CHEMISTRY

Overall grade boundaries

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

The range and suitability of the work submitted

The number of candidates submitting extended essays for the November session is considerably smaller than for the May session. Even so, there was an impressive range of essay titles and a good number that received an 'excellent' grade. The most common titles involved some aspect of vitamin C analysis. Other common titles included a comparison of biodiesel with diesel or gasoline as an alternative to fossil fuels, the determination of the aluminium content of underarm deodorants and questions involving the preparation or analysis of aspirin. One of the most interesting essays this year looked at how the iron content of biltong varies with temperature and attempted to relate the findings to the Voortrekkers' susceptibility to disease during the Great Trek. Perhaps the recent introduction of the Food Chemistry option in the programme provided the ideas for some of the essays and there was one particularly good essay that looked at the total antioxidant ability between organic and locally grown garlic. Most titles chosen had the potential to produce a suitable research question. However many of the research questions stated were either too broad or not clearly expressed to be treated effectively within the word limit. Some essays seemed to lack imagination with research questions that were effectively just data collection, for example finding the amount of aspirin in a number of different commercial tablets, rather than having any real research question such as "the effect of X on Y". Almost all did choose suitable areas of investigation which could lead to at least a 'satisfactory' grade. A few candidates chose topics that were either far too broad or were too simplistic with the result already being known. One of the poorest essays which asked "Which has the greatest effect on rate – concentration, surface area or temperature" fell into the second of these categories. The best essays were the ones where the candidates used their own initiative by developing new methods or apparatus which was clearly under their own control and where there was a genuine interest in the work being covered.

Clearly a sharply focused research question is the key to writing a good essay. However even with a good research question many candidates did not then produce a suitable essay. Too many candidates (with perhaps the encouragement of their supervisors) wrote what were essentially laboratory reports rather than essays. Sometimes it seemed as if they were addressing the internal assessment criteria rather than the extended essay criteria. Headings such as Design, Data Collection, Data Processing etc. were commonly present. Often missing were the context, significance and worthiness of the research question, including well documented background information, and a reasoned argument. Many candidates spent much time analysing the uncertainty of the equipment used without questioning underlying chemical assumptions or realising that an experiment that has only been performed once is not scientific.

Candidate performance against each criterion

A: research question

Most candidates did state the research question clearly in the introduction, although it was not always sufficiently focused. When formulating their research question candidates should ask themselves whether or not it could be narrowed down even further and should avoid giving more than one research question. In a few cases the research question was assumed to be the same as the title of the essay as no specific reference to it was made in the introduction.

B: introduction

This was the first time candidates were actually required to write an introduction. Generally this criterion was a help to those writing chemistry extended essays as it directed them towards explaining the context of the research question. Good candidates handled this well and were able to explain clearly the significance of the topic and why it was worthy of investigation. However many of the weaker candidates seemed to have little idea of how to put the research question into context. It was not unusual to find an introduction with no cited references or genuine background information.

C: investigation

Candidates who are carrying out their own experimental work still need to consider the work of others in their chosen field and discuss the merits or otherwise of the possible different methods that can be used and to explain why they have settled on a particular approach. One of the reasons why vitamin C is so popular is that it lends itself to analysis in a school laboratory. Too often candidates just quoted a traditional laboratory method (e.g. titration involving iodine) for their own investigation without discussing any alternatives (e.g. DCPIP titration or colorimetric methods) or ways in which they had adapted the method to address their own situation. Candidates who gather all their data from elsewhere need to show that an imaginative range of resources has been consulted – too often this was lacking with the essay being little more than a précis of a single resource.

D: knowledge and understanding of the topic studied

If there was a widespread weakness, it was to omit to explain the theory behind techniques and to a lesser extent not to make it clear that the Chemistry behind the research question was understood. One candidate wrote a whole essay on the merits or otherwise of a simple ‘homemade’ electrode and omitted to even state what the electrode was made of, or to explain the underlying theory of how it worked. Some candidates also simply gave an equation or formula for calculating the result from their chosen method without showing its derivation.

E: reasoned argument

This is the criterion that clearly distinguishes the excellent extended essay from the rest. Those candidates that scored highly produced a convincing argument in relation to the research question. These candidates set out their ideas clearly and logically and analysed the strengths and weaknesses of their claims. Candidates who wrote mainly descriptive or narrative essays scored poorly on this criterion.

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

There was considerable variation in performance on this criterion. The best looked at the underlying assumptions behind their method and tried to determine the source of real weaknesses and uncertainties. Too many candidates worked out percentage uncertainties as they have been taught for the internal assessment without looking critically at the source of their information. For example, if three significantly different titration results are given as raw data for exactly the same experiment then the source of the problem is more likely to be the candidate's weakness at manipulative skills rather than the uncertainties associated with the equipment. Some candidates seem to have difficulty in distinguishing between trivial uncertainties and more relevant uncertainties. The uncertainty associated with using a balance that masses to + or – 0.001 g when weighing masses of 10.000 g or more will have negligible effect on the uncertainty of the final answer. Perhaps even worse is that some candidates based their whole scientific argument on a single result. Many candidates only looked at the uncertainties due to their own work and omitted to question the validity of the Internet sources they used. There were several cases where wrong equations or formulas were taken from Internet sites with no attempt made to analyse whether or not the information was correct chemistry.

G: use of language appropriate to the subject

The language of chemistry is complex and some candidates demonstrated a very good grasp of it. For example, they used IUPAC or common names consistently throughout the essay rather than changing them according to which references they were using. They included the correct units and correct number of significant figures when necessary and labelled the axes on graphs correctly. They used correct structures for organic compounds and ensured that all equations were balanced and accurate. Weaker candidates did not comply with some or many of these points.

H: conclusion

There was considerable variation in performance on this criterion. Common reasons for not scoring highly were: including new material not consistent with the evidence presented in the essay; failing to be consistent with the evidence presented and not including unresolved questions. Perhaps because of the internal assessment criteria some candidates wrongly included an evaluation of their experimental method in their conclusion.

I: formal presentation

Most candidates 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. Almost no candidates exceeded the 4000 word limit for the body of the essay. 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. Although they were not penalised, candidates should be made aware of the fact that the abstract is not part of the extended essay itself and should not appear in the table of contents.

J: abstract

In the extended essay guide it is strongly recommended that supervisors give advice to candidates on writing an abstract. Some benefited from this advice and wrote clear and succinct abstracts. Many however seemed to have little idea of how to write an abstract and missed out some or all of the key elements. Some, for example, gave almost no information on how the investigation was undertaken. Rather surprisingly another common error was for candidates to include a research question in the abstract which was different to the one stated in the introduction. Some candidates scored zero for writing more than 300 words.

K: holistic judgement

Unless the essay was almost totally descriptive candidates tended to score at least two of the four marks for this criteria provided they showed some personal involvement and understanding. The evidence written by the supervisor on the cover sheet was taken into account here. The best supervisor's reports included some information about the candidate's responses in the *viva voce.* Examiners found this very helpful as an aid to assessing qualities such as depth of understanding and insight.

Recommendations for the supervision of future candidates

- Schools must ensure that all teachers acting as supervisors are adequately trained.
- Supervisors must ensure that candidates 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 candidates are fully conversant with what is expected of them and are familiar with the assessment criteria.
- Ensure that candidates have access to some past chemistry extended essays which have been graded excellent.
- Encourage candidates to carry out a risk assessment for any practical work they undertake.
- Check that the method(s) used by the candidate 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 candidates 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 candidates to think critically and not mindlessly follow the internal assessment criteria.
- Encourage candidates to be innovative and 'take a risk'.
- Encourage candidates to use other resources as well as Internet websites.

- Provide guidance on documenting sources, writing a bibliography and an abstract.
- Discourage candidates from working on sophisticated topics chosen by others where the candidate cannot demonstrate depth of understanding or personal initiative and involvement.
- Write helpful supervisor's comments on the cover sheet and include some reference to the *viva voce*.
- Ensure that the candidate 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.