

SNAIL PIE ON THE MENU

The thought of 'snail pie' appearing on the menu in UK schools would provoke nothing short of horror for most pupils. But, while snails are not a common food on the British plate, the same is not true in many other parts of the world. Europeans – the French, Spanish, Portuguese, Greeks and Cypriots – as well as Americans, Australians and North Africans have been enjoying these molluscs in a variety of recipes for centuries. And it seems that the British people might be missing out.

SLOW FOOD

According to nutritional studies published by the USDA National Nutrient Standard Reference, snails are high in protein and low in fat, and a rich source of minerals such as iron, magnesium, phosphorus, potassium, copper and zinc. Indeed, according to a nutritionist in Nigeria, snails might be the answer to serious malnutrition and iron deficiency in children and young mothers in developing countries.

Reporting in the *International Journal of Food Safety, Nutrition and Public Health*, Dr Ukpong Udofia, of the University of Uyo in Nigeria and her team examined the moisture levels, protein content and iron composition of the flesh of the giant West African land snail and compared these data to those values in beef steak. The team's findings suggest that



snail is more nutritious than beef. The fresh snail had a higher moisture content as well as higher protein and mineral content than fresh beef. Moreover, the value of iron in snail was 16.95 per cent compared to 10.20 per cent in fresh beef. So while beef is a good source of iron, snail is better.

TASTE BUGS

But does snail meat taste as good as beef, and what about its texture and appearance – how do these compare? To find out Udofia and

her research team baked snail and beef pies, and asked a group of 50 young mothers and 50 school children to try them – none of the tasters knew which meat pie they were eating. The results indicate that the majority of the group preferred snail pie to the beef variety on all counts – appearance, texture and flavour.

There is no quick fix to the problem of malnutrition in developing countries, but Udofia says an alternative to high-cost meat products could help.

Did you know?

You can make 'ice candles' that look like Swiss cheese. Pour wax into a mould (eg an old washing-up liquid container) to a height of ca 1 cm³ and stand a thin candle in the middle. Leave until the base is solid. Pack ice cubes around the candle, and pour wax over the ice to the top of the mould. Leave to cool and remove the mould. But what's the chemistry?

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IS PROPOFOL A I

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Few people will not have been touched by the tragic death of musician and pop icon Michael Jackson last summer. The cause of his untimely death has been linked to the drug propofol. What is propofol and is it lethal?

Conrad Murray first met Michael Jackson in 2006 when he was treating one of his children. He became the star's personal physician a few weeks before Jackson's death. In police reports, he admitted injecting the singer with 50 mg of propofol each night to help him get off to sleep, which is about half the dose used to induce anaesthesia for major operations.

THE REPORTED TRAGEDY

On the day Jackson died Murray allegedly told detectives that he feared Jackson was becoming addicted to propofol (1) so he was trying to wean him off it by reducing the dose to 25 mg, and supplementing this with two other intravenous drugs – midazolam and lorazepam. These drugs are similar to Valium, which is commonly used to treat anxiety and insomnia. The former is a short-acting anaesthetic agent, the latter a longer acting sedative.

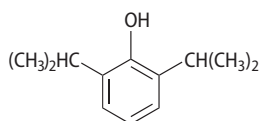
The cocktail had apparently been successful, and eventually only midazolam and lorazepam were given. However, on the night of 23 June, this was insufficient. Murray started by giving Jackson 10 mg of Valium at 1.30 am, then injections of midazolam and lorazepam at 2.00 am, both of which were administered again at 5.00 and 7.30 am. When all of these failed to send his patient off to sleep, at 10.40 am he is reported as saying that he responded to the star's repeated pleadings by giving him a 25 mg injection of his 'milk' – the intravenous emulsion of propofol. Within minutes Jackson was dead.

NEAL PRESTON/CORBIS

Michael Jackson – King of Pop



KILLER?



(1) Propofol

Had Jackson been killed by this last injection? Lee Cantrell, director of the San Diego division of the California Poison Control System was reported in the papers saying: 'Twenty-five milligrams of propofol is not a whopping amount, but by combining it with a cocktail of other sedatives, known as benzodiazepines, it might have been the trigger that pushed him over the edge. . . . This is horrible polypharmacy. No-one should treat an insomniac like this'.

The Los Angeles county coroner ruled that Michael Jackson's death on 25 June was homicide. In the US 'homicide' means death occurred as a result of someone else's actions, but does not necessarily mean that murder, or even any crime, was committed. So what do we know about the use of propofol as an anaesthetic?

ANAESTHETICS – A BRIEF HISTORY

During the first half of the 19th century hospital operations were uncommon, perhaps averaging a couple per week in a large city hospital. Not only was death from blood poisoning a real possibility, with up to half the patients dying from post-operative wound infections, but without anaesthetics the pain was almost unbearable. The terrified patient would be strapped down on the operating table, awaiting the knife and surgical saw.

The introduction of anaesthetics in the 1840s was to change this radically. Chemicals would send the patient to sleep while the surgeon did his work. Three effective anaesthetic agents dominated practice for the next 100 years: nitrous oxide (N₂O), also

known as laughing gas, for short operations such as tooth extractions; and ether and chloroform (trichloromethane) for longer operations.

But ether and chloroform had disadvantages. Inhaling these vapours caused feelings of suffocation, so patients tended to struggle while being prepared for the operation; and nausea and bouts of vomiting were common during the hours it took to recover from the anaesthetic. A remedy for both these defects eventually came in the form of a short-acting drug, sodium thiopental, which could be given by intravenous injection.

Sodium thiopental was used increasingly from the mid-1930s to induce anaesthesia for about 5–10 minutes, sufficient for brief operations. Repeated injections could prolong the anaesthesia, but led to long recovery times. While popular with anaesthetists, its drawbacks prompted chemists to continue their search for something better.

Propofol – for pain relief



This won't hurt a bit

WHENCE PROPOFOL?

On reflection, phenols were unlikely candidates as anaesthetics. They are poisonous and, used undiluted, caustic to skin. Their limited solubility meant there was no safe way of getting them into the patient. During the 1950s, however, chemists 'solubilised' these compounds by converting them into an emulsion using an agent well tolerated by the body (a popular one was Cremophor EL, an epoxyated castor oil).

In the 1970s chemists at the ICI Pharmaceuticals Division, Macclesfield, decided to see if emulsified phenols might have some anaesthetic potential. Of the many tested, the best was 2,6-di-isopropyl phenol. Christened propofol, it was even better than sodium thiopental, and is by far the most common anaesthetic used today. Repeated injections allow longer operations and once these are over, patients wake remarkably clear-headed and without the traditional feelings of sickness.

A DRUG OF ABUSE?

Propofol is not a popular drug of abuse. It has to be administered by intravenous injection: too little and you are wide-awake; too much and you are asleep; a bit too much more, and you are dead. In theory a 'high' is possible – a sleepy stress-free twilight as you are briefly 'going under'. Because the drug is short acting, abusers would need to inject themselves 50–100 times for the desired effect, which is not conducive to getting the dose right. Not surprisingly, there are few abusers, and most come from the medical profession – doctors, nurses and anaesthetists.

Paul E. Wischmeyer, professor of

“... IN THE WRONG HANDS IT [PROPOFOL] IS A VERY LETHAL DRUG...”

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anaesthesiology at the University of Colorado is an expert on propofol abuse. Writing in *Time magazine* in August 2009 he said, ‘The potent drug has benefits in the operating room but poses major risks for abusers. In the right hands, the drug is the most effective, safest anaesthetic that many of us use. In the wrong hands, it’s a very lethal drug.’

According to Wischmeyer, he first encountered a death from propofol in 1999, when a fellow student over-dosed and was found with the syringe still stuck in his arm. Although safe when used properly in the operating theatre, self-administration even by medically qualified staff is risky. Wischmeyer estimates that one third of such abusers will die

from it, commenting, ‘I’ve never found a non-medical person abusing this drug that has ever lived. Propofol’s potency leaves very little margin for mistakes. The terrifying thing about this drug is that it might take your stress away, but if you take one or two cm^3 more, you stop breathing.’

LESSONS LEARNED

The Michael Jackson tragedy has led to calls for greater control over the availability of propofol. Patients, no matter how rich or famous, should be advised if they have major problems with substance abuse (prescribed or otherwise) and that continued substance abuse prevents normal sleep patterns. A better approach would

An inspirational figure

be to help patients address these problems. Propofol belongs in the operating theatre and intensive care unit, nowhere else. Excessive restrictions on its storage and availability will, sooner or later, leave a critically-ill patient waiting in pain for propofol – not unlike the situation in the early 19th century. A disaster for one individual should not provoke an overreaction that could damage others.

Alan Dronsfield and Pete Ellis

that's chemistry

Simon Cotton looks at molecules in our lives. In this issue: ethanol

That's alcohol isn't it?

Strictly, ‘alcohol’ means a family of compounds with the –OH functional group, of which ethanol (1) is just one. The first part of the name tells you how many carbons there are in the molecule, just as in alkanes, the ending indicates the presence of the –OH group. Ethanol is the alcohol found in alcoholic drinks.

Is it safe to drink?

No. Ethanol is a drug, and if you drink a few hundred millilitres of the pure substance, it can be fatal. Alcoholic drinks are dilute in pure ethanol – spirits may contain 30–40 per cent ethanol by volume, wines 10–14 per cent

and a regular beer 4–5 per cent. In an episode of the BBC school drama *Waterloo Road*, aired in November 2009, students stole ethanol from the science lab and used it to make homemade cocktails which they sold to other students. The result being one barely conscious student was rushed off to hospital apparently suffering from alcohol poisoning.

Was the drink too strong?

Yes, that's very likely but there is an even more serious health issue. Methanol (CH_3OH), another alcohol, is often added to ethanol to make it undrinkable – this mixture is known as industrially denatured alcohol. When schools

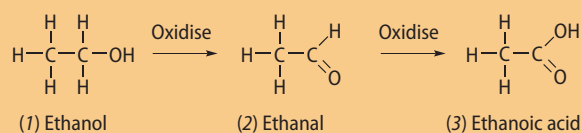
need ethanol for experiments, it is sold to them as industrially denatured alcohol by a specialist chemical supplier, under licence, and must be stored under lock and key. This is probably the stuff that the students used to make the bootleg drinks.

Why does methanol make ethanol undrinkable?

Because it's more toxic than ethanol. In our bodies ethanol is broken down by enzymes in the liver, which catalyse its oxidation

to the aldehyde ethanal (2) which is further oxidised to ethanoic acid (3). The body then breaks the acid down into CO_2 and H_2O . Ethanal is more toxic than ethanol and is in part responsible for the symptoms of a hangover.

Methanol is processed in a series of analogous reactions resulting in more toxic products (methanal, HCHO , and methanoic acid, HCO_2H) that can attack the human optic nerve and cause blindness. A lethal dose of methanol can be as little as 30 ml.



ON-SCREEN CHEMISTRY

Jonathan Hare asks...

LOST AT SEA: could you find your way using alchemy?

In the 1600s British Navy ships were often getting lost or running aground on rocks because they had no way of reliably knowing where they were. So insurmountable was the problem thought to be that in 1715 the British parliament, through the Board of Longitude, put up a large prize – of the order of *ca* £3 m in today's currency – to anyone who could find a proven way to determine the latitude and longitude at sea. This navigational story has been lively recounted in Dava Sobel's wonderful book *Longitude*,^{1,2} which was later made into a film starring Jeremy Irons and Michael Gambon.³

The problem with longitude

While latitude can be determined relatively simply from observations of the sun, moon or stars, the longitude was much harder to determine. What was needed was a reliable way of determining the time difference between an agreed reference point (say Greenwich in

London) and wherever you happen to be. Once you have the time difference you can get the longitude because each hour difference represents ($360/24 =$) 15 degrees of longitude. If the ship's time is found to be earlier than Greenwich, the ship is west and if later it must be east of Greenwich.

A mystical solution?

Many proposals for finding the longitude were suggested, the best of which advanced several areas of science. Some ideas, however, were fairly crazy. Perhaps the strangest of all was the use of the 'Powder of Sympathy' by Sir Kenelm Digby (1603–65). Digby started out as what could be loosely termed a pirate but he had a keen and clever mind and later retired to study alchemy and was a founding member of the Royal Society.

In the film *Longitude*, Steven Fry plays the eccentric Digby, who claims that his miraculous substance – the Powder of Sympathy – could heal at a distance.³ The powder was apparently green vitriol or ferrous sulfate, which was ground in a mortar and dried in the sun. According to Digby, in use all one had to do was to sprinkle some of the powder onto an article of clothing that used to belong to the injured person and they would start to heal. Digby goes on to suggest that the Powder of Sympathy could be used to determine longitude.

To quote Sobel on Digby: 'The daft idea to apply Digby's powder to the longitude problem follows naturally enough to the prepared mind: send aboard a wounded dog as a ship sets sail. Leave ashore a trusted individual to dip the dog's bandage into the sympathy solution every day at noon. The dog would perforce yelp in reaction,



and thereby provide the captain a time cue. The dog's cry would mean, "The Sun is upon the meridian in London", so allowing the difference in time to be immediately determined giving the longitude.'

No prizes for the Powder of Sympathy

Needless to say the Powder of Sympathy never succeeded in winning the coveted Longitude prize or for that matter any kind of prize or success. One has to remember that this was a time before most people had any kind of science education, and scientific enquiry had not established itself in any disciplined way, and so to many the strange logic of the Powder of Sympathy story might even have sounded feasible. One wonders how many poor dogs suffered in the trials.

REFERENCES

1. Dava Sobel and W. J. H. Andrews, *Longitude – the illustrated book*. London: Fourth Estate, 1998.
2. Dava Sobel, *Longitude* (audio). London: HarperCollins, 1996.
3. *Longitude*, Granada Film Production, Channel 4, 2002 (see 'Longitude lunatics' selection of the 'play scenes' on the DVD).

Dr Jonathan Hare, The CSC Centre, chemistry department, University of Sussex, Brighton BN1 9ET (www.creative-science.org.uk/TV.html).



Alchemist Sir Kenelm Digby

BACKYARD CHEMISTRY

DR HAL SOSABOWSKI PRESENTS EXPERIMENTS YOU CAN DO ON YOUR OWN

IN THIS ISSUE: DIY indicators

THE SCIENCE

Acids and alkalis form solutions that have a pH of <7 or >7 respectively. The pH is a measure of acidity and is defined as $-\log_{10}[\text{H}^+(\text{aq})]/1 \text{ mol dm}^{-3}$. Indicators are substances which exhibit different colours in acidic and basic (alkaline) solutions. They are often coloured organic substances such as litmus, which is extracted from lichen. Litmus turns red in acids and blue in alkalis.

Anthocyanins are organic dyes found in many plants, *eg* geraniums. They also are found in red cabbage and can be used as pH indicators because they exhibit different colours in acids and alkalis; they are red in acid, purple in neutral and blue in basic solution.

MATERIALS

You will need:

- a small red cabbage;
- a knife, coffee filter papers;
- Pyrex (heat-proof) glass container or casserole dish, eight small glasses;
- baking soda (sodium hydrogencarbonate, NaHCO_3);
- washing soda (sodium carbonate, Na_2CO_3);
- lemon juice (citric acid, $\text{C}_6\text{H}_8\text{O}_7$);
- cream of tartar (potassium hydrogentartrate, $\text{KHC}_4\text{H}_4\text{O}_6$);
- vinegar (ethanoic acid, $\text{CH}_3\text{CO}_2\text{H}$);
- antacids (calcium carbonate, calcium hydroxide, or magnesium hydroxide);
- Alka-Seltzer (carbonic acid, H_2CO_3);
- hydrochloric acid (found in some household or masonry cleaners).

EXPERIMENTS

Chop the cabbage into small pieces until you have about two cups full. Place the cabbage in the large Pyrex glass container (or casserole dish) and add boiling water to cover the cabbage. Allow at least 10 minutes for the colour to leach out of the cabbage into the water, which should change from colourless to bluish-violet.

Now filter the plant material to obtain the bluish-violet liquid. This liquid is at *ca* pH 7. The exact colour will depend on the pH of the water in your household taps. Pour about 100 ml of your cabbage indicator into each small glass.

Add various household solutions to your indicator until a colour change is obtained. Use separate containers for each household solution, and do not mix the separate household solutions because they may react unexpectedly. Confirm whether the solutions are acidic or basic (see Table).

Try a 'titration' using the solutions and the cabbage indicator. Add an acidic solution, *eg* lemon juice, to the indicator until the colour is red. Now drip in a solution of baking soda – the colour should change as the pH rises.

You can prepare pH litmus paper by soaking a fresh piece of coffee filter paper in a concentrated cabbage juice solution (made by using more cabbage and boiling in less water), and leaving overnight to dry.

Cut into strips and use to test the pH of various solutions.

Table Red cabbage pH indicator colours

pH	Colour
2	Red
4	Purple
6	Violet
8	Blue
10	Sea-green
12	Yellowish-green

HEALTH & SAFETY

Wear a lab coat or apron, eye protection and disposable laboratory gloves (or Marigold-type gloves) throughout these experiments. Take care when using boiling water – it will scald. At the end of the experiments rinse the working area thoroughly with water and pour the solutions down an outside drain, rinsing through with plenty of water.



A DAY IN THE LIFE OF...

RESEARCH SCIENTIST:

Tom Salter

Tom Salter has spent the past two and a half years working for Dstl as a research scientist. He talks to James Berressem about his typical day.



Tom Salter in the field

The Defence Science and Technology Laboratory (Dstl) is an agency of the UK Ministry of Defence (MoD) and exists to supply the best, impartial, scientific and technical research and advice to the MoD and other government departments. Its workforce of 3500 scientists and engineers are located at three main sites. Based at the Fort Halstead site in Kent, Tom is a member of the explosives detection equipment team, which develops innovative equipment to detect and identify explosives such as TNT. He specialises in the application of spectroscopy in the detection of explosives.

DETECTING EXPLOSIVES

Currently Tom is the technical lead on four projects, each of which aims to address particular detection requirements identified by the UK's armed forces. But developing a useful detector based on techniques such as Fourier-transform infrared (FTIR) spectroscopy and Raman spectroscopy is not straightforward. 'Since the equipment will be used by a non-technical user the detector must be easy to use', explains Tom. 'The detector must give a quick and clear result, and it must be lightweight, robust and reliable so that it works in all conditions and temperatures.'

Often equipment development projects are based on a collaboration between Dstl and external research organisations, *eg* universities, companies and other government departments. Tom spends some of his time reviewing published research to identify groups that are working on new technologies which might be exploited for detecting explosives. He visits developers of potential useful technology to find out more and agree contracts for them to contribute to his project. These project partners are based across the UK and the world so Tom travels a lot with work. He regularly attends large international science conferences each year to keep up to date with the latest research and meet useful contacts.

FROM LAB TESTS TO FIELD TRIALS

When he is not meeting with project partners Tom spends his day in the laboratory evaluating new technologies and prototype detectors. Tom evaluates new equipment against lab-based spectroscopic instruments such as FTIR, uv-vis and Raman spectrometers. Using samples of explosives, he tests the product's selectivity and sensitivity and builds up profiles on particular characteristics such as its false alarm rate.

Tom also takes new equipment out for field trials where he conducts his own tests and trains the military in using the detection equipment so that he can collect feedback from soldiers on its performance. 'Placing the equipment in the hands of the military is the ultimate test of robustness – if it's possible to break something, you can guarantee they will break it', he says. Tom analyses the data collected from lab and field tests and writes a report. In his report Tom may recommend that the detector is put into production or purchased so that it can be supplied to troops or he may highlight to the developers modifications that are required.

APPLYING KNOWLEDGE TO SAVE LIVES

The threat UK armed forces face from explosive devices is continually changing which means Tom's work is always varied and challenging. In particular, he enjoys the applied nature of Dstl's work. 'I'm really happy that every day I'm using my knowledge of chemistry to solve real problems', he says. 'And it's satisfying to know that I'm developing products that will help save people's lives.' ■

PATHWAY TO SUCCESS

- 2007–present, research scientist, Defence Science and Technology Laboratory, Fort Halstead, Kent
- 2003–07, PhD in molecular spectroscopy at the University of Leicester
- 1999–2003, MChem in chemistry at the University of Leicester
- 1997–99, chemistry, maths, physics A-levels, The Hundred of Hoo Comprehensive School, Rochester

£50 OF HMV TOKENS TO BE WON!

Benchmark

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PRIZE WORDSEARCH No. 48

Students are invited to find the 32 words/expressions associated with pesticides hidden in this grid. Words read in any direction, but are always in a straight line. Some letters may be used more than once. When all the words are found, the unused letters, read in order, will spell a further 10-letter word. Please send your answers to the Editor at the usual address to arrive no later than Friday 5 February. First correct answer out of the editor's hat will receive a £20 HMV token.

S	E	T	A	H	P	S	O	H	P	O	N	A	G	R	O	E
S	A	C	E	T	Y	L	C	H	O	L	I	N	E	H	Y	R
D	E	I	S	E	D	I	C	I	T	N	E	D	O	R	R	U
I	T	N	S	N	N	B	I	Y	F	I	X	O	T	E	D	D
C	H	S	E	A	O	E	S	T	E	R	S	S	S	N	I	E
A	I	E	D	T	I	M	A	L	A	R	I	A	E	E	N	C
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O	E	L	I	C	A	Y	N	H	A	C	R	W	Z	O	C	P
R	N	A	T	E	L	G	C	D	L	E	B	D	A	U	T	G
O	D	R	S	N	A	E	D	D	T	S	O	E	I	S	I	N
H	A	V	E	Z	M	N	E	T	H	N	N	R	R	S	C	I
P	Z	A	P	Y	R	E	T	H	R	I	N	S	T	Y	I	L
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ACETYLCHOLINE

ALDRIN

BIODEGRADED

CAPTAN

CARBON

DDT

DETOXIFY

ENZYME

ENZYME CHEMISTRY

ESTERS

HANDLING PROCEDURE

HEAD LICE

HEALTH

INSECT

INSECTICIDES

INSECT LARVAE

LINDANE

MALARIA

MALATHION

NERVOUS SYSTEM

ORGANOPHOSPHATES

OXYGEN

PESTICIDES

PHOSPHORUS ACIDS

POWDERS

PYRETHRINS

RED SQUILL

RODENTICIDES

SARIN

THIOBENDAZOLE

TRIAZINES

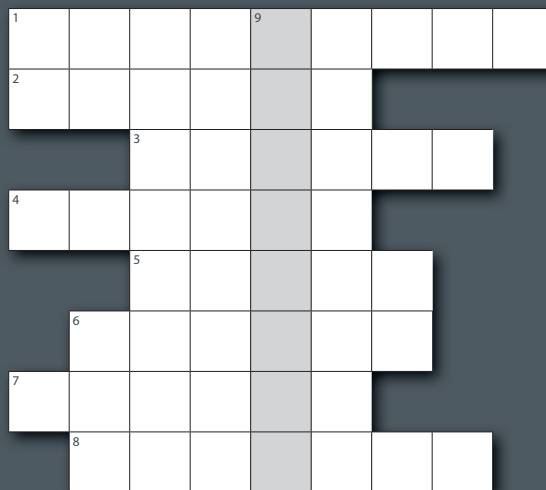
WARFARIN

FIND THE ELEMENT No. 11

Students are invited to solve Benchmark's *Find the element* puzzle, contributed by Dr Simon Cotton. Your task is to complete the grid by identifying the eight elements using the clues below.

ACROSS

1. Element present in a NPK fertiliser.
2. Unreactive metal. Forms a blue sulfate.
3. Group VI element that forms an acidic oxide.
4. This element must be present in excess to ensure complete combustion of a fuel.
5. Inert gas, used in arc lamps and as a general anaesthetic.
6. This metal burns with a very bright yellow-orange flame.
7. Gas used in weather balloons.
8. Element used as a reagent to distinguish between an alkene and an alkane.



If you have found the correct eight elements, in 9 down you will have generated the name of a non-metal that becomes a conductor when illuminated and is used in devices such as photocells and photoelectric lightmeters.

Please send your answers to: the Editor, *Education in Chemistry*, the Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA, to arrive no later than Friday 5 February. First out of the editor's hat to have correctly completed the grid will receive a £30 HMV token.

Elemental England winner

The winner of the Elemental England challenge published in the November issue of *InfoChem* was Bethany Bryne-McCombie of Sandwick Junior High School, Shetland.

The answers were: 1. Bradford; 2. Preston; 3. Manchester; 4. Liverpool; 5. Derby; 6. Stoke on Trent; 7. Wolverhampton; 8. Dudley; 9. Birmingham; 10. Reading; 11. Bristol; 12. Southampton; 13. Plymouth; 14. Newcastle upon Tyne; 15. Leeds; 16. Sheffield; 17. Kingston upon Hull; 18. Nottingham; 19. Leicester; 20. Coventry; 21. Northampton; 22. Milton Keynes; 23. Luton; 24. London; 25. Portsmouth.