cost being a reason to recycle even though the stem of the question explicitly says that it is much cheaper to obtain from ore.

(b) (i) Successful responses correctly identified B because of its less closely packed chains, due to more alkene groups. Less successful responses misunderstood the concept and chose compound A due to size. Others demonstrated poor understanding that the strength of the secondary interactions between chains affects the melting point and not the strength of primary double covalent bonds.

(ii) Few responses gained 4 marks. Most students indicated that bromine reacts with carbon-carbon double bonds with a colour change from orange to colourless. Some stated triglyceride A would be less changed than B, as if the colour change operated on a scale like a pool testing kit does. These students didn’t recognise that the orange/brown colour of bromine is only evident when it is in excess, such that a persistent colour is a measure of end point. A common error was using the word clear’ instead of ‘colourless’. Very few students considered the need for equal quantities of triglyceride A and B in a test. The best responses described the test in terms of a titration.

(iii) (1) About half of the responses gave a correct answer of methanol or ethanol and most incorrect responses were water or sodium hydroxide.

(2) Very poorly answered. Many students drew carboxylic acids, salts or even glycerol here. A poor knowledge of biodiesel was evident.

(3) Most responses gained at least 1 of the 2 marks. Common mistakes were dividing by the density (instead of multiplying) and missing the unit conversion for density.