The Chemistry of Life

SCIENCE WEEK 13 - 20 NOVEMBER 2011

Elemental Cosmos

Everything in the Universe is made up of the same elements.

The most abundant element in the entire universe is Hydrogen. Hydrogen makes up three quarters of the matter of the cosmos, mostly in the form of clouds of gas and stars.

The magnificent Spiral Galaxy M31

Carl Sagan, the famous American astronomer stated "we are all made of star stuff". Nearly every atom from which we are made (before the solar system formed) was once inside a star!]

By weight, 75% of the visible universe is made up of Hydrogen, a colourless gas. In space, huge quantities of Hydrogen interact with the light from stars to create spectacular sights such as this image of the Eagle Nebula, taken by the Hubble Space Telescope

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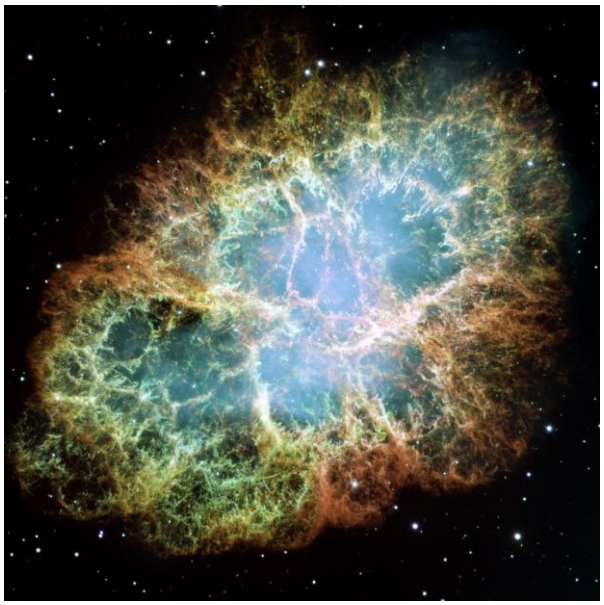
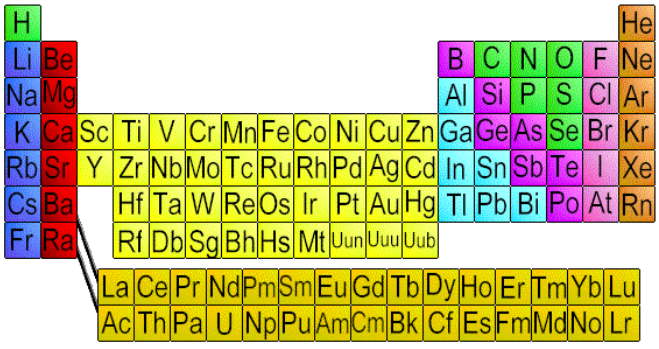
Over time, stars burned some of their hydrogen to make the heavier elements. These elements can be released in massive supernova explosions, and combine with the remaining gas, eventually seeding the universe with material for new stars, planets etc...

All material on Earth except for hydrogen, helium and lithium is the burned material from a star. Our Sun is a later-generation star, meaning that it contains material created by other stars and captured by our Sun at the beginning of its lifecycle.



Crab Nebula (image - ESA/Hubble): The remains of a massive explosion so bright that Chinese and Arab astronomers recorded seeing it in 1054. The name was given by the Irish astronomer and politician William Parsons, 3rd Earl of Rosse. Some people think it looks a bit like Ireland!



The classic Periodic Table.

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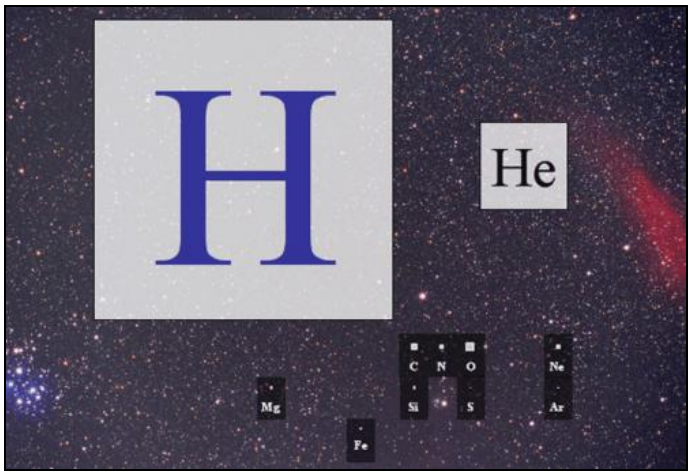
If we compare the classic Periodic Table to the astronomer's view of the elements in the cosmos (relating to the amount of each element there is)



Astronomer's Periodic Table

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How to make Hydrogen in the classroom

What you need

a) A Bunsen Burner
b) Two test tubes - one bigger than the other so it can be placed entirely over the smaller one.
c) A rubber bung
d) A splint
e) A test tube rack
f) A pipette
g) Safety goggles
h) Dilute hydrochloric acid (1 mol/dm3)
i) A strip of zinc

What you do

1. Do not have the bunsen flame lit for the entire experiment - you will only need to use it to light the splint at the very end.
2. Place the smaller test tube in the test tube rack.
3. While wearing safety goggles use the pipette to third fill the smaller test tube with dilute hydrochloric acid.
4. Carefully drop in the strip of zinc, and place the larger test tube over the top of the smaller one.
5. Wait…
6. You should see bubbles forming around your zinc which rise to the surface.
7. After a few minutes lift the larger test tube off, do not turn it over, and insert the bung into it.
8. Now turn it over, and light the splint from your bunsen burner.
9. Take the bung out of the test tube and slowly insert your lit splint into the neck of the larger test tube, keeping you goggles on and your face back. You should hear a pop, and the splint should go out.

What's going on?

Zinc is reasonably reactive; it reacts with dilute hydrochloric acid to form hydrogen and the salt zinc chloride, which is dissolved in water.

The released hydrogen is lighter than air. It floats to the top of the larger, inverted test tube and is trapped. As more hydrogen is produced it forces the air out of the larger test tube.

Once a lit splint is brought near the hydrogen in the larger test tube the hydrogen reacts explosively with any oxygen nearby. Since there isn't that much hydrogen the explosion is a tiny pop, but it is enough to blow out the lit splint, which is also relying on oxygen nearby to stay alight.

The hydrogen and oxygen 'explosion' produces a tiny amount of water vapour.

Special safety advice

Do not have your bunsen burner lit unless you are about to use it. Only light the splint at the last minute.

Even dilute hydrochloric acid is caustic so keep the lid on the bottle at all times unless you are filling the test tube.

Be careful when lifting the larger test tube off, the smaller test tube may be warm.

Dispose of all the chemicals according to your labs safety procedures.

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Now, can you find out how to safely test for other gases in the classroom? Work with your teacher to investigate how to collect gases and test for them!

Did you know? The name Hydrogen comes from Hydrogenium, which comes from Ancient Greek meaning "water-forming". Water has two Hydrogen atoms (H) and one oxygen atom (O). Hence H2O!

Collecting your own space dust

The Periodic Table also includes the metals. Did you know that tonnes of Iron rain down from space onto the surface of the Earth every day as micrometeorites? Where is the best place to find this material? On your roof, of course!

The best places to collect micrometeorites are from the drains of a house or building as rain will wash all the material of the roof and down the drain spout.

What you do

a) Place a bowl or basin at the base of a spout to collect material washed of the roof by rainfall. Now, not all of the material you are going to collect will come from space! Leaves, dust and other airborne material will be in there too. Remember to wear gloves and wash hands thoroughly after doing this activity as it might get a bit messy!
b) Remove leaves etc. from the collected material. Place the rest of the material on paper and allow to dry overnight. (If a school has access to an oven then use this on very low setting to dry).
c) Next day, place the material on a piece of paper and place a magnet directly under the paper. Use the strongest magnet available. Tilt and tap the paper so that all of the non-metallic particles are removed.
d) Now the cool bit… some of the remaining metallic particles are pieces of space dust that now belong to you! To examine them, place the paper under a microscope. You will need a high power to see them. A lot of the material will not be from space but the small rounded particles, which may have small pits on their surface are micrometeorites that have had a very hot trip to the surface of Earth after hurtling through the atmosphere!

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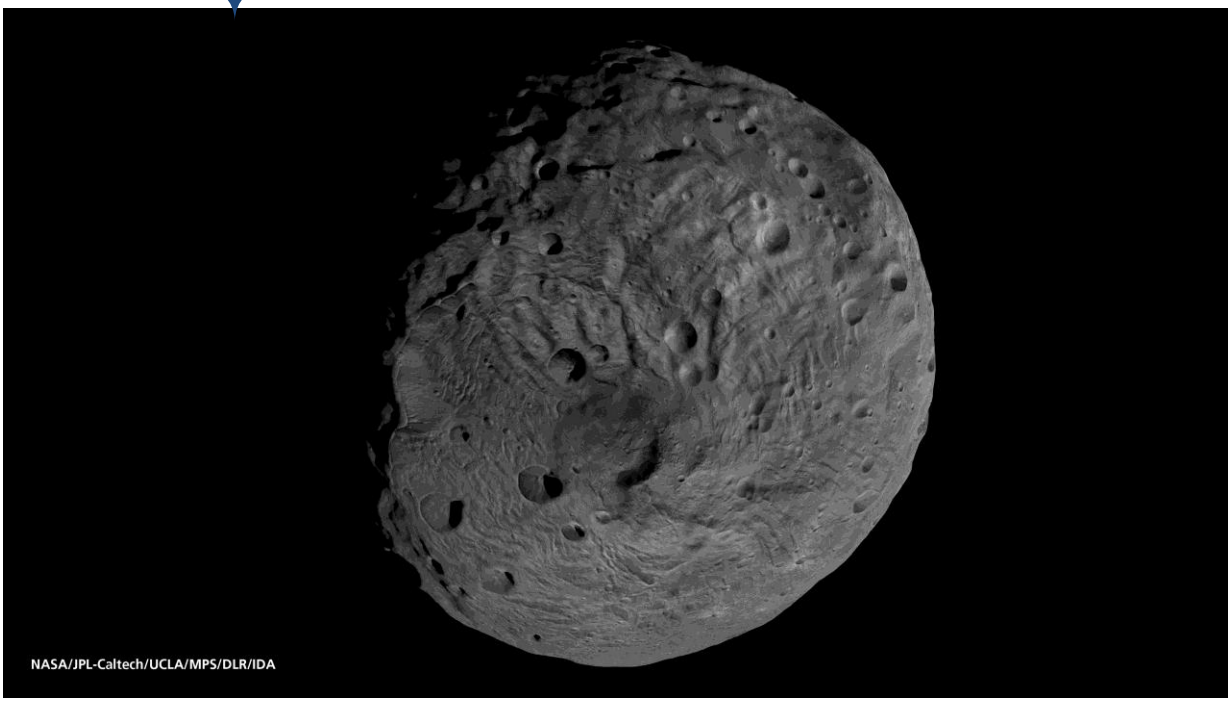
No way! These little rounded micrometeorites are around 4.6 BILLION years old and date from the formation of the solar system! They are the building blocks of the planets and asteroids that orbit around our Sun.



The asteroid Vesta. Image taken from the Dawn satellite encounter in 2011

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