
The Global Chemistry Experiment

For the International Year of Chemistry 2011

White Paper

“Water: A Chemical *Solution*”



United Nations
Educational, Scientific and
Cultural Organization



International Union of
Pure and Applied
Chemistry

Partners for the International Year of Chemistry 2011

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Background¹

The International Year of Chemistry (IYC 2011) is an initiative of IUPAC, the International Union of Pure and Applied Chemistry, and of UNESCO, the United Nations Educational, Scientific and Cultural Organization. It involves chemical societies, academies, and institutions worldwide and relies on individual initiatives to organize local and regional activities.

IYC 2011 is a global celebration of the achievements of chemistry and its contributions to the well-being of humankind. Under the unifying theme “*Chemistry—our life, our future,*” IYC 2011 will offer a range of interactive, entertaining, and educational activities for all ages during 2011.

The goals of IYC2011 are to increase the public appreciation of chemistry meeting world needs, particularly how chemistry helps achieve the U.N Millennium Development Goals; to encourage interest in chemistry among young people; to generate enthusiasm for the creative future of chemistry, and to enhance international cooperation.

The Global Chemistry Experiment

Involving the public, and in particular students, in the activities of the International Year of Chemistry is one of the most important goals for chemistry in 2011. IUPAC and UNESCO have developed a set of activities called the Global Chemistry Experiment to entice students around the world to learn about how chemistry contributes to one of the most important resources in their daily lives. The global experiment engages students in schools across the world in practical activities around the theme “Water: A Chemical *Solution*”. The chemistry of water as a solution as well as the role of water in society and the environment is highlighted.

Water, H₂O, is the most abundant substance on the Earth’s surface. Water is the only compound found naturally in the liquid, solid and gaseous states. It covers about 70% of the planet’s surface, is essential for life, and it makes up about 70% of the human body. The unique chemical properties of water make it an ideal topic for the Global Chemistry Experiment.

Water is rarely found pure. Because many substances, mostly of mineral origin, dissolve in water, water is often referred to as the Universal Solvent. Interactions with natural and artificial systems lead to a diversity of aqueous solutions that play key roles in environmental phenomena and in a multitude of applications. 97% of the water on Earth is sea water of high salt content and is not adequate for most uses. Therefore the availability of water around the world, in terms of both quality and quantity, requires that practical methods be found for proper treatment. Water fit for human consumption, or potable water, is essential for health and well-being. Purification of potable water demands adherence to a series of quality criteria embodied in physical, chemical and microbiological parameters, all of which require measurement according to prescribed procedures. The Global Chemistry Experiment demonstrates these concepts clearly and simply for students around the world.

The Global Chemistry Experiment consists of four component activities: each can be carried out by children of all ages in schools across all continents. The activities are adaptable to the skills and interests of students of various ages and use equipment that is widely available at little or no cost.

¹ Text adapted from the official IYC 2011 website.

For more information on IYC, see <http://www.chemistry2011.org/about-iyf/introduction>

The activities provide students with an appreciation of chemical investigation and data collection and validation. By the end of 2011, the results will be displayed on an IYC data collection website as an interactive global data map - demonstrating the value of international cooperation in science.

Water: A Chemical Solution

The Global Chemistry Experiment will give students across the globe the opportunity to study **water quality** and **water purification** in their own environment. Each aspect is supported by two component activities from which teachers can choose the best fit to their own educational program.

Measurement of water quality:

- i. **pH:** students collect data measuring the pH of a water body, using indicator solutions (and pH meters if available).
- ii. **Salinity:** students explore the salinity of a water body

Water purification:

- i. **Filtration and disinfection:** students will learn how chemistry is used to help provide safe drinking water
- ii. **Desalination:** Students will construct a solar still from household materials and experiment with its use to purify water.

The experiments in practice

Each activity has been selected and assessed by a task force of teachers, university faculty, industrial scientists, and representatives of the Royal Society of Chemistry (U.K), IUPAC and UNESCO. The activities have been carefully selected on the basis of strict criteria (see Annex 1) in order to ensure they are suitable for implementation in schools across the world; they have been tested to ensure workability, especially in developing countries. Full details on both the criteria for selection and the activities themselves can be found in Annex 2 of this document.

Resources

Resources for teachers and students can be produced relatively easily. As a minimum requirement, resources for teachers will include written instructions. However, certain of the experiments could benefit from the use of particular reagents (e.g. a liquid indicator or reagents for precipitation tests).

Communication

The International Year of Chemistry logo and the Global Experiment theme "Water: A Chemical Solution" should be as widely disseminated as possible (advertised in the written press, websites, flyers). The media and PR strategy for the Global Experiment will be developed with the collaboration of groups such as UNESCO, the Water World Council and the World Monitoring Day. These groups have long standing experience and expertise in similar initiatives from which to build (Annex 3).

Annex 1

Water: A Chemical Solution – The Global Chemistry Experiment

Selection Criteria

The experiments must fulfill the following criteria

Address chemistry that:

- is widely accessible;
- is based on concepts and learning goals in primary and secondary school curricula;
- takes into account our heritage of scientific discoveries; and
- gives a clear demonstration of the value of chemistry to society.

Involve experiments that:

- can be carried out with equipment and materials available almost everywhere in the world;
- involve minimal use of equipment other than everyday reagents and materials;
- pose no significant safety hazard; and
- can be carried out at different levels of sophistication to match students' skills and interests.

Generate data of wide interest that:

- provides students with insights into data collection and validation;
- allows for ready display to a global audience (via an IYC data collection website); and
- will lead to discussion about societal issues and the vital role chemistry can play.

Annex 2

Water: A Chemical Solution – The Global Chemistry Experiment

Component Activities

MEASUREMENT OF WATER QUALITY

i. **pH:** *Students will collect data measuring the pH of a water body, either marine or fresh water, using indicator solutions (and pH meters if available). The results will be suitable to be reported to a database for display on a global map.*

- The experiment has been developed and tested with both primary and secondary school classes. Results of suitable quality can be routinely achieved by students.
- The topics of acids and bases, and water quality are common in both upper primary and junior and senior high school.
- Students will replicate measurements and aggregate individual results to gain an appreciation of the scientific process of establishing the reliability of results,
- Ancillary activities will encourage teachers to help students become familiar with acid-base concepts through measurement of the pH of household materials and exploring the stability of pH.

Requirements: A kit comprising: 100 mg samples of the two indicators, a colour chart for each indicator, test tubes and dropper pipettes, and instructions for the experiment, will be required for each class.

ii. **Salinity:** *Students will explore the salinity of their local water body. The tests they perform will depend on equipment available and will include: measurement of the mass of material remaining after evaporation of the water, an estimate of the salinity based on a home-made conductivity device calibrated for sodium chloride, and a reportable measurement of salinity where a calibrated conductivity meter is available. Results from the salinity measurements may be suitable for submission to a global database.*

- The experiment will be developed based on versions that have been extensively used in Portugal, South Africa and Australia.
- Ionic compounds and their solubility form an important part of the curriculum in both junior and senior high school and the ideas are frequently applied to class environmental studies. Salts are commonly introduced in primary school as a class of substances without elaboration of their chemical nature.
- Ancillary activities to the salinity measurements will be provided to help teachers develop student's understanding of the underlying chemical concepts.

Requirements: The experiments all require equipment starting with a balance for the dissolved solid measurement, and either home-made, or commercial conductivity meters. Arrangements in which equipment is shared between schools may be possible. Instructions will be required for each class.

Annex 3

Water: A Chemical Solution – The Global Chemistry Experiment

The Website

The Global Experiment website will be the central source of information both for schools and for other interested groups. It will be interactive and the site for data reporting. Resources being written for the project include:

- **A toolkit** for schools containing the necessary materials for carrying out the activities. These materials will be available for downloading and will include: a teacher guide, activity protocols, suggestions for how the activities could be integrated into the curriculum and guidance on how and where to order special equipment. Logos and branding materials are being developed for publicising the event within the school and in the wider community.
- **A registration site** for schools where teachers can register their interest in the project and sign up their school to the activities.
- **A mapping tool** that will that will both display the global data as it is submitted and also display school information including a Google map of schools are taking part in the experiment.
- **School coordination tools** which will facilitate collaboration and data submission and may include file archives, an internal messaging system and chat groups and forums. The possibility of students being invited into this space for e debates and/or chats with experts is being explored.

Annex 4

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Support: Water-related Initiatives

- **The 2030 Water Resources Group:** The 2030 Water Resources Group was formed in 2008 to contribute new insights to the increasingly critical issue of water resource scarcity. Initiating sponsorship for the project came from The International Finance Corporation (IFC), part of the World Bank Group, which provides investments and advisory services to build the private sector in developing countries. The World Bank also provided substantial input from its experience in the water sector.

An extended business consortium provided sponsorship, guidance, and expertise. This included: The Barilla Group, a global food group; The Coca-Cola Company, a global beverage company; Nestlé S.A., a global nutrition, health, and wellness company; SABMiller plc, a global brewer; New Holland Agriculture, a global agricultural equipment company; Standard Chartered Bank, a global financial institution, and Syngenta AG, a global agribusiness

- **World Water Day:** The international observance of World Water Day is an initiative that grew out of the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro.

The United Nations General Assembly designated 22 March of each year as the World Day for Water by adopting a resolution. This world day for water was to be observed starting in 1993, in conformity with the recommendations of the United Nations Conference on Environment and Development contained in chapter 18 (Fresh Water Resources) of Agenda 21.

States were invited to devote the Day to implement the UN recommendations and set up concrete activities as deemed appropriate in the national context.

The Subcommittee welcomes the assistance offered by IRC International Water and Sanitation Centre to contribute to an information network centre in support of the observance of the Day by Governments, as required.

- **World Water Monitoring Day:** World Water Monitoring Day™ (WWMD) is an international education and outreach program that builds public awareness and involvement in protecting water resources around the world by engaging citizens to conduct basic monitoring of their local water bodies.

An easy-to-use [test kit](#) enables everyone from children to adults to sample local water bodies for a core set of water quality parameters including temperature, acidity (pH), clarity (turbidity) and dissolved oxygen (DO). Results are shared with participating communities around the globe through the WWMD Web site.

World Water Monitoring Day is officially celebrated on September 18; however, the monitoring window was extended for the first time in 2009 from March 22 ([World Water Day](#)) until December 31. Participants are encouraged to celebrate with WEF and IWA in September or to observe their own WWMD anytime during the extended window. The deadline for submitting data to the WWMD database is December 31.

The coordinators of WWMD, the [Water Environment Federation](#) (WEF) and the [International Water Association](#) (IWA) plan to expand participation to one million people in 100 countries by 2012.

Web-based water-related initiatives:

- **The co-operative ethical water campaign:** <http://www.co-operativewater.co.uk/>
- **Clean Water Campaign website:** <http://www.cleanwatercampaign.com/>
- **Inside the Bottle :** <http://www.insidethebottle.org/>
- **Inside the Bottle** watch is a part of the Polaris Institute. Polaris is designed to enable citizen movements to act for democratic social change on major public policy issues in an age of corporate driven globalization.
- **H₂O Conserve :** <http://www.h2oconserve.org/>; [http://www.h2oconserve.org/?page_id=51&pd=edu](http://www.h2oconserve.org/?page_id=51&pd=edu;); http://www.h2oconserve.org/wc_disclaimer.php
- **Water Conserve:** <http://www.waterconserve.org/>Water Conservation Portal & Search Engine. Featuring a Genuine Water Conservation Internet Search Engine
- **End Water Poverty: Sanitation and Water for All:** <http://www.endwaterpoverty.org/>The End Water Poverty campaign is demanding that governments provide sanitation and water for the world's poorest people. They are calling for: (i) One global action plan for sanitation and water monitored by one global task force; (ii) 70% of aid money for sanitation and water to be targeted at the poorest countries; (iii) Water resources to be protected and shared equitably.