

Name	Professor Alan Armstrong			
Home Institution	Imperial College London			
Email Address	a.armstrong@imperial.ac.uk			
Name(s) of course(s) examined <i>e.g. Tripos Part/ MPhil/ MRes</i>	Chemistry Part II/III (Organic and Biological)			
Academic year of examination	2021-22			
Level (<i>Delete as appropriate</i>)	Undergraduate			
Year of Appointment	1 st	2 nd	3 rd X	4 th

	Yes	No	N/A
1. Are the academic standards set for the award appropriate for the qualification, and comparable with similar programmes in other UK institutions?	X		
2. Are you satisfied that you received sufficient programme materials (handbooks, regulations, marking and classing criteria) in a timely manner?	X		
3. Are you satisfied that you were consulted adequately on draft examination papers, and that your comments and suggestions were taken into consideration?	X		
4. Are you satisfied that the assessment was pitched at the appropriate level?	X		
5. Was the general standard and consistency of marking appropriate?	X		
6. Do the assessment processes measure student achievement rigorously and fairly against the intended outcomes of the programme?	X		
7. Are you satisfied that issues raised on your previous report form have been properly considered and, where applicable, acted upon?	In part		
8. Did you receive a written response from the Department to your previous report form?		X	

If you replied No to any of the questions above, please expand here:

I did not receive a written response to last year's report although most of my points have been discussed with staff in the Department, who provided a useful verbal response.

The main points I raised last year were:

- In some cases, provision of fuller model answers/mark schemes for draft exam questions
- Project marking – consideration of the weighting given to the supervisor mark, and the range of these marks.
- Practical assessments – consideration of a marking system that gives greater reward for practical competence and leads to a wider spread of marks.

Do you have any concerns about the course, including standards and quality?

As in previous years, I remain impressed by the Cambridge course. It covers the foundations of organic and biological chemistry and progresses to advanced topics reflecting the current forefront of organic chemistry in synthesis, catalysis and chemical biology. The standards are very high; the examinations are challenging but the intensive supervision system allows most of the students to perform very well.

This year, there was some evidence of an increased proportion of students attaining 2.2 degrees, and a possible bimodality in distribution of scores in some papers. The supervision system already provides probably greater support to the weaker students in the cohort than they would receive elsewhere with regards to preparation for exams. I think the Department should also consider using a greater diversity of assessment methods – at the moment, assessment of lecture material is heavily focused on final examinations. Many other UK universities in recent years have adopted a much broader range alongside traditional exams including e.g. group projects, presentations, essays, posters. Many students find these extremely enjoyable, allowing them to put the theory they have learnt into broader context, leading to improved engagement as well as equipping students with highly valuable broader transferable skills for their future career.

Are you satisfied that the procedures associated with the assessment are efficient (e.g. timeframes, draft papers, questions, design and conduct of exam, meetings, vivas)?

I received notice of the timescales for receiving and submitting comments on draft exam papers well in advance, which was very helpful. Ample time was allowed for me to scrutinise the papers. They arrived in good order with few (and only minor errors), for which I thank the department's staff. I received a written response to my comments on the Part II papers, although not formally for Part III papers.

As in previous years, the standard of draft mark schemes/model answers varied. The best were very detailed, with a full outline answer, comprehensive mark scheme, and clear information about how the content related to what students had seen before in lectures. Others were much more brief on all of these points.

On arrival in Cambridge, the External Examiners were provided with a very helpful verbal briefing and overview briefing documents on Part II and Part III performance which allowed us to focus our activities effectively.

The final Examiner's meeting was held in person and was conducted in an appropriate manner, with the External Examiners explaining our views on the borderline candidates we had been asked to scrutinise and delivering more general feedback on the Cambridge courses.

Do you have any comments on marking and classing (e.g. range of marks, action around borderline marks, penalties, moderation, double marking, reconciliation of marks)?

The Organic and Biological Chemistry exam questions in Parts II and III were popular choices with the students and all questions appeared to have appropriate average marks and distributions.

We noticed some examples where marking on exam scripts was not clear – the requirements for mark annotation and processes for checking them need to be reviewed.

The Externals looked closely at Part II research projects, particularly for borderline candidates. I also looked at several others from the Organic and Biological sector. I was happy that projects were marked fairly and the marks were well justified by supervisor/marker comments. I am still of the opinion that the proportion of the project mark provided by the supervisor (50%) is too high, and that the system used to restrict the supervisor marks to a narrow range could potentially reward insufficiently those students who really have made outstanding intellectual and practical contributions in their project.

We looked very closely at the marks and project work of several borderline candidates and felt able to make clear recommendations on their degree class without the need to hold any viva exams this year.

In Part III, more students than usual seem to have performed more poorly overall than they did in Part II; I know the Department will be monitoring this for future years.

There was also some evidence that the trend of reduced gender achievement gap in recent years might have slowed or reversed. Again, I know that the department are already looking into this in more detail.

Do you have any comments on the student experience of the course and/or their experience of the assessment process?

The three External Examiners were delighted to have an engaged discussion with a group of Part II and Part III students. Overall, the students were very positive about their experience on the Cambridge course. They made some constructive comments on issues to be considered by the Department:

- **Part III project allocation.** This topic was discussed in detail. The students understood the imbalance of supply (supervisor and lab space) and demand for some project topic areas and there was a divergence of views on how to manage this, particularly as to whether students' prior performance should be used to prioritise allocations. The main request was for greater transparency in the system (particularly with regard to the role of supervisors' preferences) and for any measures that could avoid the current need to select project supervisors tactically.

The Part III students offered reassurance that many of them had very much enjoyed their projects this year even if they were not in their initial first-choice groups.

- **Project expectations.** The expected hours were perceived to vary considerably with supervisor. Some students reported choosing not to attend lectures in order to meet the expected time in the lab. They also felt that some projects are over-ambitious for students at their experience level and the possibility of vetting projects was suggested. Some students felt that the weighting to the project should be higher to reflect the amount of time they generally put into it.
- **Preparation for research.** The students had enjoyed the "catch up" lab sessions provided for those who had missed some lab work in Part II due to the Covid situation. However, several of them still felt there had been a big gap in their research skills between Part II and their Part III project. For example, they had felt unprepared in searching the literature to work out synthesis procedures for themselves. (On this point: at my institution, we have started to move away from set lab scripts in the later stage of the undergraduate labs, requiring students to look up literature procedures and turn them into protocols themselves).
- **Supervisions** – the flexibility in how these were run was appreciated but it was felt that knowledge of the answers to problems should be more consistent between tutors.

- **Lecture courses.** The students felt that it was not always clear what they were required to know for some of the courses - they emphasised that they were not asking for extra information on likely exam topics, rather to have an idea of the intended learning outcomes for each course. More information on expected pre-requisites (prior study) would also be useful. There was some concern about imbalance in the available lecture course topics (a lack of Inorganic courses was mentioned, for example) and some discussion on constraints in course choice.

Do you have any comments on University policies (e.g. the role of the external examiner, policies around plagiarism, script annotation)?

Please see my earlier comments with regards to annotation by markers on exam scripts, which was unclear in some cases.

With regards to plagiarism– I note that the materials we saw were generated under controlled circumstances (exams) or were highly individual (projects). I believe (but am not certain) that projects are screened for plagiarism against databases of work in the literature or in other theses (this is standard practice for all coursework at my institution).

As I commented last year - at other Universities I have experience of, mitigating circumstances are considered prior to the final Examiners' meeting, but I understand they are dealt with at a later stage in Cambridge. The onus seems to be on the students to appeal their result, and I hope that they do not feel discouraged from doing this.

Please describe here any recommendations for improvement.

To summarise the key points raised elsewhere in this report:

- Review of the requirements for annotation of marking on exam scripts and checking of marks
- Project marking – consideration of the weighting given to the supervisor mark, and the range of these marks.
- Consideration of a broader range of assessment methods, which may allow a more diverse range of students to develop and demonstrate skills beyond exam sitting.
- Consideration of how to bridge the gap between the current practical courses and the Part III research project – possibly by introducing more open-ended/less prescriptive experiments in Part II.

Please highlight any good practice you encountered.

As last year, I found the performance summaries provided by the Part II and Part III Senior Examiners to be extremely useful and helpful (and it was good to see an analysis of student performance by gender).

Have you seen any evidence of grade inflation?

No.

If this is your final year as external examiner? If so, have you seen improvements over your tenure? Has the Department acted on your advice?

Over the last 3 years, the Department has consistently acted on my comments on draft exam questions and there has been some improvement in the answers associated with draft exam papers. The department has also respected our opinions with respect to candidates at degree borderlines.

One of the key concerns raised last year was the fact that some Part II students had missed out on practical work due to Covid – so it was very pleasing that the department responded to this by running a catch-up lab course prior to the start of this academic year.

More substantial suggested changes (e.g. to project weightings or assessment methods) clearly take time for consideration and consultation and in the last couple of years, I suspect that adapting course delivery as needed for the Covid situation has not surprisingly been the priority (and the department is to be congratulated for achieving this successfully). I understand that a Curriculum Review is intended which will allow contextual consideration of broader change.

Do you have any other comments?

I thank the Department staff for their help in answering our questions and assisting us in evaluating the course and students' work.

Name	Charlotte Williams	
Home Institution	Oxford University, Oxford Chemistry	
Email Address	Charlotte.williams@chem.ox.ac.uk	
Name(s) of course(s) examined <i>e.g. Tripos Part/ MPhil</i>	Chemistry (Natural Sciences) Part II	
Level (<i>Delete as appropriate</i>)	Undergraduate	
Year of Appointment	2 nd	

	Yes	No	N/A
1. Are the academic standards set for the award appropriate for the qualification, and comparable with similar programmes in other UK institutions?	x		
2. Are you satisfied that you received sufficient programme materials (handbooks, regulations, marking and classing criteria) in a timely manner?	x		
3. Are you satisfied that you were consulted adequately on draft examination papers, and that your comments and suggestions were taken into consideration?	x		
4. Are you satisfied that the assessment was pitched at the appropriate level?	x		
5. Was the general standard and consistency of marking appropriate?	x		

6. Do the assessment processes measure student achievement rigorously and fairly against the intended outcomes of the programme?	x		
7. Are you satisfied that issues raised on your previous report form have been properly considered and, where applicable, acted upon?			
8. Did you receive a written response from the Department to your previous report form?		x	

If you replied No to any of the questions above, please expand here:

Do you have any concerns about the course, including standards and quality?

I do not have concerns about the course quality or standards – both are exemplary and highly demanding which is a difficult combination.

The part II Chemistry course is delivered and assessed through 4 compulsory courses (A = Inorganic I: Structure and bonding; The foundations of organic synthesis; High resolution molecular spectroscopy; Theoretical techniques) and ~20 optional courses of which the students typically select 6 (from B and C) courses. This year all lectures and supervisions were delivered on-line. There are also practical courses but due to the covid-19 pandemic, these practical courses were not delivered in lent and trinity terms in 2021. Part II is assessed through 4 examinations (75% of mark) and the practical write-up (25%). Examinations were conducted, for the most part in person.

The course standards are high and lecture material is demanding, detailed and at an appropriate level. Examinations are also generally well-constructed and clearly marked. This year there were some issues with low grade averages on one of the papers (paper 2B) and on one of the questions. The department made recommendations regarding scrutiny of candidates affected by these issues and also regarding the grade boundaries. It may have been preferable for the department to have conducted further scrutiny and re-marking of those particular papers/questions in advance of the externals arriving in Cambridge since addressing these issues was time-consuming.

The external examiners spent nearly all our time in Cambridge examining papers, reports, mark-schemes and ensuring that the recommended grade boundaries were appropriate. We did not elect to conduct viva examinations because we were satisfied that the recommended boundaries were appropriate and to reduce stress for the students.

Are you satisfied that the procedures associated with the assessment are efficient (e.g. timeframes, draft papers, questions, design and conduct of exam, meetings, vivas)?

The procedures for the administration of the examination process were good. Exam papers were sent in reasonable time, although just before the Easter vacation with comments to be received just after it, with around 2-3 weeks to examine the papers. I made a series of suggestions regarding the Inorganic Chemistry and Materials Chemistry aspects of the course which were responded to properly, appropriately and in a timely manner by the lecturers and examiners.

The process for the external examiners 'visit' to Cambridge was very well managed, with all the relevant documents either being accessible during the visit, albeit with a variety of different platforms and passwords being used which did make finding all the data somewhat challenging. The time-frames for examining the documentation (exam scripts, mark sheets, written commentary) were quite narrow, but they were sufficient to allow for proper scrutiny, benchmarking and reading.

The lead departmental examiner – James Keeler – is exemplary. He was available for questioning, providing clear inductions to the process, understanding all aspects of the questions, providing detailed and clear answers in an exemplary manner. It is quite clear that James Keeler and the broader team of project lecturers, supervision teachers and examiners within Cambridge Chemistry are highly professional and have worked very hard to deliver a high-quality education for students in part II of the course.

Do you have any comments on marking and classing (e.g. range of marks, action around borderline marks, penalties, moderation, double marking, reconciliation of marks)?

The exam marking was, in general, very good and clear rationale for marks was provided in the cribs and was evidently being applied to the exam scripts. It was not always clear that exams had been second marked and some consideration should be given to this aspect. It is also recommended that where papers have low grade averages, a third marking or group of markers is convened to examine the specific cases and to try to address these issues.

The exam board made recommendations regarding the grade boundaries and after very careful and detailed scrutiny of candidates at those borderlines, the external examiners were content with the placement of the boundaries.

Do you have any comments on the student experience of the course and/or their experience of the assessment process?

The external examiners were able to meet with the students and to hear of their experiences. The students were generally happy with the course and had enjoyed the combination of practical and theoretical education in part II. Students were concerned about a lack of transparency in the allocation of part III projects and in particular a lack of consistency in the 'interviews' for potential project supervisors. Students were concerned that it wasn't very clear how decisions were made by some supervisors.

Do you have any comments on University policies (e.g. the role of the external examiner, policies around plagiarism, script annotation)?

My only comment would be to recommend that first and second markers use different coloured pens and that where papers have lower/higher than expected grade averages, third marking is applied.

Please describe here any recommendations for improvement.

None

Please highlight any good practice you encountered.

The exam questions are well constructed, fair and very demanding. This is an extremely difficult balance to achieve but was well demonstrated in the part II papers I was asked to evaluate. The mark schemes and cribs presented to external examiners were also clear. In the best cases, questions were well designed, leading the student through from concepts which should be familiar to completely new problem solving and encouraging independent analysis/evaluation. The best mark schemes clearly signalled to students how much time should be devoted to particular questions and the amount of

detail required. The topics covered in the compulsory aspects are those you'd expect to see being taught for Chemistry. It's important to emphasise that concepts are not taught superficially and that the numerical and theoretical rationale underpinning concepts in Inorganic chemistry is emphasised – this is excellent practise. The optional courses are also at an appropriate level and, in the main, provide an up-to-date presentation of theory, methods and applications for Inorganic Chemistry. In terms of content, there is a heavy emphasis on somewhat dated concepts from main group chemistry and there should, probably, be more attention paid to transition metal and lanthanide chemistry, as well as ensuring strong links to solid state chemistry/lattices/band theory. It is also important to recognise the hard-work, dedication, professionalism and commitment to the students shown by the senior examiner, James Keeler. Overall, the quality of the education being delivered in Chemistry is excellent and the efforts which have been made to ensure delivery in very demanding circumstances should be recognised.

Have you seen any evidence of grade inflation?

None – this is a very good thing.

If this is your final year as external examiner? If so, have you seen improvements over your tenure?
Has the Department acted on your advice?

Not relevant.

Do you have any other comments?

No

Name	Charlotte Williams	
Home Institution	Oxford University, Oxford Chemistry	
Email Address	Charlotte.williams@chem.ox.ac.uk	
Name(s) of course(s) examined <i>e.g. Tripos Part/ MPhil</i>	Chemistry (Natural Sciences) Part III	
Level (<i>Delete as appropriate</i>)	Undergraduate	
Year of Appointment	2 nd	

	Yes	No	N/A
1. Are the academic standards set for the award appropriate for the qualification, and comparable with similar programmes in other UK institutions?	x		
2. Are you satisfied that you received sufficient programme materials (handbooks, regulations, marking and classing criteria) in a timely manner?	x		

3. Are you satisfied that you were consulted adequately on draft examination papers, and that your comments and suggestions were taken into consideration?	x		
4. Are you satisfied that the assessment was pitched at the appropriate level?	x		
5. Was the general standard and consistency of marking appropriate?	x		
6. Do the assessment processes measure student achievement rigorously and fairly against the intended outcomes of the programme?	x		
7. Are you satisfied that issues raised on your previous report form have been properly considered and, where applicable, acted upon?	x		
8. Did you receive a written response from the Department to your previous report form?		x	

If you replied No to any of the questions above, please expand here:

There are some issues with marking protocols and checking of marks in the part III dissertation which remain unresolved.

Do you have any concerns about the course, including standards and quality?

The part III year of the course is both very demanding but very important to ensure that graduates are taught the most recent specialist aspects of Chemistry and are able to learn the skills, methods and techniques of contextualised research through an original research project. Overall, the standards and quality are acceptable.

Are you satisfied that the procedures associated with the assessment are efficient (e.g. timeframes, draft papers, questions, design and conduct of exam, meetings, vivas)?

The procedures were fine from the point of view of the administration of the examination process. Exam papers were sent in good time, although just before the Easter vacation with comments to be received just after it, with around 2-3 weeks to examine the papers. I made a series of suggestions regarding the Inorganic Chemistry and Materials Chemistry aspects of the course which were responded to properly, appropriately and in a timely manner by the lecturers and examiners. The process for the external examiners 'visit' to Cambridge was well managed, with all the relevant documents either being accessible during the visit or easy to find via a weblink. The time-frames for examining the documentation (exam scripts, mark sheets, project reports and mark sheets) were quite narrow, but they were sufficient to allow for proper scrutiny, benchmarking and reading. The department also provided a thorough guide to the part III process and how it had been modified in the light of the covid-19 pandemic. The lead departmental examiner for part III - Finnian Leeper – made himself easily available for questioning, provided clear inductions to the process, understood all aspects of the questions, providing detailed and clear answers to any queries. It is quite clear that the broader team of project supervisors, lecturers and examiners within Cambridge Chemistry are professional and have worked hard to deliver a strong part III education.

Do you have any comments on marking and classing (e.g. range of marks, action around borderline marks, penalties, moderation, double marking, reconciliation of marks)?

The marking arrangements for part III projects should be considered carefully by the department. I feel the range of marks is too narrow and this is a result of the 'banding' approach used for supervisor grades. It seems that the supervisor mark is rather heavily weighted in Cambridge, at least compared to my university (Oxford). Additionally, there is not always a clear rationale for marking and more consistent second, and where grades diverge third marking, should be applied. The part III theses are an important aspect of chemical education and the student's degree so it would be appropriate to demand more in the marking justification. That said, the grades for the projects that I 'spot-checked' seemed appropriate, well balanced against both the cohort in Cambridge and against other institutions where I've worked and examined externally. My major concern is for students at the upper and lower ends of the fields that the grade range is too narrow.

The exam marking was, in general, good and clear rationale for marks was provided in the cribs and was evidently being applied to the exam scripts. Given the importance of rigorous marking of papers, particularly at grade boundaries, and the number of different makers being used for some papers, careful checking of scripts is essential to ensure that all questions are marked. As an external examiner I have found small grade errors (marking addition problems or missed answers) in scripts for the past 2 years. This should not recur in future as it does not reflect well on the level of diligence and professionalism the department applies to its teaching and education.

The exam board made recommendations regarding the grade boundaries and after very careful and detailed scrutiny of candidates at those borderlines, the external examiners were content to accept the recommendations and the placement of the boundaries.

Do you have any comments on the student experience of the course and/or their experience of the assessment process?

The external examiners were able to meet with the students and to hear of their experiences. The students gave a very articulate and clear account of their experiences and in the main they had thoroughly enjoyed the course. There were a lot of positive reflections on the quality of the teaching, laboratory training, part III projects and also on the enjoyment the students had in the degree – this was really great to hear. The students are wonderful ambassadors for chemistry and the Cambridge Natural Sciences training.

There were some areas that the students highlighted as of concern and these include:

Research projects – students found they spent a lot of time on this and most spent more than the recommended time per week on the research. The guideline is 4 h/week but most students find this is insufficient. Most of the students did not feel any pressure to work longer hours but some did feel expectation/pressure from the research group to spend more time in the laboratory. The student cohort is concerned by the mismatch of departmental vs. certain group expectations of their time and output in the project. The students would like the project to be worth a greater proportion of the grade (50% of year 4 was proposed by the students). There is a need to construct the project appropriately so that it can be achieved based 20 per week and this is very difficult in some areas of chemistry. The students emphasise that some expectations of what can be achieved by them seem to be somewhat unreasonable and projects may benefit from being re-designed appropriately. The students feel the pressure of the supervisor being involved both in education and assessment of the projects – they feel this may drive the **over-working culture** in the research projects. The supervisors may need to manage the amount of time students are spending working more pro-actively to reassure them that they do not need to over-work. One solution proposed would be for the student and supervisor to set

a project plan at the outset of the work, perhaps including time for contingency arrangements and write-up of work regularly.

The students commented on the difficulties of the **Covid lab issues from 2020/2021**. The department was praised for arranging a 2-week 'catch-up' lab sessions which many commented was very helpful. The supervisors also were sensitive to the difficulties of missed lab hours for those students affected by these issues.

Part III project allocation process – the students feel the process is opaque. It would be helpful to understand more clearly the process for matching students and projects/supervisors. The students feel unsure how they should navigate the application process or how it works. There is a big disparity in ways that different groups/professors 'interview' or are perceived to select candidates for part III. The students felt particularly anxious where they had not been selected for their top choice projects and they were keen to know how to improve their interview technique for success in future. As an alternative model, the students felt that being able to select a research theme/area would work well and might allow greater flexibility in project assignment. They felt it might also overcome the difficulties of being unsure about interviews/selection processes. There was not consensus in the group through with some students very motivated towards specific projects/supervisors whilst others would be happy to be assigned to an 'area' of science for their research.

The main aspect of concern was the lack of clarity about how the process works and what the selection criteria are (for example, prior lab experience or grades).

Do you have any comments on University policies (e.g. the role of the external examiner, policies around plagiarism, script annotation)?

None

Please describe here any recommendations for improvement.

I have two main recommendations:

- 1) The marking scheme for the part III research projects could be reconsidered to ensure a stronger emphasis is given to independent marker over supervisor grade and to ensure a breadth of marks are awarded. I would also recommend that research mark pro-forma sheets are modified to ensure that markers substantiate in greater detail their decisions/assessments.
- 2) The department may be advised to carry out a detailed analysis of gender and achievement data. There may be a need to consider policies, assessment methods and teaching practise to ensure fairness and expected progress for all students in terms of grades/attainment.

Please highlight any good practice you encountered.

The exam questions are well constructed and very demanding but they do appear, in the main, to be able to differentiate the students and to be fair. This is an extremely difficult balance to achieve and yet the part III papers were good demonstrations of how to balance these subtle criteria. The mark schemes presented to external examiners were also, in the main, excellent, with clear evidence of how marks would be awarded. Questions appear to be very well designed, leading the student through from concepts which should be familiar to completely new problem solving and encouraging independent analysis/evaluation. The mark schemes help the students understand how much time should be devoted to particular questions and how they are weighted. The topics being covered and taught to students in part III are very interesting and appropriate as specialist lecture courses. For Inorganic Chemistry these span Main Group Chemistry, Organometallic Chemistry, Inorganic Materials, Polymers, Magnetism, Electrochemistry, Bio-inorganic Chemistry and Supramolecular Chemistry, to

name a few. It's also a great strength that the department is well ahead of old-fashioned stereotypes of IOP in the teaching of Chemistry. This is a major advantage for the students and ensures that they are educated to solve real problems and think broadly about chemistry.

The breadth and depth of research projects being undertaken by students supervised in the Inorganic and Materials sections are very impressive. Projects also capitalize on the Natural Sciences degree and show-case the outstanding undergraduate students at Cambridge and their many skills. It was really impressive to see the level of analysis, in depth research evaluation and independent evaluation of the literature. Further, research outputs were well described and clearly presented by many students. The range of topics being covered in research projects is contemporary and spans major societal challenges. This is important as students will graduate having conducted exciting, important and highly relevant research projects. It's also clear that supervisors are highly committed to providing an excellent student experience and that every effort has been made to train students in the skills, methods and techniques of chemistry research.

Have you seen any evidence of grade inflation?

No and it was very useful to be provided with such clear data on grade histograms over more than a decade.

If this is your final year as external examiner? If so, have you seen improvements over your tenure?
Has the Department acted on your advice?

No

Do you have any other comments?

No