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Home institution: University of Leeds
Award or subject area examined: Part II and Part III 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. <b>Any recommendations made are for the purposes of enhancement to the course and its assessment.</b>	<input checked="" type="checkbox"/>
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<b>Please tick as appropriate:</b>	Yes	No	N/A
Are you satisfied that you received sufficient programme materials (programme handbooks, regulations, and marking criteria)?	x	<input type="checkbox"/>	<input type="checkbox"/>
Are you satisfied that you were consulted adequately on draft examination papers, and that the level of questions was appropriate?	x	<input type="checkbox"/>	<input type="checkbox"/>
Were you given sufficient opportunity to scrutinise the general standard and consistency of marking of examination scripts and coursework?	x	<input type="checkbox"/>	<input type="checkbox"/>
Have issues raised in previous report(s) been addressed to your satisfaction?	x	<input type="checkbox"/>	<input type="checkbox"/>

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

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

27<sup>th</sup> July 2015.

**Subject: External examiner's report for Chemistry, Parts II and III**

Dear Vice Chancellor

This has been my third year as an external examiner for the Department of Chemistry. As in the last two years, my overall impression is that both Parts II and III are rigorous, challenging parts of the Natural Sciences Tripos. The level of assessment is appropriate, both in the examinations and the Part III projects, and the strong performance of the student cohort is justified. This report is now broken down into sections following the suggested guidelines.

*The extent to which standards are appropriate for the examination and the qualification*

The absence of modularity in the exam structure, and the degree of mathematical problem-solving, ensures that the Cambridge course is challenging. Candidates for Part II and III are required to answer questions with significant problem-solving components - generally, around 30% of the marks are awarded for problems that go beyond material covered in lectures and supervisions. A large degree of choice is permitted on most of the exam papers, which encourages some degree of specialisation into biological, organic, inorganic, physical or theoretical chemistry. It was interesting to see that in the Part III exams there was a more even spread of answers across biological, organic, inorganic and physical compared with 2013-14. Even in theoretical chemistry, which was relatively unpopular last year, there has been a welcome increase in the probability of students attempting a question (and, as we saw last year, the theoretical questions are answered relatively well).

There are a number of positive aspects to the examination process: the exam structure tests accumulated knowledge in both years; the indicative mark scheme for the sections of questions allows flexibility in awarding credit; and the 3-hour exam format also allows longer, more testing questions to be set.

*The extent to which standards are comparable with similar programmes in other UK institutions with which you are familiar*

During the last six years I have examined at three other Russell Group universities, although at these institutions the students had done a 3 or 4-year degree in pure Chemistry rather than Natural Sciences. One result of spending less time doing chemistry is that the Cambridge students acquire deep knowledge in narrow areas of chemistry, but sometimes lack breadth. This was borne out during the *viva voce* exams, where (in my area of physical chemistry) there was a lack of general knowledge in kinetics and spectroscopy. The organic and inorganic externals found the same thing. On the other hand, the students have wider knowledge in other physical or biological sciences than students who have only studied chemistry. Given that a lot of the excitement in chemistry is at the interfaces with other sciences, this is an advantage.

The fraction of students achieving 1<sup>st</sup> Class results at Part III (48% of the cohort, down slightly from 2013/14) is higher than in many other research-intensive universities, where a typical figure would be around 40%. In my view these Part III results were fairly earned. It is clear, from a correlation analysis produced as part of our briefing, that marks from practical work and projects are not offsetting lower theory marks to produce high overall results for the cohort of the students.

*The extent to which processes for assessment, and the determination of awards were sound and fairly conducted*

Dr James Keeler, Director of Teaching, sent out the examination papers and model answers in sufficient time to scrutinise them properly. Although the standard of model answers was higher than in my first year, there is still a wide range in the style and clarity of the answers. For example, some of the theoretical question answers were scans of what appeared to be pages handwritten in pencil, which were barely legible. Some answers confusingly contained sections which had been omitted from the questions at the scrutinising stage. Nevertheless, the exam papers were produced to a very high standard with few typographical errors. The comments I made on the papers were responded to in detail by Dr Keeler and satisfactorily addressed by the setters of the exam questions.

At the final assessment meeting, Dr Keeler provided a briefing to accompany the extensive notes and statistical analysis on both Part III and Part II. Apart from a small number of errors on the exam papers that were dealt with at the start of the exams, it seems that the examination process proceeded smoothly. The mean marks on the Part III papers were within 2% of the desired 65%, and so did not require further adjustment. The Part III project counts for 25% over the overall total, and so it is important to assess this as fairly as possible. The supervisor's assessment of the student's performance of the project contributes to the final project mark, but the project dissertation is independently marked by two other members of staff, who also interview the student. This process - which limits the supervisor's contribution to the overall assessment - is a sound practice which avoids mark inflation, and should be encouraged in other universities. The average project mark of 72% seemed fair, based on our reading of a selection of project reports and the vivas with the Part III students. Importantly from the externals' point of view, the justification of marks - for competence, achievement etc - is clearly laid out, as well as an explanation of how a final mark is arrived at in the event of a disagreement between the two markers.

At Part II, the average paper scores were within 1% of the desired 65%, and the average practical mark was 69% - again, a balanced outcome, and very close to the 2013/14 results.

The exam questions seemed to be fairly marked based on a pretty detailed sampling. As I stated last year, it would be useful if there was more uniformity in the way markers annotate the scripts to

indicate how marks were arrived at in certain circumstances. For instance, showing how credit is awarded when a small mistake in an early part of the question leads to the rest of the question being wrong because of error carry-through. Only some markers annotated the answers to show that this was being done. Markers should also indicate the total marks awarded at the end of each question, perhaps shown as  $x/y$  inside a circle. This sort of practice would have avoided one problem we found where one question on a paper had been marked out of the incorrect total.

The final meeting between the external and internal examiners within the Department of Chemistry proceeded efficiently and our advice on borderline cases was accepted without further discussion.

*Any good practice which you feel could be usefully identified for further dissemination*

Following our suggestion last year, Dr Keeler arranged for the external examiners to meet in private with around 15 students from Part II and III. This was an informal session for an hour-and-a-half over coffee, and attendance was open to all students from these cohorts. The students who came turned out to represent a wide cross section in terms of their interests, level of performance on the course, and career aspirations. They spoke quite freely to us, making a number of useful points which we then discussed at the subsequent exam board meeting. The students were uniformly positive about the supervision system, several stating that this was the best part of their course. There was also agreement that the standard of lectures is generally high and lecturers are approachable to answering questions outside of their lectures.

Several suggestions were made to improve the course: providing model answers for exam questions, as apparently is done in departments such as Physics and Engineering (even just numerical answers for the physical/theoretical questions would be welcome); a computer programming course with wider appeal, since only ~20% of the cohort do this at present; and making it even clearer to students that statistical mechanics is a pre-requisite to other theoretical courses in Part III. There were also several suggestions regarding the Part III projects: structuring the advertisements for the available projects by sub-discipline; providing more clarification about the procedure for allocating project supervisors, and completing this process early in the summer; scheduling the project vivas before Easter to avoid interfering with revision; and clarifying how project marks are moderated. There was also a request for extended Part II practicals, if timetabling would allow this. The externals found this meeting informative, and hope that feedback of this kind is useful to the Department. We agreed that it would be good to continue with this arrangement next year.

In conclusion, I would like to thank Dr Keeler and the other internal examiners for enabling the work of the externals to proceed so smoothly, and for their kind hospitality during the last three years.

Yours sincerely,

A handwritten signature in cursive script that reads "John Blane".

Name and Title: Professor Patrick Steel
Email: p.g.steel@durham.ac.uk
Home institution: Durham University
Award or subject area examined: Chemistry
Associated University of Cambridge Faculty/Department: Science / Chemistry

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

TICK HERE

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Please also forward copies to your Chair of Examiners.

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2nd July 2014

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

Dear Vice-Chancellor,

RE: External examiner's report for Chemistry, Parts II and III, 2015

This is my second year as an external examiner for the Department of Chemistry and again it has been a positive experience made very easy by the superb organisation of the whole examination process (papers, marks and meetings) by James Keeler and his team. We are specifically asked to cover the following points:

- *the extent to which standards are appropriate for the examination and the qualification*
- and
- *the extent to which standards are comparable with similar programmes in other UK institutions;*

Based on last year experience I looked forward to the challenge of review the examination papers. I was not disappointed – the questions I reviewed were challenging and require the students to display considerable depth of knowledge. Particularly at Part III the level of specialised knowledge required in some topics is impressive. However, given that students have an ability to select courses as to their strengths and interests this is not inappropriate. Although, at first glance the course seems to produce a relatively large proportion of first class degrees 48% of the cohort when the fact that the entrance level to Part III is set at the 2i/1 borderline this does not seem to be wrong. Moreover, when combined with the challenge of the written examination component I am confident that the top Cambridge student would be a top student any of the other leading UK chemistry Departments.

- *the extent to which processes for assessment, and the determination of awards were sound and fairly conducted;*

I remain impressed by the process of setting and reviewing of exams. It is an example of best practice - each question was supplied with model answer, a proforma that confirmed that it had been internally peer reviewed, and indicated the level of effort required by the student to answer the question. The quality of the question setting was good requiring relatively little clarification or comment. However, each comment I did make was considered in the response I received. At the examiners meeting we were presented with the ranked marked list and given a detailed briefing on the conduct of the exams and the outcome of the internal board meeting. All questions and papers had marked to the appropriate averages (Part III 64-67% with the project 72%; Part II 64-66% with continuously assessed course work 69%) although as noted last year this can mask class distributions (see below). We were then able to independently review the papers and project reports etc. Any queries we had were promptly addressed. We interviewed several borderline candidates before discussing all of this with the internal exam board. Overall this is an exemplary process and I am confident that the process is both robust and fair.

This year I gave myself a little more time to look through more of the papers. I was impressed by the students at the top of the class who had performed exceptionally well across the board. However lower down there is a tail reflected in the fact a number of students went down from Part II marks. I recall that last years Part II which had a high average but a bimodal distribution so perhaps this is not surprising. The marking seem to be robust but for

these weaker students it is not always easy to see where they have gain or lost marks. Some examiners are (over) zealous in accounting for this, most are fine but there remain a significant minority that have a policy of not commenting on the answer or showing how marks are awarded. In these cases it appears to be common practice to simply provide a total mark at the bottom of a page / end of a section and it is not even clear what the final break down of marks is for each of the sections. I am not concerned if the proposed marking scheme given in the model answer has been changed but I would like to be able to understand what was finally used (X marks from a total of Y for each section would be a start). In contrast(?) the marking system used for the projects appears to be both very robust and very clear (even if the average mark is relatively high). If there was a discrepancy between these and then the moderated mark was clearly identified along with a rationale for this revision. Having read several of the reports I am confident that the systems in place provide a fair measure of student effort and performance which is I think is important to any discussion on the weighting of these projects.

At Part III, we were highlighted one candidate who had an overall first class mark but no paper at Part III with a mark over 70%. However, having reviewed the project and associated assessment reports we were confident that the student was an exceptionally good and talented researcher who had found their niche and fully deserved their first class classification.

. At the more important 2i/2ii border there was a larger break in the aggregate marks and a review of the papers for these candidate suggested that the boundary had been correctly defined. Finally we were asked to review the marks for three candidates at the bottom of the class and felt that the recommendations proposed by the internal board had been correct and fair.

Collectively I was happy that the borderlines in the final ranked list are appropriately placed and that the degrees these student are receiving reflect their performance in the assessments and correlate with other students doing equivalent programmes elsewhere. Apart from the comment about marking schemes I have little to suggest about the assessment process, which I think is both good and fair.

- *any good practice which you feel could be usefully identified for further discussion / dissemination.*

One observation relates to specialisation / breadth that merits a bit of thought. One of the Part III interviewees commented that he had done no organic chemistry since before Christmas of his third year. This early specialisation struck me as a little undesirable and surprising. On analysis in Part III, students have a high degree of choice. There is the possibility to focus solely on just one branch of chemistry, which is possible with the option to answer six questions from eighteen in Papers 1 and four questions from three sections in Papers 2 and 3. My analysis is that if I include the biological chemistry component and supramolecular chemistry as an organic course there are 5 units in one block and 4 in the other so it is easy for students to miss out completely from studying physical, theoretical and inorganic chemistry. The alternative pathways also exist but are possibly slightly harder for the student to plan with confidence. In the final year of most chemistry courses a degree of focusing on strengths and interests is not unusual but what I think makes this a little unique is when one also considers Part II. In papers 1 and 4, Part II does effectively have a core course but this is relatively small and narrow. The level of choice in Papers 2 & 3 means that students can opt out of complete elements of the syllabus too early in their education. A bigger longer core is one solution and a second potentially simpler solution would be to give less choice in Papers 2 and 3 – four questions from four different sections or to cluster branches of chemistry into papers together such that it is not possible for students to drop complete sections of chemistry at this stage of their degree. I realise I mentioned this last year and accept that these students will get an MSci degree not an MChem but I think that it is something that merits some internal consideration.

This year we had the opportunity to meet a cross section of students from both cohorts. This was a pleasant occasion. The students obviously appreciate the opportunities they get from their time at Cambridge particularly the diverse training they receive through their supervisions. They also enjoy their research project but feel that they get less credit for it than they have to contribute. I am sympathetic for this view but appreciate the Department's concern not to overly influence the final result. I think the assessment system the Department has in place is very robust and could cope with a higher weighting. This could be tempered if the average mark was perhaps not so high. We had the same pressure and with careful moderation have managed to mark to a slightly lower average whilst still using as much of the range as possible. The second issue relates to student allocation of projects. It appears that some students did not yet know who their project supervisor was let alone what their projects would be about whilst others did and had already been able to start preparation. This does not seem correct and needs some sort of centralised oversight and speedier allocation.

One final thought, post the examination meeting in Cambridge, is that we spent quite a bit of time reviewing students at the 2i/1 level at Part II when most of these will be staying for a research project and actually therefore reviewing their progress is not essential. This year we were fortunate that there was no one at the lower borderline meriting serious discussion. For the 2i/1 borderline it might be construed as hard on the candidate if they have a viva when they don't need it or this could be considered as giving them an unfair advantage in terms of enhanced marks or added experience. I don't see why candidates who are planning to leave after Part II are not required to make this clear before the start of the exam period and those that do so following publication of marks simply forfeit their right to have an oral if they were at the borderline.

To conclude, I would like to reiterate my thanks to James Keeler and the other examiners for their efforts in making this such an efficient process.

With apologies for the (over) long report.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Patrick Steel', written in a cursive style.

Patrick Steel  
Professor of Chemistry

## External Examiners Report for Department of Chemistry, University of Cambridge 2014/15

Prof. L Yellowlees (Edinburgh)

As external examiner for Chemistry parts II and III I have had the privilege of working with Dr James Keeler and colleagues throughout the academic year 2014/15. At the outset let me say that standards, assessment and course material are all of a high standard that is comparable with similar programmes at UK institutions with which I am familiar (Edinburgh, Imperial, Manchester, Birmingham). Examination questions are testing and Cambridge students rise to the challenge very well reflecting positively on the standard of teaching and the quality of the student base. The assessment process relies almost entirely on a formal examination process apart from the final year project worth 25% of the final mark and laboratory/practical marks in earlier years. Within this system the determination of awards is sound and the assessment processes fairly conducted. The students understand what is expected of them and talk positively of their experience at Cambridge.

All necessary information was sent to me giving me plenty of time to comment and all my comments were responded to – this aspect of my role as external examiner was exemplary. The vast majority of the examination questions contained a problem solving element that was fair and which stretched even the most talented of students. I applaud the Department of Chemistry for their insistence on problem solving rather than memory recall. One area where help could be given to external examiners would be for question markers to annotate examination scripts such that we could understand where marks were allocated and satisfy ourselves that all parts of the answers had been noted and marked. I was pleased to note that the average mark for questions was good reflecting care on behalf of the internal examiners.

I particularly enjoyed meeting some of the students from both parts II and III. They had obviously enjoyed their time studying at Cambridge and were full of praise for Supervisions – something many of us outside Cambridge regard with envy. Specific points raised by the students at this meeting have been passed directly to James Keeler and colleagues – there were no serious points raised by the students. I look forward to continuing my role as external examiner next year.



Name and Title: Professor Lesley Yellowlees
Email: l.j.yellowlees@ed.ac.uk
Home institution: University of Edinburgh
Award or subject area examined: Chemistry
Associated University of Cambridge Faculty/Department: Chemistry

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

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

Please also forward copies to your Chair of Examiners.

## **Response to the External Examiners' reports for Part II and Part III Chemistry 2015**

As ever we are grateful to the External Examiners for giving up their time to be part of our process, the care with which they have undertaken the duties, and the valuable comments that they have made on our courses and the examining process.

### **Timetable**

As a result of comments made by last year's External Examiners the timetable for the closing stages was modified and an informal meeting between a selection of students and the External Examiners was introduced. These arrangements appear to have worked well, and we will carry them forward to the coming year.

### **Model answers and annotation of scripts**

Professor Plane and Professor Steel note that there have been improvements in the annotation of scripts in the sense of it being clear how and where part marks have been awarded. However, they both express the view that there is still room for improvement, and we will therefore continue to impress on colleagues the need for explicit and clear marking. It is interesting to note in this context that official University guidance is that no marks whatsoever should be made on any exam script. There continues to be a problem with the preparation and legibility of some model answers, and we will continue to press this point with colleagues.

### **Specialisation in the course**

Professor Steel comments on the fact that the course structure enables a significant level of specialisation at Part II, and an even narrower focus at Part III. This has been an ongoing issue for many years in the Department, with opinion divided amongst the staff as to whether or not this degree of specialisation is appropriate. Some are with Prof. Steel in feeling that it is not, while others (probably the majority) feel that within the context of the Natural Sciences course the permitted degree of specialisation is not inappropriate. Students arrive in Part II with a diverse range of experiences in the first and second year, and there is a feeling that this needs to be respected by offering a range of pathways in Part II and Part III.

The Teaching and Outreach Committee will keep this matter under review, and in particular will consider the option of a more extended core to Part II or of grouping courses together.

### **Computer programming**

The computer programming course was run for the first time last year. It is being offered again this year, over a longer period in order to make it possible for more students to take advantage of it.

### **Identification of those intending to graduate after Part II**

Professor Steel suggests that we should attempt to identify those who intend to graduate after Part II so that that scrutiny at key borderlines could be focused on these individuals. We see the sense in this, but feel that there are some practical difficulties. First, we would have to obtain this information by asking the students, and they might for perfectly genuine reasons be unclear as to whether or not they were graduating – the data would therefore be imperfect. Second, we are concerned that the students will be anxious over which answer they 'should' give i.e. should they say

that they are graduating in order to increase their chances of an oral, or should they say that they are not graduating in order to avoid an oral. Our experience is that some students can get worked up about trying to work out the 'right' thing to do in these situations, and we would not want to cause them extra stress. Overall, therefore, we would prefer not to try to collect these data.

### **Allocation of Part III projects**

Understandably, students want to know who their Part III project supervisor will be as soon as possible after the Part II examinations. However, in practice it can take many weeks to sort these assignments out, leading to frustration on the part of the students. The reason for the delay is simple: just three or four academic staff (offering synthetic projects) are put down as a choice by a significant fraction of the class. Of all these students, only a few will be allocated projects with the popular members of staff. There then follows the complex process of trying to match up those disappointed in their first choice with alternative projects. We have tried to explain to students why there are delays, and why they should not all choose the same few project supervisors, but to no avail.

An alternative would be for the Teaching Committee simply to assign students to supervisors, without allowing either party to choose (or at least only in broad areas). This would certainly be a quicker process, but we do not believe that either the academic staff or, ultimately, the students would find it any more satisfactory.

### **Changes to the course for 2015/16**

In the light of comments made by this and previous sets of External Examiners, along with consistent feedback from our students, we have made the following changes for 2015/16

1. The credit for the Part III project will be increased from 25% to 35% (and in compensation the carry-over of marks from Part II to Part III will be reduced to 15%). In making this change we are encouraged by the comments from the External Examiners on the robustness of our system for assessing projects.
2. Suggested answers to past Tripos questions will be released to students once five years have passed. This will release a useful number of answers, while retaining the more recent exam questions for use in supervisions.
3. Reconfiguration of the arrangements for Part II practicals. The amount and intensity of practical work in Part II puts a lot of pressure on our students and we have been looking at ways to alleviate this somewhat. There is limited scope for reduction since the amount of practical experience is already rather low by the standards set by the RSC, but we have been able to rearrange the pattern of work in a way which we think, in conjunction with a small reduction in the requirement, will result in less pressure.

Second draft 11/11/2015