RSC | Advancing the Chemical Sciences

RSC stance on topical issues in Science and Society 20th March 2009	
Issue	**RSC Stance**
Academic salaries	To attract the best and most able teachers in HE, academic salaries need to be competitive. From our 2008 member's salary survey, academic salaries are several thousand pounds below the median for practising chemists [RSC members] independent of age. This is a rough & ready comparator because it's an average but it is a good indication of an issue that needs to be addressed. It's a neglected area and one where the Government should invest more money.
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Acryl amide	CH_2=CHCONH$_2$. This substance has been in the news recently. Swedish researchers found acryl amide at levels from a few tens of parts per billion to 2300 parts per billion in a range of fried, oven-cooked and processed foods such as chips, crisps, biscuits, breakfast cereals and crisp breads. Acryl amide is known to cause cancer in laboratory animals, and so these findings might also be significant for human health. In a statement, the FSA said: 'The Food Standards Agency is aware that this work has been published. Acryl amide has never before been found at these levels in foods, but we do take this work seriously and will investigate the issue further. In the meantime, there is no need for people to change their diets.' It is UK policy that exposure to carcinogens such as acryl amide should be as low as reasonably practicable. [A subsequent paper in the British Journal of Cancer has found no increased in the risk from cancer from acryl amide.] Clearly this is a concern, however, on a cautionary note; the improvements in analytical chemistry mean that lower and lower levels of components can be detected. Because you can detect something it doesn't mean that it is dangerous nor does it necessarily mean that it wasn't there before – it may be that you could not detect such small amounts previously. This is an area where more research is needed.

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Air quality	In many respects the air quality in most cities is a vast improvement over that found in the period up-to the 1950s. Coal is no longer burnt in homes but is still used in industry, especially in developing economies. Increasing efficiency of car engines means that emissions per car are falling. [However the number of cars is increasing and emissions also depend on type of journey.] Catalytic converters have made important improvements in removing pollutants. Lead free petrol has also led to less pollution. Look how the air quality in LA improved in the 2nd half of the 20th century. Chemistry has played a key role here and will do in the future. There are concerns over the air quality in South East Asia [clouds of smoke from forest fires] and in cities such as Beijing. These are areas where more control of air quality is needed. Going forward: • Understanding the fate and impact of atmospheric pollutants requires the expertise and knowledge of chemists. • The RSC advocates an integrated approach to regulating air quality which takes account of the complex chemical interactions which occur between pollutants in the atmosphere. • Research must continue to explore and understand ozone pollution events and pathways of intercontinental pollution transport. • Chemists will be critical in the development of new structural and catalytic materials to improve vehicle performance and efficiency. • Emissions from aircraft and rising air travel are significantly impacting air quality around airports. The research community and industry need to work together to tackle this problem.
A-level results 2007	We: • Welcome achievement of students taking an A-level that University of Durham CEM centre's studies indicate is one of the most difficult. • Welcome fact that more of this cohort have applied to study chemistry at university (up 13% on last year) and the emphasis on the subject from our Chemistry for our Future programme. • Realise that these specifications need change – as they will do from Sept 2008 where we are glad to see renewed emphasis on free energy and entropy as the underlying principles underpinning chemistry. • welcome the efforts of industry in supporting the development of the subject particularly Reckitt Benckiser in enhancing teaching of physical chemistry Shire Pharmaceuticals in enhancing teaching of organic chemistry and INEOS in supporting the Chemistry Olympiad. • This is against a background of government still not investing enough in providing first class laboratory accommodation in schools as shown by the recent report of the Commons Select Committee on sustainable schools. • A major concern is that government and the regulatory authority (QCA) will not seize the opportunity provided by the revision of A-level for first teaching in Sept 2008 to address the issue of A-levels being of differing difficulty.

	The RSC is not pressing for A-level Chemistry to be made easier but to be in a level playing field with other subjects.
Animal testing	The RSC strongly supports the development of alternatives to the use of experimental animals, and for significant resource to be made available for their validation and adoption by international regulatory bodies. Significant investment should continue to be made to permit such research to continue. For example, the study of genomics has the high potential to permit the development of many more non-animal methods. Specific safety tests using vertebrate animals are a legal requirement for the registration of chemicals, pharmaceuticals, pesticides, biocides, etc., in the European Union and other countries in the world. Similarly, animal experimentation continues to play an important role in the understanding of human and animal diseases, and the identification of potential therapeutic agents. The use of animals for such research is controlled through strict licensing regulations and animal welfare considerations in the UK and elsewhere. Alternatives to animal testing are now validated for a number of different end-points, and many others are being developed. However, no in vitro test or battery of tests is currently available that can completely replace the use of animals and still provide the essential health and environmental safeguards that society demands. Until such studies are available to replace the use of animals, the RSC supports the 3R's principles of Reduction, Refinement and Replacement wherever possible, thus reducing the number of animals, reducing the possibility of suffering, and the replacement of animals where suitable alternatives are available.
Bio fuels	• • The RSC has severe concerns about bio fuel. The amount of land that will be taken to grow the crops is unfeasibly large. A flight to New York on bio fuel would require the yield from an area the equivalent to 30 football pitches. The RSC believes that second generation bio fuels offer far greater potential for reducing cost and environmental impact compared to first generation bio fuels. Furthermore, unlike first generation bio fuels, second generation bio fuels do not necessarily compete with food production. • First generation bio fuels will play a major part in meeting the targets by legislation such as the Renewable Transport Fuel Obligation on a very short time scale. However, the use of second generation bio fuels needs to be encouraged as soon as possible. • With significant effort second generation bio fuels will have substantial market impact by 2015, but it is important to accept that bio fuels alone cannot mitigate the environmental impact of transportation. However, second generation bio fuels can play a significant role alongside other measures. • Using a life cycle assessment (LCA), the environmentally

	best route for bio fuel production can be determined and even whether bio fuels are a valid long-term measure. However it is essential that the EU adopts a uniform methodology to ensure a simple and transparent process for comparison. • Key considerations concern the quality, reliability and safe use of bio fuel products. It cannot be assumed that measurements and standards developed for fossil-based fuels, and its associated infrastructure, are suitable for bio-based fuels. • The chemical and biosciences as well as engineering disciplines are critical in developing efficient catalysts, separation processes, high throughput systems and additives to maximise the effectiveness and efficiency of bio fuels. There need to be parallel developments of engine technologies and surface chemistry to deal with potential bio fuel issues.
Cambridge Congestion Charge	Cambridge Council is proposing to introduce a congestion charge of possibly £3-5/day. This would affect staff and visitors to the RSC's offices on the Science Park in Cambridge. The RSC is committed to reducing its environmental impact and is moving to minimise its energy consumption that is consistent with running the organisation effectively. Car sharing schemes are promoted and providing facilities for cyclists have been a priority for the RSC. Our science policies call for action to address the issue of global warming and we will continue to argue for a holistic approach to addressing this important issue for the world. However the introduction of a congestion charge on its own is a blunt instrument that will adversely affect many RSC staff and minimum impact on the problem. Along with other employers we oppose its introduction, in the absence of suitable alternative transport options that individuals can use.
Cancer causing chemicals	Cancer is a natural phenomenon. Everything around us is made up of chemicals. Chemicals are natural. Humans are chemicals. As well as chemicals that occur naturally there are chemicals that have been made by human activity. Life expectancy has increased in the past 100 years despite of all the scares that we read about cancer. Regulations require strict testing and risk assessment of chemicals to minimise any harmful impact that they may have. One of the problems in this area is the long lead times – it can be many years before the effect of any chemical, natural or man-made is realised. Natural things cause cancer as do some of those made by humans. There are many more natural cancer causing agents than synthetic ones. It all a matter of exposure limits [how much] and exposure times [how long] – and it is a very complicated process involving genetic susceptibility in some cases. People tend to get many of these ideas out of proportion, understandably.

Carbon Capture & Storage	• **The RSC has criticised the Government for dragging its heels over the introduction of carbon capture and storage plants (CCS) which are vital to combat the carbon threat. The country also needs to improve the skills of its young people and those in work already to be able to build and run the facilities. This means investing in science education now** • The RSC believes that due to increasing energy demand and supply security, fossil fuels are likely to remain part of the UK energy portfolio for the next 50 years. In order to mitigate climate change we must reduce CO_2 emissions by using Carbon Capture and Storage (CCS) technologies. • All storage options for CO_2 must undergo rigorous research and development to ensure the effective, safe and long term storage of CO_2. Developing the right regulatory framework for managing the risks associated with the long-term storage of CO_2 is required. • Carbon Capture and Storage technologies need to be deployed on a global scale if they are to be effective in reducing CO_2 emissions. The UK has considerable expertise in CCS which should be utilised by demonstrating CCS technologies. • Any CCS demonstrations should support post combustion carbon capture technologies as these could be retrofitted to power plants already in operation. • The RSC believes that the chemical sciences can play a major role in developing uses for captured CO_2, such as a chemical feedstock, which is preferable to a CO_2 'storage' option.
Chemical Weapons	Chemistry brings many benefits but like everything else in life it has the potential to be misused. Science, technology, the arts and literature can all be used both in positive contributions to society, and negative. The United Kingdom abandoned its chemical weapons offensive capability in 1956, and was a founding State Party to the international Chemical Weapons Convention in 1993. The RSC is proud of the leading role that it played in assisting Parliament during the passage of the Chemical Weapons Act 1996, an Act which the Society strongly supports and remains committed to helping to implement. The RSC is also pledged to support the work of the UK National Authority under that Act and in particular its scientific advisory board. In the UK, along with nearly all other countries, it is a crime for anyone to have, make or use chemical weapons under the Chemical Weapons Convention (CWC) (1997). The CWC is administrated by the Organisation for the Prohibition of Chemical Weapons (OPCW), advised by the chemical community. Destruction programmes are underway to dispose of all existing chemical weapons. Furthermore, the international treaty covers the misuse of all toxic chemicals and chemists are encouraged to consider the potential for causing harm, or for chemicals to be misused, before starting work. The RSC strongly supports this position. The RSC has 44,000 members with 7500 outside the UK. It is

	not in a position to police the research of all its members. The RSC recognises that some of its members will be carrying out research on defence against chemical weapons so as to be able to protect the public, both in the UK and worldwide. All members of the RSC are called upon to adhere to the RSC code of conduct and guidance on professional practice, that requires them to ensure that any adverse effects of their activities on the environment are and that their work is in the public interest and does not infringe legislation. Indeed, activities that are aimed at protecting the public from the effects of a chemical attack are an important public duty. The RSC supports international cooperation on scientific research and political legislation in the desire to suppress the unethical misuse of chemicals. This is in agreement with the CWC and the International Union of Pure and Applied Chemistry (IUPAC) report on the Impact of Scientific Developments on the Chemical Weapons Convention (2002). This report identified a variety of needs to be addressed, including: • To maintain awareness of new advances in synthetic and manufacturing technologies and in bio molecular science with potential for misuse • To clarify issues in relation to existing schedules of chemicals regarded as presenting a particular risk • To review options for analyses of unscheduled chemicals and of biological samples • To obtain explicit agreement on required levels of detection • To monitor the increased versatility of chemical production facilities and review the effectiveness of the verification regime • To review penal legislation in view of the increasing ease of access to toxic chemicals by terrorist groups • To maintain the technical expertise of the Secretariat and to update and improve the versatility and mobility of its analytical equipment • In view of increasing demands for monitoring of destruction facilities, to consider the introduction of remote monitoring procedures and/or reduction in manpower requirements for verification • To increase awareness in the worldwide scientific and technical community of the Chemical Weapons Convention and its benefits The RSC welcomes the involvement of IUPAC, as the appropriate international body for the chemical sciences, and supports IUPAC's advice in this matter. We must remember that a monitoring system is in place for a range of key chemicals. For some chemicals quantities are strictly limited to amounts which can be justified for research, medical, pharmaceutical or protective purposes. Any facilities using chemicals which could pose a risk to the purposes of the CWC are required to make annual declarations of relevant activities and, and will be subject to international monitoring and on-site inspections. The RSC would be interested to know if any of its members break these rules so that advice can be

	offered or action taken. The very nature of cutting edge research is such that it is impossible for the RSC to be aware of the precise nature of research activities of all its members and institutions but we are alert to the possibility.
Chemistry Courses and Terrorism	There was an appeal before the High Court in July 2008 concerning an individual who is the subject of a control order by the Secretary of State. The appeal is against the Secretary of State's decision not to allow the individual to enrol on an AS Human Biology and AS Chemistry courses because the coursework could be turned towards terrorism. This is a dangerous principle if upheld that could restrict the teaching of a range of science subjects, not just chemistry and human biology. The RSC believes that it is not the course material that is dangerous it is how knowledge is used. Our statement is: '**High Court judgement makes a scapegoat of chemistry** The chief executive of the Royal Society of Chemistry today criticised a High Court ruling that bans a 'suspected terrorist' in the UK from studying chemistry. Dr Richard Pike said: "There's a vitally important principle in this issue which must not be overlooked, which is the need to avoid depicting, wrongly, school chemistry as a starting point for attempts by potential young terrorists to produce explosives. "There is nothing on the AS Level chemistry course that cannot be found easily on the web and through other means. "I would stress emphatically that the Royal Society of Chemistry would never support any principle that we thought might threaten the British public; but not to object to the High Court ruling would be to accept the misleading image of school chemistry being a subject of particular value to potential terrorists. "That would be a dangerous precedent which would have the effect of making the public wary of a subject that is the central science essential to the research and development of medicines, foods, fuels and materials and addressing environmental issues. "In effect the court is making a scapegoat of chemistry, which emerges from the judgement with an image that can only encourage people to see it as a threat to life and to public security." He added: "We in the chemistry community believe in the need for principles to apply in every way in life. It is right that we fight terror. But we also believe in truth - and the truth in the case of AS level chemistry is that there is nothing in it that can be said to be a special tool for terrorist activities. "We cannot allow such a suggestion to remain unchallenged because such a misconception would work against the public good now and in the future."

	"We will be making our concerns known to the Home Office at the earliest opportunity."
Cloning of human embryos [see Therapeutic cloning]	All RSC members have to adhere to a Code of Conduct and guidance on professional practice that requires them to ensure that any activities in this area are carefully considered. In the case of cloning of human embryos the RSC would reflect on whether the activity was legal in the country where the activity was taking place. Currently the RSC has no formal position on whether cloning of human embryos should be permitted or not – however it is likely to favour controlled licensing for medical purposes over an outright ban. The RSC recognises that this is a controversial area with strongly held views and beliefs on both sides of the argument.
Comprehensive Spending review: science education	The RSC made the following key points in its submission for the last government comprehensive spending review The Government has made developing a highly skilled work force, building an excellent education system and creating an environment that promotes innovation and economic investment its highest priorities. The RSC welcomes and supports these developments. The RSC considers that investment should continue to be prioritised for these key areas to secure the gains already made and to ensure future prosperity. **Maintaining strength in UK physical science** The RSC considers that there is a demonstrable case for an additional investment of £3.4bn between 2008 and 2010 to achieve the following goals: **Securing the future of the chemical sciences in Higher Education Institutions** Total funding of £338m was needed for physical science and engineering in 2008 in universities, including £128m for chemistry. A further £306m per annum is required for 2009 and 2010. This will provide the necessary financial breathing space for Vice-Chancellors to draw up long-term plans for the sustainable provision of laboratory based subjects which are expensive to run, and to prevent economically damaging department closures. In the long term, funding should cover the full cost of provision, calculated by the Transparent Approach to Costing (TRAC). **Providing the best chemistry education in schools** Good school science facilities A capital allocation of £1.9bn is required to provide modern science laboratories in all schools, and £70m per annum for equipment. The RSC report The State of School Laboratories will assess the progress that the Government is making in this area. Specialist school teachers in the sciences Funding of £70m per annum (£210m between 2008 - 2010) is needed to provide specialist teachers in the sciences for all students aged 14 -16 years, by increasing the number of appropriately qualified science graduates entering teaching, continuous professional development (a minimum of 5 days per annum, costing £2.6m) and boosting retention.

Copyright in RSC Material	For RSC journal articles the RSC does not take Copyright Assignment, but rather a Licence to Publish. The RSC has, however, copyright of the entire journal. For RSC books (excluding Proceedings) the RSC takes Copyright Assignment. The case of the Proceedings is analogous to that of the journals.
Creationism in schools	*The RSC believes that creationism has no place in the science curriculum in schools. Evolution, based around the theories of Charles Darwin is the basis for scientific understanding. Creationism or intelligent design has no place in science lessons – they do have a role in school theory of religion based courses.*
Dietary Supplements [see also Food supplements; Herbal medicines/remedies]	There have been reports that taking excess doses of vitamins [via supplements] can be damaging to health. Providing that an individual does not exceed the RDA [recommended dietary allowance] then they should be okay – unless there medical problem. Remember 'natural' does not always mean safe. This is a public safety issue
Dioxins	Dioxins [a name given to a group of 210 similar chlorinated organic chemicals] are produced naturally – from volcanoes and forest fires. They are also produced from the by-products of some industrial processes [smelting, bleaching of paper pulp and manufacture of some herbicides and pesticides]. Dioxins are found throughout the world in air, soil, water sediment, and some foods, especially dairy products and meats. The higher up the food chain you go the higher the level of dioxins. 98% of people's exposure to dioxins comes through the food chain (direct inhalation accounts for the remaining 2%). Dioxins may cause adverse health effects, depending on the level, timing, duration and frequency of exposure, the particular compounds, and the susceptibility of the person exposed. Most concern is expressed over the link between long-term exposure to dioxins and the risk of cancer. Key is to improve industrial processes to reduce side products – green chemical technology is working towards this. Otherwise the monitoring and testing of foods to ensure that the dioxin level – if any - is below the set safety level is maintained. However, it is unclear whether there is a threshold below which exposure to dioxins will have no effect. The World Health Organisation (WHO) and the UK Department of Health's advisory committees assume there is a 'no-effect' threshold, and thus set slightly less stringent standards [ie an exposure limit has been set rather than an 'acceptable' exposure level]. Studies investigating health effects and dioxin exposure in specific locations (eg the area surrounding waste incinerators) have yielded inconclusive results. [See cancer causing chemicals]

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Dual Support system in HE	The RSC has consistently welcomed the recent increases in research funding provided through the research councils. The RSC has also welcomed funds invested in universities' fabric through JIF and SHRIF, and notes that a number of chemistry departments in the UK have benefited from the investment. In welcoming those funds that RSC also notes that HEIs have attracted investment in laboratory facilities from other sources, e.g. industry and venture capital, as well as committing their own resources. The RSC believes that it is difficult to carry out research in the chemical sciences in UK universities as the funds provided for such work do not pay for the full costs of that research. As chemical science research and teaching is particularly expensive due to the costs associated with providing a safe working environment, safe disposal of waste products etc., budgets are under particular pressure. Consequently the RSC welcomes any moves to increase the overheads associated with research. We also welcome Government funding to cover overheads on grants from external bodies such as charities.
Energy policy for the UK	UK energy policy must promote a diverse energy mix and avoid over reliance upon a single energy source. 1. A clear and co-ordinated energy policy is vital. The policy should: a. be long-term; b. not unfairly bias specific technologies but instead provide a level economic playing field for all clean energy technologies; and c. perhaps best be made by an independent, cross-party energy commission rather than the Government of the day. 2. Technology will not provide a short-term solution to meet Government carbon emission reduction targets; reducing energy demand is the only way to achieve these targets. The critical sectors to concentrate upon are domestic living and transportation. 3. With sufficient support, the chemicals sciences will be critical in developing clean energy technologies in the medium and the long-term. Technologies will include solar power, fuel cells, hydrogen as a fuel, safe nuclear waste management, carbon capture and storage, energy storage and energy efficient lighting. These technologies will reduce our reliance upon imported energy sources and reduce UK carbon emissions. 4. The RSC believes a UK geological repository for nuclear waste is vital and once the recommendations of the Committee on Radioactive Waste Management (CoRWM) are made the Government must act quickly to ensure the run down in skills is addressed and that facilities and finances are put in place. This must happen before any firm decision to build new nuclear power stations is taken.

Environmental Policies for RSC Printers	The RSC's strategy is to use suppliers of manufacturing (printing and binding) services that have an environmental policy that focuses on saving energy and water, encourages the adoption of recycling technologies, and which aims to reduce chemicals use, emissions and waste. Suppliers of paper are expected to ensure that paper is sourced only from sustainably managed forests. The use of online journals is likely to lead eventually to a reduction in the number of hard copy journals, with associated environmental benefits.
Enterprise Committee inquiry into the impact of England's university fees on Scottish Higher Education	Background Over recent years Scotland has seen reductions in the numbers choosing to study science at higher grade and on into higher education. While numbers of pupils studying science at Standard Grade remains steady there has been a fall of up 15% in the number of pupils opting for Higher Grade biology, physics or chemistry. There have also been reductions of up to 34% in applications for places and of intake into degree courses in the sciences. The 2001 Research Assessment Exercise showed significant increases in the proportion of chemistry research units rated as 4, 5 or 5* in Scotland. In the 1992 exercise 2 institutions out of 10 were rated as grade 4 or above, in 1996 3 out of 8 were rated as 4 or above, and in 2001 5 out of 6 institutions were rated 4 or above. The RSC feels strongly that the 2001 figures accurately reflect the true international standing of UK research in chemistry as shown by bibliometric measures. However it is worth noting that the number of chemistry cost centres in Scotland has fallen from 10 to 6 since 1992. Abertay, Dundee, Paisley and Napier Universities no longer have research cost centres; only Paisley and Dundee still offer chemistry degrees. Apart from the declining numbers the main reason for the reduction in departments is the cost of running chemistry. The funding provided by SHEFC for teaching chemistry students does not meet the real costs of providing such courses. Chemistry courses by their very nature are more expensive and require more space on campus which forces University administrations to put the financial squeeze on departments which host such courses. The Scottish Executive's "Smart, Successful Scotland" strategy is widely accepted and that Scotland's 40,000 scientists are vital to the success of that strategy. Also, there have always been particularly strong and economically beneficial links between science and engineering in Scotland. However significant barriers to commercialisation of research still exist. The UK lags well behind on industrial R&D spending compared with the average of our leading competitors—translating to £6 billion less each year. Despite a recent increase of over 30%, Scotland's industrial R&D record is even worse accounting for only 3.5% of the total UK investment. Recent increases in spending on science by the Scottish Executive and UK Government have helped to reverse that position but there is still a long way to go to bring Scotland up to the level of the rest of the UK and even further to match our G8 competitors. Tuition fees The RSC notes the rejection of tuition fees by all the Scottish political parties. However, this will lead to chronic under

	funding and differences between parts of the UK could lead to a further contraction of chemistry in Scotland. There are many examples of Scottish scientists leaving the country to take up positions in US departments where preferential funding is available. UK based companies are increasingly spending their research budgets outside the UK, a trend that could be accelerated in Scotland unless the funding gap is bridged. This staff emigration could be followed by a student emigration who would wish to follow the best staff and be attracted by better funded departments. It easily follows that if the best staff and students vacate the Scottish chemistry benches then the aims of the "Smart, Successful Scotland" strategy will be more a distant aspiration than a reality in the near future. Solutions The issues facing chemistry, and science, teaching and research in Scotland are already grave and are likely to be exacerbated by an additional financial pressure from south of the border. The RSC believes that the subject weighting factors for chemistry for teaching and research are inadequate and should be subject to urgent review. The RSC is willing to contribute data to that review.
EPRSC Engineering & Physical Sciences Research Council	During the past few months, the RSC has had a dialogue with representatives of the EPSRC over the mounting concerns in the Chemistry community about the allocation of research funds. We have held several meetings with EPRSC officers, including the Chief Executive, Professor David Delpy, and the Director Research Base, Dr. Lesley Thompson, and some improvement in the understanding of the important issues has been achieved. Also, the RSC in partnership with the Royal Society, the Institute of Physics, the Mathematical Society, and many of the Engineering Institutions has met Professor David Delpy and other senior EPSRC representatives to discuss a range of issues concerning the financial support for research in the physical sciences (Chemistry, Physics, Materials Science, and Mathematics) and Engineering. This group, headed by Lord Rees, been campaigning explicitly and through discrete discussions to support efforts to increase the Government's science budget. This would consolidate the welcomed increases in research expenditure in recent years, and, thereby, provide mid-to-long term support for the UK economy. This is necessary in any case but the argument is strongly reinforced by the actions of the Obama administration to significantly increase its investment in fundamental research in the US. Additional resource in the UK science budget may help EPRSC address some of the financial challenges that it is facing. However, it is important to note that picking short term research winners is unlikely to lead to longer term economic success. Furthermore, advances in medical and related sciences require a strong base of physical science. The RSC, together with our sister scientific societies, have been very concerned at the low success rates (average ca. 15%) achieved for responsive mode submissions over the past 12 months and the EPSRC have just introduced "new measures to improve peer review" that will be phased in from April 2009. We appreciate that EPSRC felt the need to take measures to address the problem of the low responsive mode success rates. However, despite our dialogue with EPSRC representatives, the RSC are disappointed that we were not consulted about the new measures and had no advance

	notification of the details of the changes. Thus, a situation has emerged that has caused some anxiety and anger within the UK Chemistry community, inhibiting the necessary constructive dialogue. The academic community does need to examine the pressures that lead to staff submitting several grant applications in rapid succession and appreciate that aspects of this policy may work to the detriment of the UK chemistry research community as a whole. Given that the EPSRC is the major provider of funding for chemistry research, UK chemists – at all stages of their professional development – could find it very difficult to maintain momentum in their research programmes due to administrative constraints at the EPSRC. In addition the RSC is worried that young researchers may not be getting the support needed to launch their research careers. We need these key problems to be addressed to ensure that the research base in the UK thrives and replenishes itself. The RSC is worried that the EPSRC may have lost the trust of a significant section of our chemistry research community and raised some fears, not least whether the majority of individuals (ca. 1,000) who were returned in RAE2008 will continue to be funded and, therefore, leading some to question the future viability of some UK Chemistry Departments. The RSC is committed to address the problems highlighted above.
Equivalent or Lower Level Qualifications funding	The Leitch Review recommended that the proportion of UK adults with a degree or equivalent should increase from 29% in 2005 to at least 40% by 2020. However, 70% of the workforce in 2020 have already left school, and will have several different careers during their lifetimes. So to meet this target, the current workforce will need to be able to retrain, often on a part time or distance learning basis, to support lifelong learning and to support government initiatives to boost workforce participation. The proposal from HEFCE to remove funding from adults working towards Equivalent or Lower Qualifications (ELQ), will reduce the overall ability of adults to undertake retraining. The RSC is pleased to see that strategically important and vulnerable subjects, such as chemistry, will receive funding to replace that which would have been lost under this proposal, but the total amount allocated will be based on past numbers of students with no allowance for funding the increased numbers of ELQ students that retraining our workforce will require. This may also have a damaging impact on institutions such as Birkbeck College, The Open University and Manchester Metropolitan University, which have a high number of part time and distance learning students will struggle to meet any increased demand for retraining in strategically important and vulnerable subjects. The RSC is calling for the current exemption from ELQ policy, which covers teacher training, social work and undergraduate medicine, to be extended to cover strategically important and vulnerable subjects, including chemistry. The UK should be willing and ready to support those individuals who are prepared to gain the skills that the country needs to underpin our future prosperity.
EU Chemicals White Paper	See REACH
European Research Council	RSC welcomes the proposal in principle as potentially enabling the expansion of European research activities, with increased emphasis on longer-term, visionary and multidisciplinary

	projects. However, RSC's support is conditional on the following critical requirements: • Proper recognition of the central role of chemistry in pan-European scientific research • Availability of a new funding stream additional to national research budgets • Allocation of funds on the sole basis of scientific excellence as judged by peer review • Administrative independence from the European Commission
Fees in English Universities	The RSC notes the current debate on fees in the HE system. Current fees of around £3,000 provide welcome additional funding to universities. Whilst the fees cap is less that the cost of all degree programmes universities essentially charge the same for all courses and so students choose between courses without taking the cost of the course into account. The main issue for students is whether to take longer courses which result in greater debt on graduation, or shorter ones with lower debt. The evidence is that the demand for longer courses remains whilst fees are around £3,000. The RSC accepts that to provide world class education the HE sector may have to charge higher fees. However, caution should be exercised as the recent study for UUK does suggest that the HE sector believes that charging higher fees (£7,000 plus) will affect student demand whereas charging fees of up to £5,000 is unlikely to affect demand. If demand is affected by higher fees then it is likely that in addition to those students who choose not to study in HE, a proportion of students will move from longer to shorter courses, thus affecting the demand for MChem courses in favour of BSc courses, thus reducing the total number of full time equivalents (FTEs) on course and therefore reducing the income to STEM subjects and in particular chemistry and physics. This in turn may affect the financial viability of chemistry departments, and other departments in expensive subject. Furthermore, if fees are raised to a level where STEM subjects charge higher fees than non-STEM subjects, or even to the point where differential fees are charged for different STEM subjects, it is likely that chemistry will be one of those subjects with higher fees attached, and this in turn will reduce demand, and affect income to chemistry relative to other subjects. Another consequence of differential fees is likely to be that less affluent students turn away from more expensive and longer courses. This will make expensive subjects open to accusations of elitism and may well reduce standards as some of the best less affluent students may choose not to read chemistry. The RSC urges that in making any decisions on the level of student fees that the long-term effects on more expensive STEM subjects are borne in mind. The RSC also urges that research is carried out to model any changes in demand that increasing fees will have. Reductions in the numbers reading chemistry and other STEM subjects could counteract the financial advantages to HEIs of the extra income that higher fees generate, and may reduce the number of STEM graduates, which will consequently have an adverse effect on the UK's long term future, and its ability to come out of the recession in good shape.
Fluoride in water	We have seen the plan for a ban in Belgium of chewing gum

	and tablets containing fluoride – the validity of which may be challenged under EU law. This is a public health issue and the public need to be involved in any decisions to add fluoride to water. Young children are likely to develop stronger teeth and to suffer less dental decay in later life if they have enough fluoride in their diet. Fluoride is found naturally in water supplies and in food but except for a few areas in the UK – principally the West Midlands, Cumbria and Northumberland - the natural levels found in water are not sufficient to strengthen teeth. Fluoridation of UK water supplies began in the early 1960s. The law now allows water companies to add fluoride at the request of a District Health Authority. [In May 2003 the Government indicated that it would bring in powers make it easier for fluoride to be added to drinking water]. Water companies that add fluoride must ensure that the concentration meets standards based on EU law. This has a wide margin of safety built into it. The Drinking Water Inspectorate also checks that fluoridation has been properly carried out. Too much fluoride is harmful. It can result in dental fluorosis [mottling of teeth]. This is usually a cosmetic problem but in severe cases it can lead to physical damage to teeth. At high levels it can also affect the skeleton and may lead to calcification of the ligaments. Mainstream opinion is that there is no public health risk from fluoridating water supplies. However some people are against compulsory mass-medication while there's still some concern about possible long-term health effects of fluoride. They argue that: • fluoridation isn't completely effective in preventing tooth decay and while it can help, diet and dental hygiene are also important • Fluoride is most effective in young children but by adding it to the water supply everyone receives it. • tooth decay is an important issue but seldom life-threatening • Fluoridation is costly and inefficient. The public water supply is used for many purposes and only a small proportion (less than 0.01%) of fluoridated water is consumed by young children. • There are better ways of giving fluoride to people, eg fluoridated toothpaste. • Some people may already get much more than the average amount of fluoride from their diet and adding it to water may because them to get too much in total. Although there are some potential problems, the process of adding fluoride to water and monitoring levels shouldn't present any real difficulties with modern equipment and technical expertise. Food and drink manufacturers who use fluoridated water supplies must not exceed required maximum levels of fluoride in their products.
Food supplements [The Food Supplement Directive C5-0640/2001]	The food supplement directive sets out to ensure a high level of protection for consumers and facilitate their choice of food supplements. The products put on the market must be safe and bear adequate and appropriate labelling. Remember 'natural' does not always mean safe. This is a public safety issue.

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Food safety	The Food Standards Agency plays an important role here. Food quality has improved over the years and there is better monitoring – carried out by chemists, often RSC members – many of whom are Public Analysts [these are all RSC members & hold qualifications from us – MChemA]. On a cautionary note, the improvements in analytical chemistry mean that lower and lower levels of components can be detected. Because you can detect something it doesn't necessarily mean that it is dangerous nor does it mean that it wasn't there before – it may just be that you could not detect such small amounts previously. If they were to be introduced today you wouldn't get a licence for potatoes or aspirin!
Funding for Chemistry Depts in HE	The RSC welcomes HEFCE's commitment to provide an extra £25m a year for Strategic and vulnerable subjects on a permanent basis. Although numbers entering chemistry have risen significantly in the last few years, and now stand at over 4000 across the whole of the UK, the cost of providing chemistry courses is not covered by standard funding streams and so the extra money is welcomed and demonstrates HEFCE's recognition of the importance of chemistry. We are looking forward to working with HEFCE to secure additional funding so that the true cost of providing an education on a laboratory based subject is funded.
GCSE results	• Welcome the achievements of students. • Welcome the range of types of specifications provided by awarding bodies as alternatives to the much publicised 21 century science and look forward to data on uptake of these. • All this is against a background of government still not investing enough in providing first class laboratory accommodation in schools as shown by the recent report of the Commons Select Committee on sustainable schools. • We remain concerned about the imbalance in specialism amongst science teachers (19% physics, 25% chemistry, 44% biology from 2005 NFER study) and would ask government to facilitate teachers attending our Chemistry for Non-Specialists programme (CFNS) funded by DIUS, GlaxoSmithKline and the RSC.

Global warming (and climate change)	Chemists have a major role to play in developing energy sources that contribute less to global warming and new materials and technologies that use less energy. The RSC believes that the Government is dragging its heels and that more needs to be done to address the problem. One of the keys is provision of people with the right science skills and encouragement of rigour and accuracy at school and university level. Our views on relevant teaching standards and on other aspects are available through our press releases on the RSC website. Global warming is a serious issue - possibly the most important issue facing the world - which we all should be concerned about. Human activity is interacting with a natural phenomenon – the world would be too cold to support human life without the contribution from natural global warming. The debate and uncertainty is about how much the human activity is affecting [and adding to] the natural processes. It is now accepted by the scientific community that unless we seriously change human behaviour the planet will be damaged. A major problem is that the developed world [especially US] contributes massively more per head to global warming than the developing world. As the developing world advances it is unlikely to adopt more sustainable approaches unless the developed world does its bit. Global warming doesn't mean UK will necessarily be warm and sunny! It may be wetter and stormier. Some effects of global warming may be step changes, eg rapid switching off of the gulf stream. Due to the 'residence time' of global warming gases in the atmosphere we may have to adapt to some global warming as well as trying to ameliorate it. Efforts to reduce global warming are increasingly coinciding with efforts to find new energy sources in anticipation of oil running out. The RSC welcomes the ambition of the UK Government to lead by example in setting statutory carbon dioxide (CO_2) emission reduction targets. However, the UK accounts for only 2% of global greenhouse gases; therefore if UK CO_2 emission reductions are not matched by concerted global efforts then the UK economy will suffer and the world will continue to warm. The RSC believes that it is absolutely critical that the legislation be fit for purpose and that it must be must be fully scrutinised so as to avoid unanticipated and detrimental effects. Presented below are the key views from the RSC to the Consultation on Setting up a Government Committee on Climate Change & Climate Change Bill: • The RSC has significant concerns over the make up of the committee and in particular over the three identified expert positions of technology development, energy production and climate science. The RSC recommends the experts serving on the Committee each be advised by a shadow stakeholder group that will comprise experts covering the key aspects of the topic so that the Committee member can present balanced unbiased advice to the Committee on Climate Change. • The Draft Climate Change Bill does not stress the importance of adaptation sufficiently. The RSC recommends that the Committee on Climate Change should have a dedicated position for an expert on

	adaptation expert (and associated expert shadow stakeholder group). • The RSC is concerned that focusing purely on CO_2 and not on other greenhouse gases may limit the extent to which global warming can be tackled, particularly if the UK is to invest in international projects. • The RSC is unclear as to the implications if the Government should fail to achieve 5-year, the interim 2020 or the final 2050 targets. • There is a need for the Government to introduce long-term measures to support research, development, demonstration and deployment of technologies that reduce greenhouse gas emissions and also to support the development and retention of skilled people.
Genetically Modified Organisms [GMOs]	Genetic modification as a process is going on all of the time – it's a natural phenomenon. In principle using science to help may be safer than the random processes in nature. What is different is the insertion of genes from one species into another in some forms of genetic modifications – there are uncertainties in doing this. There are issues about how genetically modified crops may interact with other plants in the local environment. As with all scientific advances we must listen to the public's concerns and take them seriously. Choice is the best way forward – allow people to choose GMOs if they want. The safeguards are high and rightly need to be so. Continuous monitoring is important. In some parts of the world it will be important to have these new GMOs to help feed the growing population.
Girls in chemistry	See [Women in Chemistry]
Government expenditure on R&D	In the UK expenditure is around 1.8% of GDP [The figures include any government spending that is defined as being spent on R&D and therefore do include MoD spending. One reason UK spending has continued to fall despite increased spending on public sector R&D is that MoD (and MAFF) spending has been falling. Its well below the EU average or the US [2.5%] and Japan [3.0%]. [The figures include any government spending that is defined as being spent on R&D and therefore do include MoD spending. One reason UK spending has continued to fall despite increased spending on public sector R&D is that MoD (and MAFF) spending has been falling.] Government has done a lot in recent years but must do more - Government expenditure on R&D is relatively small compared to industry. Industry must also invest more. Tony Blair said that science was key to the UK economy and Gordon Brown has expressed similar views. This is true and we must invest more to reap the benefits.
Health & Safety in schools	Pupils in more danger of having an accident on the school playing field by falling over than from something going wrong in the school laboratory. There is misplaced concern over the possible danger. There is no excuse for not doing practical work or demonstrations on safety grounds. Health and safety legislation doesn't ban anything that would normally be done in school chemistry practicals. We need to get teachers to recognise this. The RSC has an extensive programme of support and material promoting practical work and demonstrations.

Health & Safety in HE	Health & Safety issues are important in HE. This is where the underpinning training of the next cadre of scientists is undertaken. HE needs to maintain high standards and ensure that these are inculcated in students.
Herbal medicines/remedies [Traditional Herbal Medicines Directive (Directive 2001/83/EC)]	The Herbal Medicines Directive as regards traditional herbal medicinal products prescribes that "no medicinal product may be placed on the on the market without having obtained a marketing authorisation on the basis of harmonised requirements. In principle, the application for such a marketing authorisation has to contain the results of tests and trials on quality, safety and efficacy of the product". Herbal remedies have the ability to evoke a physiological/pharmacological response when taken alone or in conjunction with other active substances and as such could be considered as drugs. Therefore, in order to protect the public, such compounds should be governed by harmonised manufacturing guidelines and clearly labelled. UK manufacturers of traditional herbal remedies and others in the herbal sector agree that that there is a pressing need to require systematic quality standards throughout the supply chain to protect the public and the reputation of the sector. The proposed standards are those which are currently met by various UK manufacturers of herbal remedies, including small and medium sized businesses and are therefore not unrealistic. Remember 'natural' does not always mean safe. This is a public safety issue.
Hydrogen economy [see energy]	A great deal more scientific research is needed to understand the best way to implement a hydrogen economy. In particular, research needs to be done into developing new and more efficient ways to generate, store and transport hydrogen. To this end, the UK government needs to encourage a massive increase in investment, both public and private, in developing the hydrogen economy (the UK government currently spends around £18 million a year on renewable energy research). Along with this increased funding, the UK research councils will need to co-ordinate and focus their research activities in this area; this co-ordination should be between each of the councils, as well as with the private sector and other countries. A coherent policy framework for renewables, which includes a firm provision for developing 'hydrogen technologies', needs to be established by the UK government. An aggressive policy on emission regulations, such as the zero emissions mandate recently introduced in California, should form the central tenet of any framework. Such a policy would help to guarantee a future market for hydrogen and fuel cells, and would encourage private companies to invest the huge amounts of money that will be needed to set up the necessary refuelling infrastructure. Although installing the necessary supply infrastructure will be expensive, the long term cost to the UK of developing a hydrogen economy should be far less than the cost of the current reliance on fossil fuels (if all costs, such as the environmental and health costs of using fossil fuels, are taken into account). On long enough timescales the hydrogen economy should become economically competitive. So far, the UK has lagged behind other developed countries,

	such as Canada, the US and Japan, in developing a hydrogen economy, but there is no reason why that should continue to be the case. Indeed, there are many reasons why the UK should lead the way. It is an island state with access to a variety of renewable energy sources, and it has an active science base that is well placed to develop the necessary technologies.
Irradiation of food	Irradiation of food has the potential improve the safety of some foods. Like all technologies, there is the potential for misuse – irradiating food that has passed its 'sell by' date then selling it to consumers. It would be a pity to let the possibility that someone 'could' do this stop society from reaping beneficial effects of the technology.
Jobs in the chemical industry	The industry contributes over £4+bn/yr to the balance of payments. The UK has a long tradition in this area. In recent year UK companies have been moving into 'higher' added value products. The industry has become more global with major consolidation of companies. Some jobs have gone but others in SMEs have emerged. The Chemical Industry is an important part of the UK economy. In the UK the industry employs around 230,000 people; around 10% are graduates, with several hundred thousand employed in related industries. The industry invested £3.5 billion or 10 per cent of sales in UK research and development in 2000 - more than £9 million every day. Chemical industry exports in 2001 were an estimated £28 billion, creating the trade surplus of more than £5 billion.
Jobs in the pharmaceutical industry	Some of the world leaders – GlaxoSmithKline, Pfizer – have a major presence in the UK. Our science and scientists are excellent. The industry has become more global with major consolidation of companies. Some jobs have gone but many others in SMEs and start-ups have emerged. The Pharmaceutical Industry is an important part of the UK economy. In the UK-based it employs around 70,000 people, 25% of them graduates, with about another 250,000 people employed in related industries. The industry invested £2.9 billion in UK research and development in 2000 – around £8 million every day. Pharmaceutical industry exports in 2000 were an estimated £7.25 billion, creating a trade surplus of £2.35 billion.
Long instability due to Climate change	Royal Society Chemistry (RSC) shares the concerns expressed by Professor John Beddington, the UK government's chief scientist, at a Sustainable Development UK conference in Westminster, that food, water and energy shortages will unleash public unrest and international conflict. The RSC recognises that matching energy and food demand with declining natural resources, without permanently damaging the environment, is the greatest technological challenge humanity faces. The RSC believes that action and mitigation are both necessary and urgent. Through its recent work to define the role of the chemical sciences in meeting global challenges, the RSC has outlined how the chemical sciences and engineering can provide technological solutions to food, water and energy shortages and illustrated the critical role chemistry will play in the pursuit of sustainable development. The development of clean and secure renewable energy sources is essential in the quest to solve these interlinked issues and will rely on developments in chemistry. In its work the RSC has demonstrated how the

	technologies the chemical sciences engender will improve the quality of daily life, underpin prosperity and will increase our readiness to face the challenges of the future. In order to ensure technological solutions are developed and embraced, the RSC urges that independent scientists are involved more directly in the government's policymaking, especially to advise on the role of the chemical sciences in solving issues relating to energy and the environment. Full details of the RSC's work in defining the role of the chemical sciences in tackling global challenges can be found at www.rsc.org/roadmap. A report on the work will be published at the end of April 2009.
Nanotechnology	Nanotechnology is the creation of functional materials, devices, and systems through control of matter at the nanometre length scale (1 to 100nm) and the exploitation of novel properties and phenomena developed at this scale. A nanometre is one millionth of a millimetre which is about the size of 10 atoms and about 1/80,000 of the diameter of a human hair. The term nanotechnology is used to describe a spectrum of very different technologies that function at the nanometre scale. Nanoscience is the study of the scientific phenomena that underpin nanotechnology. Nanotechnology is important because it represents a new, potentially 'disruptive technology' that could eventually lead to a fundamental change in our technological landscape. Future advances in nanotechnology could change our approaches to manufacturing, electronics, IT and communications technology making previous technology redundant and leading to applications we could not develop without this new approach. The economic impact of this new technology can not yet be predicted. There has been considerable media attention given to the potential health and environmental impacts and the ethical and societal implications that new nanotechnologies may present. It should be noted that as nanotechnology represents a diverse number of technologies and it is not possible to generalise on the potential risks of all nanotechnologies. One cause of some concern is the potential health and safety risks of nanoparticles and nanotubes. It is known that nanoscale particles are likely to be more reactive than the same material in bulk, and those nanoparticles may be able to penetrate human cells. There is no evidence that the limited number of nanoparticles used in cosmetics can cause any damage. At present there is little research into the general toxicity of nanoparticles with respect to respiratory and genetic damage. More evidence is needed to understand if there is any cause for concern and more research needs to be carried out by the scientific community. Present UK and European health and safety legislation is in place to cover the toxicity testing and control of new chemicals, however up to now, these regulations do not acknowledge that the toxicity of a nanoparticle may not be predicted from that of a larger particle of the same substance. Additional toxicity testing of nano-phases is not required at present for a known chemical. The RSC supports the recommendation made by the Royal Society/Royal Academy of Engineering study, that the EC (supported by the UK), should develop its regulatory

	framework so that nanoparticles are treated as new chemicals. Those wishing to use such particles commercially would be required to carry out the requisite toxicity testing. Further research and appropriate test development will be necessary to facilitate this.
National Curriculum [England]	Science must be a core subject because a scientific understanding is a key attribute for all citizens. [see 14-19: Opportunity and Excellence]
Nuclear power [see energy]	• The RSC believes that nuclear power will have a key role to play in reducing CO_2 emissions and thus meeting targets for reductions in CO_2. • Nuclear energy production involves various aspects of chemical research and chemists will make their contribution to the safe utilisation of nuclear energy. • The scientific and technical expertise of the nuclear industry must be rebuilt to build, operate and decommission nuclear plants until it can be shown that additional nuclear power will not be necessary to meet our targets. • Failure to invest in future nuclear power production could leave the UK strategically vulnerable to a major shortfall in energy supply. • There needs to be a commitment to research and development into the long term safety of geological disposal as well as improved methods and means of storing waste.
Number of HE Chemistry Departments [see Scotland: University Chemistry Depts]	Removal of the binary divide [University/Polytechnics] in the 1990s resulted in less diversity in the system. The country needs a diverse range of chemistry courses – some vocationally focussed; some more aimed at preparing for research careers. The UK also needs a regional presence for chemistry courses to support the needs of local industry; and a national supply of people trained though chemistry to support a variety of industries and to go into teaching, as well as producing the next cadre of research chemists upon which the knowledge and enterprise economy will be built. Demand for part-time day release study has fallen as participation in HE has risen, hence the fall in undergraduate chemistry numbers a few years ago which has now been corrected thanks to some extent to the work of the RSC. A reduction in the number of discrete 'chemistry departments' is on the cards although many places will still teach the subject. Institutions may bring together areas where chemistry is taught: materials, environmental sciences; biochemistry; biological sciences to share resources and focusing on key expertise. You cannot have a strong science faculty in any university without strong chemistry teaching – chemistry is the key underpinning science. Focussing resources on fewer but larger regional chemistry departments may have advantages. The teaching infrastructure needs major investment to bring it up-to-date and to improve the working conditions for lecturers and students – recent government spending has started to address this, but we were starting from such a low base that a greater sustained investment over many more years will be needed. It will also demonstrate that chemistry is a modern and relevant subject. 'Departments' are administrative structures hence focusing on these rather that depth and quality of chemical science teaching within an institution can be misleading.

	In recent years it has been pleasing to see new Chemistry course being offered at University of Lincoln; Queen Mary, London; University of Lancaster; and the re-introduction of an HND at Mid Kent College. This emphasises a renewed interest in the study of chemistry among undergraduates.
Number of A – level students/Highers	There are 36-40k chemistry 'A' level students every year and nearly 10k chemistry Highers students in Scotland. These numbers have been 'effectively unchanged' for many years. Chemistry is popular – the challenge is to encourage students to choose to study BSc/MChem chemistry. Increasingly students are using chemistry as a passport to business studies, law, economics, computer studies as well as the ever popular medicine.
Number of HE Chemistry Students	Students study chemistry for a variety of reasons. Some undertake their studies for vocational reasons: they want to pursue a career in or using chemistry. Others study chemistry as a general education: the skills developed [analysis of data; numerical skills; problem solving] through a chemistry course are much sought after by employers. Around 3800 students were accepted on to chemistry degree courses in 2007 and overall the numbers have risen by 34% in the last 5 years; following a decline in the late 1990s.The numbers of students choosing the MChem/MSci route has also increased over the last few years with figures from UK university chemistry departments showing that there is now an almost 50/50 split between those on BSc courses and those on MChem/MSci courses. There is no actual 'shortage' of chemists in numerical terms. Some companies would like to see higher quality in interviewees that they are trying to recruit. The more chemically trained members of the population there are the better as it raises the scientific literacy, generally. Chemistry graduates have always found good careers outside of the practise of chemistry: their skills are always in high demand. The yearly trend is positive and upwards. Applications up 11% in 2007; Admissions up 9% in 2007.
Number of PhD chemists	At higher degree level (PhD degrees and standalone Masters) the trend overall has been a rise in numbers since 2000; in 2006 there were 1370 higher degree chemistry graduates. At research level these students are supported by a number of research councils, charities, companies and universities. Chemistry graduates at all levels have always found good careers outside of the practice of chemistry: their skills are always in high demand. Increased stipends and some relief from the burdens of student loans would help ensure continued supply and avoid the temptation of taking a job following graduation rather than doing postgraduate research. There is no actual 'shortage' of chemists in numerical terms. Some companies would like to see higher quality in interviewees that they are trying to recruit. The more chemically trained members of the population that there are the better as it raises the scientific literacy, generally. Chemistry graduates have always found good careers outside of the practice of chemistry: their skills are always in high demand.
Number of science/chemistry teachers	Age profile is loaded towards the over 50s. It is encouraging that more people are considering a career in teaching. Recent Government initiatives on student loans [waived on completion of course and getting a teaching job] and support for training are welcomed. We need to encourage more of our best chemists to consider and go into teaching.

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Open Access	RSC launched Open Science, our hybrid open access model. In a hybrid approach authors can pay to have their articles made freely available to all alongside a normal subscription model for access to the remainder of the content. [Many of the RSC's competitors seem to be going down this route, and recently both ACS and Wiley have announced the introduction of hybrid open access models.] The scheme is as follows: • RSC will adopt an open-choice author-pays model for all RSC journals with the following rates: £1000 for a communication, £1600 for a primary paper, £2500 for a review. [If all authors moved to OA this would generate considerably less revenue than subscriptions.] • We will need to accede to proposals before US Congress etc in our policies regarding deposition in institutional and other repositories. Our policies on these things will be adjusted where necessary, as will our licences. Overall the RSC wants to keep authors and subscribers as long as possible and maintain the relevance of RSC publishing to its markets. By adopting this new strategy and encouraging the development of a new revenue stream, ie from authors, RSC publishing positions itself for possible changes in the market without betting on how the market will eventually distribute itself. <u>FAQs</u> Q. Can I still publish with the RSC without paying an author charge? A. Yes. It is envisaged that for the foreseeable future most authors will wish to publish via the normal 'free' route. Q. Will my willingness to pay an author fee affect whether my article is published? A. No. Only after the article is accepted for publication is the invitation to have your article published in the normal way or to pay for access is made after the article is accepted for publication. This preserves the independence of the peer-review process. RSC Open Science will have no impact on the outcomes of the peer review process or on any editorial decision. Q. Can I arrange to have an article I published previously with RSC made freely available? A. Yes, contact the Editorial Office with details of the paper and you will be asked to complete a new licence and to send the appropriate fee. Once these have been received your article will be made freely available to all. Q. Is there a discount on the RSC Open Science fee for RSC members? A. Yes, there is a discount of 15% of the relevant fee for RSC members. Q. Is there a discount on the RSC Open Science fee for Owner Societies of journals published by the RSC? A. Yes, there is a discount of 15% of the relevant fee for members of Owner Societies publishing in Physical Chemistry Chemical Physics and Photochemical & Photobiological

	Sciences. Q. Is there a discount for authors from subscribing organisations? A. If your organisation has a current subscription to RSC's packages A or B you are entitled to receive a 15% discount on the relevant RSC Open Science fee. Q. If I choose to pay an RSC Open Science fee when will my article be made freely available? A. If the article is ready for publication and the relevant licence and fee have been received by the RSC the article will be made freely available immediately upon publication as an Advance Article and thereafter in PDF and HTML versions. If the licence and/or fee arrive after the article has been published, the article will be made freely available once both licence and fee have been received. Q. Does the RSC Open Science fee cover any other publication charges? A. The RSC does not levy publication charges except for cover charges, author-paid colour (that is colour in printed versions that is deemed not scientifically necessary for the understanding of the paper), cover charges and charges for printed reprints. These charges are not covered by the RSC Open Science fee. Q. Which version of my article will be made freely available if I pay the RSC Open Science fee? A. The Advance Article will be made freely available provided the appropriate licence and fee are received during the period of Advance Article publication. The PDF and HTML versions of the article will be made freely available as and when they are ready provided that the licence and fee have been received by RSC. Q. Where can I post any articles of mine that are freely available as a result of my having paid the RSC Open Science fee? A. In consideration of the RSC Open Science fee the RSC will make freely available the final published version in all online formats on the RSC's website for an unlimited period of time. The RSC will deposit the accepted author version of the paper in selected repository(ies); no embargo period applies where the RSC Open Science fee has been paid. You may deposit the accepted version of the submitted article in other repository(ies) as required, with no embargo period, except that you are not permitted to deposit your work in any commercial service. Q. What does RSC define as an "accepted author version" of an article? A. The author version of an article is the author's revised version that has been accepted for publication. Q. If I opt for free publication, where can I post my articles? A. Upon publication you can deposit the accepted author version of your article on an Intranet; you can self-archive in a web repository after 12 months. The RSC will deposit the accepted author version of the article in a repository (ies) as

	deemed appropriate with an embargo of making this deposited material available to the public of 12 months. Q. Will RSC take author-pays revenues into account in setting future journal prices? A. Yes, but with the caveat that, along with many other publishers, RSC considers the author-pays open access model to be an experiment rather than a proven business model. Running this model alongside the normal subscription route for access represents a risk and the RSC reserves the right to withdraw the author-pays open access model at any stage.
Ozone depletion	There is no ozone 'hole' as such - what is referred to as a hole is a thinning of the ozone layer. • Chemists have been instrumental in furthering our knowledge and understanding of the ozone layer. It was a climate chemist, Susan Solomon (who sits on an RSC editorial board) who worked at the South Pole to explain the cause of the so-called "hole". • Full compliance with the Montreal Protocol is essential for recovery of the ozone layer. • Further research is required to look at the impact of climate change on the recovery of the ozone layer. • The RSC would welcome co-ordination of international policies which regulate ozone-depleting substances and greenhouse gases. • Chemists are uniquely placed to provide safer alternatives to ozone-depleting substances. • Ingenuity from chemists is required to find ways of managing and disposing of existing stocks of ozone-depleting substances.
Patents	Under the 1977 Patent Act, employees are entitled to be rewarded if the patent on their invention creates an 'outstanding benefit' to their employers. This is an area where the Government is looking to bring UK law into line with changes to the European Patents Convention, by giving employees new rights to compensation. In the RSC's Code of Conduct and Guidance on Professional Practice to which all RSC members adhere, members have obligations as employees as set out below: When members become employed, most of the contractual rights and obligations will be specified, either in a formal contract of service, or a letter of appointment. In any case, all employers in the UK are obliged to produce a document containing the main conditions of service. There are also obligations, some legally enforceable, that arise from the relationship between the member and the employer. These apply even if they are not set down in writing. The main obligations in summary are …… • to allow and assist the employer to profit fully from discoveries and inventions arising from the normal duties of the employment (there may be a legal provision for an employee to derive benefit from an innovation of outstanding benefit to the employer)

	The RSC's view is that employees should be rewarded if the patent on their invention creates an 'outstanding benefit' to their employers. The definition of 'outstanding benefit' is decided by the courts. Any moves to increase the opportunities for scientist to share in the financial rewards of their discoveries would promote the entrepreneurial and enterprise culture in the UK.
Pesticides	Some pesticides occur in nature – others are manufactured. The quantities of pesticides used are declining as the industry develops pesticides with more specific activity. Pesticides have played an important role in improving crop yields but are often very hazardous materials, [requiring proper containment and use, sadly not always the case eg in developing world]. The improvements in analytical chemistry mean that lower and lower levels of pesticides can be detected. Because you can detect something it doesn't necessarily mean that it is dangerous.
Pollution	We all 'pollute' [eg when we drive or produce rubbish].This is an important issue for the planet. We need to develop sustainable technology and minimise pollution. We need to recognise that as more economies develop that the issue becomes increasingly important. In chemistry the development of the 'green chemistry' movement with its friendlier technologies has huge potential to play a role in reducing pollution. This is a wider issue than just chemistry – it's about global economics.
Publishing	The RSC is a leading worldwide publisher of chemical information. Our journals are leaders in the field of chemical science. They have high impact factors and have some of quickest times to publication from receipt of a manuscript. We have invested heavily in organising and supporting the peer-review process and in the necessary IT infrastructure in order to ensure the highest level of service to the scientific community. Relative to others, our prices are modest for the service that we provide. Learned Societies generally charge much less, in $ per page, than commercial publishers. Any surplus that we make is re-invested in chemical science worldwide with a primary focus on Europe. For instance we have a grants scheme for our authors than means that they can travel to enhance their research collaborations. We are also major supporters of educational programmes supporting the teaching of chemistry in schools. For RSC journal articles the RSC does not take Copyright Assignment, but rather a Licence to Publish. The RSC has, however, copyright of the entire journal. For RSC books (excluding Proceedings) the RSC takes Copyright Assignment. The case of the Proceedings is analogous to that of the journals. Suppliers of manufacturing (printing and binding) services that have an environmental policy that focuses on saving energy and water, encourages the adoption of recycling technologies, and which aims to reduce chemicals use, emissions and waste. Suppliers of paper are expected to ensure that paper is sources only from sustainably managed forests. The use of online journals is likely to lead eventually to a reduction in the number of hard copy journals, with associated environmental benefits.

RSC | Advancing the Chemical Sciences

REACH [see http://www.rsc.org/images/Reach_tcm18-83940.pdf]	The RSC welcomes a single harmonised regime for assessing and controlling the effects of chemicals on health and the environment. However the Society would like to stress that: • it is vitally important that REACH is based on risk • REACH should be compatible with existing and proposed international initiatives on the control of chemicals • the RSC fully supports the principle of transparency under REACH • REACH should only require data that has real value • The RSC welcomes the simplified and reduced Registration requirements but has serious concerns about the resources and expertise within the European Chemicals Agency, competent authorities in member states and in testing laboratories for coping with REACH. • One particular concern is that the REACH could lead to useful chemicals ceasing to be available due to the high cost of testing. This will be of concern to schools & colleges. • REACH should not inhibit innovation **Recent developments** The Society, representing the views of professional chemists in the United Kingdom, has followed the development of the proposed REACH regulation with interest and has contributed to the debate both directly and via the Chemical Stakeholder Forum. We had a number of concerns about the original text proposed by the Commission, but we recognise that, as a result of much work in the Council and Parliament, most of our original disquiet has either been eliminated or diminished. We are aware that reaching a Common Position in the Council is a priority of the UK Presidency and what follows is intended to support this aim. We also believe that what is said below may assist in ultimately achieving a text that would be acceptable to the European Parliament. We remain concerned about some of the amendments proposed by the Parliament to Title VII, dealing with Authorisation, which may lead to unintended consequences for innovation and sustainable development, particularly in process chemistry. Uncertainty as to whether an authorisation might be rejected (Art. 53), not renewed (Art. 55) or even if a specific process chemical might require authorisation (Art. 54f) provides an additional pressure to undertake novel synthesis and process R&D outside the EU which would be to the detriment of the chemical sciences. We consider that substances having intrinsic hazardous properties do not necessarily pose significant risks either to humans or the environment solely on the basis of these properties. Indeed, nature abounds in such materials. However, we recognise that it is rational to exert a higher degree of scrutiny and control of human use of such materials and where appropriate to substitute them by more suitable ones. Thus we strongly support the Council text, which achieves a realistic compromise. It permits authorisation where the risk is adequately controlled and requires evidence of socio economic benefit and absence of alternatives where this cannot be done. It allows authorisation time limits to be determined on a case by case basis and provides an improved, although still unclear, definition of 'equivalent concern'. However, in order to make progress towards a consensus with

	the Parliament we offer the following suggestions: **Justification of Authorisation** As stated, we support the current Council text, but we recognise that the Council and Parliament texts differ significantly. If a compromise has to be found, then requiring a substitution assessment for <u>all</u> potential authorisations might be acceptable. In the demonstrated absence of an acceptable substitute, authorisation would then be granted for those uses where the risk was adequately controlled, and, for those uses where adequate control could not be guaranteed, might be granted if there was sufficient socio-economic justification. **Substitution** This should always be based on a holistic approach to the impact of a substance, and should include an assessment of efficacy and efficiency as well as the impact on energy and raw material consumption as well as human and environmental safety concerns. Consequently we recommend that if Amendment 364 is accepted the phrase "**the most sustainable substances available"** should replace "**the safest substances available"** and, in any case, that substitution should be defined in this manner in Article 3. **Equivalent Concern** The words "**causing serious and irreversible effects to humans or the environment which are equivalent to those of other substances"** should be retained in Article 54f. EP Amendment 217 is too ill defined to provide regulatory certainty for potential innovators. **Time Limitation** We agree that authorisations need time limits, but these should reflect the scientific realities to avoid creating uncertainty. Even where a substitute has been identified it may take more than 5 years to implement the changes in a complex supply chain and in some situations substitution may not be possible e.g. gallium and germanium (PBTs) in transistors. Consequently we suggest that time limits should be set on a case by case basis with a maximum of 15 years. Finally, on behalf of the 44,000 professional chemists comprising our membership, we are concerned about the implications of EP Amendment 285 which states that **"experts and scientific and technical advisers shall not have economic or other interests in the chemical sector which may prejudice their impartiality."** We are sure that the Parliament did not intend to defame our members, however, we would point out that the impartiality of those receiving grants from, campaigning on behalf of, or financially supported by 'green' organisations may also be prejudiced. In our view it is better to use individuals with real expertise, whether from academia, industry or NGOs, whose interests, financial and other, are transparent than those who are completely impartial but without expert knowledge. We therefore recommend that the wording in the current Council Text is retained.
Renewable energy sources RES [see energy]	• **The RSC is extremely active in encouragement of RES Its CEO Richard Pike has written extensively on the issues and we can provide (via our website) copies of his materials.** • Electricity generated from renewable resources will be fundamental in ensuring a secure and continuous energy supply whilst minimising CO_2 emissions and environmental impact. • The UK will need to use a variety of renewable energy resources to meet its target of reducing CO_2 emissions by

	20% by 2020. These sources will include solar, biomass, wind, geothermal (heat from the Earth's interior), and ocean power (including salinity-gradient energy). • There is a considerable challenge for chemists to improve the efficiencies of existing renewable energy technologies as well as to develop new technologies. This can only be achieved through extensive funding, full scale demonstration projects and collaboration with other scientists and engineers. • Advanced energy storage technologies necessary to tackle the issue of the intermittency of renewable energy sources will present significant opportunities and challenges for chemical and material scientists.
Research funding in HE	The RSC welcomes how well chemistry did in the recent Research Assessment Exercise and welcomes the intension to ring fence monies for STEM subjects. If the UK is to compete on a global basis it is vital that government supports basic research in Science Technology Engineering & Mathematics. Investment in chemistry is vital if the UK is to meet global and societal challenges such as climate change and the need for low carbon energy source.
Risk	Risk is not the same as hazard. The most 'dangerous' chemical in the world can be 'safe' if it's properly contained [ie a low risk]. Conversely a relatively innocuous chemical can be dangerous if used incorrectly. Perception of risk is personal. It's a difficult subject to deal with. The scientific method requires that theories are challenged. This can give the perception that scientists disagree on the basic facts and sometimes there is not agreement on the 'facts'. In most cases the basics are agreed and discussions occur at the margins. We, as the public, find such disagreements disconcerting. 'Nothing is totally safe' – our 'personal reaction' to this statement depends on the context to which it is applied. Understanding 'risk' will not reduce 'fear': these are two separate things: one more rational, the other more emotional!!
Safety in science	See Health and Safety
Sainsbury Review of UK Science & Innovation,	The Society greatly welcomed the Sainsbury Review, to which the RSC made a contribution. "Coming from such an experienced former Minister of Science, it was a valuable analysis of what we need to do to make Britain a world-class place in which to do science. As we ourselves are a Society with a global reach – and members all over the world – we wholeheartedly endorse the view that the UK must not ignore globalisation but redouble its efforts for the international scientific cooperation necessary to deal with global challenges such as future energy sources and climate change. "We still look to the Government to match the country's aspirations with funding for refurbishing school laboratories, Continuing Professional Development for teachers as well as promoting innovation. Taking a supply chain approach to the whole process, as eloquently laid out in the Sainsbury Report, is the only way forward. Continuing the investment seen in the past 10 years is vital for our future success. We must remember that we are improving our performance across a

	range of science and innovation indicators; but relative performance is key and if we don't outperform our global competitors we will be effectively going backwards. The blueprint sets out our future strategy
Scientific advice	As far as it is possible, scientific advice to the Government should be independent and should be published in the public domain.
Scientific advice in the European Commission	The RSC supports measures designed to strengthen the network of scientific advice throughout Europe and supports the introduction of a Chief Scientific Adviser to the European Commission. This must be supported by a wider network of Scientific Advisers that are aligned with EU structure and accredited by the European Commission. **Background to RSC position** Policy-making should be based on sound evidence and science and engineering play a vital role in contributing evidence. With a view to the use of science in the formulation of policy, the RSC commends the appointment of Chief Scientific Advisers to 17 UK Government departments that use science-based policy-making and we would like to see the embedding of science extended to all Government departments. The recent call by John Beddington, the UK government's chief scientific adviser, for more brutal scientific advice for European commissioners and MEPs suggests that the current infrastructure in Europe is not effective at integrating science and engineering into policy making. Professor Beddington is leading efforts to update Europe's science advice system and is calling for more independent advisers. Scientific support for the Commission is currently provided by the Joint Research Centre. The Commission draws on this body when establishing scientific panels and expert working groups to deal with specific themes or issues. This forms the basis of excellent scientific expertise to be drawn together on specific issues where the Commission has identified a need for it. However, there is currently no mechanism in place for more proactive scientific advice, which policy makers might not want to hear, to feed into the Commission. The appointment of a Chief Scientific Adviser to the European Commission is one idea that would show that Europe recognises the value of science and engineering in policy-making. This would help to overcome the current fragmented system of scientific advice in Europe. The RSC welcomes measures designed to strengthen the network of scientific advice throughout Europe. We support the introduction of a Chief Scientific Adviser to the European Commission. This must be supported by a wider network of Scientific Advisers that are aligned with EU structure and accredited by the European Commission. Science and engineering should be central to evidence-based policy-making and while putting structures in place to gather evidence is a positive first step, this must be back up by improved scientific literacy amongst civil servants
School science – curricula	The RSC has been and still is very vocal on the issue of the erosion of standards in school science teaching and exams. We believe that there has been a drift away from quantitative science and mathematics at a number of levels and we campaign for a return to high standards. The RSC is actively involved in advising the Government on

	how the curriculum should be developed. The introduction of science into the national curriculum has been a great success and we are only now beginning to see the benefits feeding through the system. At 16 the RSC believes that science should remain compulsory for all but that the curriculum should reflect that for the majority of students, science education is about preparing them to become citizens rather than scientists. GCSE courses should reflect this while still providing a sound basis for those who do wish to peruse science based study post-16 and in HE. Post-16, courses should lay the foundation for HE. Chemistry courses need to be modern reflecting the subject today. Courses should not be driven by assessment needs ie – we can't teach something because it's not easily assessed eg societal issues.
School science – labs	The Roberts' Report called for more funding to improve school laboratories. This Report backed up the RSC campaign for better and more modern school laboratories. This will improve working conditions for teachers and pupils. It will be motivating and show science to be the modern and relevant subject that it is. CSR delivered major increases in capital investment to improve school labs. This is welcomed by the RSC
Science Diploma	The Science Diploma offers an opportunity for a radical revision of school science provision, which we as members of SCORE welcome and embrace. However, we believe that at present the government is in danger of not making the most of this massive opportunity due to the timescale and constraints imposed on the development and implementation of the qualification. We would wish to work with the appropriate groups to ensure that the Science Diploma achieves its potential but at present our concerns are so great with the current development that we do not feel able to continue to support the development phase. We believe a serious review of purpose, structure, content and implementation is needed before any further work is undertaken. We would be happy to work with Government to help achieve this. **Key points** ▪ Purpose and philosophy – Clarity on purpose and philosophy has not yet been achieved and until this is clear then development of the Science Diploma will be flawed. ▪ Meeting the needs of all students – The current constraints on the development of the Science Diploma (e.g having to take all the subjects rather than providing specialist routes within the framework) makes this an impossible task. ▪ Progression post-19 – We don't think it will encourage or enable any more students to study science post-19 and may even be detrimental to this cause. ▪ Social mobility – If it can't enable/expand post-19 study, it won't address this agenda. ▪ Broadening access to STEM – Rather than broadening access, the Diploma model may reduce access to STEM related subjects/qualifications at Level 3 and post-19. ▪ Delivery/implementation - The timescale for implementation will not mean that the teachers and schools are ready, competent and confident to deliver the Science Diploma.
Science Funding	The RSC is fully supportive of the Department for Innovation, Universities and Skills (DIUS) request for a £1bn investment in UK science funding. Science and engineering should be at the

	heart of any economic stimulus package announced in the spring 2009 budget. It is crucial that the funding of science is not neglected during the economic downturn. We should return to the idea of a knowledge based economy, move away from being dependent on the financial sector, and support UK process industries and manufacturing. An injection of cash into science, technology and innovation will help to secure a future for the UK economy. According to NESTA, the biggest gains for society in the recession will be found in those sectors that both offer the most immediate growth potential, drawing on the UK's existing strengths, and help meet long-term challenges: green energy, environmental services, biotechnology, and services for an ageing society.[i] The chemical sciences will make a vital contribution to solving these long-term challenges. The RSC recommends that government ensures any additional funding will include support for the chemical sciences. RAE 2008 identified that major growth points and strengths of UK chemistry are found at the boundaries with biology, engineering, environmental sciences, materials science, medicine and physics. Work together these disciplines can solve long-term challenges. Chemistry is leading the way in interdisciplinary working as demonstrated at the Chemistry Biology Interface. Over recent years, Chemical Biology has grown rapidly in spread, depth and quality to become one of UK Chemistry's strongest fields of multidisciplinary research. Alongside investment in interdisciplinary research, the RSC strongly recommends that there is an injection of funds into fundamental chemistry research and training. This will ensure that a strong UK research base is maintained which is essential to underpin solutions to global challenges. A decreased emphasis on funding of fundamental research could mean that the UK may not remain truly innovative and internationally competitive. The RSC believes that the Government should provide cash injection into UK science to encourage the retention of UK talent. The RSC recommends greater investment in early career research staff and the successful development of their careers. We operate in a global market and the brightest of our young academics could move to other countries, notably the USA with the commitment of President Obama to inject significant new resource into science and technology. The economic downturn has resulted in fewer start-up companies being formed. There is also a lack of growth within medium sized companies. Funding is also needed to support and nurture SMEs to protect the future UK chemical industry. [1] NESTA - attacking the Recession http://www.nesta.org.uk/assets/Uploads/pdf/Interim-report/attacking_the_recession_discussion_paper_NESTA.pdf
Science & Innovation – 10 year Framework	This was welcomed by the RSC. Key highlights for the RSC from the outcome include **Working to secure the future of the chemical sciences in Higher Education (HE)** • £70m allocated to enhance [UK] capabilities in areas such as the physical sciences • HEFCE to take a more active role in examining regional provision of science teaching, including setting up of an

	expert group to review impact on economic development • Increased role of RDAs **Providing the best facilities to train and inspire scientists of the future** • An increase in the overall DfES capital budget from £5bn to £7bn • Provision of science facilities highlighted as part of the DfES "Building schools for the future" programme for England. **Providing the best chemical sciences education in schools** • Government target to achieve a step change in the quality of science teachers and lecturers in very school, college and university • Increases in the science teacher training bursary and Golden Hello • Expansion of continuous professional development opportunities • A review of SET teaching staff turnover. The outcome is very positive for chemical sciences and the Government is to be congratulated for finding resources to address these key issues now. The RSC will seek to work in partnership with it and others to ensure that these ambitions are realised.
Scotland – current key issues for the Parliament	A Scottish centre for teaching excellence To build on recent developments in science and teaching, the Scottish Executive should back the creation of a Scottish centre for science education. The centre would support Continuing Professional Development for science teachers and should be a partnership of all Scotland's universities and the scientific societies and institutes with a centre in every region of Scotland. More science teachers To help tackle the potential shortage of quality science teachers, the Scottish Executive should consider targeted incentives to assist recruitment. School laboratories fit for the 21stcentury To provide a modern science teaching environment an additional £13 million should be invested every year to fully equip Scotland's secondary school laboratories and keep them up to date. This would also help to attract more pupils to the sciences. The £8 million announced for science equipment and training for primary and secondary schools earlier this year is welcome but simply not enough. An audit of secondary school laboratories should also be conducted to assess what investment is required to bring all facilities up to an excellent standard. A network of Scottish science centres The Scottish Executive should invest in Scotland's sciences centres in order to secure their financial future, support their work on the public engagement with science, cut the cost of entry to the public similar to the scheme for free entry to museums and develop their role in the formal science

	education network. [see Enterprise Committee inquiry into the impact of England's university fees on Scottish Higher Education]
Scotland - University chemistry departments	The health of chemistry in Scottish universities is different from the rest of the UK. The RSC has some concerns but is also pleased with other more encouraging signs. On the up side, £37million is being invested in chemistry and physics research over the next four years. The funding from the Scottish Higher Education Funding Council, the Office of Science and Technology and the universities themselves will enable groupings of universities to pool their resources in two special alliances called SUPA for physics and ScotCHEM for chemistry. It will allow 380 researchers to compete more effectively on the world stage with additional benefits for the economy. Student numbers in chemistry have fluctuated over the years. They declined between 1997 and 2001. Since then there has been a considerable rise with at least one department recruiting more students than ever before. However, on the down side Dundee University decided to close its Division of Physical and Inorganic Chemistry and Robert Gordon's University ceased teaching its chemistry degree. The RSC was disappointed about these decisions but is comforted that chemistry is still an important element at both institutions. One of the reasons that Scotland has not faced an Exeter University type closure is that the Scottish research funding formula is more favourable to 4 rated departments. However, the underlying funding arrangements for teaching and research at Scottish Universities still do not reflect the real cost of doing chemistry. The new investment in chemistry is solely focused on research, but it is important that, for chemistry to flourish, the whole education process is addressed. The Scottish Executive and Scottish Higher Education Funding Council need to take further action to enable chemistry to thrive here. The measures include: • Continued investment in the teaching and research infrastructure especially teaching laboratories • A review of the teaching and research funding arrangements for chemistry • Efforts to increase the number of students opting for chemistry and science at school and at university and an improvement in schools chemistry teaching. • A program to increase public awareness of the benefit to the individual and the community of education in chemistry At a UK level the Royal Society of Chemistry wants the Government to invest £300 million (£90million for chemistry) to support the short term future of university science departments whilst more sustainable long term arrangements are put in place.
Standards – schools	In summer 2008 the RSC ran the 5 decade challenge. Schools

	were invited to enter their best 16 year olds in a fun competition where the questions were drawn from O-level and GCSE chemistry questions from the last 5 decades. The paper was dominated largely by numerically-based questions. Nearly 300 of the country's brightest 16-year-olds took the on-line two-hour test and some did remarkably well. Students did well in the test – a tribute to their endeavours and the skills of their teachers with those participating on average scored just 25% of available marks. More importantly analysis of the results showed some alarming trends: ▪ Many teachers want to take the opportunity to stretch the abilities of their most promising pupils, and these pupils are eager to take up this challenge. The large number of entries to this competition indicates that teachers strongly support their pupils proving their abilities outside of GCSE examinations. We congratulate the pupils and teachers who took the time to participate in this competition, despite most candidates having recently completed their GCSE examinations. ▪ Performance against each decade showed a remarkably steady step-wise progression, with the average scored for the 1960s questions being 15%, rising to 35% for the current 2000s decade. Changes to the syllabus and to the language used in examinations since the 1960s may partially explain this progression, but are unlikely to provide a complete explanation. There was a significant increase in average marks between the 1980s and 1990s, corresponding to the transition from the O-level to the GCSE system, which was first examined in 1988. The increase between the 1990s and 2000s was small, suggesting that the level of difficulty of the numerical or analytical component of GCSEs has remained unchanged over the twenty years since this transition, although such questions form a small proportion of typical papers. ▪ There is an urgent need to enhance the level of problem-solving and quantitative skills of 16-year olds in the UK. The average mark in this largely quantitative test was 25%; some students scored no marks at all. However the distribution of marks was skewed and there were also some outstanding performances; the highest mark was 94%. ▪ Questions or their components requiring a single-step mathematical operation were answered most successfully, followed by questions requiring no mathematics (typically recall or logic). Those needing multiple mathematical steps, without prompting, were answered least well. As few as one-tenth of the marks of more recent papers are allocated to numerically-based questions and often have prompting to guide the student. Correct steps following errors in multi step questions were not considered in the marking scheme for this competition. ▪ Only limited skills of applying mathematics to chemistry problems were evident, with questions requiring even very simple manipulation of numbers posing difficulties for many participants. Determining the relative formula mass of magnesium chloride, given the chemical formula and relative atomic masses of magnesium and chlorine (from the 1990s), was answered correctly by only 56% of

	participants. Calculating the percentage mass of phosphorus in calcium phosphate, again with the formula and all relative atomic masses given (1960s), was answered correctly by 52%. ▪ Some more complex mathematical questions from earlier decades are no-longer taught at this level, and related topics, definitions and formulae were unfamiliar to most participants. As expected, less than 1% of participants were able to answer a question on enthalpy and bond energies between pairs of atoms within the benzene molecule. ▪ Students from independent schools (25% of entrants) performed significantly better than those from the state sector (75% of entrants). Boys overall were more successful than girls, particularly in answering those questions regarded as more difficult mathematically. Independent schools are more likely to teach science as three separate subjects (physics, chemistry and biology), and are understood to have a higher proportion of specialist science teachers. The gender difference in this competition is unusual; in GCSE chemistry on average girls attain similar, if not slightly higher grades and typical gender differences in GCSE science and mathematics are comparatively low. ▪ The competition results indicate that the current educational system fails to recognise the most exceptional students with wider knowledge of the subject and the ability to tackle science-based problems. The distribution of the results from this examination demonstrated the exceptional ability of some pupils; however, despite many teachers indicating they nominated A/A* students, most did not score well in this competition. In the 2008 GCSE examinations 77,000 took chemistry as a separate subject and over 52% achieved the top grades of A* or A. The point here is that our most able young people in schools are not being stretched and the mathematical skills needed for scientific careers are not being examined: hence they are not being given the due emphasis needed in schools if the UK is to have an internationally competitive economy. We must address this issue hence the RSC has sponsored a petition on the No10 web site @ http://petitions.number10.gov.uk/examstandards/ The Roberts' report showed that standards of those going into HE has is still high. The numbers of students with mathematics, physics and chemistry A level subject combinations have been in a steep decline for 25 years. The broadening of the school curriculum is feeding through into HE. Comparing A-level now and A-level in 1970 is hard – apples and pears. They measure different skills, less factual recall more problem solving & application skills. A study by Durham University showed that pupils find it harder to get high grades in science subjects than arts and that employers are concerned that they will not have sufficiently qualified people to meet their needs in future.
Standards – HE students	Employers since 2000 have reportedly complained that graduates do not have the skills that they want especially communication skills. University is about education, not training for a specific job.

Teacher Qualifications	The RSC believes that chemistry should be taught by subject specialists for courses aged 14 years and above [GSE and A level in England], and be exposed to the full range of subject specialists when science is taught to 11-14 year olds in secondary schools. This follows a DfES report on the 'Deployment of Teachers and Support Staff to Deliver the Curriculum'[DfES Research report RR708, 2006] that showed exposure to fewer subject specialist could affect students' perceptions of chemistry and physics and possibly militate against students selecting these sciences for further study'
Teachers' salaries	Salaries have increased a lot in recent years and the package when the index-linked final salary pension scheme is taken into account is competitive. Recruiting teachers is a supply/demand issue. When the economy is buoyant it can be difficult to recruit teachers. Differential salaries may be an option – you don't pay everyone the same in industry even though they work as a part of the same team [eg you don't pay all the footballers in a team the same so why pay teachers the same?]. Working conditions [modern laboratories, technical support] and benefits [holidays, pension scheme] are equally important. The RSC plays its part by providing over 1800 days worth of chemistry related CPD for teachers from its own resources.
Therapeutic cloning	This technology has the ability to be a powerful tool in improving health care. We must recognise that some people mistrust the technology and others object because of their personal beliefs. Open dialogue with the public is important in this area.
University Chemistry - teaching	The quality of teaching in UK chemistry departments is high despite the bias forced on system to the due to the pressure of the Research Assessment Exercise. Students are well looked after by dedicated staff. [See Number of HE Chemistry Departments] [Scotland: University Chemistry Depts]
University Chemistry - research	The last Research Assessment Exercise showed that the quality of chemistry research in the UK has improved tremendously. All credit must go to the Chemistry Departments and their staff. The Government needs to allocate sufficient research money to reward the improvements not penalise them. [See Research funding in HE] Scotland: University Chemistry Depts]
Water quality	The RSC has recently published a major report into water quality which gained much media attention, mainly because some papers misinterpreted facts. This led to claims that there were cancer causing chemicals in tap water, which the RSC has never claimed. We can furnish the report or it can be found on our website policy section. Generally, water quality in the UK has improved tremendously over the last 100 years. There are the occasional mishaps and these need to be avoided if at all possible. The improvements in analytical chemistry mean that lower and lower levels of components can be detected. Because you can detect something it doesn't necessarily mean that it is dangerous nor does it necessarily mean that it wasn't there before – it may just be that you could not detect such small amounts previously.
Women in chemistry	At A-level the ratio of female to male in chemistry is ca 45 F: 55 M. In degree courses the ratio is about 50:50. At PhD the ratio falls to 40:60. For post-doctoral fellows the female: male

	ratio lies heavily in favour of males – this could be due to the working environment and culture in some research groups. The ratio of females to males in academic appointments is low. There is some evidence that females do not put themselves forward for selection for academic positions. Progression factors in chemistry are no different to any other field of employment – we have carried out independent research which indicates this. [Networking, contacts, being good at your job are all key factors. It is known that many women do not put themselves forward for prominent roles. We are seeing a changing attitude towards career progression among women ca <40 who expect to be judged and measured as equals and ask for no special treatment.] RSC female:male ratio reflects undergraduate ratio in terms of recruitment. Below ca 40 years of age ratio is good and improving: above male dominated – reflecting social norms of the time. RSC actively involves all members in its activities and entry to the RSC is on merit.