

## CHEMISTRY

### Overall grade boundaries

<b>Grade:</b>	E	D	C	B	A
<b>Mark range:</b>	0 - 7	8 - 15	16 - 22	23 - 28	29 - 36

### The range and suitability of the work submitted

Over 1500 candidates submitted an extended essay in chemistry this May session. As usual there was a wide range of achievement. Some of the essays were genuinely excellent but as in the past, many scored less well for several different reasons. The two most common reasons for students failing to perform well were a poor choice of initial research question and failing to address specific criteria. Although there are probably some exceptions, both of these failings can generally be attributed to poor supervision. Assistant examiners commented that many candidates seemed to be unaware of what is required to address each criterion. Candidates lost marks unnecessarily through failing to comply with very clear guidelines such as, for example, including an abstract that exceeded 300 words.

One of the key functions of the supervisor is to guide students throughout the whole of the research and writing process of the extended essay. Unless there is a sharply focused research question the rest of the essay will suffer. Supervisors are failing their students if they do not adequately discuss the choice of topic with them and help them formulate a well-focused research question that it is capable of being addressed in 40 hours of work and in 4000 words. As in previous years many of the topics involved the concentration of vitamin C, aspects of aspirin analysis, the use of biodiesel, aspects of water hardness and water purity, the caffeine content of particular consumer products and the use of luminal in forensic science. All of these topics are capable of producing good essays if the particular research question is well formulated and also shows some degree of originality rather than questions along the lines of "does this contain what it says on the label?" Examples of some of the best research questions received which led to really good essays this year included:

- "How do the concentration of sodium chloride in aqueous solution and the pH of a solution affect their absorption by diaper gel, sodium polyacrylate?"
- "How does changing the concentration of the reagents affect the formation and spacing between Liesegang rings in the reaction between cobalt(II) chloride and ammonia when conducted in a test tube?"
- "What effect do the various edible coatings found on aspirin tablets have on the rate of hydrolysis of aspirin?"

Other good topics concerned the amount of iron in broccoli, the difference in the total carbonate content in a range of different avian egg shells and the density of the growth of a particular plant (*Spartina alterniflora*) on the concentration of phosphate ions in the

surrounding marsh water. What was also noticeable this year is that several excellent essays were to do with academic chemistry rather than having an environmental or social slant. For example, "An investigation into the spontaneity of the reaction between ammonium thiocyanate and barium hydroxide", "How does the length of the carbon chain affect the amount of aldehydes produced during a given time when primary alcohols are oxidised?" and "How does the values of the equilibrium constant for the esterification reaction between ethanol and ethanoic acid change with temperature?"

One factor seems to be changing for the better. Compared to the past more essays do now contain at least some relevant background research rather than going straight into the design of a particular experiment. This is probably due to the inclusion of Criterion B which requires students to write an introduction. Mainly because of this the percentage of students achieving at least a satisfactory grade or better (A-C) has improved, as has the percentage of those gaining an excellent grade.

The influence of the internal assessment criteria is still evident in Criterion F: application of analytical skills and evaluative skills. Many students write unnecessary pages discussing the accuracy or otherwise of their equipment and yet do not question either the underlying chemical assumptions they have made or make any attempt to analyse the validity of the secondary sources of data they have used.

Some students included material in the appendix that should be in the body of the essay and there were several cases where students only did single unrepeatable experiments from which no serious scientific deductions could be made. There are also still examples of essays submitted by students on work they have done whilst attending summer courses at universities which is often unsuitable for an extended essay.

Many of the comments made in the May 2009 and May 2010 reports are still pertinent and rather than repeat all of them supervisors are encouraged to read and take note of the comments also made in these two reports.

## **Candidate performance against each criterion**

### **Criterion A: research question**

It clearly states in the assessment descriptor that the research question should be stated in the introduction and yet several students did not do this. Some students stated it at the beginning of the introduction which is acceptable although possibly a more logical approach is to use the introduction to lead into the research question. Good students highlighted the research question in some way (e.g. used bold font) so that it was obvious. A few students had several research questions which is often a sign of lack of clear focus.

### **Criterion B: introduction**

There was a considerable difference in the quality of some of the introductions written. Some really used the introduction effectively to explain how the research question had arisen whereas others gave some background information but did not make the connections as to show how it was relevant to the research question or why the research question was significant and worthy of investigation. Several candidates made no references to external

sources in the introduction. This is a poor and unacceptable practice as it shows a complete lack of research. There were also examples of sweeping statements in some introductions which had no attributable source.

### **Criterion C: investigation**

Having settled on the research question in the introduction, good students considered all (or at least several) of the possible approaches as to how they could go about answering it in the investigation. For the vast majority of essays involving the student's own practical work this meant looking at all the possible methods, discussing the merits and disadvantages of the possible approaches and explaining why they settled on a particular experimental technique. They then explained how they had either adapted a traditional method or designed their own novel approach. Weaker students often just followed a traditional method without any obvious personal input or originality. Those students who relied solely on secondary data needed to show that an imaginative range of resources had been consulted. Poorer essays were often little more than a summary of just one source.

### **Criterion D: knowledge and understanding of the topic studied**

One assistant examiner asked how they should mark an essay from a student which contained work done at a university on a rather esoteric topic. This answer lies in how the student addresses this criterion. If, after reading the essay, the examiner is still unclear then the student has failed to communicate that they understand what they have done. Too many students either use equations without explaining how they arise, miss out the theory altogether or spend far too many words explaining simple chemistry that is a fundamental part of the core on the IB programme. Good students succinctly explain the underlying theory and also point out the possible weaknesses in the technique(s) they used – for example, the Beer-Lambert Law is only applicable for dilute solutions.

### **Criterion E: reasoned argument**

As has been stated previously, this is the criterion that clearly distinguishes the excellent extended essay from the rest. Those students that scored highly produced a convincing argument in relation to the research question. These students set out their ideas clearly and logically and analysed the strengths and weaknesses of their claims.

### **Criterion F: application of analytical and evaluative skills**

This is the criterion where there are many problems as some students seem to have received little guidance on what is required. They should consider that this criterion is also addressed by students submitting non-practical essays in the other five IB Groups and therefore should not be solely about the accuracy or otherwise of the equipment used in their own experiment. Very few students analyzed specifically the validity of their secondary sources of data. Some thought they have covered it by putting in a generalized statement to the effect that published resources are more reliable than Internet resources. The best students actually questioned specific resources and used cross-referencing to test their reliability or even pointed out chemical errors in a resource they had found.

### **Criterion G: use of language**

It would be nice to see all students writing elements and compounds such as sodium or sodium chloride correctly instead of writing Sodium and Sodium Chloride in sentences. They were not penalized for this particular error but it does illustrate that chemistry does have its own rules about language and they should be applied correctly. What was penalized was the inconsistent use of language such as mixing  $\text{cm}^3$  and ml or propanone and acetone throughout the essay and the use of wrong chemical formulas, structures and units (or their omission).

### **Criterion H: conclusion**

This criterion does not actually judge the quality of what has gone before in the essay. It looks at whether the conclusion given is consistent with the body of the essay and is related to the research question. Many of the weaker candidates tended to give a very generalized conclusion and did not include the quantitative outcomes of experimentally determined evidence. A good conclusion in chemistry should also include unresolved questions and suggest the direction that future research could take.

### **Criterion I: formal presentation**

Most students were able to score at least two of the four marks for this criterion merely by checking that the required elements, such as including a table of contents and numbering the pages, were present. Pleasingly very few candidates scored zero by exceeding the 4000 word limit - although an amazing number claimed the essay was 3998 or 3999 words! Supervisors should emphasise to students that the Microsoft Word count is not actually the genuine word count as it includes words in table headings etc. As in previous years the weak areas tended to be not following a standard format for correct referencing, using poor or inappropriate diagrams or digital images and using the appendix for material that should be in the body of the essay in order to keep the word count below 4000.

### **Criterion J: abstract**

Writing a good abstract still seemed to be a problem for many candidates. This suggests a lack of clear guidance and supervision. There are only three compulsory elements. Some candidates gave a different research question in the abstract to the one written in the introduction and one of the weakest areas was a description of how the investigation was carried out. Some candidates omitted to give relevant quantitative information in the conclusion.

### **Criterion K: holistic judgment**

It was good to see that more supervisors were providing details of student's responses to *viva voce* questions in their report as the supervisors report is very much taken into account when marking this criterion. Even so, a few supervisors wrote no comments in their report. This is very much to the student's disadvantage. The majority of candidates did manage to achieve at least two of the four available marks as most showed some personal input and engagement. A good number of candidates showed considerable originality and insight throughout their essay and gained three or all four of the possible marks for this criterion which was very pleasing.

## Recommendations for the supervision of future candidates

- Schools must ensure that all teachers acting as supervisors are adequately trained before they undertake the task of supervision.
- Supervisors should ensure they are using the latest version of the *Extended essay guide*.
- Supervisors must ensure that students are given advice and guidance throughout and that the chosen research question is suitable for a 40 hour/4000 word essay in chemistry.
- Ensure that students are fully conversant with what is expected of them and are familiar with the assessment criteria.
- Ensure that students have access to some past chemistry extended essays which have been graded excellent.
- Encourage students to carry out a risk assessment for any practical work they undertake.
- Check that the method(s) used by the student has (have) the potential to generate meaningful data.
- Explain the importance of developing an argument when writing the essay and avoiding a purely descriptive account.
- Encourage students to find two or more different approaches to solving their research question as the merits/drawbacks of these different approaches can lead to a good argument.
- Encourage students to think critically and not mindlessly follow the internal assessment criteria.
- Encourage students to be innovative and 'take a risk'.
- Encourage students to use a wide variety of other resources as well as Internet websites.
- Encourage students to analyse secondary sources of data as well as their own experimental method.
- Provide guidance on documenting sources, writing a bibliography and an abstract.
- Discourage students from working on sophisticated topics chosen by others where the student cannot demonstrate depth of understanding or personal initiative and involvement.
- Ensure that the student has a check-list of all the points covered by the criteria to be completed to their own satisfaction before handing in the final version of the essay
- Write helpful supervisor's comments on the cover sheet and include some reference to the *viva voce* if applicable.