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Cover design: Tony Hartnett, Shoreline Graphics, Ballyvaughan, Co. Clare

Cover photo: Rio Tinto Alcan aluminium smelter at Lochaber, Nr. Fort William, Scotland in June 2009. (Photo: P. E. Childs) This aluminium smelter has its own hydroelectric plant (see the pipes running down the hillside) to provide low-cost electricity. Another aluminium smelter at Kinlochleven, also in the Highlands close to Fort William, is now closed.

Editorial

A winter of discontent

Ireland is going through a major recession and an economic crisis, with major cutbacks in public expenditure. Schools have lost teachers and in some cases minority subjects (like physics and chemistry) have been axed. The Transition Year was under threat as the grants were removed but the Green Party ensured that these were restored to 2008 levels, under the new Programme for Government. The capitation grants to encourage chemistry and physics were removed and the Second Level Support Service has been reduced to a skeleton service. Public employees have had their wages cut by employment and pension levies and more cuts are promised in the December budget. Many senior teachers, including Principals and vice-Principals have taken early retirement to avoid loss of their pension rights and gratuities. The public service unions are promising strikes to make their case for no further cuts for their members. All this adds up to a very unhappy and unsatisfactory situation in schools. How can we ever build a knowledge-based economy by encouraging more up-take of the physical sciences in schools, if we cut the necessary underpinning provision? There was already a shortage of investment in schools to support the sciences, despite many statements about its importance, and the situation is now worse. All the reports and comments that we need more students studying science in school and at third level are pointless and fruitless unless we make the necessary investment in schools. Unless we put our money where our mouth is, then the situation will remain dire and we will continue to complain about inadequate numbers of good students choosing science. We need more students but we also need better students to choose to study science and to continue in science if there is to be any impact on our economic future.

ChemeEd-Ireland returns to UL

On October 17th. on a glorious Autumn day, ChemEd-Ireland returned to the University of Limerick campus. It was organised by staff from the National Centre of Excellence for Mathematics and Science teaching and Learning (NCE-MSTL). A short report is given on p. 26 and the next issue will contain copies of the talks in the annual Proceedings. Copies of the presentations can be accessed on the NCE-MSTL website, www.nce-mstl.ie .

Next year's conference (the 29th.) will be organised by Dr Claire McDonnell at DIT on Saturday October 9th.

In 2011 the 30th. conference will be held in UCC, organised by Dr Declan Kennedy. It is hoped that the conference will alternate between the East and West coasts in the cycle: UL→DIT→UCC→DCU.

30 years of publication

The first issue of *Chemistry in Action!* was produced in 1980 and launched at the Institute of Chemistry's Annual Congress in Sligo in May 1980. Thus 2010 will see the 30th anniversary of *Chemistry in Action!* and the publication of issue #90. This will be a special issue and will contain some retrospective articles looking back over 30 years, as well as the Proceedings of the 28th. ChemEd-Ireland conference. Contributions are welcome and if you would like to share your experiences of how *CinA!* has helped you in your teaching, please send them in. Articles looking back over the last 30 years of science or science education in Ireland are also welcome. I hope there will be an event to mark this anniversary at UL in April or May 2010.

Young Scientist continue to excel

This year's BT Young Scientist and Technology Exhibition (see p. 7) broke records for the number of projects submitted and is a testimony to the health of science project work in schools, North and South. Last year's winner went on to win the top prize at the European competition (see p.6). The number and quality of the projects reflects well on the work being done by teachers and pupils in many schools. However, the excitement, creativity and interest shown by the pupils involved does not seem to translate into numbers carrying on with science and technology at 3rd level and into future careers. It is still a big question as to why the commitment to science shown by many pupils in their projects does not turn them on to science-based careers.

Peter E. Childs Hon. Editor

Education News and Views

DIT lecturer wins 2009 RSC award

DIT Lecturer Claire McDonnell has won one the 2009 RSC HE Teaching Awards. "Claire Mc Donnell obtained her PhD from University College Dublin and carried out postdoctoral research at Trinity College Dublin. She then worked in the pharmaceutical industry for several years before joining Dublin Institute of Technology (DIT) as a lecturer in Organic Chemistry in 2000.

The provision of effective learning support for first year students was the first major project she became involved in at DIT in collaboration with a colleague, Dr Christine O'Connor. The measures introduced were shown to significantly improve student confidence and progression rates. Claire has instigated or contributed to a number of other teaching initiatives including the development of both contextualised and project-based learning laboratory practicals.

This work was undertaken along with her colleagues in the DIT Chemistry Education Research Team and with Dr Sarah Cresswell (Strathclyde University) and Prof Simon Belt (University of Plymouth). Funding was awarded from the HE Academy Physical Sciences Centre and the RSC Chemistry for Our Future programme.

Another initiative was the introduction of community-based learning assignments involving interaction with local secondary schools and organisations. Examples include organising RSC Chemistry at Work events in 2007 and 2008 as well as alcohol analysis of breath and urine samples from student volunteers as part of a road safety awareness campaign.

The underlying aims of Claire's work are to support, motivate and engage learners and to evaluate changes implemented and modify them as necessary. Collaboration with her colleagues and peers and DIT Learning Teaching and Technology Centre has proven invaluable in this regard."

http://www.rsc.org/ScienceAndTechnology/Awards/HETeachingAward/2009winner.asp

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TY Science Modules

Three new titles are now available in the TY Science series and were launched at the 28th. ChemEd-Ireland in UL. The new titles are:

- Issues in Science
- Science and Medicine
- Food Science

Each module costs €10 and consists of a Student's Handbook and a Teacher's Handbook. This brings the number of modules now available to 8. For an order form send an email to: peter.childs@ul.ie

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NCE-MSTL Research & Resource Guides

The National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL) has launched the first set of Research & Resource Guides for teachers. Sets of these were sent out to schools in November, together with the Centre's Newsletters. They should be in your staff room. Please email Helen Fitzgerald (Helen.fitzgerald@ul.ie) if they didn't reach your school. The set consisted of 7 4-page guides, each covering a particular topic of interest to teachers of science or mathematics. The Guides either summarise a research topic and indicate how teachers can use the findings, or outline the resources available on a particular topic. The first 7 titles and authors are as follows:

- The Role of Language in Teaching and Learning Mathematics
  Máire Ní Ríordáin
- Different learning styles in mathematics teaching
  Miriam Liston
- How to Implement Peer Learning in Your Classroom
  Jennifer Johnston
- What is Concept Mapping and how can it be introduced into a second level science classroom?
  Joanne Broggy
- Periodical resources for the science teacher
  Peter Childs
- Promoting Inquiry Through Science Reflective Journal Writing
  Maeve Liston
- Transition Year Science Resources Part 1
  Sarah Hayes

You can download from the NCE-MSTL website by going to resources.

http://www.nce-mstl.ie/
A second set will be published at Easter 2010.

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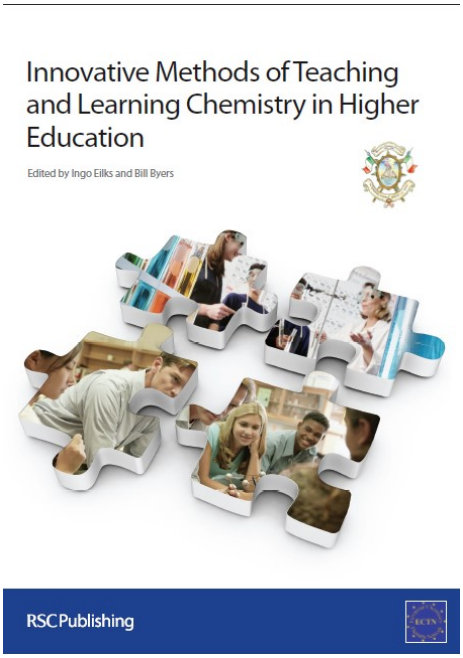
Innovative Methods of Teaching and Learning in University Chemistry Teaching

Ed. Bill Byers and Ingo Eilks

RSC Publishing www.rsc.org/books/
ISBN 978 - 1 - 84755 - 958 - 6
GBP 19.99 (35% discount to RSC members)

This new book is the product of an ECTN working group, which started in 2006. It is a collection of articles covering differing aspects of teaching and learning chemistry at third level. The book was launched ta an ECTN meeting in Dresden in September 2009. Although the target audience is 3rd level chemistry lecturers, much of this material would be interest and use to 2nd. level chemistry teachers. The book should be of particular use to new chemistry lecturers, but anyone teaching chemistry at 3rd. level anywhere in the world would find it useful. The chapters have each been written by a small group of authors, drawn from 3rd level institutions across Europe.



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Investment in research and education is key to future

Irish Times 13/11/09

In an *Irish Times* opinion piece, Jim O'Hara, general manager of Intel Ireland and a board member of Science Foundation Ireland and the Centre for Research on Adaptive Nanostructures and Nanodevices (Crann), based at TCD and UCC, has stated that Ireland will not be competitive without well-educated workers and research excellence.

"We must have a world-class, digitally connected education system and a clear government strategy across all four levels of education and on into lifelong learning. We need the best teachers in the subjects vital to the country's economic interests: science, technology, engineering and maths. These subjects will be the fundamental building blocks for this country in the digital economy of the 21st century.

Research is equally important. Ireland has significantly raised its investment in research over the last 10 years. The commitment is now 1.7 per cent of GDP – just below the European average.

This investment has enabled Ireland to be internationally competitive in research for the first time and has resulted in the formation of an integrated network between academia, industry and government that makes Ireland an attractive location for R & D.

Research excellence is now perceived internationally as a strength for Ireland. In 2008, the IDA reported the total RD investment by its client base had grown by 22 per cent to €420 million, and that almost one-third of its new RD investments were in direct collaboration with third-level research facilities.

Nanotechnology is a timely example of a success story, with the Nanoweek programme recently announced. Intel is the founding partner in the Science Foundation Ireland-funded Centre for Science, Engineering and Technology at Crann, the Centre for Research on Adaptive Nanostructures and Nanodevices, where leading researchers have used nanoscience to develop new materials and potential devices for future Intel products.

Crann now works with a dozen companies in several sectors. Nanotechnology adds to innovation in virtually every field of manufacturing, enabling nearly $250 billion (€168 billion) in products in 2008 globally, and on track to exceed $3 trillion in 2015.

Ireland has increased the number of academic researchers in this area to 600, and of €150 billion in exports in 2008, it is estimated 10 per cent were enabled by nanoscience and related nanotechnologies."

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More students than farmers in Ireland

Irish Times 11/11/09

Record numbers of students are enrolling in third-level colleges amid continuing uncertainty about employment prospects. The surge brings the number of full-time undergraduate students in Ireland to over 110,000, more than the total number engaged in farming and related activities.

The current academic year has seen unprecedented demand at the Central Applications Office (CAO), with applications up over 8 per cent to 45,582. This compares with 42,117 last year and 39,915 two years ago. In addition, growing numbers are also returning to higher education or accessing college through routes other than the CAO.

About two-thirds of 18-year-olds currently proceed to higher education, one of the highest participation rates in the OECD. The increase is expected to place fresh strains on Irish universities which are poorly funded compared to other OECD states. Between them, University College Dublin and University College Cork have accumulated debts of over €30 million.

Michael Kelly, Higher Education Authority (HEA) chairman, acknowledged the third-level sector will be "under significant pressure as we expect that demand to continue to grow". Mike Jennings, of the Irish Federation of University Teachers, said colleges "cannot provide the required high level of education for an ever-increasing number of entrants when recruitment and promotions are banned, wages and resources are being slashed, and even maternity leave vacancies cannot be filled."

The HEA figures also show a steep decline in students taking technology-related courses in the past decade. This year, only 23 per cent of higher-level degree students are taking technology courses, down from 32 per cent in 2000. Only 4 per cent are taking higher or level 8 degree courses in computing, compared to over 8 per cent in 2000.

Engineering has also seen a sharp decline in interest. Only 4 per cent are taking Level 8 engineering courses this year, compared to double that figure in 2000.

The trends will confirm the view of former Intel chief executive Craig Barrett, who told the recent Farmleigh summit that Ireland needed to "raise its game" significantly in producing top-class science graduates. His address has been widely seen as a wake-up call for the education service. In Mid November – partly in response to Mr Barrett's concern – the Government would unveil a major new programme for information technology in schools. (See next item)

The Government will point to the increase in numbers taking science and technology courses in the past year. But critics say this progress is coming from a very low base: 11 per cent of higher-level students (3,500) opted for science this year, up from 10 per cent last year.

For the first time, students accepting places in the institutes of technology (46.5 per cent) have outstripped those commencing in the seven universities (44.5 per cent).

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Classrooms to get laptop each under new scheme

Irish Times 17/11/09

Further information on the contents of the new ICT for schools plan clarified that every classroom in the country is to get a teaching laptop, software and a digital projector over the next three years as part of a new €150 million investment in "smart schools".

Speaking at the launch, Minister for Education Batt O'Keeffe acknowledged Ireland was playing "catch-up'' on technology for schools after years of under investment. He expressed confidence the new €150 million, three-year package would be accompanied by the roll-out of broadband connectivity to every school in the State.

At present, Irish schools are lagging well behind leading OECD states in the provision of information and computer technologies. (ICT). A new report, published in tandem with the launch, also warns how competitor states have moved ahead of Ireland in the digital revolution. The *Smart Economy, Smart Schools* report comes from a hi-tech industry advisory group, chaired by Paul Reillis of Microsoft Ireland.

Earlier this year the roll-out of a new, "cutting edge" maths course for Leaving and Junior Cert classes had to be scaled back because of a lack of computer support in schools. The Government is financing the new ICT programme from savings made in the school building programme where over €200 million in funding has still to be allocated

The technology gap: how Irish schools are left behind

- One-fifth of school computers are not working due to their age or the lack of technical support;
- One in three Irish 15-year-olds has not used a computer in school, twice the average in the rest of the developed world;
- Teacher satisfaction with the ICT infrastructure in their schools is lowest in Ireland;
- Ireland is 20th in a list of 30 OECD countries, with fewer than one computer for every 10 students;
- Ireland ranks 19th in the EU 27 in terms of broadband for schools.

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First prize in EU for Kinsale Young Scientists

Irish Times **16/09/09**

The winners of the BT Young Scientist and Technology Exhibition 2009 have secured a first prize worth €7,000 at the EU Young Scientist Contest in Paris, France. John D O'Callaghan and Liam McCarthy (both 14), from Kinsale Community School, achieved the success for their project "The Development of a Convenient Test Method for Somatic Cell Count and its Importance in Milk Production". The research involved developing a cheap, efficient way for farmers to detect infection in milk cows, using somatic cells as an indicator, based on the belief that a drop of washing-up liquid could help warn of infection in milk cows.

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Trinity professor named researcher of the year

Irish Times 10/11/09

A biochemist in Trinity College Dublin, Prof Luke O'Neill, has won the inaugural Science Foundation Ireland (SFI) researcher of the year award. Prof O'Neill also won the RDS */Irish Times* Boyle Medal for Scientific Excellence in 2009. He conducts world class research into the body's immune system which helps to protect us from infection.

The award was made at the 2009 SFI summit in Athlone, the theme of which was, "ideas, innovation and impact", which was particularly apt, stated SFI's director general, Prof Frank Gannon. Research provided a way to create wealth and jobs, but also delivered new ideas that could have a real impact on our lives.

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Over 600 students get biology upgrade

Irish Times 22/11/09

The State Exams Commission has apologised to hundreds of students for an error in setting a question for this year's Leaving Certificate Biology Higher Level exam. A spokesperson for the Commission said this afternoon that the mistake had been highlighted by just one parent who had contacted the department. However, the Chief Examiner had accepted that there was a valid complaint about the way in which the question had been marked.

More than 600 students who took higher biology in June have had their results upgraded following the review. The upgrade relates to candidates who

sat the Higher Level Paper only. The SEC decided to revise the marking scheme following an issue that was raised during the examinations appeal process.
The revision relates to a biological term used in the exam, called 'Predation'. During the appeals process it was argued that the definition of this term being applied by the State Examinations Commission was too narrow. The Chief Examiner accepted that argument and agreed to apply a wider definition.
The difference amounts to no more than three marks out of a total of 400 but the State Examinations Commission has re-examined any papers where these three marks could have made a difference between grades awarded. It has decided to upgrade the results of 621 candidates as a result. The State Examinations Commission has contacted the CAO and it is now contacting 44 students where an upgrade in Biology has resulted in a change in offer of a college place.

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SciFest launched for 2010

December 2009 Issue 2 SciFest
Minister Conor Lenihan, TD launched SciFest 2010 in October with a 'Celebration of Excellence in Science' in the Open Innovation Lab in Intel Ireland, Leixlip, Co. Kildare. Thirty-three second-level students were awarded Intel Excellence in Science medals in recognition of their achievement in SciFest 2009. Each of the thirty-three students had been either individual or group winners of the 'Best Project' awards at SciFest 2009.

Preparations for SciFest 2010 are already underway. Five Institutes of Technology have already set dates for their SciFest Science Fairs.
Dublin Institute of Technology:
Thursday 15 April
Athlone Institute of Technology:
Friday 23 April
Cork Institute of Technology:
Tuesday 27 April
Limerick Institute of Technology:
Tuesday 27 April
Institute of Technology, Tralee:
Wednesday 12 May

As the date of each fair becomes available it will be posted on the Exhibition Dates and Contacts page of the website. Please check regularly for updates on the website at www.scifest.ie
Entry forms will be downloadable from the website in January and the closing date for receipt of entries is Friday 12 March 2010.

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46th BT Young Scientist and Technology Exhibition

14-18th January 2009
1,588 projects were submitted for the 2010 YSTE, a record number, and 520 were selected for the Exhibition. The awards were presented on Friday 17th. January.
The BT Young Scientist of the Year 2010 was won by Richard O'Shea, from Scoil Mhuire Gan Smal, Blarney in the Senior Technology Category for *A biomass cooking stove for developing countries.*
The Individual runner-up was Hannah Eastwood, Loreto College, Coleraine in the Senior Chemical, Physical and Mathematical Sciences Category for *Green Rust the good gal*.
The Best Group project was won in the Intermediate Technology Category by Paul McKeever and Bryan Murphy from Abbey Christian Brothers School, Newry,, Co. Down for *Specs detector*, and the Group Runner-Up in the Intermediate Biological and Ecological Category was Leone Chow and Mollieanne Gallagaher from Alexandra College, Dublin for *In vitro study of how various amounts of caffeine affect protein degradation by the stomach enzyme pepsin*.
Full results at www.btyoungscientist.ie.

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The Element Makers: 8
Per Teodor Cleve 1840 – 1905

Adrian Ryder tutorajr@gmail.com

Per Teodor Cleve, the youngest of thirteen children, was born in Stockholm, Sweden, on February 10th 1840, to a well-to-do merchant family. His father was Fredrik Teodor Cleve (1798-1872), wholesaler and general merchant, and his mother was Sofia Ulrika Glansberg.

Per Cleve in early life

Per Cleve received his early education in the Stockholm Gymnasium from which he graduated in 1858. In May of the same year he matriculated at the University of Uppsala, north of Stockholm, and began his University studies. Primarily studying chemistry, Per Cleve spent the summer vacations studying mineralogy under Prof. Mosander (see no. 6 of this series.) and also took biology as another subject. Indeed over the years he was to make significant contributions to oceanography and issued far more reports in this area than in chemistry. From 1860 he held the position of assistant of the mineral section of the University of Uppsala, In 1862 he was awarded his Master's degree and in 1863 was awarded his Doctorate in Chemistry. Cleve's dissertation for his Doctorate was entitled "Mineral-analytiska undersökningar" dealing with mineral analytical techniques. Now, at the age of twenty-three, Cleve was named assistant professor in Organic Chemistry at Uppsala, moving to Stockholm in 1870. From 1870 to 1884 Cleve taught at the Technological Institute in Stockholm and combined this with the new duties arising from his appointment as professor of General Chemistry and Agricultural Chemistry in 1874.

Cleve was awarded a number of travel grants for his studies and in the years 1866-1867 he visited England, France, Italy and Switzerland, expanding his knowledge and experience in Chemistry and Geology. In later years he travelled further afield to visit Canada and the United States.

While still a student Cleve visited the research laboratory of chemist Charles Adolphe Wurtz (1817–1884) in Paris. Wurtz's reputation as a chemist was such that young chemists from all over Europe flocked to him for experience, and here Cleve made many friends. Wurtz introduced Cleve's to the problems of forming complex organic compounds. As a result of his experience with Wurtz, Cleve published his first research paper in 1861 on a complex chromium compound he had prepared and analyzed. In this paper he demonstrated that the compound was chromium trichloride-ammonia-water (in a 1:4:1 ratio). Cleve now turned to the study of complex platinum compounds, which, over the following years, he prepared hundreds. By 1872 Cleve had published four more papers on these compounds and in this year published the results of his studies "On Ammoniacal Platinum Bases" in the *Transactions of the Royal Swedish Academy of Sciences.* Other studies were on the sulpho-naphthalides and mono chloronaphthalene.

This marked the end of Cleve's first stage of research even though papers on work from this period continued to be published later. The *Chemical News* and *Journal of Physical Science* reporting on April 18th 1875 on a paper on compounds of cyanide of mercury with the sulphocyanides, which gives an indication of the amount of work which went into the investigations. Here *"The author describes the salts of potassium, ammonium, sodium, barium, strontium, calcium, magnesium, zinc, zinc-ammonium, cadmium, manganese, iron(ferrous), cobalt, nickel, cuprammonium and lead."*

The second stage of his career, which can be taken to extend to 1890, included a series of

analyses of the Rare Earth metals. One result of which was to establish Mendeleev's prediction of trivalency for these elements.

Uppsala University, Sweden

1874 was a momentous year for Cleve. In this year Cleve was appointed a full Professor in Uppsala and married Alma (abbreviation of Caralma) Öhbom on the 30th of March. Alma was only the third matriculated female in Sweden. She entered the University in 1873, falling for the up and coming young Cleve, and married him the following year. Alma went on to be a teacher and writer. The marriage of Cleve and Alma, who lived in their apartment over the Chemistry laboratory, resulted in the birth of three girls: Astrid Maria (1875-1968), who married Hans Euler, who was to later receive a Nobel Prize for chemistry in 1929 and they had a son, Ulf von Euler, who was also to receive a Nobel Prize in Physiology or Medicine in 1970; Agnes Elisabeth (1876-1951), who became an artist of note and Cecilia (usually called Célie) (1882-1944). The three girls all received their pre-university schooling from their mother, girls not being permitted, at the time, into the State Secondary Schools. The girls' instruction from their mother cannot have been of poor quality as Astrid was the first woman to receive a Doctorate in Science in Sweden in 1898.

Cleve was a prolific writer and produced his first chemistry text-book, *Lärbok i Kemi*, in 1872 followed by an Organic Chemistry for beginners in 1874, a Qualitative Analysis text in 1885, with further text-books appearing in 1886 and 1888.

Carl Mosander (No.4 of this series) had discovered didymium in 1841. Studying the spectra of this element in 1874 Cleve concluded that it was in fact two elements, but had to wait until 1885 for justification of his claim. In this year the two elements named neodymium and praseodymium were formally discovered by Baron Carl Auer von Welsbach (No. 11 of this series) from Vienna in Austria.

In 1879 Cleve published a monograph on the element samarium which had been discovered by Boisbaudran (No. 7 of this series). In this year Lars Frederick Nilson discovered the element scandium but with only tiny amounts of the metal available to investigate, assigned it an atomic weight of between 160 to 180. Cleve investigated the matter further and isolated a much greater amount of the metal. Cleve found that the Atomic Weight was only about 45. This meant, according to Cleve, that the element was that predicted by Mendeleev as eka-boron. Nilson was to later confirm Cleve's findings, thus furthering the general acceptance of Mendeleev's periodic table.

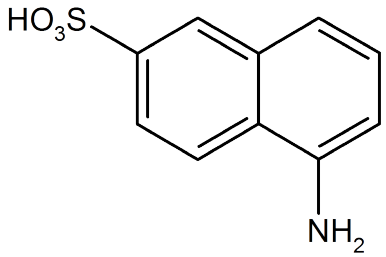
Already in 1878, alerted by a spectrum made by Tobias Robert Thalén (1827-1905), and working with a sample of erbia, from which had been removed all traces of scandia and ytterbia, Cleve had found a new element, number 67 on the Periodic Table. He named this holmium, after Stockholm, and in 1879, from the same ore, discovered element number 69, which he called thulium, after the old name for Scandinavia. (Some of the properties of the two metals are given below.) Showing the difficulties that chemists of the day had in the extraction of minute quantities of elements from ores, Cleve's holmium itself turned out to be a mixture, and Lecoq de Boisbaudran, in 1886, discovered that it also contained the new element dysprosium.

Properties of holmium and thulium

Holmium has the highest magnetic moment of any naturally-occurring element and when combined with yttrium forms strongly magnetic compounds. It is a relatively soft and malleable and is fairly resistant to corrosion and while stable in dry air , quickly oxidizes in moist air forming a yellowish oxide. Holmium is used in nuclear control rods due to its ability to absorb nuclear-emitted particles. It is used as a yellow or red glass coloring, and is one of the colorants used in the formation of cubic zirconia for use in jewelry, giving a dichroic colour in peach or yellow, depending on the lighting source. Holmium is also used as the active ion in some solid state lasers.

Thulium is a soft, malleable, ductile, lustrous silver-white metal. It does not tarnish rapidly in dry air but as with holmium should be protected from moisture. It forms compounds with oxygen and the halogens, most of which are light green. Thulium is the least abundant of the rare-earth metals. The pure metal and compounds have few commercial uses, but, without purification, in combination with the other rare-earth metals and compounds, is used in lighter flints and carbon electrodes for arc lighting, and in portable X-ray sources.

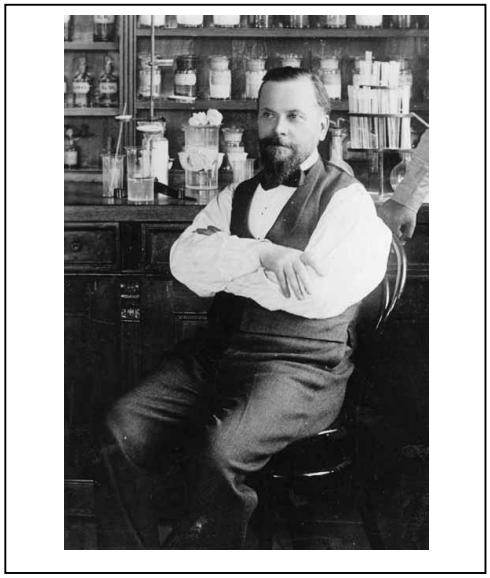
Cleve's work in organic chemistry comprised not only the various text-books on the subject but he was the first to synthesise six of the ten possible dichloro-naphthalenes. Cleve's most important contribution to organic chemistry, however, was his preparation and evaluation of the aminonaphthalenesulfonic acids, today known as Cleve's acids. These four isomeric forms are identified by the use of the first four letters of the Greek alphabet. Cleve discovered them in the years 1875 (alpha acid), 1878 (delta acid), 1886 (gamma acid) and 1887 (beta acid).



Cleve's beta acid

In 1886 Cleve published a biography of Karl Wilhelm Scheele for the centenary of Scheele's death on the 21st May 1786. On the 9th of December 1892, on the unveiling of a statue commemorating Scheele in Köping, Cleve gave the oration at the state dinner which followed, with King Oscar and members of the Swedish Royal Family being present.

In the winter of 1868–1869 Cleve made a geological investigation of the Northeastern West Indian archipelago. Here he visited the Virgin Islands, St. Bartholomew, Anguilla, St. Martin, Saba, St. Eustatius, and St. Kitts, and spent a short time in Puerto Rico. After making collections of minerals and fossils, he returned home, and communicated his results on the geology of the Northeastern West Indian Islands to the Royal Swedish Academy on November 23, 1870. This paper describes the geology and mineralogy of the islands, with some examples of the fossil forms found.



Per Cleve in his laboratory around 1900

Over the years Cleve presented a great number of papers on freshwater algae and marine biology, with some 17 papers between the years 1868 and 1900 on diatoms, to the Royal Swedish Academy of Sciences. In fact one might remark that 1890 marks the third stage of Cleve's research and a change from chemist to biologist, with chemistry now a minor part of his works. His daughter Astrid, who followed in his footsteps, had seven papers on diatoms published from 1922 – 1955. Some of Cleve's major books/papers are listed below showing his deep interest in plankton and diatoms. By 1895 he was credited with some 39 new species and had devised a method of dating glacial and post glacial deposits by their diatom content. Cleve was also able to trace the origins of ocean currents from a study of the diatoms carried by them.

One of the expeditions taken by Cleve was in 1888 to Gottland, where his daughter Astrid accompanied him. The expedition must have made a great impact on the thirteen year old girl, for she later took up this area of study and made it her own, becoming an international expert in the field.

Some major books/papers by Cleve:

1870 On the Geology of the North-eastern West India Islands
1894 Synopsis of the Naviculoid Diatoms
1896 Planktonundersökningar: Vegetabiliskt Plankton Redogörelse for de svenska ...
1897 A Treatise on the Phytoplankton of the Atlantic and Its Tributaries:
1900 The seasonal distribution of Atlantic plankton organisms (this book became a standard text in Oceanography)
1901 Plankton from the Indian Ocean and the Malay Archipelago

Cleve received many honours in recognition for his work. In 1871 he was elected as a Member of the Royal Swedish Academy of Sciences. In 1900 he was appointed a Member of the Swedish Hydrographical-Biological Commission. In 1894 he was awarded the Davy Medal of the Royal Society, London, "for his researches on the chemistry of the rare earths", the first Swede to be so honoured. In the same year he was also made an honorary Member of the Royal Institution of London. The mineral cleveite (uranium(IV) oxide) was named after him in 1878 by the geologist and explorer Nils Adolf Erik Nordenskköld (1832-1901). (Sir William Ramsey was later to isolate Helium from this ore in 1895.) The University of Glasgow awarded him an LLD. in 1896 and from 1900 to 1905 he was the President of the Royal Swedish Academy of Sciences Nobel prize Committee. Cleve was also a Member of several foreign Scientific Societies.

As President of the Nobel Committee, Cleve must have been in two minds about the award of the 1902 Prize to Svante August Arrhenius (1859-1927). Arrhenius had been a student in Uppsala from 1881 and his thesis fell under the direction of the physics Professor Thobias Robert Thalén (1827-1905) and Cleve. Arrhenius chose to disregard the advice given by both men and went his own way. On presentation of his thesis the two Professors were unimpressed, awarding Arrhenius the lowest possible grade. This grade would have meant that Arrhenius would not have been accepted for a position in the University, qualifying as a high-school teacher only. Fortunately for his career, on appeal this grade was upped one level. At the presentation ceremony for the new Doctors both Cleve and Thalén walked away without offering congratulations. It should be noted, however, that Svante Arrhenius stood as Godfather for Cleve's grandson Ulf, born the 2nd of February, 1905.

Cleve Died in Uppsala on the 18th of June 1905 at the age of sixty-five.

Reverse of the Davy Medal presented to Cleve in 1894 by the Royal Society of London.

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For a list of Davy Medal winners see en.wikipedia.org/wiki/Davy_Medal.

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Science Education Research

Irish post-primary students' attitudes towards Biology and Chemistry at senior cycle

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Introduction

There are many studies that have highlighted a worrying decline in young people's interest in and the take up of science in second level education, even when the demand for science graduates is continuously rising (Frame, 1996; Francis & Greer, 1999; Task Force on Physical Sciences, 2002; Regan & Childs, 2003; Department of Enterprise, Trade and Employment, 2006; Jenkins, 2006; European Commission, 2007; Politis *et al*., 2007). This article will present the findings of a study which investigated and compared Irish second level students' (n=300) attitudes towards biology and chemistry.

Attitude towards Biology

Biology remains to be the most popular of the science subjects at senior cycle. The ROSE (Relevance of Science Education) (Matthews, 2006) study found that both boys and girls have a shared interest in biology more so than chemistry and/or physics. More recently the NCCA (National Council for Curriculum and Assessment) reported that first year post-primary students' attitudes towards learning about biology were more positive than their attitudes towards learning about physics and chemistry (Varley *et al*., 2008). Prokop *et al.*, (2007) suggested that the main reason for students' interest in Biology lessons was that they are interested in dealing with theory about plants and animals which they can directly relate to.

Attitude towards Chemistry

The decline in the numbers choosing to study Chemistry at Leaving Certificate level is a well documented problem in Ireland (Childs, 1995; Matthews, 1995; Sweetman, 1999; Lyons, 2006). It is thought that the main reason for this decline is the lack of interest shown by students in the physical sciences. Research conducted by Regan and Childs (2003), showed that 72% (n=88) of Irish students considered Biology to be the most interesting science. Physics was found to be the least popular of the sciences, 62% of the students considering it the least interesting of the sciences and only 8.2% considering it interesting. Chemistry was considered least interesting by 33% of the sample and most interesting by 21%. The NCCA's report 'Science in Primary Schools. Phase 2' by Varley *et al*. (2008) based on data collected from 234 first year students found that their overall attitudes to biology and chemistry were more positive than their overall attitudes to physics.

Methodology

Questionnaires were distributed to 300 students in fifth (53%) and sixth year (47%). These were attending post-primary schools in counties Cork, Donegal, Dublin, Galway, Kerry, Leitrim, Limerick and Tipperary. The students surveyed were from all girls (22%), all boys (53%) and mixed schools (25%). 60% were female and 40% male. The students were studying Chemistry only (n=14) or Biology (n=24) only or both subjects (n=117) for their Leaving Certificate Examination. 65% and 38% of the students had taken higher level and ordinary level science respectively at Junior Cycle.

The questionnaires included questioning on the following:

- Their study of science at Junior Cycle;
- The science subjects they were taking at senior cycle;
- and Attitudes towards Biology or/and Chemistry (levels of difficulty, topics they were interested in, interest in the subject at junior cycle and senior cycle).

Results

58% of the chemistry students were female and 42% of the pupils were male.
62% of the biology students were female and 38% were male.

Attitudes

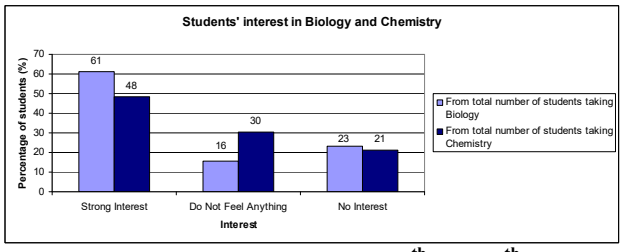

Figure 1 Post-primary students' (5th and 6th Year) interest in Biology and Chemistry from their study of these subjects at senior cycle.

Figure 1 illustrates that among the students taking biology, there is a stronger interest in this subject than among those studying chemistry. 48% of the students surveyed that are currently studying chemistry at senior cycle had a strong interest in chemistry, 21% had no interest in chemistry and 30% did not feel anything for chemistry

61% of students surveyed that are currently studying biology at senior cycle had a great interest in biology, 23% had no interest in biology and 16% of students do not feel anything for biology.

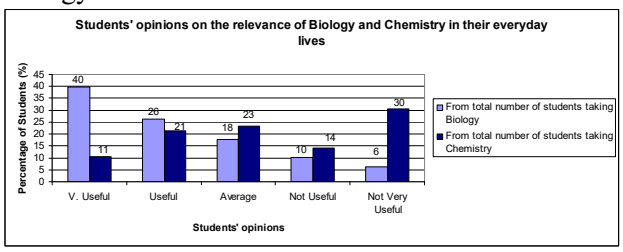

Figure 2. Irish students' opinions on the relevance of biology and chemistry in their everyday lives.

Figure 2 above illustrates that the students surveyed believe biology is more relevant and useful in their everyday lives than chemistry. 30% of the students taking chemistry find the subject not very useful in their everyday lives, 14 % find it of no relevance, 23% find it of average relevance, 21% find it useful and 11% find it very useful and relevant in their everyday lives.

40% of the students taking biology find this subject very useful in their own everyday lives, 26% find it useful, 18% find it of average relevance, 10% find it of no use and 6% find biology not very useful in their everyday lives.

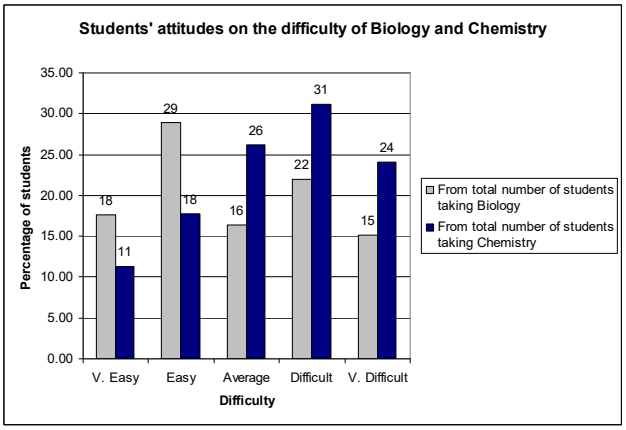

Figure 3 Irish students' attitudes on the difficulty of biology and chemistry at senior cycle.

Figure 3 illustrates that the students surveyed find biology to be the easier of the two subjects. From their experience of studying the subject in fifth and sixth year, 24% and 31% of students surveyed find chemistry very difficult and difficult respectively, 26% find it of average difficulty, 18% find it easy, with 11% of students finding chemistry very easy.
18% and 29% of the students surveyed found biology very easy and easy respectively, 16% find it of average difficulty, with 22% and 15 finding it difficult and very difficult respectively.

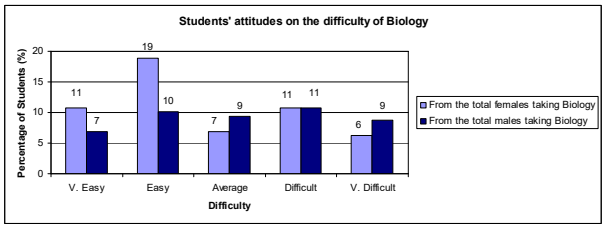

Figure 4 A gender breakdown of Irish students' attitudes on the difficulty of biology at senior cycle.

Figure 4 illustrates that the females surveyed find biology easier to study than males. 11% of females and 7% of males find biology very easy, 19% of females and 10% of males find biology easy, 11% of females and males find biology difficult, and 6% of females and 9% of males find biology very difficult.

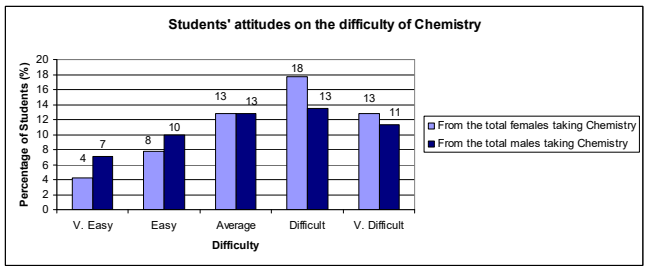

Figure 5 A gender breakdown of Irish students' attitudes on the difficulty of chemistry at senior cycle.

Figure 5 illustrates that the males surveyed find chemistry easier to study than females. 4% of females and 7% of males find chemistry very easy, 8% of females and 10% of males find chemistry easy, 18% of females and 13% of males find chemistry difficult, and 13% of females and 11% of males find chemistry very difficult.

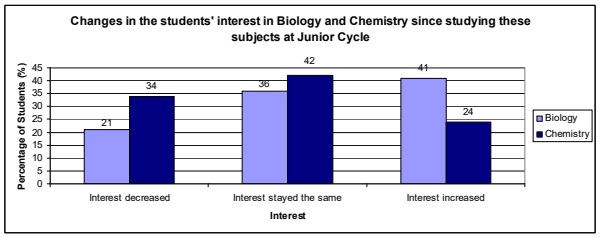

Figure 6. Changes in Irish post-primary students' (5th and 6th year) interest in Biology and Chemistry since their study of science at junior cycle.

Figure 6 illustrates that the students interest in biology is more likely to increase with their interest in chemistry decreasing from junior cycle to senior cycle. 42% of the students' interest in chemistry remained the same from their Junior Certificate, 34% of the students' interest has decreased and 24% of the students' interest has increased in chemistry.

36% of the students' interest in biology has remained the same from their Junior Certificate, 41% of the students' interest has increased, and 21% of the students' interest has increased in Biology.

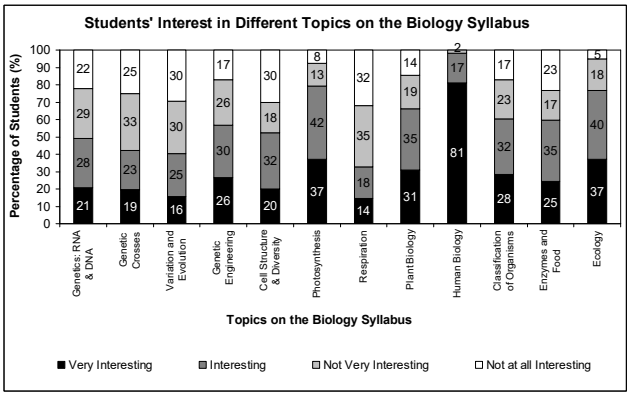

Figure 7 Students' feelings towards different topics on the biology syllabus.

The top three areas of Biology that students find most interesting were Human Biology (81%), Ecology (37%) and Photosynthesis (37%).
The top three areas of Biology that students found interesting were Ecology (40%), photosynthesis (42%), Enzymes and Food and Plant Biology (35%).
The top three areas of Biology that students found not very interesting were Respiration (35%), Genetic Crosses (33%) and Variation and Evolution (30%).
The top three areas of Biology that students find not at all interesting are Respiration (32%), Variation and Evolution and Cell Structure and Diversity (30%) and Genetic Crosses (25%).

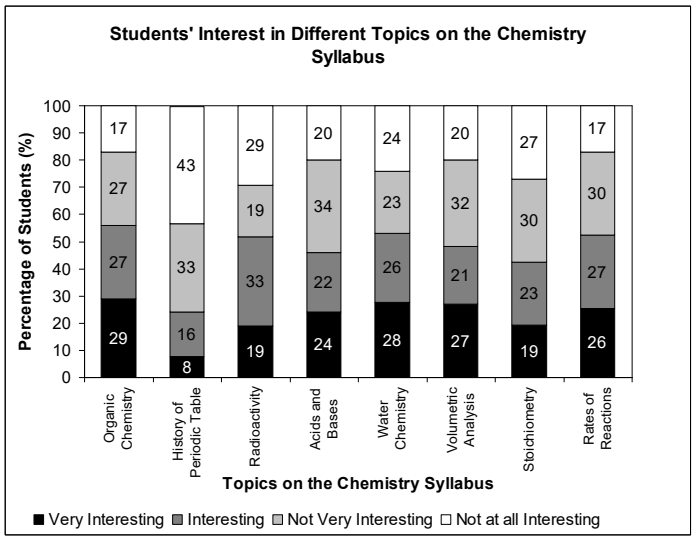

Figure 8 Students' feelings towards different topics on the chemistry syllabus.

The top three areas of chemistry that students surveyed find very interesting are Organic Chemistry (29%), Water Chemistry (28%) and Volumetric Analysis (27%).

The three areas of Chemistry that students found interesting were Radioactivity (33%), Rates of Reactions and Organic Chemistry (27%) and Water Chemistry (26%).
The three areas of Chemistry that students found not very interesting were Acids and Bases (34%), History of Periodic Table (33%) and Volumetric Analysis (32%).
The top three areas of chemistry that the students surveyed found not at all interesting are History of the Periodic Table (43%), Radioactivity (29%) and Stoichiometry (27%).

Discussion and conclusions

This research project investigated the uptake of biology and chemistry at leaving certificate level in Irish schools, and the students' perceptions and attitudes towards both biology and chemistry. As the questionnaires were voluntary, the response rates were lower than expected, thus narrowing the scope of the study to 300 fifth and sixth year students.

39% of the students surveyed were taking both biology and chemistry for the leaving certificate. Chemistry and physics was the next most popular combination, followed by biology and physics. From the 300 students surveyed a greater number of females were taking chemistry and biology for the leaving certificate than males. Biology was the most popular choice among the females and physics among the males being surveyed.

Attitudes

It was encouraging to find that students studying biology (61%) and chemistry (48%) at senior cycle did have an interest in the subjects. However >20% of the students taking biology and chemistry had no interest in the subjects. This issue needs to be addressed at both the junior and senior cycle. These results highlight the need for the science syllabi to be redesigned and taught in a way that fosters students' interest in the subjects (Task Force on Physical Sciences, 2002; Trumper 2006). The Chemistry, Biology and Physics syllabi are currently being reviewed by the NCCA (National Council for Curriculum and Assessment). Draft syllabi have now been produced by the course committees in chemistry, biology and physics.

When science subjects are being reviewed an increasing emphasis is being placed on key skills and the application of science process skills, highlighting the ever-increasing role of science and technology in society. 66% of the students surveyed find Biology very useful and useful in their everyday lives. This is in contrast to the feelings expressed by those studying Chemistry. Only 32% of these students find chemistry very useful and useful. 16% of the students taking biology find that it was not very useful and not useful. 44% of the students taking chemistry find that chemistry was not very useful and not useful. These findings suggest those reviewing the chemistry syllabus should consider designing a syllabus that students can relate to, incorporating industrial topics, current research and careers in chemistry. A more positive attitude was seen among the students towards biology. Students taking biology found the subject to be very useful in their everyday lives, as they can relate to it more easily.

Respiration, Variation and Evolution and Cell Structure and Diversity were the three main topics that the students highlighted as least interesting in their study of biology. The areas that the students find least interesting in their study of chemistry were the History of the Periodic Table, Stoichiometry and Radioactivity. These are not surprising choices and the reason behind these topics scoring the lowest can be linked to the previous above on the usefulness of the subjects. It is difficult for pupils to connect with areas, for example Respiration and the Periodic Table, when they cannot visualise the process, make any connection with it and their own lives. Researchers in science education should now concentrate on the design, development and evaluation of new approaches to introducing and teaching these areas in chemistry and biology (Childs, 1995).

Interest

41% of the students' interest in biology had increased, with 21% decreasing since their study at junior cycle. However a greater proportion of students' interest had decreased in chemistry (34%) since the junior cycle, with 24% of students' interest increasing. This is a worrying trend. The falling interest levels in science among students as they progress through the junior cycle has been previously highlighted in other studies (Task Force on the Physical Sciences, 2002; Smyth *et al*., 2004; Barmby *et al*., 2008). At present in Ireland there is a drive to increase the numbers taking science at third level and the development of a 'knowledge economy'.

Retaining students interest at senior cycle in science subjects is an important determining factor on third level course choice and career choices. In order to increase the numbers taking science at third level, attention needs to be directed at retaining students' interest in science at second level. There is a need for more up to date information in science careers that could be incorporated easily into the science lessons by teachers. All science syllabi should concentrate on linking theory being learned to possible career areas and modern advances in science.

The results also showed that the 36% and 42% of the students' interest in biology and chemistry had stayed the same respectively since the junior cycle. These results highlight that the junior science experience is the most important determinant relating to the uptake of science at senior cycle level. These students had a positive experience of science at junior cycle and so decided to study one or more science subjects at senior cycle. The content of the junior certificate science syllabus and the way in which it is taught needs to continue encouraging an interest in science among students.

Difficulty

The students surveyed felt that chemistry was more difficult than biology. The most recent report from the NCCA in Ireland titled 'Science in Primary Schools. Phase 2' suggested that the perceived difficulty of post-primary school science were due to teaching approaches; student-related factors and issues arising during the transition from primary to post-primary school (Varley *et al*., 2008, 2009). From the findings of this project and the above mentioned study different pedagogical techniques should be developed that could be implemented in the classroom to make the subjects less 'difficult' for the students (Smyth & Hannan, 2002; Task Force on Physical Sciences, 2002; European Commission, 2007). Also the senior cycle chemistry syllabus should become more student-friendly. The chemistry section in the junior certificate science syllabus also needs to be reviewed, relating the material being covered to everyday life.

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Dr. Maeve Liston is Senior Projects Officer for the Life Sciences at NCE-MSTL and Aine Regan did this study for her 4th. year project in 2008-9 under Dr. Liston's supervision. Aine Regan has just graduated from UL with a BSc Ed. (Biological Sciences with Chemistry).

How does it work? #1 Test for reducing sugars

The test for reducing sugars is done in general science, biology and home economics, as well as in chemistry, using either Fehling's solutions or Benedict's reagent. No-one seems to ask the questions as to why do we need to know that there are reducing sugars present or what's the difference between reducing and non-reducing sugars or how the test works. If you don't know how it works then it is really 'chemical magic'.

In both tests the reagents are added to a sugar, with a control or blank, and heated in boiling water – a red precipitate indicates a reducing sugar. Both reagents are blue and this is due to copper(II) sulphate, the active ingredient in both reagents. Reducing sugars are able to reduce copper(II) ions to copper(I) which forms copper (I) oxide, a red solid, under the alkaline conditions of the test.

Let us look at the composition of the reagents used. The colour obtained ranges from green to yellow to orange to red to brown depending on the amount of reducing agent present. Any colour change is taken as a positive result.

a) Benedict's reagent:
This is more convenient to use because it uses only a single test solution and it does not need to be made up freshly. It contains copper(II) ions complexed with citrate ions in sodium carbonate solution. The solution is thus alkaline and the citrate ions prevents the precipitation of $Cu(OH)_2$ by complexing the copper(I) ions.
The original paper by Stanley Benedict, 1908, can be found at:
http://www.jbc.org/cgi/reprint/5/6/485
The solution:
173 g sodium citrate-2-water, 100 g sodium carbonate, 17.3 g copper(II) sulphate-5-water, made up to a litre. This is stable and can be stored.

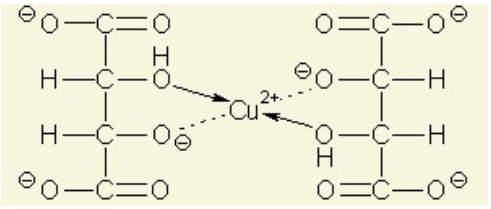
b) Fehling's reagent:
Fehling's solution for the test needs to be made up freshly by mixing equal volumes of Fehling's A (copper(II) sulphate solution) and Fehling's B (alkaline potassium sodium tartrate solution) solutions. Once mixed the copper(II) ions are complexed with tartrate ions to prevent $Cu(OH)_2$ precipitating out in the alkaline solution (see diagram below).

The solutions:
Fehling's solution A: 70 g $CuSO_4.5H_2O$ per litre

Fehling's solution B: 350 g potassium sodium tartrate-4-water ($KNaC_4H_4O_6 \cdot 4H_2O$) and 100 g NaOH per litre.

Equal volumes are mixed before use (10-15 cm^3) and a few drops of the reagent added to the sample and warmed in hot water.
The need for two solutions (which in themselves are both stable) makes this test more complex and less convenient than using Benedict's reagent.

http://www.uni-regensburg.de/Fakultaeten/nat_Fak_IV/Organische_Chemie/Didaktik/Keusch/D-Fehling-e.htm



The copper-tartrate-complex

What makes a reducing sugar?

Monosaccharides e.g. glucose, fructose etc. are reducing sugars and disaccharides like sucrose (sugar) are non-reducing sugars, as are polysaccharides e.g. starch, cellulose. If sucrose is hydrolysed by acid or saliva it breaks up into monosaccharides and then it gives a positive test. It should not give a positive test just in aqueous solution.
To be a reducing sugar means that the sugar is easily oxidised. They can form a free aldehyde group, which is reducing and is easily oxidised to a carboxyl group. The reducing sugars are able to reduce copper (II) to copper(I), which in alkaline conditions forms the insoluble copper(I) oxide. The alkaline conditions make this reduction more feasible as under acid conditions copper(I) is not stable in solution. The precipitation of copper(I) oxide removes copper(I) from solution and pushes the reduction reaction to the right.
These tests can also be used to distinguish aldehydes (reducing) from ketones (non-reducing).
http://en.wikipedia.org/wiki/Reducing_sugar
Do you have a question or something you'd like to have explained? Send in your 'Howe does it work?' queries to peter.childs@ul.ie

ChemTips: #11 Teaching about elements, compounds and mixtures

Peter E. Childs

In a previous issue (*C inA!* #79 Summer 2006) we looked at introducing metals and non-metals in relation to the Periodic Table and the importance of using real samples and illustrating the ideas with practical work.

In this ChemTips we look at introducing the **particulate nature of matter** in relation to elements, compounds and mixtures, atoms and molecules. These ideas underpin the whole of chemistry and are vital to a proper understanding of chemistry. The connection between the real, tangible macroscopic world and the invisible submicroscopic world of atoms and molecules and their symbolic representation (element symbols, formulae and equations) is neither obvious nor easy to make and many of our students do not really grasp the ideas and their heads are full of misconceptions. The ideas are very abstract and when they are introduced early in the second-level junior cycle, most of the pupils are not capable of abstract thought and are still concrete thinkers. That is, they need models and real examples in order to visualise the invisible world of atoms and molecules. The teacher's problem is to make the connection between the world of what we can see, feel and smell (the concrete world) and the world of invisible atoms and molecules and the world of ideas, symbols and concepts.

What is an element?

Teaching the topic of elements, compounds and mixtures without the use of models is confusing as the standard definitions can easily be misunderstood. "An element is a substance that cannot be changed into anything simpler by chemical means" is the historic definition of an element, deriving from a time when elements were known as simple substances - which couldn't be broken up into anything else. **What does it mean to our students today?** A better definition would be that an element is a substance that contains only one sort of atom, however these are combined together (neglecting the existence of isotopes.) Atoms are the smallest building blocks of all matter. Elements can exist as isolated atoms e.g. the noble gases, group 18. They can exist as molecules e.g. O_2, H_2, P_4, S_8, C_{60}, or as extended networks bonded covalently e.g. C or Si with the diamond structure, or metallically e.g. Cu, Na, Al. If any of these are heated strongly enough they will all eventually vaporize and at a high enough temperature will exist as monatomic gases , consisting of just one sort of atom.

The atoms may be combined in different ways in the liquid or solid element, but we still have only one sort of atom. Graphite and diamond are different structural forms of carbon, known as allotropes, but the building blocks (the carbon atoms) are the same. O_2 and O_3 (ozone) molecules are different forms of oxygen but both are made from only one sort of atom (oxygen atoms). A pure sample of an element (a pure substance) has definite physical properties e.g. colour, mpt.., bpt.. etc., but these will depend on its structure e.g. red versus white phosphorus, graphite versus diamond, and an element may be solid, liquid or gas at room temperature. The state of matter is determined by the strength of bonding between the particles that constitute the liquid or solid. Thus dioxygen is a gas at room temperature because it is composed of O_2 molecules, which are held together by weak van der Waal's bonds. Iron is a solid because it consists of iron atoms bonded together by strong metallic bonds.

The key idea is that an element (whatever its state of matter) only contains one sort of atom.

Atoms and Molecules

Molecules consist of two or more atoms joined together covalently; they may contain the same type of atom (O_3, S_8) or different atoms (CH_4, SO_2). A sample of a molecular substance contains enormous numbers ($\sim 10^{23}$) of identical molecules. Students often get molecules and compounds confused because we don't make the distinction clear. A compound is a substance made of **two** or more different types of atoms (**two** or more different elements) - its structure may be molecular (CH_4), covalent network (SiO_2, ZnS) or ionic (NaCl, $CaCO_3$). There is a danger in teaching this topic so that our pupils think molecule = compound, which is **not** true. Oxygen exists as diatomic molecules, O_2, but it is an

element not a compound as it only contains one sort of atom. All molecules are not compounds; and all compounds are not molecular - they may be ionic (e.g. NaCl) or covalent network (e.g. SiO_2) substances. Compounds can be broken up into simpler substances e.g. atoms of the elements, by strong heating. In a compound the atoms of different elements are bonded together and the compound has totally different properties to its compound elements e.g. Na(s) and $Cl_2(g)$ react to give NaCl(s). A soft, shiny reactive solid reacts with a poisonous, green gas to give a high melting point, white solid.

$$\mathbf{Na(s) + \tfrac{1}{2}\, Cl_2(g) \rightarrow NaCl(s)}$$

You can demonstrate this using a gas jar of chlorine gas and a deflagrating spoon with a small amount of molten sodium. It is a common fallacy that because the elements are dangerous or toxic or corrosive, then the compounds they form will also be dangerous or toxic or corrosive. Sodium chloride is essential for life and totally different in chemical and physical properties from its constituent elements.
(See You Tube video :
http://www.youtube.com/watch_popup?v=RgSCxyRVQnk)

The classic school demonstration of this change from elements to compounds is to heat iron powder and sulphur together to give iron(II) sulphide.

$$\mathbf{Fe(s) + S(s) \rightarrow Fe^{II}S(s)}$$

A pure compound (only one sort of substance) also has definite physical properties e.g. colour, mpt.., bpt. etc. and it may be solid, liquid or gas at room temperature.

Mixtures are not compounds

A mixture consists of two or more pure substances, either elements or compounds, mixed together - a mixture may be solid, liquid or gas at room temperature. This is a physical mixture not a chemical combination of the component substances and thus the components can be separated from each other by various physical techniques. A solution is a mixture e.g. sea water, where one substance in excess is the solvent and the other substances are the solutes. Air is a mixture of gases; the sand on the seashore is a mixture of minerals and shells; sea water is a mixture of water and salts. A mixture will have variable physical properties depending on the nature of the components and its composition e.g. the bpt. of salt solutions in water; mpt. of a mixture of organic compounds.

Models matter in teaching about matter

It is essential to use physical models to illustrate elements, compounds and mixtures; atoms and molecules. Models have always had a key role in the development of chemical ideas e.g. John Dalton's models. Most chemists find it impossible to think about chemistry without using physical models e.g. of molecular structure in organic chemistry or nowadays, molecular modelling on computers.

We should use diagrams to illustrate the ideas we are talking about in the section above, but it is probably better to start with tangible, physical models and then use diagrams to represent and illustrate them, rather than the other way round.

My suggestion for teaching this topic in a concrete way is to use plastic building blocks, preferable large ones, which contain blocks of different sizes and colours (see Figure 1). This is an idea pupils are familiar with and they already know that with a limited number of bricks they build an enormous number of models.

Figure 1 Many bricks make many models

The bricks represent atoms (the building blocks of nature) and each type of brick (differing in size and colour) represents an element. Make piles of each type of brick, sorted by size and colour (see Figure 2). Each pile now represents a sample of an element, whether they are isolated bricks (monatomic), put together in pairs (diatomic) or in larger structures. There is only one sort of atom in each pile and each pile can be broken down into a

pile of identical bricks (atoms). The different colours can represent different elements with the same valency (combining power) - the smallest square bricks now represent the group 1 (alkali metals) or group 17 elements (halogens), with a valency of one.

Figure 2 Different elements

Larger bricks then have combining powers (valencies) of 2 or 3. If we mix two or more different sorts of bricks together then we have a mixture of elements, which can easily be separated into bricks of the same size and colour (see Figure 3).

Figure 3 A mixture of elements

Now combine two sorts of bricks together e.g. one red and one blue brick, yellow and black etc. to form a compound, in this case a molecule. Make a pile (Figure 4) of each sort of molecule - this pile represents a pure substance but it is not an element (as it contains more than one sort of block/atom) and it is not a mixture (as there is only one component in each pile.) It can be broken down into its component blocks/atoms.

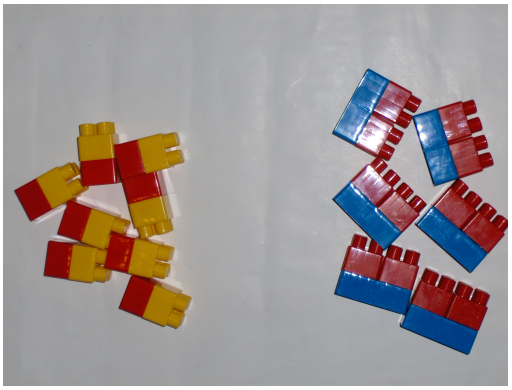


Figure 4 Two types of molecular compound

The different combinations of bricks correspond to different molecules - with a limited number of types of bricks (atoms of the 90+ elements) we can form an unlimited number of models/molecules. Each model/molecule has a distinct structure and composition (e.g. one blue brick + one red brick). A sample of a pure substance contains many identical units.

Figure 5 A mixture of molecular compounds

If we now mix two sorts of model (molecule) together (Figure 5) then we have a mixture of two substances and we can clearly see that the particles are still separate from each other and can easily be picked out (separated) into two piles. These physical models can now be backed up with suitable diagrams (see below) to get over the basic ideas of the particulate nature of matter. The drawings should also be used in tests and can be used as diagnostic tests of understanding.

Elements and allotropes

An element is a pure substance with only one sort of atom, which may be joined together in different ways, but still only have one sort of atom (Figure 6). Allotropes have the same atoms put together in different ways (structures). The different elements have different sorts of atoms, differing in atomic mass and in the number of protons (atomic

number) and neutrons in the nucleus. (Isotopes of an element have the same number of protons, but different numbers of neutrons and atomic masses.)

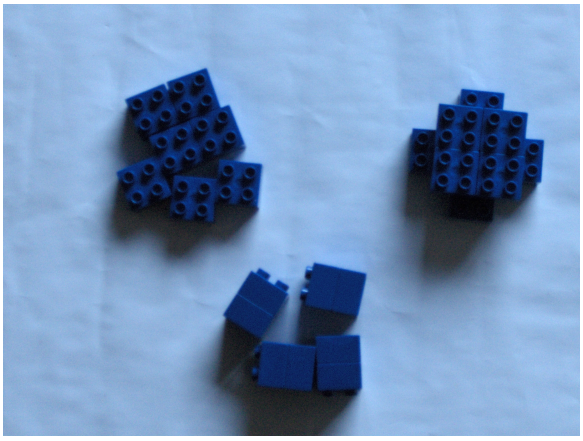


Figure 6 Three forms (allotropes) of an element

Figure 6 shows three different forms of the same element - single atoms, diatomic molecules and an extended, network structure. They are all made from the same sort of blocks/atoms.

Compounds

Figure 7 shows different types of compound - molecular and ionic/covalent network. In the molecular substance we have many identical units; in the network substance the two or more sorts of blocks are joined together in a regular way (a lattice). The common feature is that they have at least two sorts of atom combined together chemically.

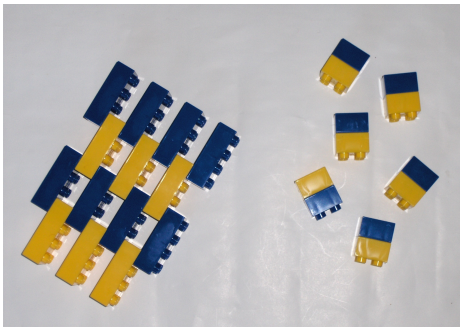


Figure 7 Network versus molecular compounds

Mixtures

Mixtures can be mixtures of elements (Figure 8) or mixtures of compounds (Figure 9) or a mixture of elements and compounds (Figure 10). The common feature is that they contain at least two different types of particle.

Figure 8 Mixtures of elements

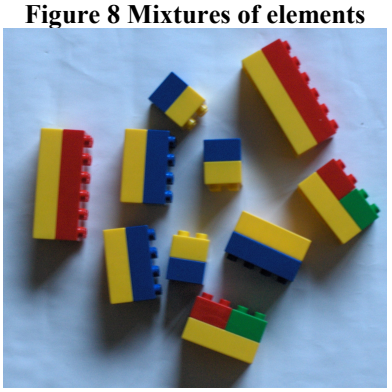


Figure 9 Mixtures of molecular compounds

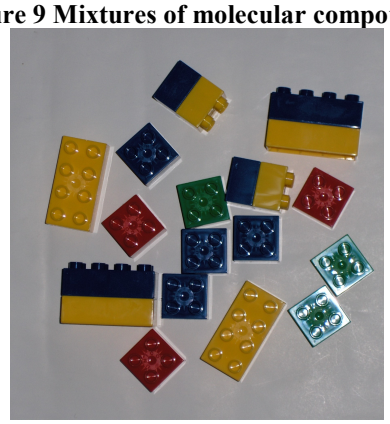


Figure 10 Mixtures of elements and molecular compounds

Mixtures may be homogeneous or heterogeneous: homogeneous means the same throughout e.g. a solution of a mixture of gases; heterogeneous means not the same throughout e.g. a mixture of two solids. A pure substance is a homogeneous substance.

Atoms versus molecules

A molecule contains two or more atoms bonded together by covalent bonds. A molecule may have only one sort of atom and be a form an element e.g. N_2, P_4, S_8 or it may be a compound, with at least two sorts of element e.g. NO, S_2Cl_2, $C_{12}H_{22}O_{11}$ etc. Molecules and compounds are not the same. It is important to use molecular substances as examples here. (Figure 11)

Otherwise pupils may think, as most of them do, that sodium chloride, NaCl, is a molecule (which it isn't). Ionic compounds (metal plus non-metal) have **no molecules** and have 3-D network structures (Figure 12), which are best modelled using a set of molecular models.

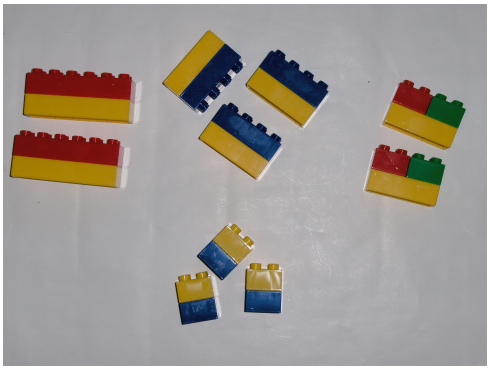


Figure 11 Models of different molecules of compounds

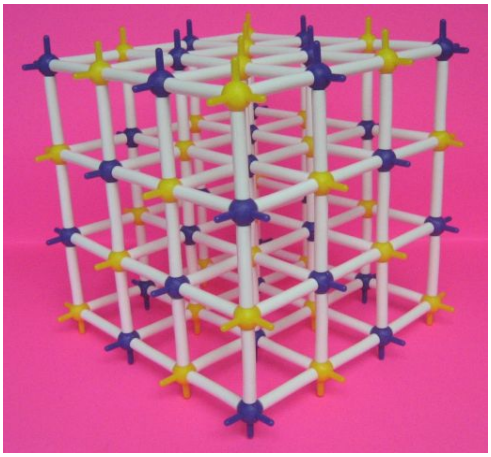


Figure 12 Model of the NaCl structure

Valency and combining power and formulae

The plastic building blocks also allow you to introduce the idea of valency (combining power) and molecular formulae. Your pupils already know this implicitly, because they know that two small bricks can combine together; that a double-sized brick can combine with two single bricks or one double brick and so on. (Figure 13)

Valency is just the combining power of an atom: group 1 and 17 each have a valency of one. Group 2 has a valency of two and so on. The formula of a compound is a way of indicating how many atoms (bricks) are combined together. Thus one blue brick (B) and one red brick (B) can be written as BR; three yellow bricks (Y) and one large red brick (R) can be written as Y_3R, where the subscript indicates three atoms of Y. 3YR would mean 3 x(YR), ie.. three molecules of YR. How can one combine a double sized brick and a triple sized brick? The simplest model (molecule) will have have 3 double blue bricks (B) to 2 triple red bricks (R), a formula of B_3R_2.

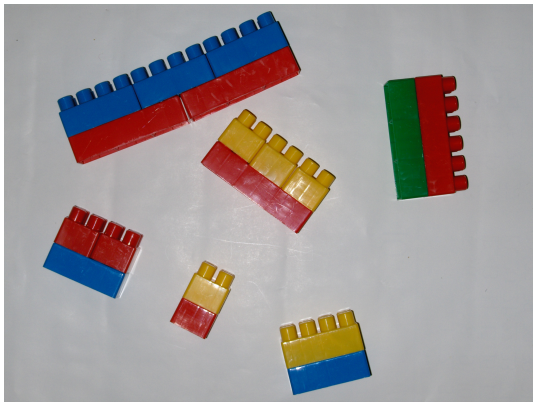


Figure 13 Combining power (valency)

Molecular models

Having used building blocks so far to get over the basic ideas, it is a good idea now to switch to using molecular models, which enable more realistic models of molecules and simple ionic compounds to be made. I think the Molymod® (www.molymod.com) system is one of the most useful. The plastic balls with different colours and patterns of holes represent atoms, which can be combined into molecules (Figure 14). The plastic connectors represent chemical bonds and using these models we can reinforce the basic ideas introduced above, but also investigate molecular shape (see article in *CinA!* #85, Summer 2008 on VSEPR theory). The Orbit® models are also very useful for making large models of crystals structures as in Figure 12. See also Figure 15 below. These are available from Cochranes of Oxford (http://www.cochranes.co.uk/main.asp).

Figure 14 Molymod® models

Figure 15 Orbit® molecular and crystal models

Figure 16 shows the interconnections of the ideas introduced in this article, in the form of a flow-sheet that helps to classify substances.

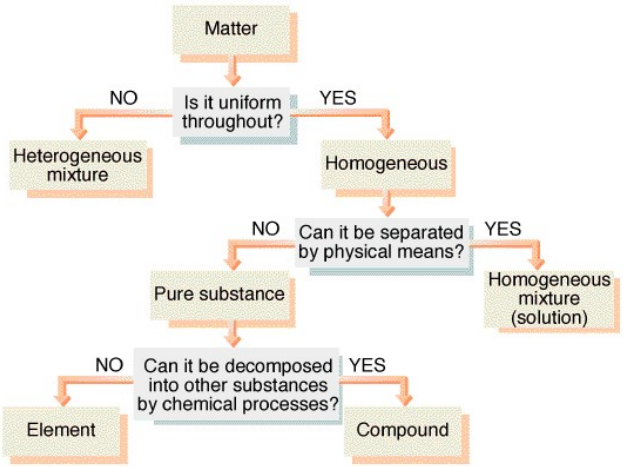


Figure 16 A classification of matter
http://www.chem.ufl.edu/~itl/2045/matter/FG01_007.GIF

You could make a large poster from this diagram and illustrate it with pictures of examples of the different substances. When we come to elements and compounds we can also classify them (Figure 17). Compounds can be classified by the type of bonding that holds the particles together. The particles may be atoms (metals, covalent solids); ions (ionic solids); molecules (molecular solids).

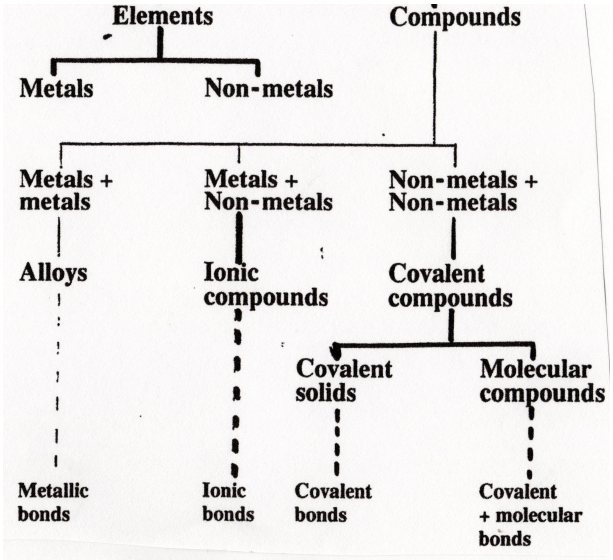


Figure 17 Classification of elements and compounds

Diagrams to illustrate the ideas and test understanding

We need to use diagrams as well as models to teach the particulate nature of matter. These can used to illustrate ideas or used to identify misconceptions or used in assessment. Diagrams such as Figure 18 are easily created and help students visualise the same ideas introduced using models.

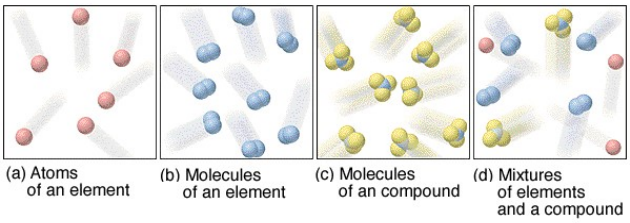


Figure 18 Illustrating the particulate nature of matter
www.chem.ufl.edu/~itl/2045/lectures/lec_1.html

Figure 19 shows an example of a conceptual test that can be used to test student's understanding of the particulate nature of matter and to identify their misconceptions.

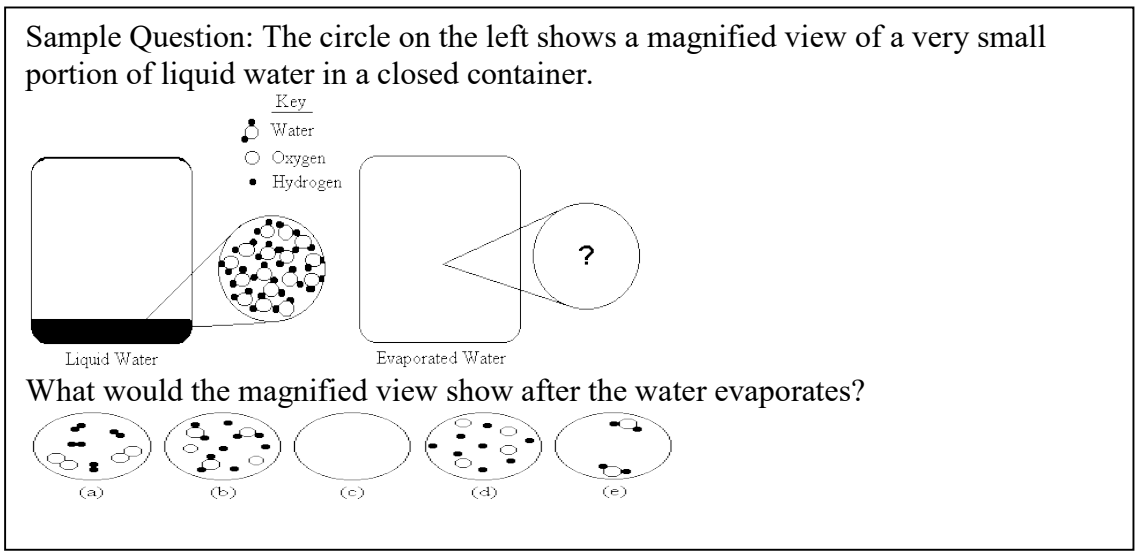


Figure 19 Sample question testing understanding of the particulate nature of matter

Conclusion

One of the main ideas behind this article is the need to give beginning students of chemistry a handle on the invisible molecular world, by using simple models and diagrams to help them understand the ideas that lie at the heart of a modern understanding of matter. The treatment here is, of course, an elementary one and we are not dealing with the structure of the atom or the nature of chemical bonding. This use of models should be linked to using diagnostic tests based on diagram like Figure 18, to make sure they understand the ideas and to identify (and correct) early on any misconceptions they may have in this area. If we don't deal with misconceptions early on and if we don't teach for understanding, rather than for the recall of definitions and facts, then their misunderstanding will persist throughout their chemistry education, as recent research on Irish students has shown (see below).

Large bags or boxes of large plastic building blocks are readily available at moderate cost. The large blocks are better than the small blocks, though these could also be used.

□

In the next article in this series, this model-based approach will be used to teach the balancing of equations.

Research on the misunderstanding of the particulate nature of matter

Research carried out in the University of Limerick by Maria Sheehan and Peter Childs has shown that the vast majority of Irish second level and third level pupils have difficulty with Chemistry topics that relate to and need a firm understanding of the Particulate Nature of Matter (Childs and Sheehan, 2009). The research has also shown that Junior and Leaving Certificate pupils possess a large number of misconceptions about this topic. Any idea or concept that varies from the scientifically accepted perception of the concept is deemed a 'misconception'. Misconceptions exist as a result of the manner in which the person learns. *'Students either consciously or subconsciously construct their concepts as explanations for the behaviour, properties, or theories they experience. They believe most of these explanations are correct because these explanations make sense in terms of their understanding of the behaviour of the world around them. Consequently, if students encounter new information that contradicts their alternative conceptions it may be difficult for them to accept the new information because it seems wrong'* (Mulford and Robinson, 2002). Misconceptions have an adverse effect on the learning of new material.

Garnett and Garnett (1990) noted this and stated that *'the formation of misconceptions will adversely affect an individual's subsequent learning'*. They also went on to point out that *'once incorrect concepts become established, they*

are resistant to change, and influence and interact with the learning of related concepts'. The number and type of misconceptions held by Junior and Leaving certificate pupils has been linked to the pupils own cognitive development. Pupils operating at the concrete level of cognitive development are more likely to possess a larger number of misconceptions. This phase of the research project also found that the majority of our pupils are operating at the concrete level of cognitive development.

The next step in this investigation into the difficulties associated with the teaching and learning of Chemistry in the Irish school system is to develop a number of teaching resources to help reduce and alter misconceptions held by Junior and Leaving Certificate pupils about the Particulate Nature of Matter, while at the same time developing their ability to think. Resources will also be developed to alter and reduce misconceptions held by Leaving Certificate pupils on the Mole concept. The teaching resources will be based on the philosophy of the Cognitive Acceleration through Science Education (CASE) project in the UK, which found substantial gains in cognitive development were attainable through an intervention programme.

These materials were trialled in a number of schools from September 2009 and the effectiveness of the intervention will be evaluated in 2010. If you would more information on this intervention programme, please contact Maria Sheehan in the University of Limerick at maria.sheehan@ul.ie or on 0879164168. Alternatively you may contact Peter Childs at peter.childs@ul.ie

After the completion of this trial period and the evaluation of the materials, it is hoped that the package will be made available to teachers. It consists of a pupil workbook and a teacher's guide, covering 12 weeks of work at the beginning of the LC Chemistry course.

This work is part of the research for a PhD being carried out by Maria Sheehan, a teacher at St. Caimin's Community School, Shannon, under the supervision of Dr. Peter E. Childs.

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Childs, P. and Sheehan, M. (2009) 'What's Difficult about Chemistry? An Irish Perspective' *Chemistry Education Research and Practice.* 10 (3), 204-218 Available at http://www.rsc.org/Publishing/Journals/RP/article.asp?doi=b914499b, accessed 12/1/10.Mulford, D. and Robinson, W. (2002) 'An Inventory for Alternate Conceptions Among First Semester General Chemistry Students.', *Journal of Chemical Education*, 79(6), 739-744.

Garnett, P. and Garnett, P. (1990) 'Implications of Research on Student's Understanding of Electrochemistry for Improving Science Curricula and Classroom Practice', *International Journal of Science Education*, 12(2) 147-156.

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'Preparing for the Future' ChemEd-Ireland 2009

The 2009 ChemEd Conference was held in the University of Limerick on Saturday 17th Oct. and attended by over ~80 teachers and educators from across the country. The theme of the day was 'Preparing for the Future: the Importance of CPD for the Chemistry Teacher'. It was organised by the National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL) in collaboration with the SLSS, RSC, ICI and SCI.

Dr. George McClelland, Co-Director of the NCE-MSTL, opened the conference saying "*Teacher professional development opportunities have never been more important giving the focus on the necessity to fulfil higher science and mathematics skills requirements for Ireland's success as a knowledge economy."*

The morning session centred on learning and Prof. Norman Reid, Emeritus Professor of Science Education University talked about how improvements in classroom learning, laboratory learning and problem solving can be enhanced by the concept of pre-learning. He said *'Let us be scientists about teaching and learning'* and talked about how information overload is an important factor to consider in order for students to succeed. There was then a session, with three speakers, on using IT to teach chemistry.

After lunch Miranda Stephenson, Deputy Director of the National Science Learning Centre in York, stressed that science education is dependent on the quality of science teaching. The shortage of specialist teachers in the UK is leading to low numbers of pupils pursuing science subjects. Miranda closed her talk by inviting Irish teachers to embrace continuing professional development, so as to enhance enthusiasm and inspiration in science teaching and learning.

Brendan Duane talked about resources for teaching chemistry and new TY Science resources from UL were also described.

Presentations from the conference are available at www.nce-mstl.ie.

Issues in Science: Nanotechnology

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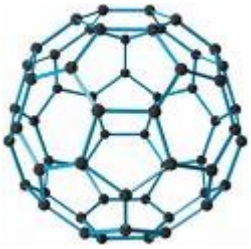
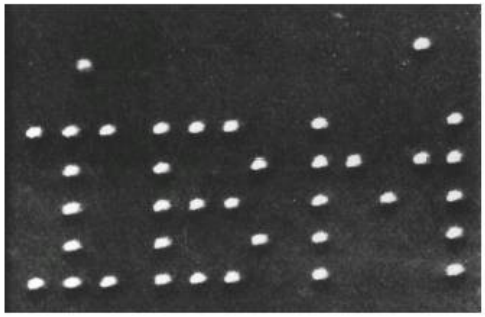
A Brief Chronology of Nanotechnology

1959 Nobel Prize-winner, Richard Feynman, gives after-dinner talk describing molecular machines building with atomic precision.
1974 Norio Taniguchi of the University of Tokyo uses term 'nano-technology'.
1977 K. Eric Drexler, author of the seminal text ***Engines of Creation,*** originates molecular nanotechnology concepts at MIT. The complete text of Drexler's book can be downloaded at http://www.foresight.org/EOC/index.html
1981 First technical paper on molecular engineering to build with atomic precision.
1981 Scanning Tunnelling Microscope (STM) invented.
1985 Buckminsterfullerene (Buckyball) discovered*



1986 Atomic Force Microscope (AFM) invented. First organisation formed.
1987 First protein engineered.
First University symposium on Nanotechnology.
1988 First university course in Nanotechnology. Moving atoms.
1989 IBM logo spelled in individual atoms.



The IBM logo spelled out using 35 Xenon atoms arranged on a nickel surface by an STM. (IBM Research)

1993 Synthesis of the first single walled carbon nanotubes was confirmed by Iijima of NEC and Bethune at IBM Almaden.
1996 * Richard Smalley and Robert Curl of Rice University, along with Sir Harold Kroto of the University of Sussex in Brighton, UK were awarded the 1996 Nobel Prize in Chemistry for their co-discovery of the fullerenes.

Twenty years on from the production of the IBM image, nanosciences and nanotechnology are established disciplines. They are predicted to underpin the next industrial revolution: the next trillion dollar industry – ironically the 'next BIG thing'! Around the world science curricula are being developed to inform students and researchers about this science and technology which has started to change life as we know it. In spite of all the promise that nanotechnology shows, there are a number of areas of uncertainty that also have to be considered. The risks to human and animal health and the environment still have to be properly assessed.

The scope of Nanotechnology

'There's plenty of room at the bottom…' The meaning of the term "nanotechnology" has changed since its theoretical capability was stated by Richard Feynman, a physics Nobel laureate, in his famous remarks, made during an after-dinner talk at the annual meeting of the American Physical Society on December 29th, 1959. *"I want to build a billion tiny factories, models of each*

other, which are manufacturing simultaneously…The principles of physics, as far as I can see, do not speak against the possibility of manoeuvring things atom by atom. It is not an attempt to violate any laws: it is something, in principle, that can be done; but in practice, it has not been done because we are too big." For many Feynman's remarks seemed like the stuff of science fiction, but half a century later they have become science fact, largely aided by developments in microscopy and computing.
(This talk was reprinted in *Chemistry in Action!* in issue #73, Summer 2004 and is available at www.zyvex.com/nanotech/feynman.html)

In the 1980s K. Eric Drexler concentrated on building machines on the scale of molecules, his so-called 'Engines of Creation'. In the US, The National Nanotechnology Initiative (NNI) was created by presidential executive order in 2001. The NNI was charged *"to accelerate the responsible development and application of nanotechnology in order to create jobs and economic growth, to enhance national security and to improve the quality of life for all citizens."*

Recognition of the potential for this 'new' science

Mikhail Roco of the US National Nanotechnology Initiative has described four generations of nanotechnology development:
1. ***Passive nanostructures***: materials developed to perform one task. Examples include dispersed and contact nanostructures; e.g., aerosols and colloids, and products incorporating nanostructures; e.g., coatings, nanoparticle-reinforced composites, nanostructured metals, polymers and ceramics.
2. A***ctive nanostructures***: this is the current generation. This includes devices that can be divided into the following: bio-active, health effects; e.g., targeted drugs and biodevices, and physico-chemical active devices; e.g., 3D transistors, amplifiers, actuators, and adaptive structures.
3. **Systems of nanosystems:** We are currently entering the third generation. By 2010 Roco speaks of systems of nanosystems that will feature thousands of interacting components.
4. **Molecular nanosystems:** Roco projects that between 2015 and 2020 we will be working with the first integrated nanosystems functioning much like a mammalian cell with hierarchical systems within systems.

All of the developments in nanotechnologies were only made possible by the introduction of the sophisticated electron microscope technologies like Atomic Force and Scanning Tunnelling. As early as the 1950's, Roger Bacon of Union Carbide may have synthesized nanotubes, but without an instrument to view them, he was not given credit for the original discovery. He was the first to describe a tube of atoms that could be capped by a buckyball. More information about his work can be found at the "National Historic Chemical Landmarks" section of the American Chemical Society's website.

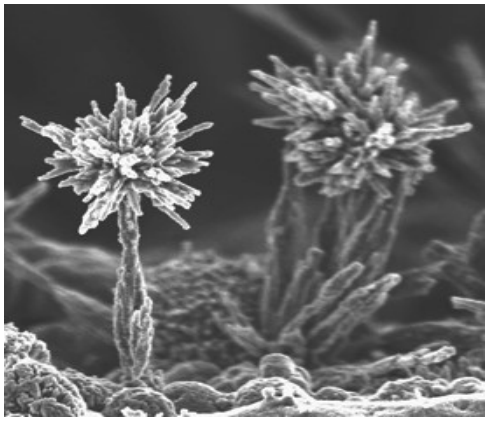
What is Nanotechnology?

Nanotechnology is the understanding and control of matter at dimensions between approximately 1 and 100 nanometres, in other words at the atomic or molecular level. It implies extreme smallness and the prefix 'nano' is derived from the Greek word for 'dwarf'. Research has shown that at this level, unique phenomena enable novel applications. Nanotechnology encompasses nanoscale science, engineering, and technology, and involves imaging, measuring, modelling, and manipulating matter at this length scale – the 'nano scale'. The nanoscale region includes micelles, proteins, DNA, antibodies, viruses, and ribosomes. Individual atoms and small molecules are smaller and fall below the nanoscale region.

A nanometre is one-billionth of a metre. A sheet of paper is about 100,000 nanometres thick; a single gold atom is about a third of a nanometre in diameter. Unusual physical, chemical, and biological properties can emerge in materials at the nanoscale. These properties may differ in important ways from the properties of bulk materials and single atoms or molecules.
N.B. in American English it is nanometer.

An example of changes at the nanoscale

Carborundum (silicon carbide) is an exceedingly hard, synthetically produced crystalline compound of silicon and carbon. Its chemical formula is SiC. Since the late 19th century silicon carbide has been an important material for sandpapers, grinding wheels, and cutting tools. More recently, it has found application in refractory linings and heating elements for industrial furnaces, in wear-resistant parts for pumps and rocket engines, and in semiconducting substrates for light-emitting diodes. At the nanoscale it's structure changes dramatically:



The image portrays the complex structure formed from silicon carbide nanowires are grown from a vapour phase. About 100,000 of these 'flowers' would fit on the head of a pin. By varying the growth conditions the morphology of the resultant films can be precisely controlled.

What properties of nanomaterials are different from the bulk material?

Increased surface area affects the physical/mechanical properties of nanomaterials. Hardness, scratch resistance, fracture toughness, and energy dissipation are all increased. Smaller particles have an increased surface area, which increases the rate of chemical reactions and suggests a role for nanoparticles as effective catalysts. High surface area also implies that electrical conductivity will be enhanced since nanomaterials will be able to hold a higher charge than conventional ones. The strength of magnets increase with size and surface area per unit mass of the grains which suggests that higher power magnets can be produced from nanocrystalline materials.

Making Nanostructures

Traditionally there are two approaches to making nanostructures

- ***Bottom-up*** i.e. building structures using individual molecular building blocks.
- ***Top-down*** i.e. making nano-sized structures using machining or etching techniques to give nanometre size design features.

Bottom-up is the traditional chemical approach of making complex and large molecules from smaller components. Top-down is an engineering approach to producing devices and machines.

Applications vary from batteries to cosmetics, drug delivery and electronics. The development of these applications is moving at different speeds. Cosmetics containing nanomaterials are already on the market, e.g. marketed sunscreens with TiO_2 and ZnO nanoparticles. Cosmetic companies like L'Oreal have a major research effort in nanomaterials.

An example of the commercial application of nanotechnology is the mobile phone: this has become smaller and smaller, but smarter and faster, and paradoxically cheaper! Self-cleaning windows coated with TiO_2 utilise nanotechnology to repel dirt. Rejection issues with hip implants have been reduced because they have a nanoscale topography that encourages acceptance by the cells in their vicinity.

How new is it???

As we can see from the timeline above the discipline of Nanotechnology is relatively new, but scientists would contend that the idea of studying mechanisms at a molecular level is not completely novel. Some people have argued that nanoscience is just a new name for chemistry!

For example every time we take a single aspirin tablet we consume more than $1x10^{20}$ molecules of aspirin (or acetylsalicylic acid), and we know that each of those molecules reacts in the body at an individual level. However, the Food and Drug Administration (FDA), which is the major pharmaceutical regulatory authority in the US and recognised world-wide, has acknowledged that research and development at the nano level requires special regulations. Historically the FDA has approved many products with particulate materials in the nanosize range. Most drugs are expected to go through a nanosize phase during

the process of absorption in the body. There have been no safety concerns reported in the past because of particle size.

The FDA calls it "nanotechnology" only if it involves all of the following:

1. Research and technology development or products regulated by FDA, that are at the atomic, molecular or macromolecular levels, and where at least one dimension, that affects the functional behavior of the product, is in the length scale range of approximately 1-100 nanometers.
2. Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.
3. Ability to control or manipulate at the atomic scale.

The Centre for Drug Evaluation and Research (CDER), which is a division of the FDA, has a number of research themes in Nanotechnology, including particle size determination, development of in vitro assays to assess toxicity of selected nanoparticles, manufacture of nanoformulations and characterization of physical and chemical properties.

Examples of Innovation in Drug Development

Currently, nanoparticle applications in medicine are geared towards drug discovery and drug delivery. In the future, the goal is to make the nanoparticles multifunctional and controllable by external signals or local environments. Biological nanodevices based on dendrimers are being developed with the potential to recognize cancer cells, diagnose causes of cancers, deliver drugs to target, report location of tumours, and report outcomes of therapy (cancer cell death). Several nanomedicine developments are now in clinical trials and could soon be available to the public. Just think of the benefits of using gold nanoparticles to detect early stage Alzheimer's disease. Other nanostructures can recognize diseased cells and deliver drugs to cancerous tumours without harming healthy cells or organs. If these developments pass the trial phases they will change the future of healthcare.

More promise from nanotechnology

Nanomaterials enhance the properties of traditional materials by making them stronger, lighter, more durable or better conductors, among other traits. On the market at this stage are baseball bats and tennis rackets with nanomaterial enhancement, but someday may also be used in bulletproof vests and light, fuel efficient vehicles. The possibilities for enhancement seem endless: water-repellent, anti-reflective, self-cleaning, ultraviolet or infrared-resistant, antifog, anti-microbial, scratch-resistant, or electrically conductive.

Cheaper, cleaner energy: Research groups are working on ways to develop clean, affordable and renewable energy sources. Nanotechnology has been used to produce prototype solar panels which are more efficient than standard designs in converting sunlight to electricity. Nanotechnology is already being used in new batteries, and nanostructured materials look to greatly improve hydrogen storage materials and catalysts needed to realize fuel cells for alternative transportation.

Clean water is a basic necessity and nanotechnology could help meet the need for affordable clean water through inexpensive water purification, as well as rapid, low cost detection of impurities. One research project has discovered unexpected magnetic interactions between ultra small specks of rust, which can help remove arsenic from drinking water.

Eco-friendly possibilities: in spite of the concerns about controlling the environmental impact of nanotechnology, there are many indications that it could have a major positive impact on our world. Nanotech- enabled sensors, some of them using gold at the nanoscale, may one day be able to detect and identify harmful chemical or biological agents in the environment.

Environmental and Health Concerns

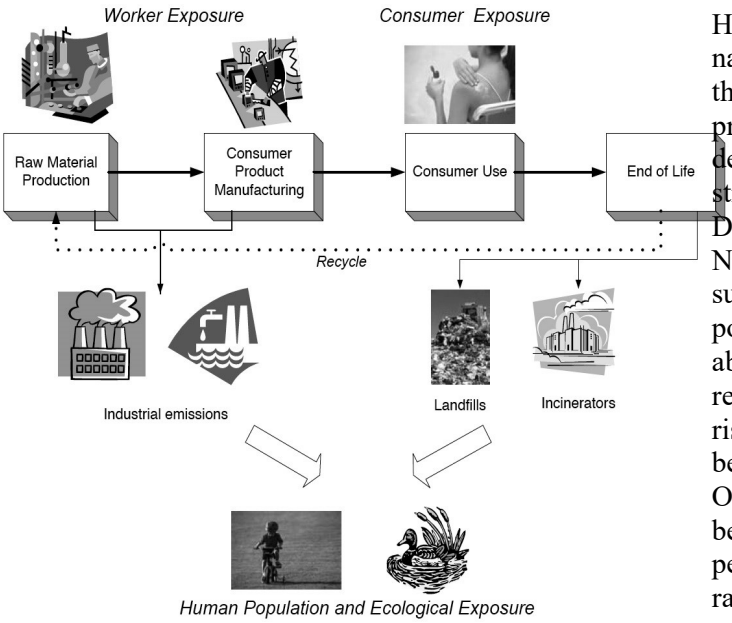
There are several issues to be addressed regarding the potential environmental impact of nanoparticles. Could nanoparticles be released into the environment following human and animal use? If these particles are released: what methodologies would identify the nature, and quantify the extent, of nanoparticle release in the environment? And what might be the

environmental impact on other species (animals, fish, plants, microorganisms)?

The manufacture and use of extremely small particles introduces personal safety issues surrounding possible ingestion and inhalation of the nanoparticles. To date, animal studies indicate that ingested particles are excreted in the urine. However, inhaled particles are a more serious concern. Exposure to nanoparticles can trigger allergic asthma symptoms or aggravated symptoms of pneumonia and cardiac and circulatory systems may also be affected. Regulation of manufacture and disposal of nanomaterials will have to be strictly enforced to address these concerns. Nanoparticles are currently used in cosmetic products like sunscreens and concerns have been expressed that nanoparticles can penetrate the skin and enter the bloodstream.

The public's fears of nanotechnology have been increased by books like Michael Crichton's *Prey* and comments by influential figures like Prince Charles in the UK about the dangers of 'grey goo'.

Concerns about Nanotechnology Products



Source:
http://www.epa.gov/osa/pdfs/nanotech/epa-nanotechnology-white-paper-final-february-2007.pdf

As some research has shown, the properties of materials can change dramatically at the nano-scale. This has led to concerns about the development of these materials and aspects of their safety, quality of material, how they can be characterized, and – not least – how they will impact on the environment.

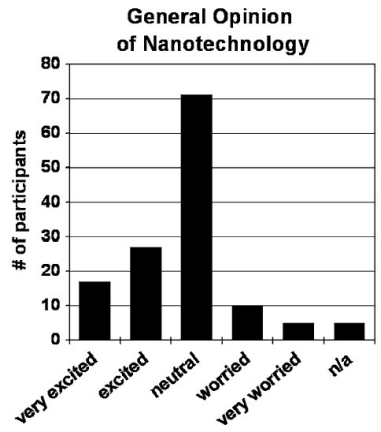
What does the public think about these new technologies?

So far there has been little research done into public attitudes to nanotechnologies but initial surveys indicate that levels of awareness of these technologies are low. In an opinion poll, carried out by BMRB for the Royal Society and Royal Academy of Engineering joint working group on nanotechnology in the UK, just 29 per cent of the public claimed to have heard of nanotechnology, while only 19 per cent could give some definition of it, whether accurate or not. Of those who were able to offer a definition, 68 per cent were optimistic about future prospects, expressing desire for products like smaller computers, and better performance and usability. They were excited by the medical possibilities arising from nanotechnology, in terms of earlier diagnosis and treatments. However, they also had concerns about the long-term potential side-effects of nanotechnology, and about its reliability.

However, greater miniaturisation due to nanotechnology also prompted suspicions about the use of surveillance equipment and loss of privacy, while others expressed concerns about development costs. Overall, participants felt strongly that nanotechnology should be regulated.
Despite the well-established National Nanotechnology Initiative in the US, in a national survey in the USA, more than 80 per cent of those polled said they had heard "little" or "nothing" about nanotechnology. Even so, 40 per cent of respondents thought that benefits outweighed risks, and another 38 per cent believed risks and benefits of nanotechnology would be about equal. Only 22 per cent said risks outweighed the benefits. The most common concerns were loss of personal privacy, a nanotechnology-inspired arms race, nanoparticle damage to health, and its possible impact on US jobs and industry.

The message for those involved in Nanotechnology is that there is a lot of work to be

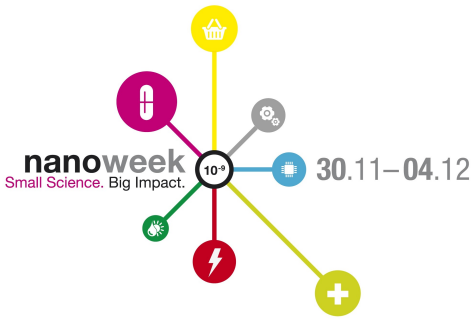
done in dissemination of information about this area, and it's potential.



Source: Journal of Nanoparticle Research ((2007) 9:183189)

Results of a survey published in the *Journal of Nanoparticle Research* ((2007) 9:183189) in which 135 participants were asked to circle the word which most represented their overall opinion of nanotechnology and its potential impact on their life and society, showed that the majority of respondents were 'neutral' (see figure above).

Ireland celebrates Nanoweek



Nanoweek 2009 brought a wide range of events designed to raise public awareness of the potential of nanoscience to improve our quality of life. The week showcased the excellence of nanoscience research in Ireland, its direct links to industry and the contribution that nanotechnology makes to the Irish economy and our future Smart Economy. Nanoweek was an initiative of the Nanoscience Network, which combines the Integrated NanoScience Platform for Ireland (INSPIRE), and the Competence Centre for Applied Nanotechnology (CCAN). INSPIRE is comprised of internationally leading researchers across 10 third level institutions and was recently funded to the level of €31.6m by the Higher Education Authority (HEA), via PRTL14. CCAN, funded by Enterprise Ireland and the Industrial Development Agency, includes leading multi-national companies, such as Intel and indigenous Irish companies such as Creganna.

CRANN is the Centre for Research on Adaptive Nanostructures and Nanodevices at TCD.. It has 200 researchers and 15 Principal Investigators from TCD and UCC. It has produced posters for schools on nanotechnology. www.crann.tcd.ie It has an education programme and has developed a placement programme for Transition Year students which which was first used during Nanoweek 2009. It should not be confused with CRANN, the Irish

Nanotechnology is here to stay

An estimated 20,000 researchers are working in nanotechnology worldwide today and in excess of $2 billion in worldwide government funding was spent on nanotechnology R&D in 2002. In the US over $1 billion of federal funding was spent on nanotechnology R&D in 2005. With a current estimated value of $20 billion, nanotechnology is projected to grow to a $1 trillion global industry by 2015, and 2 million workers will be needed to support those industries.

It is no surprise that information dissemination to the public is a priority for many organizations involved in nanotechnology (see resources at the end).

Introducing a new type of measurement: Nanometrology

For scientists there is something reassuring about being able to make accurate measurements. It follows form the development of nanotechnology, that a satisfactory system of measurement is vital. The High Level Expert Group on the generic activity "Measurement and testing" of the fifth European Framework Programme stated: "*Nanometrology must be seen as indispensable part of all kinds of nanotechnology*".
The justification for this is that standards have to be established to match technology advances and support the increasing applications of nanostructures. Nanotechnology is already a large sector of industry, and as the predictions above show, is expected to continue to grow at very fast

rate. Precise control of dimensions of objects is the key issue of nanotechnology and the science of nano-objects. With precision requested frequently of the order of 0.1 nm, development of new methods of measurement is critical. Nanostructures interpreted as arrangement of atoms or particles form new structural arrangements, e.g.fullerenes, core shell nanoparticles, tangled nanotubes, nanostructured metals, and dendrites.
Nanometrology is seen as a research and development area combining chances for discoveries in basic science and offering commercialization opportunities. Reduction of dimensions, or nanosizing, can have a range of effects on nanomaterials which can translate into new applications, as shown below.

Effect of downsizing to nanoscale	**Applications**
Higher surface:volume ratio Enhanced reactivity	Catalysis, solar cells, batteries, gas sensors
Lower percolation threshold	Materials conductivity, sensors
Increased hardness/resistance	Protective layers, hard-coating, tools
Narrower bandgap	Opto-electronics
Higher resistivity	Electronics, passive components, sensors
Improved atomic transport kinetics	Batteries, hydrogen storage
Lower melting and sintering temperatures	Materials processing
Improved reliability, fatigue	Electronic components,MEMS

Source: http://pubs.acs.org/cgi-bin/article.cgi/nalefd/2006/6/i02/pdf/n1051265k.pdf

Conclusion

The conclusion is that this is a promising new technology, but that science in the 21st century has learned from the mistakes of the past, and will ensure regulation and safety are primary concerns.

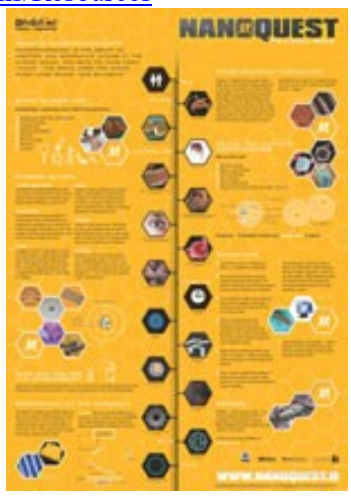
Resources on Nanotechnology

The Irish Nanotechnology Association's website www.nanotechireland.com.

Geared towards the Nanotechnology industry in Ireland, but also of interest to teachers, students and the general public. Explains what nanotechnology is about, highlights state-of-the-art nanotech Research and Development, profiles Irish companies and researchers operating in the field, lists nanotechnology events and patents.

Teaching resources for Irish curriculum:

http://www.crann.tcd.ie/index/OutreachAndCommunications/Resources



Exploring the Nanoworld
Images and teaching material, and general information about nanotechnology.
www.mrsec.wisc.edu/Edetc

A Nano Press Kit contains a wealth of information. The opening page includes an animated working model of one of the largest nanomechanical devices ever modelled in atomic detail, a parallel-shaft speed reducer gear made up of 15,342 atoms.
http://www.crnano.org/whatis.htm

The Northwestern University DiscoverNANO site offers a complete introduction to all aspects of the field of nanotechnology.
http://www.discovernano.northwestern.edu/index_html

A board game about nanotechnology issues.
http://www.mrsec.wisc.edu/Edetc/supplies/nanoventure/index.html

Nanoword.net Online distributor of publications, with a focus on nano-science, technology, and education. Includes the Encyclopedia Nanotech.
www.nanoword.net

Zyvex.com: Nanotechnology Provides a brief introduction to the core concepts of molecular

nanotechnology, followed by links to further reading. www.zyvex.com/nano

A to Z of Nanotechnology Offering nanotechnology information, news, new products, suppliers, and expert directory.
www.azonano.com/

Engines of Creation: The Coming Era of Nanotechnology
Complete text of the book by K. Eric Drexler which introduced the concept of Nanotechnology.
www.foresight.org/EOC/index.html

Nanotechnology Gallery Images: presentations, reports, and webcasts from NASA's Center for Nanotechnology.
www.ipt.arc.nasa.gov/gallery.html

U.S. National Nanotechnology Initiative
Committed to long-term nano science and engineering research; synthesis, processing, and application of nano materials; and the exploration of nanodevice concepts. **www.nano.gov**

Nanotechnology Now offers a resource portal for nanoscience and nanotech news with event information, interviews, directories, glossary, and a tutorial on the basics.

www.nanotech-now.com NanotechNews.com News for nanotechnologists.
www.news.nanoapex.com

NanoComputer Dream Team aims to directly influence the design and development of a nanometer scale computer.
www.nanocomputer.org

Nanomedicine analyzes developments in molecular machine systems to address medical problems. www.nanomedicine.com

Scientific American: Nanotechnology Features current coverage, highlights, and article archives.
www.sciam.com/nanotech
NanoTechWire.com provides news and information on nanotechnology resources, research, patents, materials, investments, industry events, and optics.
www.nanotechwire.com

ANTS: Automomous NanoTechnology Swarm
NASA mission architecture and AI paradigm for space exploration based on large numbers of autonomous specialized spacecraft working together as inspired by social insect colonies.
www.ants.gsfc.nasa.gov

Nanotechnology Engineering: Collection of articles presented by the Institute of Atomic-Scale Engineering. **www.speakeasy.org/~forrestb**

Societal Implications of Nanoscience and Nanotechnology
Final report from the September 2000 workshop held at the National Science Foundation.
www.wtec.org/loyola/nano/NSET.Societal.Implications

Foresight Institute vs Scientific American: Debate on Nanotechnology
www.foresight.org/SciAmDebate/index.html

The Basics of Nanotechnology
An interactive multimedia resource to introduce the terminology, concepts and current debates surrounding this rapidly developing science and discussing its potential applications - from Oxford University Begbroke Park and University of Oxford.
www.begbroke.ox.ac.uk/nanotech/interface.html

This web seminar introduces nanotechnology concepts and support material is provided.
http://learningcenter.nsta.org/products/symposia_seminars/NSDL4/webseminar2.aspx

nanoed.org National Center for Learning and Teaching at Northwestern University

nnin.org/nnin_edu.html *Nanooze (elementary) and much much more!*- Lessons for middle and high school (some developed by Research Experience for Teachers (RET) Program)
http://www.nano.gov/
http://www.nano.gov/NNI_EHS_Research_Strategy.pdf
http://www.nanotechireland.com/
www.nanoforum.org
www.foresight.org
http://www.wtec.org/loyola/nano/IWGN.Research.Directions/
http://www.nano.org.uk/
http://www.crann.tcd.ie/index/NewsAndMedia/News/Nanoweek
http://www.mrsec.wisc.edu/Edetc/SlideShow/slides/nanoparticles/gold_salt_citrate_mov.html

pbskids.org/dragonflytv/nano – 6 video episodes introducing nanoscience at an elementary level

mcrel.org/nanoleap *Evaluated by teachers* - "Investigation Static Forces in Nature: The Mystery of the Gecko" - "Nanoscale Materials and Their Properties"

www.nanozone.org Lawrence Hall of Science
http://acswebcontent.acs.org/landmarks/landmarks/carbon/car3.html

The Nanotechnology Consumer Products Inventory includes lists of teaching resources.
http://www.cst.gov.uk/business/files/ww6.pdf

Big Picture on Nanoscience from the Wellcome Trust. Includes links to other on-line resources:
http://www.wellcome.ac.uk/Education-resources/Teaching-and-education/Big-Picture/All-issues/Nanoscience/index.htm
http://neweconomics.org/ for information about the classroom debate kit on Nanoscience
http://www.unom.ac.in/gcl-opac/NanoSc&Tech.htm another list of resources.

Collection of e-books about nanoscience:
http://www.downloadseden.com/collection-of-ebooks-about-nanoscience/

The Exploratorium web site contains a series of Small Talk Podcasts which explore the topics presented in the articles. Podcasts include: Nature's Playing Field: Nanotechnology and Medicine (31 min.), Nanotechnology's Role in Making Cheap Solar Power (26 min.), Consumer Products Using Nanotechnology (37 min.), and Vroom! Nanocars and Nanofactories (28 min), Nanograffiti: Building from the Atoms Up (23 min).
(http://www.exploratorium.edu/ti/podcasts/smalltalk.php
http://nanotube.com/

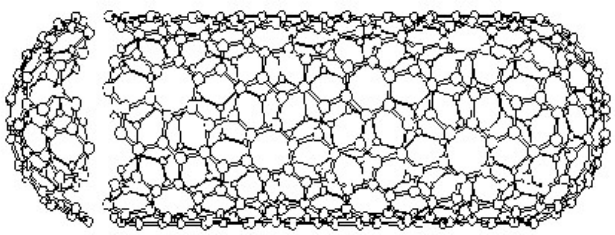
If funds are not available for the purchase of model kits, a model of a nanotube can be constructed from balloons. Complete instructions are given for building two models – a ten-foot model or a table-top model.
(http://mrsec.wisc.edu/Edetc/nanolab/balloons/BalloonNanotubes_ProgramGuide.pdf

Michael Crichton's novel *Prey* takes the creation of free-floating assemblers or nanobots to an extreme and while it does not portray good science, it could act as a discussion trigger. It has also been made into a film.

It would be an interesting exercise to collect adverts for products that claim to use nanotechnology and make a display of them.

A carbon nanotube

Source:
http://www.research.ibm.com/nanoscience/nanotubes.html



2009 LC Results

Peter E. Childs

We have been publishing an analysis of the LC science results and CAO points for science-related courses since 2001. Issue #86 looked at the LC results and CAO points for 2008. This year we will give the figures from 2006 to 2009. The 2009 figures are given in bold in Table 5 and compared with the previous 3 years to see the trends. Consult issue 72 for the 1999-2001 figures and issue 82 for the 2002-2004 figures. The examination statistics are available at the Department of Education and Science website at: **www.examinations.ie** and were published in the Irish newspapers on 12/8/09, the day the LC results were released.

In 2009 54,196 took the Leaving Certificate (LC) (this is the sum of LC (Established) and LCVP) and a further 3,259 took the Leaving Certificate Applied (LCA). Thus the number doing the LC went up by 2,052 (3.9%) from 2008.

(LC Grading at Higher Level: A1 90-100%; A2 85-89%; B1 80-84%; B2 75-79%; B3 70-74%; C1 65-69%; C2 60-64%; C3 55-59%; D1 50-54%; D2 45-49%; D3 40-44%; E 25-39%; F 10-24%; NG 0-9%)

Comments on the 2009 results

Table 1 shows that all the sciences except Physics and Physics with Chemistry gained numbers and % share and Agricultural Science and Biology made the largest % gains. Over the period 2002-2009 all the sciences gained numbers except Physics and Physics with Chemistry, which have shown a steady decline. Biology continues to be the dominant LC science subject (taken by 51.8% of the cohort) and the only science subject in the top 10 (Table 4), having moved up to 4th. place this year. The LC cohort increased this year by 3.9%, and Biology, Chemistry and Ag. Science all gained in market share (see Table 5). The LC cohort declined from 2002 to 2007 and since 2008 has been increasing (Table 7). The LC cohort in 2009 went up by 2,052 (3.9%) from 2008 and this shows continuing recovery, as birth rates in Ireland have gone up and immigration has increased the school population. This means in 2009 that we have more students (even more if you add in others returning to or entering education) chasing the same number of 3rd. level places. The result is seen is an overall increase in CAO points for many courses, and this will get worse in 2010.

Since 2002 Biology, Chemistry and Agricultural Science have all gained significantly, especially Agricultural Science (see Table 1). Physics and Physics with Chemistry have both decreased. Chemistry still has the highest % doing the Higher Level course of the science subjects (Table 2). Chemistry also shows the best gender balance (slight excess of girls), whereas Biology has more girls than boys doing it, and Physics more boys than girls. Physics is clearly in decline and this year's figures suggest that Agricultural Science may well become the third most popular science in a few years time. There is clearly a swing towards the life sciences. Physics with Chemistry has been on its last legs for some years and continues to decline - it is definitely a dead man walking, and it is a great pity that the new and innovative replacement drawn up many years ago, has never been implemented. If the course is not going to be revised it should be dropped.

Table 1 Changes in numbers doing LC Science subjects 2009-8

Subject	Δ2009 -2008	% change	Δ2009-2002 (% change)
Biology	**+1,553**	**+5.8**	**+6,102 (+27.6%)**
Chemistry	**+289**	**+4.1%**	**+906 (+13.9%)**
Physics	-190	-2.7%	-1,729 (-20.0%)
Phys+Chem.	-79	-13.2	-450 (-46.4%)
Ag. Science	**+534**	**+11.3**	**+2,381 (+82.4%)**

Table 2 LC Science - % doing Higher Level and Ordinary Level

	2009	HL 2009 (%)	OL 2009 (%)	% LC cohort 2008	% LC cohort 2008
Biology	28,160	20,101 (71.4)	7,999 (28.6)	51.8	51.0
Chemistry	7,403	6,037 (81.5)	1,366 (18.5)	13.7	13.6
Physics	6,923	4,693 (67.8)	2,230 (32.2)	12.8	13.6
Phys.+Chem.	519	408 (78.6)	111 (21.4)	0.96	1.1
Ag. Science	5,272	4,164 (79.0)	1,108 (21.0)	9.7	9.1

Table 3 % of different grade bands 2006-2009

a)Chemistry **Higher level** Ordinary level

Year	**2009**	**2008**	**2007**	**2006**	2009	2008	2007	2006
%A	**21.6**	**23.5**	**21.0**	**21.8**	9.2	11.7	8.0	7.0
%A-B	**52.9**	**54.6**	**54.1**	**50.8**	34.6	42.2	31.8	32.3
%A-C	**77.5**	**78.7**	**79.0**	**75.6**	63.1	75.0	58.5	59.7
%E,F,NG	**7.0**	**5.8**	**5.5**	**7.4**	15.3	13.9	16.8	15.5

b)Biology **Higher level** Ordinary level

Year	**2009**	**2008**	**2007**	**2006**	2009	2008	2007	2006
%A	**16.0**	**16.6**	**19.5**	**16.5**	3.6	4.8	2.7	3.9
%A-B	**43.0**	**43.9**	**46.7**	**43.7**	26.3	29.7	24.5	30.5
%A-C	**69.9**	**71.5**	**71.7**	**71.6**	59.1	63.2	57.8	64.9
%E,F,NG	**8.8**	**7.9**	**7.9**	**7.2**	15.3	11.1	15.0	13.2

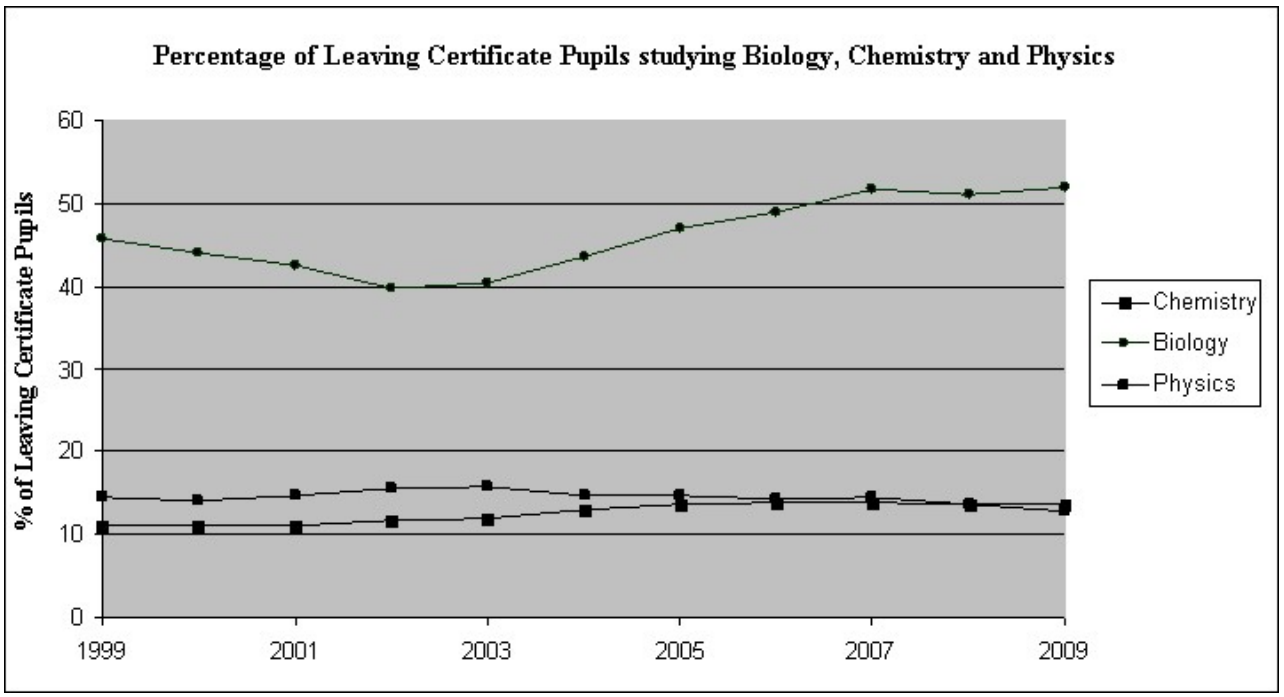
c) Physics **Higher level** Ordinary level

Year	**2009**	**2008**	**2007**	**2006**	2009	2008	2007	2006
%A	**20.3**	**19.9**	**21.4**	**19.5**	17.0	15.5	13.5	13.8
%A-B	**49.6**	**46.4**	**49.7**	**46.8**	49.7	47.3	43.8	45.7
%A-C	**72.9**	**70.8**	**75.8**	**70.5**	74.3	73.8	72.9	72.8
%E,F,NG	**7.8**	**8.6**	**7.5**	**7.2**	10.0	8.7	9.7	9.0

In Table 3 you can compare the grades obtained in each subject at Higher and ordinary level. Four bands are shown: %As, %A+Bs, %A+B+Cs and %E+F+NG (fails). Chemistry and Physics are more selective subjects i.e. they are done by smaller numbers and a higher % take the Higher Level papers, indicating that these are taken by better students. We would thus expect a higher % of good grades and less % of fails if the student populations doing Chemistry and Physics are more selective. This is what we observe. From 2006-9 the average % getting As in Higher level papers in Chemistry was 22.0% and 20.3% in Physics, compared to 17.15% in Biology. This does not mean that Biology is harder than Chemistry or Physics: it means that a larger number of students take Biology and have a greater ability spread, compared to Chemistry and Physics. This is also consistent with the average % of fails in Chemistry of 6.4% 2006-9, compared to 7.8% in Physics and 8.0% in Biology. At Ordinary Level we would expect to see smaller % of good grades, as weaker students

opt for the ordinary level papers - often at the last minute, and a greater % of fails. We would expect more % fails in Biology than Physics and Chemistry because of the greater numbers and greater ability spread of students choosing Biology. The average % getting As in ordinary level Chemistry was 9.0% from 2006-9, with 15.0% getting As in Physics and 3.8% in Biology. When we look at the % fails in the ordinary levels papers from 2006-9, 15.4% fail Chemistry, 13.7% fail Biology and 9.4% fail Physics.

Figure 1 Change in % doing Biology, Physics and Chemistry 1999-2009



We would in fact expect an even higher % of good grades in both Chemistry and Physics given the highly selective populations doing these subjects.

An important study by Kellaghan and Millar (2003) compared performance in different LC subjects by comparing a student's performance in pairs of subjects. A preliminary report on the study was given in the Report of the Task Force on the Physical Sciences (2002). This found that a student on average got lower grades in Chemistry and Physics compared to other subjects they took, indicating that it is actually more difficult to get high grades in these subjects. The difference was between half and 1½ grades, which is a significant difference. This important study should be repeated at intervals to check on the comparability of marks across different subjects. It agrees with the anecdotal perception of students, parents and teachers that it is harder to get good grades in Chemistry and Physics, notwithstanding the already high % of As and Bs in these subjects. If this effect was allowed for a greater % of students would get As in Chemisty and Physics than they do at present.

(See *Report of the Task Force on the Physical Sciences*, 2002, available at: http://www.education.ie/servlet/blobservlet/physical_sciences_report.pdf and *Grading in the Leaving Certificate Examination*, Thomas Kellaghan and David Millar, ERC, 2003 Data available at: http://www.erc.ie/documents/lc)

Table 4 shows the detailed breakdown of the results for the 2009 Science subjects.

Table 4 2006-2009 LC Science Results at HL and OL (Source: DES Statistics) (Current year in bold)

Chemistry	No.	A1	A2	B1	B2	B3	C1	C2	C3	D1	D2	D3	E	F	NG
HL 2009	**6,037**	**12.3**	**9.3**	**10.4**	**11.0**	**9.9**	**8.5**	**8.1**	**8.0**	**4.5**	**4.9**	**6.2**	**4.7**	**1.8**	**0.5**
HL 2008	5,904	12.9	10.6	10.7	10.4	10.0	8.8	8.0	7.3	5.4	4.6	5.5	4.2	1.3	0.3
HL 2007	5,729	9.7	11.1	10.7	11.7	10.8	9.1	8.3	7.4	5.4	4.9	5.2	3.7	1.6	0.3
HL 2006	5,712	12.0	9.8	9.3	9.8	9.9	8.8	8.5	7.5	6.3	5.4	5.4	5.2	1.9	0.3
OL 2009	**1,366**	**3.0**	**6.2**	**5.9**	**8.6**	**10.9**	**10.8**	**8.6**	**9.1**	**5.3**	**6.8**	**9.4**	**8.7**	**5.6**	**1.0**
OL 2008	1,210	5.3	6.4	9.2	9.7	11.6	9.8	7.9	7.9	6.4	4.8	7.3	7.8	4.9	1.2
OL 2007	1,197	3.3	4.7	5.0	8.3	10.5	9.0	9.0	8.7	8.0	5.7	11.0	10.4	5.3	1.1
OL 2006	1,359	2.1	4.9	6.0	8.6	10.7	8.2	9.9	9.3	7.1	7.2	10.2	8.2	6.0	1.3
Biology	**No.**	**A1**	**A2**	**B1**	**B2**	**B3**	**C 1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**G**
HL 2009	**20,101**	**7.7**	**8.5**	**8.1**	**90**	**9.9**	**8.9**	**9.1**	**8.9**	**7.2**	**6.7**	**7.2**	**7.0**	**1.6**	**0.2**
HL 2008	18,323	8.5	8.1	8.1	9.3	9.9	9.2	9.3	9.1	7.0	6.4	7.2	6.2	1.6	0.1
HL 2007	17,521	10.7	8.8	8.7	8.9	9.6	8.4	8.2	8.4	7.2	6.4	6.7	6.1	1.6	0.2
HL 2006	17,048	8.8	7.7	8.4	9.3	9.5	8.9	9.4	9.6	7.7	6.6	6.9	5.8	1.2	0.2
OL 2009	**7,999**	**1.0**	**2.6**	**5.2**	**7.5**	**10.0**	**11.0**	**11.3**	**10.5**	**9.6**	**7.8**	**8.4**	**9.9**	**5.0**	**0.4**
OL 2008	8,284	1.5	3.3	5.7	8.2	11.0	10.9	11.4	11.2	9.6	7.4	8.7	8.1	2.8	0.2
OL 2007	8,270	0.6	2.1	4.7	7.1	10.0	10.7	10.7	11.9	10.3	8.0	8.8	10.2	4.4	0.4
OL 2006	7,837	1.0	2.9	5.7	9.2	11.7	12.4	12.0	10.0	7.8	6.4	7.5	7.9	4.3	1.0
Physics	**No.**	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**NG**
HL 2009	**4,693**	**10.6**	**9.7**	**10.2**	**10.2**	**8.9**	**8.6**	**8.6**	**6.1**	**7.2**	**5.8**	**6.3**	**5.1**	**2.4**	**0.3**
HL 2008	4,929	12.7	7.2	10.5	8.0	8.0	7.7	8.7	8.0	6.4	5.8	8.4	6.2	2.0	0.4
HL 2007	5,223	12.4	9.0	6.3	9.0	9.4	9.0	8.5	8.6	7.2	5.6	7.5	5.4	1.8	0.3
HL 2006	5,200	10.9	8.6	8.9	9.0	9.4	7.8	7.7	8.2	7.3	6.1	8.9	5.3	1.7	0.2
OL 2009	**2,230**	**5.7**	**11.3**	**9.2**	**10.0**	**13.5**	**8.2**	**8.2**	**8.2**	**5.4**	**4.5**	**5.8**	**5.7**	**3.3**	**1.0**
OL 2008	2,183	6.6	8.9	9.2	11.1	11.5	8.3	8.9	9.3	4.4	5.7	7.5	6.0	2.1	0.6
OL 2007	2,028	3.5	10.0	6.0	8.6	15.7	9.0	9.2	10.9	4.3	6.2	6.8	5.2	3.4	1.1
OL 2006	2,135	5.0	8.8	8.1	11.4	12.4	8.8	10.6	7.7	7.5	5.2	5.5	5.5	3.0	0.5
Phys+Chem	**No.**	**A1**	**A2**	**B1**	**B2**	**B3**	**C 1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**G**
HL 2009	**408**	**7.8**	**9.3**	**7.8**	**10.3**	**8.6**	**7.6**	**9.1**	**9.3**	**6.1**	**6.4**	**7.1**	**5.9**	**3.7**	**1.0**
HL 2008	454	16.7	9.0	7.7	10.1	8.8	6.6	4.6	9.3	4.6	2.4	7.0	7.3	4.4	1.3
HL 2007	392	10.5	12.5	8.7	8.4	8.4	8.9	8.4	8.4	5.4	5.4	5.4	6.1	3.1	0.5
HL 2006	458	6.1	7.2	6.8	8.5	7.6	10.0	9.8	8.1	6.3	8.7	7.2	9.4	3.9	0.2
OL 2009	**111**	**1.8**	**3.6**	**0.0**	**2.7**	**9.9**	**1.8**	**8.1**	**16.2**	**9.0**	**9.9**	**10.8**	**11.7**	**10.8**	**3.6**
OL 2008	144	2.1	2.1	2.8	6.9	6.3	10.4	8.3	9.7	9.7	7.6	9.7	11.1	9.0	4.2
OL 2007	146	1.4	3.4	2.7	9.6	8.2	8.2	8.9	8.9	5.5	11.6	8.2	8.9	11.0	3.4
OL 2006	124	0.8	3.2	4.0	7.3	8.9	7.3	12.9	10.5	4.8	9.7	12.1	11.3	6.5	0.8
Ag. Science	**No.**	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**NG**
HL 2009	**4,164**	**5.7**	**6.9**	**8.0**	**8.7**	**9.4**	**9.8**	**9.3**	**10.4**	**9.3**	**7.0**	**7.4**	**6.6**	**1.4**	**0.0**
HL 2008	3,712	7.2	6.3	8.0	8.4	8.8	10.0	10.1	9.4	8.4	7.0	8.2	6.7	1.3	0.1
HL 2007	3,261	3.8	4.9	7.1	7.9	9.7	11.5	11.3	11.3	9.9	8.0	7.7	5.8	1.0	0.1
HL 2006	3,017	7.0	5.6	7.0	7.5	8.8	10.0	10.0	10.5	9.8	8.0	8.8	6.2	0.8	0.0
OL 2009	**1,108**	**0.0**	**0.4**	**1.2**	**3.0**	**5.1**	**7.3**	**11.9**	**13.4**	**14.3**	**10.6**	**13.4**	**13.3**	**5.8**	**0.5**
OL 2008	1,025	0.1	0.7	1.9	2.9	7.9	9.3	13.6	13.0	14.3	10.7	12.3	10.8	2.4	0.1
OL 2007	1,006	0.1	0.5	1.1	2.5	5.1	7.8	11.7	11.6	13.0	11.9	13.1	14.7	6.1	0.8
OL 2006	896	0.2	1.0	2.2	5.7	7.7	11.3	11.8	14.7	12.2	9.8	10.8	9.7	2.7	0.1

Table 5 Top 10 LC subjects in 2008 and 2007 (HL+OL)

Subject	2007 Total (HL+OL)	2008 Total (HL+OL)	2009 Total (HL+OL)	% LC cohort 2009
Maths (+FL)	49,043	50,116	51,902	95.8
English	48,455	49,382	51,032	94.2
Irish (+FL)	44,018	44,660	45,636	84.2
Biology	25,791	26,607	28,160	51.8
French	27,805	27,698	27,675	51.0
Geography	24,218	24,360	25,061	46.2
Business	18,957	18,733	18,425	34.0
Home Econs.	12,250	12,497	12,936	23.9
History	11,363	11,850	11,990	22.1
Art	10,133	10,283	10,693	19.7

Table 6 Changes in the LC cohort and science subjects 2002-2009

	LC	Biology		Chemistry		Physics	
	Cohort	Total	%	Total	%	Total	%
2002	58,489	22,064	37.7	6,497	11.1	8,651	14.8
2003	56,229	22,669	40.3	6,698	11.9	8,806	15.7
2004	55,183	24,027	43.5	7,229	13.1	8,152	14.8
2005	54,069	25,362	46.9	7,366	13.6	7,944	14.7
2006	50,995	24,885	48.8	7,071	13.9	7,335	14.4
2007	50,870	25,792	50.7	6,926	13.6	7,251	14.3
2008	52,144	26,607	51.0	7,114	13.6	7,112	13.6
2009	**54,196**	**28,160**	**51.8**	**7,403**	**13.7**	**6,923**	**12.8**

***New Biology syllabus from 2004 onwards; new Physics and Chemistry syllabuses from 2002.**

Table 7 Change in LC numbers 2005-2009

Year	LC Established	LCVP	Total LC (Est) + LCVP	LCAP	Total
2005	39,792	14,281	54,073	3,318	57,391
2006	36,932	14,023	50,955	3,155	54,110
2007	36,790	14,080	50,870	3,056	53,926
2008	37,639	14,505	52,144	3,445	55,589
2009	39,112	15,084	54,196	3,259	57,455

In 2009 (2008) there were 4,361 (4,101) external and 2,211 (1,778) repeat candidates. 29,205 (50.8%) of the candidates were female and 28,250 (49.2%) were male.

The Maths problem

Every year there is a big discussion in the papers about Maths - the small number doing the Higher paper and the high % of fails. The results for 2009 and 2008 are shown in Table 8 below. Table 5 reminds us that Maths is the most popular LC subject (95.8%) even though it is not formally compulsory. This means that virtually everyone who completes the senior cycle in Ireland has done a course in Mathematics. In the UK, for example, the majority of students drop Maths after the junior cycle and only a minority carry on with it to A level. This should mean that Ireland has one of the most mathematically literate populations in Europe, if not in the world. The % who did the Higher Level paper was 15.5% in 2009 and 16.3% in 2008. The number and % doing HL Maths is greater than that doing HL Chemistry or Physics, although we might well expect them to be the same students (see Table 9). Considering that almost the whole LC cohort does Maths, the % failures at HL (3.3%) and OL (10.4%) are quite small. Doing a course does not necessarily mean that one will pass it.

Table 8 LC Maths results 2009-8 at HL, OL and FL

Maths	No.	A1	A2	B1	B2	B3	C1	C2	C3	D1	D2	D3	E	F	NG
HL 2009	**8,420**	**6.7**	**8.1**	**9.4**	**11.7**	**12.2**	**11.8**	**11.8**	**8.9**	**7.2**	**5.1**	**3.8**	**2.6**	**0.6**	**0.1**
HL 2008	8,510	7.7	6.9	8.6	10.0	12.1	11.2	11.7	10.0	6.8	5.4	5.3	3.5	0.7	0.2
OL 2009	**37,272**	**5.7**	**7.0**	**8.3**	**9.2**	**9.7**	**9.5**	**9.3**	**8.6**	**7.9**	**7.0**	**7.3**	**7.6**	**2.5**	**0.3**
OL 2008	35,808	4.9	7.6	9.1	9.7	9.4	9.6	8.8	8.2	7.2	6.4	7.0	8.0	3.7	0.5
FL 2009	**6,210**	**4.2**	**6.7**	**10.0**	**12.8**	**13.2**	**11.9**	**10.8**	**8.2**	**7.1**	**5.1**	**4.9**	**3.7**	**1.2**	**0.2**
FL 2008	5,803	3.9	5.9	8.8	12.4	13.4	12.5	10.4	9.3	6.8	5.8	5.0	3.7	1.8	0.2

Table 9 Comparison of HL Maths, Chemistry, Physics and Biology 2009

	Maths	Chemistry	Physics	Biology
Number (%)	8,420 (15.5%)	6.037 (11.1%)	4,693 (8.7%)	20,101 (37.1%)
% doing HL	16.2%	81.5%	67.8%	71.4%
% As	14.8	21.6	20.3	16.0
%A+Bs	48.1	52.9	49.6	43.0
% fails	3.3	7.0	7.8	8.8

An important question we should ask is, "Is every pupil in senior cycle capable of taking HL Maths?" A higher % take Higher Level Maths for the Junior Certificate, but this is not as demanding a course as LC Maths, just as JC Science is not as demanding as the LC science subjects. In order to do HL Maths (and HL Physics and Chemistry as well) a pupil needs to be able to think abstractly, handle concepts, understand logic etc. This means they have to be able to think at a fairly high level, what educational psychologists call the 'formal operational level'. The evidence of large scale studies of second level students in the UK (Shayer and Adey, 1981), as well as evidence collected in Ireland (Childs and Sheehan, 2009) indicates that only a small percentage of students (<20%) at ages 16/17/18 is capable of the abstract, logical , conceptual thought needed by Mathematics. This still true for first year college students, although the % capable of formal thought is higher (30-40%),especially for self-selecting courses which require a high level of Mathematics and the Physical Sciences. So maybe one major reason why more pupils don't take HL Maths is that they are not able to cope with the intellectual demands of the course, given their own state of development. If they did it, they would almost certainly do badly. The same would be true to a lesser extent for LC Chemistry and Physics. By the same argument, because not all pupils are capable of the type of thinking required in Maths and Physical Science, we would expect to find them either avoiding the subject (for Chemistry and Physics) or opting for the OL course (Mathematics). We would also expect to find some pupils who cannot cope with the subjects at all and even though they take them, they fail. If we are taking almost the whole age cohort (at JC) and >80% at LC, we would expect a significant proportion of students to be of low ability (less

than average), who cannot cope with the demands of even OL material. We can only expect everyone to pass examinations, at JC or LC level, if we lower the standards enough so that everyone gets through. The examinations and the results then become largely meaningless as we are ignoring the innate differences between pupils. The present arrangement in Maths where it is offered at 3 levels seems to be ideal: everyone has a chance to do Maths at a level that suits their own intellectual development. We should expect and require basic numeracy for everyone, but everyone cannot and will not be a mathematician. What we should be doing is making sure that all those who can do HL Maths are in fact doing it, as it is from this pool that the future scientists and engineers as well as mathematicians will come. A new Maths course - Project Maths - started this year as a pilot project and will be examined first in 2010. It is then hoped to make it available to all schools. It is hoped that Project Maths will make the subject more interesting, more relevant and more manageable and that it will increase the % doing the HL course. Whether they will then be properly equipped with the mathematical skills necessary to pursue science and engineering at 3rd. level is another question.

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Comment on LC results from the American Chamber of Commerce

12 August 2009: The reduction in the number of students opting to sit the higher level Leaving Cert papers in maths and science is a barrier to Ireland fulfilling its potential as a knowledge economy, according to the American Chamber of Commerce.

Today's Leaving Cert results showed that only 16 per cent of students took higher level maths and just 10 per cent of students took higher level chemistry, while just 8 per cent took higher level physics.

It also emerged this week that the highest level of drop out at third level is in maths and science related courses. There is clearly a fundamental problem in Ireland in the teaching of these subjects and the way they are presented to students and this is translating from first to second to third level.

Despite the obvious pressure on the public finances it is essential that we continue to invest in addressing these problems or we are going to have serious shortcomings in the skill sets required to attract the kind of businesses to Ireland that we hope to. A real challenge for 'SMART' economy stakeholders is to improve awareness of the benefits of strategic investments in science and mathematics and how this will enhance Ireland's competitiveness and boost its attractiveness for foreign investment - and the benefits this will deliver to all in our society.One of the key attractions for US investment in Ireland is a flexible, highly educated workforce. If we are to retain and grow this investment we need to ensure a continuous pipeline of graduates with the skills which will drive innovation across all industry sectors such as ICT, pharmaceuticals, engineering, biotech and financial services. Reform in the education system to make the necessary and sizeable change to the curriculum must focus on creativity and innovative thinking and the problem solving capabilities that an engaging mathematics and science programme brings to Ireland's future development.

Today, almost 100,000 people are directly employed in over 570 US firms in Ireland accounting for 70% of all IDA supported employment. Indirect employment in sub-supply and community industry & services has been estimated at over 200,000. The IDA announced 130 new and expansion projects with companies during 2008. Almost two out of every three foreign direct investment projects coming to Ireland in 2008 have originated from the US. In 2008, US firms paid over €2.5b to the Irish Exchequer in Corporate Tax (or approx 40% of total corporate tax take in 2008) and contributed a further €13b in expenditure to the Irish economy in terms of payrolls, goods and services employed in their operations.

□

2009 A level results for the UK

(*The Independent*, 21/8/09)

There are some interesting differences between the UK A level results and the Irish LC results in maths and science. The order of popularity of the sciences (B > C > P) is the same but the difference between Biology and the other sciences is much less in the UK than in Ireland, and Physics is significantly less popular than Chemistry. This trend is true in other countries and Ireland is out of line is having such a high preference for Biology.

All the sciences and maths A levels showed an increase in numbers from 2008 to 2009 except for Biology, and the increase was very marked for the two Maths A levels. The % doing A level Maths (22.0%) is higher than that doing Higher LC Maths (15.5%), but the majority of A level students (> 70%) do not do any Maths at all. Almost all students who take Further Maths will also take Maths, so these are not extra students doing Maths. In Ireland virtually everyone in the LC cohort does one of the three Maths courses on offer.

In terms of the uptake of subjects by boys and girls, Chemistry is close to balance, Biology is favoured by girls and Physics, Maths and F. Maths by boys (see Table 2). In relation to grades girls outperform boys in all the subjects. This is also true in Ireland. The % getting As are high in all the subjects, especially in Maths and F. Maths, and the % of fails is very low in all subjects. Each year for the past 27 years the A levels results have improved. It seems almost impossible to fail an A level and quite easy to get high grades.
A* grades will be introduced from 2010.

Table 1 A level results for Science and Maths 2009 (N = 330,000)

Subject	M/F	Number	A	B	C	D	E	F
Chemistry	M	21,920	34.0	22.9	17.4	13.0	8.7	4.0
	F	20,571	34.8	25.2	18.2	11.7	7.1	3.0
	Total	42,491 (41,680)	34.4 (33.7)	24.0 (24.5)	17.8 (18.1)	12.4 (12.6)	7.9 (7.6)	3.5 (3.5)
Biology	M	23,671	26.2	21.9	20.0	16.4	11.0	4.5
	F	31,814	29.0	22.9	20.0	14.9	9.5	3.7
	Total (2008)	55,485 (56,010)	27.8 (26.7)	22.5 (22.2)	20.3 (19.9)	15.6 (16.0)	10.2 (10.5)	4.0 (4.3)
Physics	M	22,898	30.7	20.4	18.1	15.0	10.9	4.9
	F	6,538	36.4	22.3	17.4	13.4	7.6	2.9
	Total (2008)	29,436 (28,096)	32.0 (31.8)	20.8 (20.8)	18.0 (18.0)	14.6 (14.6)	10.1 (10.1)	4.5 (4.5)
Maths	M	43,055	44.2	21.0	15.2	10.5	6.1	3.0
	F	29,420	46.6	22.2	14.9	9.1	5.0	2.2
	Total (2008)	72,475 (64,593)	45.2 (44.0)	21.5 (22.1)	15.1 (15.2)	9.8 (10.1)	5.7 (5.8)	2.7 (2.8)
F. Maths	M	7,190	58.6	19.5	10.6	5.9	3.5	1.9
	F	3,283	57.2	21.4	12.5	5.1	2.3	1.5
	Total (2008)	10,473 (9,091)	58.1 (57.5)	20.1 (20.3)	11.3 (11.1)	5.6 (5.6)	3.2 (3.2)	1.7 (2.3)

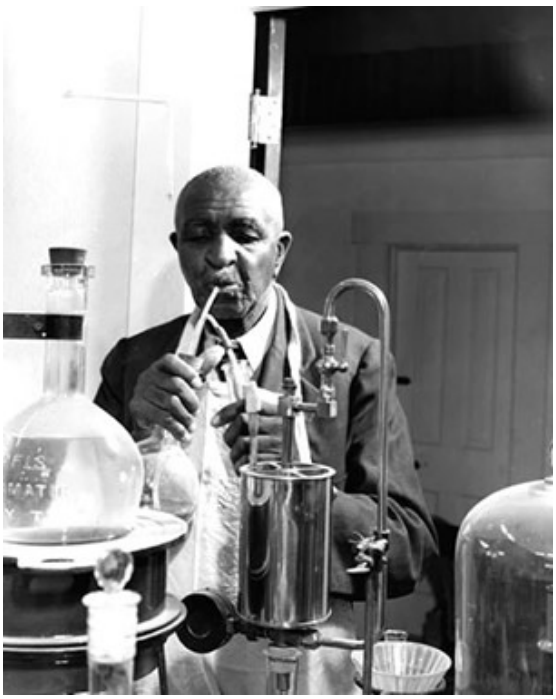
Table 2 Gender ratio, % of cohort and % change 2008-9

Subject	Ratio M:F	% cohort	Δ 08-09
Chemistry	1.066	12.9%	+1.9%
Biology	0.744	16.8%	-0.94%
Physics	3.502	8.9%	+4.8%
Maths	1.463	22.0%	+12.2%
F. Maths	2.190	3.2%	+15.2%

□

Classical Chemical Quotes #3

George Washington Carver
(1864 - January 5th. 1943)



Since new developments are the products of a creative mind, we must therefore stimulate and encourage that type of mind in every way possible.

George Washington Carver

Chemical and mining news

Compiled by Marie Walsh
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IDA Announcement List 2009

Extract from the list on IDA Ireland website to show science-based company announcements in 2009.

COMPANY	LOCATION	INVEST.	JOBS	PROJECT ACTIVITY
Trend Micro	Cork	N/A	100	Expanding Cork EMEA centre
Intel Ireland Ltd.	Shannon Free Zone, Clare	€50 million	Up to 134	Expansion of Research & Development Facility
Helsinn Holding S.A.,	Helsinn Birex Pharmaceuticals Mulhuddart, Dublin	over €13 million	10	Centre-of-excellence in Research and Development for Oral Solid Dosage (OSD)
Isotron	Tullamore, County Offaly	€8.5 million	N/A	Opening of Isotron Ireland's Electron Beam Sterilisation Facility
Boston Scientific	Galway	€91 million	45	Research, Development and Innovation (RD&I) initiative
Rottapharm	Mulhuddart, Dublin	€7 million	35	Expansion of its Irish manufacturing operation
Abbott Mature Products Management Ltd	Santry, Dublin	N/A	50	International pharmaceutical headquarters of its mature business operations
Pfizer Inc	Ringaskiddy,Cork	€11 million	N/A	Establishment of an R&D Kilo Technology Laboratory
Boston Scientific Corporation	Cork	€21.7 million	N/A	Research, Development and Innovation (RD&I) initiative
Colgate-Palmolive	Dublin	€4.6 million	N/A	R&D at its Support Services Organisation
IBM	Dublin	N/A	N/A	New Risk Management Analytics Research Collaboration
Vattenfall/Tonn Energy	Mayo	N/A	N/A	R&D Initiative in Clean-tech Energy
Wexport	Cork	€20 million	20	New R&D and a doubling of production capacity to establish site as Corporate Centre-of-Excellence
Merit Medical	Galway	€20 million	6	R&D Investment at its Galway facility
Baxter Healthcare	Castlebar, Co. Mayo	€5.5 million	N/A	Investment in installing and commissioning a 3MW Combined Heat and Power plant (CHP)

€45.5m investment in R & D

Irish Times 14/12/09

Investments totalling €45.5m by four companies are to create 26 new jobs in research and green technology initiatives. The projects, backed by IDA Ireland, are as follows:

- Wexport, part of the LEO Pharma Group, is to invest €10m, with plans for a further €10m at a later date, at its site in Little Island, Cork. It involves the establishment of a research and development centre in bio-processing technology in addition to a doubling of production capacity.
- Merit Medical Systems, which produces medical devices, is to invest more than €20m at its Galway facility for research and development of a new product and to extend the range of a number of existing products.
- Sanmina-SCI Corporation, a global electronics design and manufacturing services provider, is to invest €10m in its operation in Fermoy, Co. Cork, for the expansion of its research and development activities.
- Baxter Healthcare is to invest €5.5m in installing and commissioning a 3MW Combined Heat and Power plant (CHP) in Castlebar, Co Mayo over the next two years.

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Sligo left 'devastated' by closure

Irish Times 12/11/09

Stiefel Laboratories in Sligo is to cease operations within four years with the loss of 250 jobs. The announcement came just four months after the plant was taken over by pharmaceutical giant GlaxoSmithKline (GSK). Managing director Joe Burns, who has been with Stiefel since it opened in Sligo in 1975 with a workforce of just 10, told staff that production will cease by 2013. He said the planned closure in no way reflects on the performance or commitment of staff at the Sligo site, who had made a significant contribution to the success of Stiefel.

The company, which manufactures a range of skincare products, has attributed the development to "underutilised capacity" across the entire Stiefel and GSK network. In a statement yesterday it said that production would continue at the Sligo site until all products are transferred to alternative facilities.

Fianna Fáil TD Jimmy Devins argued that the Sligo plant was "extremely profitable". He said the loss of 250 jobs in Sligo was the equivalent of Dell closing in the mid-west, given the population of the region. Minister for Trade, Enterprise and Employment Mary Coughlan expressed "deep disappointment" at the announcement. She said she would immediately engage with the IDA and other State agencies including Enterprise Ireland and Fás, and do her utmost for staff who had "a proud record of employment" at the Finisklin Industrial Estate.

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Pfizer takeover of Wyeth completed

Irish Times 17/10/09

Pfizer has completed its takeover of rival Wyeth, combining both companies' operations under one healthcare firm. The $68 billion deal was approved by European Union antitrust authorities in July. Pfizer's vice-president of manufacturing in Ireland Dr Paul Duffy said the merger would "meaningfully advance" key strategic goals, adding that "It creates a company poised to be a leading biopharmaceutical company in a new era."

"We are now a more diversified healthcare company, with products in human, animal and consumer health, including vaccines, biologics, small molecules and nutrition across developed and emerging markets. The combined company has a robust and growing pipeline of biopharmaceutical development projects in critical areas. Our pipeline in areas such as Alzheimer's disease, oncology, pain, neuroscience, diabetes and inflammation, will allow us respond more effectively to the unmet medical needs of patients around the world."

Pfizer has a number of operations in Ireland and more than $7 billion (€ 4.7 million) of capital investment has been put into its Irish operations. Some of its best-selling medicines are produced here including Viagra. The move makes the company the largest pharmaceutical employer in Ireland. Following the closure of the deal, Pfizer now has more than 5,000 employees across 13 locations in Cork, Dublin, Kildare, Limerick, and Sligo.

It is not yet known how the merger will impact on jobs at the Irish divisions, but in January, Pfizer confirmed it would cut 19,000 jobs, about 15 per cent of the 129,500 employees it would have following the merger. This figure is in addition to more than 14,000 positions it has eliminated since 2007.

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Drogheda firm's plan to cut 101 jobs

Irish Times 10/09/09

The proposals to cut all but a handful of jobs at Irish Flavours and Fragrances (IFF) in Drogheda came "out of the blue", according to the Unite trade union. The company said yesterday that after a "strategic review" of its operations, it is seeking 101 redundancies out of a workforce of 105.

It is 30 years since IFF, which makes fragrances primarily for the perfume industry, opened in the Co Louth town. Although staff had been put on a three-day week last year, Peter Kenny of

Unite said: *"This came out of the blue, and we are extremely disappointed. There will be nothing left in the factory – it will be gone to all intents and purposes."*

IFF is based on the Donore Industrial Estate, where it is the only remaining major manufacturer. Numerous other firms have closed, and while some of the units have been let to other businesses, the number of jobs bears no resemblance to the level of employment that existed there 20 years ago.

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Teva cuts 315 jobs in Waterford

Irish Times 05/09/09

The Government has been urged to set up a jobs taskforce for Waterford after the city's second largest employer, Teva Pharmaceuticals Ireland, announced that it is to make 315 of the 705 staff at its plant in the city redundant. The call came from the Mayor of Waterford, Councillor John Halligan who described the Teva jobs cut as "another devastating blow" for Waterford following major job losses at Waterford Crystal, Waterford Stanley, ABB Transformers and Bausch Lomb.

Workers were called to a meeting with management, where they were informed that the pharmaceutical company plans to close its manufacturing plant in Waterford next year with the loss of 315 jobs. Teva Pharmaceuticals Ireland's managing director, Dr Tom McCabe, said the decision to close the facility was due to having to operate in a high-cost environment in Ireland compared to other Teva facilities and their competitors. Dr McCabe said the Waterford operation had over the past three years cut the cost of making tablets by 50 per cent, but it was still three times higher than the average cost of making the tablets at Teva plants in Poland, Hungary, Croatia and the Czech Republic.

He said wage costs were higher in Ireland and the company was also paying high charges for electricity. This made it difficult to contain costs at the Waterford plant, which produces less than 10 per cent of Teva's tablets. Dr McCabe said the firm, which is owned by an Israeli consortium and employs 38,000 in 80 countries worldwide, had yet to decide to which of the cheaper eastern European locations it would transfer tablet manufacturing when the Waterford plant closes.

But he stressed that the remaining jobs at two plants in Waterford that manufacture inhalation products and at an RD facility were secure. Teva Pharmaceutical Ireland also employs 25 more people in a commercial operation at Dundalk in Co Louth which is unaffected.

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Chemical trade keeps export figures healthy

Irish Independent 27/08/09

Soaring exports of pharmaceutical drug and chemicals spurred a 5pc increase in exports in June, according to the latest figures from the Central Statistics Office. With such products accounting for almost half of all Irish exports, their sales were enough to give Ireland a strong statistical trading position.

However, the strength of the chemicals industry is disguising steep declines in other exports -- especially the traditional area of food and drink. While chemical exports were up 14pc over the first five months of 2008, food exports were down 11.5pc by value, with a 14pc fall in dairy exports and a 7pc drop for meat. Drink exports dropped 16pc.

There are also sharp falls in other, high-tech industries dominated by foreign companies.

Exports of computers were down 29pc on January to May last year, alongside a 31pc fall in sales of other electrical machinery and apparatus, which reflected the decline in the electronics industry worldwide.

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Meath incinerator to create 300 jobs

SBP 02/08/09

Approximately 300 construction jobs are expected to be created with the awarding of two contracts for the development of a €130 million incinerator in Co Meath. The plant, which will be located in Duleek, is being developed by waste management firm Indaver and is expected to become operational in 2011. Construction firm John Sisk has been named as the civil engineering contractor for the site, while project management firm PM Group will carry out the engineering, design and construction management work.

John Ahern, managing director of Indaver Ireland, said that the majority of the 300 jobs will be construction positions at Sisk. PM Group is expected to employ between 35 and 50 people on the project.

While the new plant's primary purpose will be waste management, it will generate power as a by-product. Ahern said it was envisaged that it would generate enough electricity to power the towns of Navan and Drogheda combined.

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Cork pharmaceutical company fined

Irish Times 17/09/09

Corden Pharmachem has been fined €7,000 and ordered to pay a similar sum in legal costs after it was prosecuted for three health and safety offences arising out of two explosions at its plant in Co. Cork. Corden pleaded guilty to a charge of failing to have a proper system of storing chemicals in the first case, and of failing to assess risks in dealing with the waste, which included firstly tetrahydrofuran and magnesium, and secondly aqueous cyanide waste.

Environment, Energy and Health News

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Fall in greenhouse gas emissions

Irish Times 14/12/09

Ireland's greenhouse gas emissions fell marginally last year, according to provisional figures from the Environmental Protection Agency. However, the agency said the rate of decline, at 0.3 per cent over 2007 levels, was "disappointingly small" when seen in light of the economic downturn that had hit by 2008. The EPA said the figures were also disappointing because the initial impact of the Government's climate change strategy had not delivered the reductions expected.

The effects of the economic downturn were mainly evident in a 523,600 tonne reduction (4.4 per cent) in emissions from the industry and commercial sector with smaller decreases of less than 1 per cent from the agriculture and transport sectors. However, an increase in emissions of 603,700 tonnes from the residential sector, reflecting colder winter months, cancelled the benefit of these reductions to a large extent. Energy sector emissions were largely unchanged.

The key findings of the provisional 2008 estimates were:

- Industry and commercial emissions decreased by 523,600 tonnes (4.4 per cent), reflecting decreases in CO_2 from combustion sources and cement production.
- Agricultural emissions decreased by 172,400 tonnes or 0.9 per cent in 2008, continuing a downward trend from the 1998 peak. The decline in emissions reflects lower sheep and cattle numbers and reduced use of fertilizers.
- Transport emissions were 121,100 tonnes of CO_2 lower in 2008 than in 2007. This represents a decrease of 0.8 per cent on 2007 levels, following sustained increases in this sector since 1990. The decrease may reflect the initial impact of the economic downturn plus the changes in VRT and road tax introduced in mid-2008
- Energy emissions in 2008 were similar to 2007 with an increase of 86,000 tonnes of CO_2 or 0.6 per cent.
- Residential emissions in 2008 increased by 603,700 tonnes of CO_2 or 8.7 per cent from the 2007 level. This was the largest sectoral change in 2008 and would appear to reflect increased use of domestic heating during the winter of 2008.
- Waste emissions showed a decrease of 83,300 tonnes of CO_2 or 7 per cent from the 2007 level.

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Climate change bill to formalize targets

Irish Times 12/12/09

A statutory obligation to reduce greenhouse emissions by 80 per cent from 1990 levels will form part of the Climate change Bill when it is published early in 2010. The framework for the Climate change Bill has been unveiled by Minister for the Environment John Gormley as part of his third carbon budget. He said the new Bill and the new carbon levy announced in the main budget would form the cornerstone of the new low carbon society.

The carbon budget reports on emissions for the previous years, sets new targets for the forthcoming year and outlines the measures that will be taken to meet those targets. The proposed legislation also provides for a new office of climate change within the EPA and an expert climate change committee with a powerful advisory role.

The new target to cut emissions by 80 per cent by 2050, compared with 1990 levels, will mean that the country's emissions will need to cut current 65 million tonnes per annum to just less than 11 million tonnes. That will mean massive reductions in all sectors: transport, agriculture, residential and energy.

The disappointing figures for 2008 as outlined in the previous news clipping are mainly a marked increase in emissions in the residential sector compared to 2007. This was attributed to a colder winter last year, with an 8.7 per cent increase in this sector compared to the previous year.

Oisín Coghlan of Friends of the Earth said the Bill was a milestone in Irish climate policy with the potential to put the country on a low carbon path. He continued: "There are significant weaknesses in the Bill, however, that will need to be addressed as it passes through the Oireachtas."

Climate Bill: the key points

- A 2050 target of 80 per cent reductions in emissions from 1990 levels (down from 54.8 million tonnes to 11 million tonnes).
- Emissions reductions of an average of 3 per cent per annum will continue until 2020 (end year is 2012 at present).
- National Climate Change Strategy enshrined in legislation.

- Carbon Budget placed on a statutory footing.
- A new expert Climate Change Committee to advise on, and monitor, progress.
- A new Office of Climate Change.
- National Climate Change Adaptation framework will get legislative backing.
- A new domestic carbon offsetting or trading scheme will be set up.
- Minister for the Environment will retain overall responsibility.

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Gas pipeline for North Kerry gets go-ahead

Irish Times 11/12/09

The Commission for Energy Regulation has approved the construction of a gas pipeline to serve the proposed import and re-gassification terminal for liquefied gas on the Shannon estuary in north Kerry. The 26km pipeline will connect the terminal with the national gas network near Foynes in Co Limerick. This is considered to be the final major seal of approval for the estimated €500 million project to Shannon LNG, an Irish subsidiary of the global Hess energy corporation, on part of a Shannon Development-owned land bank.

The commission's approval is seen as a major step in the creation of an energy hub on the south side of the Shannon Estuary. It will also provide a ready supply source for the former ESB generating station at nearby Tarbert, now owned by Endessa, and is to be converted to a gas-powered facility.

The pipeline will have a capacity to transport one billion cubic feet of gas a day. Access for the pipeline from 72 landowners has already been secured. The commission has set a number of conditions, including that the pipeline be constructed within five years from yesterday's decision date.

Kerry North Fine Gael TD Jimmy Deenihan welcomed yesterday's decision. "It will bring

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Fuel groups must have 4% biofuels in sales

Irish Times 09/11/09

Companies in the fuel industry will be obliged to have 4 per cent of sales in biofuels under a new environmental regulation announced by the Government. From July 2010, fuel suppliers will have to include an average of 4 per cent biofuels in their annual sales.

There will be a requirement that the biofuels used by oil companies must produce 35 per cent less greenhouse gases than fossil fuel. Biofuels include bioethanol, which is derived from plants such as sugar maize and miscanthus, and biodiesel derived from vegetable and animal oils. The sources are either renewable, or from waste products, and therefore result in fewer greenhouse emissions.

One of the reasons the announcement has been delayed by a year arises from the controversy relating to food shortages in the developing world during early 2008. Some were blamed on biofuels. It was argued that crops traditionally grown for food were being diverted to fuel, leading to increases in prices and subsequent shortages. The basis for the direct link between food shortages and biofuels has since been questioned in some quarters. However, during the early months of 2008, several European countries, including Britain, called for a review of the EU target of 10 per cent mix of biofuels in petrol and diesel consumption by 2020.

The latest directive of the European Parliament and the Council from April 2009 states that the target must remain unchanged. However, it maintains that it is essential to develop sustainable second-generation biofuels that do not affect food supply.

It is estimated that approximately 30 per cent of biofuels used in Ireland is produced by Irish companies. However, with a 4 per cent obligation, the volume of biofuels being used will increase dramatically, with most of it being sourced abroad. The department has said it hopes the obligation will provide an impetus for increased biofuels production in Ireland.

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Minister stands over decision on biofuels

Irish Times 10/11/09

Minister for Energy Eamon Ryan is standing over his decision on new rules from next July obliging fuel companies to include a minimum 4 per cent biofuel component in all transport fuels. Mr Ryan said that it was necessary to introduce the biofuels obligation not only for environmental reasons but also for energy security reasons.

The obligation will mean that ~ 215 million litres of biofuels (about twice the current volume) will be used in Ireland each year. As a result, it is estimated that fuel prices will increase by about one cent a litre, based on current oil prices.

However, about 85 to 90 per cent of the biofuels will be imported, mostly from Brazil, the world's biggest supplier. The Minister insisted yesterday that no bioethanol would be sourced from areas where rainforests had been sacrificed. He also emphasised that rigorous sustainability tests would be applied, including a requirement that greenhouse gas emissions from biofuels will be 35 per cent less than fossil fuels. Opponents of the proposal have questioned the common sense of the carbon footprint required for transportation of these products from Brazil.

Biofuels: main points

- Biofuels, as the name suggests, are fuels derived from sustainable sources like crops and biological waste products. The most commonly produced fuels are bioethanol (which can be derived from crops like grains and sugar cane, or dairy by-products like whey) and biodiesel (made in Ireland from animal oils and from used vegetable oils).
- The EU has set a 10 per cent target for energy from renewable sources in transport by 2020, a portion of which will come from biofuels.
- A minimum percentage of biofuels in transport fuels was promised by the Government in 2007. The new proposed 4 per cent obligation was lower than the original target – promised in 2007 – of 5.75 per cent for 2010. The more modest target is due to doubts over the impact of biofuel production on food prices, on its carbon footprint, and on increased emphasis on the potential of electric cars.
- The Minister for Energy Eamon Ryan will not set a price but says the fuel companies must bear the price. Based on current oil prices, the cost of a litre of petrol and diesel will increase by about 1 cent for consumers.
- Some 2 per cent of all transport fuels in Ireland derive from biofuels, most of which is provided by 16 suppliers through a tax incentive scheme. The new obligation will mean the use of 4 per cent, or about 217 million litres of biofuels in Ireland, based on 2008 figures. The obligation requires the fuels to emit 35 per cent less greenhouse emissions than conventional fuels and to satisfy sustainability criteria.
- At present, indigenous groups account for about 30 per cent of all biofuels supplied in Ireland. This will fall to 15 per cent. The Government will need to rely on imports from Brazil, Argentina and the US. Concern has been raised about the carbon emissions involved in transporting those fuels here.
- The Opposition and bioenergy interests say there should be matching incentives to stimulate biofuels production in Ireland. They say that Ireland is capable of producing the entire 4 per cent requirement indigenously, through pure plant oil, waste products, and grains.
- There is an upper limit to the amount of biofuels that can be used in vehicles that have not been adapted. Mr Ryan said that biofuel imports would not come from rainforests or from sources that impact on the environment or lead to food shortages.
- Mr Ryan has said the biofuels component may increase between now and 2020. This will depend on the development of more sustainable second-generation biofuels such as algae, straw resources, wood waste and miscanthus (elephant grass).

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Energy from animal waste

Irish Times 23/10/09

The organic waste from a 250-cow dairy herd, if processed for biogas, could supply the electricity demands of 40 homes and reduce greenhouse gas emissions, a conference on using waste for energy was told.

Barry Caslin of Teagasc said "Anaerobic digestion has been recognised in national policy documents and circulars as a preferred treatment option for biological material. Within the agricultural sector, a number of farm waste streams can be digested by methanogen-feeding bacteria to produce biogas from which heat and electricity can be produced."

"The anaerobic digestion process effectively degasses slurry, and the remaining nutrient digestate can be land spread without any reduction in nutrients and with significantly less odour and less pathogen risk," he said.

This process was already well-developed and advanced in many parts of Europe, and there were 4,000 digesters in Germany alone. He said there were four digesters now being privately operated in Ireland, and another up-to-date facility was being built in Co Limerick. "It is totally logical to process farm and other waste into energy . . . cutting down on greenhouse gas emissions, reducing the waste levels going into land fill while creating rural jobs," he said.

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Biomass power station proposed

Irish Times 14/10/09

A €107 million biomass power station has been proposed that will convert poultry litter into energy. The plant could create up to 300 construction jobs and inject €27 million into the local economy, according to the promoters of the scheme in Co. Antrim.

Rose Energy has applied for planning permission to develop the power station – which will use poultry litter as fuel – near Glenavy, which is located in a designated area of outstanding beauty. The promoters, which include the privately owned Dublin-headquartered group, Mercury Engineering, and the Austrian Energy Environment group, claim it could deliver a long-term boost for the North if it secures planning permission. But objectors to the project say it is

'ill-considered and fundamentally flawed'.

A recent publication by the European Union highlighted the potential for waste-derived bioenergy to contribute to the reduction of global warming. The report concluded that the equivalent of 19 million tons of oil is available from biomass by 2020, 46% from bio-wastes: municipal solid waste, agricultural residues, farm waste and other biodegradable waste streams.

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Tralee homes 70x over limit for radon gas

Irish Times 14/10/09

A house in Tralee, Co Kerry, has recorded levels of the radioactive gas radon at almost 70 times the recommended level. Those living in the house receive a radiation dose equal to 47 chest X-rays each day, according to figures released by the Radiological Protection Institute of Ireland (RPII).

Radon occurs naturally, but still ranks as a class-1 carcinogen. The odourless, colourless gas which increases the risk of lung cancer in smokers and in non-smokers has in recent years been linked to cases of lung cancer in the Castleisland to Tralee area. Persistent high radon levels in the region have led to appeals to householders to measure for the gas.

Radon levels are measured in Becquerel (bq) and the maximum limit in homes set by the RPII stands at 200bq. One Tralee home had levels of 13,797bq and another reached 8,490bq. Tralee and Castleisland now have 15 of the top 20 highest measurements found by the RPII. In part this relates to the karstic limestone terrain in the region, but this is not the only type of geology which leads to radon gas seepage. Surveys by the institute have shown there are also high measurements in Sligo, Mayo, Clare and Tipperary.

To date the RPII has measured 36,700 homes in the country. It has urged residents in other areas to measure for the gas. There are legal requirements for businesses to measure for radon, and some have been prosecuted by the RPII in the Tralee area for not taking measurements.

Measuring is a relatively simple process, and more information is available at the RPII website www.rpii.ie where people can search for their address on an interactive radon map to see whether their home or workplace is in an area predicted to have high radon levels. Information can also be obtained on freefone 1800 300 600.

Nationally, radon is the second highest cause of lung cancer after smoking, and is directly linked to about 200 lung cancer deaths each year. Measuring for radon and, in the event of a high reading, reducing the levels present are both relatively inexpensive. The cost of a measurement, which occurs over a three-month period, is between €40 and €80.

All new homes built since July 1st, 1998, must be fitted with a standby radon sump which can be activated later to reduce any high radon concentrations subsequently found. For homes built in high-radon areas, the installation of a radon barrier as well as a standby radon sump is required.

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Fridge gases add to global warming

Irish Times 17/09/09

Household refrigerants that are among the most potent greenhouse gases have escaped regulatory curbs in much of the world, adding to the burden of global warming. That damage may be minimised under a proposal from the US, Canada and Mexico to phase out hydrofluoro- carbons, a class of gases known as HFCs that in some cases hold heat near the Earth's surface almost 15,000 times as effectively as carbon dioxide, according to UN scientific studies.

The US State Department said on its website that while HFCs don't deplete the ozone layer like chlorofluorocarbons, their use in air conditioners and freezers is increasing. *"Phasing down consumption and production of HFCs will send an important signal about the need for alternatives that pose no problem either for the ozone layer* or for the climate system," the State Department said.

Climate benefits of the proposed ozone plan could be 17 times greater than those achieved by the Kyoto Protocol, the Institute for Governance and Sustainable Development said.

After improper disposal of air-conditioning units and freezers, the gases escape to the atmosphere, where they trap solar heat, contributing to global warming. Eliminating the refrigerants may stop emissions equivalent to 170 billion tons of carbon dioxide by 2050, the Washington-based institute said in an e-mailed statement. That compares with the 10 billion tons of CO_2 that Kyoto aims to stop from entering the atmosphere from 2008 through 2012, the group said.

September 16th was designated by the UN as International Day for the Protection of the Ozone Layer. The 1997 Kyoto Protocol required 37 industrialised nations to cut their annual greenhouse-gas emissions by a combined 5 per cent from 1990 levels for the 2008 to 2012 average.

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Ocean Energy finishes wavepower trials

Irish Times 24/08/09

Ocean Energy has announced it has successfully concluded two and a half years of testing on a system for generating electricity from wave power. The Cork-based firm has been testing a prototype of the system that it has developed in an area off the

Galway coast. The company said the successful completion of the trials meant that it could proceed with the next stage of developing its system commercially. Each individual unit can produce up to two megawatts (MW) of electricity.

Ocean Energy estimates that this is enough to provide power to 1,400 homes for a year.

The 28-tonne, quarter-scale test device was initially launched for sea trials in November 2006, and has been tested on the Government test site, close to Spiddal, in Galway Bay, since December 2006. The system has been generating electricity, which has been fed into the national grid from a connection point close to the test bed.

Mr McCarthy believes that if it is developed successfully the technology could create up to 20,000 jobs in this country and has the potential to boost export earnings. The company also says that it could save the Government up to €1 billion a year through a reduction in carbon emissions.

Ocean Energy is one of a number of Irish and Irish-linked firms working on the development of this technology. The others include Wavebob, which has also been testing equipment off the west coast, and Aquamarine Power, which has been working on developing a system in Scotland.

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NI University to research possible Alzheimer links

Irish Times 25/08/09

Research scientists at the University of Ulster have won £350,000 (€400,000) in EU financial backing for potentially ground-breaking research into the link between particles found in sunscreens and some fuels and degenerative diseases such as Alzheimer's and Parkinson's.

Prof Vyvyan Howard and Dr Christian Holscher and their team of three researchers, based at the university's Coleraine campus in Co Derry, are pioneering research into the poisonous effect of the nanoparticles, some just one millionth of a millimetre in diameter, on the human brain. They are working particularly closely with around 20 researchers at UCD led by Ken Dawson, professor of colloid chemistry, and other academics in University College Cork as well as in Britain, Germany, the US and Japan.

Prof Howard said yesterday they would study the effects of chronic low-dose exposure to nanoparticles on the brain over a lifetime and the role this can have on the onset of degenerative diseases. "This research programme is deeply challenging and entails the gathering of entirely new knowledge in the field [of] neuronanotoxicology," he said.

Prof Dawson's team at Coleraine are especially skilled at producing nanoparticles for study. Prof Howard's team, equipped with the electron microscopes necessary for the study of nanoparticles, would study them to determine if such tiny particles, namely titanium oxide and cerium oxide, mount a significant neurotoxicological risk to humans for the two diseases.

Prof Howard said it has recently been discovered that nanoparticles can have highly significant effects on the behaviour of key proteins in the brain associated with neurodegenerative diseases such as Alzheimer's and Parkinson's.

There is some evidence to suggest that Parkinson's disease is connected to environmental pollutants and the researchers in UCD and Coleraine point to studies which show that reports of Parkinson's symptoms only begin to appear after widespread industrialisation. They also refer to claims that pesticides also pose a threat to human health in relation to Alzheimer's disease, but they admit that the evidence on this specific case is more controversial.

"The risk that engineered nanoparticles could introduce unforeseen hazards to human health is now also a matter of growing concern in many regulatory bodies, governments and industry," Prof Howard added. He hopes to be able to publish findings within the next three years.

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Sunbed use to be restricted to over-18s

Irish Times 03/08/09

New legislation on sunbed use will not include a total ban on sunbeds, despite Minister for Health Mary Harney's statement in July 2009 that such a ban was "a no-brainer". A Department of Health spokesman said the Minister's first priority was to proceed with legislation restricting the use of sunbeds to those aged 18 years and over.

The proposals are expected to ban sunbeds for the under-18s, ban unsupervised services and require the placing of warning signs on sunbeds, and in salons. Sunbed operators may be required to register with the HSE and the proposals could include the introduction of inspections, with penalties for non-compliance. They will also allow exemptions in respect of the use of sunbeds for medical use, for certain skin conditions, for example.

In July 2009, sunbeds were reclassified as a group 1 carcinogen by the International Agency for Research on Cancer. This higher risk categorisation places sunbed use on a par with cigarette smoking.

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Quality of water off Irish coast improves

Irish Times 19/08/09

Water quality in Irish coastal areas and estuaries is showing significant improvement, according to a British scientific journal. A report for the Marine Pollution Bulletin by three

scientists attached to the Environmental Protection Agency (EPA) says that dissolved oxygen conditions in a number of estuaries "continue to improve". This is "probably" due to more extensive municipal waste-water treatment, the authors, Shane O'Boyle, Georgina McDermott and Robert Wilkes, say.

They single out Castletown estuary in Dundalk, the Lee estuary and Lough Mahon in Cork city and the Liffey estuary in Dublin as showing the benefits of such treatment. The survey of 95 areas around the coast from Lough Swilly in Donegal to Dundalk bay represents "the most comprehensive overview to date" of oxygen conditions in Irish estuarine and nearshore coastal waters, the authors say.

Testing at 533 monitoring stations was conducted over four years between 2003 and 2007.

Of the 95 water bodies surveyed, 85 had sufficient level of oxygen to support aquatic life. These 85 corresponded to a surface area of 3,125sq km. Some 10 areas, representing a surface area of just over 20 sq km, were found to be deficient in oxygen but were still able to support aquatic life. No evidence of hypoxia or anoxia was found by the team. This contrasts with a global increase in seasonally-persistent hypoxic zones due to declining dissolved oxygen levels associated with coastal pollution.

Improved waste-water treatment, licensing of industrial emissions and closure of older more polluting industries has had a positive impact, the authors say.

Over 80 per cent of discharges in 2006 received secondary treatment at least, according to the EPA, compared to only 21 per cent of discharges between 2000 and 2001. However, they also note that another report in 2006 noted that a quarter of discharges to Irish surface waters from agglomerations with a population of 500 people or over received no treatment or only "very basic" treatment.

They predict that the situation is "expected to improve significantly", and oxygen deficiency may be eliminated altogether from the coast as a result of measures associated with the EU nitrate and urban waste-water treatment directives, and the Water Framework directive.

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New record for wind power

***Irish Times** 06/08/09*

A new record for the amount of electricity generated by Ireland's wind farms was achieved in the last weekend in July 2009, according to figures released by EirGrid. High levels of wind power were recorded on Friday and Saturday, with the output of Ireland's wind farms peaking at 999MW on Friday – enough to supply over 650,000 homes. At times, the amount of wind power met a record 39 per cent of national electricity demand, said EirGrid, which operates the transmission system and wholesale power market.

Ireland now has more than 1,085MW of installed wind capacity, with a further 3,900MW expected to come online in the next few years under a new system for grid connections.

The Government has set a 40 per cent target for renewable energy by 2020 – including wind, wave, biomass and hydropower – as part of its plan to build a smart economy.

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Diary

2010

Atlantic Conference on Science, Technology, Engineering and Maths Education
Feb. 25th.
Tullamore, Co. Offaly

ISTA Conference
19-21 March
Institute of Technology, Sligo
www.ista.ie and higginsy@eircom.net

E.S.A.I. Conference
Dundalk, Co. Louth
March 25-27th

20th Symposium on Chemical and Science Education, University of Bremen
May **27-29th**
ingo.eilks@uni-bremen.de

10th. **European Conference on Research in Chemical Education**
July 4-9
Krakow Poland
http://ecrice2010.ap.krakow.pl

21st International **Conference on Chemical Education**
Jul. 28-Aug. 2
Taipei, Taiwan
Dr. Mei-Hung Chiu
(mhchiu@ntnu.edu.tw)

21st. Biennial Conference on Chemical Education (BCCE)
August 1-5
University of North Texas in Denton, USA
http://www.bcce2010.org/home/home.php

SMEC10
Sept. 25-27th
Dublin, DCU

29th. ChemEd-Ireland conference
October 9th
Dublin, DIT
Claire.mcdonnell@dit.ie

National Science Week
Nov. 7 -14th

With this issue you will find a calendar of science/chemical education events in 2010 compiled by Sarah Hayes, NCE-MSTL.