Chemistry recollections

UNIVERSITY OF SURREY

Recollections of the Chemistry experience at Battersea College of Technology (BCT) in the 1960s

The decade of the 1960s heralded a booming economy in the UK and participation rates in higher education significantly increased. In 1960, BCT was experiencing rapid growth in student numbers and had recognised centres of excellence in Chemical, Electrical and Mechanical Engineering and also, most significantly, in Chemistry.

However, space for teaching and particularly research in the college was becoming severely stressed and infrastructure, especially scientific instrumentation and laboratory equipment, was limited in scope and much of the latter was dated. Despite these constraints, Chemistry had a well-established teaching and research culture, due mainly to the legacy left by its Foundation Head, Dr Joseph Kenyon, appointed in 1922.

In 1960, Dr Peter Leggett had just been appointed Principal, and Professor John Salmon was Head of the Chemistry Department. Also, BCT was affiliated with the University of London and so students reading BSc 'Special Chemistry' were enrolled as internal students of the latter. Although this had many benefits, most notably the prestige of the qualification, it also meant that the breadth and depth of chemistry knowledge which had to be accumulated over the three-year programme were, by modern metrics, truly daunting and hence a dedicated and diligent study strategy by students was mandatory.

In 1960, the Chemistry Department had an academic staff complement approaching 30, which by modern standards is remarkable since over recent decades, chemistry departments have been radically down-sized, closed down or amalgamated with other science departments, such as biology, to form bio-chemistry departments.

Overall in the 1960s, the BCT chemistry academic experience was rich and rewarding, complemented by the availability of wide-ranging extra-curricula activities, regular social events and amateur drama productions in the Great Hall, recreational activities in the nearby Battersea Park, excellent restaurants, cafés (most notably 'The Green') and pubs (most notably 'The Eagle') within walking distance of the college.

The close proximity of the college to central London was also an attractive advantage. These features, coupled with the relative ease of obtaining government study grants, meant that student life-styles matched those of the flamboyant and adventurous 60s decade.

However, the overarching event of the 1960s was the granting of university status to BCT and its move to Guildford as the new University of Surrey, the transition to which commenced in the mid-1960s and was complete by 1970. Thus, BCT Chemistry became one of the foundation departments of the University of Surrey and continued to flourish. The 1960-1970 decade was thus an exciting and challenging time for staff and students of chemistry, both at BCT and at the 'new' University of Surrey and a decade of the history of these two institutions worthy of recording.

Undergraduate perspective

In the early 1960s, the chemistry degree course on offer at BCT was the three-year BSc (Special Chemistry) in conjunction with University of London curriculum, standards and assessment procedures. The last enrolments for this degree were in 1962 and thus the last graduations from BCT chemistry with a University of London degree were in 1965.

Typically, this course had a first year intake in excess of 30 and a final year graduation in excess of 20. There was no choice of 'ancillaries' – only mathematics and physics were available and these were studied in Years 1 and 2 along with chemistry.

In addition, a proficiency test in German was required. The latter was a one-hour test and involved translation of a paragraph of scientific literature into English and vice-versa. Patterson's 'German-English Dictionary for Chemists' was an allowed reference for the test and a tutor – Richard Kempler - was available on request. This test could be taken at any time within the three-year time-frame of the degree and many students needed more than one attempt to pass it.

Lectures were of the 'chalk and talk' variety with DIY in-situ note taking. This was the era before overhead projectors and no pre-prepared notes were handed out by lecturers. This was also the era before the multitude of 'all-in-one' chemistry textbooks for Year 1 tertiary study. Recommended texts were:

- Organic Chemistry: Finar, Volumes 1 and 2; Cram & Hammond
- Mann & Saunders: Practical Organic Chemistry
- Physical and inorganic chemistry – Glasstone
- Inorganic - Cotton & Wilkinson
- Nature of the Chemical Bond: Pauling (classic),
- Orgel's 'Transition Metal Chemistry' (classic),
- Cartmell & Fowles and Vogel's Qualitative Inorganic Analysis (a BCT summary version of the basic separation/identification scheme for cations and anions was made available to all chemistry students).

It should be noted that BCT had an excellent Tate library which not only provided a marvellous atmosphere for study but also was well-endowed with a wide range of chemistry textbooks, including multiple copies of the recommended texts, so it was not necessary for students to purchase their own copies. However, if students wished to purchase textbooks, the favoured source was Dillons book shop in Gower Street.

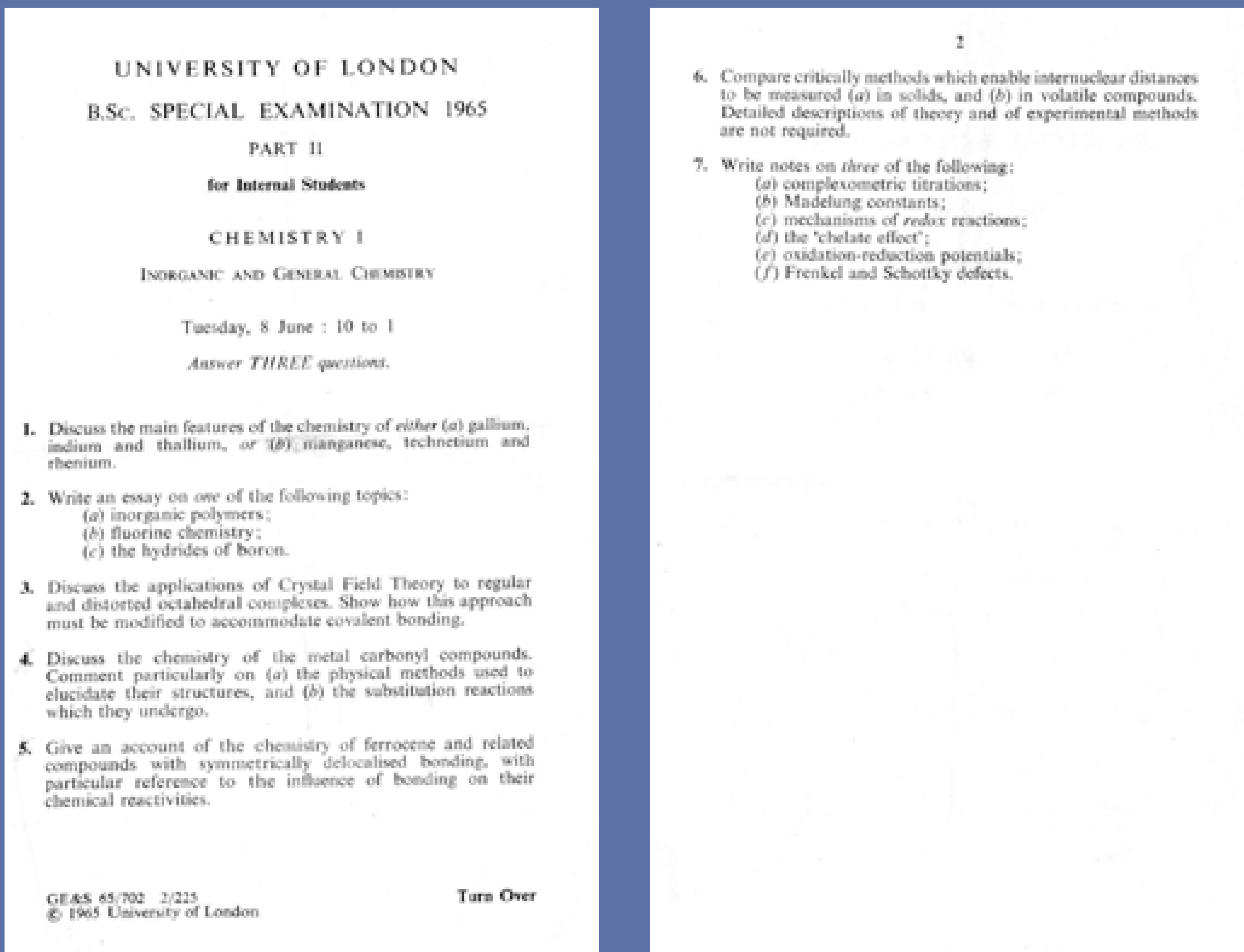
In addition to lectures, there were three-hour practical sessions each week in organic, inorganic and physical chemistry and a three-hour practical session each week in physics. Such projects could result in a publication. A full written report on each experiment undertaken was required. At this time, laboratory coats and safety glasses were optional and laboratory safety procedures were minimal by modern standards. A £5 laboratory deposit was required for each year of the course, refundable less the cost of equipment breakages and losses. Heating was achieved by Bunsen burners and weighing was done on duel pan scales. With respect to the latter, students had to supply their own box of weights and the first task in the inorganic practical session was to calibrate one of these balances – a task which most students found daunting and somewhat boring.

This was the era before digital top-loading balances, 'quick-fit' glassware and basic instrumentation such as a melting point apparatus. The latter was simply a test tube containing oil with a thermometer inserted and heated by a Bunsen burner! Also, students had to make their own melting point tubes.

Further, volumetric analysis glassware, pipettes and burettes had to be calibrated before use, which students found tedious and off-putting. However, although practical sessions involved the simplest equipment and facilities, on reflection these offered a rich learning experience. It should be noted that most of the experiments undertaken in organic and inorganic chemistry at that time would not be permitted in contemporary chemistry courses due to the imposition of OH&S restrictions! It was normal practice that graduate students acted as demonstrators for these practical sessions.

In Year 3, the practical sessions took the form of mini-projects supervised by individual staff members. This initiative provided access to a wider scope of experimental techniques and an insight into the challenging world of research.

Assessment was based exclusively on written (three-hour) exams taken at the end of each year of the course. These exams were set and marked by the University of London. At the end of Year 1, there



UNIVERSITY OF LONDON

B.Sc. SPECIAL EXAMINATION 1965

PART II

for Internal Students

CHEMISTRY I

INORGANIC AND GENERAL CHEMISTRY

Tuesday, 8 June : 10 to 1

Answer THREE questions.

1. Discuss the main features of the chemistry of *either* (*a*) gallium, indium and thallium, *or* (*b*) manganese, technetium and rhenium.

2. Write an essay on *one* of the following topics:
   (*a*) inorganic polymers;
   (*b*) fluorine chemistry;
   (*c*) the hydrides of boron.

3. Discuss the applications of Crystal Field Theory to regular and distorted octahedral complexes. Show how this approach must be modified to accommodate covalent bonding.

4. Discuss the chemistry of the metal carbonyl compounds. Comment particularly on (*a*) the physical methods used to elucidate their structures, and (*b*) the substitution reactions which they undergo.

5. Give an account of the chemistry of ferrocene and related compounds with symmetrically delocalised bonding, with particular reference to the influence of bonding on their chemical reactivities.

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6. Compare critically methods which enable internuclear distances to be measured (*a*) in solids, and (*b*) in volatile compounds. Detailed descriptions of theory and of experimental methods are not required.

7. Write notes on *three* of the following:
   (*a*) complexometric titrations;
   (*b*) Madelung constants;
   (*c*) mechanisms of *redox* reactions;
   (*d*) the "chelate effect";
   (*e*) oxidation-reduction potentials;
   (*f*) Frenkel and Schottky defects.

Chemistry exam paper 1965

UNIVERSITY OF LONDON

B.Sc. SPECIAL EXAMINATION 1965

PART II

for Internal Students

CHEMISTRY II

ORGANIC CHEMISTRY

Wednesday, 9 June: 10 to 1

Answer FOUR questions.

1. Review the evidence, including synthesis, for the structure of β-carotene, and outline current views of the biosynthesis of this compound.

2. Write an essay on the chemistry of the penicillins.

3. Discuss the evidence for the accepted structures of *two* of the following: carvone; sucrose; theobromine; cocaine.

4. Give an account of the chemistry of ergosterol, and outline the conversion of this compound into Vitamin D_2.

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5. Review reactions which are believed to involve neighbouring-group participation. Suggest mechanisms for the following:

(*a*) $Et_2N.CH_2.CHCl.CH_2.CH_3 \xrightarrow{OH^-} Et_2N.CH(CH_2.CH_3).CH_2OH$

(*b*) $CH_3.CHBr.CH(OH).CH_3 \xrightarrow{HBr} CH_3.CHBr.CHBr.CH_3$
(±)-*erythro* → *meso*

(*c*) $CHMePh.CHMeOTs \xrightarrow{HOAc} CHMePh.CHMeOAc$
(±)-*threo* → (±)-*threo*
(Ts = Toluene-*p*-sulphonyl)

6. Review the basic principles of conformational analysis. Give examples in which conformational concepts have thrown light on the course of a reaction.

7. Give an account of the synthesis and properties of non-benzenoid carbocyclic compounds which have been claimed to exhibit aromaticity.

8. Compare electrophilic, nucleophilic, and homolytic aromatic substitution, with particular reference to the influence on orientation and rate of reaction of substituents in the aromatic compound.

9. Discuss the mechanism of *two* of the following:
   (*a*) the Claisen (allyl ether) rearrangement;
   (*b*) the pinacol-pinacolone rearrangement;
   (*c*) the benzidine rearrangement;
   (*d*) the Schmidt and allied reactions of azides.

10. Discuss the factors which influence the mechanisms of olefin-forming eliminations, and the structures of the resultant products.

11. Compound *A*, $C_{15}H_{24}O$, gave a red 2,4-dinitrophenylhydrazone, and the ultraviolet absorption spectrum of *A* had an intense band at *ca* 240 mμ. On catalytic hydrogenation *A* yielded *B*, $C_{15}H_{26}O$, which showed no intense ultraviolet absorption and gave a yellow-orange 2,4-dinitrophenylhydrazone. *B* on reduction with hydrazine and alcoholic alkali gave a saturated hydrocarbon *C*, $C_{15}H_{28}$, which on selenium dehydrogenation produced 7-isopropyl-1-methylnaphthalene. Vigorous oxidation of *A* yielded a keto-acid *D*, $C_{13}H_{22}O_3$. On pyrolysis this underwent a reverse Michael reaction to give acrylic acid and 5-isopropyl-2-methylcyclohexanone.

    Deduce the structures of the compounds *A*, *B*, *C* and *D*, giving your reasoning in outline.

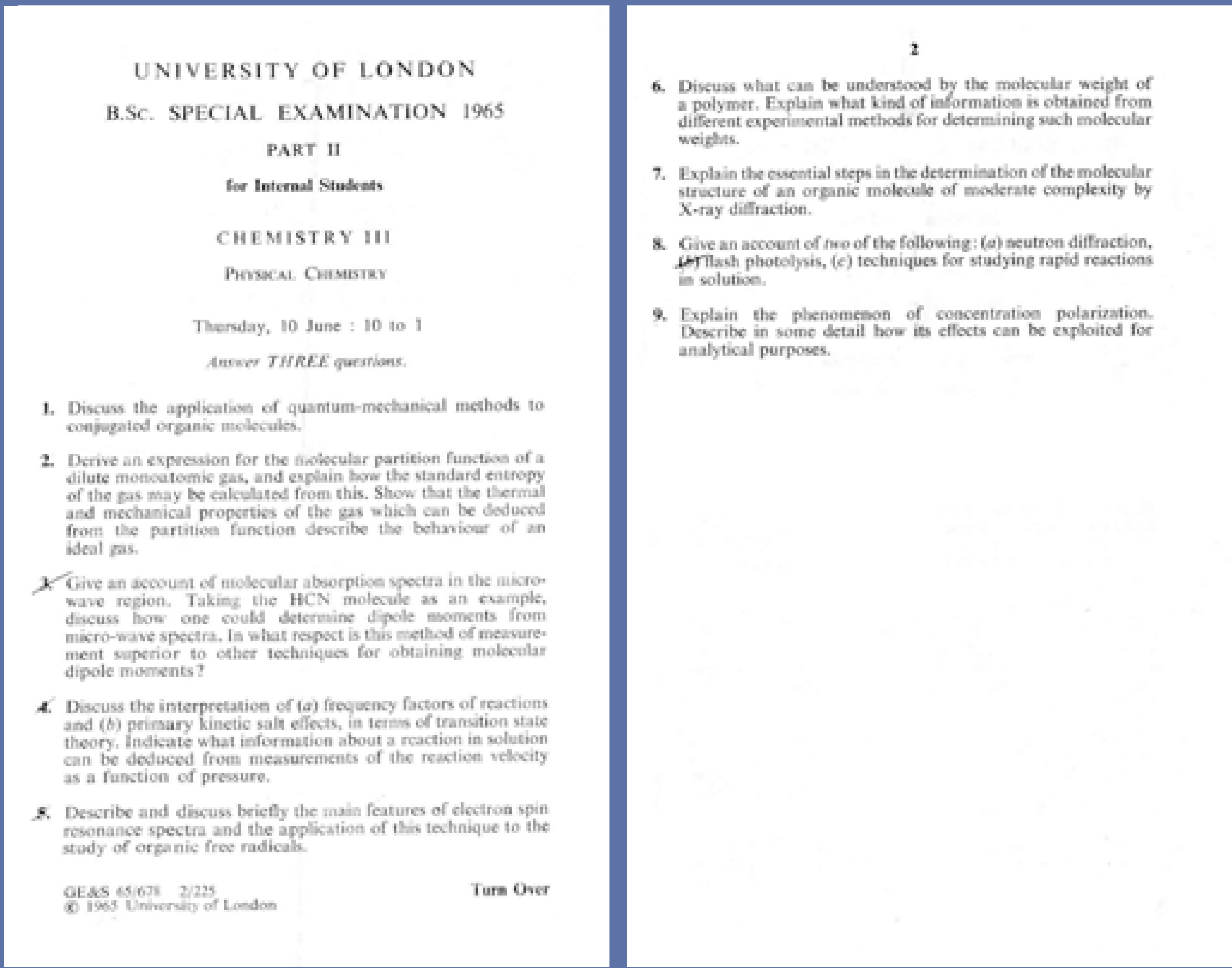
Chemistry exam paper 1965

were two, three-hour examinations in each of mathematics and physics and one three-hour exam in each of inorganic and general chemistry, organic chemistry and physical chemistry.

At the end of Year 2, there were three-hour exams in each of mathematics and physics and three-hour (preliminary final) exams in each of inorganic and general chemistry, organic and physical chemistry. In addition, at the end of Year 2, there was a seven-hour practical exam in each of inorganic and organic chemistry. The latter were held in University of London science laboratories and supervised by University of London personnel.

Certain features of these practical exams are noteworthy. The seven-hour examination was held from 9am to 4pm without a break for lunch. Students were allowed to bring their own lunch – to be consumed in the laboratory! The inorganic practical exam was in two parts – synthesis and analysis of an inorganic compound and identification of the cations and anions in an aqueous mixture by qualitative analysis (usually two of each). The former involved a gravimetric analysis and the latter followed the infamous Vogel methodology for qualitative inorganic analysis.

Similarly, the organic practical exam was in two parts – synthesis of a (solid) organic compound, recrystallization thereof and determination of melting point as a measure of purity and separation and identification of the components of a binary organic (liquid) mixture. In both these exams, minimum



UNIVERSITY OF LONDON

B.Sc. SPECIAL EXAMINATION 1965

PART II

for Internal Students

CHEMISTRY III

Physical Chemistry

Thursday, 10 June : 10 to 1

Answer THREE questions.

1. Discuss the application of quantum-mechanical methods to conjugated organic molecules.
2. Derive an expression for the molecular partition function of a dilute monoatomic gas, and explain how the standard entropy of the gas may be calculated from this. Show that the thermal and mechanical properties of the gas which can be deduced from the partition function describe the behaviour of an ideal gas.
3. Give an account of molecular absorption spectra in the micro-wave region. Taking the HCN molecule as an example, discuss how one could determine dipole moments from micro-wave spectra. In what respect is this method of measurement superior to other techniques for obtaining molecular dipole moments?
4. Discuss the interpretation of (*a*) frequency factors of reactions and (*b*) primary kinetic salt effects, in terms of transition state theory. Indicate what information about a reaction in solution can be deduced from measurements of the reaction velocity as a function of pressure.
5. Describe and discuss briefly the main features of electron spin resonance spectra and the application of this technique to the study of organic free radicals.

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6. Discuss what can be understood by the molecular weight of a polymer. Explain what kind of information is obtained from different experimental methods for determining such molecular weights.
7. Explain the essential steps in the determination of the molecular structure of an organic molecule of moderate complexity by X-ray diffraction.
8. Give an account of *two* of the following: (*a*) neutron diffraction, (*b*) flash photolysis, (*c*) techniques for studying rapid reactions in solution.
9. Explain the phenomenon of concentration polarization. Describe in some detail how its effects can be exploited for analytical purposes.

Chemistry exam paper 1965

information was given out with respect to the experimental procedures to be followed and minimal in-situ assistance was given by the supervisory staff present so these exams were extremely challenging and physically demanding.

Finals were undertaken at the end of Year 3 and consisted of three-hour exams in inorganic and general chemistry, organic chemistry and physical chemistry. It was apparent that the final honours grade awarded was based on the performance in these 'finals' but presumably previous results in chemistry written and practical exams were taken into account if borderline grade scenarios arose.

Also, students had no knowledge of mark ranges corresponding to honours grades – first class, upper second, lower second and third - and were not given their finals marks. Overall, high standards prevailed within the University of London examination procedures as revealed by the level of knowledge required to pass the chemistry exams. Although BCT students recognised the advantages of a University of London degree, they were somewhat disadvantaged with respect to the content of University of London examinations. It was understood that BCT staff were invited to submit questions for University of London examinations in chemistry, physics and mathematics but, due to the many institutions comprising the University of London, a multitude of questions were received so only rarely did 'BCT questions' appear on examination papers.

This dilemma, coupled with only loosely defined curricula, particularly with respect to chemistry, meant that it was difficult for BCT students to predict questions on examination papers with consequential uncertainties attached to their revision strategies.

Inevitably, BCT students were frequently disappointed with their performance at University of London examinations and likewise disappointed with their results. For example, for the 1963 Special Chemistry class, only two first-class honours were obtained and none were obtained by the 1965 class. The latter was blamed on a particularly difficult physical chemistry final examination containing questions which had not been covered in lectures. However, it has to be understood that University of London standards at that time were exceptionally high and that the assessment procedures were rigorous, consistent with universal recognition of University of London qualifications.

It is interesting to highlight some defining features of these chemistry examinations. With respect to the inorganic chemistry exams, the combination of general chemistry with the latter added further uncertainty in predicting examination questions since, without a detailed curriculum synopsis available, it was difficult to know in advance which topics of 'general chemistry' would be examined. Another feature of these examinations was the brevity of the questions and the depth of knowledge required on any given topic to favourably answer questions. For example, with respect to the final inorganic and general chemistry examination (1965), questions tended to be of the type: 'Write all you know about a specified topic' and given one hour to do so, which was a daunting task.

A consistent feature of inorganic and general chemistry questions in the 1960s involved 'coordination chemistry', which was evolving rapidly and was recognised as the major contributor to the renaissance of inorganic chemistry in the mid-20th Century. So although Q1 of the final 1965 general and inorganic chemistry paper only asked for the 'main features of the chemistry of either (a) gallium, indium and thallium or (b) manganese, technetium and rhenium', it was expected that the known coordination chemistry of these elements would be included in answers.

Similarly, on the final (1965) organic chemistry examination, there was a 'write all you know type' question – Q 2 'Pencillins'; the much feared 'organic reaction mechanism' type – Qs 5, 9 and 10 and Q 11 requiring detailed knowledge of synthetic organic chemistry. The complexity of the (1965) final physical chemistry examination reflected why chemistry students regarded the subject as the achilles heel of their studies and the most feared of chemistry exams because performance in these was often the determining factor influencing their final grades. BCT lectures may have covered the theory of new experimental techniques such as microwave atomic spectroscopy, electron spin resonance spectroscopy, X-ray and neutron diffraction and flash photolysis but, most certainly, students would not have had access to such instrumentation, thus making it difficult, if not impossible, for them to answer questions on these techniques.

University of London graduation ceremonies in the 1960s were held in the Royal Albert Hall with the Chancellor – Queen Elizabeth the Queen Mother - presiding, followed by an optional Service of Thanksgiving in St Paul's Cathedral. The names of first-class honours graduates were published in *The Times*.

From September 1964 onwards, chemistry students were enrolled for University of Surrey degrees and current BCT diploma of Technology students were awarded University of Surrey degrees. It was decreed that University of Surrey (chemistry) degrees would be of the same standard as those of the University of London but that the former would be wider in scope and have an applied emphasis.

Consistent with the latter, the University of Surrey chemistry degree course on offer in the latter half of the 1960s included a possible 12-month period in a chemically-based industry during which students gained valuable practical skills. However, only selected students were offered this option but those who completed it were awarded a Diploma in addition to the degree. Also, a defining feature of the Surrey chemistry degree course was that all students were assigned a tutor for the duration of the course.

In addition to chemistry courses, students undertook 'foundation courses' in mathematics and physics over the first two years of study. Chemistry coursework 'options' were available in the final year, such as 'chemical technology', 'theoretical chemistry' and 'coordination chemistry'. Also, final year students were required to undertake an individual (research) project in a specified chemistry area and the options and project were assessed and contributed to the final grade obtained. Further, the Surrey course included 'general studies' options in, for example, social studies and economics, intended to broaden and diversify the knowledge base of students.

As with the University of London predecessors, students were not given 'finals' marks, just the honours grade. H1 was believed to correspond to an average final mark of 70% or greater. The major advantage of the University of Surrey degree course over the University of London counterpart was that assessment was undertaken exclusively by University of Surrey staff and therefore the curriculum was more concisely defined in terms of less 'classical chemistry' and more 'applied chemistry'. Also, there were no assessed practical examinations or foreign language proficiency test associated with the University of Surrey chemistry degree course. However, tedious calibration of volumetric analysis glassware and balance calibration prevailed but practical sessions became more interesting with the introduction of instrumentation, such as UV-visible spectrophotometers, into the practical exercises.

The industrial experience year and the individual research projects very considerably enhanced the practical and applied skills component of the course and prepared students for careers in the chemical and allied industries.

The location of University of Surrey Graduation Ceremonies varied from 1967 to 1969 but from 1970 onwards these were held in Guildford Cathedral. Three ceremonies were held in 1967 in the Great Hall, BCT, Central Hall Westminster and Civic Hall, Guildford. The last ceremony to be held at Battersea was in January, 1968. Lord Robens, Foundation Chancellor of the University of Surrey, presided at these ceremonies. From 1968 onwards, the names of all graduates of the University of Surrey were published each year in the *Surrey Advertiser* and first-class honours graduates were published in *The Times*.

In general terms, although both the University of London and the subsequent University of Surrey chemistry degree courses taken at Battersea College of Technology in the 1960s were challenging and study intensive, these qualifications had international recognition since BCT had achieved university status and prestige over this period.

Postgraduate perspective

In the 1960s, BCT Chemistry had a well-established research culture across the three traditional branches of chemistry so there was a wide choice of research projects available for either MSc or PhD. Up to 1967 these were University of London qualifications, thereafter, University of Surrey qualifications.

However, although chemistry academic staff were enthusiastic supervisors, there were some limitations, most notably a severe shortage of laboratory space, limited facilities, minimal instrumentation (a UV-Visible Spectrophotomer was a luxury), computers were 30 years distant and electronic calculators were just coming onto the market. Strip-chart recorders were available but were not omni-present.

The strong research culture of the department was enriched by high quality seminar programmes presented by visiting chemists and internal postgraduate students. Indeed, a seminar was required of all PhD students upon submission of their thesis.

The first month of a of research project was traditionally spent buried in the Tate Library – systematically searching chemical abstracts to fulfil the requirement of a 'literature survey'. Thesis production was primitive by modern standards. The text was usually hand-written and diagrams had to be hand-drawn and inclusion of photographs was not permitted. The text was typed onto 'roneo' tablet sheets, later to be affixed to the inked roller of a hand-operated duplicating machine. The now redundant quarto size paper was used and archival paper was not available. The thesis was submitted bound involving light blue hard covers with 'PhD, Name and Year' inserted in gold lettering on the spine. No guidelines for production of the thesis were available – one simply followed the format and style of previous theses.

A defining feature of the University of London PhD examination was the 'viva' (oral examination) conducted by the University of London internal examiner in the presence of the supervisor. The viva typically lasted at least one hour and probed not only the quality of the data presented but the theory behind the data obtained. This was not a trivial addendum to the examination process and could affect the final pass/fail decision of the internal examiner. Also, if major corrections/amendments were requested at the viva examination, this meant that sections of the thesis had to be redrafted with consequential re-binding thereof.

The BCT postgraduate experience is best illustrated by examples. John Hill commenced a PhD project in 1963 on 'The thermochemistry of metal acetylacetonates', supervised by Roger Irving. Roger had just returned from a sabbatical year at the University of Lund, Sweden, learning the art of 'solution calorimetry' under the mentorship of Professor Ingemar Wadsö, a leading authority on experimental calorimetry – later to be a world authority on bio-microcalorimetry.

Roger returned to BCT armed with a prototype solution calorimeter, together with some accessories. He subsequently established a solution calorimetry system at BCT Chemistry (in 1962) and such was the acute shortage of space, this instrumentation was set up in his office!

A later version of this system was relocated in a nearby laboratory. Some notable features of this system reveal the many challenges

The Irving/Hill solution calorimeter system 1964

and constraints of undertaking research at that time. The Irving/Hill calorimetry system is best characterised as an 'in-house' construction. The only external components were the calorimeter, the potentiometer, the galvanometer and the thermostat temperature controller. The electronics associated with the calibration system and Wheatstone Bridge temperature measuring system were constructed 'in-house' by Ron Schulz, a fellow PhD student in the Irving group. All temperature-time data were obtained by hand by timing the transit of the galvanometer light spot across an arbitrary (zero) reference line using a stop watch.

The corresponding temperature-time plots were drawn by hand on graph paper and analysed with the aid of an electronic calculator. There was an additional challenge – the thin glass ampoules containing the 'reactant' had to be hand-blown since at that time, these could not be obtained commercially and many attempts to produce such ampoules failed, so patience and commitment was essential. Also, filling, weighing and attaching the ampoule to the calorimeter stirrer became an art form, never to be perfected.

Despite all these constraints and frustrations, a new method for determination of formation enthalpies of metal complexes by solution calorimetry was established and five papers resulted from the thesis – passed by the University of London in 1967 following the viva conducted by Professor Sir Ronald Nyholm (Head, Department of Chemistry, University College London). Over this period, his contemporaries were Brian Birch (Salmon), Ted Charsley (Redfern), Margaret Cross (Larkworthy), Eddie King (Larkworthy), Peter Laye (Irving), Hugh McKerrell (Irving), Ron Schulz (Irving), Siri Varothai (Salmon), Orissa Varothai (Larkworthy), Geoff Walter (Irving) and Ian Worsley (Irving) most of whom obtained a PhD while studying at BCT.

Some of these graduates had distinguished academic careers. Ted Charsley became Professor of Chemistry and Head of the Centre for Thermal Studies at the University of Huddersfield; John Hill became Professor of Chemistry and Chemical Education at La Trobe University, Melbourne, Australia, and also held the position of Pro-Vice Chancellor at that University from 2000 to 2005; Peter Laye became Head of Chemistry at the University of Leeds; Ron Schulz became a Senior Lecturer/Senior Industrial Tutor in the Department of Chemical and Processing Engineering at the University of Surrey; and

John Hill: B(Univ) Surrey, Honouris Causa, Graduation Ceremony, 2. 11. 2011.

Siri Varothai became Head of Chemistry at Chulalongkorn University, Bangkok, Thailand.

Tony Butcher commenced a PhD project in 1965 on 'The synthesis of cobalt and nickel aniline (and analogues) complexes', supervised by David Phillips and John Redfern. He was awarded a postgraduate scholarship from Stanton Instruments Ltd, manufacturers of thermal analysis instrumentation.His bench space was in a small laboratory shared with two other PhD students, Dave Key and Leo Davies.

BCT Inorganic Research Laboratory, c1965, from left Tony Butcher, Eric AH-Sing, (unidentified), Leo Davies, Orissa Varothai, (unidentified), David Key.

In the 1960s, coordination chemistry was rapidly developing and many of the metal complexes synthesised in this era became the precursors and templates forming the foundation of modern bio-inorganic chemistry. However, many challenges faced research students since instrumentation was primitive by modern standards and not readily available at BCT.

Proton - NMR became available in the early 1960s and Professor John Elvidge arrived in 1965 to introduce this new technique to Chemistry at BCT. Other instruments already available were UV-visible spectrophotomers, infra-red spectrophotomers, mass spectrometry, magnetic moment and thermogravimetric analysis instrumentation, the latter being the only one available within London higher education institutions at that time.

More sophisticated instrumental analyses, such as ESR, were undertaken at Imperial College London under an agreement with Professor Goodgame. Determination of the metal content in coordination complexes was undertaken by EDTA volumetric analysis and/or by tedious and laborious gravimetric methods. Associated carbon, nitrogen and oxygen analyses were undertaken by the Mulheim-Ruhr laboratory, Germany – at considerable expense to the Chemistry department. Tony's viva was conducted by Professor Martin Tobe (University College London) and he was one of the first PhDs to graduate from the University of Surrey in 1968. Five published papers resulted from his PhD.

Academic staff perspective

By contemporary metrics, the BCT Chemistry department in 1960 was large and comprised the following faculty members: Mike Abraham, Charles Arcus, Colin Brownlow, Gabriel Buist, Joe Bullock, Mike Burstall, Les Cort, Emeritus Professor Alwyn Davies, Jim Delderfield (Mass Spectrometry), Alan Earnshaw, John Elvidge (1965), Z. Ernst, John Genge, Vic Griffiths, Emeritus Professor Houston, Roger Irving, R. Koenigsberger, Les Larkworthy, Mark Ladd, Jasper Lee, Bob Marks, Fred Parratt, David Phillips, John Redfern, Joan Reid, Brian Reuben, John Salmon (Head of Department) and D. Stock. Mrs Cook was departmental secretary, H. Godby was the laboratory manager and Cath Godby was the laboratory supervisor/technician. It was apparent that there was close association and collaboration with the chemistry faculty at University College London, both with respect to teaching and research, which considerably enriched the BCT Chemistry academic culture and endorsed BCT's university status.

The stature and status of the Chemistry department in the 1960s were evident from its established teaching and research culture and that all faculty staff had a PhD. Such status was also evident from several international students undertaking higher degrees. In the tradition of university status, teaching of chemistry at BCT was informed by research. All chemistry faculty staff had teaching duties (both lecturing and laboratory teaching) and many had active research programmes: Abraham (physical/organic), Arcus (synthetic organic), Buist (thermodynamics, kinetics), Davies (ion association), Earnshaw (synthetic inorganic), Elvidge (NMR), Griffiths (spectroscopy), Irving (metal carbonyl complexes and thermochemistry), Koenigsberger (chromatography), Larkworthy (coordination chemistry), Ladd (crystallography), Parratt (IR), Redfern (coordination chemistry and thermal analysis), Salmon (ion exchange).

It should also be noted that at this time, research instrumentation, such as IR, NMR, ESR and MS, was at a developmental stage and only UV-Visible spectrophotometry and X-Ray crystallography was well-advanced. Gas Chromatography was emerging and HPLC was on the distant horizon.

Although BCT Chemistry possessed some of these instruments, it had access to others (such as ESR) in other University of London chemistry departments and this enabled leading-edge research to be undertaken at BCT. Special mention should be made of the research of Redfern in 'thermal analysis'. In conjunction with research student Ted Charsley, pioneering thermal analysis studies were established at BCT, involving one of the earliest commercial thermal analysis instruments – the Stanton TR01 thermobalance, which was widely used to study the thermal behaviour of materials with variation of temperature. Many of BCT higher degree projects of the era concerned with the synthesis of coordination compounds used thermal analysis as a supplementary analytical tool to characterise these compounds.

Also, the research culture of the department was enriched by a vibrant seminar programme on leading-edge areas of chemistry presented by visiting researchers. Additionally, higher degree students were required to present a seminar on their research project prior to submission of their thesis. It is worthy of noting that slide projection was the only available way of visually presenting data at this time. In addition, chemistry faculty and higher degree students often attended and presented at conferences in the UK.

Apart from many research publications by chemistry staff/postgraduate students, several staff also published books: Davies ('Ion Association'), Earnshaw/Greenwood ('Inorganic Chemistry') subsequent to his move to the University of Leeds in the early 1980s, and Ladd ('Crystallography'). These were widely recognised as definitive texts of the period and are used as reference texts to this day.

It should be emphasised that academics of the 1960s were not blessed with desktop computers and so administration, teaching and research duties were excessively laborious by modern standards. Nevertheless, BCT Chemistry staff all made serious efforts to teach chemistry efficiently and effectively, despite not having to be subjected to assessment of their teaching by students as is the situation currently. Research students were encouraged to present their work at conferences and to write papers for subsequent publication in journals. Many PhD theses of the era generated several such publications. Thus, by contemporary measurement criteria, BCT Chemistry teaching and research quality over this decade was impressive and consistent with university status.

It is also interesting and relevant to note the changes to the BCT Chemistry faculty between 1960 and the move to Guildford from 1967 to 1970. Post retirement, Abraham moved to UCL, Irving moved to the University of Wales, Cardiff, and was appointed to a Chair of Institutional Management & Home Economics and subsequently was appointed Dean of the Faculty of Education at that university. Phillips became a Lecturer in Chemistry at the University of NSW and moved to Sydney, Australia in 1971; Redfern became co-Director with Ashcroft of Stanton-Redcroft Ltd, Wimbledon (manufacturers of thermal analysis instrumentation – thermogravimetric analysis and differential thermal analysis) in the 1980s; and Reid became part-time PA to Leggett from 1963.

Arcus, Buist, Bullock, Cort, Griffiths, Irving, Larkworthy and Salmon moved to Guildford over the period 1967 – 70, thereby becoming foundation members of the University of Surrey - Department of Chemistry. Griffiths and Salmon subsequently became Pro Vice Chancellors of the University of Surrey in recognition of their contributions to the transition of BCT to Guildford and the establishment of the new university.

We conclude that throughout the 1960s, BCT Chemistry already had a well-established teaching and research profile and an expanding undergraduate and postgraduate complement but was desperately short of teaching and (particular) research space and associated facilities. Academic standards were high, consistent with University of London standards of the era. Thus, it was evident that to study chemistry at BCT was synonymous with corresponding studies at the University of London since the learning environment and research culture of the college were comparable to those of a university.

Hence, the transition of the BCT Chemistry Department to the University of Surrey in the late 1960s was seamless and enriching and the chemistry experience for students at both BCT and at the University of Surrey throughout this decade was enjoyable, rewarding and enduringly memorable.

BCT Chemistry class of 1962: Reunion, Iver, October, 2012. Back row, from left: Fred Parrett, Les Larkworthy, Joe Bullock, Joe Hegarty, Herb Askew, Malcolm Hogarth, Gordon Johnston, John Sherlock, Mike Abraham, Norman Boyland, Keith Goddard, Tony Butcher, Roger Mulberge. Front row, from left: Diane Askew, Margaret Cross (Waldron), Jean Larkworthy, Helen Hegarty, Ann Sherlock.

BCT Chemistry: Reunion, Sydney, January, 2013. From left, John Hill, Tony Butcher, Margaret Cross, and Keith Goddard

Footnote

If any BCT Chemistry graduates/staff of the decade reviewed wish to make contributions relating to their BCT chemistry experience, these will be most welcome, particularly if supplemented with photos and should be emailed to John Hill (jce.hill@bigpond.com) or Keith Goddard (kthgoddard@nasuwt.net) who will then refresh this feature as appropriate.

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