



# Chemistry

## In Action!

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**Proceedings ChemEd-Ireland 2024: UCC**

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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](mailto:peter.childs@ul.ie) together with a printed copy.

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

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## Editorial #126

### **New Minister, no change**

We start a new year with a new Minister of Education and Youth, Helen McEntee, and a new government.

There was an opportunity to row back from the previous policy to drastically change the LC, despite the strong reservations from subject teachers, unions and others. The new minister has set there will be no change in the proposals. The objections have only become stronger as the impact of AI on education has become clearer. All coursework is now suspect and teachers are not equipped or have time to monitor all students' work for AI. People have shown that AI can generate essays, practical reports and project reports in a fraction of the time needed without AI and with minimal intellectual input from the students. This is a worrying prospect and totally undermines a drive to the use more coursework in assessment. Teachers, including the ISTA, have called for the introduction of revised courses, due in September for Biology, Chemistry and Physics, to be deferred to allow schools and teachers to prepare. This is important but not enough. Introducing a coursework assessment worth 40%, for nominally 20 hours of time, is a receipt for disaster.

Reliance on coursework for formal assessment is open to widespread abuse, which AI only makes worse, and in no way produces a level playing field for all students. Having to do a high stakes assessment (which is what 40% implies) will increase the stress on students, who will be doing several assessments at once during the school year. It will effectively devalue the final exam, now only worth 60% for the majority of the student's effort and time. The need in the sciences for practical work in a research project will put enormous strain on school resources for laboratories, equipment, chemicals etc., and will highlight the disparity of provision between schools. A well-resourced private school will not be comparable to a DEIS school in a poor area, and students in one will have a clear advantage. This is true now, but it will be magnified if 40% of the marks are given for a

school-based research project. In addition to all these disadvantages, the new courses will put massive extra demands on teachers who are expected to supervise, monitor and validate the work of their own students, and detect whether AI has been used or whether the work has been 'done' by a parent, and cope with the extra demands on laboratories without any technical support. The new courses will, I fear, turn out to be a poisoned chalice which will ruin the credibility and standard of the LC nationally and internationally.

### **Change before it's too late**

At the very least, the 40% should be scaled back to 20%, so it does not have such a dominant effect on assessment or stress on students. The introduction of the new courses should be delayed by at least a year, preferably longer, to allow for the debugging of the specifications (which were rushed out), intensive training for teachers, proper resourcing of schools, and time to adjust to the new exam papers. Such a major change should not have been done in a rush, without listening to or taking account of criticisms and reservations, and without any piloting of the system to see if it is workable. Foley's folly is likely to go down in history as one of the worst, poorly thought-out and inadequately prepared 'innovations' in Irish education. When other countries are moving away from coursework towards objective and fair final exams, Ireland is going in the opposite direction. I fear it is a recipe for disaster and Ireland will be paying the cost long into the future.

### **Reduction in grade inflation**

The LC grades inflation is being reduced this year from 7.5 to 5.5%. Too little, too late. At this rate it will be two more exam cohorts before the grades are back to 2019 levels. It is much easier to inflate than to restore and students from inflated years will have an advantage in CAO points over this year's students.

*Peter E. Childs*

Hon. Editor 1980-

## In this issue #126:

This issue includes the Proceedings of ChemEd-Ireland 2024 in UCC. As usual in Cork there was a large turnout and an excellent programme. Sadly we were only able to get four of the talks, as we rely on speakers to send us a written version. Today's topical subject is AI and education and Stephen Murphy (p. 13) looks at the implications of AI for coursework assessment. Eoghan Long then looks at the maths demands of LC Chemistry, an overlooked issue (p. 16), Hilary Lynch shares her experience of a career teaching Chemistry (p. 20) and John O'Donohue reminds us of the RSC resources available for LC Chemistry (p. 23).

Continuing the maths theme, Niamh O'Meara and her maths education colleagues review the effect of bonus points on LC Maths (p. 24)

In a historical vein Peter Childs continues the series on Great Irish Chemists by featuring Eva Philbin (p. 27) and Adrian Ryder continues his series with a look at Adolphe Wurtz (p. 30).

There are many topical Issues in Chemical Education and on p. 52 the question of

new biogas plants in Ireland is addressed. There are many good economic and environmental reasons for turning organic wastes into biogas, but proposals around the country have run into local opposition.

Our modern civilisation is built on minerals and on p. 39 we look at the importance of fluorite, from which we get all our fluorine chemicals. Sulfur and its compounds are also vital in many areas and on p. 35 we look at some important sulfates.

Peter Davern contributes on p. 45 another Quirky Element (copper) and in Chemlingo (p. 44) a scurvy story is uncovered.

Ireland has a long history going back to the 18<sup>th</sup> century of harvesting seaweed for burning to produce kelp, which originally referred to burnt seaweed slag. On p. 59 you're reminded of a Place to Visit in Co. Clare where you can see the remains of kelp pits (kilns).

Finally, we have some books for summer reading, including a new one by John O'Donoghue.

There is also a collection of Education News and Views (p. 4).

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## Education News and Views

**Professor Dervilla Donnelly  
(1930-2024)**

[Professor Emerita Dervilla Donnelly: 1930  
- 2024 - University College Dublin](#)



In CinA! issue 123, Autumn 2023, we featured Professor Dervilla Donnelly, UCD, as a Great Irish Chemist. Sadly, Professor Donnelly passed away on Nov. 14<sup>th</sup> 2024, at the end of a long and illustrious career.

*“She will be remembered as a remarkable scientist, researcher and person who instilled an extremely high standard of scientific rigour and integrity in all those she encountered over the course of her career, that will remain with them throughout their scientific endeavours.”*

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## Conferences 2025

**ISTA Annual Conference  
Adapting to a Changing World in  
Science Education**

**4-5 April**

**Maynooth University**

[ISTA Annual Conference 2025 –  
Adapting to a Changing World in  
Science Education – ISTA](#)

Like last year the main conference will take place on Saturday 5<sup>th</sup>, with the Gala Dinner and awards on the Friday before.

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**ChemEd-Ireland 2025**

**18 October**

**TUD Dublin**

[claire.mcdonnell@TUDublin.ie](mailto:claire.mcdonnell@TUDublin.ie)

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**TIMSS 2023 national report**

[ERC launches the TIMSS 2023 national  
report – Educational Research Centre –  
Foras Taighde ar Oideachas](#)

The ERC is pleased to publish the results for Ireland from TIMSS 2023 in a new report: *TIMSS 2023: Insights into mathematics and science achievement in Ireland* (<https://doi.org/10.70092/2009137.1224>).

TIMSS assesses the mathematical and scientific knowledge and skills of students in Fourth Grade and Eighth Grade (Fourth Class and Second Year in Ireland). TIMSS 2023 is the eighth cycle of the study and included 656,360 students from 65 countries.

This national report focuses on trends in overall achievement in Ireland, as well as the distribution of achievement (performance at various percentiles), student performance at the TIMSS International Benchmarks, relative strengths and weaknesses on the TIMSS content and cognitive domains, and teachers' reports of curriculum coverage.

Performance in Ireland is explored in the context of selected countries; compared with previous cycles of TIMSS where data are available (since 2011 for Fourth Class and since 2015 for Second Year); and, where applicable, examined by gender and by socioeconomic status at both individual level and at school level (DEIS status).

Some key findings from the report include:

- The mean achievement of mathematics and science at both Fourth Class and Second Year is similar to 2015 and 2019, indicating stability in mathematics and science achievement since 2015.
- There were no significant differences in the achievement of boys and girls at Fourth Class, while boys significantly outperformed girls in mathematics and science at Second Year.
- At primary level, pupils in DEIS Urban Band 1 and Urban Band 2 schools had significantly lower mean mathematics and science achievement than pupils in non-DEIS schools. Similarly, at post-primary level, pupils in DEIS schools had significantly lower mean mathematics and science achievement than students in non-DEIS schools.

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### New women in STEM stamps

Two new stamps were issued in March to mark International Women's Day, featuring two living Irish scientists: Jocelyn Bell Burnett and Aoife McLysaght.

The stamps are sold in sheets of 8.



Astrophysicist Professor Bell Burnell discovered the first radio pulsars in 1967 when she was a PhD student at Cambridge University.

Her male supervisors received the Nobel prize for the discovery in 1974.

In 2018 she was awarded a Breakthrough Prize for discovering the new type of star and donated the award money of over €3million to a fund for access to science education for under-represented groups.

Her discovery of pulsars was also the subject of the physics Nobel prize in 1974, but at the time her male supervisors received the award.

Prof Aoife McLysaght, has the Chair of Evolutionary Genetics at Trinity College Dublin and one of the world's leading genetics researchers.

She has also started in a new role as Government Science Advisor.

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## Researcher of the Year 2024 (IRC legacy) Awards

### [Researcher of the Year 2024 \(IRC legacy\) Awards - Research Ireland](#)

Architectural and craft history expert Professor Christine Casey named Researcher of the Year as part of the Irish Research Council legacy awards. Dr Aaron Lim named Early Career Researcher of the Year, with Dr Jakub Gajewski announced as Impact Award winner. Top-ranked researchers in 2024 Government of Ireland scheme also recognised.

The Researcher of the Year (IRC legacy) Awards were announced at an event on Wednesday, January 15<sup>th</sup> 2025.

The awards celebrated the very best of IRC-funded researchers deemed to have made highly significant and valuable contributions to knowledge, society, culture and innovation.

In August 2024, the Irish Research Council (IRC) amalgamated with Science Foundation Ireland (SFI) to become Taighde Éireann – Research Ireland, the new national funding agency for research and innovation in Ireland. As the award recipients were previously funded by the Irish Research Council, this 2024 awards round has been made as Researcher of the Year (IRC legacy) Awards.

The winners were selected by an independent expert panel chaired by Professor Emeritus Áine Hyland.

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## Assessment for equity and excellence

### Aine Hyland

Hyland, Á. (2024) 'Assessment for equity and excellence?', *Leader*, Autumn 2024, pp. 1-7. [content](#)

In this timely and important article Aine Hyland discusses assessment in the context of the new LC specifications and the

requirement for 40% to be assessed on coursework. The Minister of Education and the NCCA seem to be deaf to the concerns of teachers and other interested parties, like Professor Hyland. There are many questionable aspects of this proposal, which is being introduced hastily and without proper preparation or resourcing, and the advent of AI threatens to undermine the credibility of any assessment based on coursework. This is how Professor Hyland closes here article, which you can access at the link above.

*“In view of these developments, there is a strong argument for postponing the introduction of the 40% AAC in the Leaving Cert pending international experience of the implications of Generative AI for assessment – or at least reducing the proportion to a more reasonable 20%. Given the high-stakes nature of the Leaving Cert and the fact that there will always be some parents who will do whatever it takes to secure a place on a high-points university programme for their offspring, it is unrealistic and unfair to ask teachers to verify that the submitted work is the unaided work of the student. In the light of the above and in the interests of equity and fairness, it is to be hoped that this ill-advised reform will be reconsidered and that the proposal to allocate 40% of Leaving Certificate marks to an additional assessment component be reconsidered.”*

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## Extra money for science resources [gov.ie - €12m funding for Leaving Certificate Science subject implementation](#)

On November 4<sup>th</sup> 2024 Minister for Education, Norma Foley TD, has today announced details of a new Science Implementation Support Grant worth €12 million to support schools with the rollout of revised Senior Cycle science subjects.

Three science subjects – Biology, Chemistry and Physics – have been revised as part of

stage one of the redevelopment of Senior Cycle subjects. The revised specifications include

a traditional written assessment worth 60% and a new additional assessment component, worth 40%.

The additional assessment component will be called Biology, Chemistry or Physics “in Practice” and will broaden the types of assessment used in Senior Cycle. Every student’s additional assessment component will be externally assessed by the State Examinations Commission.

Minister Foley announced today that €12 million in funding is being provided for a new Science Implementation Support Grant, and it will be paid to schools shortly. All schools in the free scheme will receive additional funding with a minimum base payment of €13,000 up to a maximum of €22,000. There will be no application process, and the payment will be made on an automatic basis.

The revised specifications for Biology, Chemistry and Physics will be implemented in schools nationwide for fifth year students from the next school year (2025/26), commencing in August/September 2025.

The additional assessment component in each subject will require students to use the knowledge and skills they are learning throughout the course to carry out an investigation. It will:

- involve real-world applications of science;
- demonstrate investigative skills;
- relate their investigative work to the work of scientists in society;
- communicate their findings appropriately and effectively.

Students will carry out their work on the investigation in Biology, Physics or

Chemistry throughout the course. They will fill out an investigative log along the way which they can use to help compile their final report for the State Examinations Commission.

They will begin by carrying out scientific research on an issue related to the brief. They will gather, process and evaluate information from secondary sources. The knowledge gained from this phase of the investigation may help to inform their experimental work. They will then generate a hypothesis, plan, and design their experiment. They will carry out their experiment and gather primary data. Once they have gathered their primary data, they will analyse the data and form conclusions. In year two, they will submit evidence to the State Examinations Commission for marking, showing their ability to conduct scientific research on the brief and to use appropriate primary data to investigate aspects of the brief.

### **Funding for the Science Implementation**

Funding for the Science Implementation Support Grant will be allocated based on four bands of enrolment. The enrolment bands range in size from schools up to 300 students in the lowest band, to schools with over 900 pupils in the highest band. There will be a further 10% uplift in the Science Implementation Support Grant for DEIS schools. This means a DEIS school will receive an additional 10% on top of the minimum funding for their enrolment band. This is in line with previous applications of a DEIS uplift in Departmental funding models, including the grant for ICT infrastructure.

Schools will have the autonomy to use this additional funding in a way that best suits their school and apply it to their locally identified Science needs. It is expected that schools will prioritise the purchase of consumables and related equipment needs. The funding may be used to support the implementation of the new senior cycle

sciences or more generally to support the broader science programme which may include, for example, Agricultural Science, Transition Year Science or Junior Cycle Science.

This announcement also aligns with the Department's STEM Education Policy Statement 2017-2026, which recognises the importance of initiatives that raise awareness and interest in STEM, and the need to improve STEM education. The funding is also in addition to existing support provided to schools who offer Physics, Chemistry and the combined subject Physics & Chemistry.

Teacher training is well underway - over 11,000 post primary teachers have had training since the beginning of the school year, including over 1,000 science teachers. Training will continue to ensure teachers are ready for these changes.

The €12 million funding for the Science Implementation Support Grant is additional to the €30 million allocated in Budget 2025 for curriculum reforms including senior cycle redevelopment.

**Funding details for on the Science Implementation Support Grant**

<b>Enrolment Band</b>	<b>Base Payment</b>	<b>DEIS Payment (10% Uplift)</b>
1-300	€ 13,000	€ 14,300
301-599	€ 16,000	€ 17,600
600-899	€ 19,000	€ 20,900
900+	€ 22,000	€ 24,200

**Phased introduction of Senior Cycle Redevelopment**

The National Council for Curriculum and Assessment (NCCA) began work on its Advisory Report on the review of Senior Cycle in 2016. Under the Senior Cycle Redevelopment programme, the

Department of Education and the NCCA have been working with education partners to update and redesign the Senior Cycle curriculum to meet the needs of young people today.

Changes are being introduced gradually, starting next year and continuing until 2029. By 2031, all students taking the Leaving Certificate will follow the updated curriculum. This will include additional assessments such as project or coursework which will provide students with opportunities to demonstrate real world skills.

As part of Senior Cycle Redevelopment, revised specifications for seven existing Leaving Certificate established subjects (Biology, Physics, Chemistry, Arabic, Latin, Ancient Greek, and Business) will be introduced in schools from the 2025/26 school year. Each of these new and revised subject specifications will incorporate additional assessment components that are not a traditional written examination, which will be worth a minimum of 40% of the available marks and will be externally assessed by the State Examinations Commission (SEC).

**Increased resources:**

To support these changes, €30 million has been allocated in Budget 2025 for curriculum reforms including senior cycle redevelopment.

**Teacher representation**

- ☐ Teachers and their representatives have been involved in all of the Senior Cycle redevelopment work to date – they have contributed to the development of the new specifications and the revised assessment arrangements. 50-70% of the NCCA Subject Development Groups membership comprises practicing teachers.
- ☐ This important work aims to enhance the educational experience and ensure

meaningful learning and achievement in senior cycle for all learners. See

<https://ncca.ie/en/senior-cycle/senior-cycle-redevelopment/>

□ Details on Senior Cycle Redevelopment, including the information notes which issue regularly to schools can be found at the following links:

<https://www.gov.ie/seniorcycle> ,

<https://ncca.ie/en/senior-cycle/senior-cycleredevelopment/>, as well as

[www.curriculumonline.ie](http://www.curriculumonline.ie) on which all of the recently published new and revised subject/module/programme documentation can be found.

□ The NCCA has published a schedule for the revision of all Leaving Certificate subject curricula or specifications spanning five annual tranches starting from next year (2025). This schedule is available at the above link.

### Equity of access

□ The importance of ensuring that adequate support is provided to teachers and schools in implementing the new specifications is a shared objective.

□ Additional resources are being provided. As part of Budget 2025, some €30 million of additional funding is being provided for the continuation of important curricular development and reforms and related teacher education. This is particularly in relation to the ongoing delivery of Senior Cycle Redevelopment and the Primary Curriculum Framework along with a range of other planned enhancements in how education is taught and learned in our schools.

□ For the three new science specification, for example, the new assessment components involve students completing a piece of work as evidence of their ability to conduct scientific research on a particular issue and to use appropriate primary data to

investigate aspects of that issue. It is not intended that these investigations are solely restricted to laboratory-based work.

□ Additional resourcing for the new subjects has been committed and 100 schools have been selected to be the first to offer Drama, Film and Theatre Studies and Climate Action and Sustainable Development.

### Additional Assessment Component

□ As part of the programme for Senior Cycle Redevelopment, specifications for all Leaving Certificate subjects will be revised, and will incorporate an Additional Assessment Component (AAC) worth a minimum of 40% of the available marks, broadening the range of skills that can be assessed, and recognising different types of learning whilst reducing the emphasis on terminal written examinations.

□ The introduction of AACs will broaden the range of skills that can be assessed, thereby recognising different types of learning whilst reducing the emphasis on terminal written examinations. The AACs should be understood as an integrated part of the teaching and learning of the subject that facilitates and supports good teaching and learning practices across the two years of the course and enables students to fulfil the objectives of the subject specification.

□ It should also be noted that three-quarters of all Leaving Certificate subjects already have the equivalent of an AAC component. 29 of the current 41 curricular Leaving Certificate subjects have at least a second component that we now understand as an AAC under Senior Cycle Redevelopment. These take various forms under the current system including orals, aurals, practical tests or performances and coursework.

□ Schools were informed in May about a schedule for releasing sample assessment materials to help with planning and teacher training. The first part, Guidelines on the Additional Assessment Components (AACs), will be published shortly, and sample exam papers will follow in Spring 2025. This means schools will have more than two years to prepare before students take these exams and several months before students start 5th year in the new or updated subjects.

□ Development work on Tranche 2 and Tranche 3 subjects is advancing within NCCA structures and there will be public consultations on different aspects

### ASTI Survey

(Irish Times 22/1/25)

[ASTI REDC Jan 2025 Senior Cycle Redevelopment Additional Assessment Components – survey of teachers - Association of Secondary Teachers in Ireland](#)

The ASTI polled 2,700 members' views on the new assessments.

89% felt it would increase teacher's workload

82% felt they would increase student workload.

70% felt they would increase stress among students.

*“Teachers are telling us that there is a lack of knowledge and guidance on the use of AI and on the authentication of work submitted by students.”*

□

### AI approach is an incentive to cheat

Breda O'Brien Irish Times 14/12/24

*“Any use of AI must be cited just like a textbook or internet article but a brief description of how it was used must also*

*of those subjects over the coming months ahead of their respective introductions for fifth years from 2026 and 2027.*

### The use of AI

Since 2023, the SEC has updated its guidelines to address AI-generated material.

For 2024, all instructions include rules on the use of AI. Regular, comprehensive engagement with each student's work on their Additional Assessment Component will enable teachers to confidently and legitimately authenticate any work being submitted for assessment.

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*be supplied for AI. Teachers are supposed to authenticate coursework, including ensuring that AI was either not used or cited appropriately.*

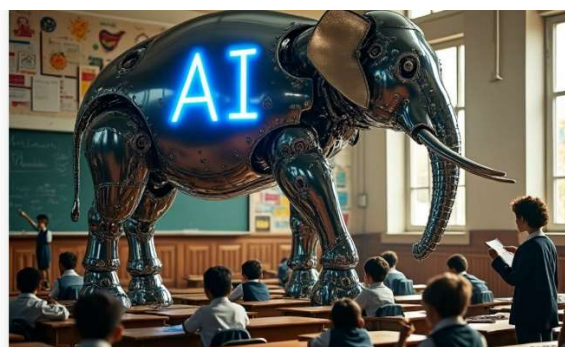
*This approach is breathtakingly naïve. There is no incentive for a student to admit to using AI and every incentive to cheat.”*

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### The AI elephant in the classroom Education's Elephant in the Room: Teachers Need AI Guidance and Training NOW!

[Patrick Hickey](#)

[\(18\) Education's Elephant in the Room: Teachers Need AI Guidance and Training NOW! | LinkedIn](#)



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# Proceedings ChemEd-Ireland 2025

Saturday October 19<sup>th</sup>., University College Cork

For many years it has been the custom to print the Proceedings of ChemEd-Ireland, which started in 1982, in the Spring issue of *Chemistry in Action!* This depends on the goodwill of the speakers and their willingness to turn a talk into a written article. I am always aware that this is an extra demand on speakers and I am always grateful for those who respond. This year's programme (see below) was excellent and we have four of the talks in the Proceedings. A printed Proceedings acts as a permanent record of the conference but it also makes the talks available to a wider audience.



## 43rd Annual ChemEd Conference

**Preparing for the new Leaving Certificate Chemistry Curriculum Specification**  
Saturday 19<sup>th</sup> October 2024

Hosted by the Eureka Centre, University College Cork, in collaboration with the Royal Society of Chemistry (Ireland), ISTA Cork branch and Thermo Fisher Ireland Ltd.

### PROGRAMME

- |               |  |
|---------------|--|
| 9.00 – 9.30   | Registration in Room G2 Kane Building, UCC.  |
| 9.30 – 9.40   | <b>Official Opening by Ken Keohane, Thermo Fisher, ISTA President.</b>   |
| 9.40 – 10.15  | <b>Supports from Olde in the new Leaving Certificate Chemistry Specification - Olde Team.</b>  |
| 10.15 – 10.50 | <b>Lithium Ion Cells in the new Leaving Certificate Chemistry Curriculum</b><br>- Dr John Hayes, Department of Electrical and Electronic Engineering, UCC.   |
| 10.50 – 11.15 | Tea/ coffee and snacks   |
| 11.15 – 11.50 | <b>An Analysis of Calculations in Leaving Certificate Chemistry Examination Papers</b><br>- Eoghan Long, Davis College, Mallow, Co. Cork   |
| 11.50 – 12.45 | <b>Implications of Artificial Intelligence for Assessment of Coursework</b><br>- Sean O'Sullivan, Coláiste Chiaráin, Limerick Winner of BT Young Scientist and Technology Exhibition 2024, and Stephen Murphy, Lecturer in Science Education, UCC. |
| 12.45 – 1.45  | Lunch (three-course hot lunch)   |
| 1.45 – 2.15   | <b>Some ideas that I find helpful in teaching Leaving Certificate Chemistry</b><br>Hilary Lynch, formerly of Clonakilty Community College, Co. Cork.   |
| 2.15 – 2.45   | <b>RSC Resources to assist chemistry teachers in teaching the new Chemistry curriculum.</b><br>- John O'Donoghue, Royal Society of Chemistry Education Coordinator.  |
| 2.45 – 3.15   | <b>Some initial observations on the new LC Chemistry specification</b><br>- Dr Ryan Gallagher, Lecturer in Science Education, UCC  |
| 3.15 – 3.45   | <b>Assessment of Leaving Certificate Chemistry - Current and Future Specifications</b><br>- Dr Gerry Hyde, State Examinations Commission   |
| 3.45 – 4.00   | Open Forum   |



## Some pictures taken at ChemEd-Ireland 2024 at UCC



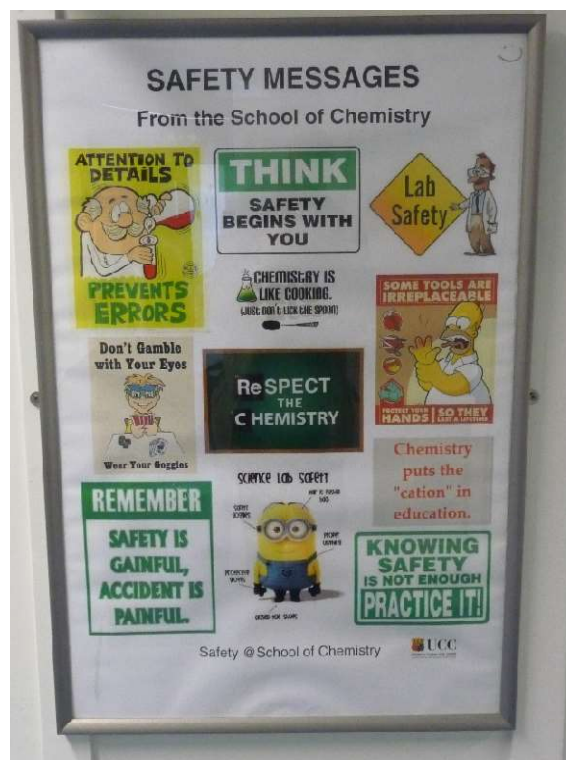
Dr Declan Kennedy opening the conference with the ISTA President Ken Keohane



Time for talk over a delicious lunch.



Part of the large crowd at the lectures.



Safety matters! From the School of Chemistry, UCC.



Dr Ryan Gallagher, UCC, giving his lecture on the new specification.

# Implications of Artificial Intelligence for Assessment of Coursework

**Stephen Murphy**

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## Introduction

*“Know the enemy and know yourself in a hundred battles you will never be in peril. When you are ignorant of the enemy but know yourself, your chances of winning or losing are equal. If ignorant both of your enemy and of yourself, you are certain in every battle to be in peril.”*

Sun Tzu, The Art of War

Artificial Intelligence (AI) refers to the ability of machines or software to perform tasks that typically require human intelligence. These tasks include learning from experience, understanding natural language, recognizing patterns, solving problems, and making decisions. AI systems use algorithms and large amounts of data to mimic human cognitive functions. Examples of everyday applications of AI include spam filters on email, Google maps and recommended videos on Netflix and YouTube.

Generative Artificial Intelligence (GenAI) is a form of AI that can create seemingly new information based on the patterns and structures found in the data used to train it (Ray, 2023). A well-known example of GenAI technology is ChatGPT. The user provides ChatGPT with a “prompt” (usually text) and ChatGPT will then provide a response (again, usually in the form of text) to the user. An example of a prompt and response from ChatGPT can be seen in Figure 1 and Figure 2 below.

*Provide me with a limerick describing how ChatGPT works and the impact it can have on academic integrity in the assessment of Leaving Certificate coursework in secondary schools in Ireland.*

**Figure 1: An example of a prompt given to ChatGPT by the user**

There once was a chatbot so keen,  
It answered with speed and unseen.  
But students may cheat,  
With essays too neat,  
So teachers must check what they mean!

**Figure 2: The response provided by ChatGPT**

There are both advantages and disadvantages associated with technologies such as ChatGPT in educational settings. The advantages are that it can provide effective feedback to learners (Meyer *et al.*, 2024) and it can also be used for self-assessment by students (Ali *et al.*, 2023). The disadvantages of these technologies are that they may not be suitable for practical classes (Araújo and Saúde, 2024) and the big issue associated with them in education is that they are easily misused and can have a negative impact on academic integrity (Volante, Deluca and Klinger, 2023; Perkins, 2023). Some precautions should be taken with GenAI technologies as they can be prone to providing false information (termed “hallucinations”), they can lack genuine understanding of the topic asked of them, they have limited knowledge (based only on the data used to train them) and may be biased (depending on the type of data used to train them).

## Artificial Intelligence in Leaving Certificate Assessment

Assessment at senior cycle level in Ireland is being reform. In September 2025, the first wave (called “tranche”) of subjects will be reformed. Among these subjects are

the sciences of LC Biology, Chemistry and Physics. Each science subject will now have a coursework component that is worth up to 40% of the final grade of the student. A written examination will be the remaining 60% of the final grade.

This coursework involves students performing both research and experimental work based on a theme. Generative Artificial Intelligence technologies (such as ChatGPT) can provide students with some ideas of projects to complete. This can be viewed as a positive development as the students can use technology to brainstorm and refine ideas through clever prompting of ChatGPT and continuing interrogation of the technology. I would argue that, if used correctly, this is a form of critical thinking. However, it may be seen as the students are simply offloading the work onto a computer and not engaging with the material.

This point becomes more evident when ChatGPT is asked to provide materials and methods to the student for their investigation. It can also provide results (i.e. raw data) and interpretation of those results. **ChatGPT can essentially do the project for the student.**

This raises the question of academic dishonesty and the academic integrity of the Leaving Certificate. In a recent ISTA report, teachers have expressed concerns about the misuse of Generative AI technologies (ISTA, 2024). The State Examinations Commission (SEC) has provided warnings to candidates on the use of AI in coursework such as Leaving Certificate Computer Science (SEC, 2024).

### Safeguarding Against AI Misuse

There is software available online (e.g. GPTZero) that can be used to detect GenAI responses, but these have various ranges of effectiveness. Their effectiveness is further hindered by websites such as Quillbot, which can paraphrase responses from GenAI to make it more difficult to attribute to GenAI technologies.

There are some ways that a teacher can protect the integrity of the assessments in their classroom:

- Frequent Checkpoints for students,
- Draft Submissions,
- Oral Examinations and Presentations,
- Learning Journals,
- Check sources and citations,
- Check for factual errors.

### Conclusions

There are some open questions that need to be answered about the use of AI in education:

1. What changes need to be made in assessment to ensure authenticity in work submitted?
2. What effect will the use of AI have on overall examination result statistics for Chemistry? Is it simply grade inflation by another name?
3. What do teachers do if they suspect the work is not that of the student? It is a difficult position in which teachers find themselves.

We need to understand how students will use GenAI to craft “better” assignments and we as teachers need to understand how we will craft better “defences” against GenAI.

**Sun Tzu was right!**

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## Biography

*Stephen Murphy is a lecturer in Science Education at University College Cork. He is a former teacher of Leaving Certificate Biology and Leaving Certificate Computer Science. He is the holder of an MSc in Bioinformatics and an MEd in Science Education. His research interests include the impact of Generative AI on academic integrity, curriculum and assessment reform, the role of Science, Technology and Society and the teaching of the sciences through the medium of the Irish language.*

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## Go Green Project concludes

The EU-funded Erasmus+ project Go Green has now finished, with an excellent final evaluation score. The project was about Education for Sustainable Development (ESD), looking at environmental protection, sustainability and green practices. The Irish Partner was TUS Limerick and Marie Walsh was the local coordinator until she retired in 2024, when she was replaced by Rita Scully. This is the website link to free learning materials on ESD for teachers as well as teaching materials, many with a focus on cross-curricular collaboration. <https://go-green.pixel-online.org/>

There are now modules of background material in ESD including videos, 30 lesson plans, a draft syllabus structure and a comprehensive assessment structure on the site. Teachers who complete the training modules can download a certificate of completion. For more information contact [Rita.Scully@tus.ie](mailto:Rita.Scully@tus.ie). We hope to have a more detailed article with examples of materials in issue #127.

□

# A Study of the Mathematical Demands in Leaving Certificate Chemistry

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## Abstract

*This article examines the mathematical components of Leaving Certificate chemistry by analysing the past ten years of examination papers. It categorises the types of mathematical demands, explores their alignment with the Junior and Senior Cycle mathematics syllabi and provides recommendations for effective teaching strategies to enhance student understanding and knowledge transfer.*

Science and mathematics have always been closely linked, with mathematics playing a crucial role throughout second-level education, from Junior Cycle (JC) science to Leaving Certificate (LC) science subjects. However, the level of mathematical demand in LC science, particularly in physics and chemistry, can both attract and deter students. Over the past 20 years, the number of students taking LC science subjects has changed significantly (illustrated in Table 1).

## Introduction

**Table 1:** Leaving Certificate candidates (HL and OL) for chemistry, physics and biology

Subject	Year (Total Candidates)		
	2005 (54069)	2014 (54025)	2024 (60839)
Chemistry (% of Total)	7366 (13.62%)	8604 (15.93%)	9417 (15.48%)
Physics (% of Total)	7944 (14.69%)	7177 (13.28%)	7310 (12.02%)
Biology (% of Total)	25362 (46.91%)	32956 (61.00%)	33211 (54.59%)

Many students perceive chemistry and physics as more mathematically challenging than biology, which may affect their subject choices. However, both LC chemistry and physics syllabi state that Higher Level (HL) LC mathematics is not required (NCCA, 1999). Much of the necessary mathematical content is already covered at JC level, as this article will show. The number of students taking HL mathematics for LC has increased from 9,843 (18.86%) in 2005 to 20,330 (36.29%) in 2024. While this suggests improved competency, research by O'Meara et al. (2023) shows the rise is largely due to the

Bonus Points Initiative, not improved performance.

Just and Siller (2022) found that some science teachers see mathematics as just a tool for calculations rather than a way to develop real-world problem-solving skills. The LC chemistry Chief Examiner's Report (SEC, 2013) highlights students' struggles with translating scientific information into mathematical form, suggesting a need for more support. It also notes insufficient practice in calculations and numerical analysis. This article analyses the past decade of LC HL chemistry exams to assess the proportion of marks allocated to

mathematical tasks, explores cross-curricular learning, and evaluates strategies to improve students' calculation skills in the LC chemistry examination.

### Methodology

This study's analysis of chemistry examination papers provides a breakdown of marks by topic. The proportion of each paper involving calculations was calculated based on the entire exam rather than just the eight questions students are required to answer. This approach accounts for variations in question selection among

candidates. Up until 2020, the total marks available across all questions regardless of individual choices was 647. From 2021 onwards, this increased to 678 due to the addition of extra parts in questions 4 and 11.

### Results

The analysis revealed that questions involving calculations, as well as graph plotting and interpretation, accounted for an average of 23.90% of the total marks in the chemistry exams. Table 2 provides a breakdown of these percentages along with marks across different topics.

**Table 2:** Summary of the percentage of mathematical calculations and allocation by topic on the Leaving Certificate HL chemistry examination papers 2015 - 2024.

	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
The Mole Concept and Stoichiometry	8.85%	11.65%	9.14%	11.36%	11.28%	9.12%	10.36%	8.19%	8.81%	8.50%
Plotting and interpreting graphs	4.57%	1.77%	10.18%	5.01%	4.02%	7.57%	6.18%	6.03%	5.56%	6.80%
Chemical Equilibrium	8.11%	7.37%	3.54%	4.42%	5.10%	4.48%	6.49%	4.17%	4.17%	3.86%
pH Calculations	1.77%	1.77%	1.77%	2.21%	2.78%	0.93%	1.39%	3.25%	2.47%	1.39%
Properties of Gases and The Gas Laws	0.88%	0.88%	1.33%	0.00%	0.93%	2.32%	0.00%	2.32%	0.00%	3.86%
Total	24.19%	23.45%	25.96%	23.01%	24.11%	24.42%	24.42%	23.96%	21.02%	24.42%

The Mole Concept and Stoichiometry consistently accounted for the highest percentage of calculation-based marks with a mean of 9.73% and a high of 11.28% in 2020. It appeared in 5–8 different question parts per paper. Most of the required mathematical skills align with Junior Cycle (JC) mathematics and are also fundamental to the Leaving Certificate (LC) mathematics syllabi such as rational numbers, percentages, and ratios. However, the main challenge for students lies in translating chemistry problems into mathematical terms. This relates to the JC mathematics learning outcome: “*make sense of a given problem, and if necessary*

*mathematise a situation*” (NCCA, 2017, p.14) and to the LC mathematics syllabus, which emphasises that problem-solving should be central to teaching and learning (NCCA, 2015). However, ‘mathematising’ is a broad and complex skill, which can be particularly difficult depending on the problem and the level of mathematical reasoning required.

Graph-related tasks had the second highest allocation of mathematical marks, averaging 5.77% over ten years and peaking at 10.18% in 2022. These tasks include plotting data, extracting values, drawing tangents, calculating slopes and

interpreting graph shapes. While covered in JC and LC mathematics, students may struggle with these skills. The Royal Society of Chemistry (2024) found that novice chemists see graphs as static, while experts treat them as manipulable mathematical tools. Common errors include misinterpreting variable relationships. Pearson (2015) recommends providing examples of different graphs before practice to improve interpretation skills.

Chemical Equilibrium had the third-highest percentage of calculation-based marks, with a mean of 5.17% and a peak of 8.11% in 2024. It involves algebraic work, such as forming, balancing and solving equations. Most of the content aligns with JC mathematics, except for the quadratic formula, which is covered at JC Higher Level and LC Ordinary Level but not at JC Ordinary Level. The main challenge is the problem-solving aspect. To find final concentrations, students must analyse a problem, translate it into mathematical terms, break it down into steps, and interpret the solution. This is especially difficult when they must interpret the solution in terms of the original question if they have to choose one particular concentration out of two possible solutions as a result of solving a quadratic equation (NCCA, 2017).

pH calculations accounted for the fourth highest proportion of calculation-based marks, with a mean of 1.97% over ten years and a peak of 3.25% in 2017. Logarithms are not covered at JC level or in LC Ordinary Level mathematics but are included in the LC Higher Level syllabus. However, a deep understanding of logarithmic laws is not required for LC chemistry, students simply need to apply them to determine pH values. Students must be able to use a scientific calculator to handle logarithmic calculations. This topic also involves square root calculations, which are covered in the JC mathematics

Number strand and the Algebra strand of LC mathematics. In practice, chemistry students primarily calculate  $\sqrt{K_a \times M_a}$  but are not required to manipulate surds as in JC mathematics.

Gas Laws had the lowest percentage of mathematical marks, with a mean of 1.25% across all questions. Gas law calculations require students to substitute values, rearrange formulae, and understand units—all of which are covered in the JC Algebra, Functions, Geometry, and Trigonometry strands. While changing the subject of a formula is a JC learning outcome, it can be difficult for students who lack a strong grasp of order of operations, a key concept in the JC Number strand. Struggles in this area at JC level can have a knock-on effect in LC chemistry and other subjects requiring algebraic manipulation.

### Considerations for Teaching

This analysis highlights the key role of mathematics in LC chemistry, particularly calculations and graph interpretation. While much of this is covered in JC and LC mathematics, learning transfer is not always seamless. Nakakoji and Wilson (2020) identified mathematical anxiety and problem comprehension as major barriers to applying mathematics in science. Students may not automatically apply classroom-taught mathematical skills to chemistry problems, requiring explicit instruction within a chemistry context. Britton (2002) stressed the importance of collaboration between subject departments for effective knowledge transfer.

In Irish schools, differing teaching methods for the same mathematical concepts (e.g., factorising quadratics) can confuse students, especially those with lower ability. Even small variations in terminology or an overemphasis on procedural rules can affect confidence and understanding. Closer collaboration between mathematics and science

departments could help align teaching methods, making skill transfer smoother and improving both problem-solving in mathematics and its application in chemistry.

## Conclusions and Recommendations

- The higher uptake of biology in the LC may stem from students' perceptions of the mathematical demands of chemistry and physics. However, this analysis of the past ten years of LC chemistry papers shows that most required mathematics is at JC level.
- The Mole Concept and Stoichiometry consistently accounts for the highest proportion of calculation-based marks, requiring a solid understanding of the Mole and its application in problem-solving.
- While the mathematical skills involved are largely covered at JC level, students may struggle with applying them in a scientific context. The ability to translate scientific information into mathematical form is a key challenge, so science teachers should focus on breaking problems into manageable steps and reinforcing prior learning.
- Closer collaboration between mathematics and science departments could improve students' performance in the mathematical aspects of LC science subjects. Aligning teaching methods and coordinating schemes of work would enhance learning consistency and create a smoother transition between subjects.

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## Biography

*Eoghan Long teaches physics, science, mathematics and applied mathematics in*

Davis College, Cork. He is an Advising Examiner with the State Examinations Commission and was previously seconded to the Professional Development Service for Teachers (now Oide) to lead the

professional development programme for the new applied mathematics specification. □

## Approaches to teaching Leaving Certificate Chemistry

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Students need to be led, and teachers need to lead them. Teachers need to motivate them, praise them, give feedback to them provide a learning environment that students enjoy.

Students should understand and be involved in the teacher's planning process. If a detailed plan is provided for them, they will see how study, the reinforcement of learning, course completion and timing must interlink for positive engagement with the subject.

There is a need for plenty of hard work, use of different intelligences enroute, learning how to study and a development of lifelong interests and learning.

Teachers must test students regularly and constructive feedback must be given.

In teaching the Leaving Certificate course, teachers can provide a bit of colour, a bit of a bang and a fizz and include music in their classes.

### Colour comes with:

- The pink and blue of sodium sulfate solution and universal indicator in the Hoffmann Voltmeter.
- The strong yellow of the test for phosphate.
- The coloured beam of the cathode ray tube.

- The emission line spectrum of sodium with the hand-held spectroscope.
- The pH range of colours using universal indicator solution.

### A bang and a fizz come with:

- The dust explosion (lycopodium and a candle).
- The burning of ethyne in oxygen.
- Calcium powder in dilute HCl/testing with a lighting splint.
- Na/K metal in water (add phenolphthalein indicator for colour).

### Including Music:

- Burning Mg in Oxygen. (holding the burning Mg in the air with music playing → like dancers at a concert).
- Singing a tune:

'Beautiful world	'Domhan Álainn
Making Oxygen	Ag Déanamh Ócsaigín
Hydrogen peroxide	Sárocsáid Hidrigín
Manganese Dioxide	Dé Ocsáid Mhanganéise
Beautiful World	Damhan Álainn
Making Oxygen'	Ag Déanamh Ócsaigín.'

### Different approaches

Different approaches to teaching that can work well in a Chemistry teaching include:

- 1) Team teaching
- 2) A Triarchic Approach to teaching (Sternberg 1994/98)
- 3) Students teaching students.
- 4) Student presentations/summarising chapters.

5) Using resources.

**Team teaching/Collaboration:**

If one is lucky enough to be time-tabled for a team-teaching class with a colleague, teacher collaboration can be at its best. Each teacher's strengths become apparent quickly, and it helps students to see that we all have our strengths and that we can help and complement each other in our learning.

Another approach to team-teaching that works quite well, involves **students teaching students**.

An example of this was the coordination of second year science students and their teachers with a group of eight fifth year students during a double class. Rates of reaction was the topic chosen because it is common to the Junior Certificate and Leaving Certificate syllabi.

In Clonakilty Community College, two laboratories were used with four fifth year students in each lab. Demonstrating specific experiments:

*Making oxygen(catalyst), making hydrogen (varying HCl concentration) and making carbon dioxide (varying particle size).*

Fifth year students guided second years (1:6 ratio) through the experiments, helping them to measure, note, graph and analyse data.

The teachers helped with providing solutions when needed and also kept an eye on laboratory safety.



**The Triarchic Approach:**

The Chemistry teacher can approach teaching in a practical, analytical and memory-based way.

**Practical:**

Titration is carried out by individual students (having previously carried out titrations with a partner).

Teacher collaboration was used in Clonakilty Community college here too. While sixteen to twenty TY students carried out their experiment, each teacher (three to four) observed and assessed four to five students.

The teachers were science teachers, and the assessment sheet involved yes/no answers to ten observations. For example:

- Is the funnel removed from the burette during the titration?
- Does the student wear safety goggles?
- Is the conical flask swirled?
- Does the student read the meniscus correctly?

**Analytical:**

The analytical section would involve analysis of titration results.

Students would be given a written example and then presented with similar results and asked to do the calculations.

#### Memory-Based:

The students watch a video and/or follow a presentation about Industrial Chemistry (Option 1). They are then given a worksheet to complete from memory.

Using this approach, it is hoped that students will learn to think while, at the same time, think to learn.

Feedback was given by participating teachers and students. The following are examples of this feedback:

**Teacher comments:** *Many of the experiments done by students in Transition year have, of necessity, to be done in groups and so it was quite interesting to see students put under pressure in that they had to do it all themselves. It made them read the instructions carefully and think through their actions. Many of the academically weak students seemed to do surprisingly well at following the instructions to the letter. It was nice to see them so engrossed in the tasks, giving it their total and undivided attention.*

#### Student comments:

*The class bonded more during the experiment as we worked to our full potential.*

*There was **satisfaction** in completing the titration in the time allotted.*

*Doing and being assessed appealed to me.*

*I liked the different teachers testing us-it was enjoyable.*

*I liked mixing all the chemicals together; It was a good **enjoyable** day.*

*The results have **given me confidence in my ability** to carry out experiments by myself.*

*It will **stay fresh in my mind** for some time.*

***You learn a lot more** if you do it yourself.*

*I prefer these practical classes because it **makes the chemistry class different to other classes.***

#### Resources:

- Worksheets/test sheets
- Competitions
- Industrial/University Visits.
- Past papers and marking Schemes
- Video clips: “The Radium Girls”, video lesson on  $\alpha$ ,  $\beta$  and gamma radiation, brief orbital clip.
- Leaving Certificate Chemistry Experiment videos (for revision).
- Conical flask.ie
- ISTA-NB: Other teachers/colleagues.
- Royal Chemistry Society.
- Models - orbitals. Molymods.
- Mnemonics.  
'Veronica is always searching desks'  
Vaporisation, Ionization, Acceleration, Separation, Detection.

#### In Conclusion:

Students must learn to capitalise on their strengths. Capitalising on their strengths should then motivate students.

#### Biography

*Hilary retired in November 2023, having taught second level students for 41 years. She also worked as an examiner in the Department of Education in UCC (2 years) and as an examiner and advising examiner with the State Exams Commission (12 years).*

*I am a volunteer with Water Safety Ireland (30 years service), where I continue to teach and examine swimming, lifesaving and tutor young teachers. She has a BSc, MEd, HdipEd and HDipEd Admin (all from UCC).*

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## RSC Resources for the new Chemistry Leaving Certificate course

**John O'Donoghue**

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The Royal Society of Chemistry (RSC) Education website continues to provide accurate and reliable resources for teaching chemistry at all levels. Although there is some new content on the 2025 Leaving Cert Chemistry course, most of it has remained the same. As a result, much of the RSC resources that we have been using to date remain relevant and useful for the new course.

The Periodic Table hasn't changed, and the RSC's print and digital version is still the go-to version for everything you need. The same goes for the fantastic Education in Chemistry (EIC) magazine articles, and this is a timely reminder that there are always new articles and ideas appearing in print and online. For example, in September 2024, Fraser Scott wrote a popular article about teaching atomic theory through modelling and in March 2023, Tim Jolliff wrote a very useful article about teaching electron configurations. The new Chemistry Leaving Certificate course now refers to bonding as a "continuum" or "spectrum" and in 2023, EIC provided a free poster resource with their print magazine which can still be found online.

However, there are a few things to note when navigating the RSC resources and EIC articles. In the interest of making the websites more accessible for the five different education systems that it supports (Republic of Ireland, Northern Ireland, Scotland, Wales and England), the resources were categorised into different ages as 14-16 and 16-18. However, it now seems that this is no longer relevant, particularly for Ireland. For Leaving Cert. bonding resources, you should use the resources labelled 14-16, since these are the

most relevant for Ireland. However, the Benzoic Acid experiment remains on the Leaving Cert. course and has now been added to the English A-levels as well, so it is correctly labelled as 16-18 on the website. In electrochemistry, the wonderful practical videos for Electrolytic Cells are labelled 14-16, while Electrochemical Cells are labelled 16-18, however, both are on the core specification of the new Chemistry Leaving Cert. course.

The RSC education team have already started work on adding the new Leaving Cert. Chemistry course to the "curriculum explorer" of the website and it should be ready by the end of 2025. We also spend a significant amount of time checking and reviewing CPD courses, resources, articles and other material to make sure they are relevant for Ireland. In conclusion, the RSC will continue to support teachers for the new course, and we look forward to meeting everyone on the road.

### Resource links:

Education in Chemistry website:

<https://edu.rsc.org/eic>

RSC Education (Teach Chemistry)

Resources Website: <https://edu.rsc.org/>

□

### Biography

*Dr John O'Donoghue is an award-winning science communicator and chemistry education researcher based at Trinity College Dublin, Ireland where he coordinates the science communication training for PhD students. John also works closely with the Royal Society of Chemistry where he has developed several popular resources for schools and provides professional development for science teachers. John regularly appears on radio to discuss scientific discoveries and has acted as a chemistry consultant for television productions. A lifelong movie buff, John's new book combines his love of the silver screen with his professional background. (See p. 47)*

# How bonus points have changed Leaving Cert Maths

[How bonus points have changed Leaving Cert Maths](#)

Niamh O'Meara, UL; Páraic Treacy, MIC Limerick  
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RTE Brainstorm 25/2/25

**Analysis: There's no doubt that bonus points are driving the uptake of Higher Level maths, but the initiative has had unintended consequences.**

In Ireland, the proportion of students opting to complete their [Leaving Certificate](#) mathematics examinations at Higher Level (HL) has [increased](#) by 130% in 13 years. Such growth would suggest that significant progress is being made in mathematics education in Ireland, but research into the reasons behind this surge may temper such optimism.

Increasing participation in Higher Level mathematics at Senior Cycle has been a key aim for Irish policymakers over the past 15 years. The [Bonus Points Initiative](#) (BPI) was introduced in 2012 with the aim of increasing the uptake of Higher mathematics and the long term goal of improving students' mathematical capabilities.

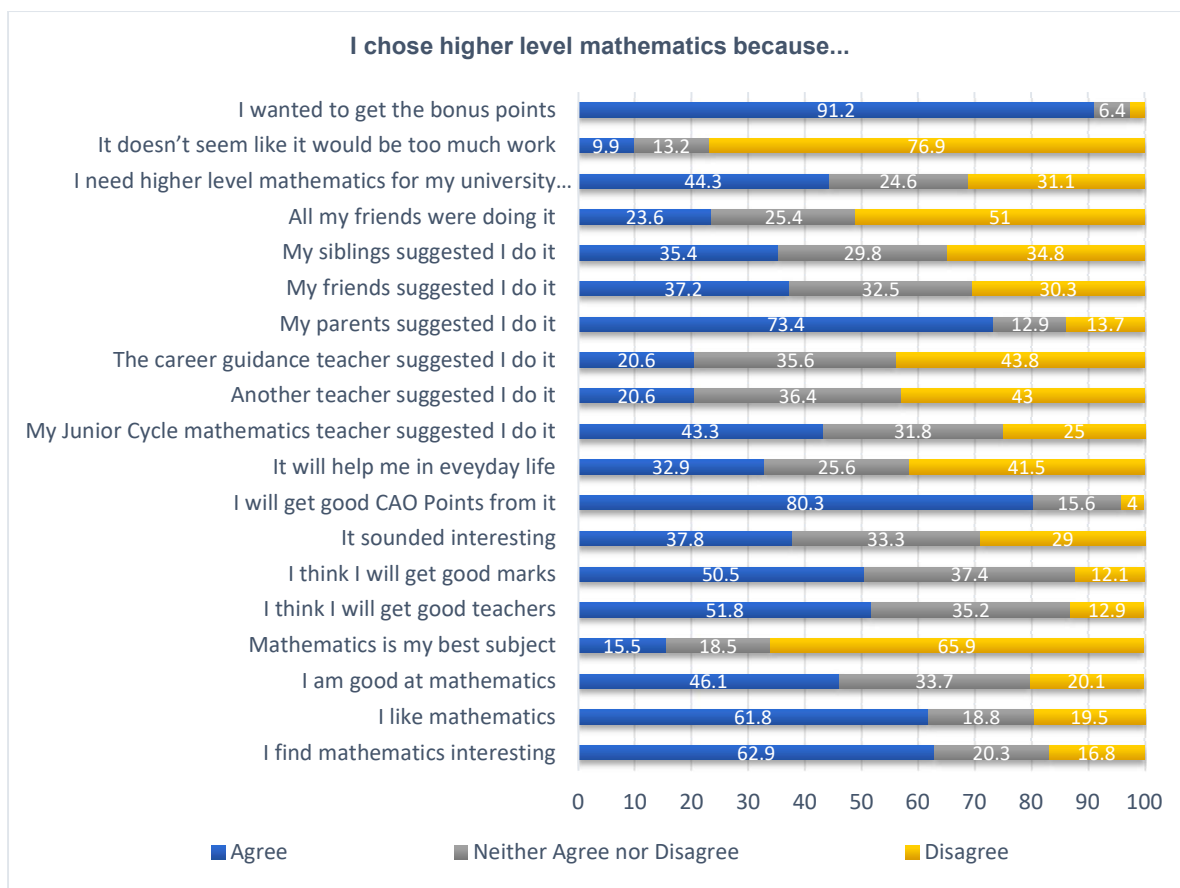
Bonus points mean that students who opt to study Higher Level maths and who obtain a score greater than or equal to 40% in their Leaving Certificate examination are awarded an additional 25 'bonus' points. Based on [the current CAO system](#), this means that a student who obtains 40% at Higher Level would receive more points (71) than a student who achieved 90-100% in the Ordinary Level paper (56).

Maths is the only subject for which bonus points are available, thus giving the subject

a special status in our education system. Despite assurances that bonus points would initially be rolled out on a four-year trial basis, it has now been in place for 12 years with no formal evaluation of the initiative conducted.

As part of an independent research project, we have carried out several studies investigating the impact of bonus points on the profile of students in the Higher Level mathematics classroom; students' motivations to study Higher Level maths; teachers' perspectives on bonus points and the impact on students' performance in the subject. The findings from these studies will highlight some of the unintended consequences of attributing such a special status to mathematics.

As mentioned at the outset, between 2011 and 2024 there has been a 130% (from 15.8% to 36.3%) increase in the proportion of students taking Leaving Cert maths at Higher Level. As such, bonus points have been successful in achieving its primary aim of increasing the number of students opting for higher maths. In 2019, we conducted a [study](#) with 911 Senior Cycle students who were taking Higher maths and asked them what factors motivated them to study the subject at this level (Figure 1). From a list of 19 factors, the two factors that most students selected were "I wanted to get bonus points" (91.2% in agreement) and "I will get good CAO points from it" (80.3%).



**Figure 1: Why 911 Leaving Cert students were taking Higher maths in 2019**

These findings leave us in no doubt that the Bonus Point Initiative is driving the uptake of Higher Level maths and Irish students are now primarily extrinsically motivated to study the subject at this level. However, research has also found that extrinsic motivational factors can lead to diminished intrinsic motivation among students. Therefore, the central role that the BPI is currently playing in motivating students to study higher maths may have longer term negative effects on students' affective reaction to the subject.

The surge in the number of students opting for Higher Level maths and the motivation behind this has also led to a change in the profile of students taking the subject. A research study with 266 Senior Cycle HL maths teachers found that bonus points often resulted in students not suited to HL mathematics persevering with it. This large number of less able students has resulted in

a much wider range of abilities than would have been the case prior to 2012. Many of these students are also less ambitious and have lower expectations of themselves, often aiming to just reach, rather than exceed, the score required to be awarded bonus points.

These findings present teachers with a series of challenges to contend with, most notably in terms of catering for much higher levels of diversity in the mathematics classroom. It is therefore unsurprising that the majority of teachers in our study would like to see the BPI retained but adjusted (56%) or discontinued and not replaced (23%).

As well as having implications for teachers, the BPI may also be impacting the grades being awarded to students. Between 2008 and 2024, the profile of students studying HL maths has changed considerably. A figure which has remained consistent in this

time is the combined proportion of students opting to complete their Leaving Certificate maths examinations at either HL or OL (ranging from 87.9% to 94.1%). Given that the maths capabilities of the combined HL and OL cohorts are unlikely to have varied too much from year to year, one would expect that the proportion of students achieving at the upper end of the HL grading spectrum would remain consistent.

However, we found this was not the case. When comparing Leaving Cert maths' results from 2008 to 2019, there is a 44% increase in the proportion of all HL and OL students achieving a score of 70% (H3 or above in current grading system) or better in the HL examination. When 2008 is compared to 2024, there is a 116% increase in this proportion. While some of this inflation can likely be attributed to the impact of the predicted grades policy in 2020 and 2021, this trend of grade inflation was already in evidence prior to 2020.

Given teachers' concerns about the profile of students now opting for HL maths, it is highly unlikely that this increase can be attributed to a better calibre of student studying HL mathematics as a result of the BPI. Grade inflation of this nature can lead to a loss of confidence amongst stakeholders regarding the capacity for Leaving Certificate grades to provide valid and reliable information about students. This can lead to students being admitted to third-level courses for which they are not sufficiently mathematically prepared, an issue which has been [highlighted](#) in Ireland recently.

Overall, these research studies offer the first comprehensive evaluation of the BPI. While it is clear that the primary objective of the BPI has been achieved, there have certainly been some unintended consequences. Assigning mathematics a special status has impacted on students'

motivations for pursuing Higher Level maths. This has led to a need for different teaching practices in classrooms; and raised concerns about the competencies of students graduating from second level. If the bonus points initiative is to continue, these implications need to be considered to ensure we develop students with the required mathematical competencies to guarantee a knowledge economy.

### Biography

*Dr Niamh O'Meara is an Associate Professor in Mathematics Education at University of Limerick. She is the Deputy Director of EPI-STEM, the national centre for STEM Education at the School of Education. Dr Páraic Treacy is a Lecturer in Mathematics in the School of Education at Mary Immaculate College, Thurles. Dr Mark Prendergast is a Senior Lecturer in Mathematics Education in the School of Education at UCC. He is a Research Ireland awardee.*

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The original papers in which this work appeared are listed below.

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# Great Irish Chemists: Eva Maria Philbin (1914-2005)

Peter E. Childs

Professor Eva Philbin was in many ways a trailblazer for Irish women chemists, and for Irish women in STEM in general.



## Background and education

Eva Philbin was born 3/1/1914 in Ballina, Co Mayo, the elder of two daughters of George Ryder (a postman, later a publican) and Kate née Donegan. She attended the Convent of Mercy in Ballina and went to University College Galway to read science. She graduated with a first-class honours BSc (1936) and then an MSc (1937). She then went to work as a research assistant to Professor Thomas Dillon, known for his work on the chemistry of seaweeds. Later she worked as a chemist for Cold Chon and Hygeia, two companies in Galway. She married John Philbin on 28/4/1943 in Dublin. Her husband was an accountant and later company secretary). At that time most married women didn't work outside the home and until 1973 in Ireland women civil servants had to resign on marriage. They

had two daughters and a son. One of her children had special needs and so she was interested in the provision of education and care for such children. She was chair of the Consultative Council on Mental Handicap (1970-75) and treasurer of the National Association for the Mentally Handicapped of Ireland.

In 1945 Eva joined the Department of Chemistry at University College Dublin (UCD) as a demonstrator, and started to work with Professor Thomas Wheeler, who worked in the area of natural substances. This was a good fit with her previous work on seaweeds. She was promoted to Assistant Lecturer in 1949, College Lecturer in 1955 and gained a PhD in 1954 in organic chemistry. She was awarded a DSC in 1957 and was appointed Professor Of Organic Chemistry in 1961. After Professor Wheeler's death in 1962 she became Head of Department, retiring in 1979. She was one of the first women professors in Science and first female Head of the Department of Chemistry. An interesting article has looked at the careers of Philbin and two other UCD scientists (Carmel Humphries (1909-1986) first female professor of zoology (1957) and Phyllis Clinch (1901-1984) first female professor of botany (1961) and Eva Philbin) and their role in academic leadership in UCD, 'Leading in the academy: women science professors at university college Dublin in the 1960s' (Harford and Murphy, 2021)

*The [Chemistry] department became a leader in the field both nationally and internationally, producing a group of postgraduate students who "were to form the basis of the development of the chemical and pharmaceutical industry in*

*Ireland". Philbin was at the centre of this trajectory. A former student recalled:*

*"Philbin was the epitome of a scientist and also a superb lecturer. I remember we would sit in G08 enthralled by her lectures, as she would sit casually on the bench at the very front of the theatre and speak to us passionately about chemistry."*

(Harford and Murphy, 2021)

UCD Sciences started in the buildings, now Government Buildings, and moved out to Belfield in the 1960s.

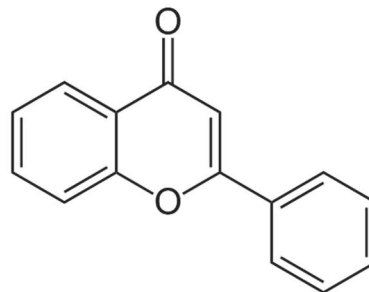
*In the early 1960s UCD began the move from its city-centre locations to the Belfield campus. The three UCD science departments that left Merrion Street with the move were all led by pioneering women professors: Phyllis Clinch (botany), Carmel Humphries (zoology) and Eva Philbin (chemistry). (Feeley, 2015)*

### Research career



Her Ph.D. degree was awarded for work on the Wesley–Moser rearrangement reaction in certain flavonoids and on the Baker–Venkataraman transformation, used in the synthesis of flavones. Philbin then held a research fellowship in 1955 at the Eidgenössische Technische Hochschule in Zürich, Switzerland, where she developed a

research interest in the stereochemistry of flavonoids. Her research career then focused on the biochemical properties of [flavonoids](#), complex compounds found in plants.



Molecular structure of the [flavone](#) backbone (2-phenyl-1,4-benzopyrone)

[Flavon - Flavonoid - Wikipedia](#)

*Philbin's work and her many papers published with Wheeler and others undoubtedly enhanced the international reputation of chemistry in UCD, although the generally low level of funding for basic science in the 1950s and 1960s hindered the establishment of research programmes. (Lunney, 2020)*

UCD developed an international reputation in Organic Chemistry, with many distinguished professors, including Dervilla Donnelly, as well as in other areas of Chemistry. Philbin's leadership played an important role in this.

### Professional activities

Eva Philbin was a founder member, later Fellow, of the Institute of Chemistry of Ireland (ICI), Ireland's professional body for chemists. She was elected vice-President (1964) and President (1966-68), the first woman to serve in the role. She was a Fellow of the Royal Institute of Chemistry from 1954 and served on its Council and that of the Chemical Society. She was elected to the RIA in 1957, one of its first women scientists, and served on its Council and as Senior Vice-President. The Royal Irish Academy is Ireland's premier

scientific body, equivalent to the Royal Society in the UK.

*“Philbin was an important pioneer and role model for young women who wanted to work in Science; ambitious and able, she had nonetheless managed to be polite to newspaper interviewers in the 1950s who archly talked of ‘girl chemists’ and their marriage prospects.”* (Lunny, 2020)

### Awards and honours

To mark her 75<sup>th</sup> birthday in 1989 her friends and colleagues produced a Festschrift containing 115 papers related to her research interests. (RIA, 1989)

After her death the Institute of Chemistry of Ireland established in 2007 the Eva Philbin Award and annual public lecture series in her honour, to be given by a distinguished chemist. The list of Eva Philbin awardees is shown in Table 1. UCD set up from 1980/81 an annual Professor Eva Philbin Medal for the top Stage 3 BSc Chemistry student.

### Table 1: ICI Award for Chemistry Recipients (2005-2007):

- 2024 Professor Stuart James
- 2023 Professor Susan Quinn
- 2022 Professor Carmel Breslin
- 2021 Professor Paula Colavita
- 2020 Professor Declan Gilheany
- 2019 Professor Declan McCormack
- 2018 Professor Anita Maguire
- 2017 Professor Donal O’Shea
- 2016 Professor John Sodeau
- 2015 Professor Michael Zaworotko
- 2014 Professor Thorfinnur Gunnlaugsson

- 2013 Professor Herbert W. Roeske
- 2012 Professor Lesley Yellowlees
- 2011 Doctor Malachy McCann
- 2009 Professor Martyn Poliakoff
- 2008 Professor Peter Atkins
- 2007 Doctor Mary Archer
- 2006 Professor A. Prasanna de Silva
- 2005 Professor David A. Leigh

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(See also The Building of the State, a history of UCD, Online at [the\\_building\\_of\\_the\\_state.pdf](#))

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# Chemists you should know: 14

**Charles Adolphe Wurtz 26/Nov/1817 – 12/May/1884**

**Adrian J. Ryder**

[tutorajr@gmail.com](mailto:tutorajr@gmail.com)

## Introduction

The subject of this essay, Charles Adolphe Wurtz, always used his second name and was the eldest of the three children born to Johann Jacob Wurtz (1787 – 1845) and Sophie Kreiss (3/8/1794 – 2/8/1878), who were married on the 28/10/1815. Adolphe's siblings were Sophie, born in 1819 and Emile Théodore (1821 – 1899).

Adolphe's father was a Lutheran pastor in Wolfisheim (on the outskirts of Strasbourg in the Alsace region of modern-day France) when Adolphe was born but was appointed to the Church of St. Pierre-Le-Jeune in Strasbourg in 1826. In July 1826 Adolphe entered the local Protestant Gymnasium, controlled by the Lutheran congregation, to begin his formal education.



The young Adolphe Wurtz with an impressive set of side-burns, which he favoured throughout his life.

## Education

During his years in the Gymnasium Adolphe became proficient, not only in the Alsace vernacular, but also in German and French. As a student he was not exceptional but did gain several yearly prizes in in-house examinations. In spite of these, his father was not impressed and was heard to say that Adolphe would never amount to anything. Adolphe did take an interest in science subjects from the start, even taking, at the age of ten, a course in Biology outside of the Gymnasium before being involved in Chemistry, which became his life-long calling. His chemical interest led to him performing experiments at home, which were not welcomed by his disapproving father, who had a career in the ministry in mind for him. Despite his father's wishes, Adolphe was to become a master, and internationally recognised, chemical experimenter.

Adolphe graduated in 1834 taking the degree of *Bachelier en Lettres*, and as he showed no interest in the ministry, his father finally allowed him to study Medicine at the University of Strasbourg, where he was placed with Dr. Schneider, a friend of the family. In Strasbourg he soon excelled in his studies and in 1835 became the second, and shortly after, a full assistant in the Chemical and Pharmaceutical department. Following a competitive examination in 1839, he was appointed *Chef des Travaux Chimiques de la Faculté* (i.e. Head of Practical Chemistry). On August 13<sup>th</sup> 1843 he was awarded the degree of Doctor of Medicine, presenting his thesis on fibrin and albumin, in which he described methods for the purification of

soluble albumin and argued that the human blood albumin and the egg albumin were different materials.

For the summer semester of 1842, Adolphe moved to the University of Giessen to further his practical work in Chemistry under the famous Justus von Liebig (12/5/1803-18/4/1873), and there he met A.W. Hofmann (1818-1892), who was to influence his later work on the amines. Hofmann also mentored Fritz Haber (1868-1934) and William Henry Perkin (1838-1907).

In 1843, following his Doctorate, Wurtz spent some months translating Antoine Balard's book into German, having been recommended for the job by Jean Baptist Dumas. Following this he went to work in Dumas's private laboratory in France. In 1845 he was appointed assistant to Dumas at the Sorbonne's École de Médecine and by 1849 was taking over some of Dumas's organic chemistry lectures.



The Sorbonne in Paris

### Research work and academic career

During his long practical career, Adolphe's work was hindered by the lack of proper laboratory conditions in the various Institutions in which he worked. Lack of commercial glassware meant that he had to blow or mould his own, and glassblowing became an important chemical skill. Here

he invented a double-bulbed fractionating column, known as the Wurtz column or Wurtz tube, for the separation of organic chemical mixtures. (See De Sella, 2023).

With no proper laboratory in the École, Adolphe opened a private laboratory in a rented property on the Rue Garanciere in 1850, which was heavily used. Unfortunately, three years later, this laboratory had to be abandoned following the sale of the building. 1850 also saw Adolphe given the professorship of chemistry in the new Institut National Agronomique at Versailles, a position which however was abolished in 1852. This setback only persuaded Adolphe to move back the following year to the École de Médecine, taking up the post in Organic and Mineral Chemistry there.

The following years saw Adolphe immersed in his post at the École before taking on the post of Dean of the Faculty of Medicine there in 1866. Over the years he sought diligently to secure proper teaching laboratories but to little avail.

In another direction he was more successful, opening the École up to women. As Dean of the Faculty, Adolphe was approached by Madeleine Brès (26/11/1842 – 30/11/1921) who wished to become a medical doctor. Women were not admitted to the Faculty but Wurtz noted that Zurich had admitted women two years earlier. Adolphe advised her to begin by taking the Science course, which leads to a B.Sc. degree. Meanwhile he would investigate the possibility of opening the medical faculty to women. He arranged that Dr Alexis Dureau (1831-1904) would go to Zurich and bring back a report which *“enquired about everything that was related, from both a legal and a practical point of view, to admitting women into foreign universities.”*

Following Dureau's return, Adolphe submitted a report to Victor Duruy, the

Minister of Education, on female education throughout Europe and, against a great deal of opposition, got approval to open the Medical Faculty to women. The first woman to be admitted was the American Mary Putman in 1867, followed by Catherine Gontcharoff, a Russian émigré, and Elizabeth Garrett from England. On her graduation in 1868, Madeleine applied for and was admitted to the Faculty. Madeleine was conferred with her Doctorate in 1875, the other three women receiving theirs' earlier, and so she became the first French woman to become a medical doctor in France, and had a long career focused on paediatric care.

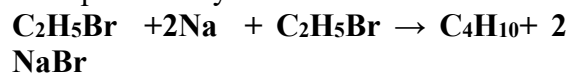


Postage Stamp issued in 2021 to commemorate Madeleine Brès

In 1875 Adolphe resigned the Dean's post at the École, but retained the Honourable Dean title, and became the first occupant of a new chair of Organic Chemistry at the Sorbonne. Here as in the École, there were no adequate laboratories and in spite of all his efforts none were to be provided until 1894, some ten years after his death.

Noted for his research in Organic Chemistry, Adolphe discovered methyl and

ethyl amines (1849), glycol (1856) and the aldol condensation (1872). He developed (1855) the widely known method of synthesizing hydrocarbons by treating alkyl halides with sodium (the Wurtz reaction). The Wurtz Reaction is shown in the example for ethyl bromide below.



Ethyl bromide and dry sodium react in dry ether to give butane and sodium bromide.

This reaction is chiefly used to produce even-numbered carbon alkanes from a single alkyl halide. If two different alkyl halides are used, a mixture of alkanes is formed, e.g. with

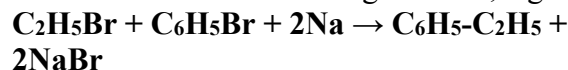
$\text{C}_2\text{H}_5\text{Br} + 2\text{Na} + \text{CH}_3\text{Br}$ , the products obtained are  $\text{C}_3\text{H}_8$ ,  $\text{C}_4\text{H}_{10}$  and  $\text{C}_2\text{H}_6$ .

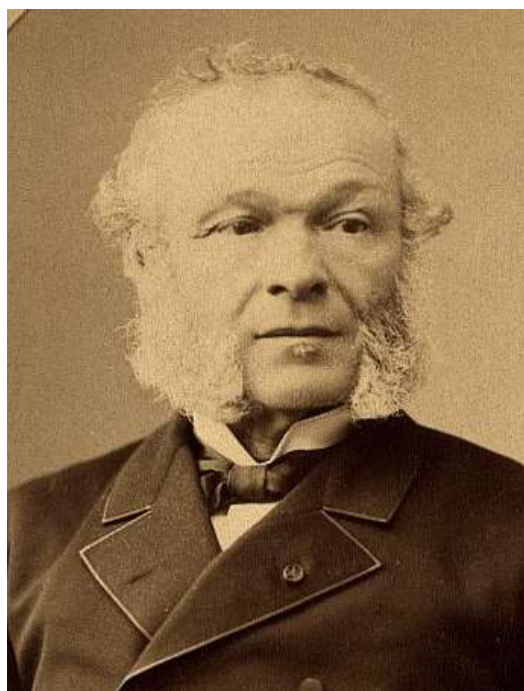
Wilhelm Rudolf Fittig (6/12/1835-19/11/1910) expanded the use of the Wurtz method to form combined Benzene ring compounds e.g.



Such a reaction is known as a Fittig reaction.

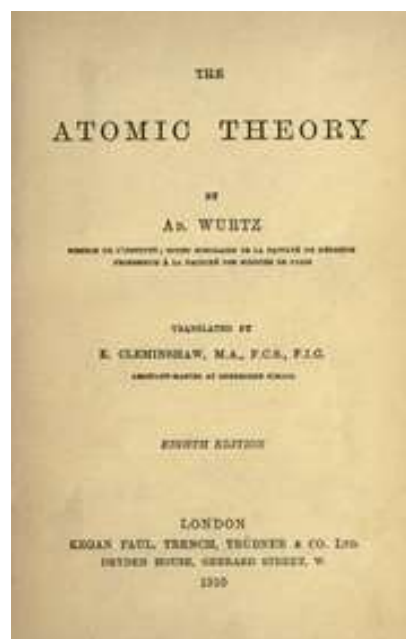
A further reaction, in which an alkyl halide and an aryl halide are reacted with sodium, is known as the Wurtz-Fittig reaction, e.g.





Photograph by Th. Truchelot & Valkman of Wurtz in later years.

Adolphe wrote influential works in support of the atomic theory and on medical and biological chemistry and the noted *Dictionnaire de Chimie Pure et Appliquée* (3 vols. 1868-78; supplement 1880-86). The English Royal Society's catalogue credits him with 73 publications previous to 1864.



Two of Wurtz's books

Wurtz was the principal founder of the Paris Chemical Society in 1858, acting as its first secretary and three times was President of the organisation. 1867 saw him elected to the French Academy of Sciences, becoming a Vice-President in 1880 and President the following year. He was elected a life Senator in 1881.

His name is one of the 72 famous Frenchmen inscribed on the North-East (La Bourdonnais) side of the Eiffel Tower, being placed between those of Louis Daguerre (1787-1851) and Urbain Le Verrier (1811-1877).

Adolphe was awarded the Legion of Honour decoration in 1850, being promoted to Officer rank in 1863, to Commander in 1869, and to Grand Officer in 1881. A street in the 13<sup>th</sup> arrondissement of Paris was named in his honour in 1893. In early 1920 Strasbourg erected a statue of Adolphe in front of the Saint-Pierre-Le-Jeune Protestant church, in the neighbourhood of the house he was born in.



Statue of Wurtz in Strasbourg.

### Personal life

Adolphe married first (17/3/1852) Constance Pauline Henriette Oppermann (1830 – 1906), the daughter of Chrétien Guillaume Oppermann (1777 – 1846) and then Charlotte de Luze (1791 – 1830). Charlotte unfortunately died shortly after the birth of her first child, Constance.

Adolphe and Constance had four children: Anne Marie Constance (1854 – 1930), who married William Oeschner de Coninck (1851-1906), a professor in the Montpellier faculty of science; Lucie Louise (1856 – 1922), who married a Swiss Artillery officer Denis Louis de Rougemont (1851-1922); Robert-Theodore (1858-1919), an associate professor of the Paris Medical School and internationally acclaimed bacteriologist, who was sent by the French Government to study and eradicate the rinderpest pestilence in Abyssinia in 1897. Robert seems not to have been married and most sources do not even mention him as one of Adolphe's children; Henri Adolphe (1862 – 1944), a Lieutenant Colonel of

artillery, who married 'Germaine' Camille Léonie de Staël de Holstein (1875-1929).

Adolphe Wurtz died from complications of diabetes at his residence, 176 Boulevard Saint Germain, on the 10<sup>th</sup> of May 1884 and was buried in the Oppermann Mausoleum, his father-in-law's, in Père Lachaise's Cimetière, Paris 20.

### Some quotes by Wurtz.

*The triumph of a theory is to embrace the greatest number and the greatest variety of facts.*

*A History of Chemical Theory from the Age of Lavoisier to the Present, Time, Lavoisier, I (p. 7), Macmillan & Company Ltd. 1869*

*Chemistry is a French Science. It was founded by Lavoisier of immortal memory.*

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# The sulfur story: devil's gold or essential element?

## 5. Metal sulfates: from bluestone to gypsum

Sulphuric acid (part 3) is made on a massive scale and one use is to produce metal sulfates, although because sulphur is widely distributed in the environment, there are many natural sources of sulfates. There is a sulfur cycle whereby sulfur compounds are recycled through the environment. In general, where sulfur occurs underground in anaerobic (reducing) conditions it appears as sulfides, and where sulfur is found exposed to air it exists in the form of sulfates, the most oxidised form of sulfur. (We will look at the sulfur cycle in the next issue.)

Metal sulfates have been known and used since antiquity and were known to the alchemists as vitriols, because of the glassy appearance of their crystals. This in turn led sulfuric acid to be called oil of vitriol (or just vitriol), as it was first made by heating green vitriol, iron(II) sulfate-7-water,  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ .

The sulfates of all metals except lead, mercury (I), barium, and calcium, are soluble in water. Silver sulfate is slightly soluble. The water-insoluble sulfates are also insoluble in dilute acids.

The vitriols are hydrated metal salts, soluble in water, and owe their colour to the transition metal ion and their partially filled d orbitals. The colour arises from the metal ion being bonded to six water molecules, which causes the d orbitals to split with an energy spacing in the visible region. When the water of crystallisation is removed, as with anhydrous copper(II) sulfate, the blue colour is lost. Adding a drop of water makes it return. The sulfates of groups 1 and 2 are colourless because they have no d orbitals, and the splitting of their energy levels lies outside the visible region.

Green vitriol  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$   
 White vitriol  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$   
 Red vitriol  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$   
 Blue vitriol  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$



Figure 1: Hydrated and anhydrous copper (II) sulfate

Metal sulfates are salts of sulfuric acid and are common minerals as when sulfur-containing minerals meet air and water they are oxidised to metal sulfates. Thus metal sulfide ore deposits are often identified by the colour of sulfates outcropping on the surface. Sulfur is common in the environment and thus sulfates are also common minerals, like for example, gypsum,  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  (see *CinA!* #125, Autumn 2024, pp 48-49. ). In this article we will look at some common sulfates and their uses.

### Copper(II) sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , bluestone, blue copperas, blue vitriol

If there's one thing our students remember from JC chemistry it is blue copper(II) sulfate crystals or solution. It produces lovely crystals. If heated carefully it loses water and turns white. Add a drop of water and it turns blue again.



Figure 2: Copper(II) sulfate crystals

Blue staining on rocks shows the presence of copper, although it may be basic copper(II) carbonate or sulfate. You can buy copper(II) sulfate in the garden shop, for use as a fungicide amongst other uses (Figure 3). [Copper Sulfate Uses: A Complete List](#)

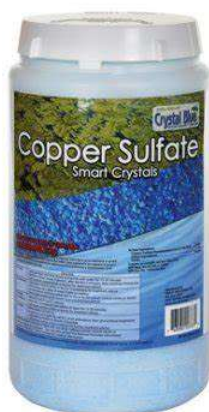


Figure 3: Copper Sulfate in the garden shop

(Note: always worth checking if a chemical used in school is cheaper in the garden shop, chemist or hardware shop,)

### Iron (II) sulfate, green vitriol, copperas

For many centuries iron(II) sulfate was known as copperas. It does not contain copper but copperas was a generic name for metal sulfates and so one had blue copperas ( $\text{CuSO}_4$ ) and green copperas ( $\text{FeSO}_4$ ). Eventually the name copperas only stuck with the iron compound. Making copperas by the slow reaction of iron pyrites with air

and water goes back centuries and may deserve the title of the first industrial chemical. It was important in making black inks, for dyeing leather and as a mordant in fixing dyes. It was a by-product of the alum industry, as alum shales usually contained iron pyrites.

Some names die hard. If you go to your local garden shop you will be able to buy Copperas, for adding iron to soils.

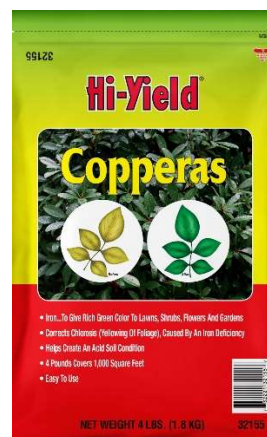
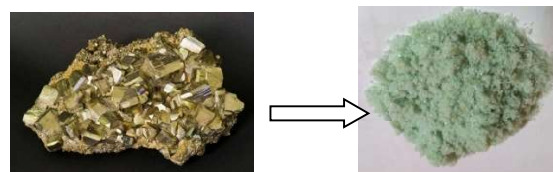


Figure 4: Copperas in the garden shop



Iron pyrites

Copperas ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ )

### [Pyrite In The Manufacture Of Iron - African Pegmatite](#)

Figure 5: From pyrites to copperas

### Sodium sulfate, Glauber's salt, $\text{NaSO}_4 \cdot 10\text{H}_2\text{O}$ , Sal Mirabilis

*The decahydrate of sodium sulfate is known as Glauber's salt after the Dutch-German chemist and [apothecary Johann Rudolf Glauber](#) (1604–1670), who discovered it in Austrian spring water in 1625. He named it sal mirabilis (miraculous salt), because of its medicinal properties: the crystals were used as a general-purpose laxative, until more sophisticated alternatives came about in the 1900s.*

[Sodium sulfate - Wikipedia](#)



Figure 6: Glauber's salt

The largest use is as filler in powdered home laundry detergents, consuming approximately 50% of world production. This use is waning as domestic consumers are increasingly switching to compact or liquid detergents that do not include sodium sulfate.

It can also be used as laxative and it also works by drawing water into the small intestine, loosening the stools. It is also a diuretic and is used to purge drugs like paracetamol from the body. Up to 2/3<sup>rd</sup> is produced from natural sources (salt deposits) and the rest by synthesis, often as a by-product of other processes.

### Magnesium sulfate, Epsom salt

Ever used bath salts to produce a relaxing bath? If yes, then you've been using Epsom salts, or magnesium sulfate. Dissolved in warm water it is supposed to have therapeutic value. (See [The Waters of Epsom Spa](#) for an article on Epsom Spa.)



Figure 7: Epsom salts

Magnesium sulfate is also used as a mild laxative, but be careful not to overdose. It works by attracting water to the small

intestine, loosening the stools. It works in 30 minutes to 6 hours. Other magnesium salts also work as it is the magnesium ions that are the active ingredient.

I came across this old article online – I'd forgotten about it, and decided it was worth reprinting here.

### Epsom Salts

*P.E. Childs Chemistry in Action!*, #40, Summer 1993.

Most of us are familiar with the phrase "taking it with a dose of salts," but not everyone knows what it means. It goes back to the practice of taking Epsom Salts as a cure for constipation.

The medicinal value of the spring waters at Epsom, Surrey was discovered in the reign of Elizabeth I (1558-1603) and the Epsom Spa grew in fame over the next half-century. Local tradition recounts the discovery of the spa in this way:

*"One very dry summer a farmer dug around a spring to make a pool for his cattle to drink. However, the cattle would not drink although they were dying of thirst. He wondered why and tasted the water: it was bitter to the taste and kept the flies off."*

The relaxing action of the water was soon discovered and by 1640 it was a famous spa. 'Epsome waters' were mentioned by Henry More in 1657 and Bergman said "the sal catharticus amarus has been in high esteem at Epsom from the year 1610" (quoted in Partington History of Chemistry, Volume 3). In 1695, Nehemiah Grew, a doctor in London, wrote an account of the medicinal value and properties obtained from the spring entitled *"A treatise on the Nature and Use of the Bitter Purging Salt contain'd in Epsom and such other waters."* In 1700 George and Francis Moulton established a factory at Shooter's Hill, near London, to market Epsom Salts. It was sold at the sign of the Glaubers-Head in Watling Street. By the middle of the 19th century the supply of mineral at Epsom was exhausted.

The active ingredient of the water was hydrated magnesium sulphate, which crystallized as  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ , known as Epsom Salt(s) in England and *sal anglicum* (English salt) on the continent. In the early 19th century St. Bartholomew's Hospital in London used two and a half tons of Epsom Salts each year. When it occurs as a mineral, the deposit is known as epsomite. There are large deposits at Stassfurt in Germany.

Epsom salts are still sold as an over-the-counter medicine. Magnesium sulphate is made industrially by neutralizing sulphuric acid with magnesium carbonate or hydroxide. It is used as a sizing agent in paper and as a fireproofing agent, as an ingredient in explosives and matches. Medicinally it is used as a mild laxative (purgative) and as an anti-inflammatory. Sea-water contains 1.668 g/L of magnesium sulphate. Water in the Dead Sea contains 52 g/L magnesium chloride.

I came across two rhymes illustrating the potency of Epsom Salts:

*Mary had a pocket watch  
She swallowed it one day  
And now she's taking Epsom salts  
To pass the time away.*

The other is an epitaph, which also has a connection with Epsom salts:

*Here lies the body of Mary Ann  
Lowder  
Who burst while drinking a Seidlitz  
powder;  
Called from this Earth to her  
Heavenly rest  
She should have waited until it  
effervesced.*

(Epitaph from Burleigh, New Jersey  
ca. 1880)

What is a Seidlitz powder? Seidlitz powder or salts were/are medicinal salts composed of tartaric acid, potassium tartrate and

sodium carbonate. In the stomach or in water these will effervesce producing carbon dioxide. They were used to 'open' the bowels, in the same way Epsom Salts were used. Obviously in Mary Ann Lowder's case they were too effective and killed her. The name Seidlitz comes from a village in Bohemia where there is a spring, whose water is impregnated with magnesium sulphate and carbon dioxide - fizzy Epsom Salts!

\*\*\*\*\*

### **Barium sulfate, $\text{BaSO}_4$ , barytes, barite**

In the school laboratory we use barium chloride solution as a test for sulfate ions: if sulfate is present, a dense white ppt of  $\text{BaSO}_4$  is formed. Although barium ions are poisonous, the sulfate is so insoluble that it is non-toxic. One of its uses in medicine is as a barium meal, ingested to show up the digestive tract to X-rays, as barium as a heavy element is a good X-ray absorber. ([Upper gastrointestinal series - Wikipedia](#)) The name barium means heavy, because its compounds (like lead) are very dense. The main use of barytes is as a dense slurry as a filler in oil and gas mining. It is also used to make barium chemicals.

Ireland has had several barytes mines in the past – in Cork, Sligo and Tipperary. The Benbulbin mines in Sligo operated from 1894-1979 and the Magobar mine at Silvermines, Co. Tipperary, produced 4.61 Mt between 1963 and 1993.

This article has mentioned a few important metal sulfates but there are many more. In the next article we will look at the sulfur biogeochemical cycle.

□

## Amazing Minerals: #4 Fluorite (fluorspar) $\text{CaF}_2$

Fluorite has been designated a critical mineral by the EU but it is fairly unfamiliar to most people. Its original name was fluorspar. Fluorine and fluorine compounds must be one of the most misspelt items in chemistry! It has nothing to do with carbohydrate (flour) chemistry!

The prefix *fluor* dates from the 1660s, an old chemistry term for "minerals which were readily fusible and useful as fluxes in smelting". It comes from Latin *fluor*, originally meaning "a flowing, flow," from *fluere* "to flow, stream, run, melt".. Said to be from a translation of the German miners' name, *flusse*. Since 1771 applied to minerals containing fluorine, especially calcium fluoride (*fluorspar* or *fluorite*). The mineral was called fluorite in English (-ite is an ending indicating a mineral) used as a flux in making iron and ceramics. This in turn gives us fluorine, the group 18 element found in fluorite.

Fluorite has the property when illuminated by UV light of giving out light of a different wavelength (colour), a phenomenon known as fluorescence (Figure 1). This is the property that makes whites look whiter. This was named in 1852, the "property of glowing in ultraviolet light," coined by the Irish mathematician and physicist Sir George G. Stokes (1819-1903) from *fluorspar* because in it he first noticed the phenomenon.

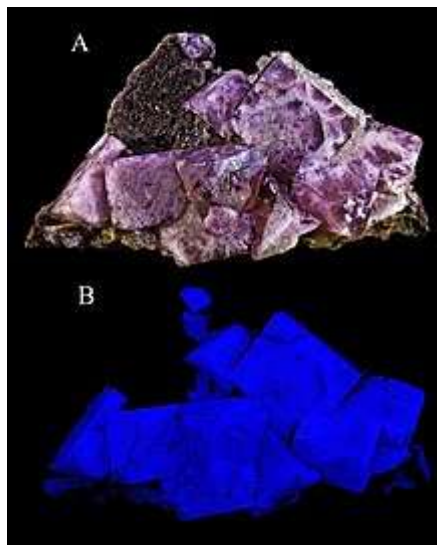


Figure 1: Fluorescing fluorite from Boltsburn Mine, [Weardale, North Pennines, County Durham, England, UK.](#) [Fluorite - Wikipedia](#)

From a mineral perspective, the word "fluorescence" was first coined by George Gabriel Stokes in a footnote on page 479 of arguably his greatest work, entitled "On the change in refrangibility of light", which was published on the 1st January 1852 in the journal *Philosophical Transactions*. [David Carter - George Gabriel Stokes and the phenomenon of fluorescence](#)

### The mineral fluorite



Figure 2: Sample of green fluorite

Figures 2 and 3 show coloured examples of fluorite crystals, which is a cubic, ionic mineral. The different colours are due to

trace metal impurities. Figure 4 shows the unit cell of fluorite. Each calcium ion is surrounded by 8 fluoride ions and each calcium ion by 4 fluoride ions. It is a fairly soft mineral, with a hardness of 4 on the Moh's scale and it melts at 1360 °C.



Figure 3: Purple fluorite

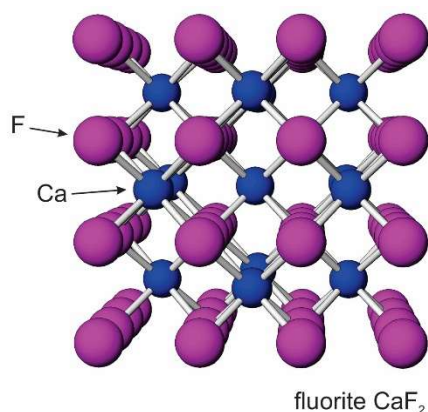


Figure 4: Crystal structure of fluorite,  $\text{CaF}_2$

A spectacular form of fluorite is called Blue John, found in Derbyshire, which is a brightly coloured, semi-precious gemstone (Figure 5). [Blue John \(mineral\) - Wikipedia](#)



Figure 5: Blue John mineral

Its crystals were some of the first specimens studied for the phenomenon of “fluorescence,” which was named after fluorite, and is thought to be caused when trace amounts of yttrium, cerium, europium, or other rare earth elements substitute for calcium in the mineral structure.

Small fluorite mines operated in the Burren at Kilweelran and Doolin. The Doolin Mine was a very small mine that was worked by the Irish Steel Company for one year (1947) and produced somewhere between 45 and 90 tons of fluorite during its short life. The deposit was discovered in 1943.

World reserves of fluorite are ~230 Mt (million metric tonnes). The main reserves are in S. Africa (41 Mt), Mexico (32 Mt) and China (24 Mt). China, as with many crucial minerals, is the main producer: China 5.7 Mt in 2023 (~68%). Global production was 8.6 Mt in 2022.

### Uses of fluorite

This website gives a good overview of the mining and processing of fluorite and its uses. All our fluorine chemicals come from fluorite.

#### [5 Key Steps in Fluorite Processing and Its Significance](#)

Fluorite is used in making steel and aluminium and ceramics, and as a source of fluorine and fluorine chemicals (HF,  $\text{F}_2$  and fluoropolymers.) It is also becoming important in making lithium batteries ([Fluorspar: the forgotten battery mineral - Metal Tech News](#)) and this use will increase.

Aluminium is made by the electrolysis of molten aluminium oxide (the alumina being obtained from bauxite, for example at Aughinish Alumina), but this process also uses aluminium fluoride ( $\text{AlF}_3$ ) and cryolite ( $\text{Na}_3\text{AlF}_6$ ), made from fluorine from

fluorite, to lower the mpt. and make the melt more conductive.

Three main grades of fluorite (fluorspar) are used in industry, depending on their purity. [Fluorite and Fluorspar: Mineral uses and properties](#)

#### Acid Grade Fluorspar

Acid grade fluorspar is a high-purity material used by the chemical industry. It contains over 97%  $\text{CaF}_2$ . Most of the fluorspar consumed in the United States is acid grade even if it is used in lower grade applications. It is used mainly in the chemical industry to manufacture hydrofluoric acid (HF). The HF is then used to manufacture a variety of products which include: fluorocarbon chemicals, foam blowing agents, refrigerants, and a variety of fluoride chemicals.

#### Ceramic Grade Fluorspar

Ceramic grade fluorspar contains between 85% and 96%  $\text{CaF}_2$ . Much of this material is used in the manufacture of specialty glass, ceramics, and enamelware. Fluorspar is used to make glazes and surface treatments that produce hard glossy surfaces, opalescent surfaces, and a number of other appearances that make consumer glass objects more attractive or more durable. The non-stick cooking surface known as Teflon is made using fluorine derived from fluorite.

#### Metallurgical Grade Fluorspar

Metallurgical grade fluorspar contains between 60 and 85%  $\text{CaF}_2$ . Much of this material is used in the production of iron, steel, and other metals. Fluorspar can serve as a flux that removes impurities such as [sulfur](#) and phosphorous from molten metal and improves the fluidity of slag. Between 20 and 60 pounds of fluorspar is used for every ton of metal produced. In the United States many metal producers use fluorspar that exceeds metallurgical grade.

Fluorine is the most reactive element and this makes it hard to obtain and contain, and

when it forms compounds, these are very stable. Although its existence was known it was the last of the halogens to be isolated. Organofluorine compounds like Teflon, once made are very stable, and this has caused and is causing environmental problems. The hole in the ozone layer was caused by long-lasting chlorofluorocarbons, which lasted long enough in the atmosphere to diffuse up to the ozone layer and destroy it. Fluoropolymers are very stable chemicals and thus are hard to destroy and break down in the environment.

**Per and polyfluoroalkyl** substances (PFAS) are a broad group of synthetic chemical species containing C-F bonds that have been used in industrial and consumer products since the 1930s. PFAS have been described as forever chemicals. They are ubiquitous and long-lasting and present a long-term health hazard. Like microplastics, all us contain PFAS chemicals in our bodies.

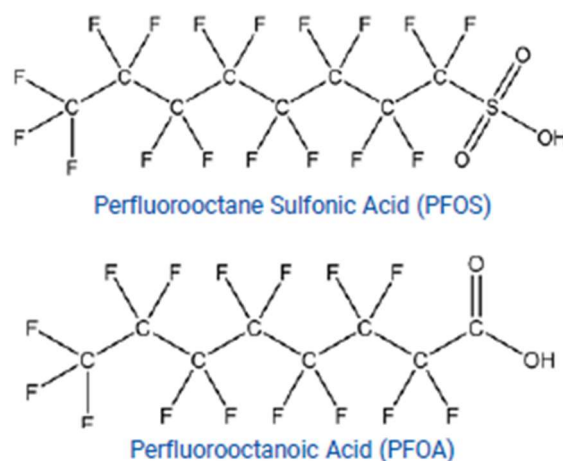


Figure 6: the structures of some PFAS compounds



Figure 7: Sources of PFAS compounds

Another area of controversy in fluorine chemistry is the use of fluoride in drinking water to prevent and reduce tooth decay. Fluoride is present at low levels in drinking water and in many toothpastes. The fluoride ion replaces OH ion in tooth enamel (apatite), which makes the mineral harder and decay resistant.

Fluorine chemicals are widely used in the microchip industry.

[How Fluorine and Fluoride Gases are Used in Semiconductor Manufacturing](#)

HF is used to etch glass to create surface designs (as in Figure 8). A design mask is used and HF eats away the glass which is uncovered. The products can then be washed away leaving the pattern etched on the glass surface. HF is a very dangerous and corrosive liquid so this should be done with great care and full PPE.



Figure 8: A design etched on glass with HF □

Fluorine is used in the nuclear industry. One of the main uses of **fluorine** is related to the manufacture of **uranium hexafluoride**,  $UF_6$ , which allows the isotopic enrichment of natural uranium. About 60% of the world production of  $F_2$  is devoted to the synthesis of this gaseous fluoride compound.

$SF_6$  is used as a gaseous insulator in the electrical supply industry, but its use is being phased out as it is a potent greenhouse gas. You may have met it as an example of VSEPR theory for 6 electron pairs – the molecule is octahedral. It is also a dense gas and has been used in demonstrations of density and to produce a very deep voice, as helium is used to produce a high voice. This video shows Steve Spangler demonstrating the properties of  $SF_6$ . [Bing Videos](#)

All these compounds and uses all go back to fluorite, the mineral source of fluorine chemicals. You can see why fluorite has been designated a critical and strategic mineral.

□

## Project work

A. You could use these mineral profiles as the basis for literature research projects in Transition Year, connecting chemistry to everyday life. Depending on numbers, give each student/group a use of fluorine to research and present as a poster and short

presentation to the class. The environmental issues provide opportunity for a 'for and against', 'pro and con' debate. Get two groups to research and present the arguments for and against, e.g. fluoridation of water, the use of fluoropolymers.

Fluorine and its compounds are too dangerous to use in school but there are many videos that can be used to illustrate the topic.

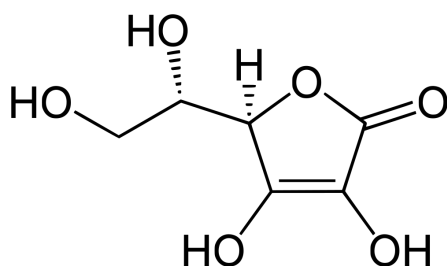
B. This article introduces the idea of fluorescence and this is a topic that could be investigate using a UV lamp, which are easily obtainable online. How many common materials, minerals and chemicals fluoresce under UV light? Fluorescence can be used to show up spots of organic chemicals on TLC plates.

□

## Chemlingo: A scurvy story

Peter E. Childs

Vitamin C is found in fruits and vegetables and prevents the disease scurvy. The biochemist Albert Szent-Györgyi isolated it in 1927 and found out it was acidic and resembled carbohydrates. He didn't know its structure and thus he coined the name *ignosic* acid, derived from an unknown sugar, *ignose*: *-ose* is the common ending for sugars and *ign-* comes from the Latin *ignorare* (= to have no knowledge of). He submitted the name in a paper to the *Biochemical Journal* and it was rejected by the editor as being too frivolous. He was asked to call it hexuronic acid instead, a more respectable and scientific-sounding name. Szent-Györgyi replied that if *ignose* was unacceptable then it might as well be derived from "*godnose*". This wasn't accepted either and hexuronic acid it became, though when it was found not to be a uronic acid at all, it was then called ascorbic acid instead, because of its anti-scurvy properties (*a-scorbutus* = without scurvy). "*The Vitamin C story started with 'ignose' and godnose'. Where will it end? Who knows?*" (1) Interestingly only the L- form is biologically active and its structure is given below.



The structure of L-ascorbic acid

This story shows that some chemists at least have a sense of humour. Naming compounds is one safe area for exercising humour and if you're lucky you may get away with.

Scurvy is caused by a specific vitamin deficiency. Vitamin C is found in fresh fruit and vegetables, especially citrus fruits. English sailors were called 'limeys' by US sailors because they drank lime juice to combat scurvy on long voyages.



Vitamins were named as the 'amines of life' in 1920 by the Polish biochemist Casimir Funk as a shorter alternative to 'accessory food factors', where *vita* meant life and they were all thought, incorrectly, to be amines, hence the ending – *amin*. Although the vitamins have no chemical relationship to each other, their role as trace nutrients has led to them all being called 'vitamins'. Vitamin B<sub>12</sub> is also called cobalamin, because it contains cobalt. Vitamin A is also called retinol, as it is important in vision and thus linked to retina.

### References:

1. *Organic Chemistry: The Name Game*, A. Nickon and E.F. Silversmith, Pergamon 1987

# Quirky Elemental Facts in Rhyme

Peter Davern

## Copper, Cu

In cable, pipe, and still-pot too, see copper's lustre "red,"  
Helps "cyto c" give cells their zip, helps doorknobs kill bugs dead!  
Helps "blue blood" lobsters prowl the sea,  
Its carbonate makes verdigris;  
Add tin for bronze, an Age thus born; add zinc for brass instead.

### **In cable, pipe, and still-pot too, see copper's lustre "red,"**

Admittedly, elemental copper is more reddish-orange than a true red. But it's one of only three metals on the periodic table that isn't the typical silvery-grey colour; the other two are the gold-coloured metals caesium and gold.

Copper is second only to the much more expensive silver in its ability to conduct electricity and has widespread use in electrical wiring and cables. A fairly soft metal, copper is easily cut, bent, and shaped, making it historically a material of choice for plumbers before the introduction of PVC pipes. In fact, copper is so ubiquitous in the Western world in particular that each person has an estimated 170 kg of copper associated with them!

Copper also has very good heat-transfer properties, which are ideal for cooking pots and kettles, as well as for whiskey still pots.

*sigh-toe-see*

### **Helps "cyto c" give cells their zip, helps doorknobs kill bugs dead!**

Copper is an essential element for life, and a number of key enzymes rely on it to function. One such copper-dependent enzyme is the *cytochrome c oxidase (cyto c)*, which is critical to the production of energy within cells.

Some hospitals take advantage of copper's antimicrobial properties when they use copper for doorknobs, bathroom fixtures, and other touch surfaces. Using copper in this way might help to limit the spread of potentially fatal bacterial infections caused by, for example, methicillin-resistant *Staphylococcus aureus* (MRSA).

### **Helps "blue blood" lobsters prowl the sea,**

Humans use the blood's iron-based molecule haemoglobin to transport oxygen around their bodies. Lobsters, octopuses, crabs, spiders, and snails use the copper-based molecule *hemocyanin* instead. Hemocyanin might not be as efficient as haemoglobin, but it's responsible for the blue colour of these creatures' blood.

*ver-dub-gree*

**Its carbonate makes verdigris;**

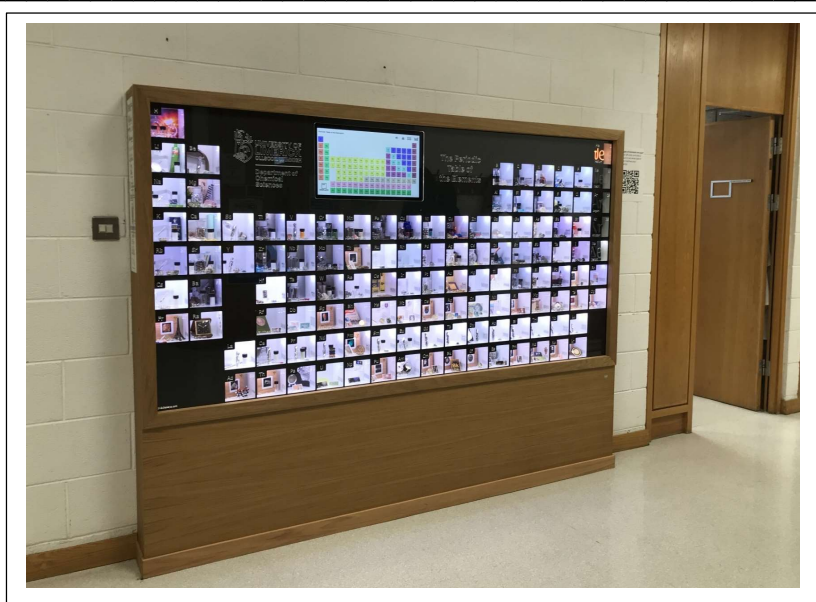
Copper develops an attractive green outer layer (*patina*), also known as *verdigris*, when exposed to atmospheric weathering – New York’s Statue of Liberty is a good example. Verdigris usually consists of basic copper(II) carbonate.

**Add tin for bronze, an Age thus born; add zinc for brass instead.**

Bronze, the 1:2 alloy of copper and tin, has a superior hardness to copper alone. It was developed around 3,500–3,000 BC in several ancient societies, marking the beginning of a period of time often called the Bronze Age. The copper-zinc alloy brass is also well-known for its hardness and its bright, gold-like appearance.

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](mailto:peter.davern@ul.ie) to arrange a free ‘guided tour’ for you and your students of the large-scale, interactive periodic table display in the Chemical Sciences Department at the University of Limerick.



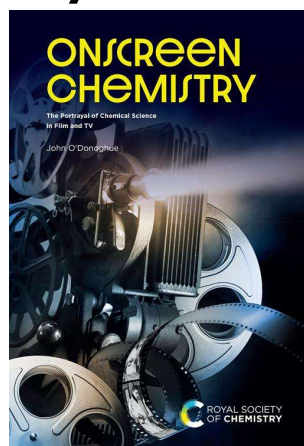
## Summer reading for Chemistry teachers

Why read books about Chemistry apart from the textbook and course specification? If you want to keep your brain alive and your enthusiasm for Chemistry fresh, then you need to read widely to keep yourself up-to-date. Reading popular Chemistry or Science books will give you new teaching ideas, anecdotes and stories to illustrate your teaching, new applications of Chemistry and generally revive your spirit. There are lots of good popular Chemistry and Science books now available. You can also lend or recommend them to your students to get them excited about Chemistry outside the classroom.

A few authors specialise in popular chemistry. John Emsley has written several good books and spoke once at ChemEd-Ireland. Peter Atkins is a prolific and successful textbook author, but he has also written some popular chemistry books. Another author I have just come across is Mark Miodownik, Professor of Materials, and a past Royal Institution lecturer. Sam Kean has written several books, of which *The disappearing Spoon* is probably the most famous. The dates given below are for the cheapest paperback version although all are available as e-books. Prices are given in Euro from Amazon.co.uk for guidance.

You can buy/order books through your local bookshop, or buy them online from Easons or Amazon. Even when a book is out-of-print you can usually access it through your local library or one of the online second-hand booksellers, like Abe Books. There are lots of books about the Periodic Table, and I covered some titles in a previous article.

Our own John O'Donoghue has a new book out on *Onscreen Chemistry* (see below).



### **Onscreen chemistry: The portrayal of chemical science in film and TV**

**John O'Donoghue (2025) London: RSC €24.99**

From Transylvania and Chernobyl to colourful glassware and narcotics, explore the fascinating world of the big and small screen through a chemist's eye as cinema and television are passed under the microscope. In *Onscreen Chemistry* Dr. John O'Donoghue tells the story of chemistry in the movies and on TV, aiming to uncover the good, the bad and the ugly, while exploring the unique duality of chemistry, much like the story of Dr. Jekyll and Mr. Hyde.

O'Donoghue works as the Chemistry Education Coordinator at Trinity College Dublin and has previously won several awards for his science communication efforts. In his new book, he brings together cinema, TV, chemistry and history as he charts a winding journey that begins with the invention of photography in the 19th century and brings us right up to modern times. For the first time, the entire history of chemistry in moving pictures is explored and condensed into a narrative format for easy reading. The resulting story takes an exciting and ever-changing journey, from the gothic horror of *Frankenstein* (1931) to the fun and inventive *Monkey Business* (1952), to the industrial accidents in *Silkwood* (1983), to the chemistry

classroom of *October Sky* (1999) and into space with *The Martian* (2015).

The idea for the book began during the COVID pandemic when he gave some online talks about “Chemistry in the Movies” for Science Week in 2020. The popularity of the talks grew, with several organisations in the UK and the US asking him for similar talks in 2021. Then, in February 2023, he was asked to do the talk in-person for the first time in Queens University Belfast as part of the Northern Ireland Science Festival. Despite the terrible weather on the night, the talk attracted over 100 people. He repeated the feat later in the same year when he was asked to present his “Chemistry in the Movies” talk for the Royal Society of Chemistry Belgium Local Section in Brussels, with another large crowd in attendance. These talks inspired John to dig deeper into the archives, which provided him with a rich and interesting story.

As well as investigating elaborate glassware and laboratories, *Onscreen Chemistry* also tracks the portrayal of chemists over time. It includes details about many fictional and real-life chemists who have graced the silver screen as John searches for the origins of the ‘mad scientist’ image. Are chemists always portrayed as relentless in their quest, like Sidney Stratton (Alec Guinness) creating a stain proof fabric in *The Man in the White Suit* (1951)? Is there any real-world basis for Emma Russell’s (Elisabeth Shue) formula for cold fusion in *The Saint* (1997)? Are the dangers and risks of forever chemicals accurately portrayed in *Dark Waters* (2019)? And, of course, did Walter White’s (Bryan Cranston) switch from teaching to illegal narcotic production in *Breaking Bad* (2007-2013) influence the real-world image of chemistry?

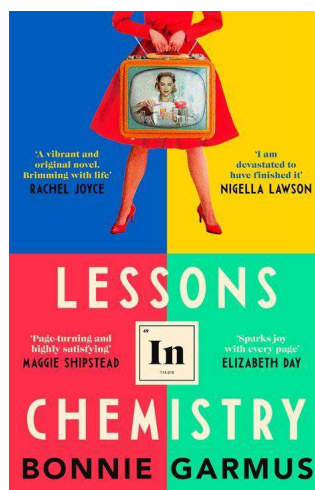
Recently, chemistry has seen a welcome revival onscreen with diverse and positive representations through the *Lessons in Chemistry* (2023) TV series and in the

children’s movie *Elemental* (2023). The book is written in a “popular science” format to appeal to all readers. So, delve into the depths of this intertwining and ever-evolving story as art imitates life and investigate the role that chemistry has played in the history of moving pictures as John investigates if we truly are at the beginning of a new golden age for onscreen chemistry.

*Chemistry World* Promotion tie-in Article about the Image of Scientists (Feb 2025):

<https://www.chemistryworld.com/opinion/exploring-the-on-screen-image-of-chemists/4020783.article>

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**Lessons in Chemistry**

**Bonnie Garmus (2022) Penguin €11.92**



*Lessons in Chemistry* is a series that is available on Apple TV+. The show will premiere on October 13th, 2023 and is available on catch-up.

If you haven’t already read this, get a copy and read it; buy copies and give to your friends. It is a brilliant book and the TV series looks excellent.

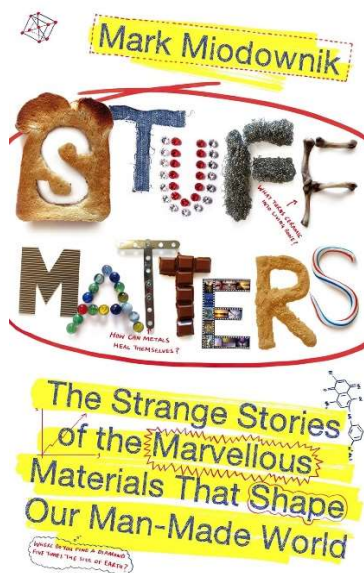
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***It's a gas The Magnificent and Elusive Elements that Expand Our World***

**Mark Miodownik (2025) Penguin €13.09**  
*Why are most gases invisible, odourless and tasteless? Why do some poison us and others make us laugh? And why do some power our engines while others make drinks fizzy? In It's a Gas, Mark Miodownik masterfully reveals an invisible world through his unique brand of scientific storytelling.*

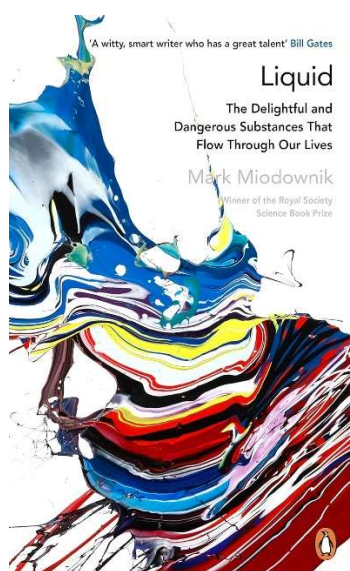
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***Stuff Matters: The strange stories of the marvellous materials that shape our man-made world***

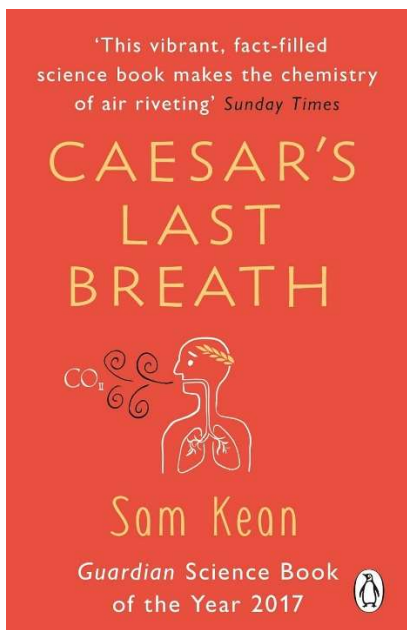
**Mark Miodownik (2013) Penguin €11.92**  
*The everyday objects: paper clips, the textiles that make your clothes and the cups you drink from. The extraordinary new materials: self-healing metals, silicon chips and bionic implants paving the future. Stuff Matters reveals the miracles of craft, design, engineering and ingenuity that surround us every day. From ancient technologies to those shaping our future, this is a book to inspire amazement and delight at mankind's material creativity.*

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**Liquid: The delightful and dangerous substances that flow through out lives**  
**Mark Miodownik (2019) Penguin €11.64**  
*Structured around a plane journey, encountering water, wine, oil and more, Miodownik shows that liquids are agents of death and destruction as well as substances of wonder and fascination. His unique brand of scientific storytelling brings them and their mysterious properties alive in a captivating new way.*

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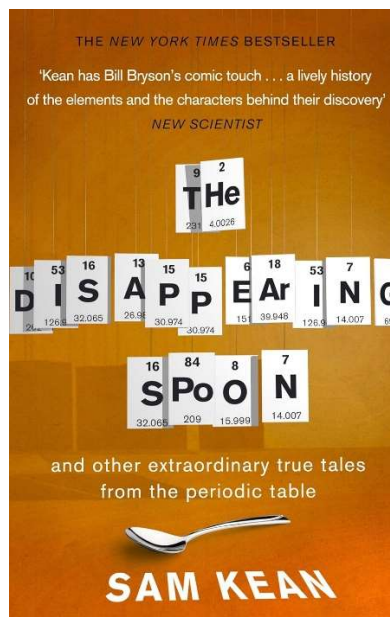
**Caesar's Last Breath**

**Sam Kean, (2018), Black Swan €15.51**

*With every breath, you literally inhale the history of the world. On the ides of March, 44 BC, Julius Caesar died of stab wounds in the Roman Senate, but the story of his last breath is still unfolding. In fact, you're probably inhaling some of it now. Of the sextillions of molecules entering or leaving your lungs at this moment, some might also bear traces of Cleopatra's perfumes, German mustard gas, particles exhaled by dinosaurs or emitted by atomic bombs, even remnants of stardust from the universe's creation.*

*In Caesar's Last Breath, New York Times bestselling author Sam Kean takes us on a journey through the periodic table, around the globe and across time to tell the epic story of the air we breathe.*

\*\*\*\*\*



**The Disappearing Spoon**

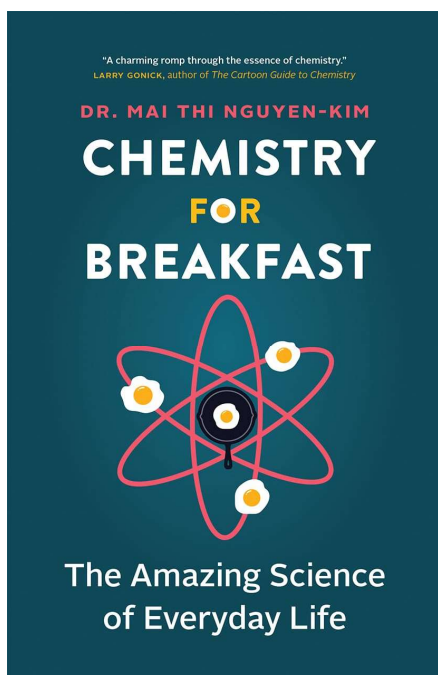
**Sam Kean (2011) Black Swan €13.12**

*Why did Gandhi hate iodine (I, 53)? Why did the Japanese kill Godzilla with missiles made of cadmium (Cd, 48)? How did radium (Ra, 88) nearly ruin Marie Curie's reputation? And why did tellurium (Te, 52) lead to the most bizarre gold rush in history?*

*The periodic table is one of our crowning scientific achievements, but it's also a treasure trove of passion, adventure, betrayal and obsession. The fascinating tales in The Disappearing Spoon follow carbon, neon, silicon, gold and every single element on the table as they play out their parts in human history, finance, mythology, conflict, the arts, medicine and the lives of the (frequently) mad scientists who discovered them.*

*Why did a little lithium (Li, 3) help cure poet Robert Lowell of his madness? And how did gallium (Ga, 31) become the go-to element for laboratory pranksters? The Disappearing Spoon has the answers, fusing science with the classic lore of invention, investigation, discovery and alchemy, from the big bang through to the end of time.*

\*\*\*\*\*



**Chemistry for breakfast: the amazing science of everyday life**

**Mai Thi Nguyen-Kim (2021)**

**Greystone Books €13.12**

*Have you ever wondered why your alarm clock sends you spiraling? Or how toothpaste works on your teeth? Why do cakes and cookies sometimes turn out dry? (Hint: you may not be adding enough sugar.) In Chemistry for Breakfast, award-winning chemist and science communicator Mai Thi Nguyen-Kim reveals the amazing chemistry behind everyday things (like baking and toothpaste) and not-so-everyday things (like space travel). With a relatable, funny, and conversational style, she explains essential chemical processes everyone should know—and turns the ordinary into extraordinary.*

\*\*\*\*\*

### **The well-read scientist**

*“A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their*

*incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: Have you read a work of Shakespeare’s?”*

**C.P. Snow**

*I grew up in Brooklyn, New York ... a city neighborhood that included houses, lampposts, walls, and bushes. But with an early bedtime in the winter, I could look out my window and see the stars, and the stars were not like anything else in my neighborhood. [At age 5] I didn’t know what they were.*

*[At age 9] my mother ... said to me, “You have a library card now, and you know how to read. Take the streetcar to the library and get a book on stars.” ... I stepped up to the big librarian and asked for a book on stars. ... I sat down and found out the answer, which was something really stunning.*

*I found out that the stars are glowing balls of gas. I also found out that the Sun is a star but really close and that the stars are all suns except really far away I didn’t know any physics or mathematics at that time, but I could imagine how far you’d have to move the Sun away from us till it was only as bright as a star. It was in that library, reading that book, that the scale of the universe opened up to me. There was something beautiful about it.*

*At that young age, I already knew that I’d be very happy if I could devote my life to finding out more about the stars and the planets that go around them. And it’s been my great good fortune to do just that.*

**Carl Sagan**

# Issues in Chemical Education: ICE

## The great biogas debate

As you pass Gort on the M7 you will see the sign: No Biogas in Gort. In the newspapers there are other reports of protests or planning objections to biogas plants around the country, even though they are favoured by government and EU policy, part of the green agenda. **Why all the controversy?**



### The case for biogas plants

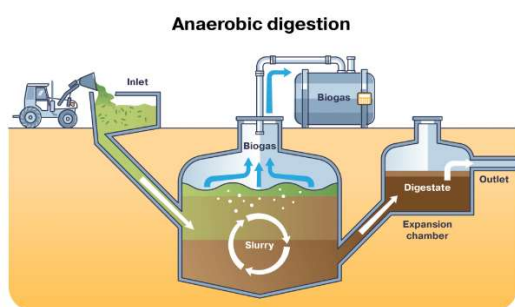
First of all, biogas plants are not new. I remember reading about them in the 1970s and a number of plants have been in operation in Ireland, North and South, for many years. There is a famous one at the Bethlehem Abbey, Portglenone since 1984. There are around 20 in the Republic and over 70 in N. Ireland, with others in the pipeline. In Europe in 2023 there were 21,322 biogas plants and in China there are 13 million biogas plants. So producing biogas from organic waste is a tried and tested technology.

Second, organic waste (farm waste, animal manure, food waste) is a major component of Ireland's waste and needs safe and effective disposal. There are several ways to do this. Organic waste can be broken

down aerobically (in the presence of air) or anaerobically (in the absence of air). Exposed to air the product of aerobic fermentation is carbon dioxide. This process occurs in sewage works. In the absence of air, anaerobic fermentation occurs, methane is produced rather than carbon dioxide (Table 1). This happens naturally in anaerobic sediments in ponds, lakes and bogs. I remember collecting 'bog gas' in an empty jam jar when I was at secondary school. I also had an experiment where science education students had to collect samples and identify what bog gas was. The other way of disposing of organic waste (apart from landfill) is incineration, which can recover the energy value of the waste at the expense of producing CO<sub>2</sub>. Another alternative for organic waste is composting, where organic matter is allowed to rot down into garden compost.

Organic matter in landfills produce methane as the organic matter decomposes and methane leaks into the atmosphere, where it is a potent greenhouse gas (Table 2). Some landfills now are capped, and methane is collected and stored for use as a fuel. Biogas plants do this on a smaller scale, fermenting organic waste in large, sealed tanks, collecting, cleaning and using the methane gas produced. Biogas is typically about 60% methane and 40% carbon dioxide, but it can be burned at source to produce heat and power. Many biogas plants do this so that energy is recovered on site. It is also possible to upgrade biogas by purification to remove CO<sub>2</sub>, when it called into biomethane (97% methane) and it can be entered into the natural gas system. When burnt the methane produces CO<sub>2</sub>, but if it is food waste, crop waste or animal manure, then this CO<sub>2</sub> was originally in the atmosphere

and there is no net CO<sub>2</sub> emission, unlike when fossil methane (natural gas) is burnt. Aerobic digestion would produce CO<sub>2</sub> not methane, as done in sewage works, so the fuel value would not be obtained but the overall carbon balance would be the same. Thus anaerobic digestion (AD) extracts energy from the waste. If the methane was allowed to go straight into the atmosphere it would cause more global warming than CO<sub>2</sub> (Table 2). Many farms use slurry tanks to allow animal manures to ferment. These are open to the atmosphere, but operate anaerobically producing a mixture of toxic gases and are a health hazard, and contribute to local air pollution. Several people die each year from inhaling slurry gas. In a biogas plant the gases produced are contained. Figure 1 shows a diagram of an anaerobic digester.



**Figure 1: Outline of an anaerobic digester**  
[Biodigesters: environmental friend or foe? - Power Knot](#)

The food and animal waste can also cause water pollution if they are allowed to run off into rivers and lakes, or leak into groundwater, leading to nutrient enrichment, algal bloom and eutrophication, and pollution of drinking water. Intensive farming of animals produces a massive waste disposal and pollution problem. Animal waste contains pathogens and it is usually not safe to spread on land as a fertiliser unless it is denatured. Treatment in a biogas plant prevents water and land pollution, and the liquid and solid residues are safe to use on land as a fertiliser.

Disposing of organic waste properly by converting it into biogas has several environmental advantages. It reduces air and water pollution. The solid and liquid byproducts of biogas product is detoxified, unlike raw manure, and can be used as a valuable fertiliser, as it still contains its N and P content. It avoids uncontrolled releases of toxic waste.

**Table 1: Composition of biogas**

Typical composition of biogas		
Compound	Formula	%
Methane	CH <sub>4</sub>	50–75
Carbon dioxide	CO <sub>2</sub>	25–50
Nitrogen	N <sub>2</sub>	0–10
Hydrogen	H <sub>2</sub>	0–1
Hydrogen sulphide	H <sub>2</sub> S	0–3
Oxygen	O <sub>2</sub>	0–0

**Table 2: Greenhouse warming potential (GWP) of various gases**

GHG	GWP for 100 years
CO <sub>2</sub>	1
CH <sub>4</sub>	23
N <sub>2</sub> O	296
HFC - 23	12 000
HFC - 134a	1 300
SF <sub>6</sub>	22 200

Source: IPCC Third Assessment Report (2001).

So, for a process which sounds so beneficial and environmentally friendly, something that will reduce our waste disposal problem, that will reduce greenhouse gas emissions overall, while also supply energy, why all the objections? It is a plan supported by the government and by EU directives.



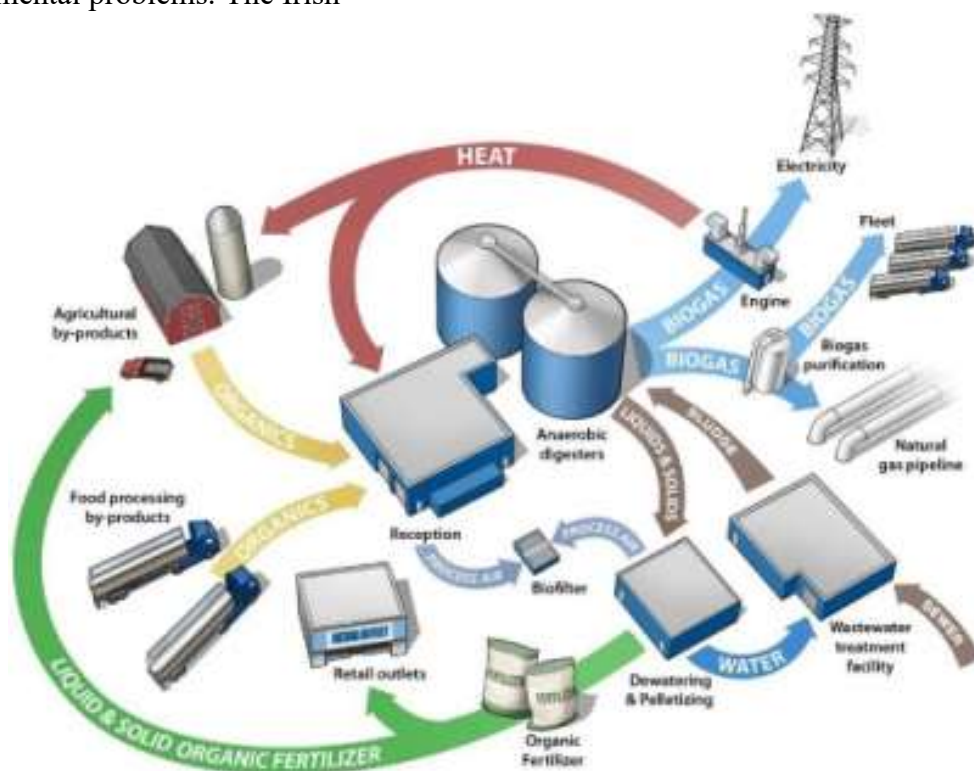
**Figure 2: A biogas plant at Lisburn, N. Ireland**  
[Biomethane boost: NI biogas plant to power 'green' trucks with food waste - Agriland.ie](https://www.agriland.ie/news/2023/05/10/biomethane-boost-ni-biogas-plant-to-power-green-trucks-with-food-waste)

Figure 3 is a schematic of a biogas plant, where the gas can be used directly to produce heat and electricity (CHP) or purified to go into the gas network. Saleable fertiliser is a by-product.

Biogas plants create jobs in rural areas, where depopulation is a problem. Ireland produces ~180 Mt of agriwastes which have to be disposed of and create major environmental problems. The Irish

government target for 2030 envisages 150-200 biogas plants producing ~10% of Ireland's gas requirements and creating 1,800 direct and 4,400 indirect jobs. It also creates income/reduces costs for farmers and others providing waste, and the digestate when used as a fertiliser reduces fertiliser costs.

Apart from meeting EU targets for decarbonisation, a key driver behind biogas, we should also take into account long-term energy security. The recent storms have shown the vulnerability of Ireland to disruption of electricity supplies. 70% of our natural gas is imported by pipeline and our own supplies from the Corrib field are running out. Biogas producing biomethane for the gas grid is a small contribution to energy security. Although, the use of gas also depends on electricity to power pumps.



**Figure 3: A schematic diagram of a biogas plant.**  
[Biofuels from Anaerobic Digestion | Antigonish Community Energy](https://www.antigonishenergy.com/biofuels-from-anaerobic-digestion)

## Objections to biogas plants

Although several biogas plants already exist in Ireland, proposals to build new ones to tackle the farm waste problem, have run into strong local opposition.

The main objections seem to be as follows and apply mainly to large-scale, industrial biogas plants, rather than smaller ones on individual farms.

There are objections to location, siting a biogas plant near occupied buildings, on the edge of a town or village.

Heavier traffic on rural roads and in built-up areas as waste is trucked in to feed the plant.

Possibility of air pollution (smells) or other leakages, even though the digesters are fully enclosed. Smells can be released when material is transferred from tankers into the biogas plant. Composting plants operate in the open air and are a bigger source of smells.

Risk of explosion as in any facility using natural gas.

Lack of benefit to the local community as the profit goes to the owners, or the local farmer who hosts the digester. (This is true of any business or industry).

Very few jobs are created locally as the plants are largely automated and the trucking in and out would often be done on contract.

### Arguments against large biogas plants

See the blog below for some of the Gort Biogas concerns.

[Gort Biogas Concerns | Help save South Galway from a catastrophic development](#)

### NIMBY?

In part the objections are NIMBY-inspired. People in rural areas or small towns don't want any industrial development near them. Every current attempt to build new biogas plants in Ireland (in Galway,

Kildare, Tipperary, Mayo) has met strong local objections. We want to meet our climate obligations, we want energy security, we want renewable energy, but we don't want the plants built near us.

The pro-biogas lobby tend to maximise benefits and minimise hazards. The anti-biogas lobby tends to maximise hazards and minimise benefits. Everything we do has risks and benefits, and no human activity is without risk. A risk/benefit assessment tries to balance the two.

### Some background resources

#### National Biomethane Strategy

[gov.ie - National Biomethane Strategy](https://gov.ie/national-biomethane-strategy)

The National Biomethane Strategy was published in May 2024.

*Government committed to the delivery of up to 5.7 TWh of indigenously produced biomethane by 2030. Delivery of this ambitious target will require the development of an AD industry at scale. A first key step is the development of a National Biomethane Strategy. This National Biomethane Strategy was co-developed by the Department of Agriculture, Food and the Marine (DAFM) and the Department for Environment, Climate and Communications (DECC). Guidance was provided by a Project Working Group, chaired by DAFM, which drew on membership across Government, under the auspices of the Heat and Built Environment Task Force.*

*The National Biomethane Strategy is Ireland's first major policy statement on biomethane and is an important milestone in the development of an indigenous sector. The Strategy sets out twenty-five actions to be delivered in the coming years to enable the development of the sector. Along with providing supports and policy certainty, these actions aim to improve the development timeline and economics of*

projects in order to meet the 5.7 TWh target by 2030.

### **Mission, Vision, Values**

The primary objective of the National Biomethane Strategy is to deliver on the ambitious target set by the Government as part of the agreement on the sectoral emission ceilings. The ambition is to scale up indigenously produced biomethane by up to 5.7 TWh per annum by 2030, which has been increased substantially from an original Climate Action Plan 2019 target of 1.6 TWh by 2030.

**Mission:** The National Biomethane Strategy will be agri-led and farmer-centric with a focus on the supply of suitable feedstocks, including animal slurries. It will align with the national biodiversity action plan, nitrates action plan, and contribute to the restoration of Ireland's biodiversity. It will align with the circular bioeconomy development contributing positively to both the sectoral emissions ceiling for agriculture, as well as to the decarbonisation of Ireland's energy mix.

**Vision:** By 2030, Ireland will have developed a sustainable biomethane industry of scale, meeting ambitious production targets set by the Government.

**Values:** Sustainability, Biodiversity, Diversification, Decarbonisation, Energy Security, Circular Economy and Bioeconomy.

### **What this means in practice**

The goal of 5.7 TWh by 2030 means  $10^9$  KWh. Current gas usage in 2022 was 57.1 TWh, so the goal is ~10% of natural gas replaced by biomethane. Only 2 biomethane plants are currently in operation but there are over 50 biogas plants.

### **Biomethane strategies**

Ireland has set a target of producing 5.7 TWh of biomethane by 2030 which will

require 120,000 ha (less than 5% of available agriculture land) and winter slurry from approx. 1.3 million cows. The role of farmers, and the rural economy, will be critical to the development of biomethane in Ireland.

Biomethane is already firmly established and available on the European market, with c. 37 TWh produced in 2022. Biomethane has the potential to progressively (albeit not fully) replace fossil gas supplies both at a European and national level.

Ireland lags behind our European counterparts in terms of biomethane production, with only two plants in the Republic of Ireland currently producing biomethane. Currently production meets less than 0.1% of our overall gas demand.

However, the Government is keen to increase the number of plants producing biomethane in Ireland from two up to 150-200 by 2030 to meet c. 10% of our current fossil gas demand.

Ireland's National Biomethane Strategy was launched in May 2024 and has set a pathway to replace up to 10 percent of the country's fossil gas needs with biomethane by 2030. It is Ireland's first major policy statement on biomethane and is a significant milestone in developing an indigenous sector. Its primary goal is to deliver the ambitious target of up to 5.7 TWh of indigenously produced biomethane by 2030, set out in the Government's Climate Action Plan.

[Turning down the gas - Biomethane & agriculture - KPMG Ireland](#)

□

### **Biomethane Energy Report, GNI**

Gas Networks Ireland produced its own report on Biomethane Energy in September 2023.

[Biomethane Energy Report](#)

The report summarised the advantages of biomethane.

*Biomethane production plants are hubs of the circular economy - streams of materials previously regarded as waste, from agriculture, industrial processes and water management can be channelled through anaerobic digesters and converted into:*

1. *renewable energy in the form of biomethane.*
2. *nutrient-rich organic fertiliser or digestate (which can be used locally as a renewable bio-fertiliser).*
3. *pure biogenic CO<sub>2</sub> (which can be used as a feedstock in multiple industrial applications).*

*The separate collection and digestion of organic waste in biomethane plants results in threefold GHG emission savings:*

- *avoided emissions from decomposing wastes.*
- *production of renewable energy in the form of biomethane, which replaces natural gas.*
- *production of organic fertilisers/ digestate - after AD, all key nutrients and micro-nutrients can be directly used on soil as a fertiliser, thereby, substituting fossil fuel based mineral fertilisers.*

*A biomethane plant can result in a net reduction of GHG emissions, capturing the naturally occurring emissions to produce biomethane. While both biomethane and natural gas release CO<sub>2</sub> upon combustion, biomethane can be net zero provided the process has captured emissions equal to or greater than those from the combustion of biomethane.*

*Methane is the most significant GHG emission from agriculture at present and biomethane plants provide the opportunity to reduce this significantly. Biomethane production also significantly reduces the net emissions of nitrous oxide, which is the second most significant GHG emission from agriculture. This saving will result from the displacement of chemical*

*fertilisers and raw slurry land spreading, with more stable and efficient digestate derived bio-fertiliser.*

### **How does a biogas plant work?**

[How Does A Biogas Plant Work? Waste Disposal Energy Fertilizer](#)

□

### **How does Ireland compare with European countries?**

It may be no surprise that Ireland is bottom of the league when it comes to biomethane production.

**Table 3: European biomethane production in 2021**

[Biomethane Energy Report p. 33](#)

Country	GWh
Germany	83,878
UK	26,224
Italy	25,763
France	10,390
Spain	8,329
Denmark	7,277
Czech Republic	6,840
The Netherlands	4,826
Poland	3,407
Belgium	2,965
Sweden	2,265
Switzerland	1,779
Austria	1,622
Ukraine	1,366
Slovakia	1,214
Ireland	487

### **A successful biogas/biomethane plant 10,000ac digestate opportunity for Dublin and Meath farmers - Premium**

Bia Energy, Huntstown, Co. Kildare was originally built in 2017 for Energia and opened in 2019. It was sold to Bia Energy in 2023 and upgraded to accept 00,000 t waste pa. Presently it produces heat and

electricity in a CHP plant but in 2025 it is due to convert the biogas into 120 GWh of biomethane. It will also produce 90,000 t of digestate as fertiliser for local farms. This article gives a nice description of an operating AD plant in Ireland.

See also [www.greengas.ie](http://www.greengas.ie) for a farm-based biogas plant in Shanagolden, Co. Limerick.

### **Problems in the biogas pipeline**

[A look under the bonnet of Ireland's future AD plants - Premium](#)

This article from the Irish Farmer's Journal (18/12/24) describes some of the AD plants in the planning pipeline. Despite the government and EU backing the development of AD plants as part of a

waste management and decarbonisation plan for Irish agriculture, there is a lot of opposition. Everyone supports the idea in principle, but not near my town or village or house. Who will benefit from the AD plants? The companies developing them are in business to make a profit; the builders and engineers employed to build them; the employees will have secure jobs; the local farmers will benefit from disposing of their waste and getting fertiliser back; the country will benefit by avoiding EU fines for not meeting CHG targets. It seems like a win-win situation except that nobody wants an AD plant near them, even though they have lived next to quarries, piggeries and farms for decades.

□

## Places to visit: the kelp pits at Spanish Point, Co. Clare

Ireland has a long history of harvesting seaweed along the western and north-western coasts. Seaweed was used a food, and directly on the land as a green manure. From at least 1700 onwards seaweed was also burnt to produce kelp, a fused slag. Kelp was first used as a source of alkali and was important for the soap, textile and glass industries in Ireland and abroad. In 1811 iodine was discovered by accident in seaweed residues and from ~1840 to the 1950s kelp was used a source of iodine in Scotland, Ireland and France. In Ireland the kelp industry involved tens of thousands of people and whole families were employed, producing a valuable source of cash income. Iodine factories were started in Donegal and Galway and the last attempt at an indigenous seaweed-based iodine industry was in Galway around 1930. A collapse in the world market for iodine meant this revived industry was no longer viable. Kelp burning continued probably in the mid-1940s and Co. Clare was a major source of kelp, exporting it to Scotland and to France. The seaweed was harvested, dried and then burnt in long, rectangular, shallow kilns or pits. The remains of kelp pits have been identified on a headland in Spanish Point (Figure 1), and a display board erected by the local community group together with a 3.5 km Kelp Walk. The headland also marks the wreck of *The Kelp* in 1916. Seaweed was collected and dried near the Strand (under today's car park) as Figure 2 shows. [Walking Routes at Spanish Point](#).

You can read more about the seaweed industry in Co. Clare in the 2025 issue of *The Other Clare*, vol. 49.



Figure 1. Two of the kelp pits at Spanish Point. (Photo: P.E. Childs)



Figure 2: The strand at Spanish Point showing seaweed heaps being dried. Probably 1950s. (Photo supplied by Jimmy McMahon.)

In 2017 the local Community Group did a reenactment of seaweed burning (Figure 3).



Figure 3: Sean Treacy burning seaweed to produce kelp. Photo: Sean Treacy

□

# Diary

## 2025

### 2025 ASE Annual Conference at the University of Nottingham

9 - 11 January

[2025 ASE Annual Conference at the University of Nottingham | www.ase.org.uk](http://www.ase.org.uk)

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### ISTA Conference

4-5 April 2025

Maynooth University

[www.ista.ie](http://www.ista.ie)

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### Chemistry Education Research and Practice

Gordon Research Conference

*Exploring Interactions in the Chemistry*

*Curriculum in Physical and Digital Spaces*

July 6 - 11, 2025

[2025 Chemistry Education Research and Practice Conference GRC](http://www.gordonconferences.com)

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### ChemEd2025

20-24 July 2025

Colorado School of Mines,  
Golden, Colorado, USA

[Learn.mines.edu/chemd2025](http://Learn.mines.edu/chemd2025)

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### ESERA 2025

25-29 August

*Embracing Transitions in Science Education*

Copenhagen, Denmark

[Conference 2025 - ESERA](http://www.esera.eu)



We warmly invite you to the ESERA Conference 2025, which will be held from

August 25th to 29th in the vibrant city of Copenhagen, Denmark. Under the theme Transitions in Science Education: Sustainability and Digital Advances, we wish to stimulate fruitful conversations and big ideas within and beyond our community.

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### 44<sup>th</sup> ChemEd-Ireland

TU Dublin (Grangegorman)

18 October

[Claire.mcdonnell@tudublin.ie](mailto:Claire.mcdonnell@tudublin.ie)

### Future ChemEd-Ireland venues

Since the 26<sup>th</sup> conference the venue has alternated between the West and East coasts.

2026 45<sup>th</sup> UL

2027 46<sup>th</sup> DCU

2028 47<sup>th</sup> TUS-Limerick

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## 2026

### iVICE

### Irish Variety in Chemical Education

Maynooth University

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### 8<sup>th</sup> ICASE WORLD CONFERENCE ON SCIENCE AND TECHNOLOGY EDUCATION

22-25 June 2026

Cork, UCC

\*\*\*\*\*

### 28<sup>th</sup> ICCE/17<sup>th</sup> ECRICE

13-17 July 2026

Erzurum, Türkiye



### 28<sup>th</sup> IUPAC International Conference on

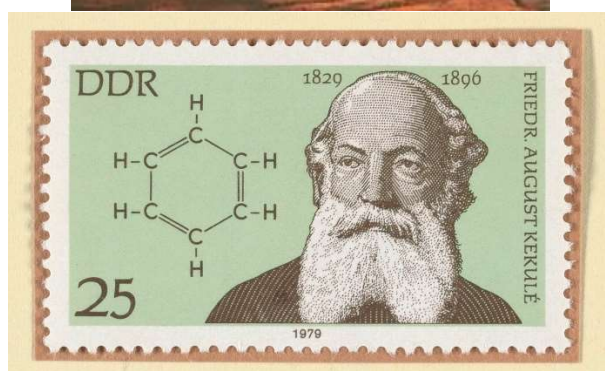
[Chemistry Education & 17<sup>th</sup> EuChemS](http://www.iupac-chemed.org)

[European Conference of Research in Chemical](http://www.euchems.org)

[Education \(ICCECRICE 2026\) – July 13-17,](http://www.iccecrice2026.org)

[2026 / Erzurum, Türkiye](http://www.iccecrice2026.org)

## Chemical Quotations: August Kekulé 1829-1896



*I was sitting writing at my textbook but the work did not progress; my thoughts were elsewhere. I turned my chair to the fire and dozed. Again the atoms were gambolling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by the repeated visions of the kind, could now distinguish larger structures of manifold confirmation: long rows, sometimes more closely fitted together all twining and twisting in snake like motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke; and this time also I spent the rest of the night in working out the rest of the hypothesis. Let us learn to dream, gentlemen, then perhaps we shall find the truth... But let us beware of publishing our dreams till they have been tested by waking understanding.*

## Information Page

### Sponsors

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### Contributions wanted!

Contributions are always welcome to *Chemistry in Action!* providing the material is of interest to second-level chemistry teachers. Articles, experiments/ demonstrations, teaching tips, book and AV reviews etc. are all welcome.

Send by email as a Word document when submitting material. Do not embed diagrams, photos or tables but just insert between paragraphs.

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Maria Sheehan (web editor)

[mariasheehan400@gmail.com](mailto:mariasheehan400@gmail.com)

Sarah Hayes

### Elementary Chemistry

*While I thought myself employed only in forming a nomenclature, and while I proposed to myself nothing more than to improve the chemical language, my work transformed itself by degrees, without my being able to prevent it, into a treatise upon the Elements of Chemistry.*

Antoine Lavoisier

[sarah.hayes@ul.ie](mailto:sarah.hayes@ul.ie)

Anne O'Dwyer [anne.odwyer@mic.ul.ie](mailto:anne.odwyer@mic.ul.ie)

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### Internet version

The most recent back issues plus some TY Science modules and other resources are available at:

[www.cheminaction.com](http://www.cheminaction.com)

For information contact the web editor, Maria

Sheehan at [mariasheehan400@gmail.com](mailto:mariasheehan400@gmail.com)

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### TY Science Modules

We have discontinued selling these modules in print, as postage got too expensive. At present 6 of them are available online, free of charge, at our website: [www.cheminaction.com](http://www.cheminaction.com)

We hope to make more of them available in future.

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### Back issues

If you would like hard copies of the last few issues (from 114 onwards) please send **€5 per copy** (cheque or PO payable to P.E. Childs) to Dr. P.E. Childs, 6 Golf Links Road, Castletroy, Limerick.

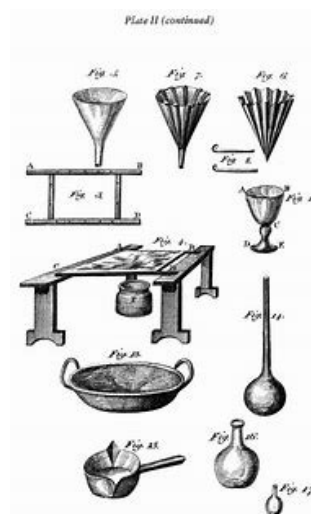
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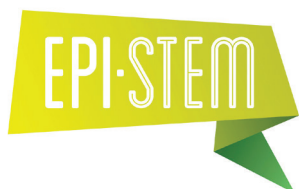
### In the next issue:

- **Great Irish Chemists: Thomas Dillon**
- **The sulfur cycle**
- **Bauxite**
- **Crucial minerals**



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