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THE HORRIBLE SCIENCE COLLECTION

NUCLEAR NASTIES

NUCLEAR BOFFINS 'FISSION' FOR ATOMIC ANSWERS

Doing the splits!

The tiny matter of enormous energy

Inside a super-stealthy nuclear submarine

Make your own horrible half-life decay chart

BASED ON THE AWARD-WINNING BOOKS WRITTEN BY NICK ARNOLD AND ILLUSTRATED BY TONY DE SAULLES

NUCLEAR NASTIES

SPLITTING THE ATOM

A BEGINNER'S GUIDE TO NUCLEAR CHEMISTRY

All matter is made up of particles called atoms.
Atoms are made of three smaller types of particles: electrons, protons and neutrons.

A diagram of an atom looks rather like an egg. The electrons orbit round the outside, like the shell, with the protons and neutrons inside, like the yolk — called the 'nucleus' of the atom.

All atoms have an equal number of protons and electrons, and their oppposite charges make them attract one another and hold the atom together.

Electrons have a negative electrical charge (-), and the protons have a positive charge (+). Neutrons, have no charge of any kind.

The presence of neutrons holds the nucleus together. If they were not there, the protons, being of the same charge, would repel one another — like when you try to put the opposite poles of a magnet together.

Protons, being of the same charge, would repel one another if the neutrons were not there to bind the nucleus.

The atoms of different types of elements — pure, unmixed chemicals — have different numbers of protons. This is what makes one element different from another.

Hydrogen is the lightest element, with atoms containing only one proton.

ENERGY MATTERS.

e = mc2
Albert Einstein is regarded by everyone who knows what's what as the greatest scientist of the 20th century.

In 1905, he wrote a paper known as his Special Theory of Relativity, which completely changed the way in which physics was viewed, and suggested that time is as much a part of matter as the physical particles are.

He spent a lot of time working things out, and came to the conclusion that everything in the universe is made from energy, and that matter and energy are actually the same thing.

He worked out a formula to describe this, and boiled it down from pages and pages of calculations to the following formula: e = mc2. This is, without doubt, the most famous formula in the universe. Doesn't look like much to show for after such complicated sums, though, does it?

This is what it actually means:

e stands for Energy.
= means that it is equal to
m stands for mass, which means the amount of something.

SHOCKING SCIENCE

NUCLEAR POWER GENERATION

One of the most pressing problems in the modern world is how to generate energy for transport and industry. Burning 'hydrocarbons' such as oil and coal has done well for us for nearly 200 years, but they cause serious pollution, and supplies will not last for ever.

So, in the race to find cheaper and cleaner ways to produce energy that won't run out, nuclear power has been in the front line for some time. It has a lot going for it in many ways, and it also has its bad points.

GOOD AND BAD THINGS ABOUT NUCLEAR POWER

Many people are strongly against nuclear power, while others think it's a good solution to some of our energy problems. Obviously, both sides can't be wrong, but both sides can't be right either. So here are some facts:

GOOD THINGS

Nuclear energy is clean, and doesn't belch out toxic fumes, or fill the atmosphere with greenhouse gases such as carbon monoxide, sulphur dioxide or nitrogen oxides, which cause global warming and damage the planet.

The cost of fuel is low and it generates large amounts of power.

Nuclear fuel is compact and efficient, so a little goes a long way — when powering ships and submarines, energy is not wasted in carrying heavy tanks.

BAD THINGS

Nuclear power produces dangerous radioactive waste material that remains live for thousands of years.

Building power stations, mining, transportation and waste storage use large amounts of oil and coal, so, although nuclear power itself does not contribute to global warning, the processes around it do.

So far there is no really safe way to store nuclear waste for ever. In some power stations it is kept in tanks that have to be cooled continuously, and in others it is kept underground. But it takes thousands of years before the waste material stops being radioactive, so although it may be safe in our lifetime, we could be leaving a problem for future generations.

FUSION AND FISSION

There are two ways to generate electricity by nuclear reaction: fission and fusion.

FISSION

A nuclear reactor is powered by uranium cakes, which are loaded into long carborundum rods — the same stuff that we call the ‘lead’ in pencils. This is to contain the reaction so that it does not explode freely, or it would become an atomic bomb, and there would be nobody left to create electricity for.

The word fission means splitting, and this is what happens to the atoms inside a reactor. Spliting atoms generates a huge amount of heat, which is used to boil water, and the steam from this is used to drive electricity generators. Much of the nuclear generating process works the same way as steam power — it’s the energy that heats the water that is different.

FUSION

The other way to create a nuclear reaction is by ‘fusion’, which means joining. This process involves squeezing smaller particles so that they melt together to form larger ones, and in doing so, give off a large amount of light and heat. The sun’s energy comes from fusing atoms of hydrogen to form helium.

Scientists have not yet found a way to control the process of nuclear fusion, so it has not yet been used to generate power. But it is thought that when this can be done, it will be a much cleaner and safer method than fission.

URANIUM

The main ingredient in the making of nuclear power is uranium. This is an element — a pure chemical that is not mixed with anything — that was formed in stars that exploded millions of years ago.

Lumps of uranium are known as yellowcake. Guess, if you can, why they are called this... Yes, you’ve got it! They look like round yellow cakes. If you should ever find yourself working on a nuclear-powered ship, be careful not to mistake one of

these for a piece of real yellow cake. It will not taste good — but it will raise your energy levels.

A lump of uranium the size of a tennis ball contains as much energy as 1 million gallons of petrol — enough to fill a 50-foot cube-shaped tank.

BET YOU NEVER KNEW!

- Uranium was discovered by German chemist by the name of Martin Klaproth, in a mineral called pitchblende.
- It was named in celebration of the discovery the planet Uranus eight years before.
- Uranium is not found in Uranus — but we won't make any jokes about that, if you don't mind.
- Uranium is present in very small quantities in most rocks on Earth, and is even found in seawater.
- The heat inside the Earth is caused mainly by the slow breakdown of uranium particles, in a process known as radioactive decay.
- Because uranium is very dense and heavy, it is sometimes used as ballast in the keels of yachts, as a small amount weighs a lot.
- Uranium melts at 1132°C — 1,132°C times the melting temperature of ice. (An especially useless fact)

DANGEROUS AND DEADLY

An accident at Chernobyl power station in the Ukraine, in 1986, released 100 times more radiation than both of the atom bombs that were dropped on the cities of Nagasaki and Hiroshima at the end of World War II. Many people are still suffering the effects of it, mostly in the form of various cancers.

The radioactive cloud that came from the explosion floated over 25 countries in Europe, and it will be many years before the real damage can be properly estimated.

It may be a relief to know that thanks to more modern processes and equipment, another accident of this type will not happen again.