

# Aye, Iodine!

Iodine is element 53 and has the chemical symbol 'I'. It was discovered in 1811 by the French chemist Bernard Courtois and belongs to group 7 of the periodic table: the infamous halogens. The chemistry of iodine lends itself to many visually impressive class demonstrations and activities. One of the element's primary sources is from the sea in the form of seaweed, from which it was first discovered. The harvesting of seaweed for iodine and soda ash was a crucial part of Scottish highland and island life in the late 19<sup>th</sup> century, the collapse of which contributed to the decline of many Scottish communities. In everyday life iodine uptake is vital for the performance of the thyroid gland and introduction of iodine to many diets worldwide has put an end to the once prevalent disease 'goitre', a distinctive swelling in the neck. However, even in developing countries, several population groups including vegans and pregnant women are increasingly at risk of developing complications relating to iodine deficiency. Furthermore, after a nuclear incident radioactive iodine can be consumed which produces cancer in the thyroid, as was the case following Chernobyl.

In this unit learners will:

- Explore the chemistry of Iodine through hands-on practical activity of extracting it from seaweed and carrying out the iodine clock experiment, both RSC recommended.
- Witness impressive demonstrations of iodine sublimation and the violent reaction of aluminium and iodine catalysed by a drop of water, both RSC recommended.
- Through a specially designed game discover the cultural, economic and political forces that led to the development of the Scottish seaweed harvesting industry and the decline of the communities that relied on it.
- Learn about the thyroid gland and the endocrine system, its role in the human body and how important iodine is for it's function. Using scientific reasoning pupils will explore the Scottish population's dietary iodine and investigate which groups are at risk of developing complications related to this.

53

I  
Iodine  
126.9045

**Learning Outcomes: Sciences:** Materials Properties and uses of substances SCN 3-15a SCN 3-15b SCN 4-15a SCN 3-16a SCN 3-16b Earth's materials SCN 3-17b Chemical Changes SCN 4-19b SCN 3-19a Biodiversity and interdependence SCN 2-02b SCN 3-01a SCN 1-02a Processes of the planet: SCN 3-05a Electricity: SCN 2-10a, SCN 3-10a Vibrations and waves: SCN 4-11b, SCN 3-11b Body systems and cells: SCN 3-12b **Health and Wellbeing:** Physical activity and health HWB 2-25a / HWB 3-25a, 4-28a, HWB 2-28a / HWB 3-28a Nutrition: HWB 3-30a, HWB 4-30a, HWB 3-31a, HWB 4-31a, HWB 4-32b, HWB 3-32a Food and the consumer: HWB 3-34a / HWB 4-34a **Social Sciences:** SOC 3-02a, SOC 4-05a, SOC 3-05a, SOC 4-06a, SOC 3-06a, SOC 4-08a, SOC 4-09a, SOC 3-10a, SOC 3-13a, SOC 4-16a **Gaelic (Learners):** LGL 2-11b, LGL 3-05a

## I from the sea

The Kelp Gatherers is a worker placement Legacy style game where pupils learn about life and culture on the coast and islands of Scotland and the development of the kelp industry which peaked between 1750 and 1830. Kelp was harvested and burned to extract pot ash, soda ash (sodium carbonate) and iodine, which was discovered as a side-effect of this industry in 1811. After the end of the Napoleonic wars the kelp industry declined but the permanent shift towards using seaweed for profit over fertiliser for the land had a detrimental effect on the populace. In recent years debates over the cost/benefits of harvesting Scotland's off-shore kelp forests has emerged.

Pupils take the role of a landowner on a fictional hebridean island with the aim of getting the biggest profit by the end of the game. Kelp, Sheep, Cattle and Herring are connected and competing industries with Kelp and Sheep designed to be the more profitable as the game progresses. But this profit is also at the expense of the crofters due to competition with use of space and for fertiliser on the land. The game raises issues related to the clearances as it is designed to provoke decisions between people and profit but with an industry crash late game revealing the true cost of unsustainable practices. Random events include cultural references such as selkies, kelpies, archaeological finds, and historical events to provide context and flavour to the game.

### Features:

- The game takes place on a fictional Hebridean island over 9 turns from 1750 and 1830.
- Dual English/Gaelic text in respect for the inspiration of the game and to support Gaelic learning and education
- The board will be permanently altered as the game progresses by gluing features at the expense of others. This means each game will be unique and personalised to the players. Encourages re-playability.
- Simple mechanisms and rules keeps the game light and the quickly accessible
- Promotes problem solving and mathematical ability
- Cattle, herring, sheep, kelp industries have unique advantages and disadvantages and are in balance with the needs of the crofters who work the industries
- Historical, mythological and cultural events influence the fortunes of the players and add context to the game.
- Time required: 50 – 90 minutes
- Designed to be transportable for compatibility with an outdoor education experience

### Resources needed:

Island map and the resource sheets to cut out and print (printable)  
Random event and time cards (printable); Scissors, glue, pens, 6 sided dice, tokens to represent money.



## Hands-on Activity: Extracting iodine from seaweed

Kelp extracts iodide ions from seawater and makes iodine containing compounds. Iodine can be extracted from kelp in the classroom, however first it needs to be gathered and dried which presents a good opportunity for a trip to the sea. The dried seaweed is heated in air to turn it to ash. The ash is boiled in water and filtered while hot.

The iodide is oxidised to iodine using hydrogen peroxide forming a brown solution. The iodine can be isolated by solvent extraction to give a purple solution of dissolved I<sub>2</sub> molecules. These stages can be performed by pupils but the teacher can collect all the iodine solutions and concentrate them to allow for collection of iodine crystals, which can be further purified in the sublimation of iodine experiment. This lesson teaches miscibility of solvents and how things can be extracted from natural resources. This is also a replication of Courtois's original experiment that led to the discovery of iodine.

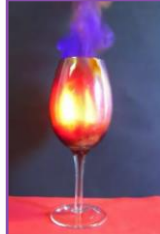
Reference: RSC *Extracting iodine from seaweed* resource (available online)

## Demonstration: Sublime Iodine

The iodine extracted from the kelp, or pre-purchased iodine powder, can be shown to undergo sublimation. Sublimation is the process where a material changes state straight from the solid to the gas phase. Iodine can be seen to do this in a classroom demonstration in a well ventilated laboratory. A cold finger can be purchased or fashioned from a conical flask, a boiling tub, gaffer tape and ice water.

The solid iodine is placed in the bottom of the flask fitted with the cold finger and gently heated to form a purple gas which will then slowly deposit crystals on the cold surface. Cooling for longer can make some large and beautiful crystals. The cold finger can be carefully removed and clamped for inspection by the class. This demonstration teaches changes of state, crystallisation and particle theory. Sublimation of iodine is used to stain chromatography plates and used in forensics to detect finger prints.

Reference: RSC *Sublime Iodine* resource by Declan Fleming (available online)



## Hands-on Activity: Iodine Clock Reaction

A solution of hydrogen peroxide is mixed with potassium iodide, starch and sodium thiosulfate. After a few seconds the colourless mixture suddenly turns dark blue. This can be performed as a demonstration or a student investigation on factors that affect reaction rates.

Reference: RSC *Iodine clock reaction demonstration* resource (available online)



## Demonstration: Reaction between aluminium and iodine

This straight forward demonstration of an exothermic reaction between aluminium and iodine is catalysed by water. Spectacular clouds of purple iodine vapour are produced. Must be performed in a fume hood.

Reference: RSC *Reaction between aluminium and iodine* resource (available online)

### Additional activities:

Most of the module can be easily altered to form part of an outdoor learning activity particularly suited to the coast. Can use the extracted iodine to test for starch or dye nucleus of onion cells.  
Hands-on activity: Reaction of zinc and iodine and electrolysis (RSC resource)  
Listen to BBC Radio 4: In Their Element Series 2, Awesome Iodine!  
Extracting and testing the iodine content of health food supplements - many health food supplements contain higher levels than they claim on the label.  
Designing a diet and preparing meals to boost levels of iodine - sushi would be a quick, simple and interesting option  
Blue Planet 2: Green Seas - section on Kelp Forests, now proposed for industrial harvesting in Scotland's coasts.  
Using a map and samples of radioactive iodine, combined with knowledge of half-life, to locate a nuclear power station failure or track stolen radioactive weapons.  
Read extracts from Chernobyl Prayer by Svetlana Alexievich.

## I to health

The thyroid gland is part of the body's endocrine system. The endocrine system is responsible for producing hormones from special tissues called glands. Hormones are unique biochemicals that travel through the bloodstream and control the body by targeting specific organs. Glands include: the pancreas; the testes or ovaries; and the thyroid, located in the neck. Pupils may be aware of the disease diabetes related to the hormone insulin, produced by the pancreas. They may also be familiar with the changes in puberty caused by the reproductive hormones produced by the sex organs. However, many people are ignorant of the importance of the thyroid gland and related diseases.

The thyroid gland releases the hormone thyroxine, partially composed of iodine, which regulates the body's metabolic rate. This affects the speed at which oxygen and food products react to release energy. If there is a deficiency in iodine then not enough thyroxine is produced and metabolic rate is affected. In the case of iodine deficiency the gland will physically swell in an attempt to gather more iodine from the bloodstream. This is a disease called 'goitre' and was widespread across the UK, including Scotland, until the 1960s. However mild-moderate iodine deficiency is still present in many countries, including Scotland.

In pregnant women, for the first 6 weeks the foetus relies on it's mother's thyroid gland and a deficiency in iodine can result in growth defects including permanent mental disability in the child.

### The lesson (50 minutes):

To simulate a real iodine health investigation the learners are given simplified data of iodine levels for a selection of the population. A local study that could be used for reference was carried out in Tayside from 1993 - 2007. The recommended iodine level is 150µg/g. Additional case studies allow the inference of dietary behaviours that can contribute to iodine deficiency and, based on a real Norwegian study, in the case of health food supplements can lead to dangerously high iodine levels. From the data and the case studies the learners will be asked to make a series of reasoned conclusions from the data which point to: women are up to 8 times more likely than men to suffer from it, increasing in pregnant women, it is seasonal due to changing in cattle feed and vegans are also at a high risk.

A graph of incidents of goitre, consumption of milk since the 1900s and iodine supplements in cattle would also show a real life correlation and explanation for the decline in goitre. This lesson develops reasoning skills, graph plotting ability and an awareness of personal and public health issues.

This section is inspired by the work of Prof Margaret Rayman, Professor of Nutritional Medicine at the University of Surrey.

