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For subscription details etc. see inside back cover.

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

Cover photo: Chemistry is spectacular - Celine Keith at the 3rd. Chemistry Demonstration Workshop (Photo: University of Limerick) - see full report on p. 38

Editorial

Third Level Science

Since the last issue an important report on 3rd. level science has been published by the Royal Irish Academy, as a result of a seminar held in February 2009. This report is reprinted in this issue. Tom Boland of the HEA also came out with strong remarks about the poor preparation of students for third level, and the resulting danger of 'dumbing down; the curriculum, the teaching methods and examination standards. Amongst other things he said were these remarks (*Irish Times,* 13/6/09):

"Increasingly, I am hearing alarm at the extent to which our second-level system is producing students who learn to the test; who in ever greater numbers are not learning to think for themselves; who receive spoon-feeding at second level and expect the same at third.

"I have a concern that, in response, too many of our academic departments at third level are responding to this learned behaviour, not by challenging it but by collaborating in it, even to the extent of worrying grade inflation."

Taken together these two items indicate that all is not well in Irish third level education. Academics and employees all agree that students and graduates are not as able as they once were. The rapid expansion of higher education and the pressures on universities to take weaker students to fill seats, has led to a situation where many of the students in science degree courses are not coping and many drop out. Institutes of Technology are often starved of students, who choose a university course in preference, and points for entry to many IoT courses are low. Dropping points for third level entry is a bad sign - it reflects low demand and weak students. Given that the average CAO score is increasing, this means that low scores (< 300 points) actually indicate a poorer performance than they did 10 years ago. However, this year the high demand for places in science and engineering has led to a welcome increase in the cut-off points.

The RIA Report makes some useful suggestions, including setting CAO points boundaries for entry into level 8 and level 6 courses. This would mean that students going to do honours degree courses would be stronger academically and the weaker students would be directed initially into level 6 courses, mostly found in IoTs.

Due to increased demand from the 2009 cohort, CAO points for many 3rd. level science courses have gone up. More students sat the Leaving Certificate in 2009 and applications to the CAO were also up. Science in UCD went up from 300 points in 2008 to 385 points in 2009. This should mean a smaller number of weak students doing science.

LC Chemistry numbers increase

The LC cohort went up by 3.9% from 2008 and numbers doing LC Chemistry went up by 289, +4.1%. 13.7% of the LC cohort did Chemistry, up slightly from 13.6% in 2008. Numbers doing LC Physics, however, went down by 190 from 2008, down to 12.8% of the cohort. There is no sign of a swing towards the Physical Sciences despite the frequent comments on their importance in the media. These students chose their subjects long before the recession and it may be that next year's figures will be better, reflecting a swing towards science shown in 3rd. level applications this year. A discussion of the 2008 LC results and CAO points will be given in issue #89.

Peter E. Childs Hon. Editor

STOP PRESS:

New element copernicium added to periodic table

The Telegraph 16/07/09

Copernicium has been chosen as the name of a new element added to the periodic table, in honour of the astronomer Nicolaus Copernicus. Discovered 13 years ago, the element previously known as element 112 was only officially added to the table a few weeks ago. It is the heaviest element in the periodic table, 277 times heavier than hydrogen. It is produced by a nuclear fusion, bombarding zinc ions on to a lead target. As the atoms of the element decay after a split second, its existence can only be proved with the help of extremely fast and sensitive analysis methods of its decay products.

Education News and Views

UK schools drop science

The Guardian 19/8/09

In 2007 247 comprehensive schools (14%) in the UK did not offer A level Physics, 187 schools (11%) did not offer Chemistry, 115 schools (7%) did not offer Biology and 96 schools (6%) did not offer Maths.

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DCU to lead a €3.4m EU research project

22 June 2009

DCU is to lead a €3.4m EU Seventh Framework Programme-funded project to bring about a change in the way science is taught in the classroom. The long-term aim is to generate a greater interest in science subjects at school, improve the take-up of science at third level and also increase the number of skilled graduates for employment in science and technology.

A team of researchers from DCU's Centre for the Advancement of Science and Mathematics Teaching and Learning (CASTeL), Dr Eilish McLoughlin, Dr. Odilla Finlayson, Dr. Tom McLoughlin and Dr. Sarah Brady will coordinate the project ESTABLISH - European Science and Technology in Action Building Links with Industry, Schools and Home.

Dr. Eilish McLoughlin has been appointed Principal Investigator of this exciting initiative. "It is in the interests of the EU economy to encourage and stimulate an interest in science, which has fallen off in recent times. We need to establish a new way of thinking about how science is learned and bring all the stakeholders together to implement and support this approach in the classroom" she said.

"A proven mechanism to achieve increased children's interest and achievements in science is to change to an inquiry-based approach. This requires a mind-set change on the part of the teacher away from a deductive approach, where the teacher often presents the concepts and information, including results of experiments even before the student carries them out, to a more inductive approach where the teacher creates the atmosphere to allow for student observation, experimentation and planning, and through teacher guidance, students can construct their own knowledge."

ESTABLISH will have a large impact across Europe with partners from the Netherlands, Cyprus, Sweden, Poland, Czech Republic, Malta, Slovakia, Germany, Estonia and Italy collaborating with CASTeL and Irish partners AG Education Services based in Dun Laoghaire, to bring about a change in the way science is taught in the classroom. The project consortium consists of over 60 partners from across these countries and involves science education researchers, scientists, teacher educators, teachers, students, parents, SMEs and Industry. It will support teachers and encourage students to enjoy science by stimulating their interest and encouraging participation in the classroom.

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CSI: The Experience

Irish Times 13/8/09

An interactive exhibition called *CSI: The Experience* is running at the Ambassador Theatre in Dublin from August until December. Visitors pay €18 to investigate one of three crime scenes or €50 for all three. It is based on the successful CSI TV series, which runs in 180 countries and has been credited for the interest in forensic science and the growth of 3rd. level courses in forensic science. The show's organiser Christopher Rahofer said: *"The show is so successful because it is a combination of education and entertainment and people can use their intelligence to solve the crime."*

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ChemEd-Ireland returns to UL

Don't forget that ChemEd-Ireland is back in Ul on October 17th. and is being organised under the auspices of the National Centre of Excellence for Maths and Science Teaching and Learning. For details and a registration form contact: Sarah.Hayes@ul.ie or www.nce-mstl.ie

The theme is ***Preparing for the Future: the Importance of CPD for the Chemistry Teacher*** and the keynote speakers are Norman Reid (Glasgow) and Miranda Stephenson from the National Science Learning Centre in York. There will also be sessions on IT packages for teaching chemistry and the new TY Science units.

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New TY Science Modules

Over 500 copies of the TY Science modules developed at UL have been sold and a new batch of modules will be available from October. The new titles include: Issues in Science, Science and Medicine, and Science and Food. Each module costs €10 and this includes a Student's Handbook and a Teacher's Handbook. Extra copies of the Student's Handbook can be bought at €5 each. Contact peter.childs@ul.ie for an order form.

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Improving Chemical Education

You might be interested in reading the Editor's thoughts on *Improving Chemical Education: turning research into effective practice* in the latest issue of *Chemistry Education Research and Practice* (CERP). This was a plenary lecture given at the 9th. ECRICE in Istanbul in July 2008. There is also an article in the same issue on *What's difficult about chemistry? An Irish Perspective* by Peter E. Childs and Maria Sheehan. CERP is a free access electronic journal, published by the RSC. (http://www.rsc.org/Publishing/Journals/RP/index.asp)

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Chief Examiner's Reports

Each year the Chief Examiners in each subject prepare a report for the State Examinations Commission. Each year a few of these are released into the public domain and made available on the SEC website. 10 subjects will be made available in 2010 from the 2009 examinations - including Biology and Physics with Chemistry. Why are the reports in **all** subjects not published **every** year? What is the rationale for only releasing a few each year? In 2008 6 LC reports were issued - including Physics and Chemistry, and the previous reports in Physics and Chemistry were in 2005 and before that in 2002. (www.examinations.ie) The marking schemes and examination papers are made available each year, so why cannot we see the Chief Examiner's reports as well?

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ESRI School Leaver's Survey 2007

The latest survey of School Leavers was published in March by the ESRI. This has been running for 30 years but has now been axed due to budget cutbacks. The survey was based on 2004/5 school leavers and shows that home background plays a major role in educational achievement. Students from farming, professional and management backgrounds get the best Leaving Certificate (LC) grades: 60% of those from such backgrounds get 4 or more higher level honours, compared to 10% from those from unemployed backgrounds. Students taking the Transition Year (TY)are more likely to get good LC results, but those from better-off backgrounds are more likely to do TY.

The report recommends that resources be targeted to reduce early school leaving.

The report can be downloaded from:
http://www.esri.ie/UserFiles/publications/20090318163500/BKMNEXT128.pdf

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High dropout rates from Science

Irish Times 10/8/09

"HUGE NUMBERS of university students are dropping out of science and technology courses after their first year in college, according to new figures obtained by ***The Irish Times***."

The article goes on to quote dropout rates of 39% at DCU and 26% at UCD for science and technology courses, with an average of over 20% across the 7 universities. The source of the data was not given. However, given the low CAO points required for entry to many science courses, and the high conceptual demand of STEM courses, these figures are not surprising.

"But in international assessments, Ireland ranks 14th and 16th respectively out of 30 OECD countries in terms of the science and mathematical literacy among 15-year-olds. In 2008, close to 5,000 students failed ordinary-level maths in the Leaving, making them ineligible for most third-level science courses."

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Dumbed down Leaving Certs?

The Sunday Tribune for 12/8/09 carried two articles on the dumbing down of the Leaving Cert based on a paper by Martin O'Grady and Brendan Guilfoyle on the LC results from 1992-2006 (http://www.stopgradeinflation.ie/LC.pdf), which was published in Jan. 2009. A+B grades at Higher level went from an average of 26% in 1992 to 42% in 2006, with an even greater increase at Ordinary level. The authors say:

"All 24 higher level subjects showed an increased rate of combined A and B grades in 2006 over 1992, with an average increase of 54.7%.

Eighteen of the twenty ordinary level subjects showed an increase in A and B grades with an average increase of 101.2%.

For the ten most popular subjects, at higher level the rate of A grades increased by an average of 144.2% and B grades by 52.2% between 1992 and 2006. At ordinary level, the comparable increases averaged across the ten subjects were 520% for A grades and 95% for B grades. Two of the ten subjects showed some decrease in A grades but all ten showed increases in the B grades."

I recommend you read the full report. Similar concerns and similar trends have been observed in the UK with A level results.

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Climate expert to lead An Taisce

Irish Times 16/06/09

Ireland's leading expert on climate change, Prof John Sweeney of NUI Maynooth, has been chosen as the new president of An Taisce in succession to botanist and broadcaster Éanna Ní Lamhna. Scottish-born Prof Sweeney is one of the 3,000 scientist-members of the UN's Intergovernmental Panel on Climate Change (IPCC), which was jointly awarded the Nobel Peace Prize in 2007 along with former US vice-president Al Gore.

He has been a lecturer in the geography department of NUI Maynooth since 1978, specialising in climatology and environmental resource management, and currently leads a number of research projects examining various aspects of climate change in Ireland. His most recent report for the Environmental Protection Agency, prepared by the Irish Climate Analysis and Research Units at NUI Maynooth, projected that temperatures in Ireland will increase by more than two degrees by the end of the century with significant changes in rainfall.

A graduate of the University of Glasgow, where he was awarded a PhD in 1980, Prof. Sweeney has taught and carried out research at universities in North America and Africa. He has also been involved in curriculum development at second and third levels. Over the past 30 years he has published some 60 scientific papers, edited or co-authored four reports on the likely impacts of climate change here and served as a contributing author and editor of the IPCC's influential Fourth Assessment, published in 2007.

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Climate change resources

The (UK) Met Office has material on climate change science, including some posters you can print out. The educational web site is at URL
http://www.metoffice.gov.uk/education/
and the downloadable climate change posters are at URL
http://www.metoffice.gov.uk/education/teachers/resources-climate-change-posters.html
There are two posters in the set, one about science and one about geography. The science poster looks at the history of climate change science and future climate projections, as well as describing how our climate forecast models work. The possible environmental and human impacts of worldwide climate change are explained in the geography poster. Both also highlight where there are uncertainties.

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O'Keeffe to support shake-up of Junior Cert

Irish Times 17/06/09

The current Minister for Education Batt O'Keeffe has signalled his support for a radical shake-up of the Junior Certificate exam with fewer subjects and a move away from traditional rote learning. He is also expressing concern about the dominance of rote learning in the Leaving Certificate exam. The Minister's move comes only days after a senior academic voiced fears of declining standards, with "spoon-fed'' second-level students struggling to cope at third level.: Tom Boland, chief executive of the Higher Education Authority, voiced fears that Irish graduates were falling behind.

The Minister says recent public debate on education has become increasingly critical of a second-level system seen by many as "driven by rote learning and examination pressures, rather than the promotion of real understanding and skills''. He says there is a need for greater emphasis on assessment for learning, practical project and portfolio assessment, and the time which is necessary to promote self-directed learning. Our learners need to be flexible, adaptable, resilient and competent, he says.

Introduced in 1989, the Junior Certificate (which replaced the Inter Certificate) was intended to broaden the educational experience of students.

But it has increasingly become a mirror image of the Leaving Certificate. Several Junior Certificate subjects are still examined entirely by written exams including English, maths, business studies, history and geography.

The examination is not approved of by educationalists who favour independent learning. However, parents tend to support the exam, regarding it as an important "dry run" for the Leaving Certificate. A recent ESRI study highlighted significant levels of stress among Junior Certificate students taking 10-14 subjects. It also pointed to high levels of disengagement from school by a significant minority – and negative views of teachers and the Junior Certificate course. Mr O'Keeffe said the report indicates that the Junior Certificate exam is influenced too heavily by written assessment and has a significant "negative backwash on what is taught and on how students learn''. The study, he says, leads to the inevitable conclusion that the current junior cycle curriculum and assessment need to be recast to reflect the fundamental principles of education and to take account of current best practice internationally.

The Minister will ask the National Council for Curriculum and Assessment (NCCA) to review the exam. He wants the NCCA to review international practice and examine the issue of overload and time for active learning. The council has already proposed a revised Leaving Certificate exam with a much greater emphasis on independent learning. The Department of Education supports the move away from rote learning, but it has been slow to back the council's plans for a remodelled Leaving Certificate because of cost issues.

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New short films about chemistry

Some short films about the work of the University College London Chemistry Department have been produced by Alom Shaha. The films were commissioned by Dr Cheryl Sacht, RSC Teacher Fellow at UCL. Cheryl wanted a series of videos which she could use in her A-level teaching to demonstrate what the chemists of today do and how their work might help shape our future. Please share the films with anyone who might be interested and leave comments on their YouTube pages.
http://www.chem.ucl.ac.uk/schools/lifeinchem/index.htm

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SCORE Report

A report by the Science Community Representing Education
(SCORE) which seems to confirm the suspicions of many science teachers that GCSE science exams are poorly written and too easy:
http://www.score-education.org/downloads/gcse_project/SCORE_report_final.pdf

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Guardian supplement on engaging science

The Guardian 23/6/09

A special 'Guardian' supplement offers examples and practical advice on projects and resources which can help teachers fully engage school children in science lessons and encourage a greater uptake of the subject at higher levels.
http://www.guardian.co.uk 23 June 2009 p.1-8

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Marie Curie voted greatest female scientist

The Telegraph

Marie Curie, the Polish-born researcher, who discovered radiation therapy could treat cancer, won just over a quarter of the poll (25.1 per cent) - almost twice as much as her nearest rival Rosalind Franklin (14.2 per cent), the English biophysicist who helped discover the structure of DNA.
http://www.telegraph.co.uk/scienceandtechnology/science/sciencenews/5715220/Marie-Curie-voted-greatest-female-scientist.html

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Contributions wanted for issue #90

Issue #90 is due to be published in Spring 2010 and will mark 30 years of publishing *Chemistry in Action*! Issue #1 was launched in May 1980 at the Institute of Chemistry's annual Congress in Sligo. The anniversary will be marked by special issue and contributions are needed - particularly those looking back over 30 years and the changes that have happened in chemistry, chemical education etc. since then. If you have an idea for an article please contact me by email: peter.childs@ul.ie - poems, cartoons, short stories, ideas for experiments etc. are also welcome.

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Molecular structure: part 3 Polarity and dipole moments

Peter E. Childs

In the first article (CinA!, #82, Summer 2007, 14-18) we looked at how to derive the Lewis structure of a molecule from its formula, working from first principles. In the second article (CinA!, #85, Summer 2008, 16-24) we started from the Lewis structure and predicted the molecular shape using Valence Shell Electron Pair Repulsion (VSEPR) theory. Now we have the overall shape of the molecule, including the effect of any lone pairs, we can predict the polarity of the molecule. Polarity, measured by the dipole moment of the molecule, is an important molecular property that affects many properties of molecules e.g. solubility, absorption of IR radiation, possibly smell.

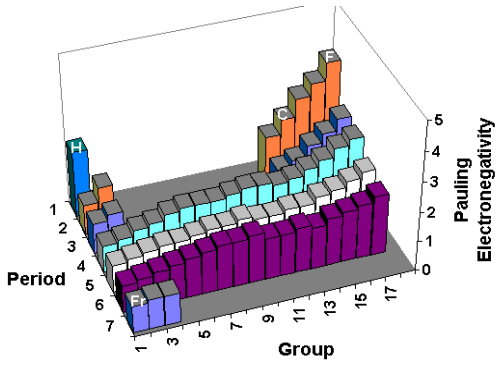
We are proceeding in stages through the flowchart:

***Formula → Lewis structure → Molecular shape →* Polarity**

Electronegativity and polarity

The polarity of a covalent bond results from a difference in electronegativity (E.N.) of the two atoms bonded. The more electronegative atom pulls electrons away from the least electronegative atom, causing a separation of charge. One atom becomes slightly negative relative to the other which is slightly positive. The electronegativity scale runs from 0 to 4: the lowest value is ~0.7 for metals (Cs) and the highest value is 4.0 for fluorine. Hydrogen is ~ mid-way with an E.N. of 2.1. Non-metals have greater E.N. values than hydrogen and metals have lower values. E.N. increases across the Periodic Table and decreases down a group. This is shown in Figure 1. There are different ways of calculating electronegativities and thus different scales, although they give ~ the same values. Linus Pauling invented the idea of electronegativity and devised the first scale. His values are known as Pauling electrornegativity values.

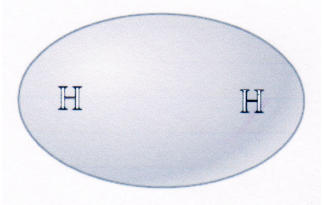
Figure 1 3D Periodic Table plot of Pauling electronegativity values (http://people.uis.edu/gtram1/organic/introduction/3d-pt.gif)



Electronegativity (E.N.) is defined as a measure of the attraction of an atom for the electrons in a covalent bond from another atom. When E.N. is equal for two atoms (usually when they are the same element) then the electrons are shared equally and the electron density in the bonding orbital is symmetrical. If one atom has a higher E.N. it attracts electrons towards itself and the electrons are not shared equally and the electron density in the bonding orbital is not symmetrical. This is shown below in Figure 2 for diatomic molecules where both atoms are the same (homonuclear diatomics) or where they are different (heteronuclear diatomics). The same thing is true of individual bonds between pairs of atoms in a polyatomic molecule - each bond will either be polar or non-polar.

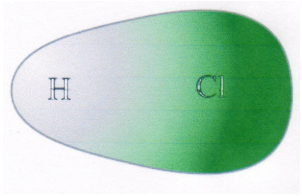
Figure 2 Polar and non-polar diatomic molecules

a) Non-polar molecule, A_2: $X_A = X_B$



e.g. H_2

b) Polar molecule, AB: $X_B > X_A$



δ + **δ -**

e.g. HCl

Polarity, dipole moment and dielectric constant

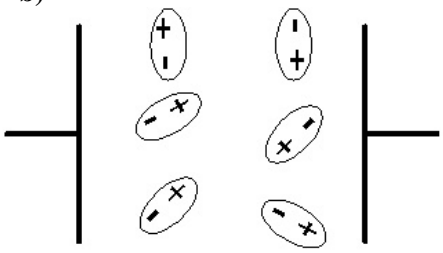
First we need to think about what we mean by polarity and how this is related to measurable properties like the dipole moment and dielectric constant. We often talk about water being a polar molecule and a polar solvent. What does this mean? We have seen above that individual bonds can be polar or non-polar. When a molecule has several bonds we are looking at the overall polarity of the molecule - is there a symmetrical charge distribution or are the centres of positive and negative charge at different points, so that there is an unsymmetrical charge distribution? A molecule may have polar bonds but be a non-polar molecule, if the symmetry is such that the polarity of individual bonds cancel out. CO_2 is a good example of this - each C-O bond is polar, but as the molecule is linear the polarities of each C-O are equal and opposite and cancel out.

Polarity means that a molecule has a separation of charge, so that it has positive and negative regions - positive and negative poles. It is still overall a neutral molecule but one side is slightly positive and the other slightly negative. This indicates that the electrical charge in a molecule is not symmetrical, due to the centre of the electron charge (negative) and nuclear charge (positive) not coinciding. When this happens a molecule will be attracted by charged plates: the positive end to the negative plate and the positive end to the negative plate. The molecules will thus line up along the electric field and are said to be polarised (see Figure 3). This in turn determines the dielectric constant of a substance: non-polar molecules have low dielectric constants in the liquid or gaseous states and polar molecules will have high dielectric constants. Table 1 gives some typical dielectric constants. We can measure the dielectric constant of a material by putting it between the plates of a condenser and measuring the change in capacitance compared to air or vacuum between the plates. This in turn enables us to calculate the overall dipole moment of the molecules.

Figure 3 Orientation of polar molecules

a) no electric field

b)



b) With an electric field

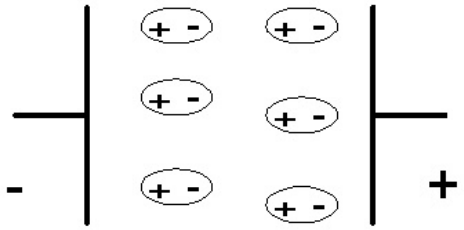


Table 1 Dielectric constants of some materials

Substance	Dielectric constant at 20°C	Dipole moment/D
Vacuum	1	0
Air (1 atm)	1.00059	~0
Benzene	2.28	0
Methanol	30	1.69
Glycerol	42.5	2.67
Water	80.4	1.85
Ethanoic acid	6.2	1.74

The polarity of a molecule is measured by the property known as the dipole moment, μ. This is defined as:

$$\mu = q \cdot r$$

(q is the separation of charges (±q) and r is the distance between the charges)

If q is in coulombs (C) and r is in m, then the units of μ. are C.m. Unit charges (1.6022×10^{-19} C) separated by 100 pm (1.0000×10^{-10} m, 0.10000 nm, 1.0000Å) would have a dipole moment of 1.6022×10^{-29} C.m. For historical reasons, dipole moments are measured in Debye units where 1 D = 3.338×10^{-30} C.m (amed after

Peter Debye). Thus unit charges separated by 100 pm have a dipole moment of $1.6022 \times 10^{-29}/3.338 \times 10^{-30} = 4.8$ D. We can use this to calculate the % ionic character in a bond if we know the dipole moment and the bond length (both experimental quantities). This is shown in Box 1.

Dipole moments are vector quantities so that when a molecule has more than one dipole moment these must be combined by vector addition. The resultant dipole moment is the dipole moment of the molecule and depends on two factors:

a) the polarity of the individual bonds (bond dipoles),
b) the shape (symmetry) of the molecule.

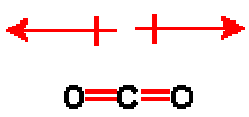
If the bond dipoles are zero the molecule must also have a zero dipole moment (unless there are lone pairs present, which have a small dipole moment and thus contribute to the polarity of the molecule e.g. ozone, see below).

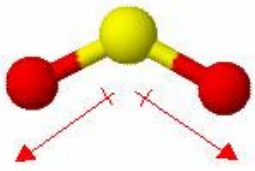
If the bond dipoles are not zero, the molecule may be **polar** (resultant dipole moment > 0) or **non-polar** (resultant dipole moment = 0), depending on whether the bond dipoles do not or do cancel out.

Non-polar molecules are those whose symmetry is such that the bond dipoles cancel out e.g. CO_2, CCl_4, BF_3.

Polar molecules are those which are not symmetrical in shape so that the bond and lone pair dipoles do not cancel out e.g. $CHCl_3$, NF_3, OCS.

Figure 4 CO_2 versus SO_2



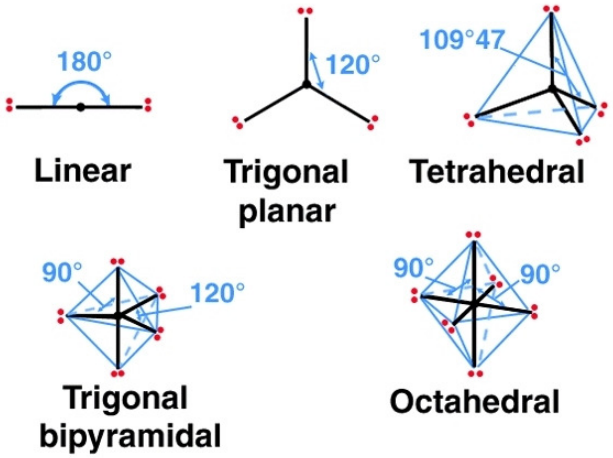


μ = 0 D **μ = 1.62 D**

All the ideal molecular shapes described by VSEPR theory (see part 2) are symmetrical and if all the bonds are the same, the molecules are non-polar. Thus all the shapes below are non-polar providing all the bonded atoms are the same. However, changing one atom for another destroys the symmetry and the molecules become polar.

Symmetrical = non-polar, μ = 0; non-symmetrical = polar, μ > 0

Figure 5 Some symmetrical molecular geometries

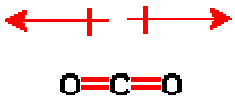


http://www.chemeng.uiuc.edu/~alkgrp/mo/gk12/shape_viz/bond_angle.jpg

Some examples:

1. Carbon dioxide

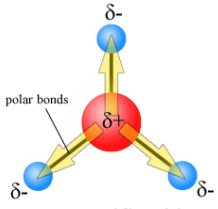
CO_2 is a linear molecule - each C=O bond is polar but the dipole moments point in opposite directions and thus cancel out..



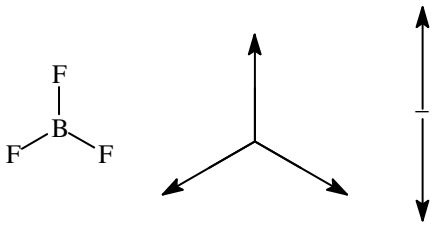
μ = 0 D

2. Boron trifluoride

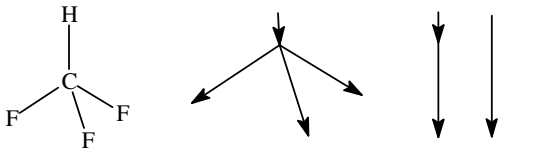
BF_3 is a trigonal planar molecule with angles of 120°. The two dipoles pointing down when resolved along a vertical direction just cancel out the dipole moment pointing upwards. ($\mu = 2\mu\cos 60^o$)



Boron Trifluoride



μ = 0 D



Resultant
μ = 1.65 D

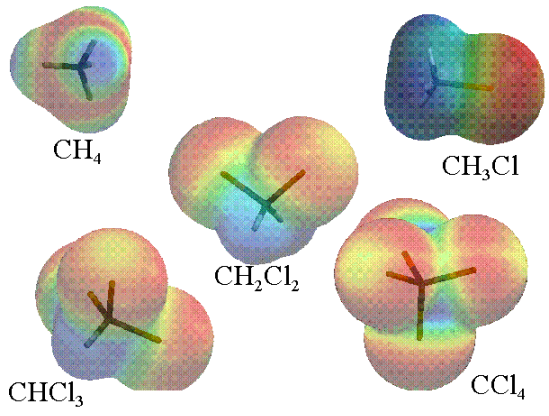
3. Substituted methanes

Methane, CH_4, is non-polar due to its symmetry, as is tetrachloromethane, CCl_4. The dipole moments of the three bonds pointing downwards, when resolved, are equal and opposite to the bond pointing upwards. However, the chloro-, dichloro- and trichloromethanes are all polar (Table 2) as they have unsymmetrical structures and the bond dipoles do not cancel out. The diagram below illustrates the electron cloud around the molecules.

Table 2

Formula	**μ/D**
CH_4	0
CH_3Cl	1.87
CH_2Cl_2	1.54
$CHCl_3$	1.02
CCl_4	0

Figure 6 The electron distribution in substituted methanes



www.canby.com/hemphill/chmimg.html

e.g. the resolution of dipole moments in HCF_3

Ionic character

There is a spectrum of bonding that runs from 100% ionic (complete separation of charges) to 0% ionic/100% covalent with no separation of charges and equal sharing of the bonding electrons e.g. Cl_2. When the two atoms have the same electronegativity the difference in E.N. is zero (ΔE.N. = 0) and electrons are equally shared. As ΔE.N. increases the bonding becomes polar covalent and the polarity of the covalent bond increases. The % ionic character also increases and when ΔE.N. is ~1.7 the bonding is 50% ionic, 50% covalent. Increasing ΔE.N. further means that the % ionic character increases and at some point a 3D ionic network structure like NaCl(s) becomes more stable (lower energy) than a polar covalent molecule like HCl(g).

It is **not** correct to say that all compounds where ΔE.N. ≥ 1.7 are ionic - it is approximately but not always true that they are more than 50% ionic but a compound like HF (ΔE.N. = 1.9) is still a polar molecule. More than 50% ionic does not make something ionic and in fact HF is only 42% ionic.

A more useful rule is to say that any compound between two non-metals (E.N. ≥ 2.1) will be molecular and any compound between a metal and a non-metal will be mainly ionic and will form a 3D network structure not a molecular structure.

Figure 7 The spectrum of chemical bonding

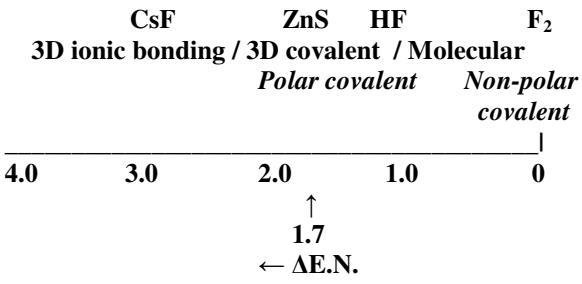
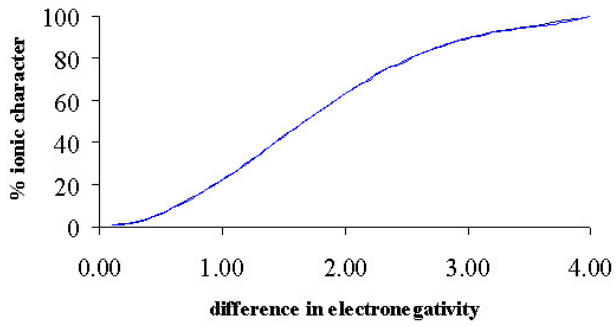


Figure 8 % ionic character versus ΔE.N. (http://www.hull.ac.uk/chemistry/images/ionic_character.jpg)



Box 1 Calculating % ionic character in hydrogen fluoride

HF has a bond length of 91.7 pm and a measured dipole moment of 1.86 D. If we had unit charges separated by 100 pm it would have a dipole moment of 4.8 D.
Remember, **μ. = q. r**

If we had unit charges separated by 91.7 pm then the dipole moment would be 91.7/100 x 4.8 D = 4.4 D.
The actual value of μ is 1.86 and thus the separation of charges = 1.86/4.4 = 0.42 or 42% charge separation = ionic character. We can do this in the same way for the other hydrogen halides Table 3).

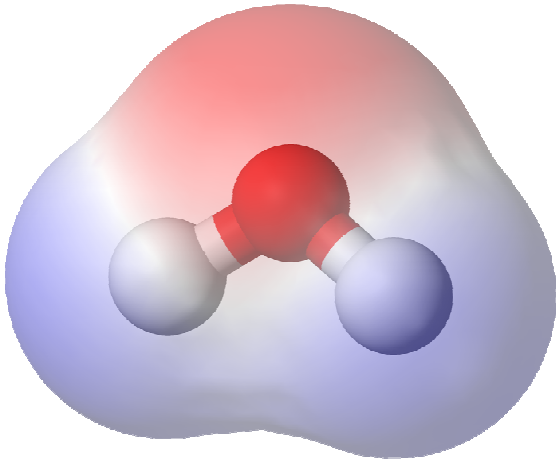
Table 3 Properties of hydrogen halides

HX	r/pm	μ/D	% ionic character	ΔE.N.
HF	91.7	1.86	42	1.9
HCl	127.4	1.11	18	0.9
HBr	141.4	0.788	11.5	0.7
HI	160.9	0.382	5	0.4

N.B. there is a good correlation between ΔE.N. and the dipole moment for single bonds.

The polarity of the water molecule

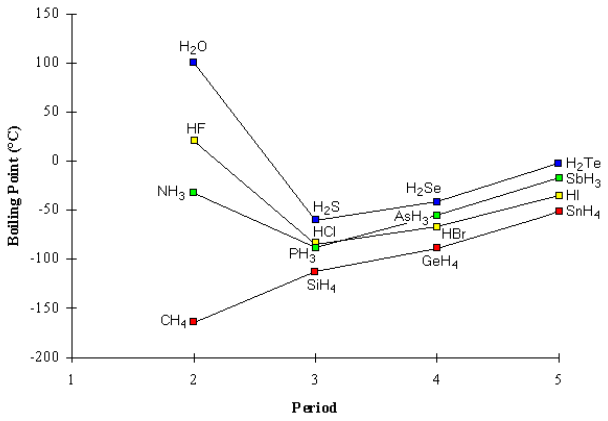
Due to its bent shape and the presence of 2 lone pairs, the water molecule is strongly polar due to the polarity of the O-H bonds and the lone pairs. The hydrogen atoms are slightly positive and the lone pairs slightly negative, making the oxygen atom negative. This is shown in colour in electron distribution diagrams. Blue is positive and red is negative: larger the charge separation the stronger the colours. Please note that there are two regions of negative charge on the oxygen associated with the two lone pairs.



Due to the large difference in electronegativity between hydrogen and oxygen, the O-H bond is strongly polar and this is the origin of hydrogen bonding. The positive hydrogens are attracted to the negative lone pairs on the oxygen of another molecule forming an interrnolecular bond, which is stronger than normal van der Waal's bonds between polar molecules. Hydrogen bonding is found when hydrogen is bonded to the three most electronegative elements: N, O and F. This means that the X-H bond will be highly polar.

The hydrides of these three elements - ammonia, water and hydrogen fluoride should be gases with low boiling points from their molecular masses. Figure 9 below shows how these three hydrides are out-of-line compared with other hydrides in their groups - the raised melting points and boiling points are due to hydrogen bonding. The strength of hydrogen bonding is intermediate between van der Waal's bonding and covalent bonding. Thus in DNA the hydrogen bonding between the base pairs is strong enough to hold the chains of the double helix together at body temperature, but weak enough to be broken to allow duplication of the DNA chains. If the bonding was too weak the double helix would not form and if it was too strong the two chains could not unravel to allow duplication. Hydrogen bonding is 'just right' for the job.

Figure 9 Boiling points of non-metal hydrides (http://www.vias.org/genchem/img/boilpts_hydrides.png)



All the unique properties of water result form the presence of hydrogen bonding: high mpt and bpt; the low density of ice so that it floats on water; high dielectric constant and solvent properties. Without the hydrogen bond there would be no life possible on earth.

Some unusual examples of polarity in molecules

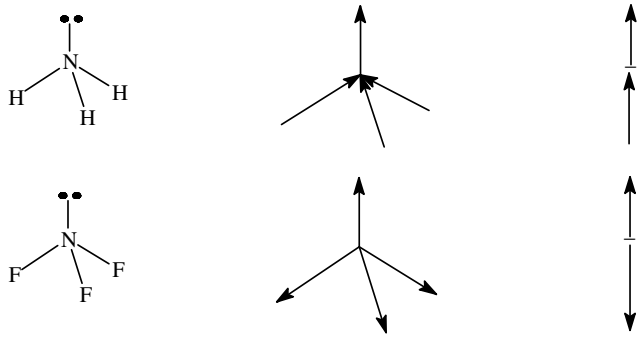
Ammonia (NH_3) versus nitrogen trifluoride (NF_3)

These have the same molecular structure - pyramidal - as each has 4 electron pairs - 3 bonding pairs and 1 lone pair. As the molecules are unsymmetrical they are polar and ammonia has a dipole moment of 1.42 D and nitrogen trifluoride has a dipole moment of 0.23 D and they point in opposite directions.

E.N. values	**N**	**H**	**F**
	3.5	**2.1**	**4.0**

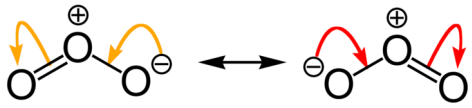
In ammonia all the dipole moments, including that of the lone pair, resolve in the same direction and so they add together with a resultant pointing upwards. In nitrogen trifluoride the bond dipoles point downwards and thus are partly cancelled by the lone pair dipole moment, giving a smaller dipole pointing downwards. Ozone is another example where the lone pair dipole is important.

Figure 10 Polarity of NH_3 and NF_3

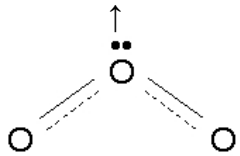


The curious case of ozone

Dioxygen, O_2, is a non-polar molecule as both atoms are the same. We might expect that the other allotrope of oxygen, trioxygen or ozone, O_3, would also be non-polar. However, it is slightly polar (μ = 0.53 D). The reason it is polar is due to its structure and the presence of a lone pair dipole. If we write the Lewis structure and then apply VSEPR theory to ozone we find it is a bent molecule, with a resonance structure, isoelectronic and isostructural with SO_2. Ozone thus has 3 electron pairs and has a trigonal planar electron distribution. Since it has one lone pair it is a bent molecule with a bond angle of 116° (< 120°.)



The O-O bonds will not be polar but the lone pair has a dipole pointing away from oxygen and this is the source of the molecular dipole moment.



The polarity and the slightly weaker bonding in ozone makes it more reactive than dioxygen. This example reminds us that we cannot ignore the contributions of lone pairs to the polarity of molecules.

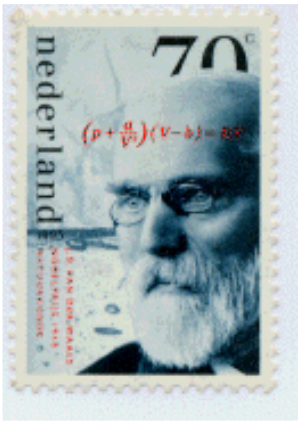
In fact all bent molecules will be polar - SO_2 is polar due to a combination of bond dipoles and the lone pair dipole.

Carbon monoxide

Carbon monoxide, CO, is isoelectronic with dinitrogen, N_2, and is bonded by a triple bond. CO will be non-polar as it is heteronuclear and we would expect it to be quite polar (ΔE.N. = 1.0) and that oxygen should be the negative end. It is polar but much less than expected (μ = 0.122 D) and carbon is the negative end! This shows that the simple theory of bonding that we have used so far does not fully describe the bonding in molecules, for which we need to use molecular orbital (MO) theory. In a similar way simple bonding theory predicts a double bond in O_2 and all electrons paired, but MO theory predicts a double bond but two unpaired electrons. This means O_2 should be magnetic (due to unpaired electrons) and it is. The bonding in CO is due to a number of molecular orbitals (σ and π) and each of these are asymmetrical due to the two different atoms. Each molecular orbital has its own dipole moment, which add together to give the resultant.
The small polarity of CO, unlike CO_2, has important consequences (just like O_3 versus O_2). CO is able to bond more strongly to metal atoms like Fe than O_2, to form a metal complex. Thus when we breathe in CO it bonds much more strongly to the iron in haemoglobin than O_2 and it displaces O_2. 1 part in 200 of CO is enough to poison us by displacing O_2. The isoelectonic N_2 is non-polar and forms much weaker bonds to metal atoms than either O_2 or CO and so is a very weak complexing agent. We would also expect CO to bond through C rather than O.

Importance of polarity

The polarity of molecules is important in many areas of chemistry, as shown below.



Johannes Diderik van der Waals
(1837 - 1923)
Nobel Prize for Physics 1910

a) Van der Waal's bonding:

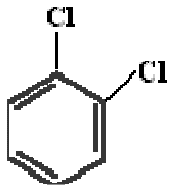
The bonding between two molecules is known as intermolecular bonding or as van der Waal's bonding and it is responsible for the mpt, bpt and hardness of molecular substances. The origin of this weak bonding lies in the polarity of molecules and their electron clouds. Non-polar molecules have no dipole moment but as the density of the electron cloud fluctuates it produces temporary dipoles (regions of excess and deficit charge), and these induce temporary dipoles on another molecule producing a weak bond (instantaneous dipole-induced dipole bonds). These are also known as London dispersion bonds. This type of bonding is proportional to the size of the electron cloud i.e. to the size and GMM of the molecule. Thus as molecules get larger van der Waal's forces increase and mpt and bpt increase e.g. the ~ non-polar alkanes change from gases to liquids to solids as GMM increases.

If molecules have a permanent dipole moment, then two other bonds come into play: the attraction of the dipoles on each molecule (dipole-dipole bonds) and the effect of a dipole on one molecule inducing an additional dipole on another molecule (dipole-induced dipole bonds). Thus the more polar a molecule, the stronger will be the intermolecular bonds and the higher the mpt and bpt. Thus alcohols have higher mpt and bpt than alkanes of similar GMM.. Hydrogen bonding arises form the especially high polarity when hydrogen is bonded to the three most electronegative atoms: N, O and F. Figure 9 shows this clearly. In the group 14 hydrides, the tetrahedral, non-polar molecules MH_4, have low bpts, which increase as the molecules get larger. This is true for the hydrides of groups 15, 16 and 17 also but NH_3, H_2O and HF are clearly out of line. Groups 15, 16 and 17 have higher bpts because the molecules are polar but the presence of hydrogen bonding for NH_3, H_2O and HF means their bpts are exceptionally high. If water was like H_2S it would be a gas at room temperature!

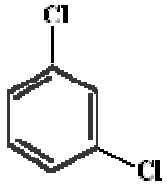
b) Isomerism and polarity

Consider the isomers of dichlorobenzene: In the development of organic chemistry measurements of dipole moments were important in determining the shapes of molecules and distinguishing between isomers.

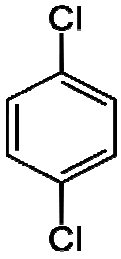
e.g. dichlorobenzenes



1,2-dichlorobenzene
Ortho isomer
2.50 D



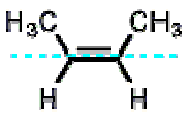
1,3-dichlorobenzene
Meta isomer
1.72 D



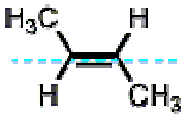
1,4-dichlorobenzene
Para isomer
0.0 D

The three isomers all have different dipole moments. One is non-polar as the dipoles of the C-Cl bonds are equal and opposite. The other two isomers are polar but have different dipole moments due to the different angles between the two bond dipoles that have to combined.

We also can distinguish between cis- (polar) and trans- (non-polar) isomers of alkenes. This is shown in the diagrams below.



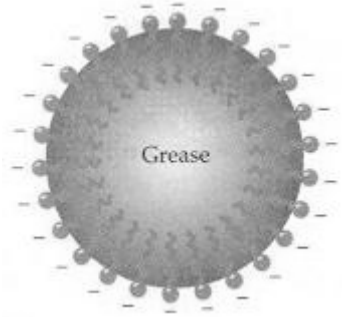
cis-
$\mu = 0.3$ D



trans-
$\mu = 0$ D

c) Polarity and solubility: 'like dissolves like'

The classification of solvents into polar or non-polar solvents derives from the polarity of their molecules and hence the dielectric constant of the bulk liquid. Polar solutes dissolve in polar solvents and poorly in non-polar solvents; non-polar solutes dissolve in non-polar solvents and poorly in polar solvents. Thus oil and water don't mix. Dry cleaning uses organic solvents like dichloromethane to remove grease and stains, which water cannot remove. Detergents have polar (hydrophilic) and non-polar (hydrophobic) ends so that one end can bond to the grease stain (made of non-polar hydrocarbons) and to the other can bond to and dissolve in water. This double affinity allows the detergent to solubilise grease as tiny micelles (or globules), with a hydrophilic surface so that they dissolve in and mix with the water molecules.



The different solubility of molecules can be used to separate and purify e.g. in chromatography (see below) or in solvent extraction using a separating funnel.

d) Absorption of infra-red radiation

Molecules can absorb infra-red (IR) radiation, which is used to increase the vibrational and rotational energy of the molecules. Molecules can be identified from their infra-red absorption spectra, which serve as 'molecular fingerprints'. Each type of bond absorbs at a characteristic frequency so that we can make deductions about molecular structure from the IR absorption spectrum. But how does a molecule interact and absorb the IR radiation? IR radiation is part of the electromagnetic spectrum and has a fluctuating electric and magnetic field. The radiation can couple with and exchange energy with a molecule if the molecule either has a permanent dipole moment (which provides a handle for the radiation to grab hold the molecule) or has a temporary dipole moment due to vibration. Thus CO_2 has no dipole moment but it has two vibrational modes where the dipole moment changes (bending mode and asymmetric stretching mode) and thus can absorb IR radiation. Why is this important? This is the mechanism that lies behind the greenhouse effect and global warming. Greenhouse gases are those molecules which can absorb IR radiation, and when they do so they warm up. The main constituents of the atmosphere, O_2 and N_2, are non-polar and do not absorb IR radiation. They do not contribute to global warming. Water molecules are polar and so also contribute to the greenhouse effect.

e) Chromatography

Chromatography involves the separation of a mixture of similar substances using a column (sheet or plate) containing a stationary phase and a moving phase (gas or liquid). The substances in the moving phase partition themselves between the stationary and moving phase based on their different affinities (strength of bonding) to the stationary phase. In many cases this is due to their different polarity which affects the solubility of the solute molecules (liquid-liquid chromatography) or the absorption of the solute molecules (liquid-solid chromatography). Molecules which bond more strongly to the stationary phase are slowed down and elute last, whereas those molecules which bond more weakly elute first. This is largely determined by their polarity.

f) Smell

Why do some substances smell and why do different substances have different smells? This is something that is not fully understood and there are different theories of olfaction. Only molecular substances smell because molecules have to be present in the gas phase to get up your nose and interact with the olfactory receptors. The smell seems to be connected to molecular shape, polarity and IR absorption frequencies. Different optical isomers have the same polarity but different smells e.g. D- and L- limonene. Polarity may be one of the key properties which are linked to smell.

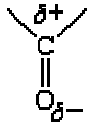
For an interesting discussion of smell and flavour see:
http://antoine.frostburg.edu/chem/senese/101/features/capsaicin.shtml

Scientists are working to produce artificial noses which use an array of sensors to respond to the properties of molecules and produce an electric signal. These could be used to detect disease, to monitor food for decay, or the sniff for drugs.

g) Organic reactivity

The difference between electrophilic and nucelophilic centres lies in their charge: electrophilic centres are positive and nucleophilic centres are negative. An electron-withdrawing group is one of high electronegativity, which pulls electric charge towards itself, thus making the atom or group it is attached to slightly positive. An electron-withdrawing group polarises the bond and makes it easier for nucleophilic attack on the positive ion. Thus oxygen withdraws electrons from hydrogen in an O-H bond, making the hydrogen acidic and allowing it to be removed by a base (a nucleophile). Polarity is the key to understanding organic reactivity and organic mechanism.

Nucleophilic attack



Electrophilic attack

Conclusion

Polarity is an important property of molecules, which is dependent on structure and shape, and influences many other molecular properties. Starting with the formula of a molecule, and knowing which is the central atom, we can predict the type and number of bonds, and the number of lone pairs; this in turn enables us to predict the shape of the molecule; the shape of the molecule allows us to decide whether it will be polar or non-polar. We can then predict many of the important properties of the molecule.

I hope the examples have shown you the importance of polarity in chemistry. Polarity determines many important properties of molecules and influences many aspects of science and everyday life.

□

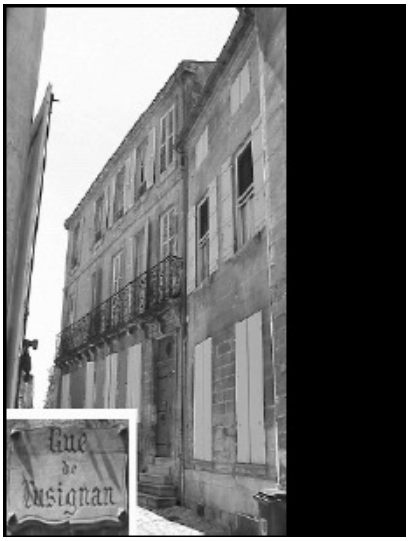
The Element Makers: 7

Paul Emile Lecoq de Boisbaudran (18th April 1838 to 28th May 1912)

Adrian Ryder tutorajr@gmail.com

The Lecoq de Boisbaudran's were an aristocratic and rich family. They were originally Protestant but most converted to Catholicism in the eighteenth century, following the removal of the Edict of Nantes. This act meant that Protestantism was again made illegal and those upholding it were deprived of their civil rights. This branch of the Lecoq Boisbaudran's, however, remained staunch in their profession of their faith. At the same time the fortunes of the family had decreased, so much so that in 1761 Etienne, the grand-father of our subject, had to sell off the family holdings. Thus it was that his children had to make do for themselves.

Paul Lecoq de Boisbaudran (born 22 Feb. 1801), the father of the subject of this article, and his brother Scevola (1802-1878), opened a winemaking business in Cognac in the 1820's. Paul married Anne Louise Alexandrine Joubert, (born 2nd Nov. 1814, died 8th Oct 1861) and the couple had three children: Paul Emile, (commonly called François to distinguish him from his father) born on the 18th of April 1838; Moēmi (died at the age of seventeen); and Laure-Alexandrine Marguerite (1842-1911), who married Jules Etienne Paul Guenon des Mesnards, a Doctor of Medicine. Laure and Jules Etienne were to have six children from their union.



Front view of the Boisbaudran home. Th e laboratory of François was on the second floor. Inset: street sign of rue de Lusignan

A gifted child, Paul Emile's education was undertaken by his mother and guided by his uncle Scevola, and he was taught history, the classics and foreign languages, becoming fluent in English. Scevola Lecoq de Boisbaudran was a graduate of the École Polytechnique in Paris and guided the growing Paul Emile through the syllabus of the Polytechnique, providing him with a laboratory on the second floor of the family house on the Rue de Lusignan. Here Boisbaudran began to repeat the experiments and analytical methods shown in text-books and after some time became expert in the use of scientific apparatus. Boisbaudran never went to University or held any academic position, but by sheer genius became widely known as a chemist of the first rank.

This portrait of the younger Boisbaudran hangs in the Museum of Mendeleev, in the St. Pe t e r s b u rg University.

Sir William Ramsay, later to write an obituary of Boisbaudran, mentions that he met him in the late 1860's while Boisbaudran was 'travelling in wine' in Scotland and found that "he spoke English fluently with very little accent". The pair were to keep in touch for the rest of their lives.

In 1858 Paul Emile joined the family winemaking business concentrating on the scientific side. He undertook detailed experiments in solution chemistry and crystallization processes. The newly discovered spectroscope of Bunsen and

Kirchoff (see #4 of this series) intrigued him and he turned his attention to the study of spectra.

Paul Emile Lecoq de Boisbaudran in later life.

During the following fifteen years Boisbaudran examined the spectra of elements and minerals and developed a theory of atomic weights in relation to atomic vibrations, which enabled him to know where to look for the distinctive spectral lines produced by elements.

His early studies with the spectroscope led Boisbaudran to three conclusions… according to Ramsay in his obituary notice for Boisbaudran these were…

1. *The lines of a spectrum are derived from one or more primitive lines, which form an elementary group; this, by successive increases or diminuations of the wave-length, repeats itself in the spectrum without altering the general appearance.*
2. *For the same natural family, the mean wave-length of the elementary groups is a function of the respective atomic weights; the general form of the spectrum therefore persists on passing from one element of the same chemical type to another; the only change is undergoes is that due to the change of mass of the molecules.*
3. *In a series of analogous spectra, the mean wave-lengths of the harmonics are greater the higher the atomic or molecular weights of the elements or compounds which give the spectra.*

In 1874 he wrote *Spectres Lumineux, spectres prismatiques et en langues d'ondes destines aux recherché de Chemie minerale* (Paris, Gauthier-Villers), which was one of the first descriptions of the new science of spectroscopy developed by Robert Bunsen and Kirchoff. In this work he detailed the spectra of some thirty-five elements in all, including some of the recently discovered rare earths, vindicating his earlier conclusions. From his studies he recognized that the spectroscope could be used to recognize new previously unknown elements in impure ores.

Bunsen's burner (1855) allowed emission spectra to be examined directly, by viewing the flame emitted when the acidulated ore was inserted directly into the flame. Boisbaudran found that better results were obtained using the oxy-hydrogen blowpipe, since the temperature here was much higher than that of the Bunsen burner. It was by the use of the oxy-hydrogen blowpipe that his first major discovery was made. Boisbaudran also made use of spectra given off by sparks. Here he made use of solutions of salts of the element to be studied in a glass tube, which had a platinum wire (made the negative pole) piercing the bottom of the tube and a stouter platinum wire (made the positive pole) a few millimeters above the surface of the liquid. Later, in 1885, he reversed the polarity and found that phosphorescent bands were obtained rather than the line spectra. He made use of this to get the first indications of three new elements, which were later to be named dysprosium, terbium and europium.

He spent eighteen months processing some 53 kg of zinc blende, a sulphide ore, from the Pierrefitte mine in the valley of Argelès in the Pyrénées. He then analyzed samples of the purified results using the spectroscope, seeking signs of new elements. Boisbaudran's efforts came to a dramatic conclusion. On August 27th 1875, between 3 and 4 am, darkness being a requisite of spectroscopic observation, Boisbaudran observed previously unknown violet lines in the spectra. He recognized them as belonging to a previously unknown, element , which he called Gallium, after the Latin word for Gaul – *Gallia*. One problem remained, the element was in a mixture and he needed to extract the pure element itself.

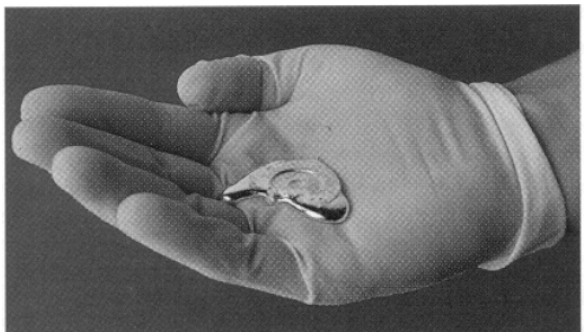
Some have claimed that Boisbaudran named the element after himself, as Gallia also means a Rooster (Le Coq), but Boisbaudran always

denied this, claiming that he named it for his native country i.e. France.

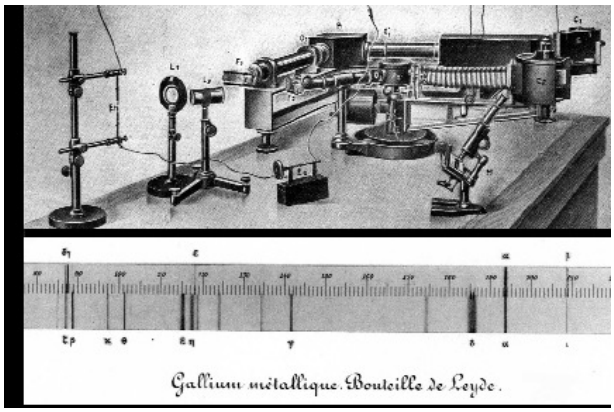
Buoyed up with his discovery, but only too aware of the limitations of his laboratory, Boisbaudran now went to Paris to the renowned laboratory of Adolphe Würtz (26 May 1817 – 10 May 1884). This was in the Rue de L'Ėcole de Mĕdecine, off the Blvd Saint-Germain, to try and isolate the pure element itself. Here, following many hours of refining several hundred kilograms more of the ore, by November of the year he was able to produce, by electrolysis, observable quantities of the metallic element. He presented the Académie of Sciences there with 3.4 mg of the new element in December.

Gallium metal is peculiar in that the heat of the hand is sufficient to cause it to melt. This phenomenon permits gallium to be used as a thermometric fluid, as it is liquid from 30 to 1700°C.

When a Russian translation of Boisbaudran's report in the *Comptes Rendus de L'Academie des Sciences* was read by Mendeleev he immediately recognized that Boisbaudran's Gallium was the element that he, Mendeleev, had predicted in 1871, where he called it eka-aluminium and described some of its expected properties. The discovery by Boisbaudran gave an enormous boost to the validity of Mendeleev's periodic table and its acceptance. By 1878 Boisbaudran was producing gram quantities of the element by cooperation with the Javal Chemical Works of Paris, where 10 hours of electrolysis were required to produce a gram mass from refined ore. This may not seem such a problem but one must remember that this was the final stage in the extraction from the ore. Boisbaudran had to use some 4,000 kg of blende to produce a mere 75 grams of the metal.



Gallium melts in the hand



The spectroscope of Boisbaudran , with which he studied gallium, the rare earths, and other elements. His spectrum of gallium appears at the bottom.

Mendeleev had predicted a new element, which he termed eka-aluminium, which would have the following properties: atomic weight about 68, density about 6 g/cc, a low melting point, a valency of 3. He predicted it would be probably be first seen from its spectrum and its oxide would have the formula Ea_2O_3 and be soluble in both acids and alkalis. Boisbaudran reported his specimen of Gallium with an atomic weight of 69.72, a density of 4.9, a melting point of 29.78°C, a valency of 3, found spectroscopically and with an oxide formula of Ga_2O_3, which was soluble in both acid and alkali. The only difference from the predictions of Mendeleev was the density. Mendeleev sent a note to Boisbaudran asking him to recheck the density. Boisbaudran did so and found, with much embarrassment, that he had erred and that the density was 5.88 g/cc, which fitted Mendeleev's prediction closely.

In 1879 Boisbaudran discovered a new element, which he called Samarium from the ore, samarskite, in which he found it. Samarskite itself was named after its discoverer Colonel von Samarski, a little known Russian mining official. Von Samarski has the honour of being the first individual to have an element named after him.

In 1885 Boisbaudran isolated Gadolinium, first discovered by J.C. Galissard de Marignac in 1880. Gadolinium is named after John Gadolin, who thus becomes the second individual to have an element named after him. It is not until 1946 that another element was named after a person, when Curium was named after Marie and Pierre Curie.

In 1886 Boisbaudran identified a new element that he called Dysprosium (Greek for hard to get at) in the Holmian earth, with indications of two other elements, already mentioned. However, he is only credited with being the discoverer of the Dysprosium. Terbium is credited to Mosander (#6 of this series, *CinA!* #87) and Europium is credited to Eugène-Anatole Demarçay from France. Dysprosium was not to be isolated in the pure form until the 1950's, when Frank Spedding of Iowa State University made use of the newly developed ion exchange technique.

Following Rayleigh and Ramsay's isolation of Argon in 1894 Boisbaudran proposed that the new element had to be a member of a previously unsuspected group of elements, now known as the rare earth metals.

According to Ramsay, Boisbaudran married late in life and while enjoying a happily married state, did not to produce any offspring. (This author has not been able to verify the marriage nor find any record of the woman involved.) After 1886 he began to spend more and more time in Cognac, but still making frequent visits to the Parisian laboratories.

From 1895 Boisbaudran found it more and more difficult to manipulate apparatus due to severe anchylosis (stiffening) of the joints and consequently produced little of note in the following years. He died in Paris on May 28th 1912, having been honoured by his country and the scientific community with the awards of the Cross of the Legion of Honour (7th March 1876), the Prix Lacaze (1880) of 10,000 francs and the 1879 Davy Medal. It is of note that the first Davy medal presented (1877) was to Bunsen and Kirchoff, the inventors of the spectroscope that revolutionized the discovery of new elements. The third presented (1879) was to Boisbaudran, who was an adept in the use of the new method, while the fifth was presented to Mendeleev and Lothar Meyer for their work on the Periodic Table, whose vision was realized by the discovery of new elements by use of the spectroscope.

Boisbaudran died in Paris on the 28th of May 1912 and his body was interred in the family vault in Cognac.

Today Boisbaudran is remembered in Cognac by a street named after him, Rue Lecoq de Boisbaudran, and by the Lecoq de Boisbaudran award which is given triannually for *"an outstanding and long-lasting contribution to the science and/or technology of the f-elements."*

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http://g.bachelier.free.fr/lecoq.htm

□

Element 112 named provisionally

IUPAC has confirmed the discovery of element 112, first announced 13 years ago, by the German team at The Centre for Heavy Ion Research at Darmstadt. The discoverers have the right to name the element and on 14th. July they suggested Copernicium, Cp, after Nicolaus Copernicus. "Since 1981, GSI accelerator experiments have yielded the discovery of six chemical elements, which carry the atomic numbers 107 to 112. The research team at GSI have already named five of them: element 107 is called bohrium, element 108, hassium; element 109, meitnerium; element 110, darmstadtium; and element 111 is named roentgenium."
(http://www.universetoday.com/2009/07/14/welcome-copernicium-our-newest-element/)
Copernicum is a d block element and is the heaviest member of group 12, lying under mercury in the Periodic Table.
http://www.youtube.com/watch?v=fqCdP9Uw5vo

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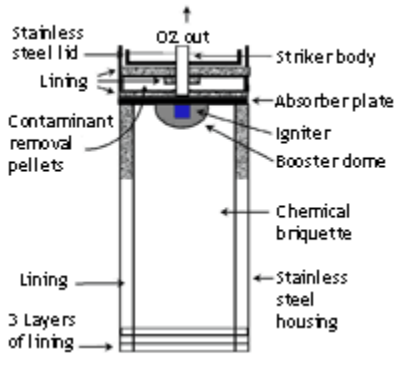
Elementary Chemistry

Oxygen candles

In 2007 an explosion on a British nuclear submarine, H.M.S. Tireless caused two deaths. (See http://news.bbc.co.uk/1/hi/england/6478127.stm The official inquest is underway in February 2009.

The source of the explosion was a so-called 'oxygen candle' or self-contained oxygen generator (SCOG), used as a back-up supply of oxygen. A SCOG uses a chemical reaction to generate oxygen and are similar to a flare in construction except that they produce oxygen. They consist of mixture of potassium or sodium chlorate (the oxygen source) plus powdered iron. When ignited the iron burns raising the temperature to ~600°C. The chlorate decomposes liberating oxygen - some is used to oxidise the iron and the rest is evolved as a gas. The candle is ignited and burns for up to an hour giving a steady stream of oxygen. One candle gives up to 3,300 L of oxygen gas. The products are iron(III) oxide and sodium chloride. Oxygen candles were originally developed during WWII. The generators use an oxygen candle (a briquette) and an igniter block, which is mechanically ignited by striking a pin. The candle is ignited inside a sealed and insulated container, with a filtered outlet for the oxygen (see below). The devices are made by a company called Molecular Products.



Sodium Chlorate has an extremely high oxygen storage capacity (784 cu ft O_2/cu ft), in fact the theoretical volume/volume storage capacity is very similar to liquid O_2 (798 cu ft O_2/cu ft). In reality, when combined with the necessary components to form a useful product which will release oxygen at a controlled and consistent rate, this storage capacity drops to around 600 cu ft O_2/cu ft.

http://www.molecularproducts.co.uk/technologies-chloratecandles.php

Similar generators are used on the Space Station as an emergency back-up supply and one SCOG produces enough oxygen for one man for one day. (See http://www.space.com/missionlaunches/050520_exp11_oxygen.html for an example.)

Oxygen generators are also used on aircraft to provide the emergency oxygen supplies (see below).

The main oxygen supply on a submarine is produced by the electrolysis of water, with the hydrogen being vented outside. The same process is used on the Space Station using a Russian Elektron generator.

For an interesting article on methods of providing oxygen on mountains and on Mars see: http://www.humanedgetech.com/news.php?id=16392

The chemistry involved:

Sodium chlorate decomposes as follows:

$2NaClO_3(s) + heat \rightarrow 2NaCl + 3O_2(g)$

Iron powder (~10%) reacts exothermically with oxygen to produce iron(III) oxide and serves to ignite the candle.

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) + heat$

Emergency oxygen on aircraft

"Commercial aircraft provide emergency oxygen to passengers to protect them from drops in cabin pressure. Chemical oxygen generators are not used for the cockpit crew. For each row of seats there are overhead masks and oxygen generators. If a decompression occurs, the panels are opened either by an automatic pressure switch or by a manual switch, and the masks are released. When the passengers pull down on the mask they remove the retaining pins and trigger the production of oxygen.

The oxidizer core is sodium chlorate, which is mixed with less than 5 % barium peroxide and less than 1 percent potassium perchlorate. The explosives in the percussion cap are a lead styphnate and tetracene mixture. The chemical reaction is exothermic and the exterior temperature of the canister will reach 260 °C. It

will produce oxygen for 15 to 20 minutes. The two-mask generator is approximately 63 mm (2.5") in diameter and 223 mm (8.8") long. The three-mask generator is approximately 70 mm (2.8") in diameter and 250 mm (10") long."

Boeing Chemical Oxygen Generator for all Boeing 737, 757 and 767 Aircraft by B/E Aerospace, Inc - the world's leader in chemical oxygen for aircraft. (Source: http://en.wikipedia.org/wiki/Chemical_oxygen_generator)

Potassium superoxide oxygen generators

An alternative chemical solution to producing oxygen is to ise potassium superoxide, KO2, which does not require high temperatures. The superoxide ion, O_2^-, is unstable and oxidising and reacts with water to produce oxygen gas.

$2KO_2(s) + 4H_2O(g) \rightarrow 2KOH(s) + 3O_2(g)$

Potassium superoxide is often used in rebreathers, to regenerate exhaled air. The moisture in the air liberates oxygen gas and the potassium hydroxide formed absorbs carbon dioxide.

$2KOH(s) + CO_2(g) \rightarrow K_2CO_3(s) + H_2O(g)$

The potassium carbonate will absorb another mole of CO_2 gas.

$K_2CO_3(s) + H_2O(g) + CO_2(g) \rightarrow 2KHCO_3(s)$

The theoretical capacity of KO_2 is the absorption of 0.309 kg CO_2 per kg of absorbent while 0.38 kg O_2 are generated per kg of absorbent. However, the CO_2/O_2 balance means more CO_2 is produced than O_2 and an additional CO_2 absorbent, like soda lime, is often needed.

Rebreathers are used by divers and fire fighters and in mine rescues. An early example was the MSA Chemox self-contained breathing apparatus (SCBA).

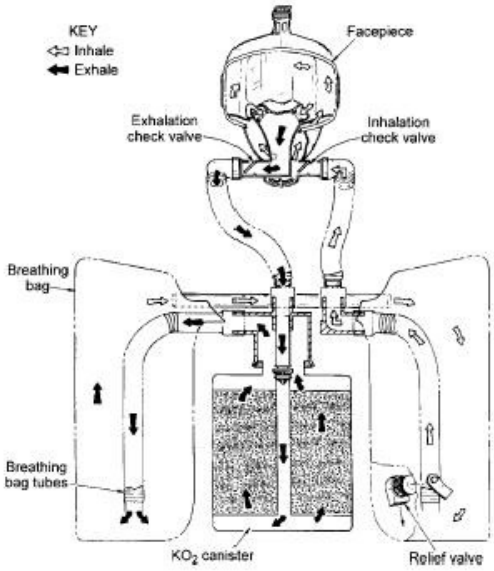


Diagram of an MSA Chemox SCBA http://www.therebreathersite.nl/Zuurstofrebreathers/USA/Images%20USA/MSA_Chemox_03.jpg

Potassium superoxide is made by burning potassium in pure oxygen. Potassium, like sodium forms three compounds with oxygen - the simple oxide, K_2O; the superoxide, KO_2; and the peroxide K_2O_2. This behaviour is only found in group 1, where the large stable cations resist oxidation.

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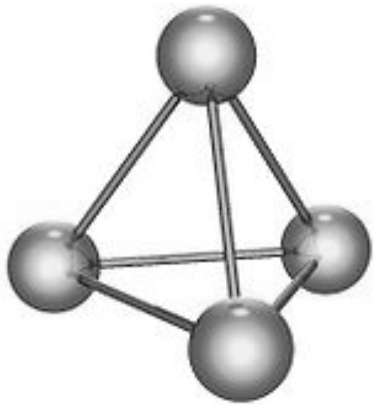
The curse of white phosphorus

White phosphorus is a nasty substance. Originally made from fermented urine in 1669 by Hennig Brand, it burns spontaneously in air emitting light (the original phosphorescence) and white smoke as it produces P_4O_{10}, tetraphosphorus decoxide (not P_2O_5 as it is often written).

$$\mathbf{P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)}$$

White phosphorus is a molecular substance and consists of P_4 molecules, with an interesting tetrahedral shape, shown below.



It must be stored under water to stop it catching fire, but burning phosphorus can only really be extinguished using sand. On the skin burning phosphorus causes nasty burns and it eats its way through to the bone. It has been banned in war as an incendiary and for anti-personnel use, although it is still allowed to create smoke screens. In the Gaza offensive 2008-9 white phosphorus shells have been widely used and many people have been burnt by fragments of burning phosphorus, which is absorbed on felt pieces inside the shells. These catch fire on exposure to air and keep on burning for some time, releasing trails of white smoke. Peter Brookes had a cartoon in *The Times* (16/1/09) where he used this rhyme:

Twinkle, twinkle, little star,
How I wonder what you are!
White with phosphorescent glow,
Burning children down below.

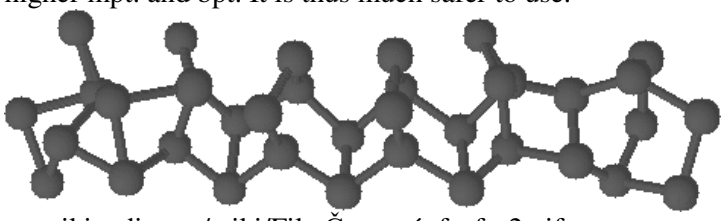
(For information on phosphorus munitions see http://www.globalsecurity.org/military/systems/munitions/wp.htm). When white phosphorus is heated at ~250°C it transforms into the more stable red phosphorus. Red phosphorus does not burn spontaneously in air as it has a different structure, with 2-D chains of phosphorus atoms linked together (see below). It is not crystalline but amorphous as it does not have a regular structure, unlike some of the structures given for it. It has a much higher mpt. than white P and can be stored in air, and is much less toxic.

Properties of phosphorus allotropes

	Mpt	**P-P/pm**	**P-P-P angle**
White P (yellow)	44°C	225	60°
Red P	~600 °C		
Black P			

Molecular phosphorus has a highly strained structure so that the bonds are easily broken, allowing it to react rapidly with molecular oxygen. It also vaporises easily and when it was used in making matches in the 19th. century it caused disfiguring injuries among the match girls, known as phossy jaw. The P_4 vapour was absorbed through the skin and destroyed bone. This led to the banning of white phosphorus in match manufacture at the start of the 20th. century. (See *CinA!* #61, available at http://www.ul.ie/~childsp/CinA/Issue61/TOC25_Phosporous.html)

Red phosphorus has a polymeric structure with 2-D chains of phosphorus atoms, still containing P-P single bonds. These are less strained than in P4 and red phosphorus is much less reactive, with a higher mpt. and bpt. It is thus much safer to use.

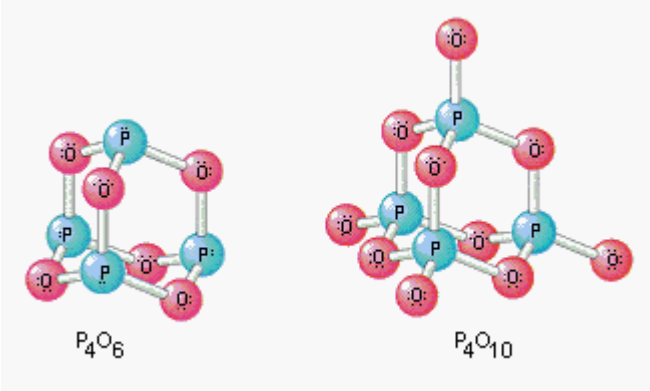


en.wikipedia.org/wiki/File:Červený_fosfor2.gif

Burning phosphorus has a characteristic garlic-like smell making it easily recognisable.

The white smoke is made of P_4O_{10} molecules, which due to their high GMM form a white solid at room temperature. It has an interesting structure (as does P_4O_6), both being based on the P_4 tetrahedron with the insertion of oxygen atoms

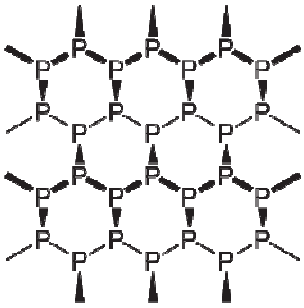
between phosphorus atoms, with an extra oxygen on each phosphorus in P_4O_{10}.



http://dwb4.unl.edu/Chem/CHEM869V/CHEM869VLinks/chemed.chem.purdue.edu/genchem/topicreview/bp/ch10/group5.html#phos

White phosphorus is molecular and so dissolves in non-polar organic solvents like benzene and carbon disulphide. This provided the basis of a spectacular lecture demonstration. A solution of white phosphorus in CS_2 was painted on filter paper and allowed to dry. As the solvent evaporates the phosphorus ignites spontaneously.

Black P has a layer structure with each P bonded to 3 others.



en.wikipedia.org/wiki/File:Schwarzer_Phosphor.svg

A series on phosphorus and its compounds was published in *Chemistry in Action!* from issue #60 onwards (www.ul.ie/~childsp/CinA/Issue60/TOC55_Urine.htm. and this issue and subsequent ones are available online at www.ul.ie/~childsp/CinA/. (The first issue discusses its production from urine and later issues looked at matches and the use of phosphates, amongst other topics.)

For some quirky phosphorus facts see http://www.lateralscience.co.uk/phos/index.html

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Governmentium, Go

A major research institution has recently announced the discovery of the heaviest chemical element yet known to science. The new element tentatively has been named... "Governmentium."
Governmentium has 1 neutron, 12 assistant neutrons, 75 deputy neutrons, and 11 assistant deputy neutrons, giving it an atomic mass of 312. These 312 particles are held together by forces called morons, which are surrounded by vast quantities of lepton-like particles called peons.
Since governmentium has zero electrons, it is inert. However, it can be detected as it impedes every reaction with which it comes into contact. A minute amount of governmentium causes one reaction in excess of 4 days to respond when it would normally take less than a second.

Governmentium has a normal half-life of 3 years; it does not decay, but instead undergoes a restructuring in which a portion of the assistant neutrons and deputy neutrons exchange places. In fact, governmentium's mass will actually increase over time, since each shuffle, so to speak, will cause some morons to mix with neutrons, forming isodopes.

TThis characteristic of moron-promotion leads some scientists to speculate that governmentium is formed whenever morons reach a certain quantity in concentration. This hypothetical quantity is referred to as "Critical Morass."... and you will know it, when you feel it!

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This new element is similar to one discovered some years ago, which featured in an earlier Chemistry in Action!, but in case you missed it:

New chemical Element Discovered

William DeBuvitz

This bit of humor was written in April 1988 and appeared in the January 1989 issue of **The Physics Teacher**. William DeBuvitz is a physics professor at Middlesex County College in Edison, New Jersey (USA). He retired in June of 2000.

Administratium, Ad

The heaviest element known to science was recently discovered by investigators at a major U.S. research university. The element, tentatively named administratium, has no protons or electrons and thus has an atomic number of 0. However, it does have one neutron, 125 assistant neutrons, 75 vice neutrons and 111 assistant vice neutrons, which gives it an atomic mass of 312. These 312 particles are held together by a force that involves the continuous exchange of meson-like particles called morons.

Since it has no electrons, administratium is inert. However, it can be detected chemically as it impedes every reaction it comes in contact with. According to the discoverers, a minute amount of administratium causes one reaction to take over four days to complete when it would have normally occurred in less than a second.

Administratium has a normal half-life of approximately three years, at which time it does not decay, but instead undergoes a reorganization in which assistant neutrons, vice neutrons and assistant vice neutrons exchange places. Some studies have shown that the atomic mass actually increases after each reorganization.

Research at other laboratories indicates that administratium occurs naturally in the atmosphere. It tends to concentrate at certain points such as government agencies, large corporations, and universities. It can usually be found in the newest, best appointed, and best maintained buildings.

Scientists point out that administratium is known to be toxic at any level of concentration and can easily destroy any productive reaction where it is allowed to accumulate. Attempts are being made to determine how administratium can be controlled to prevent irreversible damage, but results to date are not promising.

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Classical Chemical Quotes #2

Dmitri Mendeleev

(8 February 1834 – 2 February 1907)

The establishment of a law, moreover, does not take place when the first thought of it takes form, or even when its significance is recognised, but only when it has been confirmed by the results of the experiment.

Dmitri Mendeleev

MAKING THE BEST OF THIRD LEVEL SCIENCE

Foreword

In February 2009 representatives from Irish universities, institutes of technology, industry and other relevant bodies were invited to participate in a discussion on how Irish higher-education institutions have accommodated the recent increase in science undergraduate numbers; moreover the adverse (or otherwise) impact of this increase on the quality of undergraduate science education was discussed. The meeting comprised six short presentations followed by a panel discussion and open forum.

This discussion document provides a summary of the main issues, challenges and opportunities facing third-level science education in Ireland at the present, which were identified in the course of the meeting and in subsequent written contributions. These include concerns regarding 'mission drift' and grade inflation within the university sector; renewed emphasis on the importance of a quality teaching and learning experience for undergraduates; and the imperative of maintaining the highest possible standard of degrees, a point stressed particularly by industry.

The Academy trusts that the concerns expressed and suggestions offered herein will inform and contribute to policy discussion and implementation in support of Ireland's goal of becoming a world leader among the 'knowledge' economies of the future. The report is timely in that the National Strategy for Higher Education Group, appointed by the Minister for Education and Science to oversee the latest review of Irish higher education and formulate a new national strategy for the sector, has but recently commenced its deliberations.

Finally, the Academy extends its gratitude to those many colleagues who kindly gave of their time to participate in this important forum discussion. Particular thanks are due to Professor Rory More O'Ferrall for suggesting this meeting and for his unremitting support throughout the process, including his major contribution to the drafting of this document.

Professor Peter Mitchell
Science Secretary
Royal Irish Academy

Introduction

Higher education in Ireland has long played a significant role in underpinning government policies to promote economic growth. In the past ten years measures to enhance the supply of graduates in science, mathematics and engineering have encouraged universities to increase substantially the number of undergraduate places in science. This increase has gone hand in hand with a wider policy promoting greater access to higher education. At a time of uncertainty in the economy, it is pertinent to enquire how this increase has affected the quality of undergraduate education, especially in the sciences. A particular challenge for Ireland is to combine in a cost-effective manner increased participation with a demanding educational environment for its brighter students.

In February 2009 a committee chaired by the Royal Irish Academy's Science Secretary arranged a meeting of institutions responsible for higher education to consider these issues under the rubric 'Making the best of third level science'. Seventy senior representatives of universities, institutes of technology, industry and other bodies, including the Higher Education Authority; Department of Education and Science; Irish Universities Quality Board; Higher Education Training and Awards Council; and the Irish Universities Association, attended the meeting. Six short talks were presented followed by a panel discussion and open forum conducted under the Chatham House Rule. This report draws on these presentations and discussions, as well as written submissions following the meeting, to

consider how successfully Irish higher-education institutions have accommodated the growth in undergraduate numbers in science.

Perspective

A meeting on undergraduate education in science was prompted partly by lectures to the Academy in 2007/08 by Professor Joseph Ritzen (President of the University of Maastricht) and Professor James Slevin (President of the Royal Irish Academy, 2005–08). These considered respectively, the expansion of higher education in a wider European context and the response to a comparable expansion in the United States.

Since the late 1970s policies to promote greater access to higher education have been widely pursued across Europe. These led to an expansion of third-level institutions, with some negative consequences, which at first were not generally recognised. The expansion occurred gradually and encountered little opposition; however, it led to increased class sizes with students of widely varying abilities being taught in an environment geared to high academic standards. A resulting erosion of educational standards was partly concealed by 'grade inflation' and, in the UK and Ireland, by loss of the distinction between honours and general degrees, which made good degrees easier to achieve. Governments, preoccupied with increasing access to higher education as a social goal, were less focused on quality. Even students seemed reasonably satisfied, perhaps because attendance at lectures was seen to be optional and opportunities for employment within an expanding economy were plentiful.

An essential element in accommodating wide access to third level emphasized by both Ritzen and Slevin is the differentiation of higher-education institutions to cope more effectively with differences in levels of academic preparation, likely career paths and requirements for supervision of students. An example of such differentiation is provided by the Californian higher-education system, which evolved in response to demands for mass higher education in the United States following the Second World War. In California, the upper 12.5% of high-school graduates is eligible to attend the University of California (7 campuses), the top 33% is eligible to attend the California State University (23 campuses) and other qualified students are eligible to attend community colleges (>100 campuses). Mobility between institutions is impressively high and the system has gone far towards achieving its declared aim of 'access for all but fostering excellence'.

Trends in higher education in Ireland

Ireland's higher-education sector includes a number of institutions differing in 'mission and focus'. It comprises 7 universities, 14 institutes of technology, and more than 200 post-Leaving Certificate colleges. The comparatively large number of institutions reflects the significant growth in participation rates in higher education in the past twenty years. At present, 50–55% of 17–18 year olds enter higher education, substantially more than the European average. The government is committed to further widening access and the National Skills Strategy specifies a target of 72% participation by 2020.

Since the introduction of Ireland's first National Development Plan in 2000 the increase in the number of students at undergraduate level has been paralleled by significant increases in public funding for scientific research and postgraduate education. Nearly €2 billion has been invested through Science Foundation Ireland (SFI) and the Programme for Research in Third-Level Institutions (PRTLI). In comparison, the funding base for third-level education remains relatively low. Growth in student numbers has meant that resources per student have declined in recent years. OECD data show spending per student in third-level education at approximately $10,500 per annum in Ireland compared with an OECD average of $11,500 and, for example, $13,500 in the UK and $24,000 in the United States.

Undergraduate education in science

The expansion in the number of science students in Ireland has mirrored that of third level as a whole.

Indeed, it has been complemented by the government's provision of additional places in science. Full-time undergraduate enrolments in science increased from 7,900 in 1999 to 10,610 in 2007. In 2007 full-time undergraduate science courses accounted for 13% of total enrolments with universities accounting for 60% of these. At the same time, the entry point requirements for a typical university science course have fallen (see UCD case study, opposite page).

Significantly, this expansion has led to the enrolment of a cohort of school-leavers whose levels of preparation and attainment are less than those of students who entered universities and institutes of technology in the early 1990s. The increase in undergraduate science places combined with the removal of university fees in 1995 and the loss of financial support from the European Social Fund for students at institutes of technology has led to greater competition among universities and institutes of technology for science students. Thus, offered a choice, school-leavers have increasingly opted for a level-8 course at a university in preference to a level-6 or 7 course at an institute of technology. As a consequence universities are now recruiting a body of science students who hitherto would typically have entered third level through an institute of technology.

A case study of first-year science at UCD

The entry level and performance of students within first-year courses is critical to the overall quality and standard of science at third level. A consequence of the increasing proportion of school-leavers entering science in UCD has been a decline in entry standards since the 1990s. Shown below are the 2006 CAO points of students entering third level. Particularly noteworthy is the minimum entry requirement of 300 points, which corresponds to recruitment from the top 55% of students passing the Leaving Certificate. In comparison, the minimum entry requirement in 1998 was 420 points, which, according to Childs' analysis of 'points inflation', corresponds to approximately 460 points in 2006.

480	Top 15% of Leaving-Certificate students (with 480 or more CAO points)
450	Average points obtained by students entering UCD
420	Average points obtained by science students entering UCD
300	Minimum points required for science students entering UCD

The lowering of entry requirements is also apparent in student performance in mathematics. In 2007 only 23% of students entering first-year science had a B3 or higher grade in higher-level Leaving Certificate mathematics, reflecting a decline from 40% in 1999.

The first-year science class at UCD now comprises 450 or more students, nearly double the number of twenty years ago. Unfavourable consequences of such large numbers include the following:

- Difficulty in addressing the wide range of abilities within the class;
- High failure rates mitigated in part by lowering of standards;
- Branding of science as a subject with a low points requirement;
- A culture of non-attendance at lectures;
- Constrained lecture accommodation;
- A lack of qualified science students and unfilled places in institutes of technology;
- Negative effects on morale of teaching staff and educational experience of students.

The generally poor quality of undergraduate laboratories and increasing prioritisation of research over teaching underlines the impracticality of attempting to combine remedial teaching with aspirations for excellence in university science courses. The drop in standards and poor attendance at science classes contrast with the position in medicine.
(More O'Ferrall, 2009)

The intake of inadequately qualified science students has been characterised as 'mission drift' on the part of the universities. A contributory factor is the allocation of government funding between institutions based on numbers of students without regard to educational performance. In so far as the

national budget for higher education has not increased in proportion to numbers of students, this has led to increased competition between institutions for the available funding, and thus enrolment of students. The situation is exacerbated within universities by a division of funding between disciplines, which is normally also based on numbers of students.

In summary, key issues for undergraduate courses in science include:

- Increase in places available;
- Fall in entry point requirements;
- Evidence of erosion in quality of degrees;
- Poor preparation and widely varying ability of students.

Institutes of Technology and mission differentiation in higher education

Over the past 30 years institutes of technology have made an increasing contribution to Irish higher education in science and technology. In the past decade, however, a competition has arisen between institutes of technology and universities for enrolment of science students which suggests a need for further consideration of the relationship between these institutions. It seems clear that a significant fraction of students performing poorly in science courses in universities would benefit from the smaller class sizes and individual attention of undergraduate science teaching in the institutes of technology. The point was made that a student should only be accepted for a course from which there was a reasonable expectation that he or she would graduate. In this context it was suggested that the universities and institutes of technology should agree, with the HEA, strategic objectives for each institution.

If a strict analogy with the University of California system was observed, only the top 12.5% of passing Leaving-Certificate candidates would be accepted at university, with the implication that students with less than 480 points would enter an institute of technology. A distinction between institutions based solely on points at entry, however, is clearly simplistic. Important differences in mission exist including a greater emphasis on research in universities, and on professional courses and collaboration with industry in institutes of technology. The importance of recognising such differences was raised in connection with the perception of students submitting applications through the CAO. As they enter third level, students should be assisted, perhaps in some cases with the help of an interview, in making informed choices relevant to their preferred career.

Quality of science degrees: views from industry and government

The quality of Irish university education has been an important factor in attracting foreign investment in science-based industries and commercial enterprises to Ireland. There are signs, however, that the poorer educational preparation of an increasing proportion of recent graduates is beginning to attract adverse attention. So far, declining standards have been partly masked by inflation of CAO points and a strategic decision by universities in the beginning of this century to increase the proportion of first-class and upper second-class degrees awarded in line with prevailing norms in the UK. In this regard, it is noteworthy that a fall in standards has not been highlighted by quality assurance reviews. This may be because the reviews have been geared to addressing procedures and ‘good practice’ in academic programmes rather than the consequences of changes in the numbers and range of abilities of entering students.

There is clearly a degree of inconsistency between falling entry-level requirements and grade inflation in undergraduate science courses on the one hand, and government commitments to strongly supporting postgraduate education and research on the other. Postgraduate education depends on the availability of well-qualified graduates. The 2009 National Competitiveness Council report recognises this explicitly noting that, ‘The quality of undergraduate teaching is an important determinant of the quality of researchers at fourth level and skill levels of the labour force more generally’. In practice,

the recent increase in postgraduate numbers has been sustained partly by an influx of overseas students and postdoctoral fellows. While this has greatly benefited fourth-level research in Ireland, it is noteworthy that now more than 50% of SFI-funded PhD students are from overseas.

The expectations of industry and government in relation to quality of graduates can be articulated as answers to the question 'What education do we need for Ireland to be successful as a nation?' In practice, industry favours an education with a strong science base, which provides graduates of high quality, some of whom possess cross-disciplinary expertise, such as a science subject and a language. Rigour and flexibility are deemed more important than subject area. The requirement for flexibility is implied by the need for more than a good education in science and technology. Important keys to maximising economic benefit of a higher education include a focus on commercialisation, an ability to manage distribution of commercial products and the capacity to deal effectively with intellectual property issues. The position of the government differs little from that of industry, which sees the supply of highly qualified science graduates as integral to securing national competitiveness. Building Ireland's smart economy (2008), which outlines government policy with respect to economic renewal, identifies an ambitious group of actions with respect to education, research, innovation and commercialisation, which is seen as key to achieving economic growth.

Interface with schools

The influence of educational preparation in schools on the performance of science undergraduates was addressed less fully at the meeting than the topic merits. Shortcomings with respect to the attainment of Leaving-Certificate students, particularly in mathematics, were acknowledged. Universities and institutes of technology are increasingly using outreach activities to promote science as a career. Such efforts are undermined, however, by perceptions of the low level of points required for entry into general science courses. The low levels of points not only attract students insufficiently prepared to undertake such courses but deter students who could and should. Unfavourable popular images of science and a lack of clear perceptions of career paths for scientists are further deterrents to pursuing an education in science. To counteract these negative perceptions, greater exposure of transition-year students to imaginative presentations of science should be encouraged.

The professional development of science teachers was also discussed. Among the problems which require redress was a lack of professional support for teachers with biology degrees teaching physical science subjects at Junior-Certificate level. It is also significant that 60% of school-leavers undertaking honours-level mathematics do not take a science or engineering subject at third level. A further obvious priority is the need to encourage greater take-up of higher-level mathematics at Leaving Certificate, particularly among female students. This in turn has implications for schools in the context of appointing suitably qualified mathematics teachers.

Opportunities

Despite difficulties there are opportunities for improving science at third level.

- A downturn in the economy is commonly associated with an increased uptake of science subjects.
- Commerce-based subjects now offer less attractive alternatives to a career in science.
- Introduction of graduate and interview-based entries into medicine are also likely to increase interest in science degrees.
- There is still considerable potential for recruitment of women into science careers through suitable actions in schools.
- There are a growing number of outreach and national activities, e.g. Science Week, actively promoting science to schools and the wider public.
- The quality of third-level science at universities and institutes of technology is likely to be a priority for the National Strategy for Higher Education.

Conclusions

Two principal conclusions emerged from the meeting. The first was an uncompromising message expressed by representatives of commerce and industry. 'Large numbers of poorly qualified university graduates will not assist in Ireland's economic development; a "dumbing down" of standards, especially in science and engineering, would be disastrous for the country'. The implication of these strictures is clear: while not compromising support for academically weaker students, priority must be given to providing the highest educational standards for students who will most benefit from them.

The second conclusion highlights the unfavourable distribution of science students between universities and institutes of technology. Competition for resources within a funding model in which core institutional grants are based on numbers of students has contributed to the over-expansion of universities' undergraduate numbers in science and a decline in the uptake of places by qualified students in institutes of technology.

A resolution of these problems may be made easier in the context of pending government initiatives likely to lead to substantial changes in undergraduate structures. One such initiative is the reintroduction of undergraduate fees, which is made probable by the present financial constraints on the sector and the economy. It was noted that if fees were introduced their confinement to the universities would restore an advantage enjoyed by institutes of technology before 1995 and encourage a greater uptake of places by qualified school-leavers. A second is the development of a national strategy for higher education, which is expected to address the institutional mix in the higher-education system, analyse demands made on the system and review the current use of resources.

Potential ways forward

A number of suggestions and proposals are summarised here. Several linked proposals relate to the distribution of science students between the universities and institutes of technology. Additional suggestions mainly concern first-year science courses.

1. University entrance. A clear proposal is that the universities should substantially reduce their intake of science students. This objective would be achieved by restriction of entries to level-8 courses (especially in universities) with a consequent promotion of level-6/7 courses.

2. Promotion of level-6/7 courses. The low preference of students for level-6/7 courses arises largely from the current availability of level-8 courses. The preference could be improved by a guarantee of transfer to a level-8 course on reaching a recognised standard. This currently applies in the 'add-on' facility operating in institutes of technology. That transfer could be to a university as well as within an institute.

3. Coordination of enrolments. A straightforward proposal is that the top 20% of students would be offered a level-8 course in a university or institute of technology and that the next 20% would be offered a level-6 place at an institute of technology, with a university as a transfer option. Borderline cases could be subject to interviews, which would assist students in making an informed choice between institutions.

4. Funding and transfers. An important obstacle to restricting numbers of first-year students at universities is that funding is based on numbers of students and a smaller enrolment would imply a loss of core grant to the institution. In amelioration, this loss would be reduced by a higher student retention rate (in an improved educational environment) and by confinement to science courses. In principle, an appropriate transfer system would allow addition of suitably qualified students after the first year. Transfer of students from universities to institutes of technology should also be facilitated.

5. Institutes of Technology and universities. It was considered important to address concerns that the

institutes of technology might become feeder colleges for universities. It seems unlikely that this would happen on a significant scale where an internal transfer from a level-6/7 to a level-8 course is available. A further opportunity for transfer then exists following graduation and transfer to a postgraduate degree. In principle, competition between universities and institutes of technology in providing quality undergraduate teaching is desirable.

6. University fees. Although outside the remit of the meeting, it was suggested that were fees for third-level institutions to be reintroduced there would be a benefit in applying them only to universities, or at least differentiating in favour of institutes of technology. This might help redress the current imbalance in numbers in first-year science classes between universities and institutes.

7. Oversight of new courses. The perception that there are too many student places available in science may imply a need for a national oversight of new courses offered.

Proposals for first science courses
At the meeting, emphasis was placed on the importance of first-year science courses and a number of suggestions related to these were presented.

- NUIG places a priority on first-year science courses. This includes streaming students with and without Leaving-Certificate physics separately. It has a major advantage in that it reduces class sizes.
- A significant suggestion was that part of any funding raised by fees be applied to improving (a) science facilities in schools and (b) first-year laboratories in universities and institutes of technology, which provide the interface with schools. This was recommended in the 2002 report of the Task Force on the Physical Sciences. The value of an excellent experience for first-year students at university or institute of technology being passed back to the schools was pointed out.
- The desirability of sustaining two foundation years in which a final commitment to specialisation was deferred so that students uncertain of their preference could transfer easily between subjects.

The purpose of the meeting on which this paper is based was to raise and clarify issues deserving further consideration. Thus less attention was given to implementation of proposals, which would need to be addressed at a later stage. It can, however, be reiterated that within the limited field of science there should be scope for inter-institutional cooperation and initiatives, which may be less easily undertaken by institutions as a whole.

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CheMiscellany

Chemical anagrams
1. Itchy tearoom
2. Diabolic Peter
3. Corn pope cabaret
4. A Scenic Rhyming Trio

Answers
1. Atomic theory
2. Periodic Table
3. Copper carbonate
4. Inorganic Chemistry

The grave of Ellen Shannon in Girard, Pennsylvania

In loving memory of Ellen
Shannon
aged 26 years
Who was fatally burned
March 21, 1870
by the explosion of a lamp
filled with "R.E. Danforth's
Non-Explosive Burning Fluid"

This seems to be the one and only reference to this product - I wonder why?

A tidy laboratory means a lazy chemist.
Jöns Jacob Berzelius

What's special about -40^{o}C and -40^{o}F?
They are the same temperature.

Climate change and health

http://www.ucl.ac.uk/global-health/ucl-lancet-climate-change.pdf

A major report has been published by scientists from University College London and The Lancet on the effects of climate change on health in the 21st. century. The full report can be read online at the URL given above and on the UCL website (http://www.ucl.ac.uk/news/news-articles/0905/09051501/). It says: *"Climate change is the biggest global health threat of the 21st century."* (p1693 column 1)

The report looks at direct and indirect effects of climate change: changing disease patterns, heatwaves, water shortages, malnutrition, extreme weather events, poor living conditions, and the effects will be felt disproportionately by the developing world. One might say, the rich pollute and the poor pay.

"Effects of climate change on health will affect most populations in the next decades and put the lives and wellbeing of billions of people at increased risk. During this century, earth's average surface temperature rises are likely to exceed the safe threshold of 2°C above preindustrial average temperature." (p1693 col 1)

The lead author is Professor Anthony Costello of UCL and he said: *"The big message of this report is that climate change is a health issue affecting billions of people, not just an environmental issue about polar bears and deforestation. The impacts will be felt .. all around the world - and not in some distant future, but in our lifetimes and those of our children."*

"The report identifies five key challenges to be addressed if we are to successfully manage the health impacts of climate change. We need:

- *more information at global, national and local levels*
- *an accelerated drive to address poverty and equity*
- *new technological approaches to food and water security, prevention of disease, better buildings and reducing vulnerability in poor communities*
- *stronger engagement by all individuals in the social and political aspects of moving to low-carbon living*

•*greater co-ordination and accountability of efforts to address the health effects of climate change by international institutions and governments."*

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17 molecules that changed the world

http://www.cosmosmagazine.com/node/2403/full

What would your choice be for the world's most important molecules - the ones that changed the world and improved human life? The Australian science magazine, *Cosmos*, came up with a list of 17:

PENICILLIN — R-$C_9H_{11}N_2O_4S$
SODIUM CHLORIDE — NaCl
POTASSIUM NITRATE — KNO_3
ASPIRIN — $C_9H_8O_4$
SODIUM STEARATE — $NaC_{18}H_{35}O_2$
SILICON — Si
RUBBER — C_5H_8
SILICON DIOXIDE — SiO_2
POLYETHYLENE — $(C_2H_4)_N$
DDT — $C_{14}H_9C_{l5}$
MORPHINE — $C_{17}H_{19}NO_3$
AMMONIA — NH_3
IRON — Fe
ETHANOL — C_2H_6O
SULPHURIC ACID — H_2SO_4
PROGESTIN — $C_{21}H_{30}O_2$
CARBON DIOXIDE — CO_2

Do you agree with this list? Would you any chemicals or subtract some on this list?

Cosmos comes out 6 times a year and for subscription details contact: www.cosmosmagazine.com/

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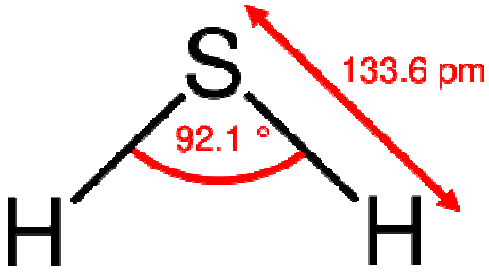
H_2S is a killer gas



A horse died and the vet riding him nearly died when riding on a beach in Brittany. The culprit was hydrogen sulphide gas, released when from a layer of rotting algae on the beach. The gas was trapped under a crust on the surface of the algae and when the horse broke through the crust and released the gas it was overcome with toxic fumes. A council worker was also treated in hospital after he collapsed when clearing the algae. The growth of the sea weed has been promoted by nitrates and animal slurry running off land into the sea and by the warm weather, which encourages growth.
http://news.bbc.co.uk/2/hi/europe/8195180.stm

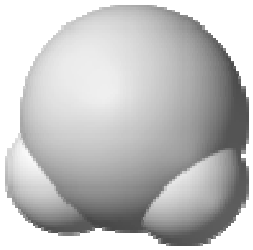
Every year people die on farms from the fumes produced by fermenting slurry. There is no visible sign and the gases produced, including H_2S, are heavier than air. One person goes into a slurry tank and collapses and another person goes in to pull them out and also collapses. If not removed quickly the exposure can be fatal. H_2S has a characteristic smell - rotten eggs - which humans can detect at low concentrations. At higher concentrations the gas overloads the olfactory nerves and cannot be detected. H_2S affects the nervous system and knocks out cellular respiration by binding to iron in mitochondrial cytochrome enzymes. Its toxicity is comparable to that of hydrogen cyanide. Personal H_2S monitors of workers exposed to H_2S e.g. sewerage workers are set at 5-10 ppm.

The table below shows the effects of H_2S at different concentrations. For comparison CO_2 is air is currently 387 ppm and is harmless. 1% CO_2 (10,000 ppm) will make some people feel drowsy and concentrations of 7-10% will cause dizziness and eventually unconsciousness. Carbon monoxide, CO, starts to become toxic at 50 ppm and at 400 ppm will kill. It first causes unconsciousness and the death as CO replaces O_2 on haemoglobin, so cells are starved of oxygen.

Effects of H_2S on humans

0.03 ppm Can smell. Safe for 8 hours exposure.
4 ppm May cause eye irritation. Mask must be used as it damages metabolism.
10 ppm Maximum exposure 10 minutes. Kills smell in 3 to 15 minutes. Gas causes eye and throat injury. Reacts violently with dental mercury amalgam fillings.
20 ppm Exposure for more than 1 minute causes severe injury to eye nerves.
30 ppm Loss of smell, injury to blood brain barrier through olfactory nerves
100 ppm Respiratory paralysis in 30 to 45 minutes. Needs prompt artificial resuscitation. Will become unconscious quickly (15 minutes maximum).
200 ppm Serious eye injury and permanent damage to eye nerves. Stings eye and throat.
300 ppm Loses sense of reasoning and balance. Respiratory paralysis in 30 to 45 minutes.
500 ppm Asphyxia! Needs prompt artificial resuscitation. Will become unconscious in 3 to 5 minutes. Immediate artificial resuscitation is required.
700 ppm Breathing will stop and death will result if not rescued promptly, immediate unconsciousness. Permanent brain damage may result unless rescued promptly.

http://www.wccoff.org/hydrogen%20sulfide%20gas%20fact%20sheet.pdf



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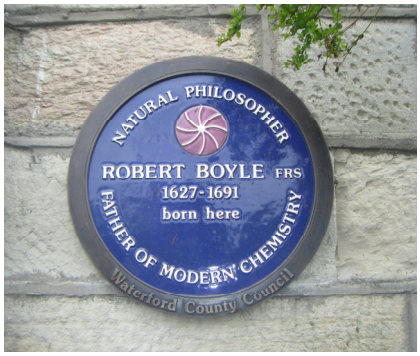
Editor's note:
When I first did chemistry at school the air was full of H_2S as we used it for qualitative analysis of metals using a Kipp's apparatus (in a fume cupboard) to generate the gas. It has a disgusting smell and one that always reminds me of chemistry lessons.

Places to Visit: Robert Boyle's birthplace - Lismore, Co. Waterford

David Kett

Lismore Castle

Lismore is a town steeped in history and beauty. It is home to the famous Lismore Castle, the Towers woodland trail, the magnificent St. Carthage's Cathedral and is the birthplace of the renowned chemist, Robert Boyle. Aptly named 'The Father of Modern Chemistry', Boyle was born in Lismore Castle in 1627 to the First Earl of Cork, and was the youngest of fourteen children. He lived in Lismore until the age of eight, at which time he had already learned to speak Latin, Greek and French. As was customary at the time, he was then sent to a boarding school in Eton and went on to become one of the most celebrated scientists of his time. He was the first chemist to collect a sample of gas, he helped found the Royal Society, he was the first to insist that all experiments must be documented and, perhaps what he is most remembered for, 'Boyle's Law', a principle that is still being learned by Science students all over the world.



Plaque marking Boyle's birthplace

This picturesque heritage town is the perfect location not only for a Science-class visit but for any budding Scientist who wishes to become immersed in its colourful and well-preserved past.

Other than viewing the castle itself and its grounds where Boyle grew up, the Lismore Heritage Centre also houses the Robert Boyle Science Room. This is a 17th century styled gentleman's study dedicated to the life and scientific discoveries of Robert Boyle. Wonderful illustrations of alchemists and Boyle's achievements appear on large information panels.

Bust of Robert Boyle

Furthermore, the Centre shows an informative and enjoyable animated film depicting the life and interests of Robert Boyle. This is an accredited Discovery Science Centre, which helps to promote Science in both Primary and Secondary Schools through hands-on Science Workshops. Tour packages are operated with certain educational activities and can be booked using the details given below. In these, pupils work in small groups to carry out experiments which aid in their understanding and enjoyment of different scientific principles such as Electricity, Light, Force, etc. Worksheets based on the appropriate

subject matter are supplied for pupils to experience Science first hand. Teachers also receive an experiments and activities pack on the day to reinforce and further student learning.

Whilst there, one can enjoy a packed lunch at the beautifully decorated Millennium Park and learn of the founding of Lismore by St. Carthage in the year 636 from the Heritage Centre's unique audiovisual display which illustrates the town's history right through to modern times. As Boyle himself once said of Lismore: *"one of the noblest Seates and greatest ornaments of the province of Munster."* This town has not forgotten its past, least of all it's most renowned resident, and follows in his stride by providing relevant learning experiences for pupils with connections to everyday life.

Boyles Law - 'At a constant temperature, the volume of a given mass of gas is inversely proportional to its pressure.'

Address:
Lismore Heritage Centre,
Lismore,
Co Waterford,
Ireland.
Telephone: +353 58 54975/54855
Fax: 353 58 53009
Email: lismoreheritage@eircom.net
Website: www.discoverlismore.com

Opening Hours
Year Round: Monday – Friday 9.30am – 5.30pm
May – October: Saturday 10.00am – 5.30pm,
Sunday 12 noon – 5.30pm

Getting To Lismore
Situated in beautiful County Waterford in Southern Ireland, the historic town of Lismore is well sign posted on the N72, the main route to Killarney via the picturesque Blackwater Valley. The town is 30 minutes drive from Dungarvan, 45 minutes drive from Midleton and 60 minutes drive from both Waterford and Cork Cities.

Additional:
Birthplace of Ernest Walton
Abbeyside, Dungarvan, Co. Waterford.
Though Lismore is not the only place in West Waterford where one can visit the birthplace of a famous Irish scientist. Twenty minutes drive to the east on the N25 and you will find yourself in the harbour town, Dungarvan.

Walton Causeway Park, Dungarvan

A short distance over the causeway is Abbeyside, birthplace to Irish physicist and Nobel Prize winner, Ernest Walton. Walton was born in Abbeyside in 1903 and is the only Irishman to have won a Nobel Prize in Science. He worked with other physicists under the supervision of Sir Ernest Rutherford at Trinity College, Cambridge. There he helped design an instrument to split the atom and verify experimentally Einstein's $E = mc^2$ formula. For this they received the Nobel Prize in Physics in 1951 together with Sir John Cockcroft.
(http://nobelprize.org/nobel_prizes/physics/laureates/1951/)
In recognition of Walton's achievements, 'The Walton Causeway Park' in Abbeyside was dedicated in his honour. After his death in 1995, a plaque was placed at the site of his birthplace in Abbeyside. The West of Waterford clearly holds an impressive and proud history in science.

David Kett graduated in 2009 from UL with a BSc in Physical Education with Chemistry.

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Conference Reports

3rd. Chemistry Demonstration Workshop 22nd -25th June 2009

University of Limerick

Flames, flashes and frozen flowers

Celine Keith shows off her new skills - this really gets you credibility in the classroom.

This year's Chemistry Demonstration Workshop, the third in the series, was held in glorious weather on UL's campus at the end of June. 17 teachers were expected but two had to drop out for health reasons. Ten teachers were able to stay to the end and give their magic shows.

The course participants and presenters - Sarah Hayes far left, Peter Childs far right

This workshop is residential and most of the costs are covered by the sponsors - the Second Level Support Service (through Brendan Duane), Pharmachemical Ireland (through Siobhan Murphy) and the RDS Science Live for Teachers programme (through Claire Mulhall). The workshop was also supported by the Department of Chemical and Environmental Sciences at UL and the new National Centre for Excellence in Mathematics and Science Teaching and Learning at UL (NCE-MSTL). The course organiser was Peter Childs and the co-presenters were Sarah Hayes (NCE-MSTL) and Brendan Duane (SLSS). Sarah is well known in schools in Munster as for the last two years she has been taking a Science Magic Show around schools.

Sarah Hayes in action with liquid nitrogen

The guiding philosophy of the course is that first we **tell** the teachers what and how to do things, with a major emphasis on safety; then we **show** them how to do things; then we let them **do** the demonstrations themselves. This approach builds confidence and expertise based on knowledge and an awareness of safety, and learning from mistakes. You can do spectacular demonstrations if you know what you're doing and take the proper precautions.

This is not going to hurt, believe me.

We took a slightly different approach this year, as after watching Sarah Hayes' Science Magic Show, the teachers then went round a circuit in pairs and did all the experiments in the show themselves. This meant everyone started the workshop off with a basic set of demonstrations they could use in school or in science magic shows. This seemed to work well as everyone managed to do more demonstrations this year than on lat year's workshop.

Mixing chemicals is sensitive work and also a spectator sport

The screaming jellybaby experiment - not for the fainthearted

Teachers were then encouraged to select other demonstrations they wanted to do from materials in their folders, or from the RSC's Chemistry Demonstrations book or from the internet. These were checked for safety and availability of materials before teachers could do them. All the demonstrations which had been assessed for safety were then available to all the participants to try. This approach allows for a large number of demonstrations to be tried out and teachers were encouraged to share their ideas with others. All in all teachers came away from the course with over 30 demonstrations tried and tested.

Brian Wall sees the world in a silver mirror of his own making

Vicky Hennessy shows how the flame test should be done.

Brendan Duane came in and did a very useful session on using IT in lessons e.g. downloading video clips and using them in PowerPoint presentations. This session took place in a computer suite provided by the University of Limerick. After the IT session on Wednesday morning the teachers were paired up again to prepare for the finale of the workshop: the magic show presentations. Each group had to devise, script, practise and present a short Science Magic Show to the other teachers (and invited guests). These shows were videoed so teachers could learn from their and other's performances after the workshop was over. The teachers stayed on campus in one of the new student villages at UL and everyone ate together in the Paddocks

restaurant. This social element is an important feature of the course.

Evening meal and discussion in the Paddocks.

Some other highlights of the workshop were: making (and eating) ice-cream using liquid nitrogen (without having to visit the Fat Duck restaurant); doing the 2 L Diet Coke and Mentos experiment outside; putting on a short chemdemo 'photo op' at the opening of the new National Centre of Excellence. We had hoped to 'blow' up the Minister of Education, Batt O'Keefe, but he couldn't make the opening at the last minute.

Teachers waiting to sample the instant ice-cream (outside the laboratory, please note!).

The teachers came from far and wide (the furthest from Donegal) and form a range of backgrounds; some were newly qualified teachers, others longer in the fray; some were chemistry teachers and others biologists looking for help in teaching chemistry. These courses are about learning from each other and sharing experiences and being free to try things out.

Vicky Hennessy and Marie Lawlor discuss a tricky point.

Brian Wall shares his teaching ideas with the other teachers.

From the feedback on past workshops and the feedback received from this one, teachers have found the experience extremely helpful, with the course *"surpassing expectations"* and they have used many of the ideas and demonstrations in school, and shared them with colleagues.

Why does regular Coke sink but Diet Coke and Coke Zero float?

Sometimes the simplest demonstrations can make effective teaching points (see above), but it's hard to beat that unexpected bang or flash.

The course finished with the teachers putting on their own Science Magic Shows in pairs, and there were 5 shows, which were videoed and the videos will be sent out on DVD to all the participants. The Magic Show is where the teachers put all their ideas together into a show and have to present it to their peers - this is a major challenge and as in previous years, the shows went off really well. They showed imagination, technical competence, a good attention to safety and the shows all engaged their audiences. Every show had something new or unique that wasn't in the others. The teachers worked really hard throughout the course and putting on a 20 minute Science Magic Show is □the real thing.

Anne O'Dwyer does some liquid nitrogen magic.

Sharon Boyle and Carol Porter during their magic show.

In the three years the workshop has been running we have now trained nearly 40 teachers.

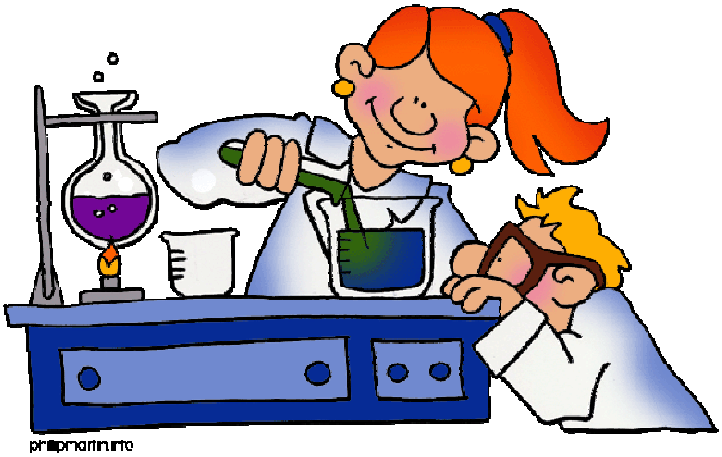
If you are interested in coming on the workshop next year, please drop us an email and we'll consider it! Places are limited and we hope the workshop will be subvented again next year.

Peter E. Childs and Sarah Hayes
peter.childs@ul.ie sarah.hayes@ul.ie

□

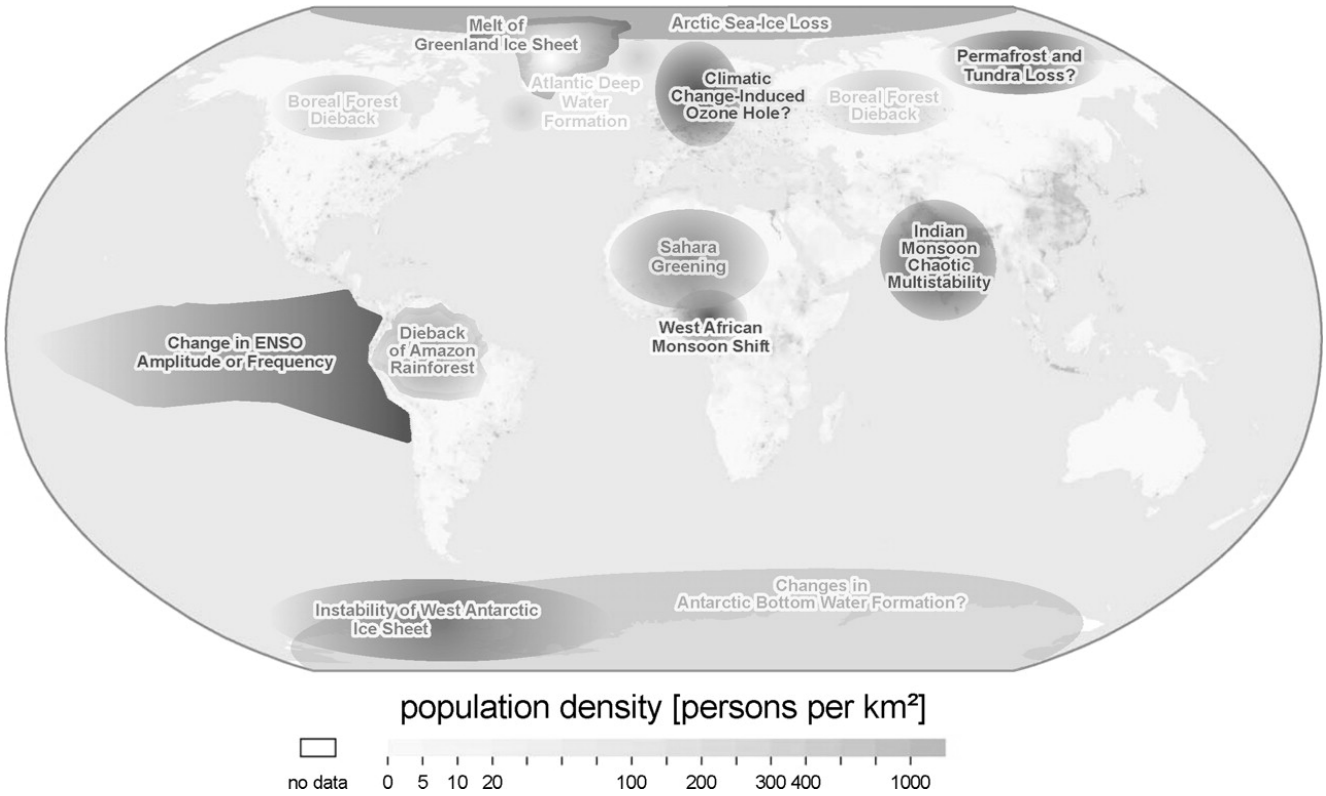
Have you got a favourite demonstration?

Do you have a favourite demonstration, maybe even an original one, one that you would like to share with your colleagues? If so, please send in details (including safety precautions!) to peter.childs@ul.ie.

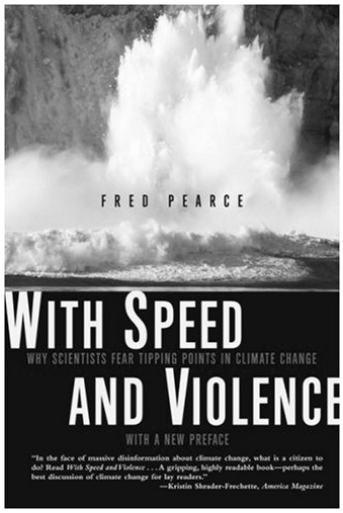


Climate tipping points

http://www.pnas.org/content/105/6/1786/F1.expansion.html



Legend for graphic - Map of potential policy-relevant tipping elements in the climate system, overlain on global population density. Subsystems indicated could exhibit threshold-type behavior in response to anthropogenic climate forcing, where a small perturbation at a critical point qualitatively alters the future fate of the system. They could be triggered this century and would undergo a qualitative change within this millennium. We exclude from the map systems in which any threshold appears inaccessible this century (e.g., East Antarctic Ice Sheet) or the qualitative change would appear beyond this millennium (e.g., marine methane hydrates). Question marks indicate systems whose status as tipping elements is particularly uncertain.



Coal-fired power stations are death factories. Close them

"The climate is nearing tipping points. Changes are beginning to appear and there is a potential for explosive changes, effects that would be irreversible, if we do not rapidly slow fossil-fuel emissions over the next few decades. As Arctic sea ice melts, the darker ocean absorbs more sunlight and speeds melting. As the tundra melts, methane, a strong greenhouse gas, is released, causing more warming. As species are exterminated by shifting climate zones, ecosystems can collapse, destroying more species."

James Hansen

The Observer 15/2/09

www.guardian.co.uk/commentisfree/2009/feb/15/james-hansen-power-plants-coal

Chemical and mining news

Compiled by Marie Walsh, Limerick Institute of Technology

Ireland's biggest gold find is still at the end of the rainbow

Sunday Independent 12/07/09

In mid-2008, AIM-listed exploration company Conroy Diamonds and Gold discovered up to one million ounces of gold (potentially worth as much as €600m at the time) in the area around Clontibret. Company chairman, Professor Richard Conroy does not believe the credit crunch will delay the gold mine and is confident that finances will be available, given that the price of gold is up is the general world situation – with demand for gold greater than supply." However, feasibility studies still have not yet begun on the Clontibret site.

Earlier this year, the company indicated that Clontibret could become "an economically viable mining project". But "These studies are at a very early stage, however, and must be treated with caution." Last month the firm confirmed that it had found gold at Clay Lake, Co Armagh, 7km north-east of Clontibret. This came only a few weeks after it had found 'extensive' zinc traces south of Clay Lake.

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Novartis makes €19 million profit

Sunday Business Post 21/06/09

The profit at Novartis Ringaskiddy was up more than 40 per cent on the 2007 figure of €13.5 million, which was made on revenues of €119.9 million. At the end of last year, the Cork-based firm had accumulated profits of more than €235 million. It employs about 450 staff and paid out €37 million in wages and pension payments in 2008. The Ringaskiddy business was founded in 1989 and makes chemicals for other companies in the Novartis group. Swiss-based Novartis was formed in 1996 through the merger of Ciba-Geigy and Sandoz. It had sales of $41.5 billion last year and has about 100,000 staff in 140 countries. The Ringaskiddy facility is one of four manufacturing sites in its chemical operations worldwide, and has been used as a launch site for several of its biggest drug developments.

Hovione opens drug plant in Ringaskiddy

Irish Times 23/04/09

Contract pharmaceutical manufaturing firm Hovione has formally opened its operation in Ringaskiddy. The Portuguese company has acquired the former Pfizer plant at Loughbeg, outside Cork, and, with assistance from IDA Ireland, will employ 50 people by the end of the year, rising to 80 by mid-2011. Hovione chief executive Guy Villax said the Cork plant would allow the company to address a large number of chemistries, and he expressed confidence that the company had the right team to succeed in servicing its customers from Cork. "We have been manufacturing in China for over 25 years – we know very well what China can do for the pharma industry, but we also know what it cannot do – and it is for those reasons that we are now in Cork," he said. Chief financial officer Miguel Calado said the group decided to have a site in Cork because of the region's "high concentration of API [active pharmaceutical ingredients] production, its vast and deep talent pool and its excellent good . . . record with the health authorities".

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GlaxoSmithKline under pressure to reduce costs

Sunday Business Post 05/04/09

The Irish division of multinational drug maker GlaxoSmithKline (GSK) is facing ''major economic difficulties'' and is coming under mounting pressure from its US owner to reduce overheads and strip down costs. The pharmaceutical giant employs more than 1,600 people in Ireland and has plants in Dublin, Cork and Waterford. However, the Irish division has said it is under ''significant pressure'' from its parent company to reduce costs in order ''to ensure the plant's competitiveness and sustainability''. In February 2008,GSK said it would lay off about 100 people at its factory at Currabinny in Cork. It blamed ''falling volumes for the product portfolio manufactured at the site'', but said Currabinny still had ''strategic importance'' for developing new products.

A number of other multinationals have announced significant redundancies recently. Pharmaceutical company Schering-Plough announced that it is closing one of its Co Wicklow operations by 2011, with the loss of 240 jobs.

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Roche swallows Genentech in third large drugs deal

The Times 13/03/09

The third huge pharmaceuticals deal of 2009 was struck when Roche agreed to buy the 44 per cent of Genentech that it did not already own for $46.8 billion (£34 billion), giving the Swiss group scope to cut costs and complete control over a range of

cancer drugs. The deal ends eight months of wrangling in which Roche first reduced its offer in response to the falling value of the Swiss franc against the US dollar, before raising it twice. It continues the rapid transformation of the pharmaceuticals industry as the biggest players seek to prop up profits amid the loss of patents on key block-buster drugs, falling prices and increasing competition from generic drug makers. The deal will allow Roche total control of their shared cancer franchise, which includes the Avastin and Herceptin drugs.

Merck agreed to buy Schering-Plough, a rival New Jersey pharmaceuticals group, for $41.1 billion in March after Pfizer's $68 billion takeover of Wyeth in January. A tie-up between Sanofi-Aventis and Bristol-Myers Squibb would be the next logical deal since the two groups already operate a joint venture for Plavix, which is designed to reduce the risk of heart attack or stroke.

Both groups declined to comment. Such a merger would catapault Sanofi well ahead of GlaxoSmithKline in the global league table of pharmaceuticals giants. GSK, the world's second-biggest group, will slip into third place on completion of the Merck deal with Schering-Plough and a Sanofi/Bristol deal would push it into fourth place. These deals, whether potential or actual, are adding to the intensifying pressure on GSK to buy AstraZeneca to create a UK champion that would be the world's biggest pharmaceuticals group, according to analysts. GSK has said repeatedly that it does not wish to do a large takeover, while AstraZeneca has always declined to comment on potential deals.

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Bord na Mona to create 50 research positions

Irish Times 24/03/09

Bord na Mona is creating 50 new jobs in innovation, research and development, with a €50 million investment over the next five years. The company is withdrawing from the management and exploitation of peat bogs and moving into environmental services, waste management, horticulture and energy.

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Prehistoric gold source traced to Mourne mountains

Irish Times 17/06/09

Ireland's Mountains of Mourne have been fabled in song but now they have a new focus as scientists believe they were the source for most of Ireland's prehistoric gold. Ireland has a very high level of prehistoric gold objects especially from the early Bronze Age (2400-1800BC) when large quantities of it was used by skilled craftsmen. This led to speculation for centuries about the source of so much easily available gold and a belief there had to be lots of gold available locally to the craftsmen. Now archaeologists and geologists believe they have found that source, following a 14-year study which used not only the most modern scientific equipment but also involved the teams using primitive gold-mining methods.

According to a report in the current edition of Archaeology Ireland, the scientists used X-ray fluorescence spectrometry to look at the silver content of prehistoric Irish gold in more than 400 objects. As that work was going on, others were literally out panning for gold in Irish rivers, walking the mountains looking for gold in the hills and extracting gold from rocks by fire, as prehistoric people would have done. The teams even extracted gold from rocks on Croagh Patrick, Co Mayo, by heating and quenching the rock, crushing it and panning the resultant sand.

The scientific work found the average silver content of gold in the early Bronze Age ornaments was 10 per cent and this matched perfectly the profile of gold taken from the river Bann and its tributaries but not that of gold taken from other Irish sources. Examination of gold recovered from artefacts matched because gold grains from areas of high gold abundance invariably exhibit a distinct compositional signature, said the report.

The authors of the report, Richard Warner, Bob Chapman, Mary Cahill and Norman Moles, said the dearth of early Bronze Age ornaments from the area itself should not affect their conclusions. "It is a great satisfaction to be able to suggest, with solid evidence, that the Irish early Bronze Age ornaments were not only made of Irish gold but probably of gold from Co Down's Mourne Mountains," it concluded.

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370 jobs to go at Element 6 in Shannon

Irish Times 23/07/09

Element Six (formerly known as De Beers Industrial Diamonds) is closing its industrial diamond manufacturing and distribution unit in Shannon, a move that will lead to the elimination of 370 jobs. The redundancies from the company, which says the Shannon operation was the most expensive in its global manufacturing network, are in addition to 200 job cuts in the past 12 months. The Shannon business is one of several international plants operated by the company in China, Germany, the Netherlands, South Africa, Sweden and Britain.

Only 80 jobs will remain in the operation, which is now set to concentrate on research and development and customer services. The Shannon plant has been operating at 40 per cent capacity in recent times, compared with the last year.

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Research foundation sets sights on new drugs to treat cancer

Irish Times 26/06/09

Highly effective new drug treatments for cancer are expected to develop from an Irish initiative that involves some of the country's top cancer researchers. It will develop promising new "smart bomb" drugs that specifically target cancer cells while leaving normal tissues unaffected. The "strategic research cluster" will involve academic and company partners and State support worth €5.6 million. Research partners will produce designer drugs against cancer and be able to take them through to human clinical trials, according to the consultant medical oncologist who will lead it, Prof John Crown.

The new Strategic Research Cluster in Molecular Therapeutics for Cancer will be based at Dublin City University and include partners in University College Dublin, the Royal College of Surgeons in Ireland and Trinity College Dublin. The cluster will pull together the academic institutions and some of the biggest pharmaceutical companies in the world and also Irish drug developers including GlaxoSmithKline, Pfizer, Merck Sharpe Dohme, Novartis, Roche, Amgen, Erigal, Caliper Life Science and AntiCancer Inc. 26 young researchers will begin the research.

While general purpose chemotherapy had greatly improved cancer outcomes, particularly in childhood leukaemia, it was poorly targeted and "largely a development of the chemical weapons industry", professor Crown has said. Advances in cellular and molecular technologies have enabled scientists to look at the inner workings of individual cells. Direct comparisons between what happens inside a healthy cell could now be compared with what happens inside a cancerous cell.

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Environment, Food, Health & Energy News

Compiled by Marie Walsh, Limerick Institute of Technology

Engineered Maize's vitamin boost

BBC News
http://news.bbc.co.uk/1/hi/sci/tech/8020925.stm

A genetically modified (GM) maize fortified with three vitamins has been created by European researchers. The modifications make the growing maize, or corn, produce large amounts of beta carotene and precursors of vitamin C and folic acid. The development marks the first time any plant has been engineered to make more than one vitamin. The creators argue the crop could help improve diets in poorer nations, but anti-GM campaigners are sceptical.

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Nuclear bomb tests identify fake whiskey

The Telegraph **02/05/09**

Bottles of vintage whisky can sell for thousands of pounds each, but industry experts claim the market has been flooded with fakes that purport to be several hundred years old but instead contain worthless spirit that was made just a few years ago. Scientists have found, however, that minute levels of radioactive carbon absorbed by the barley as it grew before it was harvested to make the whisky can reveal how old it is. Researchers at the Oxford Radiocarbon Accelerator Unit discovered that they could pinpoint the date a whisky was made by detecting traces of radioactive particles created by nuclear bomb tests in the 1950s.

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World's tiniest lamp

New Scientist 01/05/09

The smallest ever incandescent lamp, made using a single carbon nanotube, has been created by physicists in the US. At 1.4 micrometres long and just 13 nanometres wide, the filament is invisible to the naked eye until it is switched on. A team at the University of California, Los Angeles, attached a palladium and gold electrode to each end of the carbon nanotube, which spans a tiny hole in a silicon chip and is held in a vacuum.

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No more catch up

Nature http://www.nature.com 23/04/09

An editorial argues that the European Medicines Agency (EMEA) needs to be more flexible and proactive in how it develops guidelines and regulations for innovative new medicines. The piece refers to a second article that describes how the EMEA has been unable to adapt its procedures to work with an academic consortium developing new drugs using transgenic plants.

Complex molecules seen in space

***BBC News* 22/04/09**

Astronomers have detected two of the most complex carbon-rich molecules ever found in interstellar space. Their models suggest even more complex may yet be discovered, including amino acids - which are essential for life. The results were presented at the European Week of Astronomy and Space Science meeting being held in the UK. Researchers detected the organic molecules in the star-forming region of space known as Sagittarius B2, close to the centre of our galaxy.

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New era for fossil fuels

Guardian 08/04/09

The world's first retrofit of a power plant with carbon capture and storage (CCS) technology will begin operating this month in the south of France. At a power plant at Lacq, energy company Total has upgraded an existing gas-fired boiler with CCS technology – a crucial step towards reducing carbon emissions from fossil-fuel power plants worldwide. With renewable energy sources a long way from covering the world's increasing demand for energy, many experts believe that developing reliable technology to allow countries to burn fossil fuels without releasing dangerous amounts of CO2 into the atmosphere is essential to avoid the worst impacts of climate change.

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Decline in nickel kick-started evolution

***Daily Telegraph* 09/04/09**

The massive influx of oxygen into Earth's atmosphere some 2.4 billion years ago that set evolution on a path to multicellular life was unleashed by a cascade of events in which nickel was a key player. What scientists call the Great Oxygen Event "irreversibly changed surface environments on Earth and ultimately made advanced life possible," said Dominic Papineau of the Carnegie Institution's Geophysical Laboratory. The dominant life form before the Great Oxygen Event was the methanogen - a single-celled ocean organism that exuded methane as a by-product of its metabolism. To survive, these creatures ate nickel, which existed 2.7 billion years ago in quantities 400 times greater than today. By 2.5 billion years ago, nickel levels in the oceans had dropped by more than half. Starved of this nutrient, the methanogens declined and their output of methane plummeted. It is believed this cleared the way for a class of photosynthesising life forms and ocean plants.

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Eating chocolate can improve your maths

The Telegraph 05/04/09

Mental arithmetic became easier after volunteers had been given large amounts of compounds found in chocolate, called flavanols, in a hot cocoa drink. They were also less likely to feel tired or mentally drained, the findings, presented at the British Psychological Society annual conference in Brighton show. Prof David Kennedy, director of the brain, performance and nutrition research centre at Northumbria University, and a co-author of the study, said that chocolate could be beneficial for mentally challenging tasks.

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Harvesting rain to cut water use

***Irish Times* 10/12/08**

Harvesting rainwater could significantly extend the life of water treatment plants and cut down on the waste of drinking water across the State, a study by the National Rural Water Monitoring Committee has found. Two pilot projects found harvested rainwater offered huge environmental and economic benefits and could replace up to 40 per cent of mains water used in houses. Collecting rainwater can eliminate the use of treated water for flushing toilets, washing, gardening, and supplying water for livestock, the committee found.

The domestic rainwater harvesting project, carried out in a rural housing development in Co Carlow, found the use of rainwater to flush toilets reduced demand on mains water by up to 33 per cent. Samples taken from the harvesting system all complied with EU bathing water standards and 37 per cent complied with more stringent drinking water regulations. The agricultural project carried out at a 250-acre livestock farm in Co Meath led to rainwater replacing 43 per cent of the mains water used in animal troughs.

The committee, established by the Department of the Environment, recommends that rainwater harvesting be considered for widespread use to supplement mains water for non-drinking purposes, and should be built in to any new developments. The report concludes that rainwater harvesting offers cost savings to local authorities and developers, but educational programmes and grants are needed to make it more appealing for users.

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Downturn means CO_2 targets now achievable

***Irish Times* 07/02/09**

Behind every cloud there's a silver lining: Ireland is now likely to meet its Kyoto targets for greenhouse emissions because of the downturn in the economy, an authority on environmental and economic policy has said. According to Frank Convery, professor of environmental policy at UCD, the extraordinary turnaround in the country's finances had made the exacting Kyoto targets suddenly

achievable. His view was shared by Dr Lisa Ryan of Comhar, the Sustainable Development Council, which Prof Convery also chairs.

Prof. Convery said that as recently as September 2008, it was being forecast that GDP would continue to grow at a rate of at least 3 per cent. But less than five months later the ESRI concluded that GDP had already dropped by 9 per cent bringing us back to the 2005 income level. "We are now unlikely to overshoot our Kyoto target in 2012, and won't have to spend up to €300 million set aside to buy allowances to cover the overshoot," said Prof. Convery.

The Kyoto target for Ireland is 63 million tonnes of CO_2 emissions per annum. During 2005 and 2006, emissions had risen to 70 million tonnes, making it seem likely that the State would have to buy carbon credits after 2012. According to Prof Convery the chances of a carbon tax in every EU state is remote so the European Emissions Trading Scheme (ETS) is effectively the only mechanism which allows a price signal to be put out on carbon.

Under the ETS scheme, emitters are given a quota in the form of tonnes of emissions of CO2 gases each year. The overall number of tonnes allowed is limited. The companies covered under the ETS include power companies, cement and glass manufactures, steel manufacturers, pulp and paper manufactures.

However, under the pilot scheme of the ETS the price of carbon dropped from a high of €25 to zero when it became apparent that too many allowances had been allotted. Prof Convery also said that splitting the market into trading (subject to ETS) and non-trading (such as transport, agriculture, household and not subject to ETS) was also a disadvantage. Under the second phase which began last year the overall supply of allowances dropped by 6.5 per cent, he said.

In recent months the price of carbon has again fallen dramatically from a high of €26 to a little over €10. Some Irish companies now had surpluses of carbon allowance to sell, he said. They included CRH, Platin (1½ million tonnes), Alumina in Limerick, (1.1 million tonnes), Quinn Cement (1.0 million tonnes) and CRH, Limerick (0.9 million tonnes).

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Dioxins in pigmeat

***Irish Times* 08/12/08**

The pig meat dioxin crisis which hit the headlines in early December began when the Food Safety Authority and the Department of Agriculture and Food during routine surveillance identified a pig with residue of polychlorinated biphenyls (PCBs) in excess of the permissible levels. The sample was taken on November 19th and the result was reported on November 28th. This triggered an investigation on the farm at which the pig had originated.

Once the result was known, no pigs from the farm were allowed into the food chain and further pigs were sampled, as were all the components of the ration being fed to the animals. One ingredient in the pigs' diet tested positive, which led the investigation to the source of this ingredient, a mill in Carlow, where bread and confectionery was being recycled into animal feed. More samples were taken from the mill, and all the farms supplied from it were immediately identified and locked up, and samples were taken from them.

Eight other pig farms were identified. These were shut and pigs from the farms were tested. The testing requires the pigs to be slaughtered, and samples of kidney fat taken for analysis.

Testing for these chemicals is a pain-staking analytical process and initial results only give the family of chemicals. Further analysis is required to identify the specific chemical and quantities present. Samples from Ireland had to be forwarded to a laboratory in England for definitive identification. The preliminary results were shared with competent authorities in other EU member states.

When the results of dioxin tests from the English laboratory became available, Irish authorities took the decision to order a total recall of all Irish pig meat processed since September 1st. Once pig meat enters the processing sector and is turned into sausages and processed meats, traceability to the processor and perhaps the day of production may be possible, but not back to the individual farm. Because the regulatory authorities in Ireland had no way of knowing which meat came from the nine farms, they initiated a recall on all pig meat. There are 400 pig producers in Ireland and although only nine pig farms fed the contaminated ration, meat from the other 391 was also caught up in the recall.

Students and teachers will be familiar with the word dioxin, as it has appeared for example in the controversies over installation of incinerators, or indeed in relation to illegal 'back yard' burning. 'Dioxin' refers to not one but a group of chemical compounds that share certain similar structures and mode of action on the body. Over 30 of these compounds exist and are members of three closely related chemical families; the chlorinated dibenzo-p-dioxins (CDDs), chlorinated dibenzofurans (CDFs) and certain polychlorinated biphenyls (PCBs).

Dioxins are produced when organic material is burned in the presence of chlorine, whether the chlorine is present as chloride ions, or as organochlorine compounds, so they are widely produced in many contexts such as:

- incinerators for municipal waste;
- iron ore sinter plants;
- incinerators for clinical waste;
- facilities of the non-ferrous metal industry;
- A contaminant produced in the manufacture of chlorinated herbicides such as 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid.

Dioxin builds up in living tissue over time, so even small exposures can accumulate to dangerous levels. They bioaccumulate because of their high solubility in fatty tissue.

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Slurry from dioxin feed is still on farms

***Irish Times* 13/02/09**

An estimated one million litres of pig slurry from the 10 pig farms hit by the dioxin contamination crisis in December, will be spread on tillage land and not land used for grazing animals. The Department of Agriculture announced it had given the go-ahead to the pig farmers to dispose of the slurry which has been held on the farms since the crisis broke on December 7th.

The decision was taken following consultations between the department, the Environmental Protection Agency (EPA), the Food Safety Authority of Ireland and the European Commission, said a spokeswoman. She said the farmers involved had been told of the decision which related only to slurry which was produced by the pigs involved. No decision has been taken yet about the spreading of manure from the dozen or more cattle farms which were also shut down because of the scare.

The EPA had originally raised concerns about the possible contamination of land from slurry produced from the animals which had ingested dioxin-laden feed from the Millstream Recycling Plant in Co Carlow in the period September 1st-December 7th. It had sought tests on the manure which had been building up on the farms where the animals were being kept in quarantine awaiting slaughter and destruction. The EPA had insisted the slurry being generated on the farms be kept in separate holding tanks on the pig farms.

Following consultations with all the parties, agreement was reached that the slurry was safe and represented no threat to public health when disposed of in the manner specified.

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Experts criticise lack of secure storage for nuclear waste

Irish Times 24/03/09

A lead box containing a compound of radioactive uranium, and nuclear material stored in a garden shed in Co Meath, are among a number of radioactive finds in Ireland in recent years, the Radiological Protection Institute of Ireland has said. Responding to EU concerns at more than 1,300 finds of radioactive material worldwide since 1993 – 16 of which constituted weapons grade nuclear material – the institute said finds in the Republic have tended to be "orphan sources", mislaid or inadvertently dumped by industry and hospitals. It said such finds amount to less than one per year, but it has repeatedly expressed concern that Ireland has no centralised storage facilities for waste or unwanted equipment from the 1,600 licensed users of radioactive substances. Unwanted or "orphan source" radioactive materials are held at 80 locations.

In its 2007 annual report the institute said the legal responsibility for industrial radioactive materials rested with the owners but such storage represented "an accident waiting to happen". The institute was critical of successive governments' failure to provide a central, secure storage facility for nuclear waste. It also recommends that new practice would require suppliers of equipment which depended on nuclear material to take the equipment back at the end of its useful life.

In mid-March. at the EU's Institute for Transuranium Elements in Karlsruhe, Germany, the European Commission unveiled its "atomic detectives", a team of scientists who carry out "forensic nuclear analysis" on finds. The scientists, who previously confirmed nuclear material found in Germany had come from Hitler's second World War atomic programme, this year identified a contaminated shipment of steel detained in Rotterdam as having come from Russia and linked a pipe found in a scrap yard in Karlsruhe to a Soviet nuclear reactor.

The institute said it was concerned at the growing number of nuclear finds and trafficking of material across Europe. But while the scientists instanced border frontier detection and enforcement measures, the EU Commission stressed the storage of nuclear material as well as detection of the illegal movement of nuclear waste was primarily a matter for national governments.

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Irish water shows 30 *times UK E.coli level*

Irish Times 23/04/09

Levels of E.*coli* contamination in Irish drinking water supplies are almost 30 times higher than those found in supplies in England and Wales, according to an Environmental Protection Agency (EPA) report. The report on drinking water quality identifies one-third of all public water supplies as potentially risky to human health and requiring replacement or upgrading. Some 320 out of 952 water supplies appear on the agency's remedial action list. This is a marginal improvement since the list was drawn up 18 months ago, but the

EPA says it is not satisfied with the progress made by local authorities in upgrading treatment plants.
For example, just seven of the 64 supplies identified in 2007 as having no treatment barrier to remove cryptosporidium had installed one since the outbreak of the parasite in Galway that year. About 5 per cent of samples taken from public water supplies were contaminated with E.*coli* bacteria. Almost 90 per cent of the population gets its water from public schemes. Over 31 per cent of samples from private group water schemes reported E.*coli* at least once during 2007.The report says that boil-water notices were put in place on 53 supplies serving 118,000 people last year. The EPA issued 47 binding directions to 15 local authorities in relation to remedy water treatment faults. Galway Council Council was prosecuted for failing to install a chlorine monitor and alarm. It was fined €4,000.

There was also evidence of poor practice in smaller water treatment plants, such as incorrect dosing with chemicals, a failure to check the source of chemicals and inadequate maintenance. EPA audits found problems with filters in two-thirds of treatment plants, and inadequate chemical dosing arrangements in half the plants examined.

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2020 target for 350,000 electric cars

Irish Times 29/04/09

A new report from the Oireachtas Joint Committee on Climate Change and Energy Security recommends targets whereby all new cars on sale by 2020 would have electric engines, with at least 350,000 electric vehicles in use by that year, 100,000 more than the target already set by the Government. By 2016, the committee wants 100,000 privately-operated battery electric vehicles on Irish roads. No petrol or diesel engines will be sold as new cars by 2020 – the difference between running them and running electric vehicles will be so vast there will be no demand, said the report's author, Fine Gael TD Simon Coveney. He added, "We are talking about transforming car transport in Ireland to reduce emissions by up to eight million tonnes per year. "We have about 1,200 megawatts of capacity coming from wind in Ireland at the moment, but only a fraction is used in peak times for energy and, if we can create a symbiotic relationship between transport and energy, driven by electricity, both sectors can benefit." The report does not go into specifics on incentives for buyers and it notes that the success of electric vehicles depends in part on manufacturers ramping up production of both batteries and vehicles and the presence of the proper infrastructure.

The committee has met with Better Place, a start-up led by former SAP executive Shai Agassi. The Better Place model is that the battery, which makes up a major cost of an electric vehicle, would be treated separately to the car. Buyers would lease the battery and buy kilometres, just like minutes are bought from a mobile phone company. This would not only keep the cost down, but would also address the issue of the short range of such vehicles. A purpose-built swapping station would allow users to swap batteries. Pilot programmes of Better Place are being rolled out in Israel, Denmark and Japan.

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EPA predicts wetter winters and drier summers

Irish Times *28*/04/09

Average temperatures in Ireland will rise by between 1.4 degrees and 1.8 degrees by 2050, according to a new report on climate change impact published by the Environmental Protection Agency (EPA). The research also indicates that summer and autumn will warm faster than winter or spring, with the midlands and east warming more than coastal areas. Winter rainfall is expected to increase by 10 per cent within 40 years with converse reductions of summer rainfall. The decrease in summer precipitation could be between 12 and 17 per cent.

The report, ***Climate Change in Ireland: Refining the Impacts for Ireland***, suggests that we need to plan for these changes, which are already occurring, but which will be clearly evident within four decades. The lead author of this report, Prof John Sweeney from NUI Maynooth said that Ireland would experience changes in extremes at both ends of the spectrum. The new projections are in line with earlier reports provided by NUI, Maynooth and Met Éireann. However, these new projections are based on outputs from a wide range of global climate models, thereby increasing confidence in the projections.

The report states there is an urgent need to adopt appropriate mitigation and adaptation responses to the risks posed by climate change, notwithstanding the challenges of recent economic events. Detailed studies and research of impacts also highlighted the implications for water resources and also warned about an increase in flood risk, especially in areas that are vulnerable to flooding. Case studies were presented for a number of the rivers including the Suir, Blackwater (Co Cork), and Barrow. Among the serious findings was a projection that the return period of the "10 year" flood would reduce to a three-year event on most catchments by 2050.

In addition the report identifies the most vulnerable habitats as sand dunes, lowland grasslands, mountainous heath, raised bogs, and some fens, turloughs (winter lakes) and upland lakes. The threat posed to Irish peatlands is also emphasised. The research concluded that despite the uncertainty inherent in the analysis, there is an urgent need to adopt appropriate mitigation and adaptation responses to the risks posed by climate change, notwithstanding the challenges of recent economic events.

Cancer deaths 4% lower in North than Republic

Irish Times 24/04/09

Death rates from cancer are 4 per cent lower in Northern Ireland compared with the Republic, a major report has found. However, the report also noted that overall cancer survival continues to improve throughout the island. ***Cancer incidence, mortality, treatment and survival in the North and South of Ireland: 1994- 2004***, is the third joint report compiled by the Northern Ireland Cancer Registry (NICR) and the National Cancer Registry of Ireland (NCRI).

The report shows that more than 21,000 people on the island of Ireland are diagnosed with cancer annually. Most common cancers among men in the 10-year study period were prostate, colorectal, lung and lymphoma (a cancer of the lymph glands); among women breast, colorectal, lung and ovarian cancers were more often diagnosed. The authors of the report say the overall number of cancers has increased due to population growth, an ageing population and the increased detection of some tumours. Cancer deaths have fallen, primarily due to better survival for patients with breast, bowel and prostate cancer.

Male cancer rates were lower in the North by 10 per cent because of higher levels of prostate cancer in the Republic. However, this does not mean the disease is more prevalent in the Republic; rather it is a reflection of the greater use of testing for the disease here. Elevated levels of prostate specific antigen (PSA) in the blood may indicate the presence of prostate cancer. However, it appears that doctors following guidelines in Northern Ireland perform the test less often than their counterparts in the Republic. According to Dr David Donnelly of the NICR, lead author of the report, "tobacco use is a major factor in explaining higher rates of cancer in urban areas. and in the most deprived geographical areas in Ireland compared with the most affluent". He noted the incidence of some smoking related cancers had fallen among males, although lung cancer among females, North and South, is on the rise.

Irish Kyoto target forecasts out of date

Irish Times 02/04/09

New projections for Ireland's Kyoto targets published in mid-March may already be out of date, Green Party TD Ciaran Cuffe has said. The Environmental Protection Agency's projection, published on March 12th, relied on new economic research that showed Ireland's carbon emissions will markedly decrease because of the dramatic downturn. The "economic shock" scenario was prepared by the Economic and Social Research Institute (ESRI) and showed that, because of the downturn, carbon emissions may be only 1.3 million tonnes above Ireland's annual 62.8 million tonnes annual target if all the Government's policies are implemented. Only last year, the EPA predicted that annual emissions would be as much as 3.6 million tonnes above target.

But yesterday Mr Cuffe said the "economic shock" scenario prepared by the ESRI was already out of date and conservative. He said the analysis was prepared in January and estimated there would be a cumulative decrease of 7 per cent in gross domestic product (GDP) between 2008 and 2010."We will have a fall of 7 per cent in GDP in 2009 alone," said Mr Cuffe, "which means that it's a conservative estimate."

Mr Cuffe was speaking after a meeting of the Oireachtas Committee on Climate Change and Energy, at which a delegation from the EPA briefed TDs and Senators on its latest projections for Kyoto, and also for the EU's carbon target, which requires a 20 per cent reduction in greenhouse gas emissions by 2020. Dr Eimear Cotter of the EPA agreed the economic situation had changed since the ESRI research in January.

In relation to the new EU target that requires a 20 per cent reduction in emissions by 2020, the EPA estimates that with additional measures, and taking the "economic shock" scenario into account, Ireland will miss its target by 2.7 million tonnes. However, that figure relies on Ireland using carbon sinks, including afforestation. Dr Macken told the committee that the Irish Government has lobbied strongly for carbon sinks to be included. He said that while it was highly likely they would be included, it would be determined with certainty by the outcome of the global talks on climate change in Copenhagen later this year.

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2008 Emissions fell by *one million tonnes*

Irish Times 07/04/09

The amount of greenhouse gas produced by Ireland's largest emitters fell by almost one million tonnes last year, the Environmental Protection Agency (EPA) has said. The reduction continues a downward

trend in recorded Irish emissions since the EU-wide Emissions Trading Scheme (ETS) started in 2005 in an attempt to tackle emissions of carbon dioxide and other greenhouse gases to combat climate change.
Under the scheme, high emitters are given a quota in the form of tonnes of emissions of CO_2 gases each year. Companies covered under ETS include power companies and glass and steel manufacturers. Verified greenhouse gas emissions in Ireland have fallen from 22.43 million tonnes in 2005 to 20.38 million tonnes last year, the EPA said. Some 21.25 million tonnes were emitted in 2007. It has been acknowledged that one factor in the reduction could be the economic downturn.

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Gormley to limit amounts of waste for incineration

Irish Times 05/06/09

Minister for the Environment John Gormley plans to issue a policy directive to the Environmental Protection Agency (EPA) and the local authorities placing limits on the volumes of waste going for incineration. In the meantime, they have been told that the Minister is "pressing ahead" with initiatives compatible with the overall objectives of his review of waste management policy, including an increase in the landfill levy and the introduction of a levy on incineration and recommending that local authorities should intensify efforts to promote home composting and other small-scale local composting initiatives. They are also being advised to roll out brown bin collections, encourage access to waste streams for composting or anaerobic digestion, recycling and other processes high on the EU "waste hierarchy", and promote segregated collection of commercial bio-waste.
These "interim actions" are intended to help meet the EU Landfill Directive targets while implementing commitments in the programme for government The Minister has also initiated a strategic environmental assessment on proposed policy directions requiring the EPA and local authorities to "limit incineration capacity to ensure that waste is not drawn to incineration which could have been dealt with by recycling".
The proposed directions would also tell them to "refrain from exercising their powers in such a way as to direct waste to landfill or incineration". The Cork Harbour Alliance for a Safe Environment, which opposes plans for an incinerator at Ringaskiddy, described the circular as very significant. "These clear moves away from incineration leave Indaver's incinerator with no role to play in waste management," it said in a statement.

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British firm Serica Energy finds oil off Mayo coast

Irish Times 10/06/09

London and Toronto-listed Serica Energy, an exploration company, has made the first discovery of oil off the west coast for almost 30 years - in an exploration well where it originally expected to encounter natural gas. The well is located in the Slyne Basin, around 80km off the Mayo and Connemara coasts, and 40 km south of the Corrib field, where Shell has discovered enough natural gas to supply Irish needs for 10 years.
Serica began drilling there last month, and after probing close to 2,000 metres under the sea bed, discovered oil. The company said that the volume cannot yet be estimated with certainty as it has more technical work to complete, "but the results to date are encouraging", it added. If the oil find does turn out to be commercial, it would be easier to process and get to the market than gas. Local objections have hit Shell's efforts to get the Corrib gas ashore.

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Investment in wind energy essential

Irish Times 16/06/09

The government needs to invest up to €700 million over the next 18 months to begin meeting its targets for renewable and secure energy, it has conceded. Launching a new report on investment in the wind energy sector, Minister for Energy Eamon Ryan said that investment in the national electricity grid was essential if Ireland was to achieve a potential investment of almost €15 billion from the wind energy industry over the next decade. He said the total investment in the grid would reach €4 billion by 2025. Yet the upgrade would need to attract other investment that would create up to 10,000 jobs in construction and smart technologies over 10 years. He said the upgrade would also result in an annual saving on fossil fuels of €1 billion for the State from 2020. An added benefit would be the reduction of electricity prices for the consumer.

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Incinerator waste to go to landfill site

Irish Times 17/06/09

It has emerged that hazardous waste material generated by up to three incinerators operating around Ireland is expected to be dealt with at a landfill site in the "greater Dublin area". The landfill site will accept hazardous "fly ash" generated through the incineration process. Fly ash matter makes up about 7 per cent of all ash residual material created as a result of incinerated waste. Because of its toxic nature, the fly ash will be disposed of in an airtight cell buried underground at the location of an existing landfill facility in Leinster, according to Indaver Ireland.

The landfill operator, which has not been identified, is in "advance stage" talks with Indaver Ireland – which is currently constructing a €130 million incinerator at Carranstown, Co Meath – to negotiate a deal to accept hazardous waste material from incinerators operating around Ireland. Director of Indaver Ireland John Ahern said the landfill operator would be in Leinster, where it was geographically predisposed to accept hazardous waste from incinerators at Poolbeg in Dublin, Carranstown and a third proposed toxic waste facility currently planned for Ringaskiddy, Co Cork.

The Environmental Protection Agency is currently seeking tenders from companies to develop a National Difficult Waste Management Facility to deal with up to 100,000 tonnes of hazardous waste landfill per annum. The waste anticipated to be dealt with by the successful company would "be generally deemed not suitable for disposal by waste incineration or export", according to the EPA guidelines for prospective tenders. In information issued to prospective companies interested in the tender process, the EPA states: "The National Hazardous Waste Management Plan recommended that at least one hazardous waste landfill should be developed in Ireland, capable of accepting the wide range of hazardous wastes that would otherwise be exported for landfill. Such a facility would be expected to provide a key national resource."

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Biomass energy plant could create 150 jobs

Irish Times 23/07/09

Details of an €85 million biomass energy plant with the potential to employ 150 people which will be located in the west of Ireland have been given to a Dáil sub committee. The *Sub Committee on Job Creation through Use of Renewable Energy Resources* was told by Seán Daly, of Carbon Sole Industries, that plans were well advanced for the plant. He said finding a suitable site for the venture which would see 75-100 people involved in the building stage, was one of the difficulties facing the company. "The plant will probably be located 50 kilometres off the N17 route in the Western Corridor and we have already researched eight sites in the Mayo, Sligo, Leitrim and Roscommon area," he said.

The Irish plant would produce electricity, heat and pellets and would initially produce pellets for heating systems and electricity.

Meanwhile, Dr Andrew Walsh, managing director of Celtic BioEnergy, said small-scale producers of energy were not being paid enough for it and this was preventing the development of the industry. And a third presenter to the committee, Brendan Cooney, senior executive scientist with Wexford County Council, said anaerobic digestion could handle the 132 million tonnes of slurry and sludge and create thousands of jobs. He said plans were well advanced for opening a second anaerobic digester in Co Wexford which would use 99,000 tonnes of organic matter and generate 5mw of electricity, enough to power approximately 2,500 homes. Patrick Berridge, who operates an anaerobic digester and alternative energy on his farm in Co Wexford, said prices being paid for green electricity were too low and far below other European countries.

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Gene scientist to create algae biofuel with Exxon Mobil

The Guardian 14/7/09

Gene scientist Craig Venter has announced plans to develop next-generation biofuels from algae in a $600m (£370m) partnership with oil giant Exxon Mobil. His company, Synthetic Genomics Incorporated (SGI), will develop fuels that can be used by cars or aeroplanes without the need for any modification of their engines. Exxon Mobil will provide $600m over five years with half going to SGI.

http://www.guardian.co.uk/environment/2009/jul/14/green-algae-exxon-mobil

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Just add lime (to the sea) – the latest plan to cut CO_2 emissions

The Guardian 06/07/09

Putting lime into the oceans could stop or even reverse the accumulation of CO_2 in the atmosphere, according to proposals unveiled at a conference on climate change solutions in Manchester today.

According to its advocates, the same technique could help fix one of the most dangerous side effects of man-made CO_2 emissions: rising ocean acidity. The project, known as *Cquestrate*, is the brainchild of Tim Kruger, a former management consultant. "This is an idea that can not only stop the clock on carbon dioxide, it can turn it back," he said, although he conceded that tipping large quantities of lime into the sea would currently be illegal.

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Taking fish oil supplements can reduce memory loss

The Telegraph 12/07/09

Researchers have found that taking a supplement of omega 3 for six months had a beneficial effect on people with age-related forgetfulness and loss of learning ability. They tested the affect of docosahexaenoic acid (DHA), which is most commonly found in fish oil, on 485 healthy people and found that memory and general brain function increased significantly.

The research, based on volunteers with an average age of 70, showed taking 900mg capsules every day was the equivalent of turning back the clock three years, it was found. Now it is hoped that further studies could show that the fatty acid could help stave off Alzheimer's disease if new techniques can be found to diagnose it before it take holds.

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Carbon capture and storage technology tested

BBC 28/05/09

New carbon capture technology is being tested for the first time in the UK on a working coal-fired power station. A 30-tonne test unit will process 1,000 cubic metres of exhaust gas per hour from Longannet power station in Fife. Carbon dioxide will be removed using chemicals and turned into a liquid, ready for storage underground. Energy company ScottishPower wants to test technology which could lead to a full scale carbon capture plant becoming operational by 2014. The UK government recently gave the go-ahead for a new generation of coal-fired power stations provided they were able to limit their CO2 emissions.

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Diary

2009

ESERA 2009
30 August - 4 September
Istanbul, Turkey
www.esera2009.org/

Variety in Chemistry Education/ 3rd. Eurovariety
2 - 4 September
University of Manchester, Manchester
www.heacademy.ac.uk/eurovariety

28th. ChemEd-Ireland
17 October
University of Limerick, Limerick
Sarah.hayes@ul.ie

Science Week Ireland 2009
8-15 November
www.discover-science.ie

2010

ASE Conference
7-9 January
University of Nottingham
http://www.ase.org.uk/htm/conferences/annual_conference_2010/index.php

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

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

Please send in details of forthcoming national and international events.