The Periodic Table of Sustainable Elements

Date: xx

School: xx

Name:

United Nations Educational, Scientific and Cultural Organization

2019 IYPT

International Year of the Periodic Table of Chemical Elements

DEAKIN UNIVERSITY

About this event

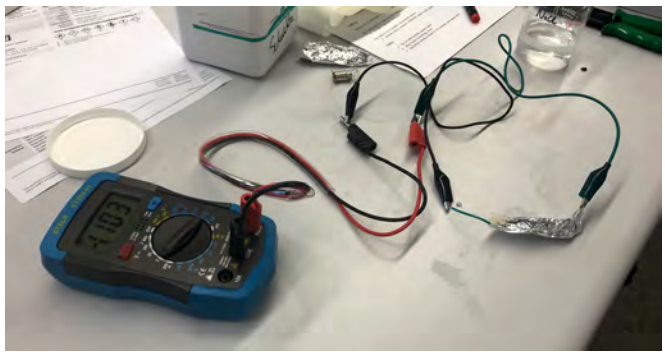
2019 is the International Year of the Periodic Table of Elements!

To celebrate, we have designed activities to show you some elements that you use in your everyday life. We also want you to see the importance of chemistry in sustainability, because some elements are endangered and we can recycle them rather than throwing them away.

This event is organised by Deakin University, and is financially supported by a 2019 grant from the Australian National Commission for UNESCO grant. We also thank Professor Stuart Batten (Monash University) who designed, sourced and provided the periodic table sets.

At the back of this booklet is a periodic table. Colour/shade in each of the elements that you use in your activities today. Are any of these elements endangered? Ask the people helping at each station, and mark it on your periodic table.

Making an aluminium - air battery



What did you do?

What did you see?

Why did this happen?

Did you know?

Renewable energy sources such as wind, solar and hydroelectricity require energy to be stored in batteries. Different types of batteries are needed for different purposes; some need to be small and light, others can be heavy and bulky. *Lithium*-ion batteries have a lot of important uses in today's society, but the name is deceptive. They contain a lot more *Carbon* (as Graphite)*, Nickel, Copper* and *Aluminium* than they do Lithium.

Copper crystals grown on Aluminium sheet

What did you do?

What did you see?

Why did this happen?

Did you know?

Copper has excellent conductive properties, requires little maintenance, resists corrosion and is infinitely recyclable. Copper was one of the first commonly used metallic elements, in alloys such as brass (mixed with *tin*) and bronze (mixed with *zinc*). In fact, bronze was first made over 6000 years ago! Copper was so abundant back then that you could find it in river beds, but is now normally produced from copper ore.

Turning copper coins ‘silver’ and ‘gold’

What did you do?

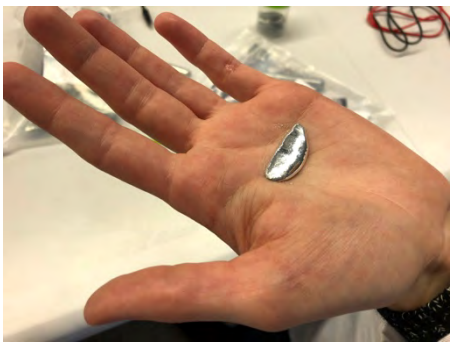
What did you see?

Why did this happen?

Did you know?

Zinc is used to protect other materials from corrosion (rust). Galvanised iron is used extensively in Australia for roofing, water tanks and many other purposes. Globally, over 80% of all zinc is used to coat steel structures, to protect them from corrosion. This makes zinc one of the most important (and most endangered) elements in the world. Zinc is also an important element for human and plant growth, and is present in over 300 different enzymes in the human body!

Periodic Table sets and gallium



What did you see and feel with the gallium?

From the Periodic Table set, which elements look similar to you?

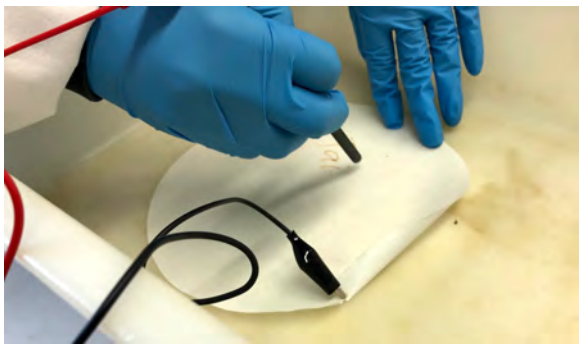
From the Periodic Table set, which elements look different to you?

Did you know?

There are so many amazing elements to look at! *Gallium* is used extensively in semi-conductors, including in blue LEDs violet-coloured lasers. *Indium* is an essential element for flat screen TVs and solar panels.

Tantalum is an extremely stable element, and is present in EVERY electronic device. It is found in few places, and two mines in Australia produce more than half of world supply. Illegal mining of coltan (a 'conflict mineral' containing Tantalum) fuelled the Second Congo War ('The Great African War'), the world's bloodiest war since World War II.

Carbon Rod Writing



What did you do?

What did you see?

Why did this happen?

Did you know?

Iodine exists in two forms: iodide (with a negative charge) and iodine (with zero charge). Iodide is colourless and iodine is brown/purple. That is why you can see the change when you use electric current to convert between them. You can also use other chemicals to convert between the forms. Iodine is toxic, but is also an essential element for life, as your body uses it in hormones for growth and metabolism. You therefore require a *very* small amount (130-150 micrograms) in your daily diet.

More Iodine experiments

A) Disappearing messages

What did you do?

What did you see?

Why did this happen?

B) Fingerprinting

What did you do?

What did you see?

Why did this happen?

DEMONSTRATIONS

Cobalt Pink and Blue

What did you see?

Did you know?

Cobalt and other metals in the middle of the periodic table are important in biology because they can have different amounts of positive charge, and can make different numbers of chemical bonds. In your body, *iron* is the metal that carries oxygen in your blood from your lungs to your muscles. Cobalt is used to help your body make blood cells. You only have a very small amount of cobalt in your body but without it you would die.

'Traffic Light' and the 'Blue Bottle' reactions

What did you see?

Did you know?

The amount of *oxygen* dissolved in solution changes the colour of the dye. Indigo carmine is used as a food colouring and a pH indicator. Doctors also use it to study kidney and bladder function - they inject the dye into the bloodstream and see how long it takes for the urine to turn green!

The Thermite Reaction

What did you see?

Did you know?

The thermite reaction, also known as the Goldschmidt process, is used to join train tracks together via an amazing process called exothermic welding, which basically involves sending molten iron into a sand mold.

It is very useful for welders as it does not require charcoal or *carbon* like smelting does, and so leaves a nice relatively pure iron metal. Other metals such as *copper* can also be prepared by a thermite reaction. Even *uranium* has been produced from uranium ore by the thermite process!

The most valuable material in the recycling bin – Aluminium (Al)

Aluminium is used for many purposes in modern society. It is very light (look where it is on the periodic table!), non-toxic, does not easily corrode, and it can easily by shaped and moulded. On its own, it is not strong, but mixed with other metals like copper, magnesium and silicon it is very strong while remaining lightweight, making it perfect for planes and other transport.

It is not an endangered element. 8.1% of the earth's crust is Aluminium! But not only is it used a lot, and it is also very energy intensive to make.

This is because aluminium, like most metals, doesn't exist in pure form. Most metals are found in types of rocks or sediment called ores. Bauxite ore is the world's main source of aluminium and is very common in Australia. Making aluminium from bauxite requires enormous amounts of heat and electricity and has a massive environmental impact.

3% of all of the electrical energy produced in the entire world is used just to produce aluminium. In Victoria, it is even higher. One aluminium smelter (which turns bauxite ore into pure aluminium) in Portland uses nearly 10% of all of Victoria's energy supply.

However, aluminium can be recycled easily. Recycling aluminium requires only 5% of the energy that is needed to produce it from bauxite.

Aluminium holds a great amount of chemical potential energy - it is able to make a battery, grow copper crystals, make sparks and even melt iron. Throwing away aluminium cans instead of recycling them is like throwing money in the bin and leaving the lights on for weeks – a huge waste!

Much chemistry research is happening both in Australia and globally, to find ways that industry and the community can use chemicals and elements more sustainably. Chemistry has a central role to play in meeting the 21st century's global sustainable development challenges.

Periodic Table of the Elements

1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.9412	4 Be Beryllium 9.0122											5 B Boron 10.8117	6 C Carbon 12.0108	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.1898
11 Na Sodium 22.9898	12 Mg Magnesium 24.3051											13 Al Aluminium 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.9738	16 S Sulphur 32.0655	17 Cl Chlorine 35.4532	18 Ar Argon 39.9481
19 K Potassium 39.0983	20 Ca Calcium 40.0784	21 Sc Scandium 44.9559	22 Ti Titanium 47.8671	23 V Vanadium 50.9415	24 Cr Chromium 51.9962	25 Mn Manganese 54.938	26 Fe Iron 55.8452	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.5463	30 Zn Zinc 65.4094	31 Ga Gallium 69.7231	32 Ge Germanium 72.641	33 As Arsenic 74.9216	34 Se Selenium 78.963	35 Br Bromine 79.9041	36 Kr Krypton 83.7982
37 Rb Rubidium 85.4678	38 Sr Strontium 87.621	39 Y Yttrium 88.9059	40 Zr Zirconium 91.2242	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.942	43 Tc Technetium (98)	44 Ru Ruthenium 101.072	45 Rh Rhodium 102.9055	46 Pd Palladium 106.421	47 Ag Silver 107.8682	48 Cd Cadmium 112.4118	49 In Indium 114.8183	50 Sn Tin 118.7107	51 Sb Antimony 121.7601	52 Te Tellurium 127.603	53 I Iodine 126.9045	54 Xe Xenon 131.2936
55 Cs Cesium 132.9055	56 Ba Barium 137.3277	71 Lu Lutetium 174.9671	72 Hf Hafnium 178.492	73 Ta Tantalum 180.9479	74 W Tungsten 183.841	75 Re Rhenium 186.2071	76 Os Osmium 190.233	77 Ir Iridium 192.2173	78 Pt Platinum 195.0849	79 Au Gold 196.9666	80 Hg Mercury 200.592	81 Tl Thallium 204.3833	82 Pb Lead 207.21	83 Bi Bismuth 208.9804	84 Po Polonium (208)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (293)	117 Ts Tennessine (293)	118 Og Oganesson (294)

57 La Lanthanum 138.9055	58 Ce Cerium 140.1161	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.2423	61 Pm Promethium (145)	62 Sm Samarium 150.362	63 Eu Europium 152.9641	64 Gd Gadolinium 157.253	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.5001	67 Ho Holmium 164.9303	68 Er Erbium 167.2593	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.043
89 Ac Actinium (227)	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251).	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)