Chemistry In Action!

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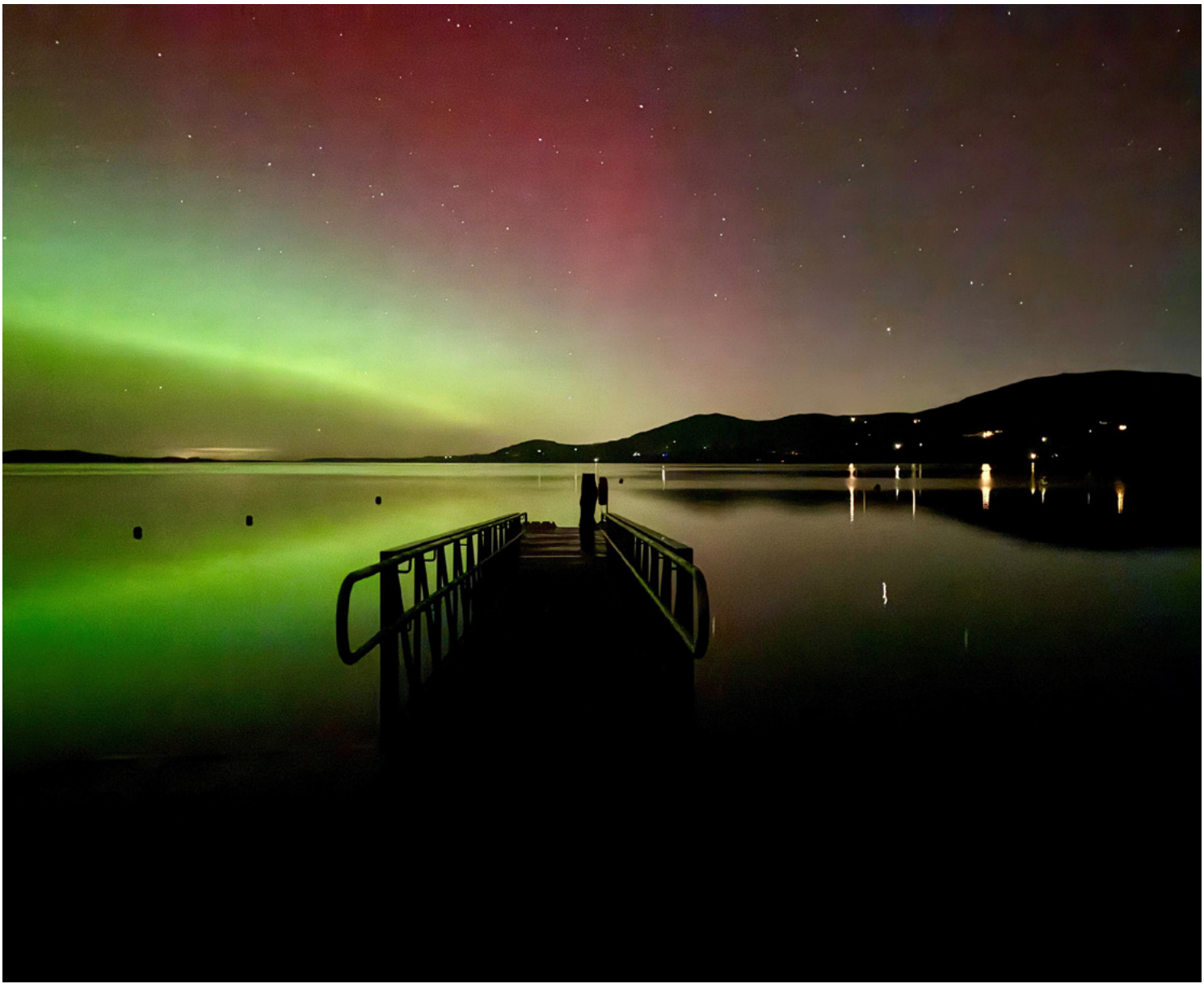

The Northern Lights over Lough Derg

Photograph by: David Corcoran

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Disclaimer

Contributions on any matter of interest to second-level chemistry teachers are welcome. Normally the results of research (chemical or educational) are **not** published, except in a general form or as a review. Articles should be submitted electronically (email or disc) to **peter.childs@ul.ie** together with a printed copy.

For general information, subscription details etc. see inner back page.

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Editorial #128

The die is cast for good or ill

For better or worse the new LC science specifications and the new AAC component have been launched into schools, without adequate resources and without any piloting of a radical new educational experiment. Apart from all the other issues, the ISTA has commissioned a report (p. 8) on the Health and Safety implications of the AACs. This is an important issue. Schools and teachers are expected to provide the facilities for every LC science student to do lab-based research projects in under-resourced and over-stretched laboratories without any technical assistance. The ISTA has asked for a pause in the introduction of the AACs in the LC sciences. This is a sensible suggestion, but it has implications for the assessment scheme as 40% (much too high) has been allocated to the AAC. Such a major change in the structure of the courses, using an untried, untested major assessment component, should not have been rushed into schools to satisfy political aims. At the very least, the AACs should have been piloted in each subject in a number of schools to identify the problems and flaws. They should not be introduced until every school is properly resourced and health and safety requirements have been met. Even then, the AACs should have been introduced progressively in the three main sciences so as not to overload the system in schools. And finally, the likely impact of AI should have been allowed for with a reduced weighting for the AAC of 20%, more commensurate with the time involved, and stronger criteria to prevent the use of AI or outside help for students. Oral exams have been suggested to check that students understand what they have done and written in their reports and verify that it is indeed their own work. The whole AAC initiative is a logistical nightmare, in its implementation for over 50,000 students across three sciences, the need for teachers and schools to authenticate a student's work, and then the massive marking load and standardisation of over 50,000 reports. Any outside observer would say about this journey: 'I wouldn't start from here!'

The value of conferences

Francis Bacon (1561-1626) said many years ago:

Reading maketh a full man; conference a ready man; and writing an exact man.

He stressed the important of reading, writing and conference in a person's intellectual development. Conference with others, interchanging ideas, being exposed to new ideas, interacting with new people is a vital part of a science teacher's professional development. This year there is an abundance of science conferences for teachers to attend in Ireland, never mind overseas conferences (see Diary p. 62). It's much cheaper, of course, to attend conferences in Ireland especially if one can attend by the day. The following conferences of interest to chemistry teachers are running in 2026.

- 10th April IViCE at TU Dublin. Aimed at third level chemistry lecturers and postgrads.
- 11-12th June. SMEC 2026 - a biannual STEM conference run by DCU. This is particularly aimed at those involved in STEM research.
- 22nd - 25th June Joint ISTA/ICASE conferences in UCC. The ISTA conference has moved to run in conjunction with the ICASE conference, and this should be a must in your calendar.
- 24th October. ChemEd-Ireland returns to UL focusing on chemical education in schools.

Internationally the highlight of the year is a joint ECRICE/ICCE joint conference in Turkiye 13-17th July (one to combine with

a summer holiday). This is the first joint conference since Rome 2012.
Why not make a resolve to attend at least one science/chemistry education conference this year?

Peter E. Childs
Hon. Editor

In this issue: #128

The Spring issue each year is meant to contain the Proceedings of the previous year's CheEd-Ireland conference. Last year this was in TUD on October 19th, organised by Dr Claire McDonnell. This depends on the goodwill of the speakers to prepare and submit a written version of their talk or workshop. This ensures a wider circulation and archives their contributions. Some years this is very successful but this year we have received no articles from authors. We are pleased to have part 2 of the article on batteries from John Hayes (p. 26), based on his talk at the 2024 ChemEd-Ireland conference in UCC. Two more articles relate to battery storage: using plant waste in batteries (p. 30) and different ways of storing surplus renewable energy (p. 47).
The ISTA launched an important report in February by Dr Mike Watts on the health and safety and other implications of the new AAC requirement in the new LC science specifications (p. 8). This is an important report on a crucial element of introducing lab-based project work for over 50,000 students on a crucial issue which hasn't been properly addressed. Will the minister and the NCCA act on this report?
A new primary curriculum is also on the stocks awaiting launching and on p. 11 we have a review of the enhanced STEM component by Peter Childs and Anne O'Dwyer. What happens in primary schools has a direct impact on students' preparation for second level science and maths courses.
Professor Wesley Cocker from TCD features in the series on Great Irish Chemists (p.23). Although English he's included because he spent most of his professional life in Ireland and had a major influence on the development of academic chemistry in Ireland.
Michelle Starr reports on two initiatives from Epi*Stem at the University of Limerick (p. 16 and p. 26).
Our modern world is literally built on limestone, one of the most important amazing minerals (p. 33). Chemlingo (p. 61) looks at some of the language of limestone.
The next part of our profile of the element sulfur deals with sodium thiosulfate, an important lab chemical but also a key player in the history of photography (p. 39).
Climate change isn't going away and one of the side-effects of increased CO_2 levels is ocean acidification, an ongoing and increasing phenomenon (p. 59). Small changes in pH can have big effects on marine life.
The history of the discovery of the elements is fascinating and full of mistakes and controversies. Adrian Ryder starts a new series on elemental discoveries on p. 42.
Peter Davern's Quirky Chemical Facts looks at tin, Sn (p. 54).
Last but not least, we have some background on the science behind our amazing cover of the Northern Lights over Lough Derg (p. 56), a fascinating example energy levels and atomic spectra. Something here I hope to interest every chemistry teacher.

Education News and Views

The National Science Museum Saga

I am tempted to call the attempts to build a National Chidren's Science Centre (NCSC) a fiasco rather than a saga. (See https://www.nationalchildrensscience centre.ie/) It has been revealed by the OPW that the proposed Children's Science Museum (CSM) in Dublin, if it actually goes ahead in Earlsfort Terrace (the designated location), could cost the State €70 million. Evidently this is a contract the OPW cannot get out of. This is in the same league as the gold-plated Dáil bicycle shed, but more so. In 2003 the OPW signed an agreement with the Irish Children's Museum Ltd. (ICML) to build and fund a National Science Centre and in 2013 the site in Earlsfort Terrace was identified as the preferred location. Originally the Centre was going to be on a site next to Heuston Station, but this was derailed by the 2008 property crash. Ireland is unique in Europe in having no National Interactive Science Centre or Museum – there is one in Northern Ireland, W5 in the Odyssey Centre, Belfast, which opened in **2001**. In addition, there are many regional science centres in the UK. (see https://www.big.uk.com/centres for a list of UK Science Centres.) There are multiple science centres across Europe, which have been running for decades. It is a national disgrace that Ireland hasn't funded one given the stated importance of STEM education and the success of STEM-based companies in Ireland.

explorium

But in fact, Ireland does have an excellent science centre, Explorium, in Sandyford, just off the M50. (https://explorium.ie/) The ISTA held its annual conference there in 2019, just before Covid struck. It is accessible by road and has parking and a great view over Dublin. It closed during Covid but reopened in 2024. One might ask, why does Ireland need a second Science Centre in Dublin? It might make sense to fund a second one on the West coast, to reach the western half of the country, and Limerick would be a good central location. €70 million is a lot of money and would build a second centre outside Dublin and fund an expansion and subsidy of Explorium, which is a private venture.

The €70 million could alternatively be diverted to fund other STEM activities. For example, building new labs, equipping and renovating existing school labs; funding science technicians in schools; funding STEM education research. €70 million would gio a long way towards improving STEM education.

Private money is much better in getting things done, on time and within budget. A public-private partnership with Explorium makes a lot of sense, rather than funding an expensive white elephant of a Centre in central Dublin, on a constricted site, with all its transport and parking problems. Given the legal wrangle, which the OPW doesn't seem to be able to escape, and the slowness of delivering government-funded projects, which always over-run in cost, it is unlikely that the NCSC will be built and opened in the educational lifetime of today's primary children. In the meantime, let us support and fund Explorium, so that it could reduce its fees, making it more accessible to schools and families. Explorium is actually delivering the aims of the NCSC; it is not an expensive

pipedream. Meanwhile, please support Explorium and take your family and school trips there. Your children and students will be blown away by the experience.
See also:
https://www.siliconrepublic.com/innovation/national-childrens-science-centre-dublin-earlsfort-government-funding

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RSC Education Awards 2025

Ireland has won three awards in the prestigious RSC Education Awards for 2025. A total of 60 Nobel Prize laureates count among previous winners of RSC awards over the 150 years in which the learned society has honoured scientific excellence.

2025 Excellence in Higher Education Prize - Kevin Morgan Queens University, Belfast

A senior university lecturer has been honoured with a major education award from the Royal Society of Chemistry (RSC) for his leadership and 'sustained contributions to innovation' in science teaching**.**
Queen's University Belfast academic Kevin Morgan was named as the winner of the RSC's Excellence in Higher Education Prize for his 'sustained contributions to innovation in chemistry pedagogy, commitment to inclusive education, and leadership and advocacy within the wider chemistry education community.'
Kevin is one of nine Excellence in Education Prize winners this year and, in recognition of his efforts, he will receive £3,000, a medal and a certificate, as well as joining an illustrious body of prize winners.
Reflecting on the award win, Kevin said: *"Receiving this prize is an incredibly moving experience. It's a reminder that the long hours spent developing teaching, supporting students, and helping colleagues grow are noticed and valued by those who understand the work best."*
Kevin's work centres on making chemistry and chemical engineering more engaging, accessible, and relevant to society. He develops innovative teaching methods, outreach programmes, and recruitment initiatives that inspire students and the wider public to explore science.
A core element of his approach is embedding sustainability throughout education, helping learners understand how chemistry can contribute to solving global challenges such as climate instability, clean energy, and responsible manufacturing. In doing so, he connects scientific learning with real-world impact, motivating the next generation of scientists and engineers.
Alongside this, Kevin supports both staff and students in developing their skills and confidence. For students, this involves mentoring and creating opportunities to grow as independent learners and future scientists. For colleagues, he offers guidance, training, and resources to enhance teaching practice and to embed innovative, sustainable approaches across the curriculum. Through this work, he fosters a community of educators and learners equipped to make a positive and lasting impact on society.
Kevin, who originally comes from Dungannon, noted: *"More than an award, it feels like a shared celebration with colleagues and students; a recognition that together, we are making chemistry education more engaging, meaningful, and impactful. It inspires me to keep pushing for positive change and to continue supporting others on their own journeys."*

Virtual Labs Team wins prestigious Royal Society of Chemistry prize for transforming the future of laboratory learning

2025 Team Prize for Excellence in Higher Education – Virtual labs – Maynooth University, Technological University of

the Shannon, University College Cork, Dublin City University.

A tech-driven team using immersive digital labs to reinvent practical science and prepare students for future industry has been honoured with a major Royal Society of Chemistry (RSC) award.
The Virtual Labs Team has been the RSC's Team Prize for Excellence in Higher Education in honour of their collaborative work that is helping students build more confidence about participating in hands-on lab work.
After selecting them as one of nine Excellence in Education Prize winners this year, the RSC credited the team 'for their cross-institution collaboration to integrate virtual labs aimed at enhancing the laboratory experience and preparing students for the industry of the future.'
The group is made up of 10 researchers from Maynooth University, University College Cork, the Technological University of the Shannon, Dublin City University and Dundalk Institute of Technology. Together, they focus on the use of virtual laboratories as a teaching tool for the chemical sciences and puts student partnership at the centre of their approach.
By working with enterprise partners and education technology providers, students ranging from first-year undergraduates to master's-level researchers have had a chance to try a new way of learning. The project started in 2020 and is due to reach the end of its lifetime next year.
In recognition of their efforts, the team will receive £3,000, a team trophy, a certificate and token of recognition for each team member, as well as joining an illustrious body of prize winners.
In a statement, the team said: *"It is a huge honour to have been awarded the 2025 Team Prize for Excellence in Higher Education. It is a significant recognition of our shared commitment to excellence in laboratory education and highlights the strength of our collaboration and of working together across roles, disciplines, and institutions.*
"It confirms the importance of having a community of practice where ideas are shared and innovation can thrive. Our team is proud to be contributing to a wider movement in laboratory education that embraces innovation, inclusivity, and evidence-based, digitally enhanced laboratory learning.
We hope that, by receiving this award we will inspire others to work collaboratively across institutions to support and enhance their students' education."
The team's goal is to determine and implement the most effective strategies to enhance laboratory education in ways that best prepare students to embark on future careers in STEM.
While laboratory education is a very significant component of an experimental science curriculum, the laboratory remains a complex learning. In an environment where laboratory teaching is often constrained in terms of both time and space, educators are challenged to find the best way to provide a quality experience for the modern student which embeds transversal skills alongside developing experimental competencies.
A blended approach to laboratory education has obvious advantages in terms of accessibility, and inclusivity was a key priority for our team. Students can complete pre- and post-lab simulations at a time and place that suits their own schedule.
"The team is made up of staff from different institutions, disciplines, genders, and career stages, and we're learning so much from each other. It's a rare kind of collaboration in laboratory science, and it's changing how we teach," said Project Lead Professor Denise Rooney, of Maynooth University.

2025 Early Career Prize for Excellence in Secondary and Further Education - Conor Eivers Sacred Heart Secondary School, Drogheda

An inspirational secondary school teacher has been honoured with a prestigious award for his work persuading children to pursue their passion for science.

Conor Eivers, who works at Sacred Heart Secondary School, Drogheda, called it a 'real honour' to receive the Early Career Prize for Excellence in Secondary and Further Education from the Royal Society of Chemistry (RSC).

One of nine Excellence in Education Prize winners this year, he was credited his 'for inspiring students and teachers through his creativity, dedication and passion, in order to develop their love for the subject.'

Conor teaches students from Junior Cycle through to Leaving Certificate level, helping them understand how science explains the world around them. However, his commitment to science education extends well beyond his own classroom, as he has also written science textbooks and revision books designed to make learning hands-on, engaging and accessible for all students.

In recognition of his efforts, he will receive £3,000, a medal and a certificate, as well as joining an illustrious body of prize winners.

Reflecting on the award win, Conor said: *"It's a real honour to receive this prize and to be recognised by colleagues whose work I deeply admire. Chemistry education has always been a genuine passion of mine, so to have that passion acknowledged in this way is very special."*

Conor called his progression into the profession a 'natural path' for him as he always wanted to be a teacher. His choice of career is perhaps unsurprising given his family history, with his great-grandmother Julia, grandmother Kathleen, grandfather James and father Shane were all teachers before him.

A secondary school teacher with a background in chemistry, mathematics and science education, Conor's work focuses on helping young people develop curiosity, confidence and a real appreciation for how science connects to everyday life.

Conor, who originally hails from Ashford, Wicklow, and now lives in Drogheda, said: *"I love seeing that spark of curiosity when they realise how something works or when a practical makes a concept click. Those moments remind me that teaching isn't just about passing on knowledge - it's about inspiring students to think, question, and explore the world for themselves."*

He added: *"Teaching is such a collaborative profession, and I'm incredibly grateful to the students, colleagues, and mentors who have inspired, challenged, and supported me along the way. This recognition is as much a reflection of their influence as it is of my own work."*

The first two of these awardees will speak at IViCE 2026 in TUD on April 10th. Conor Eivers will be invited to speak at ChemEd-Ireland 2026 in UL on October 24th.

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ISTA Publish Watts' Report

The Irish Science Teachers' Association (ISTA) Calls for Immediate Pause on Leaving Certificate Science AAC Over Safety, Equity and Feasibility Concerns.

The Irish Science Teachers' Association (ISTA), representing almost 1800 science educators nationwide, in February 2026 released an independent report warning that the proposed Additional Assessment Component (AAC) – laboratory-based research investigations worth 40% of Leaving Certificate Biology, Chemistry and Physics – cannot proceed as planned without risking student safety, teacher wellbeing, equity and the integrity of Ireland's high-stakes exam system.

Professor Mike Watts of Brunel University, London, has written a detailed report (extending to over 130 pages) on his analysis of the data gathered in a recent survey conducted by the Irish Science Teachers' Association (ISTA). The survey was circulated to all schools throughout Ireland and completed by the Head of Science in consultation with the science teaching staff of each school. A very high response rate of 351 secondary schools (almost half of all schools in the country) was obtained. The data gathered by the ISTA was forwarded to Professor Watts for his independent analysis. The data obtained gave details about the laboratory facilities and level of safety preparedness in a wide variety of different types of secondary schools (See Executive Summary of Chapter 2 on p. 11 – 12 of Watts Report).

The full report, ***A National Analysis of the Implications of the Proposed Introduction of AAC Laboratory-Based Research Investigations***, is available below (direct link at https://ista.ie/the-watts-report-2026/)

Key Findings:

- Health and Safety Risks: 89% of schools lack safe storage for ongoing projects; labs cannot safely support mixed activities; there is low teacher confidence in risk-assessing open-ended investigations; there are no lab technicians in most schools. (see p. 70 – 75 Watts Report).
- Infrastructure Gaps: Laboratories are outdated, overcrowded or absent; recent Department funding was deemed insufficient by two-thirds of respondents. (See p. 78 -79 Watts Report)
- Workload Crisis: AAC expected to dominate labs for weeks, squeezing Junior Cycle practicals; teachers predict far more than the allocated 20 hours needed; high

stress and early retirement risks are reported. (See p. 58 – 59 and 85 – 86 Watts Report).

- Equity and Integrity Issues: Better-resourced schools are advantaged; generative AI threatens authentication of out-of-class work; there is potential widening of social divide for DEIS schools. (Watts Report p. 103 – 104).

Detail on Key Findings & Recommendations:

The Watts Report has found major systemic shortfalls in laboratory infrastructure, equipment, storage, funding and teacher preparedness and has recommended that the Department of Education undertakes a comprehensive national audit of science laboratories and associated facilities in all post-primary schools. (See Recommendation 2, p. 95-96 of the Watts Report).

The Watts Report has also found that while some funding has been provided by the Department of Education for the new Biology, Chemistry and Physics specifications, this is completely inadequate and has recommended that targeted capital investment be provided to bring all post-primary school science laboratories and associated facilities up to an agreed national standard (See Recommendation 3, p. 96 Watts Report).

Professor Watts has also identified major concerns from teachers about the AAC model proposed by the Department of Education and has recommended that the model be piloted to evaluate the feasibility, safety, workload implications, equity considerations, academic integrity safeguards, and assessment reliability of the AAC model. (See Recommendation 4, p. 97 Watts Report) and also that the 40% allocation to the AAC laboratory-based research investigation be reduced to 20% in keeping with international best practice for project work as used in the International Baccalaureate (See Recommendation 5, p. 98 Watts Report)

Professor Watts has analysed the workload involved in carrying out the AAC laboratory-based research investigations and has warned about the huge increase in workload for teachers. He has recommended that each post primary school should be provided with the technical support of a laboratory technician (see Recommendation 6, p. 99 Watts Report).

The Watts Report also expresses concern for the wellbeing of students who will be under continuous pressure having to complete multiple projects in overlapping subjects. He has recommended that an independent national study be commissioned to examine the impact of these AAC projects on workload, stress levels and overall wellbeing of students during Senior Cycle (see Recommendation 7, p. 99 – 100 in Watts Report).

Professor Watts also warned of the integrity of the assessment of the AAC model as it is very vulnerable to external assistance being given to students or being carried out with the aid of artificial intelligence tools. He recommends that an alternative model be developed and gives examples of alternative models to safeguard the integrity and international standing of the Leaving Certificate (Recommendation 8, p. 100 Watts Report and Recommendation 9, p. 101 – 102 Watts Report).

Whilst none of the questions in the survey asked about the recruitment and retention of science teachers, in his analysis of the data, Professor Watts has expressed concern at the significant numbers of teachers who, because of the huge increase in workload and the Health and Safety concerns identified by them, have indicated that they will be taking early retirement or leaving the profession. The Watts Report recommends that the Department of Education should undertake an urgent strategic review of the impact of the current AAC model on science teacher recruitment, retention and professional morale (Recommendation 10, p. 102 Watts Report).

One of the most alarming findings in the Watts Report is that the AAC laboratory-based research investigations will give a clear advantage to the fee-paying schools as these schools can afford to hire laboratory technicians and invest funding in state-of-the art laboratories and equipment. He points out that the principle of fairness for all candidates should remain paramount within the Leaving Certificate system and that no candidate or group of candidates should derive and advantage or suffer a disadvantage. The AAC model in Biology, Chemistry and Physics clearly confers and advantage on students who

have the assistance of laboratory technicians and can carry out their research investigations in well-resourced laboratories (Recommendation 11, p. 104 Watts Report).

Finally, Professor Watts points out that the training that has been provided to teachers so far has not been responsive to the needs of teachers. A whopping 97% of teachers reported that they had never received training on how to carry out risk assessment for the AAC laboratory-based research investigations (See Watts Report p. 68) and that they did not feel it a safe environment to supervise a wide range of different research investigations being carried out at the same time (see p. 94 Watts Report). In Recommendation 12 he points out the need for the Health and Safety training to be prioritised while the implementation is being paused (See Recommendation 12, p. 104 – 105 Watts Report).

Quotes from ISTA Chairperson Humphrey Jones:

"Science teachers support inquiry-based learning but not this flawed, high-stakes model imposed without piloting or supports," said ISTA spokesperson Humphrey Jones. "Professor Watts stresses that these 12 recommendations do not work in isolation – a broad, integrated approach is essential to address the systemic issues highlighted by frontline teachers."

"This landmark independent report by Professor Mike Watts, which gives voice to the professional expertise of 351 science departments across Ireland, simply states that our schools are not ready to fairly adopt the proposed Additional Assessment Components (AACs) in Senior Cycle Science. Our members – almost 1800 dedicated educators – have long raised alarms about the AACs in Leaving Certificate Biology, Chemistry and Physics. This evidence confirms those concerns are not mere objections, but systemic realities that demand urgent action."

"Teachers welcome the intent to foster genuine scientific inquiry, but the proposed 40% laboratory-based research investigations simply cannot be delivered safely or fairly in most Irish schools today. From inadequate storage and outdated labs to unmanageable supervision loads and the unknown risks around AI in authenticating the word, the data paints a clear picture: without major infrastructure upgrades, additional support and piloting, we risk student safety, teacher burnout and an erosion of equity in our high-stakes Leaving Certificate."

"Professor Watts' 12 integrated recommendations form a roadmap for success, not as isolated fixes, but as a coordinated national strategy. Pausing implementation now allows time for a full laboratory audit, targeted investment, reduced weighting and alternative forms of assessment. This is not about resisting change; it is about ensuring change that works for every student, every school and every science teacher."

"We invite the Department of Education, NCCA and SEC back to the table. Science education is Ireland's future – let us build it on solid foundations, not rushed assumptions. ISTA stands ready to collaborate for a model that enhances learning without compromising safety or fairness."

Professor Watts' Recommendations:

1. Health and Safety: Pause AAC implementation immediately on health and safety grounds.
2. National Audit: Conduct a comprehensive audit of all post-primary science laboratories and facilities.
3. Capital Investment: Provide targeted investment to upgrade school laboratories to international standard, plus additional ring-fenced annual funding for maintenance.
4. Piloting: Formally pilot the AAC model in representative schools before nationwide rollout.
5. Reduce Weighting: Cut 40% AAC weighting to align with international practice (e.g., IB's 20%).
6. Teacher Workload: Audit additional workload; provide timetabled planning time and lab technicians.
7. Student Wellbeing: Commission a national study on AAC's impact on student stress and workload.
8. Assessment Integrity: Develop an AI-resistant model using supervised lab notebooks for evidence-based assessment.

9. Alternative Model: Replace with an external oral exam based on authenticated lab notebooks.
10. Recruitment/Retention: Review AAC's impact on science teacher morale and STEM workforce sustainability.
11. Social Equity: Design a revised model to prevent disadvantage for DEIS/under-resourced schools.
12. Targeted CPD: Deliver needs-led training on risk assessment, safety, exemplars, marking and AI guidance.

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The place of STEM in the new Primary Curriculum (2025)

Peter E. Childs and Anne O'Dwyer
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A new primary curriculum

In Sept. 2025 the Minister of Education, Helen McEntee, launched the new Primary curriculum, which was last revised in 1999.
https://gov.ie/en/department-of-education/press-releases/minister-for-education-and-youth-helen-mcentee-td-launches-redeveloped-primary-curriculum-specifications-for-all-primary-and-special-schools/#gradual-and-phased-introduction

"This new curriculum is designed for the children of today and tomorrow. It reflects the world they are growing up in – one that is fast-changing, interconnected, and full of opportunity. Our goal is to ensure every child in Ireland receives an education that is inclusive, empowering, and deeply relevant to their lives."

The existing *Primary School Curriculum* was introduced in 1999 (DES, 1999) and the revised *Primary Curriculum Framework* (NCCA, 2023) outlines the basis for high-quality learning, teaching, and assessment for all children attending primary and special schools. It reflects our shared understanding of, and trust in, the many positive features of education in our primary and special schools while providing the blueprint for guiding the enhancement of primary and special education for the coming years (NCCA, 2023). This framework:

- *builds on the successes and strengths of previous curricula while recognising and responding to challenges, changing needs, and priorities*
- *provides agency and flexibility in schools*
- *makes connections with what and how children learn in preschool, primary, special, and post-primary schools*
- *identifies and responds to emerging priorities for children's learning*
- *changes how the curriculum is structured and presented*
- *supports a variety of pedagogical approaches and strategies with assessment central to learning and teaching.*

The Primary School Framework (NCCA, 2023) is available online: The Primary Curriculum Framework | Curriculum Online

A Curriculum for the Future

The redeveloped curriculum is designed to support high-quality, inclusive, and evidence-based learning for all children. It recognises the right of every child to thrive and make progress across all areas of

learning and development, and it views teachers as skilled professionals who play a central role in children's learning from early childhood through primary and special education and into post-primary education.

Key features of the new curriculum include:

Integrated Learning: Children will experience a more connected curriculum that builds key competencies such as critical thinking, creativity, collaboration, and communication – skills essential for navigating the real world.

Being a Communicator: Through the Primary Language Curriculum/Curaclam Teanga Na Bunscoile, children will deepen their understanding of English and Irish and begin to develop basic competence in a modern foreign language, laying the foundation for plurilingualism and intercultural understanding.

Innovation: The curriculum fosters curiosity and innovation, encouraging children to explore, design, and create through science, technology, engineering, and mathematics.

Playful and Inquiry-Based Learning: Greater emphasis is placed on active, engaging, and inquiry-led learning, with more opportunities for outdoor education and child-led exploration.

Being Creative: Children will express themselves confidently and creatively such as through Art, Drama, Music, and emerging artforms to include dance and media arts.

Being an Active Citizen: Children will learn to see themselves as active citizens with rights and responsibilities, empowered to engage with local and global issues.

Being Well: A new Wellbeing specification integrates Physical Education and Social, Personal and Health Education equips children with the knowledge and skills needed to lead active, healthy, and fulfilling lives.

For more detail see: Primary | Curriculum Online

The development process for the new curriculum is shown in Figure 1(April 2025).

Figure 1: The curriculum development journey for the new Primary Curriculum, accessed: en_3rd-communication-re-primary-curriculum.pdf

The revised Primary Curriculum (2025) involves five strands:

- **Arts Education (Art, Drama, Music)**
- **Language (including Modern Foreign Languages from Stage 3)**

- **Social and Environmental Education (History and Geography)**
- **STEM Education (Science, Technology, Engineering, Mathematics)**
- **Wellbeing (Physical Education and Social Personal and Health Education)**

Previously in the primary school curriculum (DES, 1999), Science was in the curricular area of Social Environmental and Scientific Education (SESE). SESE includes History, Geography and Science. The allocated time per week was 3 hours: shared equally as one hour History, one hour Geography and one hour Science. The strands of the Primary Science curriculum (1999) were: Environmental Awareness & Care, Living Things, Materials and Energy & Forces.

In the new specification (NCCA, 2025), Science is now part of the Science, Technology, Engineering, Mathematics (STEM) curriculum.

The new STEM specification

Figure 2: The new STEM specification in the new Primary Curriculum.

Figure 3 shows the curriculum areas and subjects. Until now *Technology* and *Engineering* were not formally included in the primary school curriculum. Science is now grouped with Technology and Engineering in the STE specification (Figure 4). Nature of STEM is a new addition to the primary curriculum along with technology and engineering. In the primary STEM curriculum (NCCA, 2025), *Nature of STEM* refers to understanding how STEM professionals work, developing 'STEM eyes', exploring the history and evolving Nature of STEM and identifying key features of the STEM disciplines. This brings the primary curriculum into line with the second level sciences, which include a Nature of Science strand.

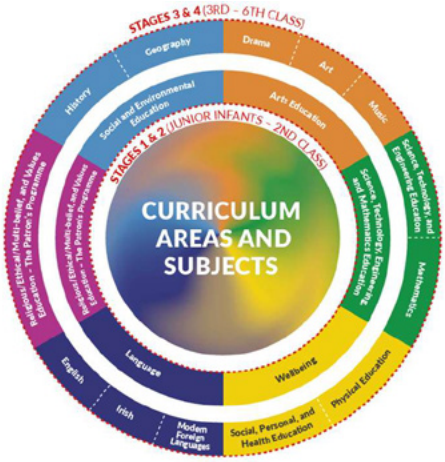

Figure 3: Curriculum areas and subjects in 4 stages from Junior Infants to 6th class. ((NCCA, 2025, p.15).

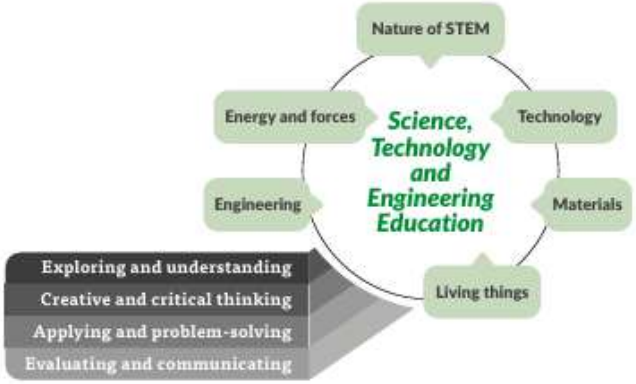

Figure 4: The strands and elements of the STE specification (NCCA, 2025, p.41).

It is notable from this Figure that '*Environmental Awareness & Care'*, which was a strand of Primary Science (DES, 1999), is no longer within the STE specification. This has been moved to the *Social and Environmental Education specification*, which focuses on History

and Geography content. So, the three main 'science' strands are now: Energy & Forces, Materials and Living Things.

Another notable change is the time allocation. Science (6 strands) was previously allocated one hour per week in the 1999 primary curriculum. Suggested revised time allocations are outlined in the Primary School Framework (NCCA, 2023) as follows for STE:

- Stage 1 (infants) - 3 hours 20 minutes (per 4 weeks)
- Stage 2 (1st & 2nd class) - 4 hours (per 4 weeks)
- Stages 3 & 4-(3rd & 6th class) - 5 hours (per 4 weeks)

This time allocation suggests less than or approximately one hour per week for STE. This will ultimately result in reduced time for primary *Science* (specifically), as it encompasses the 6 STE strands (Figure 4). Furthermore, it is envisioned that primary teachers will complete one integrated STEM learning experience per term. Some of this time will have to be taken from the STE allocation. Integrated STEM in the primary curriculum (NCCA, 2025, p.52) is described as follows:

[It] *begins with the children's own interests, questions and wonderings. These spark the learning task, challenge or problem that children engage with, ensuring that it is meaningful and child-led. The teacher's role is to support and scaffold the process, helping children explore, investigate and deepen their understanding over time. As children engage with tasks, the teacher highlights the STEM knowledge and skills they are using. Where challenges arise or gaps in understanding are identified, the teacher can respond to these 'teachable moments' to support and ensure learning progression, always encouraging children to take the lead in their own discovery and problem-solving.*

Circular 0067/2025 (DEY, 2025) was released following the launch of Primary School Curriculum (NCCA, 2025). The circular specifies that the introduction of the redeveloped primary curriculum will be a gradual and well supported process lasting **at least** 6 years.

This school year (2025/2026) was outlined as an introductory year focusing on the Primary Curriculum Framework. Then, from the 2026/2027 school year, schools can avail of focused support in one curriculum area (of the 5 listed above) each year, with each area taking two years to fully enact. From the second year onwards, two areas will be in progress simultaneously - one in its first year and another in its second (see Table 1). Schools are given liberty to choose the order of enactment, but the *Wellbeing* specification must be one of the first three areas selected. A range of supports will be provided to help schools introduce each of the redeveloped curriculum areas.

School Year	Curriculum Area in Focus (Year 1 of Enactment)	Curriculum Area in Focus (Year 2 of Enactment)	Notes
2026/2027	Curriculum Area 1	-	First area selected and two-year enactment process begins
2027/2028	Curriculum Area 2	Curriculum Area 1	Schools select second area, working on two areas simultaneously
2028/2029	Curriculum Area 3	Curriculum Area 2	Ongoing annual cycle continues Enactment of Wellbeing specification must have commenced.
2029/2030	Curriculum Area 4	Curriculum Area 3	Ongoing annual cycle continues
2030/2031	Curriculum Area 5	Curriculum Area 4	Final area begins
2031/2032	-	Curriculum Area 5	All areas will be fully in place by 2031/2032. If schools opt to take a consolidation year, it will mean all curriculum areas will be fully in place by 2032/2033.

Table 1. Timeline of enactment for Primary School Curriculum (NCCA, 2025)

Many of the current primary pupils will enter the second level junior cycle around 2032/33. However, given that schools have agency to decide which of the five curricular areas to introduce first, some primary schools may begin implementing the new STEM curriculum in 2026/27 or others may not begin to engage with it until 2030/31. In this manner, it may be 2035 by the time most students entering second level have experienced in full this new primary STEM curriculum (NCCA, 2025).

This matters to the JC Science teacher because it will determine in future the STE foundation of incoming students into second level. Science, Technology and Engineering are integrated in the courses, together with Maths, which is in the same STEM specification. This will be very challenging for primary teachers, who teach all subjects, and very few have a strong background in Science, or in Technology and Engineering.

The new Junior Cycle Science specification was introduced in Sept. 2017. The new LC science specifications were introduced in September 2025. This sequence of development raises questions about overall curriculum development process. Primary STEM feeds into second level STEM, first at junior cycle and then into senior cycle. Each level builds on what was done before, in terms of both

subject content, skills and pedagogical framework. The logical sequence for STEM curriculum development would be:

STEM at primary level

STEM at junior cycle level

STEM at senior cycle.

Will JC Science be revised to take account of the changes at primary level, so that there is a seamless transition and avoidance of overlap? Will the LC sciences then be designed to follow on directly from JC Science? One major criticism over the years of curriculum development in Ireland has been this lack of coordination between the different levels and especially the large gap between JC Science and the LC sciences.

References

Department of Education and skills (DES) (1999). Primary School Curriculum. Available: PSEC_Introduction-to-Primary-Curriculum_Eng.pdf

National Council for Curriculum and Assessment (NCCA). (2023). *Primary Curriculum Framework (for primary and special schools).* Dublin: NCCA. https://curriculumonline.ie/getmedia/84747851-0581-431b-b4d7-dc6ee850883e/2023-Primary-Framework-ENG-screen.pdf

National Council for Curriculum and Assessment (NCCA). (2025). *Science, Technology, Engineering and Mathematics (STEM) Education specification: For primary and special schools.* Dublin: Department of Education & Youth/NCCA. https://www.curriculumonline.ie/getmedia/70081350-c004-4773-8948-f70b0d4ef554/Primary-STE-and-MATHS-Spec-ENG.pdf

Department of Education and Youth (DEY) (2025). *Circular 0067/2025.* Available: *Circular_Primary_Curriculum_Specifications_EN.pdf*

Biography

Dr Anne O'Dwyer is a lecturer in Science Education at Mary Immaculate College, Limerick and did her PhD with Dr Peter Childs at the University of Limerick.

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Chemistry in Action: Linking Irish Industry, Research, and the Classroom

Michelle Starr

EPI•STEM National Centre for STEM Education, University of Limerick

www.epistem.ie

A partnership between EPI•STEM, the National Centre for STEM Education at the University of Limerick, and SEROSEP, a Limerick-founded diagnostics and environmental testing company, is bringing real industrial chemistry, product development, and scientific problem-solving directly into second-level classrooms nationally. This project aligns the science curriculum with what scientists and technicians do in Serosep Ltd. Limerick.

To make this possible, Martha Cosgrave, a PhD researcher in Science Education at

EPI•STEM, spent time in SEROSEP over the holiday period, gaining first-hand experience of the company's work-life roles and operational environment. Working with the wider EPI•STEM research team, these experiences are being translated into curriculum-aligned classroom resources designed specifically for Irish post-primary science.

For chemistry teachers, this means access to materials that connect core curriculum concepts—such as water testing and environmental and sustainable pathways, and microbes and an introduction to diagnostic testing and uses in health. In this way, students will see how the chemistry they learn underpins real products, real decisions, and real societal impact.

This partnership connects the students' classroom learning with the wider world of scientific work. The new resources are designed to help students explore:

- How scientific knowledge becomes technology**:** students get the opportunity to see how scientific principles underpin diagnostic tools and technologies.
- Interdisciplinary ways of working: how the sciences interact with engineering, data analysis, and evaluation, as well as the historical and socio-political contexts that shape scientific challenges and reflective problem-solving.
- The ethical and social dimensions of scientific decisions: A critical sociological lens is woven through the activities, encouraging students to consider the human, environmental, and societal implications of scientific innovation.

The new STEAM curriculum resources emerging from this partnership supports cross-curricular links with CSPE, Geography, Politics and Art, making them ideal for whole-school STEAM initiatives. They will be freely available to teachers nationwide by registering with the **EPI•STEM Academy of STEM Teachers**: **www.epistem.ie/resources/**

The partnership highlights the value of connecting students with real career pathways. SEROSEP, founded in 1997 by Dermot and Noreen Scanlon, has grown into a global leader in diagnostic testing, manufacturing over 1.25 million tests annually and employing 115 staff across Ireland, the UK, the USA, and South Africa. Its flagship EntericBio® system revolutionised gastroenteritis testing, and during the Covid-19 pandemic the company rapidly developed the RespiBio® PCR test—an achievement that contributed to its recognition as "Medtech Company of the Year" in 2021. These stories offer examples of scientific innovations shaping public health, responding to global crises, and leading to diverse career opportunities.

Biography

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13th Irish Variety in Chemistry Education IViCE

This conference for Irish third level chemistry lecturers to share ideas on the teaching and learning of chemistry, was started many years ago by the late Dr Bill Byers and Dr Peter Childs. The programme for this year's conference is given below. Thanks to Dr Claire McDonnell and the chemistry education group at TU Dublin for organising this.

13th Irish Variety in Chemistry Education Meeting

Friday, 10th of April 2026, 10:15 am to 3:00 pm

Time:	Speaker:	Topic:
10:15 - 10:30	**Registration and refreshments**	Location: **Renehan Hall**
10:30 - 10:40	**Diego Montagner (MU HoD)**	**Welcome**
Chair	**Denise Rooney & Carmel Breslin (MU)**	**Session 1**
10:40 - 10:55	**Oral presentation - Joseph Byrne,** School of Chemistry, University College Dublin	*Implementing Universal Design for Learning in Chemistry Lecture Notes*
10:55 - 11:10	**Oral presentation -John O'Donoghue,** School of Chemistry, Trinity College Dublin	**From Optional to Core:** *Preparing for the arrival of the new Leaving Cert Chemistry Students in Sept 2027*
11:10 - 11:15	**Lightning talk 1 - Quancheng Hunter Hu,** School of Chemistry, University College Dublin	Implementing Prequestioning in Irish Undergraduate Chemistry: Early Insights from a Diagnostic Feedback Intervention
11:15 - 11:20	**Lightning talk 2 - Nicholas Mullins,** Technological University of the Shannon - Midlands	Beyond TLC: Reimagining Classic Undergraduate Chemistry Experiments with Benchtop NMR
11:20 - 11:25		**Opportunity for questions on the previous 2 lightning talks**
11:25 - 11:35		**Comfort Break**
Chair	**Frances Heaney (MU)**	**Keynote Session**
11:35- 12:35	**Keynote Speaker: Giorgio Chianello,** School of Physical & Chemical Sciences, Queen Mary University of London	"Generative AI tools to support education, learning and research."
12:35- 13:35		**Lunch and opportunities for discussion**
Chair	**Joseph Byrne (UCD)**	**Session 2**
13:40 - 14:10	**Speaker: Kevin Morgan,** School of Chemistry & Chemical Engineering, Queen's University Belfast	Strategic Leadership in Chemistry Education: Creating Value, Reach and Impact Across the Educational Pipeline
14:10 - 14:25	**Oral presentation - Claire McDonnell & Sarah Rawe,** School of Chemical & BioPharmaceutical Sciences, Technological University Dublin	From small seeds towards ... a living lab
14:25 - 14:30	**Lightning talk 3 - Fun Man Fung,** School of Chemistry, University College Dublin	Bringing Senpai Learn from Singapore to Ireland: Chemistry Education's Journey Across Continents
14:30 - 14:35	**Lightning talk 4 - Justina Ugwah,** School of Chemistry, University College Cork	From Lab Bench to Reels: Designing Short-Form Videos for Chemistry Education
14:35 - 14:40	**Lightning talk 5 - Carl Poree,** Department of Chemistry, University of Manchester	Less is more – good practice in CRA engagement with a low barrier to entry?
14:40 - 14:45		**Opportunity for questions on the previous 3 lightning talks**
14:45 - 15:00	**Claire McDonnell & Sarah Rawe (TU Dublin)**	**Summing up, planning for the next Irish Variety Meeting and Closing**

Supported by the Royal Society of Chemistry, Chemistry Education Research Group, the Royal Society of Chemistry Higher Education Group and the Virtual Labs HCI P3 Initiative.

Chemed-Ireland 2025 TU Dublin 18/10/25

The Spring issue of *Chemistry in Action!* is usually devoted to the Proceedings of the previous year's ChemEd-Ireland. This year we received no articles and so can only include the programme below and some photos taken on the day. Publication of the Proceedings is a way of archiving the talks but also widening the audience, and over the years *CinA!* has published some excellent articles. Thanks to Claire McDonnell for the photos and or organising the conference.

ChemEd-Ireland 18th October 2025 10am to 4pm TU Dublin
Theme – Chemistry is Everywhere

Time	Speaker / Workshop Facilitator	Activity	Location
9.30-10.00		Registration (with tea & coffee available from 9.15 am)	Foyer & outside CQ-009
10.00-10.10	Claire McDonnell, Technological University Dublin	Welcome to the School of Chemical & Pharmaceutical Sciences, TU Dublin	Lecture theatre CQ-009
10.10-10.50	Louise Hussein, *RSC Ed. Community Ireland Region Invited Speaker*	Resources to Support Chemistry Teachers	Lecture theatre CQ-009
10.50-10.55	Sean Kelleher, Oide	Oide Supports for Chemistry Teachers	Lecture theatre CQ-009
10.55-11.00		Raffle for 2 Molymod kits (from Lennox Educational)	Lecture theatre CQ-009
11.00-11.30		Tea / Coffee & pastries. Exhibits- RSC, CJ Fallon, Lennox Ed, CCI, Oide	Foyer
11.30-11.40	John O'Donoghue, Royal Society of Chemistry	Royal Society of Chemistry Resources for Teachers	Lecture theatre CQ-009
11.40-11.55	Claire McDonnell, Technological University Dublin	The Apprenticeship Route to Laboratory Technician or Laboratory Analyst	Lecture theatre CQ-009
12.00-1.00 Workshops Session 1 (fourth floor)	Sarah Rawe, Technological University Dublin	**WS1:** Escape Room Type Puzzles on Core Chemistry Topics	CQ406
	John O'Donoghue, RSC & Trinity College Dublin	**WS2:** From CBAs to AACs: How to Write a Lab Report	CQ408
	Sean Kelleher and Declan Cronin, Oide	**WS3:** Modelling pH Titration Curves and Exploring Challenges in Weak Acid–Weak Base Systems	CQ409
	Ryan Gallagher, Lecturer in Science Education, UCC	**WS4:** Using Wireless Electronic Sensor Technology to Gather Primary Data in Experiments Relevant to the New Curriculum Specification in Chemistry	CQ411
1.00-2.00		Lunch 1-1.30pm and exhibit stands in Central Quad foyer 1.30-2.00pm	Rathdown House Canteen
2.00-3.00 Workshops Session 2 (fourth floor)	Sarah Rawe, Technological University Dublin	**WS1:** Escape Room Type Puzzles on Core Chemistry Topics	CQ406
	John O'Donoghue, RSC & Trinity College Dublin	**WS2:** From CBAs to AACs: How to Write a Lab Report	CQ408
	Sean Kelleher and Declan Cronin, Oide	**WS3:** Modelling pH Titration Curves and Exploring Challenges in Weak Acid–Weak Base Systems	CQ409
	Ryan Gallagher, Lecturer in Science Education, UCC	**WS4:** Using Wireless Electronic Sensor Technology to Gather Primary Data in Experiments Relevant to the New Curriculum Specification in Chemistry	CQ411
3.00-3.35	Susan Kelleher, Dublin City University *Invited Speaker*	Applications of chemistry – from Recycling Textile Waste to Studying Lunar Dust	Lecture theatre CQ-009
3.35-3.45	Claire McDonnell, Technological University Dublin	Resources to Support Chemistry Teachers	Lecture theatre CQ-009
3.45-4.00		Close of Conference and Venue Next Year	Lecture theatre CQ-009

ChemEd-Ireland 18/10/2026

Chemistry simulations as a new steam education approach to teaching and learning

Michelle Starr, Epi*Stem , University of Limerick

Dr. Vo Van De, EPI•STEM Research Ireland Enterprise Partnership Fellowship Awardee alongside Professor Geraldine Mooney-Simmie, Professor of STEM Education University of Limerick and Director of EPI•STEM National Centre of STEM Education.

EPI•STEM The National Centre for STEM Education in the University of Limerick (UL) welcomes Dr Vo Van De as a new Postdoctoral Research Fellow, tasked with designing and developing new online chemistry simulations. This is a new cutting-edge STEAM Education approach to the teaching and learning of chemistry in Irish post-primary schools. Dr Vo Van De's supervisor is Professor Geraldine Mooney Simmie, who is well known to chemistry teachers in Ireland. Geraldine is the Professor of STEM Education at UL and Director of EPI·STEM The National Centre for STEM Education.

This prestigious two-year Research Fellowship was awarded by Research Ireland under their Enterprise Partnership Programme, as a collaborative research and innovation partnership between EPI·STEM, Elli Lilly Limerick and science teachers nationally. The aim is to provide young people with motivating and immersive experiences in their learning of chemistry, and ready access to feedback loops. Inclusion of the Arts and Sustainability will provide opportunities for science to interplay with Science-in-Society issues and will assist young people in navigating the complex challenges facing contemporary society.

What This Means for Chemistry Teachers

Sustainability is one of the core elements within the Irish science curriculum, and chemistry plays a central role in many of the challenges students are asked to explore — from the study of matter and energy to emerging environmental technologies and the development of new materials. This project aims to support teachers by developing resources that help students to: • think critically about scientific matters
• experience the joy of learning when engaging in chemistry simulations
• develop a critical appraisal of the ethical and societal implications
• connect chemical ideas to real-world sustainability issues
• learning to become reflective and caring for people, place and planet.

Why STEAM Education?

A key feature of the project is the integration of the Arts into STEM learning. For chemistry classrooms, this opens-up creative ways for students to:
• understand scientific inquiry and its connection to community and communication • explore environmental trade-offs and technological impacts
• link historical scientific practices to today's sustainability challenges

• use simulation, visualisation, modelling, and design to deepen understanding
These approaches help students move beyond content knowledge toward the reflective, ethical, and imaginative thinking needed to engage with complex global problems.

Free Digital Resources for Teachers
This school-enterprise-university project will produce new digital teaching and learning materials for the junior cycle science classroom and the senior cycle chemistry classroom and will be designed to support research-led teacher professional learning and classroom practice. All resources will be freely available through the EPI•STEM Academy of STEM Teachers: https://epistem.ie/resources/
The project reflects EPI•STEM's commitment as an internationally renowned research centre to high-quality STEAM teacher education and meaningful industry partnerships. The project aims to engage young people with wholesome sustainability challenges and to develop their confidence in critical thinking - and to support chemistry teachers in bringing important conversations into the chemistry classroom.

Biography
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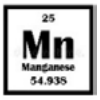
Elementary Chemistry



Manganese in Cork tap water

Manganese has been reported in Cork water supplies for several years. Its presence is indicated when the tap water is black or dark brown. Running it until clear will get rid of most of the contamination. Manganese and iron are found in many rocks and soils, and often remind in sediment at the bottom of lakes and reservoirs, or in pipes. Flooding or turn over of ake sediments can increase manganese levels in water. Mn is a neurotoxin and babies and young children are particularly susceptible to poisoning.
EU regulations allow a maximum of 50 microgrammes per litre (µg/L), while the WHO threshold is 80µg/L.

The water, which was tested by Uisce Éireann, all came from Uisce Éireann's Lee Rd water treatment plant.

The highest incidence of manganese exceedance in clear water came in the week of October 20 last year, when water from Knockfree Avenue, tested at 8HU, contained 127µg/L of manganese.

Uisce Éireann measures water clarity in Hazen units (HU), with an upper discolouration limit of 20HU, below which water is deemed to be clear.

In Boreenmanna Rd on September 8, 118µg/L manganese was found in water tested at 16HU, and at Thomas Davis Bridge, 107µg/L manganese was found in water tested at 5HU.

Last September (2025), manganese levels of 428µg/L were recorded at Friars Walk, at more than eight times the EU limit.

https://www.echolive.ie/corknews/arid-41827724.html

The contamination is not due to industrial pollution and can be argued to be natural, much as the arsenic pollution in India and Bangladesh is due to arsenic leaching out of rocks. Not all pollution is man-made.

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Great Irish Chemists: # 5
Wesley Cocker (1908-1907): a methodical chemist

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Professor Wesley Cocker (1908-1907)

Wesley Cocker was born in England and came to Ireland in 1947, to take up a post as Professor of Chemistry in Trinity College Dublin, Ireland's oldest university. He never left and spent the next 60 years in Ireland, remaining an active researcher into his 90s. Can we count him as an Irish chemist? An Irish chemist can be someone, who is born on the Ireland of Ireland, was educated in Ireland and practised their chemical career here. Burt it can also include someone who was born, and was educated here or abroad, but spent their professional life as a chemist outside Ireland. There are many such people among the Irish diaspora, including Robert Boyle and Kathleen Lonsdale. Then there are chemists, like Wesley Cocker, who were born and educated abroad, but migrated to Ireland and spent most of their career here, making an indelible contribution to Irish chemistry.

I don't think Professor Cocker has made it yet into the *Dictionary of Irish Biography*, but his death was noted in the *Irish Times* ('First of a new breed of science professors' and radical reformer' 17/2/2007) and by Brian McMurray, a longtime colleague in TCD, in *Irish Chemical News* ('Professor Wesley Cocker – an appreciation', 23(2), 2008, 29-30. In the Nov. 21st 2023 issue of *Trinity News*, Randal Henly has a nice anecdote of being lectured by Professor Cocker during his time at Trinity (see below). A whle chapter in the 2025 history of Chemistry at TCD (Boyle, 2025, ch. 4) deals with the Cocker years.

Early years and education

Professor Cocker was born on 31st January 1908 in Ostwaldtwistle, Lancashire, to William and Elizabeth (nee Buckley) Cocker. His father was a manager in several cotton mills. He attended Accrington Grammar School and then went to the University of Manchester, to study Chemistry. He was awarded a first class degree in 1928 and a scholarship for a research Masters, and was later supervised for a PhD by Professor Lapworth. After his PhD, which was on the addition of hydrogen cyanide to carbonyl compounds, he stayed on as an assistant to Professor Lapworth for one year.

He left Manchester to work for a time ICI Dyestuffs at Brackley, on research related to Perspex, polymethylmethacrylate. He left to join his cousin William Cocker in forming Cocker Chemicals, where they made chemicals for the production of tyre rubber and the ingredients used in the antiseptic, Dettol. The lure of chemical research in

academia beckoned and in 1937 he moved to join the staff at Exeter University, where he met and married Eleanor Garstang, a maths teacher. In 1939 he moved to Newcastle University, where their daughter Kathyrn was born. He applied for the job as Professor of General Chemistry at Trinity College Dublin, and was appointed to the on 1/1/1947, on what was then a good salary of £1,150 a year.

As you might gather from his Christian name, Professor Cocker was a lifelong Methodist, a Protestant denomination founded by John Wesley in the 18th century. At one time the Professor of Chemistry, Wesley Cocker, and the Professor of Physics, Ernest Walton (Ireland's only science Nobel Prize-winner), were both Methodists. Methodists are strongly teetotal and evidently Professor Cocker would not allow any potable alcohol in the Chemistry Department, although it was OK of course for chemical use. He withdrew from being President of the Institute of Chemistry of Ireland because he would have to host dinners at which alcohol was served. Surprisingly though, he was a heavy smoker, arguably a more dangerous pursuit. Wesley College, the Methodist secondary school in Dublin, has a Cocker Chemistry Prize. He was a Board Member at Wesley College for 23 years.

Impact on TCD

Chemistry was housed in part of an 1887 building and Cocker described the state of the laboratories as *'Ill-lighted, ill-equipped and.. ancient beyond belief'*, which were also known as an *'alchemist's den'*. He found a run-down, old-fashioned department and set about getting funds to create a modern teaching laboratory and research facilities, as well as revising and modernising the undergraduate Chemistry curriculum. The new Chemistry Building was opened in 1957.

Cocker was definitely a new broom. When he came TCD exams were held in September, outing TCD graduates at a disadvantage in the job market. Cocker campaigned and got finals moved back to June in 1959. Surprisingly TCD had no external examiners for its courses, normal university practice, and in 1954 Cocker introduced the use of external examiners. 1949 saw the Cocker Prize in Organic Chemistry, funded by his cousin Sir William Cocker. In 1947 he helped start the Werner Chemical Society (named after the previous Professor of Chemistry). He developed a chemical library in the Department and oversaw the purchase of chemical instrumentation. He obtained funding for the first UV spectrometer, first IR spectrometer, first NMR spectrometer and first mass spectrometer in the Irish Republic.

Brian McMurray said at his funeral service: *"Wesley was the first of a new breed of science professors in the college and he brought with him a whole series of then revolutionary ideas.*
He immediately set about revising the undergraduate chemistry curriculum and introduced the latest concepts into the lecturing programme. He was a brilliant lecturer himself."

Before its move to Belfield, UCD's Chemistry Department was in Merrion Street, now Government Buildings. Cocker had a good relationship with Professor Tom Wheeler and Professor Eva Philbin of UCD. They tried to institute joint lectures, but this fell foul of an archepiscopal ban. (Catholic students were not allowed to study in TCD from 1944 to 1970.)

His 31 years in TCD as Head of Chemistry is described by David Grayson in ch. 4 of the History of Chemistry at TCD (Boyle, 2025, 102-180). He retired in 1978 at the age of 70, and sadly his wife died 6 months after his retirement.

Randal Henly reminisces: Memories of my undergraduate years

University of Dublin, Trinity College, 1958 — 1962

https://www.trinitynews.ie/2023/11/memories-of-my-undergraduate-years/

In the Junior Freshman year, Professor Wesley Cocker lectured on organic chemistry at 9 a.m. on Mondays, Wednesdays, and

Fridays in the large theatre in the Chemistry Department. Every topic on the course was demonstrated; the long lecture bench would be laid out beforehand and the Professor would start at one end and do the various demonstrations as appropriate, and at the end of the hour he would have reached the far end. Thank you, Professor Cocker, for those great teaching sessions. Sadly, this approach died out when the Professor retired in 1978, at the age of 70.
However, he 'came back' six months later, to continue his research and he could be found in his laboratory most days. He continued to publish the results of his research but had to finally give up at about the age of 95, when he had to move into a nursing home. He died in 2007, just short of his 99th birthday. His colleagues reckoned he must have been the oldest organic chemist in existence!

David McConnell's memories of Cocker's lectures (in Boyle, 2025, 142-143)

"A small man, his glasses on the end of his nose, wearing his black academic gown, he wrote across four contiguous blackboards 10 metres in length covering them with chemical formulae, wiped them clean and started again. I had never studied chemistry before and it all seemed quite magical to me and soon I was hooked. Every now and then he go to the laboratory-style bench at the front of the lecture hall where he had set up some experiments, he would pour liquid into a test tube, twiddle the tube with a characteristic élan, perhaps heating it over a Bunsen burner, and hey presto, there would be some reaction, perhaps some bubbles with a puff of vapour or a change of colour. The experiments brought to life what he was describing in his clipped, precise Lancastrian voice, and illustrating in his immaculate script on the board. The Fisher proof of the structure of glucose was one of his most brilliant expositions."

Research

Wesley Cocker has 124 papers listed on Research Gates. He was a consistent and steady researcher in the Organic Chemistry of natural products and remained active after retirement until his 90s. He didn't make any earth-shattering discoveries in Chemistry, but he maintained a steady output and might be described as a journeyman chemist, contributing block by block, paper by paper, to the edifice of Chemistry. His early work was on santonin, found in wormwood. His research was in natural products, and he worked on various Irish shrubs and the chemistry of carene, found in American turpentine. He was active in research despite a heavy administrative and lecturing burden, and he continued this after retirement. He was a good and inspiring lecturer, using anecdotes and lecture demonstrations to bring Chemistry to life. In his research he worked variously with Dr Patrick Shannon, Professor Brian McMurrayand Dr Mary Carson, as well as many PhD students.

Professional honours

Cocker played a full part in Ireland's scientific community. He held office in the Institute of Chemistry of Ireland (ICI), the Chemical Society (later the Royal Society of Chemistry), the Royal Institute of Chemistry, and the Society of Chemical Industry. He supported ICI's annual Research Student Colloquium, which is still going strong. He was joint Honorary Secretary of the British Association for the Advancement of Science (BAAS) when it et in Dublin in 1957.
He was elected a member of Royal Irish Academy in 1950 and filled various roles. He was nominated unsuccessfully for the Royal Society. In 1997 he was awarded an honorary doctorate from Dublin City University. He was nominated for the Nobel Prize in Chemistry in 1958, 1964 and 1970.

The legacy

Wesley Cocker had a major effect on the growth of Chemistry at Trinity College, in both numbers and research impact, and hence on Chemistry in Ireland. Trinity College Dublin is the oldest Irish university with the oldest Chemistry Department. In international rankings TCD is the top Irish university and has the top Irish Chemistry Department. The

relative positions of Irish universities and departments varies with the different ranking services but TCD is always top. TCD is ranked 75th overall in the QS world university rankings and the Chemistry Department is 77=, both major achievements for a small country, despite an underfunded educational system. Professor Cocker laid the foundation for a strong, research active department, and he fought to build a modern department with good teaching and research facilities, with modern analytical equipment, and well-qualified staff. He led the department for 31 years and by hiring good chemists from Ireland and abroad, ensured its growth and academic reputation. The academic staff increased from 5 in 1947, with little research activity, to 14 in 1978. The story of the Cocker years at TCD is given in detail in ch. 4 of the history of Chemistry at TCD (*Trinity College Dublin: 300 years of Chemistry*, published in 2025 and reviewed in *CinA!* issue 127).

Professor Cocker presided over a long period of fruitful growth, which consolidated the position of the department as the leading Irish Chemistry Department, which it still holds today.

The main teaching laboratory at TCD is known as the Cocker Laboratory; the ISTA and TCD both have Cocker Lectures, and the SCI has a Wesley Cocker award for the best paper or patent in Industrial Chemistry.

Professor Wesley Cocker definitely left an indelible mark on Chemistry at TCD and in Ireland, as shown by Chemistry in TCD still being the premier Department of Chemistry in Ireland.

□

If anyone has an anecdote or personal reminiscence of any of our Great Irish Chemists, please send them in to the Editor. In the next issue: Professor Robert Kane (1809-1890)

A Brief History and Overview of Lithium-ion batteries

John Hayes
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This history of lithium-ion batteries continues from the early history of batteries in the previous edition (#127, Autumn 2025)

The element lithium was discovered in the early 1800s and is named for the Greek word for stone "*lithos*". Lithium, the third element in the Periodic Table, is the lightest metal and has the highest electrochemical potential of any element. Thus, lithium has been a source of battery research for decades from the early 1900s. However, lithium is relatively reactive, especially with water and air, and can be quite a challenging metal from a safety perspective. The first commercial lithium metal primary cells appeared in the early 1970s. The lithium metal cell has a solid or elemental lithium anode and is not rechargeable. The early cathodes were iodine-based, while the electrolyte featured a non-aqueous lithium salt solution. These cells were developed for medical pacemakers. In a lithium metal cell, the lithium is stored in the anode as a solid or elemental metal, rather than in ionic form.

The rechargeable, or secondary, lithium-ion battery has transformed our lives in this millennium. This was acknowledged with the award of the 2019 Nobel Prize for Chemistry. The 2019 Nobel Prize for Chemistry was awarded to three scientists for their contributions to the development of the rechargeable lithium-ion battery. These rechargeable batteries are termed lithium-ion because they do not feature

elemental lithium and because the lithium appears only as ions within the battery.

The contributions of the three inventors are illustrated graphically in Fig. 1 (a-d).

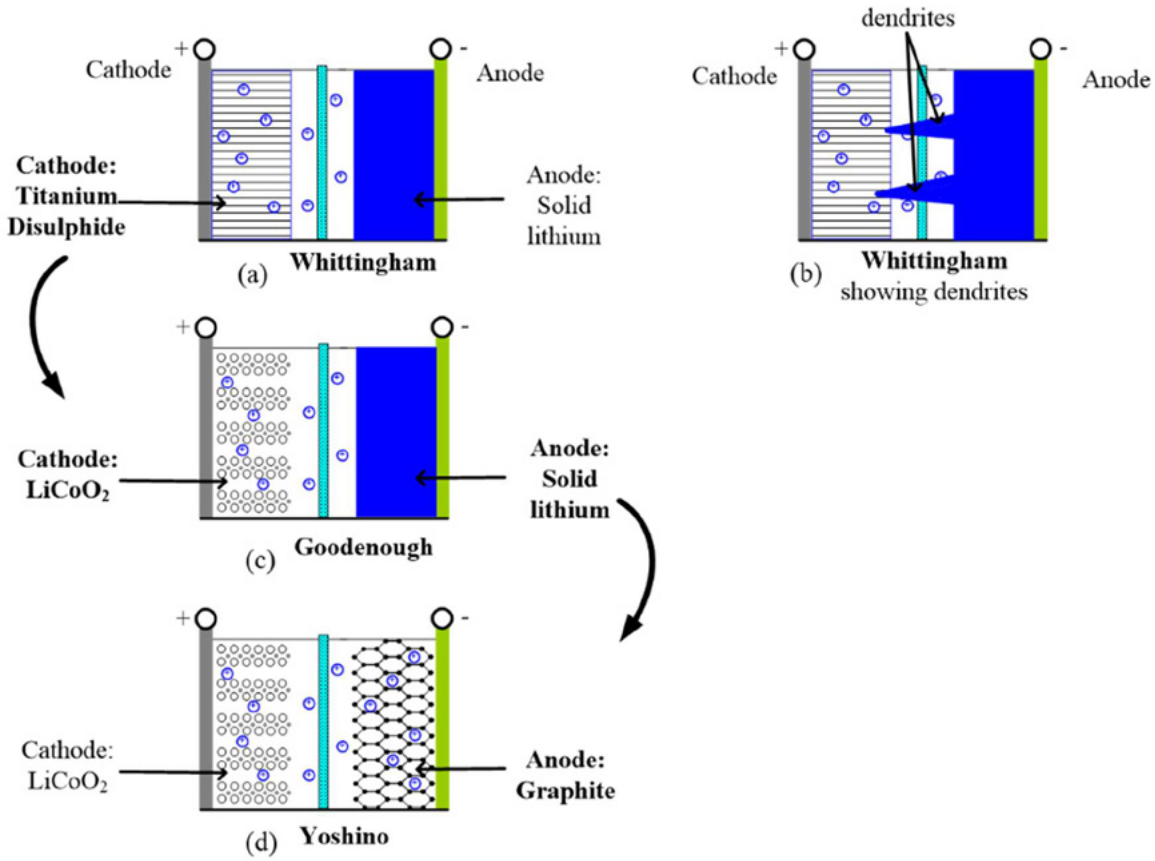

Figure 1: Simple diagrams illustrating the contributions of the 2019 Nobel Prize winners

Stanley Whittingham (1941-) is credited with developing a cathode using titanium disulphide to **intercalate** or house/host the lithium ions, as illustrated in Figure 1(a). Interestingly, Whittingham was working at the oil and gas giant multinational corporation Exxon, who funded the battery development in their pursuit of fuel alternatives to petroleum.

Intercalation is the reversible insertion or positioning of ions, atoms or molecules in a lattice structure, where they sit between layers of the structure.

It is worth giving Whittingham's own explanation of intercalation. Whittingam writes "*The phenomenon of intercalation has been most commonly been applied to the calendar, such as the quadrennial intercalation of February 29 in the calendar year. In chemical terms, intercalation has been associated with the insertion of guest species between the layers of a crystalline host lattice.*" This was a significant breakthrough. However, the cell voltage was low at about +2 V and the cell was too volatile and explosive to be practical. One significant problem was the build-up of lithium branches or whiskers from the anode. This buildup of lithium whiskers on the anode is known as a **dendrite**. The dendrite can result in a short circuit to the cathode by penetrating the separator, as shown in Figure 1(b). This short circuit can result in explosive cell failure.

The next breakthrough is credited to **John Goodenough** (1922-2023), who developed a cobalt-oxide cathode (CoO_2), as seen

in Figure 1(c). This was significant as the cell voltage with the cobalt-oxide cathode was close to +4 V, achieving the full electrode potential of the lithium. Additionally, the cell was more stable. However, both the Whittingham and Goodenough batteries featured an elemental lithium anode. The solid metal anode worked well for the primary cell but was to remain a source of explosive failure in the rechargeable cell, as dendrites built up as the cell was recharged.

Akiro Yoshino (1947-), working at Asahi Chemical of Japan, solved the anode problem by replacing the solid metal anode with a petroleum coke anode, as in Figure 1(d), which, like the cobalt-oxide cathode, could intercalate the lithium ions.

Asahi Chemical's **Isao Kuribayashi** pushed hard to get working prototypes of the Yoshino battery developed and then to develop a partnership with Sony. In the end, Sony commercialized the first Li-ion battery cells in the early 1990s, and their expertise in portable electronics was supported by their battery development and manufacturing expertise. The commercial battery was based on the petroleum coke-based anode, the cobalt-oxide cathode and a non-aqueous electrolyte. Despite his contributions, Kuribayashi did not share in the Nobel prize, which is limited to three recipients. The rechargeable Li-ion battery has gone on to transform the mobile electronics world from phones to laptops, and with time, electric vehicles. The drive towards renewables, based on wind and solar, has also been enabled by Li-ion technology to provide large storage batteries.

The half-cell and cell reactions and voltages are shown in Table 1. A half-cell voltage of +1 V is developed at the cathode with -3 V at the anode. The difference between the cathode and anode, +1 V minus -3 V, gives the overall cell voltage of +4 V.

Table 1: Half-cell equations for charge and discharge of Li-ion cell.

Chemistry	Electrode	Reaction	Equation	Voltage (V)
Li-ion Charge	Cathode	Oxidation	$LiCoO_2 \rightarrow CoO_2 + Li^+ + e^-$	+1
	Anode	Reduction	$C_6 + Li^+ + e^- \rightarrow LiC_6$	-3
	Cell		$LiCoO_2 + C_6 \rightarrow CoO_2 + LiC_6$	+4
Li-ion Discharge	Cathode	Reduction	$CoO_2 + Li^+ + e^- \rightarrow LiCoO_2$	+1
	Anode	Oxidation	$LiC_6 \rightarrow C_6 + Li^+ + e^-$	-3
	Cell		$CoO_2 + LiC_6 \rightarrow LiCoO_2 + C_6$	+4

The rocking-chair analogy is commonly used to explain the operation of a Li-ion cell. The image is that of the lithium ions rocking back and forth between the

cathode and anode as the cell is discharged and charged, as illustrated in Figure 2.

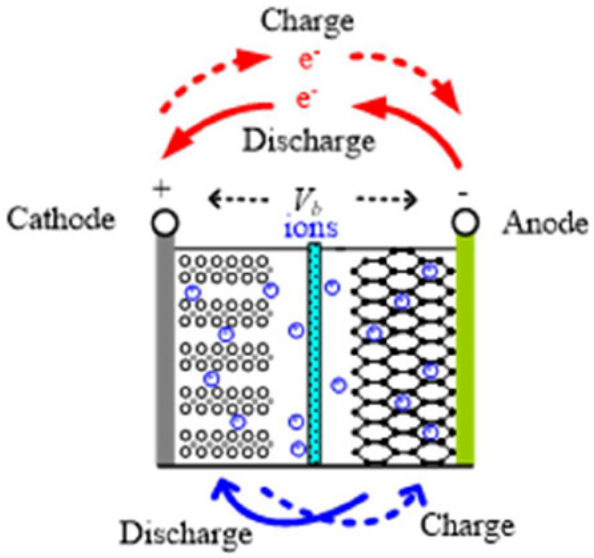

Figure 2: The rocking chair analogy

Common examples of lithium batteries are shown in Figure 3. The button or coin lithium cell is widely used in many devices. The CR2032 is a non-rechargeable, or primary, lithium metal cell. The cylindrical 18650 (18 mm diameter and 65 mm in length) lithium-ion cell is widely used in rechargeable devices. Devices, such as laptop computers, will use flat lithium-ion batteries, known as pouch cells. Here we see four pouch cells in series to give a higher voltage.

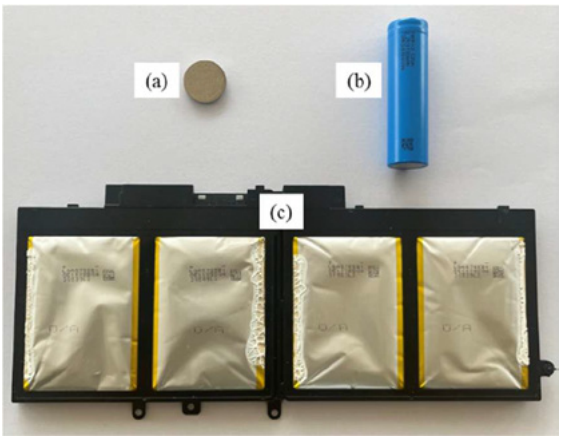

Figure 3: Examples of (a) a non rechargeable CR2032 lithium coin, or button, cell, (b) a rechargeable cylindrical 18650 lithium-ion cell, and (c) a rechargeable laptop battery with four lithium-ion pouch cells.

Biography

Dr. John Hayes is a senior lecturer in Electrical and Electronic Engineering at University College Cork. John specializes in electrical power and electric vehicles. He is the lead author of Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, published in English by John Wiley & Sons in 2018, and in Chinese by China Machine Press in 2021.

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From plant waste to batteries: could wood and sodium power the future?

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Batteries power much of modern life. Phones, laptops, electric vehicles (EVs) and renewable energy storage devices all rely on rechargeable batteries. Today, most of these devices use lithium-ion batteries, but lithium is scare and designated a critical raw material so scientists are increasingly searching for alternative battery chemistries that are cheaper, more sustainable and easier to produce. One promising option is the sodium-ion which is abundant and sustainable. Our research at the University of Limerick explores how plant-derived materials could help improve sodium batteries in terms of their efficiency and battery life allowing for example longer ranges and faster charging of EVs. .

Why look beyond lithium?

Lithium batteries work very well but have some limitations. Lithium is relatively scarce and most deposits are found in only a few countries. Mining lithium can also have environmental impacts, particularly through water use. Sodium, however, is one of the most abundant elements on Earth and is found in seawater and the Earth's crust. Because of this, sodium batteries could potentially be cheaper and easier to produce. During charging and discharging, sodium ions move between two electrodes through an electrolyte, see Figure 1.

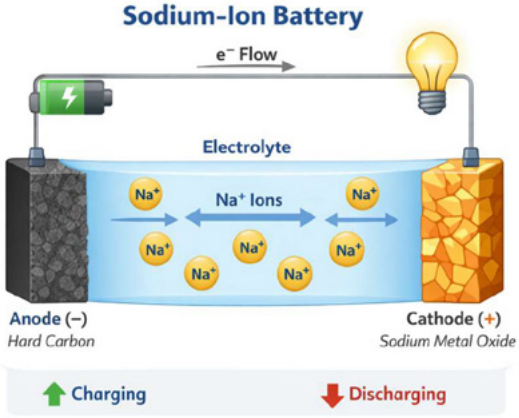

Figure 1: Sodium-ion batteries' working diagram.

Rechargeable batteries contain two electrodes: a cathode and an anode. For sodium batteries, a promising anode material is hard carbon, which contains many tiny spaces that can store sodium ions. Instead of petroleum-based materials, our research uses lignin from wood, lignin iscarbon-rich and is a by-product of the paper and pulp industry with the cellulose used to produce paper and packaging, to create sustainable carbon nanofibres for battery electrodes as shown in Figure 2.

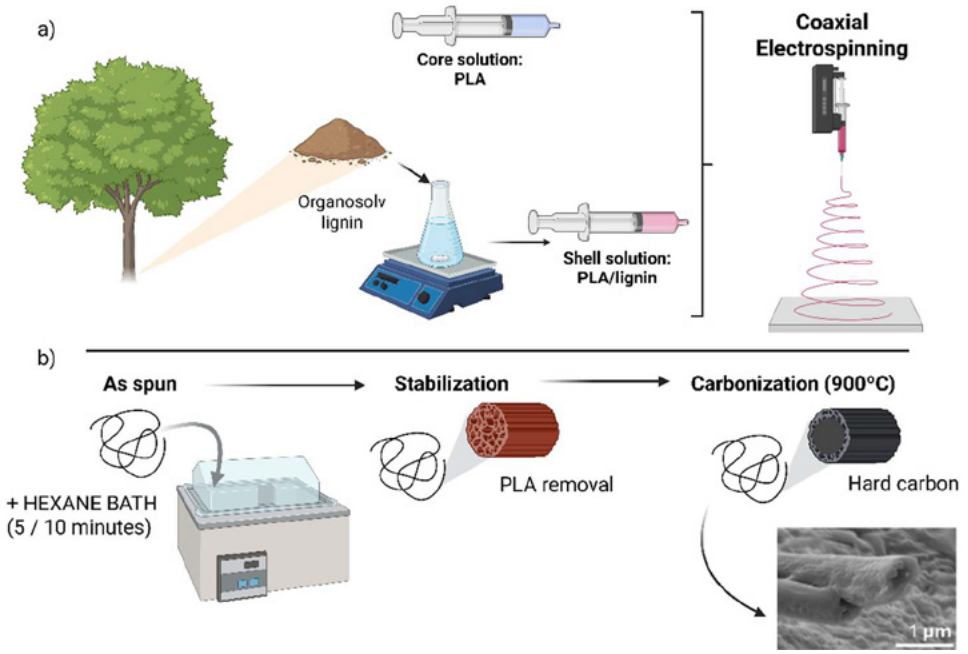

Figure 2: Production of lignin-based carbon nanofibres using coaxial electrospinning.

In this process, two polymer solutions are pushed through a special nozzle and stretched into nanofibres using a strong electric field. After heating, the inner part of the fibre disappears, leaving hollow carbon nanofiber tubes. These hollow structures provide additional space for storing sodium ions during battery operation.

Strengthening the fibres

During early experiments we found that some fibres collapsed during heating, which reduced their performance. To improve their stability, we introduced a simple extra step. After electrospinning, the fibres were briefly placed in a hexane solvent bath before heating.

The length of this treatment turned out to be important. Fibres treated for 10 minutes began to fuse and lose their shape. However, fibres treated for 5 minutes kept a more uniform structure and formed well-defined hollow fibres after heating.

Testing the fibres in a battery

To evaluate their performance, we assembled small laboratory batteries commonly known as coin cells. Our wood based carbon nanofibres were used as the anode, while sodium metal acted as the counter electrode. The batteries were repeatedly charged and discharged to measure how much energy they could store. The fibres treated for 5 minutes in hexane stored more than twice as much charge as the untreated material (Shell 3), Figure 3. In fact, the capacity increased by 129%, while remaining stable over 250 charge cycles.

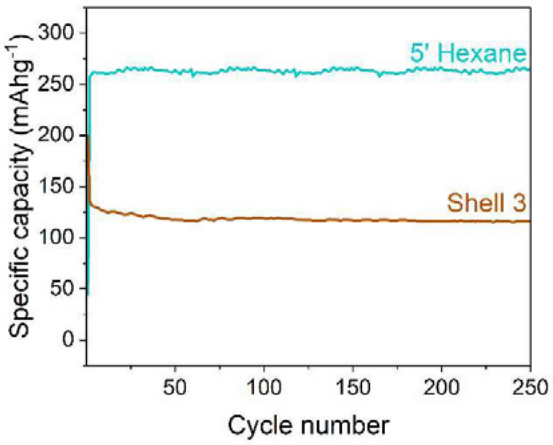

Figure 3: Comparison of battery performance for untreated fibres and fibres treated in hexane for 5 minutes.

Looking ahead

Our research shows that plant-derived materials such as lignin can be transformed into effective battery components. By carefully controlling how these materials are processed, we can improve their structure and performance. Sodium-ion batteries are still being developed, but advances in materials like these suggest that

they could become an important technology in the transition to more sustainable energy storage. In the future, batteries made partly from plant waste might help power everything from renewable energy grids to everyday electronic devices.

Biography

JMJ did her bachelor's degree in bioengineering at the Universitat Internacional de Catalunya, Barcelona, Spain. Having worked in several fields in industry, such as 3D printing and prosthetics, she started her PhD in materials science in 2023, at the University of Limerick.

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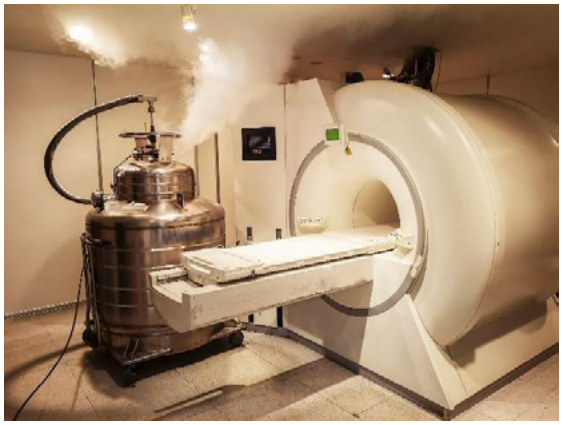
Editor's note: Sodium batteries are already in production and use. China already has sodium battery plants and looks likely to dominate this market as it does the lithium battery market.

https://www.iea.org/commentaries/sodium-ion-battery-momentum-grows-but-challenges-remain

Elementary Chemistry

Threat to helium supplies

Helium is a relatively rare element as once it is released into the atmosphere it is lost. It has important uses in making semiconductors by providing an inert atmosphere, making iptical fibres, also in welding, and in cooling superconducting magnets for MRI machines and NMR instruments.



It is a by-product of the production of natural gas, originating is radioactive decay, and the Gulf is a major supplier. Around 33% of global supply comes from Qatar, and it is shipped around the world as liquefied helium. It has a shelf life of ~45 days and so the helium trapped in the Gulf by the war is slowly wasting away. The other major supplier is the USA (40%). This would be a major loss of an irreplaceable resource. In 2025 190 x 10^6 m^3 of helium were produced worldwide. Supplies of helium are essential for the manufacture of silicon semiconductors. Contrary to popular opinion, the use of helium in balloons is a minor use, as is the use in airships.

For the major uses of helium see:
https://rockymountainair.com/blog/10-helium-uses/
Helium crisis favours the USA.
https://theoregongroup.substack.com/p/helium-crisis-puts-us-in-control

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Amazing Minerals #6 Limestone

Limestone, calcium carbonate, $CaCO_3(s)$, is probably one of the best-known minerals, and one of the most ubiquitous in the landscape, and one of the most widely used minerals worldwide. Limestone rock underlies most of Ireland (Figure 1).

Figure 1: Geological map of Ireland (GSI)

The global market for limestone reached a volume of 6.18 billion tonnes in 2024 and is projected to grow to 9.78 billion tonnes by 2034. Around 350 million tonnes of lime, derived from limestone by calcination (heating), are produced each year, emitting large amounts of CO_2. Cement production and iron and steel production are major consumers of limestone and emitters of CO_2. Modern civilisation is literally built on or using limestone: building and road construction, cement, railway ballast, iron and steel. Take these away and there's very little left. It is one of the most important raw materials for the chemical industry and is important in agriculture, in water treatment, and in the food industry. In fact, limestone and its derivatives (lime and slaked lime) have so many uses that it's impossible to cover them in a short article.

The largest reservoir of carbon by a large margin is limestone and it is one of the major carbon sinks.

It is often said that the use of sulfuric acid is a measure of industrial prosperity, after Justus von Liebig first said it in the 19th century. 270-300 million tonnes of sulfuric acid are produced each year and used in a variety of industries and processes. Limestone could perhaps be considered a better indicator in the 21s century, as 30 x more limestone is used in a wide variety of industries, including many chemical uses.

Different types of limestone

There are many different types of limestone, which are mainly composed of calcium carbonate. They differ in hardness, colour and density as the photo below illustrates. Even marble comes in many different patterns and colours (Figure 2).

Figure 2: Different types of limestones. **Limestone: Formation, Types, Uses, and Sustainability**

We tend to think about marble as one material but there are many different types of marble as the Figure 3 below shows, which are just a fraction of the variety available. One of the best known is Carrara marble from the Carrara quarries in Italy.

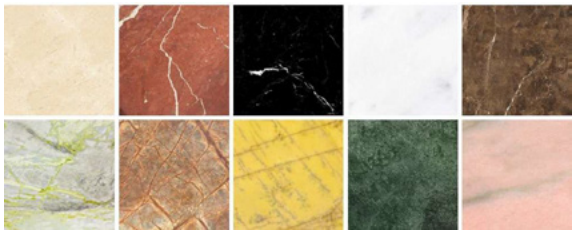


Figure 3: Some of the varieties of marble available.

Figure 4: Cararra marble quarries, Tuscany, Italy.
Photo by Michele Buzzi, Studio Cicero, Milano, 2006.
Carrara Marble quarry - Carrara marble - Wikipedia

Some different generic types of limestone

Limestone is a broad classification which encompasses many different minerals.

List of types of limestone - Wikipedia

- Bituminous limestone
- Carboniferous Limestone – Limestone deposited during the Dinantian Epoch of the Carboniferous Period
- Coquina – Sedimentary rock that is composed mostly of fragments of shells
- Coral rag – Limestone composed of ancient coral reef material
- Chalk – Soft carbonate rock
- Fossiliferous limestone – Limestone containing fossils
- Lithographic limestone – Type of limestone with hard fine grain
- Marble – Metamorphic limestone
- Oolite – Sedimentary rock formed from ooids
- Rag-stone – Work done with stones that are quarried in thin pieces
- Shelly limestone – Limestone containing many fossils
- Travertine – Form of limestone deposited by mineral springs
- Tufa – Porous variety of limestone rock

Lime kilns

Figure 5: Some typical Irish lime kilns

As you travel around Ireland or England you will come across derelict lime kilns (Figure 5), used to turn limestone rock, calcium carbonate, into lime, calcium oxide, by heating it in a kiln at high temperatures, a process known as calcination. These were very common around Ireland and lime was made locally

until the early 20th century, when it became easier and cheaper to buy it ready-made from large industrial producers. The chemistry involved is simple.

$$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$$

Lime (quicklime) was used to raise the pH of acid soils, and was slaked with water to form slaked lime, used to whitewash houses. A lot of heat is liberated when lime is slaked.

$$CaO(s) + H_2O \rightarrow Ca(OH)_2(s) \rightarrow Ca(OH)_2(aq)$$

Quicklime Slaked lime Limewater

A saturated solution of calcium hydroxide is known as limewater used as a test for $CO_2(g)$. These reactions are shown in the lime cycle diagram below (Figure 6).

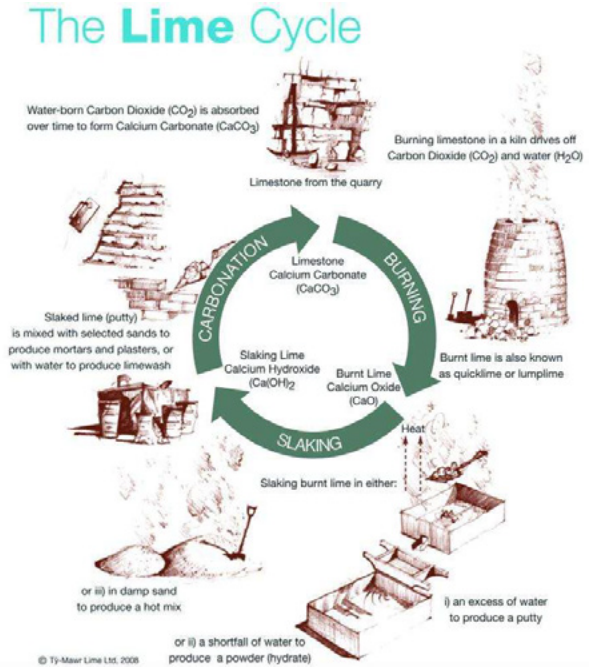


Figure 6: The lime cycle diagram
https://www.lime.org.uk/knowledge-base/introduction-to-lime-lime-and-its-production/

The carbon cycle

The carbon cycle shows how carbon, in different chemical forms, cycles around the environment between the atmosphere (gaseous), the hydrosphere (aqueous), the biosphere and the geosphere or lithosphere (solid). (Figure 7)

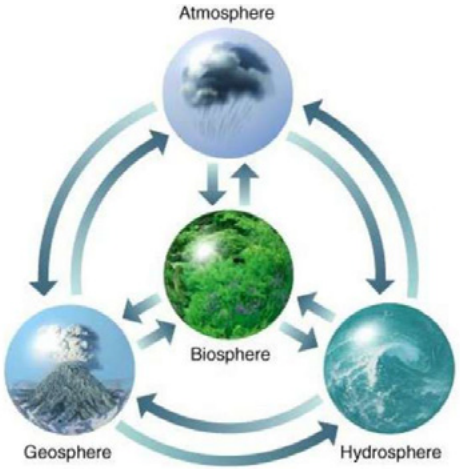


Figure 7: The earth's four interacting spheres

Calcium carbonate, calcium hydrogencarbonate and carbon dioxide play important roles in all four spheres as part of the carbon cycle, along with other carbon compounds (Figure 8).

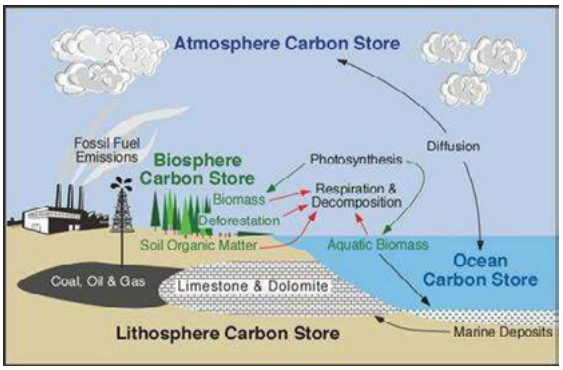


Figure 8: The carbon biogeochemical cycle
https://www.geomon.co.uk/carbon-storage-in-ecosystems/

It is implicated in the greenhouse effect, global warming and climate change (through CO_2 levels in the atmosphere); it regulates the pH of the oceans, it acts as a sink for CO_2 in the oceans and is the major carbon reservoir n sedimentary rock. Table 1 shows estimates of the carbon content of various reservoirs in the environment. These numbers can't be measured directly and so have to be estimated, and so different diagrams and publications will have different numbers. There is no shortage of carbon and the biggest

reservoir is limestone. Our massive use of limestone is only a drop in the bucket, a small rock in a massive cliff. Calcium carbonate forms corals and shells, and precipitates out in the oceans to form sediments and is converted over geologic time into sedimentary rocks.

Table 1: Carbon reservoirs in the environment (1 Gt = 10^9 t)

Location	Size/ Gt carbon
Hydrosphere: Oceans	38,400
Atmosphere	720
Biosphere	
Terrestial	2,000
Aqueous	1-2
Lithosphere	
Sedimentary carbonates	>60,000,000
Kerogens	15,000,000
Fossil fuels (oil, gas, coal)	4,000

Uses of limestone

Figure 9 shows the range of uses of limestone in its different forms. Vast quantities are mined or quarried each year and used in a variety of uses. Limestone is important for making cement, iron and soda-lime glass, various chemicals, as well its use in construction and in agriculture. Modern society couldn't function without limestone.

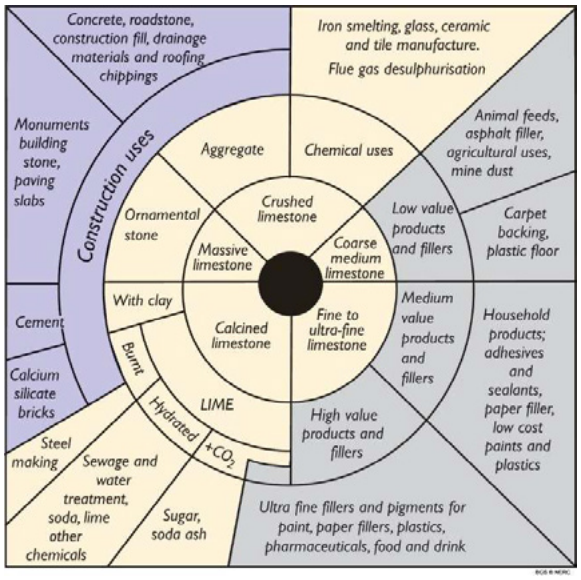


Figure 9: The many uses of limestone (British Geological Survey; Google Image Result)

The chemical uses of limestone

Chemical uses are when limestone is converted into a new substance or used to make chemicals. Here are **some** of the chemical uses of limestone. Modern civilisation is largely built of two things: iron and steel and concrete (from cement). Limestone is a vital ingredient in both. Both industries are massive emitters of CO_2 as limestone decomposes when heated releasing CO_2.

a) Making iron and steel. Limestone is used as a flux in a blast furnace. For every tonne of steel made by the blast furnace/basic oxygen furnace route (BF/BOF), we need 270 kg limestone (70% total steel production). If steel is made using an Electric Arc Furnace (EOF) only 88 kg limestone are needed 30% total steel production). In 2024 world production of steel was 1.9 x 10^9 t (1.8 Gt). The iron and steel industry only uses ~3% of limestone production.

b) Cement production. Massive amounts of cement are made each year (~1.5 Gt/yr.) Limestone is 80% of the raw materials for making cement. Every tonne of cement needs 1.5-1.6 t of raw materials of which 1.2 t is limestone. Ireland produces over 5 Mt of cement each year and so needs 6 Mt of limestone.

c) Limestone is burnt to produce lime, CaO, and each tonne of limestone produces 560 kg of CaO and 440 kg CO_2. A major use would be in agriculture for liming acidic soils. Farming uses >2 Mt/yr of limestone.

d) Premier Periclase in Drogheda used to make magnesia (MgO) from seawater using limestone, converted into Ca(OH)2 to precipitate Mg(OH)2 from seawater. Sadly the company closed in 2022. It made 100,000 t MgO each hear as a refractory and this needed ~ 230,000 t/yr of limestone.

e) CAN fertiliser is made by blending calcium nitrate and ammonium nitrate, which prevents the use of ammonium nitrate as an explosive. Calcium nitrate is made by reacting limestone with nitric acid. It used to be made by NET in Arklow.

f) Pfizer started in Ireland by producing citric acid, made by fermentation in Ringaskiddy (from 1969-1990). Limestone (or lime) is used to purify the citric acid by precipitating out calcium citrate. This can be filtered off and washed and citric acid reformed by adding sulfuric acid to precipitate calcium sulfate (gypsum).

g) The most common type of glass is soda-lime glass, used in window glass, bottles and jars. Soda-lime glass is composed mainly of silica (~70-75%), sodium oxide (soda, ~13-15%), and calcium oxide (lime, ~9-10%). About 100-150 kg limestone are used to make 1 t of glass. It is the most common form of glass and world production is ~84 Mt/yr which would need ~8.4 Mt limestone.

h) Sugar can be obtained from sugarcane or sugar beet once an important Irish agricultural industry. Limestone played an important role in the purification of the extracted sugar. In beet sugar processing, about 125 kg (0.125 tons) of limestone is required to produce one tonne of sugar. Limestone is burnt to produce lime and this is slaked to produce milk of lime ($Ca(OH)_2$, aq). This is added to the raw sugar juice to precipitate impurities and control the pH. Global sugar beet production is approximately 250–280 million tonnes annually, accounting for roughly 20–25% of the world's total sugar supply, with the remainder coming from sugarcane. This means making sugar from sugar beet uses 31-35 Mt limestone per year.

i) Soda ash or soda is sodium carbonate. It is now mostly made by the Solvay process and limestone is one of the raw materials (as a source of CO2), together with brine (NaCl, aq) and ammonia. The diagram below shows the various chemical steps. Ammonia and CO_2 are recycled in the process. The Solvay process produces ~ 50 Mt/yr soda ash using roughly 1.5 to 1.6 tonnes of limestone and 1.5 to 1.7 tonnes of salt per tonne of soda ash produced.

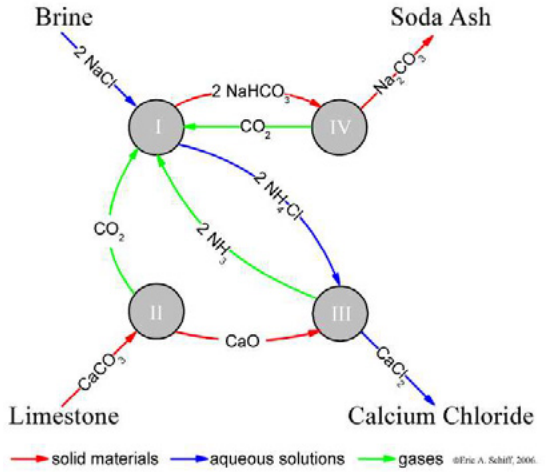


Figure 10: Chemistry of the Solvay Process https://en.wikipedia.org/wiki/Solvay_process#/media/File:Solvay_Process.PNG

j) Removing sulfur as sulfur dioxide is important in flue gas desulfurisation (FGD) to reduce air pollution from power stations, and is his is done using a wet slurry of limestone (basic) which absorbs the SO_2 (acidic) to form calcium sulfite or sulfate (gypsum).

Project work

Researching the uses and chemistry of limestone would be a good class project for Transition Year. Displays could be built around samples and the chemistry involved in making lime, cement and iron could be illustrated. Local quarries could be located, and students could find out what they produce and how the raw material used. It could include the geological importance of limestone, water chemistry, stalactites and stalagmites, CO_2 and atmospheric chemistry and climate change. Students could be asked to look

out for old lime kilns and make a photographic display. The uses and chemistry and role of limestone is a vast topic and each group could research and present on a different topic and make a classroom display. For example, how is limestone used in the sugar industry, the glass industry, obtaining magnesium oxide from seawater, making citric acid, in toothpaste etc.

□

Chemlingo (p. 61) looks at some of the words associated with limestone and their etymology.

Elementary Chemistry

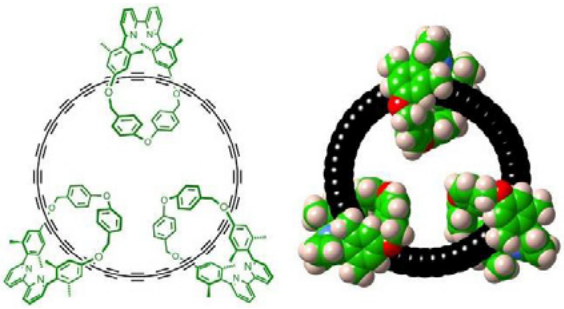
A new carbon allotrope

It's hard to keep track of new structural forms of carbon. Chemists have made a new circular form of carbon, C48, with 48 linked carbon atoms.

The new molecule – cyclo[48]carbon, made up of 48 carbon atoms in an alternating single/triple bond pattern – is stable enough to be studied in liquid solution form at room temperature.

The study – only the second example of a new type of molecular carbon allotrope that can be studied under normal laboratory conditions.

In the new study, the molecule cyclo[48]carbon was synthesised as a [4]catenane, i.e. with the C_{48} ring threaded through three other macrocycles. These threaded macrocycles increase the stability of C_{48} by preventing access to the protected cyclocarbon.



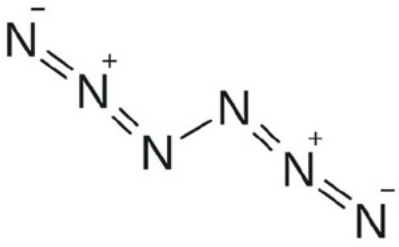
https://www.chem.ox.ac.uk/article/synthesising-a-new-allotrope-of-carbon

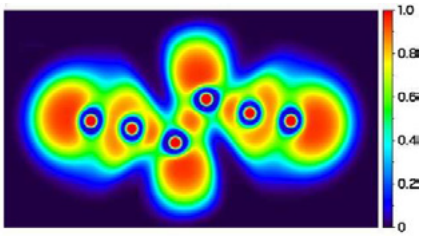
□

New form of nitrogen

New form of nitrogen

Unlike carbon or oxygen, nitrogen is lacking in allotropes, different forms of the same element. Nitrogen prefers to exist as the very stable N2 molecule. Chemists have now made hexanitrogen, a neutral molecule with 6 linked nitrogen atoms. It was made from silver azide and is two azide ions linked together.





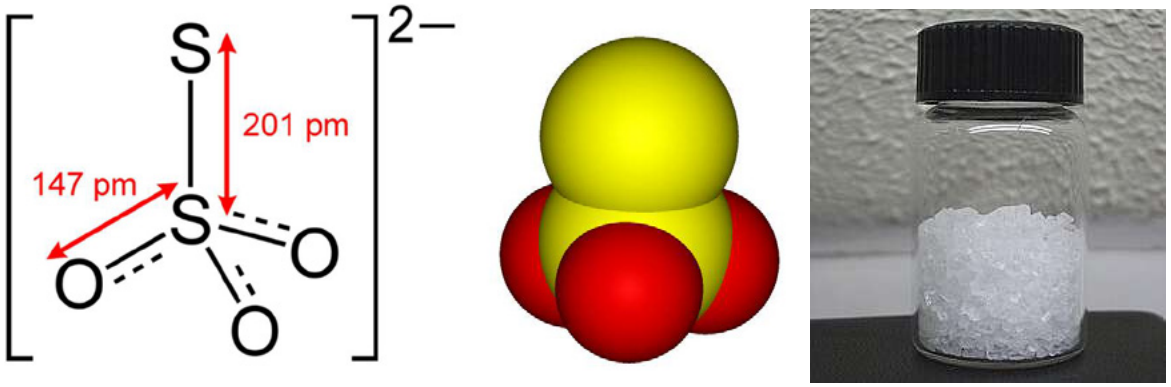
https://en.wikipedia.org/wiki/Hexanitrogen

□

The sulfur story: devils' gold or essential element? #7 Sodium thiosulfate, $Na_2S_2O_3$ https://en.wikipedia.org/wiki/Thiosulfate

If you were ever an amateur photographer with a home darkroom, before digital cameras, you will have come across Hypo, aka Fixer, sodium thiosulfate, a key chemical in processing film and paper. It is probably more familiar in the school laboratory for iodine-thiosulfate titrations and in kinetics experiments. The structure of the thiosulfate ion is tetrahedral, with a sulfur at the centre, bonded to 3 oxygen atoms and 1 sulfur atom. The outer sulfur has replaced an oxygen atom in sulfate. The S-O bonds have a delocalised double bond character using p orbitals on the oxygens and the S-S bond is a weak single bond, so that it is easily broken.

Sodium thiosulfate was first made by Sir John Herschel in 1819 and he discovered that it would dissolve silver halides. He shared this information in 1839 with Louis Daguerre and William Fox Talbot, which enabled early silver-based photography. The reaction of iodine with starch to form a blue colour, the basis of iodometry, was first described in 1814, shortly after the discovery of iodine in seaweed in 1811. Robert Bunsen developed specific iodometric techniques in 1853, establishing it as a reliable method for quantitative analysis.



The thiosulfate ion and sodium thiosulfate pentahydrate crystals

Uses

a) Silver-based photography

Before the advent of digital cameras photography was based on silver salts, especially silver bromide or chloride. Films and printing papers were coated with tiny grains of silver salts. On being exposed to light the salts decomposed to give silver nanoparticles. During development of films or paper a fixer solution of sodium thiosulfate was used to fix the exposed image by dissolving away the untouched silver salts as a soluble silver complex, leaving the silver particles behind. Light exposure produced black silver particles, so you got a negative image. When printed the process was reversed, black became white, and a positive image emerged. The fixer was again used to dissolve the unaffected silver salts in the printing paper. Sodium thiosulfate (old name was sodium hyposulfite hence Hypo). Today the ammonium salt is used rather than the sodium salt because it reacts faster.

$AgX(s) + Na_2S_2O_3(aq) \rightarrow Ag_2S_2O_3(aq) + 2NaX(aq)$

Negative and positive images. www.belindajiao.com

Silver-based photography has largely been replaced by digital photography. 50 years ago 40% of silver was used in photography. In 2000 218 million oz. of silver were used, 25% of the total silver usage. In 2020 this had dropped to 30 million oz., ~3.3%.

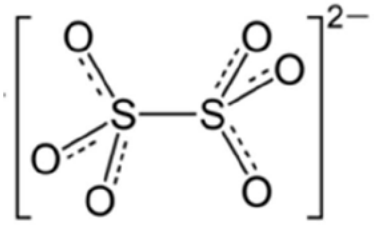
Used fixer solutions contained silver in solution and it was worth collecting to extract the silver for reuse. There were three main ways of recycling silver from used fixer solution.

1. Chemical reaction using sodium chloride or sodium sulfide to produce insoluble AgCl or Ag_2S, or using sodium hypochlorite and hydrazine to produce solid silver.
2. Electrolysis so that metallic silver is deposited on the cathode.
3. Metal displacement using steel wool, where the more reactive iron displaces silver which forms a sludge.

b) Iodometry

Iodine can be determined using sodium thiosulphate solution, which is a reducing agent. The thiosulfate is converted into the dithionate ion (see structure below) and the iodine into iodide ion. Starch is used near the end-point as an indicator for free iodine. This titration is commonly used to analyse for oxidising agents which quantitatively convert iodine into iodine, which is then determined by thiosulfate titration. The Winkler method for dissolved oxygen is an application of this chemistry. The Winkler Method - Measuring Dissolved Oxygen (The iodine is actually in the form of the soluble I_3^- ion as the non-polar iodine is effectively insoluble in water.)

$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$



Dithionate ion

The dithionate ion illustrates the tendency of sulfur to form single bonds with itself, as in the elemental form, S_8.

The chemistry of thiosulfate is used in two reactions illustrating kinetics.

i) This reaction with iodine is the basis of the iodine clock reaction used to demonstrate kinetics.

In the first, slow reaction, iodine is produced:

$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(s) + 2H_2O$ Slow

In the second, fast reaction, iodine is reconverted to iodide ions by the thiosulfate:

$2S_2O_3^{2-}(aq) + I_2(s) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$ Fast

After some time when all the thiosulfate has been used up, the solution changes colour to a very dark blue, almost black due to the presence of starch indicator.

Iodine clock reaction - Wikipedia

Scoilnet recipe. 37888.pdf

ii) Thiosulfate ions decompose in the presence of acid to give elemental sulfur (a white precipitate) and sulfur dioxide gas. This is a reversal of its preparation.

$8S_2O_3^{2-}(aq) + 16H^+(aq) \rightarrow 8SO_2(g) + S_8(s) + 8H_2O$

This is the basis of a kinetics experiment to either show the effect of concentration on rate or to determine the rate law. The solution gradually goes cloudy as sulfur is produced.

Microsoft Word - SulfurClockLab.doc

c) Medical uses

Sodium thiosulfate is used as an antidote to cyanide poisoning, but only if it is administered quickly and after administering sodium nitrite. In cyanide poisoning, sodium nitrite creates methemoglobinemia, which removes cyanide from the mitochondria. Sodium thiosulfate then binds with cyanide, creating the nontoxic thiocyanate.

Thiosulfate is also used to reduce the side-effects of cis-platin, an anticancer drug.

d) Miscellaneous uses

Thiosulfate is a reducing agent and it can be used to dechlorinate drinking water or to lower chlorine levels in swimming pools. This reaction is analogous to the iodine-thiosulfate reaction. It can also be used to removed unwanted bromine.

It has been used in alkaline solution as an alternative to cyanide in leaching gold from ores.

Preparation

Sodium thiosulfate is prepared by heating sodium hydrogensulfite (bisulfite)with sodium hydroxide and sulfur:

$2NaOH(aq) + S(s) + 2NaHSO_3(aq) \rightarrow Na_2S_2O_3(aq) + 2H_2O$

Or by heating sodium sulfite with sulfur:

$S(s) + Na_2SO_3(aq) \rightarrow Na_2S_2O_3(aq)$

It is crystallised out as the pentahydrate, $Na_2S_2O_3.5H_2O$, a white ionic solid, which is the form it is usually supplied in. It is a primary standard.

Resources

For the chemistry of the thiosulfate ion see: The chemistry of thiosulfate ions – teacher notes

□

Elementary Discoveries: who first isolated the element?

No. 1 Arsenic Albert the Great, Albertus Magnus, ca. 1200 to 15/11/1280 AD

Adrian J. Ryder
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In this series we look at the discovery of some of the elements, where the priority was disputed.

Little is known about Albert the Great's family, but it seems likely that he was born into a prosperous officer class family in Lauingen sometime between 1193 and 1207. Lauingen was a small town in Germany (today's population c. 10,800) on the left bank of the Danube some 37 km northeast of Ulm. Surnames were not then in use and Albert always signed himself as Albert of Lauingen on documents. He appears to have had a brother, Henry of Lauingen who became prior of the Dominican house in Würtzburg. Other than this there is nothing found about Albert's family or his childhood. The three images of Albert, shown below, depicting him at different stages of his life, were made hundreds of years later and probably have no resemblance to the man himself. Figure 1 shows the memorial to Albert the Great front of the Lauingen town hall.

Figure 1: Memorial to Albert the Great front of the Lauingen town hall.

The earliest reliable date is given by Albert himself when describing the earthquakes in Lombardy in midwinter 1222-3, of which he was an eyewitness. It seems that he had independent resources that enabled him to spend years travelling and visiting various mining districts, with a long stay in the University of Padua, which had just opened there in 1222. Although undertaking studies in the classical arts he also seems to have found time to study medicine, which at the time was the only formal scientific study in any University. Whatever courses he did take however, were not to lead to a degree.

The Dominicans were founded in Toulouse by a Spanish priest, St. Dominic, (8/8/1170-6/8/1221), being approved by Pope Honorius III (1150-18/3/1227) on 22/12/1216. Their mission was to preach the Gospel and to combat heresy, which it did by teaching and scholastic involvement, and put them at the forefront of the Middle Ages intellectual life. It was in Padua that Albert first became acquainted with the Dominicans through their second Master General, Jordan of Saxony. However, opposition from his uncle caused him to consider what he ought to do and it was not until 1229 that he was received into the order. Since he came from the German-speaking part of Europe he was assigned to the Teutonic province, whose main centre was in Cologne and it was here that he devoted his time to theology and moral philosophy,

the studies necessary for ordination to the priesthood.

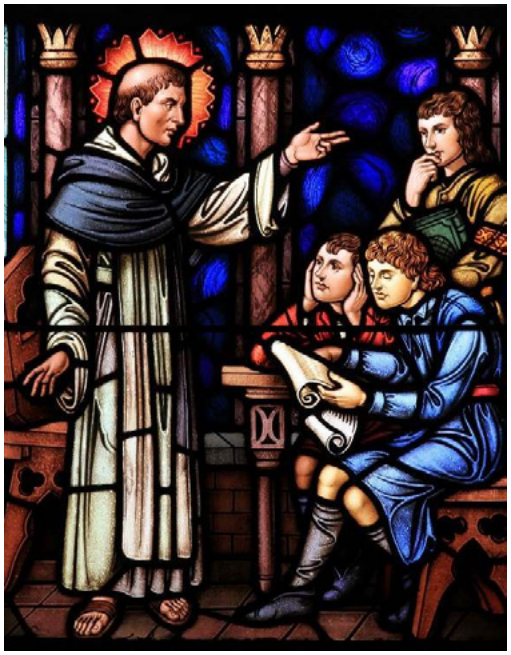

Figure 2: Artist's impression of Albert as Lector

He was now appointed as lector (Figure 2), someone who interpreted the various scriptural readings for the less educated members, and was sent around to various Dominican houses. He was in Hildescheim about 1234, Freiburg in 1236 and later in Regensburg and Strassburg, before returning to Cologne. In 1238 Jordan of Saxony died in a shipwreck off the Syrian coast, leading to the election of a new Master (the third of the Order) and Albert was already so well thought of that he was put forward as Cologne's choice. However, the French province had put Hugo of St Cher forward and the election saw both candidates with equal votes. With each group not willing to accept the others choice, a compromise was found in the election of a Spaniard, Raymond of Pennafort.

Albert remained a lector for some years after 1238 at various Dominican schools and recorded seeing the Great Comet of 1240 while in Saxony. However, in 1243 he was sent to the University of Paris where the Dominicans had operated a school for advanced studies since 1217. Here he was awarded a Master of Theology Degree in 1245, and a professorship there until 1248.

The works of the Greek philosophers, which had only just begun to appear in the West in recent years, were denounced by the Church as anti-Christian in 1210, 1215 and later in 1231. They were championed by Albert and so successful were his efforts that by 1254 they were required reading for a degree. Albert set himself the task of collecting, collating and explaining the works of the Greek philosophers. Many of their works were fragmentary, coming from various sources and where sections were missing or contradictory, they needed to be edited to give the best interpretation of them. Another task he set himself was the collection of all the current scientific knowledge of the time. Unfortunately, his genius was totally undermined by his acceptance of the totally false theory of the four elementary components of matter: fire, air, earth and water. As well as that, his non-experimental testing of the opinions of others, many of whom were charlatans, led to many of his writings being later shown to be rubbish. The following generations slavishly accepted him as virtually all-knowing and it is not until the seventeenth century and the arrival of men like Robert Boyle (*Chemistry in Action!,* #72, Spring 2004) that scientists began to become to rely on experimentation to validate theories. A few examples of his writings on precious stones are given below in support of the above.

> *Adamas, Diamond, is so solid that neither fire nor iron can soften or destroy it, but it is destroyed and softened by the blood and flesh of a goat, especially if the goat has for a considerable time beforehand drunk wine with wild parsley or eaten mountain fenugreek; for the blood of such a goat is strong enough even to*

break up a stone in the bladder, in those afflicted with the gravel. It is also destroyed by lead on account of the great amount of quicksilver in it.
Its power is greater if mounted in gold, silver or steel. Magicians say that, bound on the left arm, it is good against enemies and insanity and wild beasts and savage men, and against disputes and quarrels, and against poisons and attacks of phantasms and nightmares.
Amyethyst is good against drunkenness and gives good understanding in things that may be understood. (No details of how to use it)
Beryl (Clear), carry it with you and it shall drive away your enemies and make them meek. It causes one to be well mannered and gives good understanding.
Emerald when borne gives one a good memory, augments his riches and if held under the tongue will cause one to prophesy. It has been found by experience in our own time that this stone, if it is good and genuine, will not endure sexual intercourse: because the present King of Hungary wore this stone on his finger when he had intercourse with his wife, and as a result it was broken into three pieces. And therefore what they say [of this stone] is probable-that it inclines the wearer towards chastity. They say, too, that it increases wealth, and confers persuasive speech in [pleading] causes; and suspended from the neck, cures hemitertian fever and epilepsy . And it has been found by experience to strengthen weak sight and to preserve the eyes. They say also that it improves the memory, and averts tempests, and is good for divination; and therefore it is sought after by magicians.

He writes that Aristotle said of the clear transparent gemstones, such as rock crystal and beryl, that they are made of water by the complete removal of heat (fire). Albertus accepts that all transparent coloured gemstones are made of water, but insists that a little subtle earth is adjoined giving the various colours.

(Professor Dorothy Wyckoff's translation and commentary on his work, the book of minerals, referenced at the end is well worth a detailed reading to gain a full understanding of the state of Science at the time. Prior to Albertus there had been no systematic study of minerals.)

Albertus' writings were collected after his death and amounted to 38 volumes. The covered such subjects as logic, theology, botany, geography, astronomy, mineralogy, chemistry, zoology, physiology, and phrenology, all of it the result of logic and observation not experimentation. Much of his philosophical writings were interpretations and re-workings of Aristotle's works, in order to align with church dogma. He believed that religion and science were compatible and did not present mutually exclusive viewpoints. His scientific works were based on hearsay and on traditions passed on through the generations rather than on any scientific experimentation. His acceptance of the four element nature of matter, fire, air, earth and water prevented any notable scientific findings, apart from his isolation of arsenic about 1250, which he seems to have laid aside as having no practical use (except, of course, for the removal of unwanted rivals).

In 1248 the Dominicans established higher schools , of university standing, in each of its four provinces of Lombardy, Provence, England and Teutonia, with Albert appointed lector (here the office encompassing that of Regent of Studies) in the Teutonia province's school in Cologne.

1252 saw his involvement in settling disputes between the citizens of Cologne and the Archbishop, which often degenerated into bloody fighting. His

intervention was necessary at various times afterwards.

In 1254 the Provincial Chapter elected Albert as Prior Provincial of Teutonia, an office he held to 1257. As Provincial he was obliged to formally visit the various Dominican houses in the Province, which extended from Alsace, Lorraine, the low countries, Germany, Austria, Switzerland, Bohemia and parts of Poland, Lithuania and Latvia. As a Dominican his travels were on foot, relying on the generosity of locals for his shelter and food. 1256 saw Albert defending the rights of the Dominican and Franciscan monks to teach at the Paris University and afterwards going to Rome, where he lectured at the Curia. In May of 1257 he obtained his release as Prior provincial and resumed his duties as Lector and his studies of Aristotle and the other Greek philosophers. His services as peacemaker were called upon again and again in the various disputes between, not only the Cologne Archbishop and its citizens, but others as well. In 1260 another dispute saw the incumbent bishop of Regensberg forced to resign, with the Curia in Rome naming Albert as the new Bishop. He was enthroned on March 30/3/1260.

Figure 3: Artist's impression of Albert as Bishop

Having dealt with the outstanding issues and reorganisation of the diocesan affairs he got permission to resign as Bishop in May 1262. The Pope, Urban IV, now brought him to Rome to join a select group of scholars and theologians to work on the Church's doctrines. In 1263 the Pope appointed him to Preach the Crusade in Germany and Bohemia, giving him the powers of a Papal Nuncio. On his way to Cologne, he consecrated local altars and churches, granted indulgences and settled local disputes, finally arriving in Cologne in July. Here he was to witness another agreement between the belligerent Bishop and the citizens, after which he went on his missionary journeys through Holland and North Germany, finally coming to his brother in Würzburg, where he remained until May 1267.

Figure 4: Artist's impression of the ageing Albert

Over the next eight years Albert, now an old man, continued in the service of the Pope in various parts of the Province, but returned to live with the Dominicans in Cologne in 1275, where he remained until his peaceful death on the 15/11/1280 and his interment in the Dominican's church there.

His grave quickly became a place of pilgrimage and he was regarded as a saint. His remains were transferred to a reliquary

and placed on an altar in 1483. The church was torn down in 1804 and Albert's bones were removed to the nearby church of St Andrew. This church was severely damaged in WW2 and afterwards, while being restored, the crypt beneath the choir was re-excavated and made into a simple white-walled chapel. In 1954, Albert's relics were placed there in a plain stone sarcophagus which rests beneath the high altar. Albert was canonised in 1931 and in 1941 was declared the patron saint of Scientists.

Isolation of Arsenic

While in Paris about 1250 Albert made the discovery that entitles him to a place in the hall of scientific achievement.

Figure 5: Arsenic (Wikipedia.org)

The courts of royalty and upper classes, (which included the Catholic Hierarchy), were dangerous places to be for rivals for preferment, in the middle-ages, with the services of professional poisoners much sought after. The favoured poison of these was the easily obtained white arsenic (As_2O_3), which was quite soluble in water when powdered, had no smell, odour or colour and was undetectable when added to food or drink. Small quantities ingested led to rapid diarrhoea, vomiting, paralysis and death. The initial reactions mimicked those of food poisoning. An acute fatal dose of arsenic is as little as one tenth of a gramme. Also since arsenic is a cumulative poison, much smaller doses taken over time would also remove the obstacle, without any outcry of foul play being raised.

Figure 6: Photo (Top) White Arsenic (IndiaMart)
Photo (Bottom) 100 ct Orpiment and Realgar ore specimen (Author)

Church leaders would have been prime targets for arsenic 'treatment' and it is likely that Albert made studies into its preparation and possible treatments, for those unfortunate enough to be on the receiving end. It should be noted that food tasters were much in demand in that time, being well rewarded, but with a limited life expectancy.

The usual arsenic ores were the yellow Orpiment, As_2S_3, arsenic trisulphide, and the red Realgar, AsS, arsenic monosulphide. Both of these were highly poisonous, but for the professional poisoner they had the great disadvantage of being highly coloured and easily seen when added to solid or liquid food. Heating either of the two in air to a moderate heat, as in a small wood fire, caused the ores to change to the white trioxide, As_2O_3, our poisoner's friend.

Albert in his experimenting, wrapped the yellow orpiment in soap and consigned it, using a bellows, to the fire. After the fire had burned out the ashes were separated by immersion in water, causing the metalloid arsenic to fall to the bottom as shiny, silvery pieces. He had isolated pure arsenic, a metalloid, the first person in recorded history to so do. In keeping with his acceptance of the four elements of matter, fire, air, earth and water, Albert would have explained that the fire added to the material had caused the water and air of the material to be removed, leaving the heavy earth part behind. Since the pure arsenic has a specific gravity of 5.7 whereas that of the orpiment is 3.49 and that of the white arsenic is 3.74 (Realgar is 3.56), he would not have been too surprised at the result.

Unfortunately, he did not put his experimental procedures in writing and we have no idea of what uses his isolated material had, or indeed of any suggestions from him for the treatment of the poison itself. However, he still gets the credit for the first isolation of arsenic.

(As a footnote to history, the arsenic ores were also used by artists for the preparation of vivid yellow and red colours, but being unaware of the poisonous nature of the ores, many of them succumbed to their fatal attraction. The book and film *The Name of the Rose* features the danger of arsenic pigments.)

Some references:

https://collections.nlm.nih.gov/ext/dw/2301096R/PDF/2301096R.pdf

https://ia800600.us.archive.org/35/items/308059821ALBERTUSMAGNUSTheBookOfMinerals/308059821-ALBERTUS-MAGNUS-The-Book-of-Minerals.pdf

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Energy storage: the missing link in the energy equation

Peter E. Childs

Not all batteries are electric!

Let's suppose we had enough renewable rated energy capacity, mainly wind and solar, to meet 100% of Ireland's electricity demand, would that be OK? There are two main problems. Firstly, and most important, the sun doesn't shine every day, and the wind doesn't blow every day or night in Ireland. The rated output is no use if there's no output. This is why we need backup energy providers, mainly gas-fired power stations or imported electricity via interconnectors (some of which from the UK and France is nuclear-based), or efficient ways of storing renewable energy. These are so-called baseload providers, which can provide consistent, 24-7 power if required.

Secondly, at times there is a surplus of renewable energy, and this can be wasted, stored or exported. Thus, a crucial element of the energy matrix is energy storage: storing energy in times of surplus to be used in times of shortage. To survive only on renewable energy means having a storage capacity much greater than daily usage, to enable supplies at night (when solar doesn't provide) or when the wind doesn't blow. The problem is that when it is cold and energy demand is highest, solar output is low or non-existent and the wind often doesn't blow. There can never be enough stored energy to make up this shortfall as stored energy rapidly gets used up. It is at best a stopgap not a substitute. Energy security means that we need backup power either using gas (including

LNG), by importing electricity (if other countries have a surplus when we need it) or by building (heaven forbid in Ireland) nuclear power stations, especially using small reactors. The energy crisis due to the war in the Gulf has shown how precarious our energy supply is and how dependent we are on outside sources.

If everyone switched to electric vehicles by the 2030s, as government wanted us to, we wouldn't have enough charging capacity. As it is, 25% of electricity is used by data centres and this is putting pressure on the system. To avail fully of renewable energy sources, we need adequate storage capacity, ideally enough for several days' supply, and as well we need backup power stations which can be switched on and off as required. Gas and nuclear are the only real options there, as oil and coal are more polluting. We don't have enough hydroelectric capacity or potential to be significant. Tidal power is a continuous and renewable resource but still presents big engineering challenges. Another problem is the Irish public's lack of appetite for any new energy infrastructure, for example, the resistance to building biogas plants (see *CinA!* #126 Spring 2025) or battery-based energy storage facilities or new wind farms or solar farms. We want and need the energy, but we don't want anything built near us. That is a recipe for future blackouts.

In this article we will look at some of the energy storage options, many of which are well developed and tried and tested options. It is also worth noting that any energy storage option costs energy to build but also to operate and there will be energy losses in any energy conversion. But losing 10 or 20% is better than losing 100% without storage. We often think of electrical batteries when we think of storing energy and so storage devices are often called, by analogy, batteries – so we have, for example, a sand battery or a gravity battery. Not all batteries are electric! This is a useful topic to talk about different kinds of energy and energy inversions.

Energy storage options

1. Storage in electrical batteries

When we think of energy storage we tend to think first of electrical batteries, electrochemical storage systems, like the lead-acid batteries in the car or lithium batteries in our phone of computer. Batteries offer a direct way of storing electrical energy from photovoltaic panels or from wind turbines. The power is stored and released as direct current and needs an inverter to convert to AC power for use.

Battery energy storage systems, often referred to as BESS, are regarded as a vital part of the Ireland's fledgling renewable energy sector and demand for them has never been higher.

ESB Networks also recently announced that Ireland's electricity grid now has 1 gigawatt (GW), or 1,000 MW, of electricity storage connected to Ireland's network.

This figure includes 731.5MW of battery energy storage system projects and 292MW from Turlough Hill pumped storage power station.

Battery energy storage systems are a vital piece of Ireland's renewable energy puzzle

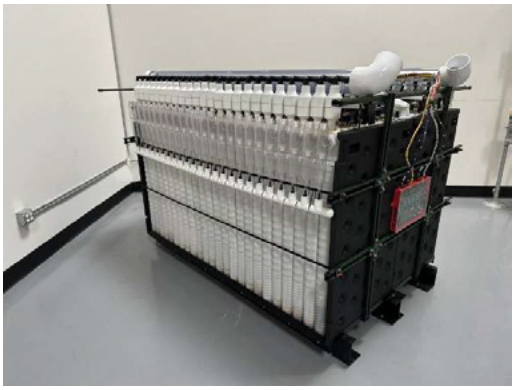
A number of so-called battery farms have opened up around the country to store surplus renewable energy. Most of these use banks of lithium batteries, which are housed in containers. Lumcloon Energy is one of the biggest players in the Irish storage battery market and has two 100MW BESS sites located on former ESB peat-fired power stations, at Shannonbridge and Ferbane.

[Lumcloon And Shannonbridge 200mw Bess]

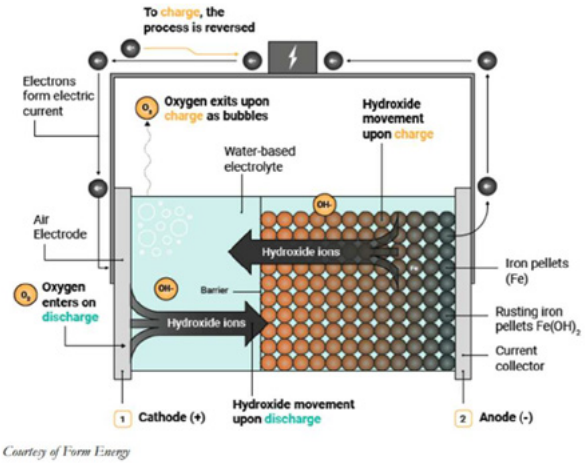
A recent proposal for a battery storage facility for Ballynahone, Buncrana, Co. Donegal uses iron-air batteries. It is rated at 10 MW and can store 1 GWh of energy, capable of discharging for 100 hours. It will be a joint venture of Ireland's state-owned forestry business Coillte and utility ESB, with batteries supplied by the US company Form Energy. The chemistry of the battery is based on rusting, cycling between iron metal and iron (II) oxide. The materials are cheap and safe, the batteries do not suffer from thermal runaway and can't catch fire, unlike lithium batteries. A battery farm like this is just a collection of container modules, linked to the grid. They are unobtrusive, don't involve a lot of road traffic, and present very low risk due to the nature of the chemistry involved. However, not surprisingly, a strong opposition group has sprung up locally to the proposed facility. The main objection seems to be that it is a relatively new battery technology.

A campaign poster

Visualisation of Form Energy's proposed iron-air battery farm at Buncrana.



An iron-air battery module.



The chemistry of Form Energy's iron-air battery.

Other electrochemical storage options include flow batteries, for example based on vanadium chemistry. (See *CinA!* #123, Autumn 2023) Watch this space for more battery chemistries being used in energy storage.

2. Thermal storage

Surplus heat can be stored by raising the temperature of solids (sand or bricks) or by melting salts or using a phase transition. Surplus electricity can be turned into heat using resistive heaters, and the heat is then stored in an insulated container containing a suitable solid or salt mixture. Using an embedded heat exchanger, heat can be extracted and used to generate steam to drive a turbine, or the heat can be used in district heating. This involves several energy transitions so there is an energy loss at each transition, but the technology is relatively simple.

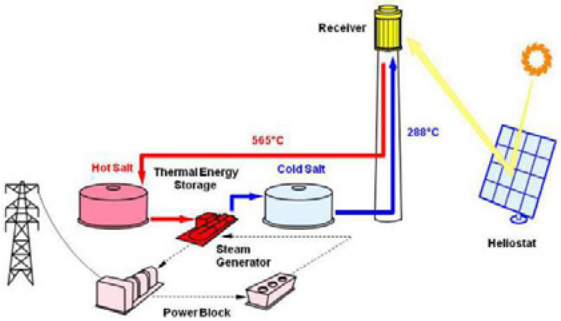
A sand battery recently opened in Finland.

This is a 13-metre silo in a small, Finnish town in the Pornainen region, which is home to a 2000-ton sand battery marking one of Europe's boldest climate pivots. On June 11, 2025, the system officially went live, eliminating oil from the town's heating network and reducing carbon emissions by approximately 70%, equivalent to around 160 tonnes per year. This is not a pilot; it's a working model, and one that doesn't rely on lithium, cobalt or even complex chemistry. It doesn't even store electricity. Instead, it stores excess renewable energy as heat using crushed soapstone and then delivers it back to the homes through the district.

Finland's sand battery slashes emissions « Euro Weekly News

Some solar farms focus the light from collecting mirrors onto a furnace, heating a heat transfer medium, which is then stored. Molten salts, graphite and molten sodium have all been used to store the heat. When electrical power is needed, the hot liquid is passed through a heat exchanger, heating water to produce steam to drive a turbine.

A solar energy plant.



How a solar energy pant works.

Storage heaters use this principle, using off-peak electricity to heat bricks, which then slowly release the heat during the day. If you have a solar water heater, the panels collect heat from the sun to heat water which is stored in an insulated tank for use later.

3. Mechanical energy storage

One way of storing energy mechanically is in a flywheel. Surplus energy is used to spin up the flywheel, which stores it as kinetic energy. It can be discharged by coupling to a generator. They are suitable for short-term usage and system up to 20MW and 30MW have been built. Flywheel Energy Storage Explained

A pendulum clock stores energy by winding up the weights. As they slowly fall

under gravity, they provide the energy to drive the clock mechanism. China is developing gravity energy batteries to store energy in raised weights in specially designed buildings, as in the Energy Vault project in Rudong, China, shown below. Other companies have suggested using old mine shafts.

A gravity battery under construction in Rudong, China. Rudong-EVX-Sept-2023-1.jpg (1600×900)

Compressed gas storage batteries

Energy can also be stored mechanically by compressing air (or other gases) and then using the high-pressure gas to drive a turbine. EnergyDome uses this idea in a CO_2 Battery, which reversibly compresses and liquefies CO_2 and then allows it to evaporate and expand to drive a turbine. It is a closed cycle so no CO_2 escapes.

EnergyDome CO_2 batteries in Sardinia. CO2 Battery can cover a large set of use cases due to its long duration, and fast response time, enabling revenue stacking for customers

4. Potential energy storage

Hydroelectric power stations use the potential energy of water as it flows from higher to lower level to drive turns to generate electricity, as at Ardnacrusha and Ballyshannon power stations. Energy can be also stored as potential energy in pumped water storage, as in the successful facility at Turlough Hill, Co. Wicklow. This is rated at 294 MW capacity and was built in 1974. When there is surplus electricity, often at night, water is pumped from a lower reservoir to a higher one. When electricity is needed, the water is allowed to run down through turbines generating 294 MW when there is peak demand. It is a simple and effective solution but needs the right geography. It is an elegant and brilliant solution to the energy storage problem.

The Turlough Hill pumped storage facilty. Turlough Hill

Another pumped storage facility is in the planning stage at Silvermines near Nenagh, Co. Tipperary. The old Magcobar barytes mine left a large hole in the hillside, which has filled with water. This is planned to be the lower reservoir and a higher storage lake will be built higher up the hillside.
The project is supported by the EU as a Project of Common Interest (PCI), which are essential infrastructure projects that aim to strengthen the European energy market and help the EU achieve its energy and climate goals. It will cost €650 to build and will provide 296 Megawatts (MW), with a daily storage capacity up to 2,175 MWh of electricity. It will employ 400 in construction and 50 permanent jobs. It was originally proposed in 2016. Silvermines Hydroelectric Power Station home page introduction
A variation on hydroelectric and pumped storage power plants is the use of tidal or wave energy. Many designs have been

tested to extract energy from ocean waves, which are an inexhaustible resource. However, harnessing the energy is very difficult as the ocean is a demanding environment. More feasible is the idea of a tidal barrage, which uses the twice a day movement of the tides to generate electrical energy. This can be used when the tide comes in or out, or by trapping the water at high tide behind a barrier, it can be used for short-time energy storage. The most well-known one is the 240 MW tidal power barrage at Rance in Brittany opened in the 1980s. They are expensive to build but then the energy is free. Tidal barrages have been proposed for the River Severn and for Cardiff Bay.

The tidal barrage power station at Rance, Brittany.
https://en.wikipedia.org/wiki/Tidal_barrage

5. Storage in capacitors

A capacitor is an electrical device which can store electricity for discharge at will, used for example in a car ignition. Capacitors store electrical energy without involving electrochemical redox reactions. Supercapacitor Energy Storage facilities are in their infancy. Rapid charge and discharge, long cycle life, and increased safety are major selling points.

An integrated solar, wind and supercapacitor energy storage 2 MW site in Turkey.
https://balkangreenenergynews.com/turkeys-first-supercapacitor-is-energy-storage-unit-for-wind-park/

6. Chemical storage

If we could convert renewable energy (heat or electricity) into chemicals, which can release chemical energy, then we could use this as a form of energy storage. The main example of this is hydrogen energy. Electricity can used to electrolyse water to produce hydrogen (and oxygen). The hydrogen can be stored as a compressed gas or in liquid form and then converted into heat energy (by combustion in an engine or turbine) or into electricity using a fuel cell. Other suggestions are to use renewable energy in ammonia synthesis and ammonia can then be used as a fuel.

Conclusion

We need to be able to store surplus renewable energy to be used when energy demand is high or supply is short. Ireland has massive potential to produce wind energy, both onshore and offshore, and probably also in the future, tidal energy, with a smaller contribution from solar energy. However, we need to be able to store surplus energy to be used when it is needed.

We won't be able to decarbonise our electricity supply if every new project – whether battery storage or biogas plants or solar farms – is automatically objected to. We don't want LNG storage facilities, and we don't want nuclear. It also seems that no

local community wants energy storage plants in their neighbourhood (NIMBYism). The energy versus environment problem seems almost insoluble and perhaps we will only wake up when the lights go out and the cost of energy rockets.

It is clear from this short survey that a lot of time, energy and money is being put into developing energy storage systems worldwide, based on a wide range of technologies. This article hasn't exhausted all the energy supply projects being developed and you should look out for other ideas.

Project work

This is a good topic for project work, perhaps especially in Transition Year. Groups could each choose one energy storage method, research it, look at its potential for use in Ireland or its actual use; the arguments for and against; how much each method could contribute to Ireland's energy needs. Each group can produce a poster or short video or a model to illustrate the process, and then give a class presentation. This can then lead to a debate on what Ireland should be doing to meet the future energy crisis.

□

Elementary Chemistry

Lithium in the brain

Lithium has long been used as a treatment for schizophrenia. New research at Harvard University has suggested that lithium deficiency in the brain many be a cause of Alzheimer's disease and that treating people with lithium many prevent the awful disease. Lithium's role in brain chemistry is linked to its chemical similarity to magnesium due to similar polarising power, so that lithium ions can replace and mimic magnesium ions. Polarising power = ionic charge/(ionic radius)^2. High polarising power favours covalent bonding. Lithium and magnesium have ~ the same polarising power and thus form similar bonds.

The work, published in Nature, shows for the first time that lithium occurs naturally in the brain, shields it from neurodegeneration, and maintains the normal function of all major brain cell types. The findings — 10 years in the making — are based on a series of experiments in mice and on analyses of human brain tissue and blood samples from individuals in various stages of cognitive health.
The scientists found that lithium loss in the human brain is one of the earliest changes leading to Alzheimer's, while in mice, similar lithium depletion accelerated brain pathology and memory decline. The team further found that reduced lithium levels stemmed from binding to amyloid plaques and impaired uptake in the brain. In a final set of experiments, the team found that a novel lithium compound that avoids capture by amyloid plaques restored memory in mice.

https://hms.harvard.edu/news/could-lithium-explain-treat-alzheimers-disease

Polarising power and ionic/covalent character.
http://wwwchem.uwimona.edu.jm/courses/CHEM1902/IC10K_MG_Fajans.html

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Quirky Elemental Facts in Rhyme

Tin, Sn

In bronze 'n' solders, pots 'n' pans, soft tin's been such a must.
In truth, did great Napoleon's bright buttons turn to dust?
Helps micro-coat our "tins" of peas,
Thank ITO for LCDs!
Tops nature's "League of Isotopes" with nine tins, all robust.

In bronze 'n' solders, pots 'n' pans, soft tin's been such a must.

Tin is the soft, silvery-white Group 14 metal known since ancient times that helped shape early human history. The bronze produced when tin was alloyed in small amounts with copper transitioned human civilization from the Stone Age to the Bronze Age (around 3,000 BCE). Pliable and easily worked, tin was also a popular material for household utensils and cookware during the Middle Ages. Today it's widely used in solders.

In truth, did great Napoleon's bright buttons turn to dust?

When a sample of pure tin is cooled below 13°C, its crystal structure slowly transforms from tetragonal to cubic. This causes the sample to physically change from its normal metallic form (known as *beta-tin*) to a powdery, grey solid (known as *alpha-tin*). This transformation has been observed during prolonged periods of cold, wintery weather. For example, the majestic tin organ pipes in some churches have developed unsightly grey patches (known as *tin plague* or *tin pest*) that crumble to dust when touched. The phenomenon was also implicated—more by way of folklore than fact—in the freezing to death of many of Napoleon's soldiers during their retreat from Moscow in the winter of 1812. The soldiers' uniforms' tin buttons were said to have crumbled in the cold!

Helps micro-coat our "tins" of peas,

What most people think of as "tin" cans are, in fact, cans made from sheet steel coated with a thin layer (about 15 μm) of tin. This commonly named *tinplate* consumes most of the tin produced each year.

Thank ITO for LCDs!

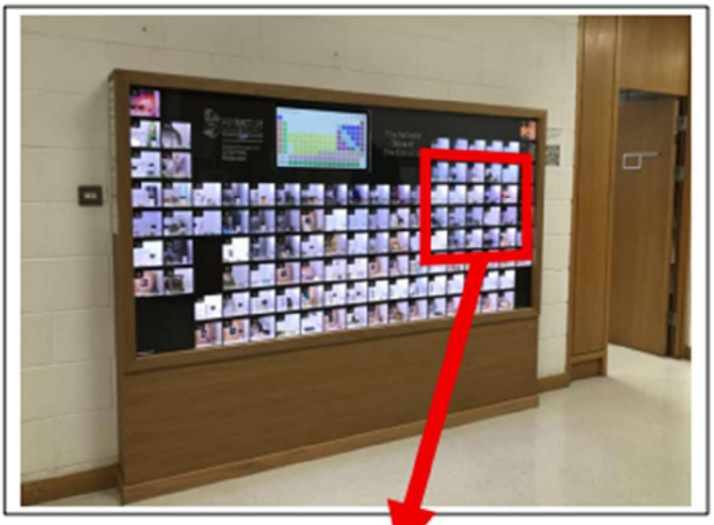
Indium tin oxide (ITO) is essential for the liquid-crystal displays (LCDs) so ubiquitous in computer screens, flat-screen TVs, and mobile phone touch screens.

Tops nature's "League of Isotopes" with nine tins, all robust.

Tin holds the record for the element with the greatest number of naturally occurring yet stable (non-radioactive) isotopes, boasting a grand total of nine.

Are you interested in the chemical elements and their uses? Might you be passing through Limerick at any stage?

If so, then email peter.davern@ul.ie to arrange a free 'guided tour' for you and/or your students of the large-scale, interactive periodic table display in the Chemical Sciences Department at the University of Limerick.



Peter Davern, Chemical Sciences, University of Limerick
peter.davern@ul.ie

The Northern Lights – the Aurora Borealis

https://en.wikipedia.org/wiki/Aurora

Figure 1: The Northern Lights over Lough Derg (David Corcoran)

The Northern Lights are usually visible at high latitudes but in the last few years they have been visible in Ireland and the UK. They are an example of electronic transitions in excited atoms in the upper atmosphere. When atoms are excited they absorb energy, and electrons jump from lower orbitals to higher ones. When they fall back down to the lower levels, they emit radiation and if this falls in the visible region, then we see colours. This is the basis of flame tests , where atoms are excited in a flame and emit characteristic colours (see Table 1). Figure 2 shows schematic electron transitions.

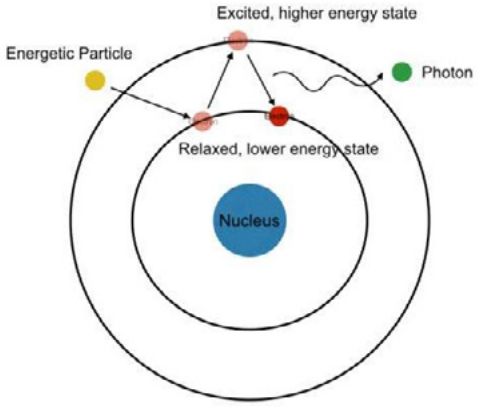


Figure 2: Electronic transitions in an atom

The colour of fireworks is also due to electronic excitation in atoms in the burning firework, which then emit coloured light as electrons fall back to lower levels. The colours of discharge tunes, especially containing the noble gases, arise from the same cause. An

electric discharge through gases at low pressure, results in characteristic colours (Table 2)

Table 1: The colours of flame tests and fireworks

Cation	Colour of Flame
Li^+	Red
Na^+	Yellow
K^+	Lilac
Ca^{2+}	Orange–red
Cu^{2+}	Blue–green

Table 2: Colours of discharge tubes

Neon (Ne): Bright red-orange.

Argon (Ar): Violet to pale lavender blue.

Helium (He): Pink-orange.

Krypton (Kr): Gray off-white to lavender or whitish purple.

Xenon (Xe): Sky blue, blue-gray, or white-blue.

Radon (Rn): Although rarely used, it emits a red colour

These are known as atomic emission spectra and arise from excited atoms. Tranisitons in excited molecular species are molecular emission spectra. In the upper atmosphere molecules are mostly dissociated into atoms and ions and are at low pressure. Excited particles (electrons and protons) from the sun (the solar wind) travel to the earth and interact with the earth's magnetic field. This excites atoms and as they relax back to lower energy levels, some of them emit visible light and we see the northern lights (aurora borealis) in the sky. The stronger the solar wind due to solar activity the more likely we are to see them and the further south they spread. The shape of the earth's magnetic field means that the effects are mostly notice at the north and south poles (aurora australis).

A variety of colours can be seen, which arise at different altitudes. The primary colours of the Northern Lights are green, red, and purple, though other colours like pink, blue, and yellow can also occasionally appear. (Figure 3)

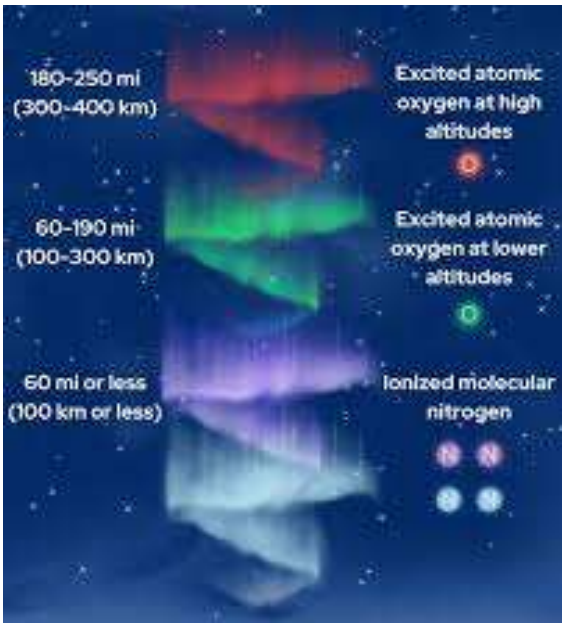


Figure 3: The colours of auroras and altitudes
https://www.facebook.com/MIStormChasers/posts/ever-wonder-why-we-see-different-colors-in-the-aurora-heres-a-chart-that-explain/829134299902575/

The most common northern lights colour is green. It is produced when charged particles, mainly electrons, collide with oxygen atoms at altitudes around 60 to 150 miles (100 to 240 kilometres) above the Earth's surface. During these collisions, the energy from the electrons is transferred to the oxygen atoms, which then release that energy in the form of green light.

Purple hues in the Northern Lights are less common but visible every now and then, especially during intense solar storms. These colours are usually produced by a mix of nitrogen molecules and oxygen atoms at varying altitudes and involving different

energy levels. The specific shades of purple and pink depend on the altitude and the types of molecules involved. Figure 4 shows the visible spectrum of the aurora showing the different line transitions, which give rise to the colours. Notice that the observed colours are due to multiple transitions and emission lines.

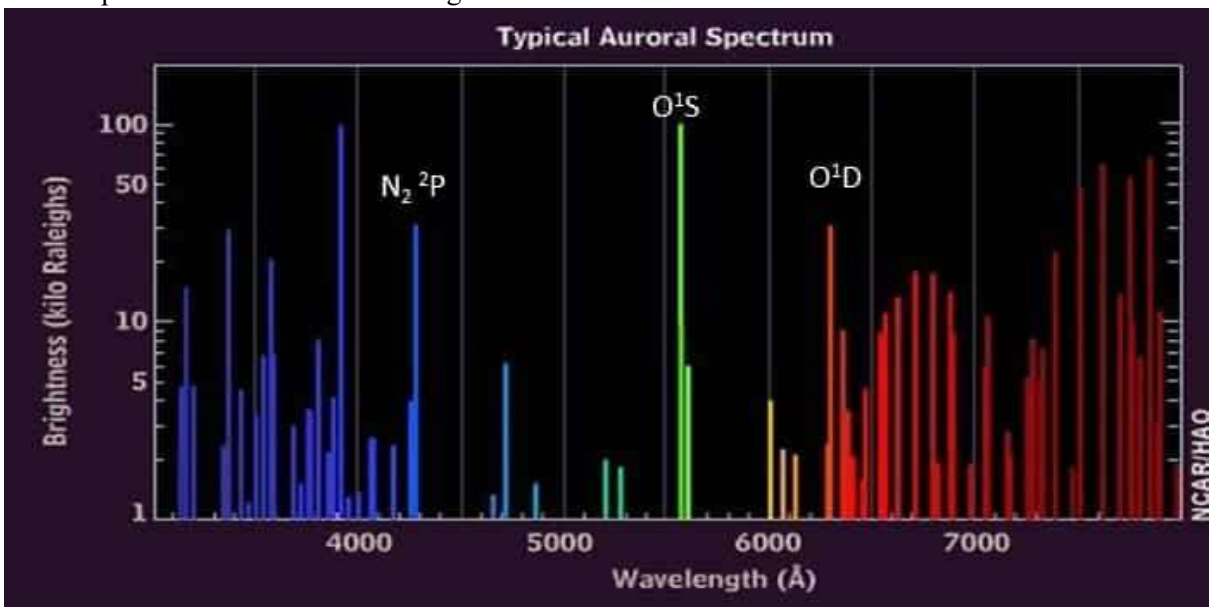


Figure 4: Typical aurora spectrum
https://www.stellarnet.us/aurora-spectroscopy-with-stellarnet/

Further information:

Andy Brunning of Compound Interest has a good explanation and graphic at https://www.compoundchem.com/2024/09/05/aurora/.

https://perlan.is/articles/northern-lights-colours

□

Ocean acidification: a growing problem

Seawater isn't neutral, it has a pH ~8, meaning that it is slightly alkaline due to dissolved carbonate ions. The ocean dissolves carbon dioxide from the air and we know that CO_2 levels in the atmosphere are increasing, affecting global climate and increasing global temperatures. Thus the oceans are warming slightly, which increases their volume and also decreases the solubility of CO_2 and other gases. However, the net effect is that CO_2 concentration in the oceans is increasing as atmospheric levels increase, and the pH of the ocean is decreasing (Figure 1).

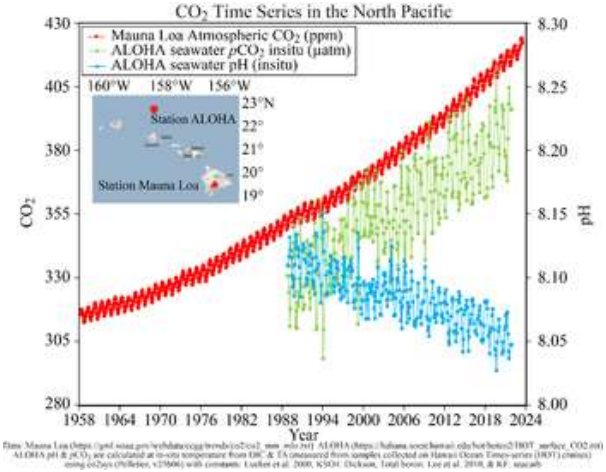


Figure 1: Change in atmospheric CO_2, CO_2 solubility in the ocean and pH levels (measured on Hawaii). (NOAA) Ocean acidification - Understanding Global Change

The oceans are in equilibrium with the atmosphere and with carbonate rocks. As CO_2 dissolves it converts carbonate ions into hydrogencarbonate ions as shown in Figures 2 and 3. This reduces the availability of carbonate for building shells, coral etc. and actually results in shells dissolving and weakening. By the end of the century pH will have fallen from ~8.1 to ~7.8, which doesn't sound much but we must remember that the pH scale is logarithmic not linear. A change of 0.3 pH units is ~ a change of 50%.

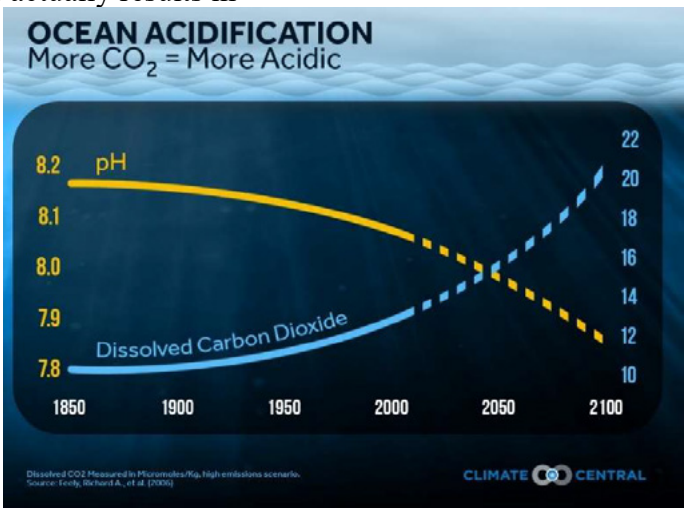


Figure 2: pH and [CO_2(aq)] (Climate Matters)
2015OceanAcidification_CO2Graph.jpg (1920×1080)

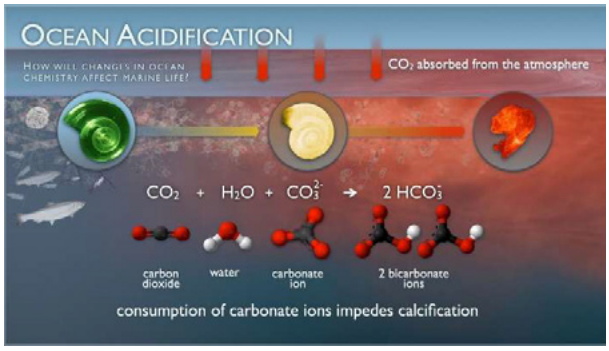


Figure 3: A pteropod shell is shown dissolving over time in seawater with a lower pH. When carbon dioxide is absorbed by the ocean from the atmosphere, the chemistry of the seawater is changed. (Image credit: NOAA) Download Image

At ~pH 8 most of the dissolved carbon is in the form of hydrogencarbonate ions, and the small fraction (~2%) of carbonate ions is used to make shells and corals, and reducing it will reduce the formation of and slowly dissolve carbonate minerals. CO_2 solubility is affected by pressure (concentration) according to Henry's Law – greater [CO_2] means more solubility – and by temperature (lower temperature increases solubility). Thus, CO_2 levels are greater in the deep oceans and photosynthesis (which uses up CO_2) is reduced. Overall, the oceans are a sink for CO_2, absorbing about 30%, and there is 50 times the amount of CO_2 in the ocean than in the atmosphere.

The interaction of atmospheric CO_2 with the oceans is part of the carbon cycle (Figure 4). One of the lessons of history that we are slow to learn, is that it is unwise to mess with natural systems. The law of unintended consequences kicks in when least expected.

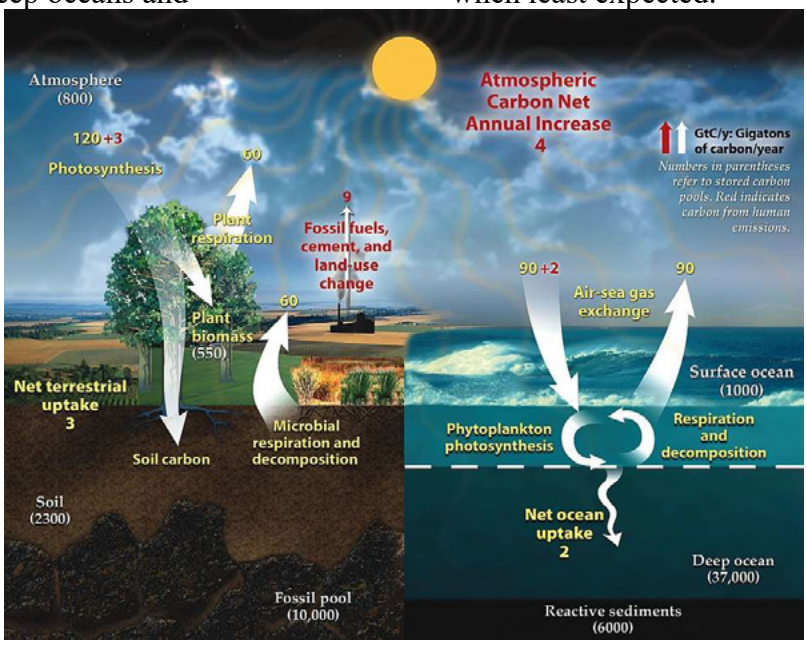


Figure 4: The carbon cycle. This diagram of the fast carbon cycle shows the movement of carbon between land, atmosphere, and oceans. Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon. Carbon cycle - Ocean acidification - Wikipedia

Resources

NOAA website

Ocean acidification | National Oceanic and Atmospheric Administration

Ocean acidification | Definition, Causes, Effects, Chemistry, & Facts | Britannica

Ocean acidification - Wikipedia

□

Chemlingo: Chalk it down!

Peter E. Childs

The phrase ‘chalk it down’ refers to using blackboard chalk to make a mark noting something down on a blackboard. But blackboard chalk isn’t chalk at all! It’s made from calcium sulfate (gypsum) not calcium carbonate, of which chalk is a soft white form, as found in the white cliffs of Dover.

The Latin for chalk is *creta*, from which we get the term cretaceous, referring to the geological era when chalk deposits were laid down. The word was coined by the Belgian geologist Jean d’Omalius d’Halloy in 1822. It refers to the period 143 to 66 million years ago, which includes the age of the dinosaurs. The word chalk is from Old English, *cealc*, borrowed from the Latin *calx*, which referred to limestone or lime. This is turn became the Greek *khalix*, meaning a small pebble. Pebbles were used for counting, which gave us calculate and calculus. The same word, calculi, is used for kidney stones.

Calx was first used to mean lime made by heating limestone in a kiln but then came to mean any oxide produced by heating a metal in air or metal compound. Oxides were known as calxes. The process of heating to produce a calx was then known as calcination, but came to fere to any heating to produce chemical change. Alkaline, chalky soils are known as calcareous soils. Calcification refers to the build up of insoluble calcium salts in water pipes or bodily tissues, from calx via the French *calcify*.

Calcium is the parent element of chalk and lime and the name was coined by Humphry Davy in 1808 when he first made the group 2 element by the electrolysis of moist lime and mercuric oxide. Calciferol is an alternative name for vitamin D, which is involved in calcium absorption.

The word caulk also derives from calx as it means a substance used to block up cracks and seal joints, from *calicare*, to block up with lime. Lime was used to make lime mortar and slaked lime (a suspension of calcium hydroxide) was used to whitewash walls. Lime originally meant sticky in Old English *lim*, from its use to make sticky lime mortar, made by heating limestone. Quicklime also meant lime, calcium oxide, from its vigorous exothermic reaction with water. It was used to prevent the spread of disease and hasten decomposition by spreading it over corpses. Interestingly, the Romans thought that limestone could consume bodies and so they buried people in limestone *sarcophagi* = body eaters.

Limelight was used to light theatres before electric spotlights. A bright light is produced when lumps of lime are heated to a high temperatures by an oxy-hydrogen or oxy-acetylene flame. (https://www.youtube.com/shorts/NwrKwjcNhfA?feature=share)

So chalk it down for chalk, limestone and lime, as they have had an immense role in the development of modern civilisation, and continue to do so.

□

Diary 2026

iViCE
April 10th
TU Dublin
claire.mcdonnell@tudublin.ie

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SMEC,
The Human Element in STEM Education: Community, Innovation, and Sustainability
June 11-12th
St. Patrick's College, DCU
https://castel.ie/smec-stem-education-conference/

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8th ISTA/ICASE World STE Conference, UCC, Cork,
June 22-25, 2026
www.icaseonline.net/icase2026

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10th EuChemS Chemistry Congress (ECC10), Antwerp,
July 12-16, 2026
10th EuChemS Chemistry Congress (ECC10) - IUPAC | International Union of Pure and Applied Chemistry

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28th ICCE & 17th ECRICE, Erzurum, Türkiye,
July 13-17, 2026
Chemical Education in the Age of Artificial Intelligence
www.iccecrice2026.org/

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2026 BCCE, University of Wisconsin-Madison, USA
July 26-30, 2026
https://conferences.union.wisc.edu/bcce2026/

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13ISMC26 The 13th International Symposium on Microscale Chemistry, UK
July 8-10 2026

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45th ChemEd-Ireland, UL, Limerick, October 24th 2026
Sarah.hayes@ul.ie and Geraldine.mooney.simmie@ul.ie

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