

## 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

There was a wide range of achievement this session. Many of the essays were of a high standard but, as in the past, some scored less well for several different reasons. There was strong evidence that many of the satisfactory or better essays had been well supervised. In many of these cases a sensible research question, capable of being addressed in 40 hours and 4000 words, had been chosen and students addressed many of the specific criteria well. The two most common reasons for students failing to perform well were a poor choice of initial research question and failing to address the criteria properly.

### Candidate performance against each criterion

#### Criterion A: research question

A carefully worded and well-focused research question is the key to producing a high-scoring essay. The EE guide (first examinations 2009) lists seven assessment objectives on page 6. Six of the eleven assessment criteria are concerned with testing the first objective which is 'planning and pursuing a research project with intellectual initiative and insight'. Objective 1 can only be achieved (and hence good marks scored on many of the criteria) if a suitable research question is chosen. As well as the usual vitamin C, aspirin, caffeine and biofuels topics examples of some of the good research questions which scored the maximum of two marks this session were:

- An investigation of the effect of temperature during storage on the antioxidant effect of cloves in reducing auto-oxidation of sunflower oil.
- How does the length of the carbon chain in an alcohol affect its acidity as measured by its rate of reaction with sodium?
- An investigation into the effectiveness of different concentrations of ascorbic acid on lowering the conversion of nitriles commonly found in sausages to the carcinogenic nitrosamines using spectroscopic analysis of the diazo coupling reactions.
- Determination of the difference in calcium content of fried chicken bones compared to uncooked chicken bones using EDTA back titration.

- What is the best reflux time to obtain the maximum yield of 'oil of wintergreen' in a laboratory setting and also determine its  $R_f$  value using TLC with the following solvents (acetone, hexane and 30% acetone: 70% hexane)?

Some research questions submitted had good potential but were not focused enough to obtain full marks.

### **Criterion B: introduction**

Good students used the introduction well to explain why they had chosen the topic and how they had arrived at a sharply focused research question. A good introduction should contain references to work done by others in the field of study and highlight the significance and worthiness of the topic. A few students lost marks unnecessarily by not including the research question in their introduction.

### **Criterion C: investigation**

The best students looked at what else had been covered in the chosen field and considered the different ways in which they could approach the experimental component of their work. During the introduction they analyzed the possible different approaches and explained why they settled on the approach (or approaches) chosen. It is strongly recommended (but not compulsory) that students try to obtain some of their data through their own experiments but it is also important that they consider secondary sources. Good students explained how they had adapted an existing method or devised their own method. 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**

Many students demonstrated a good knowledge and understanding of the topic. One way in which some students achieved this was to include a section on 'background information' where they gave the relevant underlying theory. It is not necessary to explain chemistry that is covered in the core but they should carefully explain any new chemistry or techniques that might be unfamiliar to the reader and perhaps more importantly show that they can use the chemistry correctly. Students should be encouraged not to just give formulas and then 'plug' numbers into them without first deriving the formula.

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

This criterion tended to discriminate well between good students and those of only average or below average ability. Students who scored highly produced a convincing argument in relation to the research question. These students set out their ideas clearly and logically and analyzed the strengths and weaknesses of their claims. Weaker students often just arrived at a conclusion to their experimental work without questioning any assumptions or possible counter-claims.

### **Criterion F: application of analytical and evaluative skills appropriate to the subject**

Some student still see this as simply analysing all the uncertainties in their apparatus as they have been trained to do for the Internal Assessment. Whilst this could be part of this criterion what is required is questioning the underlying chemistry of any reactions (for example, are there possible side products or will some product be lost due to the techniques such as recrystallisation that are being used?) and the validity of claims made in secondary sources. For example, how reliable are the secondary sources and do they contradict other secondary sources? Some students made blanket statements such as “Internet sources are not as reliable as journals”. This looks as if they have been trained to cover this point superficially but what is required is reference to the specific sources used.

### **Criterion G: use of language appropriate to Chemistry**

Generally students scored well on this criterion. Consistent and correct use of terminology and units together with correct formulas is what is required.

### **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. Weaker students tended to give only a 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. It is noteworthy how many essays contain 3998 or 3999 words. Supervisors should emphasize 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 following a non-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 as a way of keeping the word count below 4000. Candidates should be reminded that new information should not be introduced in the appendices, as examiners are not required to read them.

### **Criterion J: abstract**

It is the supervisor’s responsibility to explain to a student how to write an abstract. A disappointing number of students were unable to write an abstract which contained the three required elements as outlined in the EE guide to obtain the maximum of two marks. Sometimes the research question in the abstract did not match the research question given in the introduction and the description of how the investigation was undertaken often lacked sufficient detail.

## Criterion K: holistic judgement

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

## Recommendations for the supervision of future candidates

- All supervisors should ensure that they are adequately trained before they undertake the task of supervision.
- Supervisors should ensure they are using the most recent version of the EE guide available on the OCC.
- 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.