

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.

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<p>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.</p> <p>Any recommendations made are for the purposes of enhancement to the course and its assessment.</p>	X
<p>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.</p> <p>HOWEVER, there are some risks to the future assurance of the course and its assessment, as outlined in my recommendations.</p>	<input type="checkbox"/>
<p>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.</p> <p>These require immediate action on behalf of the University to prevent reoccurrence in the next set of examinations.</p>	<input type="checkbox"/>

Please tick as appropriate:	Yes	No	N/A
Are you satisfied that you received sufficient programme materials (programme handbooks, regulations, and marking criteria)?	<input checked="" type="checkbox"/>	<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?	<input checked="" type="checkbox"/>	<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?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Have issues raised in previous report(s) been addressed to your satisfaction?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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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.

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



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

29th June 2016

Dear Vice-Chancellor,

External examiner's report for Chemistry, Parts II and III, 2016

This is the third, and final, time I have had to report on the examinations in Chemistry at Part II and Part III. As in previous years the Department produced a set of examinations that are rigorous and challenging but fair and the students who have scored highly have certainly merited their good degrees. This report will follow the standard format and address the following areas.

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

The papers for both Part II and Part III, particularly the specific questions that I was asked to review, are largely problem based and go well beyond lecture note recall. However, they are highly structured, giving scope for students across the class range to succeed, and I feel are pitched at an appropriate level. In most cases these are excellent questions that provide a real challenge to the students (and to me). Some, particularly at Part II, are very specialised and whilst the students obviously cope this must require a degree of specialisation in their learning which must therefore be accompanied by gaps elsewhere.

This year many of the boundaries were clearly defined through the internal assessment processes.

Collectively,
this, and our review of other papers and project reports, would suggest that the boundaries are correctly placed.

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

The students at Cambridge are certainly very good and the depth of this quality is significant. This is reflected in the number of 1st class degrees which this year was very high (51%). Whilst cohort tracking suggests that this was a high achieving group of students, this builds on a high proportion last year and some care needs to monitor that this doesn't become grade inflation in the future. In particular, as is the case at many other Universities, the Department needs to ensure that project marks accurately reflect the performance of the students and not dominate the final marks. There is a tail of weaker students but it is probably smaller than at many other places which may be a benefit of students' ability to focus on specific parts of chemistry.

As noted above, for half the papers at Part II and all those at Part III the students have considerable freedom to choose their courses and this leads to a much greater degree of specialisation than is the case for other (accredited) straight Chemistry courses. Whilst this leads to some spectacular peaks in knowledge, this is inevitably accompanied by some very broad troughs. Even accepting that the students are gaining a Natural Science degree the ability of students to disengage from large parts of the core chemistry curriculum at such an early stage is probably not desirable. It certainly challenged the students called to interview, particularly the Part III student, and *perhaps the Department might wish to consider how all students can retain more of the core knowledge as they graduate – possibly some form of synoptic assessment?*

Lastly, in both cohorts, the performance of male and female students is surprisingly different with the latter performing markedly and disturbingly less well. Moreover, the gender balance in both cohorts looks poor. This may be due the ability of Natural Science students to choose their 'major' with more of the top female students moving towards the biosciences. However, other places don't see this stark gender imbalance in either choice or performance outcome and it is something the Department needs to consider in reviews of teaching and assessment.

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

The assessment / examination process at Cambridge is very efficiently organised by Dr Keeler. With a few exceptions the papers arrived as advertised accompanied by suggested / model answers. The internal review / editorial process for the exam papers has obviously been very thorough as there is frequently very little to comment on. One effect of this is that sometimes the model answer does not correspond to the final question and this can cause confusion with the external's comments not being fully understood by the setter. *It would therefore be helpful for future examiners if when a question is revised the model answer could be updated prior to being sent out for review by the external examiners.* I received a detail response to each of my comments and I am happy in the way the process is handled.

The exams meeting itself was also very efficiently organised. We were given a detailed briefing by Dr Keeler who was available to answer any queries we had. We sampled each of the papers and are confident that the marks award reflect students performance on the day. In the majority of the cases, the marking is exemplary and it is easy to see where marks were gained or lost. However, for a minority it is very hard – for example there may be an initial or a tick at the margins of each sheet and then a number at the end of the question. This is compounded when the marking has clearly had to deviate from the originally proposed marking guide. *It would therefore be helpful for future examiners that if the marking scheme has had to be substantially amended the revised version used could be included in the set of papers supplied at the external examiners meeting.*

As noted above, at Part III the awarded marks had led to a large, but not excessive number, of 1sts and we were particularly requested to review a number of cases in which students had received very high project marks but not managed to obtain a first class mark in any papers. We looked at the thesis and examiners reports and are confident that the work achieved by the students was not inconsistent with their project mark. Moreover we were happy with the principle that some students are exceptional experimentalists and this can compensate for a lower written examination performance. The caveat is that the project marks, averaging at ~ 73% compared with examination performance averaging ~ 68%, are probably a little too high, even allowing for the 60% entry point for the Part III year. At Part II moderation of practical marks, to what is deemed an appropriate level, is undertaken and this practice could be applied here. The system for assessing projects with a supervisor's report and then two independent assessors is very good. However, I suspect that if the project assessors more closely followed the guidelines/ criteria for assessment focusing on the quality of the written report and not the results obtained this may in part address the imbalance. In specific consideration for this cohort of students we were able to ascertain that neither the high project mark nor the change in weighting of the project made a significant difference to the number of 1st class degrees awarded and that those students who had achieved this level deserve their degree class.

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

As last year we had the opportunity to meet a group of students for an informal discussion about the course at Cambridge. Building on comments raised last year the students had appreciated the developments in online supporting material – particularly the availability of past paper questions and guided solutions. The one issue that still remains is how the allocation of the 4th year project is made with some students apparently learning what their project is much earlier in the year than others and consequently being in a position to prepare earlier. Whether or not this gives a significant advantage, this is not perceived as fair. I have some sympathy with this opinion and suggest that the Department review how the allocation is managed / announced. Apart from this they gave us a very positive impression of both the Department and Chemistry within the Natural Science Programme. They have enjoyed their time studying chemistry and appreciated both the challenge of the course and the opportunities it enables.

Finally, the process has been superbly managed by Dr Keeler. This is really an example of best practice and he and his team of examiners have made it a simple, efficient and even an enjoyable experience. I thank them for their help over the past three years

Yours sincerely,



Patrick Steel
Professor of Chemistry
University of Durham

Name and Title: Professor Lesley Yellowlees
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Home institution: University of Edinburgh
Award or subject area examined: Chemistry
Associated University of Cambridge Faculty/Department: Chemistry

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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;
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 - any good practice which you feel could be usefully identified for further dissemination.
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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.
10. The University will take reasonable endeavours to ensure the accurate reproduction of material and information provided by External Examiners; all other warranties and undertakings are excluded, including liability for direct or indirect loss to an External Examiner.
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 for Department of Chemistry, University of Cambridge 2015/16 –
Professor Lesley Yellowlees, University of 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 2015/16. At the outset let me say that, as reported last year (2014/15) 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 degree classification relies almost entirely on performance in the final year of study/or complete reliance on final year of study for Parts III and II respectively. I note that the project weighting for Part III has increased to 35% of the total mark – I commend the Department for this increase. However the contribution to the Part III mark from earlier years of 15% is very low and is out of alignment with comparator institutions. I would ask the Department to consider the relative marks contributing to the final classification. Within the current system the assessment processes are fairly conducted however I observed that the high project marks meant that there were instances of students receiving a first class degree with no first class marks in their written papers. The students understand what is expected of them and talk positively of their experience at Cambridge.

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 noted that one paper (IDP2) had no marks on it at all, not even a final mark which meant that the external examiners could not satisfy themselves that the paper had been properly marked. I would encourage both staff and students from using pencil on examination scripts. I was pleased to note that the average mark for questions was good reflecting care on behalf of the internal examiners.

The average project mark is on the high side. I noted that high marks seem to have been awarded in some cases for good results rather than a good presentation of the project. It is, of course, tempting to award high marks for good results but they should not be awarded when marking the written dissertation. Marks for the report should be based on the descriptors given to the markers. I would therefore encourage examiners to use the descriptors when awarding marks – this may help to lower the high average.

I have a deep concern about the male:female ratio in Part III. This year it was approximately 5:1. I have checked the ratio at my own institution, Edinburgh, and this year it was approximately 1:1. I noted that in Part II it was 2:1 with a significant clustering of female students in the tail. I therefore fear that the picture will not be very different for next year's Part III. I would ask the Department to look for explanations – is it the curriculum, assessment, teaching, initial recruitment? I would be very interested to hear your thoughts on this issue. I know the Department of Chemistry was recently awarded a Silver Athena Swan – congratulations – but this huge disparity in Part III indicates, to me, that something is not quite right.

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.

DEPARTMENT OF CHEMISTRY

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The Vice-Chancellor,
University of Cambridge,
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10 July 2016

Dear Vice Chancellor,

This has been my first year as external examiner in the Department of Chemistry, an appointment which I regard as a considerable honour. The following observations are therefore based on the experience of a single year and I have tried to avoid drawing too many firm conclusions.

I'd like to start by complimenting the Chemistry Department examinations team, and, in particular, the Director of Teaching, Dr James Keeler, for the highly professional organisation of this whole process. The draft papers were received in good time with sufficient time for external examiners to scrutinise them. The explanations of what is a highly complex course structure were clear and the arrangements for our visit in June, together with the recommendations from the internal Board were managed very well.

During our visit to Cambridge, time was allowed to meet and discuss the course with students. This is an excellent recent initiative. The students speak very highly of the Chemistry Department and the course, indeed we had to work hard to solicit any criticism at all. Views inevitably differed on minor points but on the whole they were very happy with their time in Cambridge.

This report will first address the specific points examiners are requested to consider followed by some more general observations.

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

You can be assured that the Cambridge chemistry Part II and Part III courses are rigorous and challenging, even for the most able students. The standard of the examination papers is impressive, especially given the complex permutations it is possible for any one student to take.

The nature of the examination papers (typically three hour papers comprising long questions) lends itself to detailed testing. There were many examples of excellent questions starting with basic core knowledge and developing into advanced application.

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

I am, of course, best able to provide a comparison with the chemistry students at my own institution, Oxford University. I am comfortable that the overall standard of course at the two institutions is comparable. This is not to say that the two courses are similar – indeed, the differences are striking. In Oxford, chemists learn three years of core chemistry with only minimal optional content in year 3, followed by a full year research project. By contrast, the Cambridge NatSci / chemistry course sees students with a diverse and general background knowledge (after part 1A) specialise quickly, often ending up taking a small number of advanced Part III courses (many of which would be graduate level elsewhere) from a restricted area of chemistry. This specialisation comes, inevitably, at the expense of breadth of knowledge and there was clear evidence that several final year students are taking (for example) exclusively organic chemistry. Even the Part II students we saw for *viva voce* examinations had attempted very little physical chemistry in their theory papers.

This ability to specialise clearly suits the able student who knows where his or her strengths or interests lie. There is a risk, however, that some students build unbalanced courses leaving themselves ill-prepared for further study except in one very narrow area of chemistry.

The fraction of Part III students achieving 1st class marks is high (52%). This compares with typically $41 \pm 2\%$ in Oxford and elsewhere. However, given the (recently implemented) 2.1 hurdle at the Part II level required to proceed to Part III, I do not consider this fraction unreasonable. This hurdle does, however, appear to have produced a fall in the number of students continuing to Part III (from *ca.* 70 to *ca.* 55) but this was presumably a factor considered in its introduction.

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

The Cambridge examination system is highly complex reflecting the differing backgrounds of students and the admirable range of choice they have. The draft papers were received by external examiners in good time, together with a clear timetable for actions. In addition, I was pleased to receive a thorough response to each of my comments / suggestions for changes to individual questions. The final papers were prepared to a very high standard. The quality of the model answers provided was, on the whole high if, in a small minority of cases, somewhat eccentric.

Dr Keeler produced informative summaries of the raw results for the external examiners and highlighted in advance any unusual observations, drawing our attention to a range of issues we might wish to investigate. Ample time was left for us to consult scripts / project reports and consider borderline cases.

Part III:

One consequence of the recent increase in the credit given for the Part III project mark (to 35% of the total mark), is that now fully 85% of the final mark is awarded for work in the final year. I understand that this brings chemistry more into line with other Cambridge degree streams (including other NatSci courses) but is extremely unusual for UK Universities. Given the level of choice, it also distorts the marks towards a student's preferred area. In the absence of demonstrably synoptic papers in Part III some students are being examined in a very narrow range of chemistry.

The external examiners were asked to consider if it was appropriate, given the new project weighting, that someone might end up with 1st class degree having never attained 1st class marks in any written paper. This examiner feels strongly that a diversity of assessment methods is highly beneficial and that the project tests very different aptitudes to written papers. Should an individual student demonstrate a particular talent for research and scientific writing, they should receive their due reward. That said, this

year saw an uncomfortably large discrepancy between the *average* marks for the project and the theory papers (73.4% versus *ca.* 68%). I see no obvious justification for this variance and would be more comfortable were they more closely aligned. In this context, all external examiners noted a discrepancy between the marks being given and the descriptors on the project proforma. As expected, though, some of the project reports I had the chance to skim-read were genuinely outstanding.

Part II:

The averages for each paper were within 2% of the target 65%. Examination at this level is to be expected to be more reliable given the larger numbers attempting each question and the more standard nature of the material. The assessed lab work mark of 68.5% is understandably higher than in theory papers and in keeping with results elsewhere.

We conducted three *viva voce* examinations (two at Part II and one at Part III) in order to assess the appropriate location of classification borderlines. These were led by my organic and inorganic colleagues as none of the candidates has done very much physical chemistry. In each case, our suggestions were agreed by the full board.

Any good practice which the External Examiner feels could be usefully identified for further disseminations

I have found this experience most stimulating. Much, however, is expected of the “physical chemistry” external examiner – somewhat over half of all questions set at Part II and III combined (67 questions in total) were marked explicitly for my consideration. Given the speciality of the Part III courses, it is hard to imagine anyone being able to comment in detail on all aspects. I teach all of our own Oxford physical and theoretical chemistry course but this has, for me, been a most challenging test and, in several cases, the model answers were very much needed. It is arguable, in fact, that the only cohort of people on the planet equipped to sit these papers is the one that is required to.

One uncomfortable truth which both Cambridge Chemistry and Oxford Chemistry share is in the “gender gap” in performance at final honours school. On the face of it the fact that men in Cambridge achieve marks +3.4% higher than women at Part III (+1.6% at part II), may not seem statistically significant (less than one standard deviation). However, this gap is prevalent at every assessment stage for the same cohort (1A, 1B, II and III) in all forms of assessment used. It was notable to me that the same gender gap also manifests itself in the project mark in Cambridge – this is usually not the case in final year projects in Oxford.

Dig deeper into the gender gap and more startling trends become clear. At Part III, *ca.* 58% of men achieved 1st class marks (28 of 48) this year compared to 20% of women (2 of 10). At Part II, the respective fractions are 41% (M) and 25% (F). The statistics in Oxford are similar but not as extreme as these.

I regret that I have no solution to offer. Oxford chemistry wrestles with this problem too. Pet theories, of course, abound – is it the admissions interview system that is flawed? Do men get more out of the unusual tutorial / supervision system common to our two institutions? Is it a (common) paucity of female role models? I do, however, strongly encourage the Directors of Undergraduate teaching at our two Departments to continue to share experience and best practice in an attempt to eliminate this divide.

One area which the external examiners agreed could be improved for the benefit of students was the allocation of projects which is currently an unnecessarily slow process. I understand the bottleneck lies with academic staff deciding which students to accept. Although the students with whom we discussed this were not overly concerned, there is no obvious reason why it couldn't be done in a few days if everyone involved is forewarned of the timetable.

Finally, I note the drop in numbers between Part II and Part III is significantly larger than can be accounted for by the 2.1 hurdle to proceeding. It seems a shame that each year several very able Part II chemists (i.e., with 1st or 2.1 class marks) decline to continue to Part III. Perhaps this is because the 4th year (Part III) is perceived as "more of the same" despite the project component. Maybe this will change given the increased prominence of the project (now 35% of the final mark) and certainly it would seem that the project could be marketed as an attractive and valuable part of the course. In Oxford we find that the final year project is almost universally acknowledged as the most popular part of the whole course.

It would be interesting to know if the Department understands the reasons people commonly "cash in early" after Part II. I find it hard to believe that people make life-changing decisions like this on the basis of the marks received at Part II. Equally, if people know they will be staying on (grades willing) for Part III there is no need to classify them at this stage since only a mark goes forward. The external examiners could thus better spend their time assessing the boundaries for only those intending to graduate after part II.

Let me end by again thanking Dr Keeler and his staff for all their work in this process and for their hospitality during our visit.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Stuart Mackenzie". The signature is written in a cursive, flowing style with a large initial 'S' and 'M'.

Professor Stuart Mackenzie

Name and Title:	Professor Stuart Mackenzie
Email:	stuart.mackenzie@chem.ox.ac.uk
Home institution:	University of Oxford
Award or subject area examined:	Natural Sciences (Chemistry)
Associated University of Cambridge Faculty/Department:	Chemistry

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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.
10. The University will take reasonable endeavours to ensure the accurate reproduction of material and information provided by External Examiners; all other warranties and undertakings are excluded, including liability for direct or indirect loss to an External Examiner.
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.