Jonathan Clayden
Professor of Chemistry

School of Chemistry
University of Bristol
Cantock's Close
Bristol BS8 1TS
UK

email j.clayden@bristol.ac.uk
tel +44 (0) 117 331 8054
fax +44 (0) 117 927 7985

www.claydenchemistry.net

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Professor Sir Leszek Borysiewicz
The Vice Chancellor
University of Cambridge

Dear Vice Chancellor

External Examiner's Report, Natural Sciences Tripos: Chemistry 2018-9

This is my final year as examiner in Chemistry, and the report below covers aspects of the examining, marking, project and practical work, and feedback from the students.

Standards

I was sent papers for Part II and Part III Chemistry and asked to comment on the material. I was given plenty of time to provide a response, and on working through the papers I found that they were of higher standards of readiness than I had received in previous years. I found very little in the way of errors, and made just a few suggestions for improvements, all of which were either implemented or rejected with sound explanations. Suggested answers to the problems were provided, and again unlike in previous years these all corresponded well to the final version of the questions. My view is that the questions are in general challenging, and certainly questions tend to be characterized by a high level of difficulty throughout, without the graded structure that would be more typical at other institutions. There was however some considerable variation in difficulty between questions on different parts of the course. Indeed, sometimes I found it difficult to discern differences between the difficulty of Part II and Part III questions. In discussion with the students, it is clear that some are aware of this, and steer clear of courses they consider the exam questions to be difficult. This is particularly true for theoretical chemistry, where the number of answers is extremely low.

The high level of specialization is characteristic of the unique course at Cambridge, and certainly required students to perform at a higher and more specialized level in these final years that at most other institutions, after a much broader first two years. This is something very characteristic of the course, and a particular strength at Cambridge. In previous years we have noted gaps in more fundamental understanding of some areas of chemistry, even among high performing students, which could be a concern. In contrast, this year, all of the students we examined orally performed well across the fields of questioning.

Some answers required a large amount of writing or drawing, and it would certainly be worth instituting a system (Bristol uses this) where a colleague is given the question to answer and times (with a stopwatch) themselves writing, longhand, what is required. The students in discussion felt that some questions left no time to think, given the amount of written material. The short question paper came in for particular criticism in this regard.

Marking

The examiners' meetings were efficiently organized by Dr Keeler, and papers, projects, and other information was made really available to the examiners. Overall, I was fully satisfied that the course and examining process is carried out with a high level of rigour, but with one area of concern detailed below.

I inspected the marking of a number of papers, especially those of students lying close to borderlines, and I found that in general the marking was clear and in many cases markers have provided very useful annotations on the paper indicating where marks had been lost or gained.

In one or two cases it was not clear that marks had been correctly assigned for answers that seemed fully appropriate, and where the students were close to borderlines we allowed some credit for these. In addition I found one paper in which a page of answer at the back of the booklet had received no marks, and it was not clear whether the markers had seen this work or assigned credit; in another paper it seemed that one part of a question had not received any form of mark, even though it seemed correct. After the examination meetings were complete, another matter of incorrect arithmetic was brought to our attention by the Department, which had the consequence of bringing a candidate to close to a borderline (see discussion on borderlines below)

These matters are a significant concern: it is very easy for students to be disadvantaged by busy examiners failing to turn to a final page, or making a mistake with arithmetic. In every institution in which I have worked or examined in the last 5 years administrative staff will check that some form of mark has been assigned to each page and that the marks have been correctly added, indicating with initials or a tick on the front of the booklet, otherwise querying possible errors with the markers. This is good practice in assuring that students are given the credit deserved for their answers and the errors found this year (plus those which may remain undetected) mean that a check of this kind is essential. Clear guidance should be given to examiners to make some form of mark on each page and to assign a written mark for every section part, even if it is 0.

In the case in the interdisciplinary papers not only was there no indication of a double-check of arithmetic, but there were no marks visible at all, making any form of check impossible and allowing no way of telling how the mark assigned had been arrived at. This makes the job of the external examiner very difficult, and to some extent pointless. We have previously been told that it is university policy for markers not to annotate papers to indicate how marks have been arrived that. If this is the case, it serves no purpose other than to disadvantage students, and I would strongly recommend that this advice is changed.

Practicals and Projects

Apart from the examinations, marks feeding into the final degree classification include those from the Part II practicals and Part III research projects. The normalization of practical marks means that most students fall into a very narrow band of marks, with the effect that the practical marks tend to lower the overall marks of the high-performing students and raise the marks of the low-performing students. I would recommend that the department revisits its mode of assessment of practicals, particularly with the criticism of this from discussions with the students [see below].

I viewed a number of project reports, again particularly those at the top of the class list and those from students falling near the borderline. Cambridge terms are short, and this limits the amount of time that students are able to spend working on their projects. Nonetheless the project write-ups are in general much shorter and less detailed than would be typical for final year research work. In one or two cases the results were presented in no more than 4-6 pages. In a short project the introduction must necessarily be concise, but in some cases it was difficult to discern from the introduction whether the students really understood why they were doing the research work and what implications were. The projects did indeed vary quite significantly in length and in detail, and I would propose that the Department should give more detailed guidance to students and indeed to supervisors what is expected from a project report to allow fair comparisons to be made when marking.

The project marking appeared to be fair, if necessarily subjective. Previous recommendations to provide a robust method for assigning supervisory marks appear to be working, but there are still some improvements that could be made. In particular, the marks assigned for intellectual contribution from the student is narrowed by the algorithm, where in fact this could provide a very useful way of distinguishing the best and most engaged students from those who work hard but do not provide their own significant scientific input. In discussions with the students, the nature of this 'tick-box' marking came under considerable criticism, partly through misunderstanding, and I would suggest that the Department seek to disseminate clearly to the students how the assessments are made, and expand the narrative explanation of the mark assigned by the supervisor.

Borderlines and Interviews

The borderlines between the classes had been fairly set, and the examiners considered in some detail those candidates whose marks brought them very close to 69.5 or 59.5.

At Part III, after looking at papers and project, we promoted one candidate, on 69.41, without viva;

A few days after the examiners had met, it was brought to our attention that another candidate had been incorrectly assigned 5 marks for one question instead of 15.
After discussion, and having reviewed the paper and project marks, we decided that had we had the opportunity to consider this candidate we would have interviewed them. On this basis, given the performance of the other interviewed candidates we recommended this candidate be promoted to first class.

At the lower borderline, there was a natural eak between 60.64 and 59.01, and although we considered the papers and projects of the four candidates below this borderline in some detail, we did not propose raising any to 2i.

At Part II, we considered six students just below the borderline, of whom we decided to promote two (69.36, with three first class paper marks, and 69.05 but with some marks possibly not assigned correctly) without interview.

The sixth of the group showed no strong case for interview in their marks, and was not promoted.

At the lower borderline, we considered three students but there was little compelling evidence to make a case for them to be promoted.

Feedback from the students.

The examiners spent some time discussing the course with a group of students from the Part II and the Part III cohort. All expressed strong views about the course. The main points raised were

• Variability in quality of lecture material – particularly from lecturers who used the blackboard and whose lectures were therefore not captured.

• Clashes between lecture and practical courses, particularly where lecture material is not available online.

• Time pressure in the exams – especially in the short questions. [We noticed on inspecting the answers a number of cases where evidently able students had clearly had insufficient time to answer a question]

• Courses which should stand alone but which nonetheless have considerable input from other courses.

• The distribution of topics among B and C courses – most students found they had plenty of choice of B courses but struggled to select C courses.

• The cancellation of one particular course (C2) after choices had already been made and after B courses had started, narrowing choice considerably for some students.

• Concern about the robustness of project marking which is perceived as being ‘by one tick on a tick sheet’ – dissemination of how projects are marked and what sort of research practice merits high marks would be helpful here.

• Variability (or lack) of contact with academic supervisors. It is good practice to have several points in the project where a formal timetabled meeting allows both parties to raise concerns. In Bristol we also timetable two meetings with a second assessor during the project to allow the students to raise issues they feel they cannot bring to their supervisor, to allow them opportunity for feedback on broader matters connected with the project, and to give them experience in explaining their research to a non-specialist.

• Lack of clarity about what to do when a major incident (in this case a family bereavement) occurs. Students experienced a disconnect between their college DoS and the department about how missed practicals could be compensated, for example. As examiners we were assured such procedures were in place, but the student concerned seem to have suffered unnecessary additional trauma in this case.

• Marking of practicals, which was felt to be more like a theoretical viva than anything to do with the work done in the lab.

• Lack of preparation for practicals, which turned them into an exercise in following a recipe and getting through the tasks as fast as possible. (I have mentioned previously that development of an effective online pre-lab introduction, as is used in Bristol’s Dynamic Laboratory Manual for example, would be very beneficial here).

• Overall there was a general feeling that the course requires a large amount of memorization of material, and that there is immense time pressure to get things finished. This was of course a self-selected subset, but some said they felt so stressed by the whole experience they were pleased to be leaving science. One or two expressed an alternative view, that they had enjoyed the challenge and the ability to choose the areas to work in.

Summary

The Cambridge course is rigorous and demanding, and requires much of the students. Later years are highly specialized, and students need to be resourceful in negotiating a way through their choices of courses and projects. There are a number of aspects of course delivery that the department could consider to improve the experience of the students. The assessment methods are sound and robust, though some improvements could be made to details.

Yours sincerely

UNIVERSITY OF CAMBRIDGE

REPORT COVERSHEET FOR EXTERNAL EXAMINERS

Name and Title:	Professor Ivan P. Parkin.
Email:	I.P.Parkin@UCL.AC.UK.
Home institution:	University College Londk.
Award or subject area examined:	Natural Sciences (Chemistry)
Associated University of Cambridge Faculty/Department:	Chemistry

Please tick the statement which most closely reflects your views of the examinations. TICK HERE

The standards set for the award(s) or subject area(s) above were appropriate. The processes for assessment, examination and the determination of awards were sound and fairly conducted. **Any recommendations made are for the purposes of enhancement to the course and its assessment.**	☐
The standards set for the award(s) or subject area(s) above were appropriate. The processes for assessment, examination and the determination of awards were sound and fairly conducted. **HOWEVER, there are some risks to the future assurance of the course and its assessment, as outlined in my recommendations.**	☑
There are immediate concerns or risks relating to the standards set for the awards or subject areas above and/or the processes for assessment, examination and the determination of awards. **These require immediate action on behalf of the University to prevent reoccurrence in the next set of examinations.**	☐

Please tick as appropriate:	Yes	No	N/A
Are you satisfied that you received sufficient programme materials (programme handbooks, regulations, and marking criteria)?	☑	☐	☐
Are you satisfied that you were consulted adequately on draft examination papers, and that the level of questions was appropriate?	☑	☐	☐
Were you given sufficient opportunity to scrutinise the general standard and consistency of marking of examination scripts and coursework?	☑	☐	☐
Have issues raised in previous report(s) been addressed to your satisfaction?	☑	☐	☐

Please return this form, with your full report, to: vcexternalexaminers@admin.cam.ac.uk by July 31st for undergraduate examinations, 1st October for Masters Degrees, and 12th October for resits.

Or: The Vice-Chancellor, University of Cambridge, The Old Schools, Cambridge, CB2 1TN.

Please also forward copies to your Chair of Examiners.

This form can be downloaded from: http://www.admin.cam.ac.uk/offices/education/examiners/eecoversheet.pdf

NOTES FOR EXTERNAL EXAMINERS

Submitting reports to the University

1. All External Examiners are required to submit a written report at the conclusion of their involvement with the examination, and may comment on any aspect of the examination, including the fairness of the assessment and the standards of the candidates for the part of the examination that they are involved with.

2. Reports should be addressed to **the Vice-Chancellor of the University**; payment of the fee and expenses is conditional on receipt of the report.

3. Full guidance on the roles and responsibilities of External Examiners is provided on appointment. It can also be found at: www.admin.cam.ac.uk/offices/education/examiners/external.html. All External Examiners will receive feedback on their full report in line with University policy.

Report structure and content

4. The written report is made available for discussion by the appropriate Faculty or Department concerned with the examination and by the General Board's Education Committee. Reports are usually considered by the senior committees of the relevant Faculties and Departments. These committees include student representatives and reports should therefore be written in a form that avoids discussion of individual candidates by name or candidate number.

5. There is no University standard reporting template, but reports are expected to cover four main areas:

   - the extent to which standards are appropriate for the examination and the qualification;
   - the extent to which standards are comparable with similar programmes in other UK institutions with which you are familiar;
   - the extent to which processes for assessment, and the determination of awards were sound and fairly conducted;
   - any good practice which you feel could be usefully identified for further dissemination.

6. Reports may also include commentary on the following topics, at the discretion of the individual External Examiner:

   the examination

   - the design, structure and marking of the examination;
   - the procedures for assessment, including the basis and rationale for any comparisons of standards made;
   - the strengths and weaknesses of the students as a cohort;
   - whether your role is appropriate for the examination to which you were appointed, including whether or not you had sufficient access to any material needed to make the required judgements;

   the course

   - the curriculum, its aims, content and development;
   - resources as they impact upon student performance;
   - the quality of teaching and learning, which may be indicated by student performance.

General points

7. Submitted reports will only be used in accordance with General Board policy (for the monitoring of academic standards within the institution) and in line with current legislation.
8. Consistent with Indicator 4 of the QAA's UK Quality Code (Chapter B7), all External Examiners' reports will be made available, in full, to all students, with the sole exception of any confidential report, made directly and separately to the Vice-Chancellor.
9. The University shall own the copyright in the reports made to them by External Examiners; in accepting the appointment, External Examiners assign all present and future rights relating to the reports and any other materials created in relation to their appointment. External Examiners will also waive any rights including moral rights in connection with those materials.
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11. External Examiners are advised that, under the Data Protection Act 1998, the University will process personal information on its External Examiners.
12. External Examiners are also advised that, under the Freedom of Information Act, the University may be obliged to disclose details of their report on request.

External Examiners Report

Professor Ivan P. Parkin, UCL

On the University of Cambridge Natural Sciences Program (Chemistry)

The department were very welcoming to the external examiners. The paperwork was very well laid out and the guidance notes extensive. The accommodation, access to students, examiners dinner and willingness to answer questions were all first class.

The correspondence over the initial exam questions was prompt and the questions were provided with good model answers. My queries were quickly dealt with and I was confident that the examinations were of the correct standard and that they stretched the most able students. Last year I had an issue with the supermolecular chemistry questions- which were too difficult to draw. I was pleased to see that the questions this year were more accessible and easier to draw.

I am concerned about the lack of second marking or checking of exam marks. On some of the borderline candidates papers the externals noted that some correct questions were not assigned a mark. The externals were also contacted after signing the exam paper work on an appeal from one student where a further 10 marks were found- the examiner put down 5/20 rather than 15/20. If a second marking procedure was in place this error would more than likely have been picked up. This error caused the candidate to change a grade boundary. I strongly suggest that exams are second marked or failing that a member of professional services checks every finals paper summation of marks.

The external examiners carefully scrutinised candidates at the borderlines and looked at exit velocity and number of examinations at first class level to decide on which degree to recommend. Further we gave viva's to four students where we needed further information.

I took some time to look into the assignment of the marks to the practical component in part 2. The marks are aggregated from a variety of sources and the standards of the experimental reports I looked at was generally good. The marks for the experiments come almost exclusively from the write up and the understanding of the experiments. I would strongly urge that marks are assigned to assess the practical skills shown- for example by looking at yields, mpt, IR, UV-Vis and NMR spectra where appropriate. I was also concerned at the scaling introduced to the practical marks which reduced everyone's scores and reduced most of the scores of the most practically able students. My advice would be to change this system and have confidence in your ability to assess the practical component. Every other university I know in the UK assess the lab skills in this way. I am also concerned about the bunching of the lab marks- virtually all students get between 75-63%.

I had the opportunity to look at a variety of final year projects. These were generally of a high standard. However, there was a big difference between the presentations and numbers of words used. Some reports were substantial (ca 5000 words plus appendices) and others were ca 2000 words. I think some further guidance and standardisation here would help.

I personally don't like the way that grade descriptors D, C, B, A are used and fitted to a mark profile. This appears to be because the department are concerned about giving too many first class degrees.

I think that the program should think about the quality of the students against the standards and not be as concerned about giving more than 40% first class degrees. If the students deserve this degree by being at the correct standard they should be awarded that class of degree. The system is set at the moment to down play project and practical marks and puts emphasis on final year exam performance. The various methods of marking mean that the students are largely peer-compared and the mark range nudged so that around 40% of students achieve this mark. This is not the same as at other universities in the UK. Further students are better qualified and taught when they come to university now and by peer normalisation (which is effectively what Cambridge does) this does not allow improvements in absolute quality to be measured or rewarded.

The examination board was significantly expanded this year- which was welcomed. However not a single female member of staff attended the examinations board or attended the examiners dinner. I think efforts need to be made to broaden the attendance at the examination meetings.

The final year marks seem to favour the male candidates with 5% better outcomes. This is a cause for concern and is likely to be down to how the exams are structured and concentrated.

I enjoyed meeting with a number of students. They were nearly always positive about their experience at Cambridge. One student brought up issues , and not knowing where to turn to for help and support. felt college tutor let down. I think perhaps some clearer guidance would help (perhaps every year at the start of the year?) as to where to go to in times of trouble.

The students commented on the variability of the lecture handouts and quality of teaching. The head of department was seen as an exemplar of best practice (perhaps that could be shared more?).

Your sincerely

Ivan P. Parkin.

Ivan P. Parkin

Department of Chemistry
Stockton Road
Durham
DH1 3LE
U. K.

Dr. Colin D. Bain
Professor of Chemistry

The Vice-Chancellor,
University of Cambridge,
The Old Schools,
Cambridge, CB2 1TN

Dear Vice-Chancellor

External Examiner Report on the Natural Science Tripos: Chemistry

It was a pleasure and an honour to be invited to serve as an external examiner for Chemistry at Cambridge University. My first year as an examiner has been an opportunity to familiarise myself with the undergraduate curriculum (which I am pleased to say has evolved massively since I myself was an undergraduate at Cambridge), the structure of the course and the assessment processes. James Keeler and his colleagues in the Department were gracious with their time in helping me to navigate the sometimes complex structures surrounding the options available to the students and in responding promptly to my queries.

I would like to thank the staff of the Chemistry Department for the effort that went into preparing the examination papers and model answers on time and to a very high standard. They responded quickly and positively to the small number of comments that I made on the papers. The procedures for the visit of the external examiners were also exemplary with relevant material easily available and clearly assembled for the examiners; any queries were rapidly answered.

In this, my first report, I will be relatively brief in affirming that the Chemistry assessment within the Natural Sciences Tripos is rigorous and fair and that the standards set for the award of degrees are appropriate. I commend the quality of the students and the quality of the teaching as evidenced by the assessed work and particularly in the performance of candidates in the vivas. I highlight below three suggestions for improvement that would benefit from prompt consideration. There are other points of lesser urgency which I will reflect upon over the next two years and comment upon, if appropriate, in subsequent reports. This year I focus my report on the assessment processes; in future years I will reflect on the curriculum.

Extent to which standards are appropriate for the examination and the qualification

Cambridge attracts some of the most able students from around the world. Combined with the absence of any appreciable tail, this allows the academic staff to teach at a pace and depth that other UK universities (with the possible exception of Oxford) cannot contemplate. The examinations reflect this standard: the questions demand a high level of subject-specific knowledge and understanding and the ability to recall and analyse information under considerable time pressure. The marking is robust but fair and the grades awarded at both Part II and Part III are well-earned by the students.

Extent to which standards are comparable with similar programmes in other UK institutions with which you are familiar

Tel: +44 (0)191 3342138 Fax: +44 (0)191 3342051 E-mail: c.d.bain@durham.ac.uk

I examine Chemistry at Durham and have been external examiner at Bristol, Warwick and St. Andrews in recent years. The standard of the examinations is at least as difficult as those at these comparator universities. The standard of performance required to achieve a first-class or upper-second class degree is at least comparable to these universities.

Extent to which processes for assessment, and the determination of awards were sound and fairly conducted

In general, I was very happy with the processes for assessment and determination of awards. The conduct of vivas is rare now in UK higher education but I personally feel that they are a valuable component of the assessment process and for validation of standards. This year, a number of students were promoted to an appropriate degree level where an algorithmic process might have unjustly penalised them.

I would draw the attention of the Department to three areas for improvement.

(i) The process for classifying awards at Part III assigns a high level credit to a small number of written exam papers, with much less credit assigned to performance in the second or third year of study, compared to other UK universities with which I am familiar. One consequence is that any error in the marking process can have a material influence on the final classification. We looked at the papers of one candidate and found that a single part of a single question had not been awarded a mark. Correcting this error changed the classification from 2:1 to 1. At most universities a small marking or administrative error is unlikely to have a material influence on the final grade; not so at Cambridge. Consequently, the Department should consider instituting procedures to ensure that all sections of all questions have been assigned marks and that the partial marks have been totalled correctly in the mark entered into the spreadsheets.

(ii) While the overall standard of the questions was high, there were marked variations in difficulty between different courses. The theoretical chemistry questions were particularly demanding, resulting in a very low number of answers per question compared to other areas of chemistry. The mark distributions were not unusual on these questions (though the statistics are poor), suggesting that the students who attempt these questions are among the more able students. Data were not available to test this hypothesis. I recommend that the Department look at cross-correlations of paper marks with overall marks to determine whether particular papers are relatively easy or difficult for the candidates. More generally, having theoretical chemistry papers that are clearly perceived by the students as being difficult discourages students from studying this important branch of chemistry. Assessment should not skew student choice.

(iii) I commented before the examinations that I felt that Paper 2A and 2B at Part I level (in which all questions are compulsory) placed the candidates under unreasonable time pressure, giving the students no time to think about a question or to attempt different routes if the initial alley proved to be a blind one. This view was confirmed in discussions with students who found Paper 2 highly stressful due to the time pressure under which they were placed. (I did not look at Paper 1, which has a similar structure). The duration of Paper 2 is 2 hours 50 minutes, including 10 minutes reading time. It is not obvious what is the purpose of reading time when all the questions are compulsory. I would recommend that the students are given the full 3 hours to answer the paper (with no increase in the length of the paper or the questions therein), without a restriction on writing in the first ten minutes.

Good practice which you feel could be usefully identified for further dissemination

There are two practices to which I would draw attention.

(i) The meeting we had with ~15 students at both Part II and Part III was invigorating and informative (the students would have talked for hours given the chance!). If this is not standard practice in other degree courses, I would suggest that it should be generally adopted.

(ii) Advanced level courses (particularly Part III) can be difficult to examine in conventional timed paper examinations. Many examiners at other universities default to descriptive questions that test recall more than understanding. I was impressed that the examination questions set at Cambridge almost invariably had a problem-solving element that makes them more discriminating and a better test of the critical and analytical skills that mark out a first-class candidate.

In summary, Chemistry at Cambridge offers a demanding and high-quality course that is rigorously and fairly assessed. The standards are appropriate for the qualifications awarded.

Yours sincerely

Professor Colin Bain