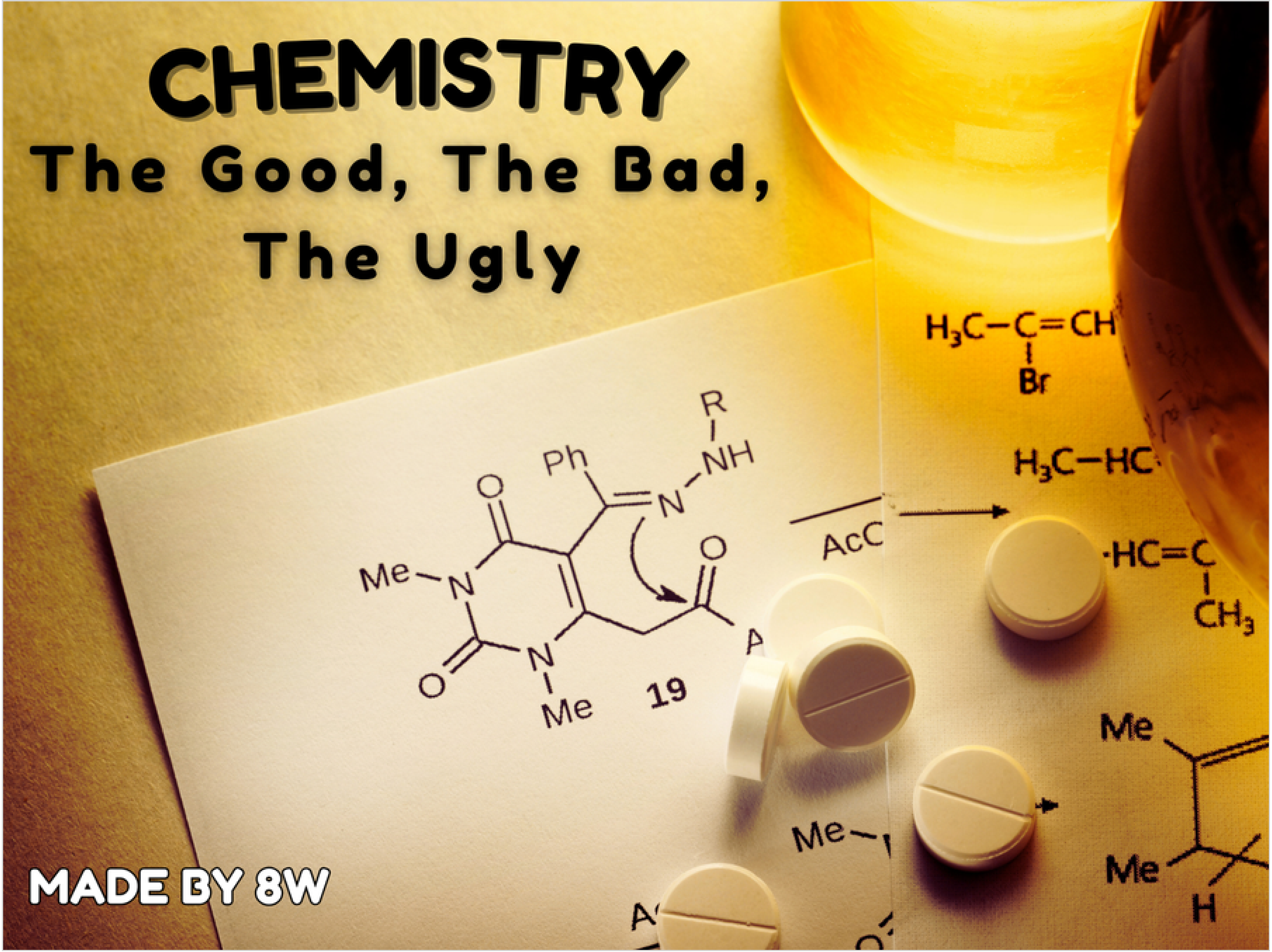
CHEMISTRY

The Good, The Bad, The Ugly



MADE BY 8W

Every aspect of the world today – even politics and international relations – is affected by chemistry.

Linus Pauling

Chemistry ought not to be for chemists alone.

Miguel de Unamuno

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Preface

In planning for the project, the Year 8W class was given a range of chemical substances to choose from and research. In small groups they began to dig more deeply into the molecule's place in history; classifying it as 'good', 'bad', 'ugly' and some cases multiple of the three. Many of the chemical substances posed historical and ethical questions, some of which are presented in the book.

In small groups, students conducted extensive research, including interviews with experts which further aided their understanding of the chemistry of the molecule and its role in history.

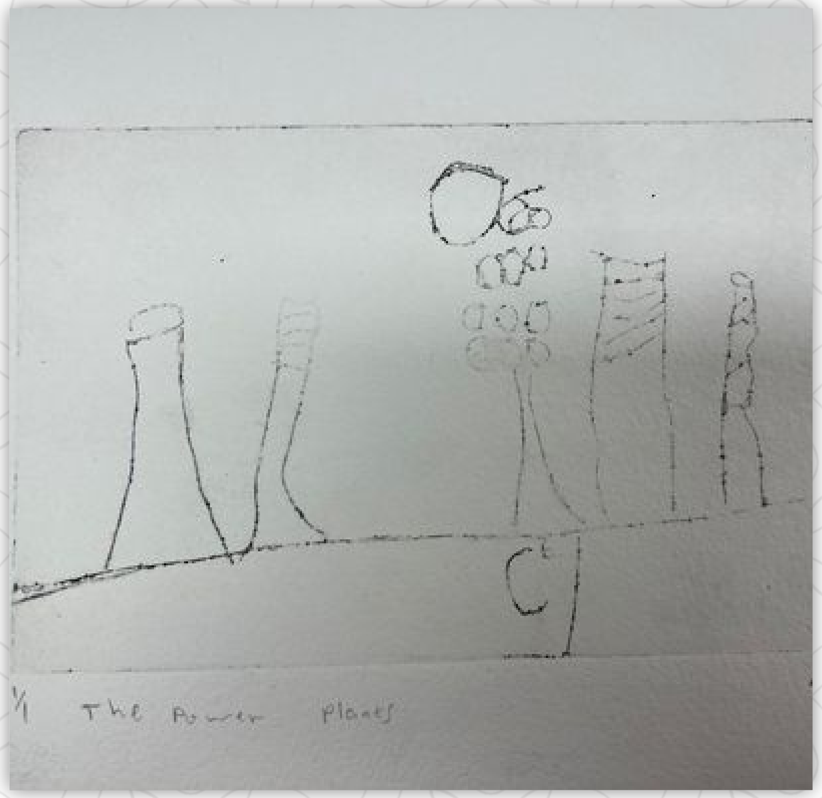
Each group was responsible for creating a piece of artwork that reflected their substance. Each piece of art was created in a complex set of steps that involved copper etchings created through a redox reaction. The final etchings were then inked and pressed to create an image on paper. The scanned artworks are included in the book, with the originals to be hung in the All Saints' College CPA Building to be showcased to the community.

PROJECT LEARNING GOALS

- To understand the importance of considering ethics in the study of science.
- To learn about transformational developments of science and its involvements in history, both positive and negative.
- To develop research, writing and editing skills.
- To develop collaboration and communication skills.

Carbon- Good and Bad

Ashton and Sam



Power plants producing carbon emissions. Statement from Ashton Lee: The reason I chose power plants is because they're the largest source of carbon emissions. Carbon emissions is carbon dioxide released into the atmosphere, negatively impacting the atmosphere. There is a positive side to this because they boost agricultural production and improve drought resistance.

Carbon has been beneficial in many ways, yet problems like carbon dioxide is a problem to the environment to this day.

Carbon is a solid, and feels hard.
It is dull, and a non-metal. As a solid, it is an insulator.
In different forms, like graphite, it is a conductor.
Some forms of carbon like graphite are incredibly soft, while other forms like diamond are incredibly hard.

Carbon is relatively reactive. It forms many types of compounds- like carbonates.

Carbon's **atomic mass** is 12.011.

Density as a solid: 2.2g/cm, making it more dense than water and air.

In solid forms carbon is not toxic but in gaseous forms it can be, like with carbon monoxide.

Carbon **boils** at 4827 degrees Celsius.

Carbon has **6 protons, 6 neutrons,** and **6 electrons**. Its atomic number is 6.

Carbon is odourless.

History of carbon

Carbon was essential in the past and is still widely used to this day.

Image of train being powered by coal, producing carbon emissions in the Industrial Revolution.

There is no definitive answer to when carbon was first discovered, it seems to be known since ancient times. In around 3750 BCE by the Egyptians and Sumerians and recognized carbon in the form of charcoal.

In 1760, carbon was widely used, in the form of coal, for many purposes. The burning of coal during the Industrial Revolution rapidly accelerated the emissions of carbon dioxide. In 1789, it was finally recognised as an element by A.L Lavoisier.

In modern day, we still use carbon frequently, in the form of coal, diamonds and graphite.
Diamonds are traded for high amounts of money, and used in jewellery. Graphite is mainly used for batteries as a conductor and pencils.
Coal being burned for fuel is still used today, and still produces a high amount of carbon emissions.

Good of Carbon

Carbon has been an extremely beneficial element throughout the past and present, thanks to its many forms and uses.

Image of carbon fibre in a car. Image from Wikimedia Commons.

During the Industrial Revolution (1760-1840) coal was very important because of how efficient and reliable it was as a fuel source, when compared to other sources.

It was used in many applications, from turning iron ore into iron, or powering steam railroads. Carbon dioxide (CO_2) is also a useful compound.
It is very useful for extinguishing fires, as fires require oxygen and carbon dioxide starves the fire of its oxygen.

Today, carbon has many beneficial uses, whether in the form of graphite as a conductor for batteries or diamonds for jewellery.

Another less known form of carbon is carbon fibre. It's useful as a strong and lightweight material.
It is ideal for transportation vehicles, such as cars, aeroplane and motorcycles. They're light so they can travel quickly. It can also absorb strong hits, such as in the event of a crash, and take force away from the driver.

Bad of Carbon

Despite carbon being beneficial to this day, there are also many issues with carbon.

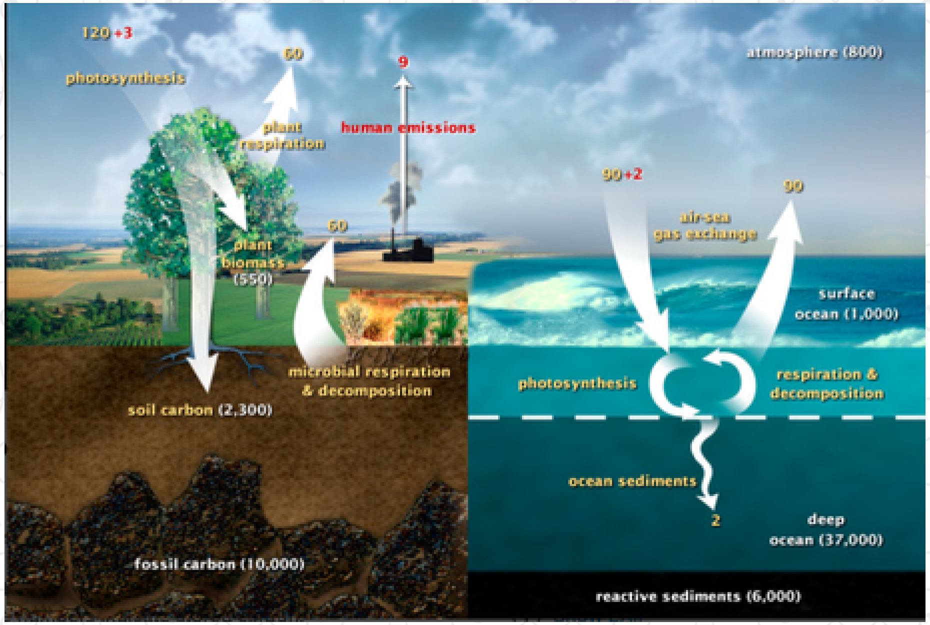


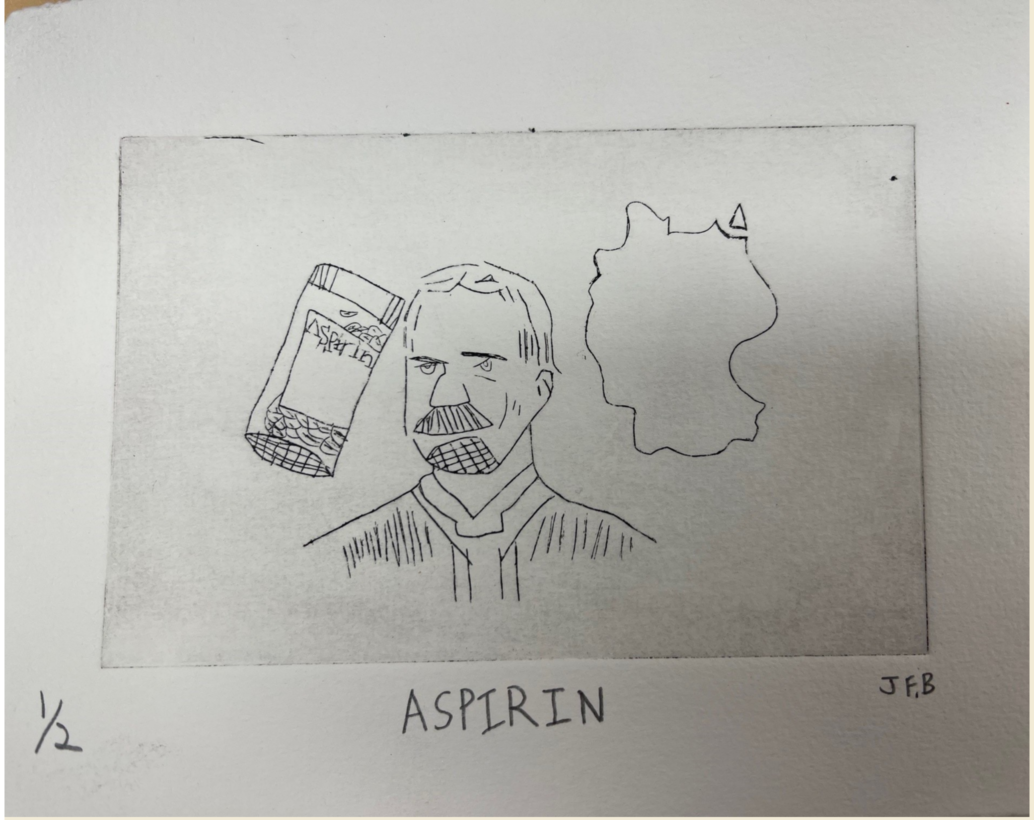
Image of the natural and manmade processes that cause carbon to be released into the atmosphere. Image from Flickr.

Carbon monoxide poisoning from smoke is common when you burn items like wood or charcoal.
Unfortunately, carbon fibre is highly flammable, and common in vehicles, so any crashes with fires are incredibly dangerous.

Carbon dioxide is the biggest issue with carbon and the issue most frequently talked about. Carbon dioxide being released into the atmosphere contributes to global warming and heats the atmosphere.

Carbon is naturally released into the atmosphere through various means, such as organisms or natural fires, however our emissions accelerate it considerably- in fact it accounts for 76% of greenhouse gas emissions! Coal is still an issue to this day, as it is still burned and used as a fuel source. Not only is it a non-renewable fossil fuel, but it also releases carbon dioxide into the atmosphere.
Since the Industrial Revolution, to the present day, carbon dioxide in the atmosphere is 50% higher than it was before.

Overall, carbon has been a very important element in history, while also being one of the biggest problems today- in the form of carbon dioxide pollution.



Left: Image of a container of aspirin

Middle: Felix Hoffmann (founder of aspirin),

Right: Image of Germany.

Felix Hoffmann synthesised aspirin on the 10th of August 1897 in Germany.

Aspirin- Good, Bad

Tim, Arya and Jun

The Good:
Aspirin is a very useful medicine that can be used to treat pain, fever and many more other things.

The Bad:
Aspirin has been linked to the deadly Reye's syndrome. It is linked to it through the use of Aspirin in young children, so children under 18 should never take aspirin when recovering from chicken pox or flu-like symptoms.

About Aspirin:
Aspirin is a non-addictive, non-steroidal drug that is used for relieving pain and/or fever. Aspirin is also known as acetylsalicylic acid.

State of matter at room temperature:
When at room temperature aspirin is a solid and it has a boiling point of 140 Celsius.

Chemical Formula:
Aspirin is a compound. Its chemical formula is $C_9H_8O_4$ *which is 9 Carbon atoms, 8 Hydrogen atoms and 4 Oxygen atoms.*

Facts about Aspirin

Origin: The person who discovered Aspirin was Felix Hoffmann in 1897. This happened when Felix Hoffmann was working for the Bayer company, when he was able to modify salicylic acid to create acetylsalicylic acid otherwise known as Aspirin. In the 20th century scientists, discovered that aspirin is an anti-inflammatory and analgesic properties. This includes molecular mechanisms of action.

Medical Uses: Aspirin is a way of relieving pain and fever, and it is non-addictive. Aspirin is a nonsteroidal anti-inflammatory drug used to reduce pain, fever, and/or inflammation, and as an antithrombotic.

Side Effects: The main side effect is indigestion and stomach pain.

Cramps or burning are also a common side effect. Bloody and cloudy urine, chest pain or discomfort, confusion, constipation and convulsion are also side effects but are rarer than the others.

Scientific terms and definitions:
Silicon - The bark of white willow contains silicon, which is a chemical similar to aspirin (acetylsalicylic acid). In combination with the herb's powerful anti-inflammatory compounds (called flavonoids), silicon is thought to be responsible for the pain-relieving and anti-inflammatory effects of the herb.

Chemical properties: In the factories where aspirin is produced, the powder mixes in with the air and it becomes very explosive.

Density :1.4g/cm^3

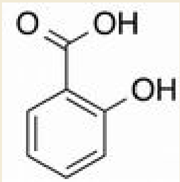
Fun Facts:
Felix Hoffmann also discovered Heroine which was later found to be very addictive. In the 1918 flu pandemic misuse of aspirin could make the pandemic worse instead of helping it

Timeline: Aspirin has been used for more than 3500 years, and willow bark has been utilized as a traditional medicine. Silicon, which would later serve as the basis for the discovery of aspirin, was the active ingredient in willow bark, but the ancient Egyptians who used it were unaware of this.

Aspirin Timeline

1934BC

Salicylic Acid
It is used to treat acne.
It is made from willow bark



1838

Flu Pandemic leads to widespread use of Aspirin
1918

First record of willow bark as analgesic
1934BC

Discovery of Aspirin
Modified salicylic acid
1897

Aspirin said to inhibit platelet function
1967

Asbestos - Bad, Ugly

Zain and Olli

Discovered in 1876

Origin of the Word:
In both modern and ancient Greek, the usual name for the material known in English as "asbestos" is amiantos ("undefiled", "pure"), which was adapted into the French as amiante and into Spanish and Portuguese as amianto.

Chemical Formula:
$Mg_3Si_2O_5(OH)_4$

Physical Properties:
State Of Matter at Room Temperature: Solid

Colours: Grey, Green, and Yellow

Odour:
Mainly Odorless

Solubility:
Asbestos Does not Dissolve in Water or Evaporate.

Density: 1000 kg/m^3 – 1400 kg/m^3

Asbestos Discovery

Discovery:

Lang Hancock discovered asbestos in 1876, chrysotile (white asbestos) was discovered in the Thetford Township, in south-eastern Quebec. Shortly afterward, Canadians established the world's first commercial asbestos mine In 1899, a man named H. Montague Murray noted the negative effect on health

Discovery of Toxicity:

In 1899, H. Montague Murray noted the negative health effects of asbestos. The first documented death related to asbestos was in 1906. In the early 1900s, researchers began to notice a large number of early deaths and lung problems in asbestos-mining towns. The first such study was conducted by Murray at the Charing Cross Hospital, London, in 1900, in which a post-mortem investigation discovered asbestos traces in the lungs of a young man who had died from pulmonary fibrosis after having worked for 14 years in an asbestos textile factory. Adelaide Anderson, the Inspector of Factories in Britain, included asbestos in a list of harmful industrial substances in 1902. Similar investigations were conducted in France in 1906 and Italy in 1908. The first diagnosis of asbestosis was made in the UK in 1924. Nellie Kershaw was employed at Turner Brothers Asbestos in Rochdale, Greater Manchester, England, from 1917, spinning raw asbestos fiber into yarn. Her death in 1924 led to a formal inquest.

Western Australian Blue Asbestos:

From 1938-1966, the Australian Blue Asbestos Pty. Ltd. (ABA), founded by Lang Hancock was in charge of the mining, bagging, and distributing of blue asbestos or crocidolite. Blue Asbestos has been found to be possibly 100 times more hazardous than white asbestos as the fibers are much smaller (from 2.5 - 10 micrometers). The inhalation of this blue asbestos results in diseases, some of which being; asbestosis and mesothelioma which in most cases is fatal. Midnight Oil's song 'Blue Sky Mine' was written in protest of the asbestos mine in Wittenoom, at which many died from health complications associated with asbestos exposure. Many families never received compensation.

Asbestos History

Discovery
1876

Lang Hancock discovered asbestos in 1876, in South-Eastern Quebec, Canada.

Mass Removal
1906 - present

In 1906, Adelaide Anderson, the Inspector of Factories in Britain, included asbestos in a list of harmful substances in 1902. Similiar investigations were discovered in France and Italy soon later.

1858

Creation
1858

Asbestos was created in 1858 by Henry Ward Johns. At this time it was unidentified until 1876

Asbestos Mining
1899

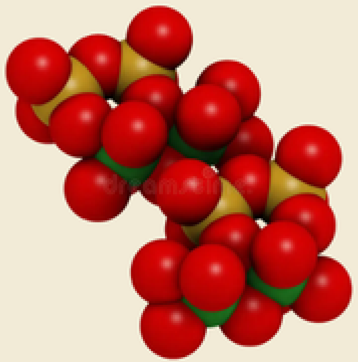
The Canadians established the worlds first commercial asbestos mine in Thetford Township, Quebec, Canada.

About Asbestos

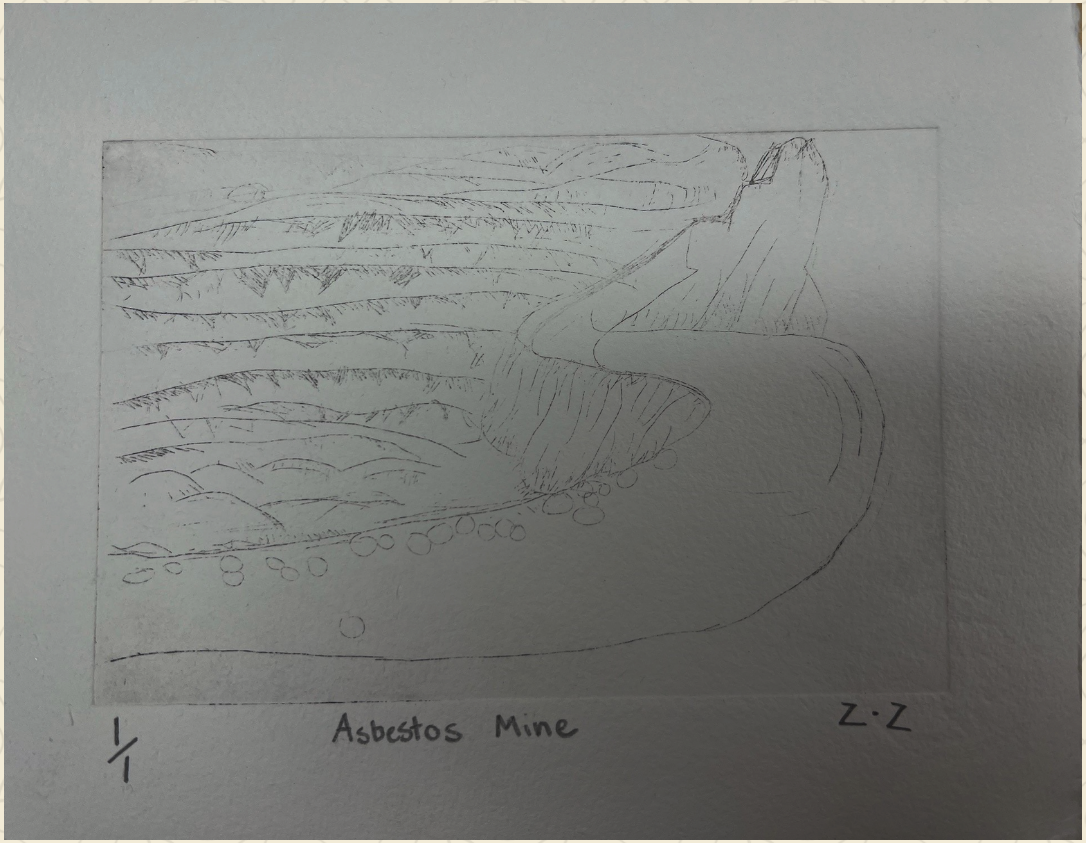
Early References and Uses:
Asbestos was found to be durable quite early in its history against chemical break-down, heat, and fire. People used it as a cheap roofing due to its durability.

Industrial Era:
The large-scale asbestos industry began in the mid-19th century. Early attempts at producing asbestos paper and cloth in Italy began in the 1850s but were unsuccessful in creating a market for such products. Canadian samples of asbestos were displayed in London in 1862, and the first companies were formed
in England and Scotland to exploit this resource. Asbestos was first used in the manufacture of yarn, and German industrialist Louis Wertheim adopted this process in his factories in Germany.

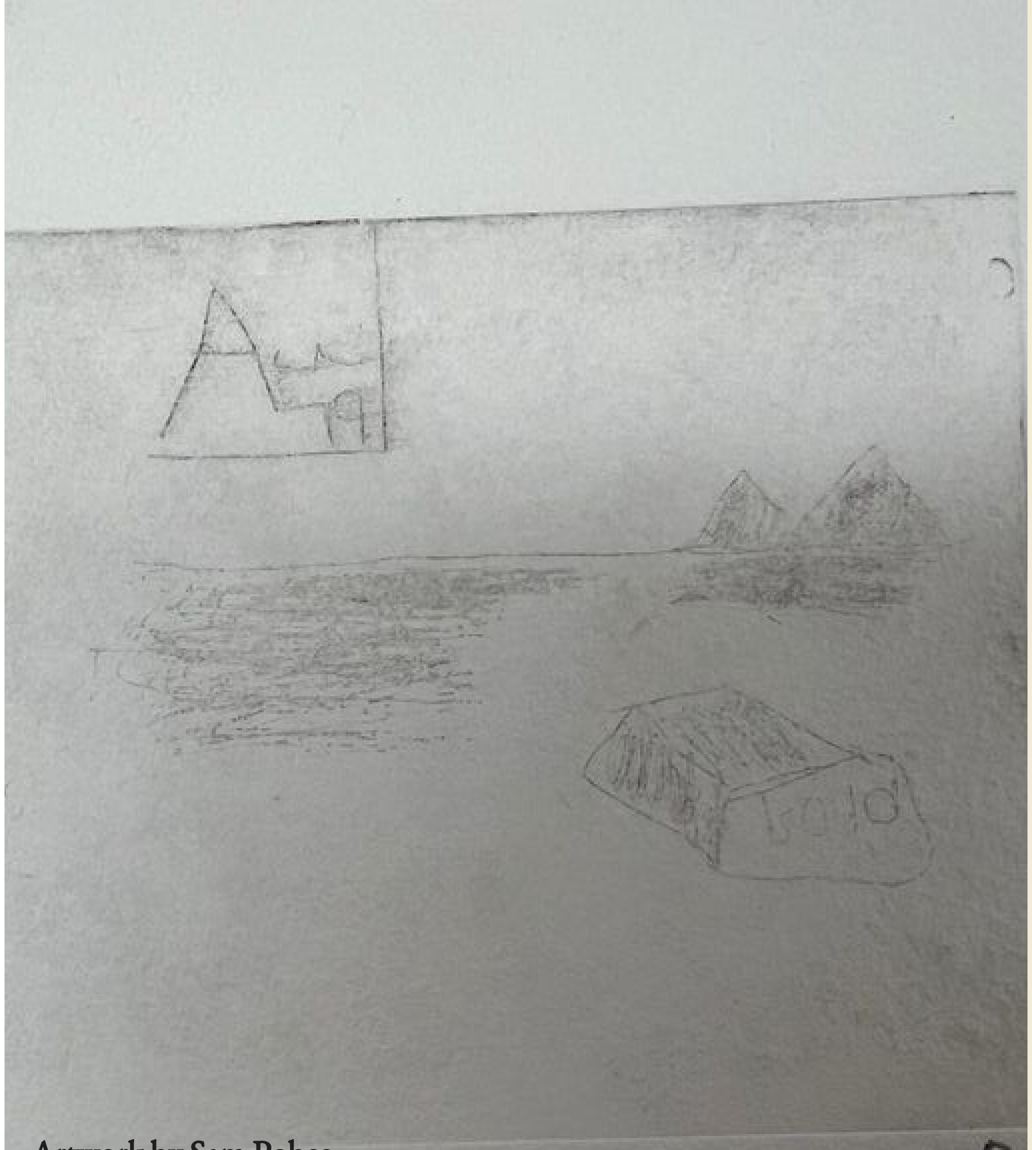
Asbestos Structure:
Asbestos is a molecular compound consisting of 3 magnesium atoms, 2 silicon atoms, 9 oxygen atoms and 4 hydrogen atoms. It is a solid (powder/dust) at room temperature meaning the atoms have a strong force of attraction between each other.



Etching Artwork



Our artwork was inspired by the first commercial asbestos mine established in 1899 and located in Quebec, Canada. This mine was the cause of a large number of deaths and lung problems such as mesothelioma in asbestos-mining towns.



Artwork by Sam Pobee-
I have chosen to draw a pyramid because it symbolizes Egypt, the place gold was first discovered. Au is the chemical symbol for gold whose origin is the Latin word Aurum, meaning shining dawn.

Gold

By Pobee and Kai

Classification: Good and Ugly

Element Symbol: Au
Atomic Number: 79
Density: 19.3 g/cm3
Atomic Mass: 196.96657 u

State At Room Temperature: Solid
Melting Temperature: 1,064 °C
Colour At Room Temperature: Metallic Yellow
Odour: Odourless

Gold History

Originally used for Jewellery and idols of worship until 1500 BC. Nubia made the first gold trade.

People have been obsessed with it for thousands of years. Imagine, a long time ago, when ancient Egyptians were building pyramids, they discovered this shiny, yellow metal hidden in rivers and rocks. They thought it was a gift from the gods because it was so rare.

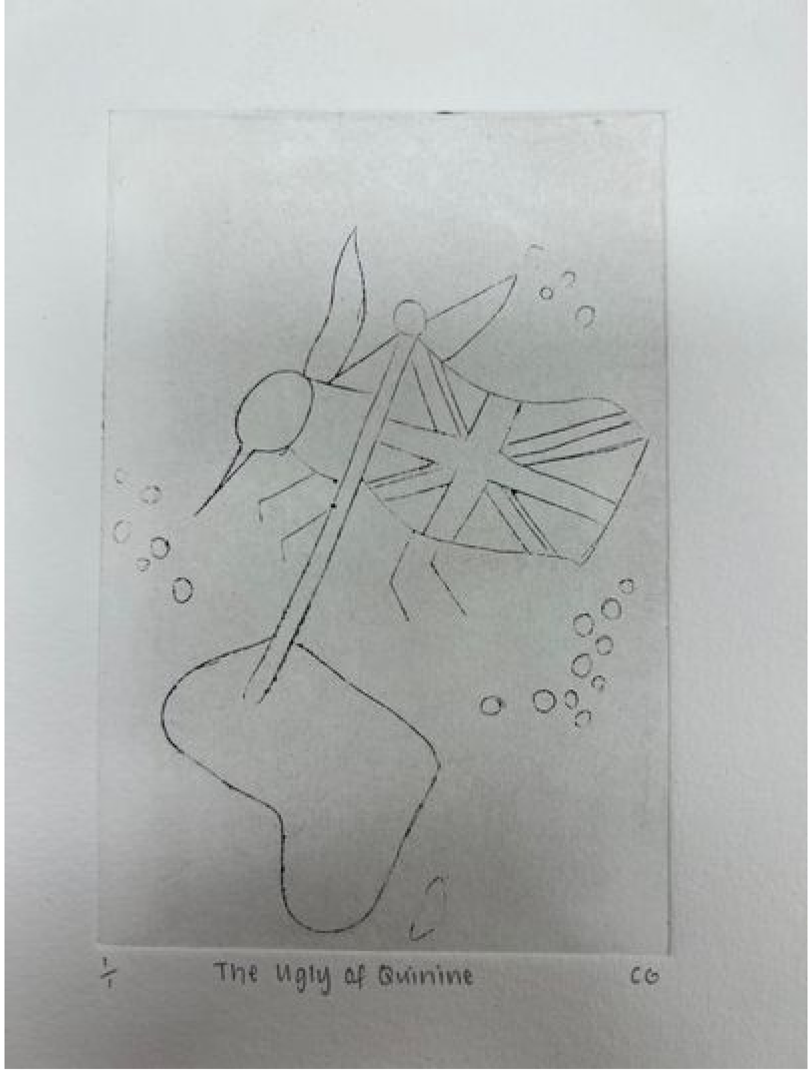
As time went on, different groups of people started using gold to make jewellery and coins. It became a symbol of wealth and power.

In today's world, gold is still a big deal. It's used in things like expensive watches, electronics, and even in some medicines. So, even though we've come a long way since those ancient times gold is still used.

Gold Controversies

Gold is a very special metal that has been cherished by people for a long time. It's not just shiny and pretty for making jewellery, but it's also useful in medicine. Doctors use tiny bits of gold to help treat some illnesses, like cancer.

But, there's a big problem with gold in parts of Africa. People are fighting over it, and it's causing trouble. There are mines in Africa where they mine gold, and some of these mines are controlled by groups who don't always treat people right. They force people to work in dangerous conditions, which also hurts the environment. So, while gold can be really good for medicine and making jewellery, we need to ensure it's mined in a fair and safe way for everyone.



Before 1858, malaria (a disease spread by mosquitoes) acted
as a barrier, preventing the British Empire from colonising the tropical areas of Africa and India. After quinine was discovered to be a cure for the disease, the colonizers who were now armed with the new antidote, were able to take over.

Quinine- Good and Bad

Nicola and Celine

Quinine is a drug used to treat malaria worldwide since 1681. It has been treating malaria before other antimalarial drugs were discovered. Quinine was also used to decrease the frequency and intensity of night-time muscle cramping.

However, Quinine can cause various side effects when consumed, such as hypoglycemia (low blood sugar), severe bleeding, kidney damage, irregular heartbeat, visual disturbances, headaches, vomiting and nausea. This is why doctors will not recommend quinine unless it's the only thing left to choose from. The colonization of India and Africa by the British also wouldn't of been possible without the use of Quinine by colonists.

Properties of Quinine

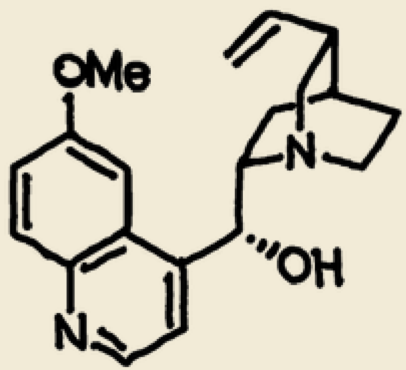
- Compound formula $C_{20}H_{24}N_2O_2$
- Melting Point: 177°C
- Uses: It is used to cure Malaria, a life-threatening disease.
- Density: 2.1g/cm^3
- Solubility: Insoluble in water

Discovery of Quinine
Quinine was first found in South America, before recorded history. By 1681 it was widely accepted as a remedy for malaria. At the time, they didn't know that the quinine itself was curing their fevers, just that the tree bark from the cinchona tree was. In 1820, scientists realized that the quinine was the part of the bark causing their fevers to go away. In 1944, scientists developed a synthetic quinine that had far less negative side affects than the natural kind, but some malarial parasites became resistant to this so now the natural kind is being used again.

Quinine's use by Colonial England
Quinine was synthisised in 1820, meaning that it was able to be widely used to cure malaria by 1885 - the beginning of the "Scramble for Africa", where the colonial powers of Europe were racing to colonize as much of the continent of Africa as possible. Malaria can be fatal if not treated, so this acted as a barrier, preventing England from colonising Africa before they had a treatment. When Quinine was found to cure malaria, however, they were able to rapidly colonise parts of Africa and India. This destroyed the lives of all the people living in these colonized lands, that the British were now able to take over. The histories of these regions may have been vastly different if we knew nothing about the antimalarial properties of quinine. This shows that while there are some clear positives to Quinine, it has also been used for terrible purposes in the past that affect people to this day.

Structure of Quinine
Quinine is a molecular compound, made up of 20 Carbon atoms, 24 Hydrogen atoms, 2 Nitrogen atoms and 2 Oxygen atoms. There is a picture of it's structure here ⇨⇨⇨⇨

It is a solid at room temperature, so it's particles have a strong force of attraction to each other. It can be dissolved in some liquids at room temperature.



History of Quinine

Use by British Colonizers
1861

Malaria prevented the British Empire from colonising parts of India and Africa as it was thought of as the world's deadliest disease. With quinine discovered, there was no longer anything stopping the British.

Banned For Use
2007 - Present

Quinine started being used for leg cramps, so the use of all Quinine products apart from Qualaquin (Which is used to treat malaria) was banned by the FDA. Qualaquin has been almost completely replaced by other Antimalarials with fewer negative side effects, however, only used in special circumstances.

1858

Discovery of Pure Quinine
1820

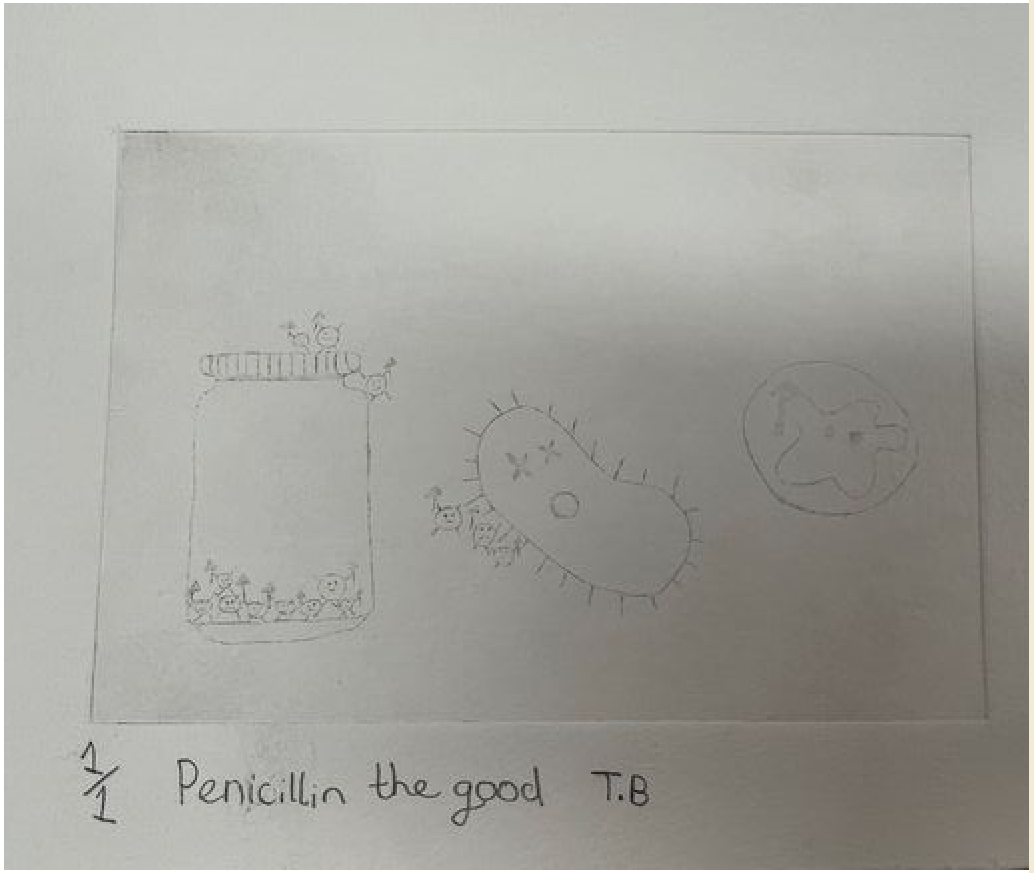
Pure quinine was first discovered in France by Pierre Joseph Pelletier and Joseph Caventou in1820, when it was extracted from the bark. This purified quinine was then widely used over the older type.

New Cures
1920s

In the 1920s, more effective, synthetic Antimalarials were found. The most used of these was chloroquine, being extensively used from the 1940s. Because of this, malaria started becoming more resistant to it. This has caused quinine to be used more again.

Image Credits to Pixabay

IMAGE CAPTION An artistic representation of two penicillin forms (mould and pills) fighting bacteria. This artwork was created by Teagan Balsdon.



The drawing that I made on penicillin is meant to represent the penicillin on the Petri dish fighting off the bacteria and the little pills of penicillin are intended to fight it with a more vital force. The little forks that they are holding represent swords to kill the bacteria. TB.

Penicillin- Good (mostly)

Leticia, Naisha and Teagan

General Information

- At room temperature, penicillin is a **solid**.
- Solid penicillin's **density** is about 1.25g/cm^3.
- Its **chemical formula** is $C_{16}H_{18}N_2O_4S$; thus is classified as a compound.

Good

Penicillin is one of the most widely used antibiotics in medical history. It has saved many lives since and continues to do so over 90 years later.

Bad

Some people are prone to allergic reactions to penicillin, which range from skin rashes to life-threatening anaphylaxis.

Ugly

When penicillin was first being developed, people were concerned about how ethical it was to conduct experiments on humans, usually without consent. The experiments were to test the effects and safety of the antibiotic and raised questions about the treatment of vulnerable populations.

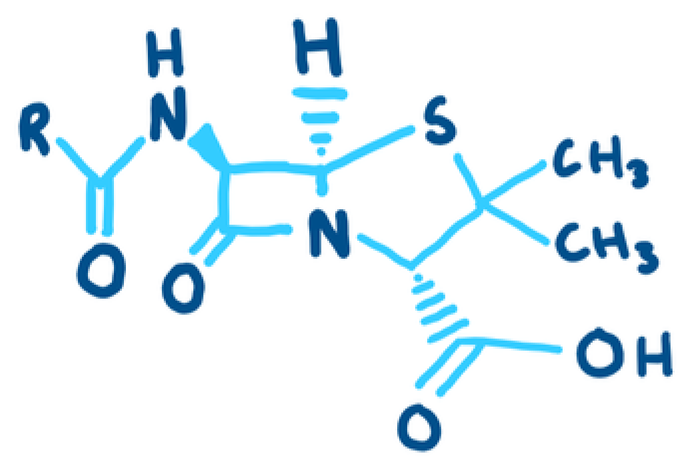


IMAGE CAPTION *The core structure of Penicillin*

Penicillin

Continued

Alexander Fleming
Fleming was born on August 6, 1881, in Darvel, UK. He was a pharmacologist, microbiologist, and physician. He won the Nobel Prize for Physiology or Medicine in 1945 with Ernst Boris Chain and Sir Howard Walter Florey "for the discovery of penicillin and its curative effect in various infectious diseases".

Interesting Fact
Fleming discovered penicillin by accident after coming back from vacation and finding that the mould was stopping bacteria growth.

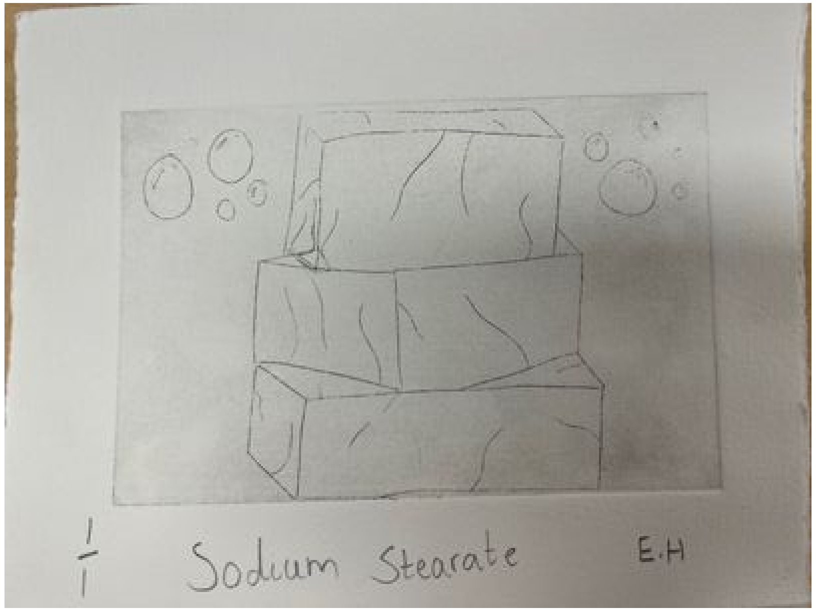
Penicillin Timeline

2023
Penicillin is now commonly used to treat infections.

1941
The first patient was treated with penicillin.

1928
Penicillin was discovered by Alexander Fleming.

1945
Penicillin started to become available in the US over the counter.



Artists Summary:
Sodium Stearate is a compound consisting of the following elements: Carbon, Hydrogen, Sodium and Oxygen. Sodium Stearate was discovered by the French Chemist, Nicholas Leblanc, who at the time, was 48, in the year 1790. He changed lives for the better. Sodium Stearate is white in colour and, at room temperature is a solid, fine powder. Sodium Stearate boiling point is 360C.

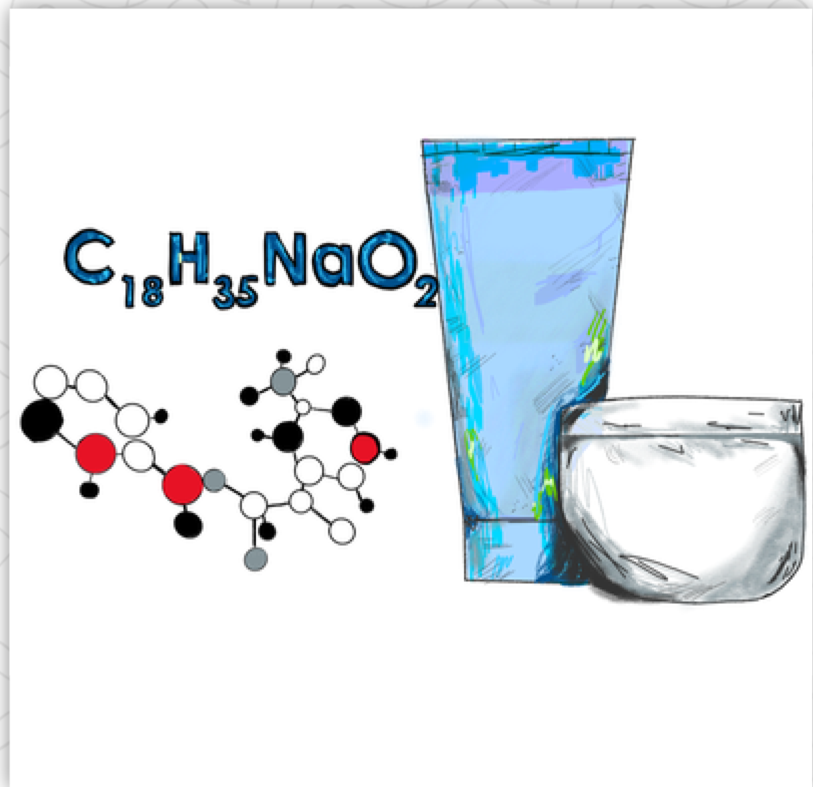
Sodium Stearate-Good

By Emily H, Emily P, Charlotte and Chelsea

Entry:
This chapter in the book is dedicated to sodium stearate; common name, soap. This is a compound which is used almost daily. It can benefit health and prevent diseases. It washes and cleansings the skin to wash away unnecessary bacteria. It is a simple process to create a homemade soap.

Sodium Stearate:
Is classified as 'The Good'.

Classification:
This would be a compound as it contains more than 2 different types of atoms, the different types of atoms used in this are carbon, hydrogen and sodium. The chemical formula is $C_{18}H_{35}NaO_2$, with 18 carbon atoms, 35 hydrogen atoms, 1 sodium atom and 2 oxygen atoms. It is considered a compound becuase it contains many different elements chemically combined.



Here is an image of what sodium stearate looks at room temperature. Image drawn by Charlotte Martin.

Discovery:

Sodium Stearate was discovered in the year 1790, founded by Nicholas Leblanc.

Nicholas Leblanc was a French Chemist, he was born on the 6th of December 1742. Meaning Nicholas was 48 years of age when he discovered Sodium Stearate. He was known for creating sodium stearate from table salt.

Physical Properties:

At room temperature, it is a solid; fine powder.
This compound's appearance is plain, its colour is white, it doesn't have an original scent but it will take the scent of its designated soap.
It's density is 1.02g/cm (cubed) while its melting point is between 245-255 degrees C and its boiling point is 360 degrees C.

The Good:

This substance is classified as 'The Good' because it cleanses dirty surfaces, and kills bacteria. Soap is used on a daily basis before and after eating, using the bathroom and more. By doing this it has prevented diseases from entering the human mouth, therefore stopping the disease from spreading throughout the body. Because of this, it has saved 100,000,000+ lives. Just was using soap.

Iron -Good and Bad

Liam, Sophie and Jake

Whether from Minecraft or from manufacturing and construction certainly everyone knows about iron. From the iron needed in your body to the iron used in ancient Rome.
You are probably thinking the chemical symbol for iron is "I" or "Ir" but it isn't! It's actually Fe. It is Fe because of the Latin name for firmness which is "ferrum".

Atomic number = 26 (26 protons, 30 neutrons, 26 electrons)
Atomic mass = 55.845
Iron is a metal
Iron = **solid** at room temperature
No-one discovered iron as it has been on the earth since it was made.
Iron is an element

Iron History

Early history of iron

From about 1,200 BCE to 600 BCE, the iron age was occurring. During this period, people started making tools out of iron. Most notably, swords, shields, hammers and farming tools. People believed copper was better than iron as it was more stable and durable. Eventually, when people discovered how to make steel, they preferred it. They preferred it because it was superior to bronze and iron by itself. Steel is better than iron as it doesn't rust. During Iron Age Europe, not much happened with iron as it was mostly just agricultural, but due to the better farming tools, this would have been a good time to be a farmer!

Iron history (Continued)

Industrial era and how iron was used

During the Industrial Revolution, almost everything was reliant on iron. The first major thing was railway tracks for trains. When the discovery of railway transport was faster than horse travel, people decided that trains would be the future. To produce the rails, the only sturdy enough metal was iron, so the production skyrocketed. In England, iron production rose to over two million metric tons a year. Around a similar time in Europe, at the start of the Nineteenth century, the Napoleonic wars were raging. Due to the increased research into military technology, and the urgent need for weaponry, iron was used to produce almost all of the key military weapons. Those were the cannons, muskets and also the pistols/flintlocks.

Iron history (Final)

Modern day

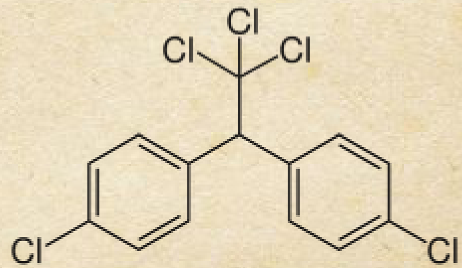
Modern-day uses of iron vary from car manufacturing and architecture. Steel (made of iron and carbon) is a quality material for building as it is very sturdy and great for building support. Iron is asuperb material to build the outside of cars, decently sturdy and can last quite a while. Also, the car body would be made out of steel, which is stronger than iron and more durable but is mostly made of iron. If you go outside, you will most likely see something made out of iron. From the car you are driving inside of to the buildings you see almost everything nowadays has iron in it.

Iron; the bad

Although iron is used widely in good things, it has also been used in poor things. Almost all military equipment requires iron, and lots of bombs used in World War Two used iron during the production. In total all of these bombs would have killed millions of people. When mining for iron, there are a lot of things that can damage the environment. When digging in the ground, the most efficient way is to use big pieces of machinery that is run by unsustainable energy sources and are very inefficient.

DDT or DichlorodiphenyItrichloroethane

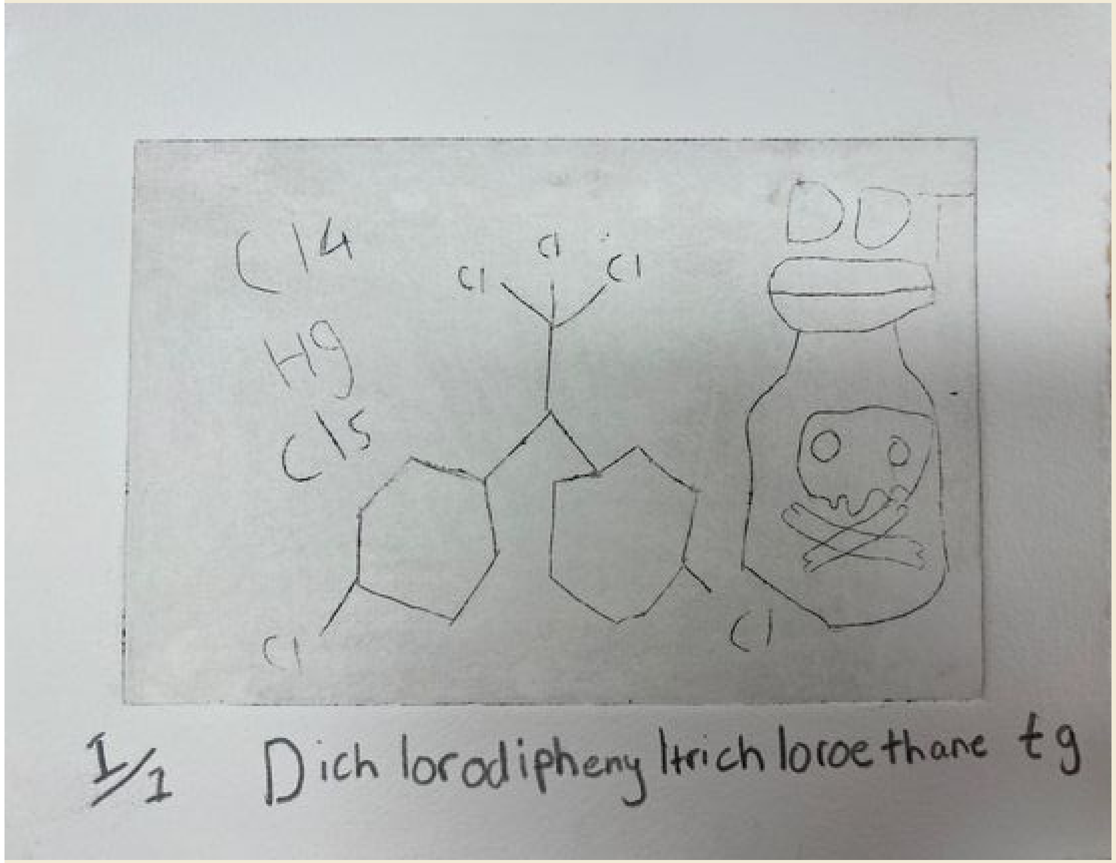
DDT is a solid at room temperature looking like a fine white grainy powder.



Chemical Formula: $C_{14}H_9Cl$
14 Carbon atoms, 9 Hydrogen atoms, 1 Chlorine atoms

DDT- Good, Bad & Ugly

Trent, Ricky, Aditya



DDT Etching Artwork by Trent

DDT is a synthetic insecticide with both positive and negative impacts. It was effective in controlling mosquitoes and preventing diseases like malaria and typhus. However, its use caused severe environmental damage and health issues for humans. Due to these concerns, it was banned in most parts of the world, but some areas still use it to fight malaria. Recent studies have shown harmful effects even at low exposure levels. DDT is a solid white powder at room temperature, but its use remains a subject of ongoing debate.

DDT is a compound, and its **formula** is $C_{14}H_9Cl_5$.
It has a **density** of 990 kg/m^3

DDT: The good

DDT has historically been recognized for its positive effects in controlling vector-borne diseases such as malaria and typhus. When it was first introduced as an insecticide in the mid-20th century, DDT played a crucial role in significantly reducing the transmission of these deadly diseases. Its effectiveness in killing disease-carrying mosquitoes contributed to a notable decline in mortality rates, especially in regions where these diseases were rampant. This success led to improved public health outcomes, better quality of life, and increased economic productivity in many parts of the world. DDT's ability to curb the spread of such diseases demonstrated its potential as a tool for disease prevention and underscored the importance of careful and regulated use to harness its positive impact.

DDT: The Bad

DDT Spraying

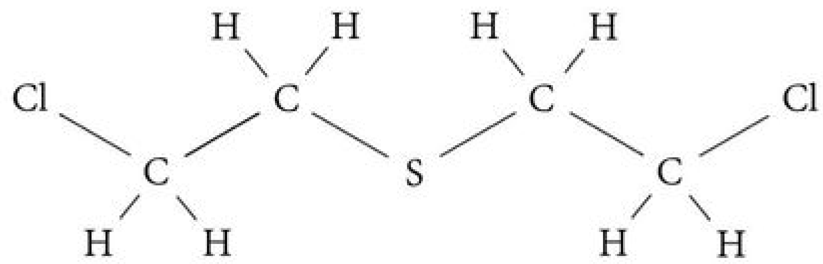
Although DDT may have some good parts, it also has a darker side. DDT gained notoriety due to its significant negative effects on the environment and human health. It had a harmful impact on bird populations, particularly the thinning of eggshells, led to significant declines in several species like eagles and falcons. Additionally, the long-lasting nature of DDT in the environment has led to its exposure to regions far from its original application sites, causing unintended exposure in ecosystems previously untouched by its use. While DDT's role in controlling malaria initially offered a public health benefit, the overall negative ecological and health consequences prompted its ban in many countries and highlighted the importance of considering the broader impacts of chemical interventions on the planet.

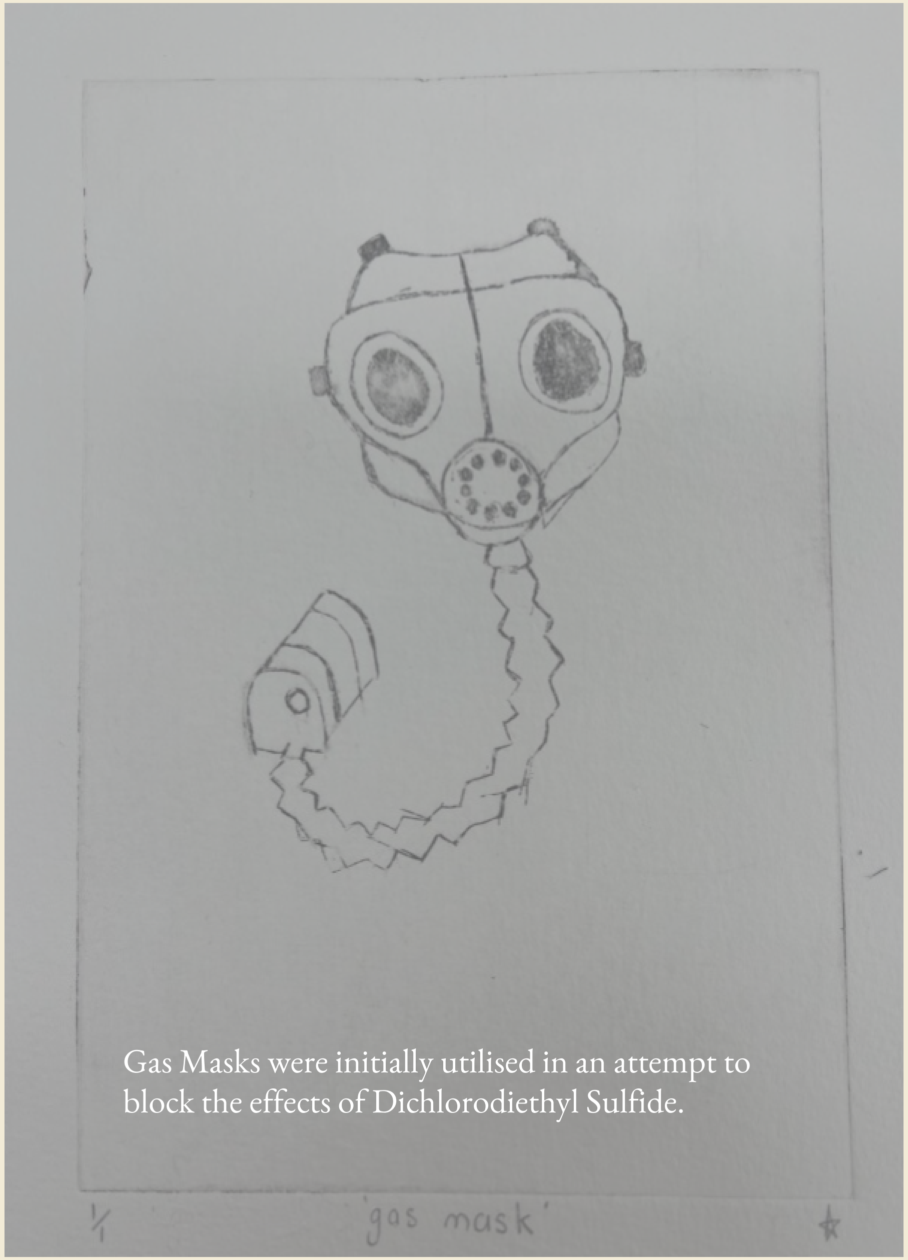
DDT: The Ugly

DDT, or dichloro-diphenyl-trichloroethane, is a potent pesticide that gained notoriety for its devastating environmental and health impacts. Its ugly side lies in its long-lasting persistence in the environment. DDT is exceptionally stable and can remain in soil and water for years, accumulating in the food chain. This accumulation can get into top predators problems like thinner eggshells in birds, and devastating declines in their populations. Also, DDT has been linked to severe health concerns in humans, including cancer, disorders, and hormone disruption. Its widespread use in the mid-20th century had catastrophic consequences for ecosystems and human health, prompting its ban in many countries and a reminder of the need for responsible and sustainable pesticide use.

Dichlorodiethyl Sulfide $C_4H_8Cl_2S$

More commonly known as ***Sulfur Mustard*** or ***Mustard Gas, Dichlorodiethyl Sulfide*** is a **bad** substance with a **ugly** history… and a surprisingly **good** future.





Gas Masks were initially utilised in an attempt to block the effects of Dichlorodiethyl Sulfide.

Chemical Information

Dichlorodiethyl Sulfide is a compound, taking the form of a thick, oily, amber liquid at ambient temperature.

- It has the c**hemical composition** $C_4H_8Cl_2S$ (4 Carbon, 8 Hydrogen, 2 Chlorine, 1 Sulfur)
- It is **heavier** than water (as a liquid) and air (as a vapor).
- Solidifies at 58°F
- **Molecular Weight**: 159.08 g/mol
- **Density**: 1.27 g/cm^3

History + Future

More than one hundred years ago passed the great conflict that uprooted the entire world—the first world war. This calamity would go on to leave seventeen million dead or missing in action, the number magnified immensely by the work of industrial chemists. In the July of 1917, Ypres, Belgium, soldiers reported a shimmering cloud of yellow dust settling at their feet, and a putrid peppery smell in the air. It wasn't twenty-four hours until uncontrollable itches developed into horrible blisters and sores, and their numbers declined as they coughed blood.

This was the first of many instances of *Dichlorodiethyl Sulfide*, one of the deadliest chemical weapons ever deployed in battle. Absorbed through skin and cloth, gas masks were rendered useless, and very few escaped *Dichlorodiethyl Sulfide's* grasp. The first use in Ypres alone left up to ten thousand deaths, and many, many more crippled, instilling terror on across the battlefield.

Dichlorodiethyl Sulfide was one of the weaponised poison gases initially developed by Fritz Harber, chemist and professor of University Karlsruhe. Even once the war had finally concluded, Harber enthusiastically promoted the use of these chemicals, and his colleagues would go on to create other deadly weapons. And hence, World War I will be known to many as the chemists' war.

Symbol for chemical warfare

The effects of *Dichlorodiethyl Sulfide* on blood cells and bone marrow was reported by Dr Eward Krumbhaar in 1919 after treating exposed patients in France. He observed that even if an individual initially possessed a surplus of white blood cells they were found with a profound decrease over the clinical course. Later, in the 1940s, with the forecasted apprehension that would be World War II, the US Office of Scientific Research Development, funded by Yale University, conducted chemical welfare research in secrecy. This team was led by researchers Doctor Alfred Gilman and Doctor Louis Goodman, physicians and pharmacologists. These studies supported the previous discoveries of leukopenia (low white blood cell count) by demonstrating that lymphomas in experimental animals dramatically decreased in size when exposed to *Dichlorodiethyl Sulfide.*

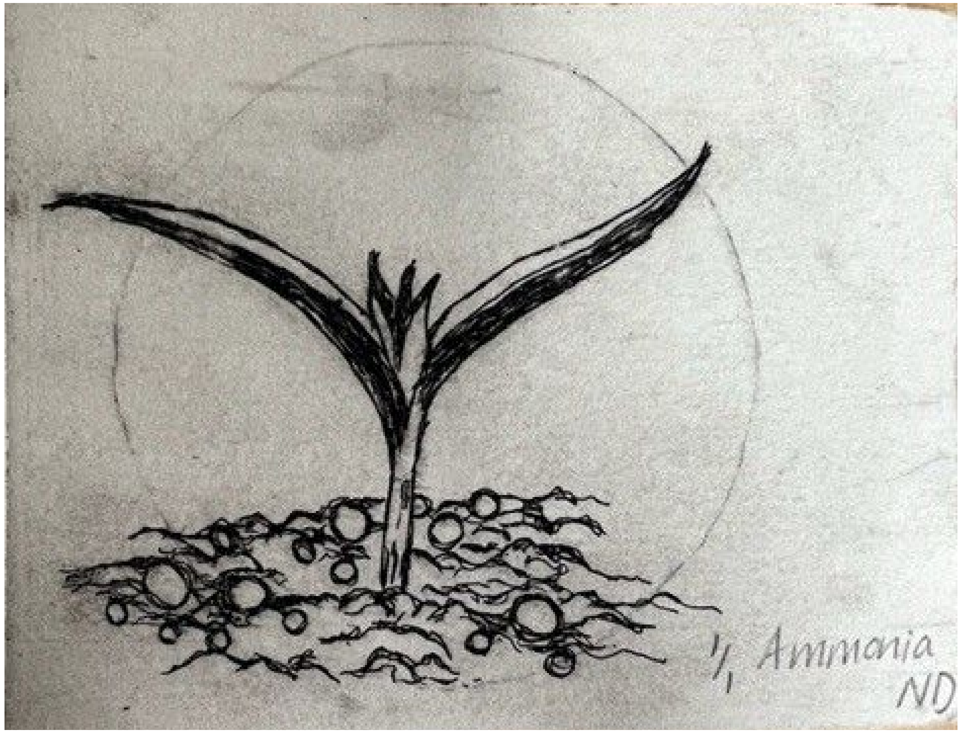
The first clinical trial investigating the use of *Dichlorodiethyl Sulfide* involved a patient diagnosed with advanced *lymphosarcoma* who received the first therapeutic trial with nitrogen mustard in low doses (Ten doses of 0.1 to 1.0 mg/kg intravenously). To everyone's amazement, the tumour regressed considerably, though the effects were not permanent.

However, what brought the medical community's attention to the Yale group's studies and truly launched the era of cancer chemotherapy was a World War II *Dichlorodiethyl Sulfide* incident. Humans were accidentally exposed to the substance during the bombardment of the Italian town of Bari on December 2, 1943. The SS John Harvey, a Liberty ship stationed on Italy's Bari harbour held a stockpile of 100 tons of *Dichlorodiethyl Sulfide*, and as a result of the bombardments of that night, seventeen ships sank, emitting the stockpile.

Nobody aboard the SS John Harvey survived and as a consequence, the townspeople of Bari were completely unaware of the *Dichlorodiethyl Sulfide* intoxication. In the days and weeks following this catastrophe, the other military and civilian victims from the accident began to develop the familiar signs of *Dichlorodiethyl Sulfide* exposure. Lieutenant Colonel Stewart F. Alexander, an American physician trained in chemical warfare confirmed the exposure to *Dichlorodiethyl Sulfide*, based on autopsies of the victims that had profound medullar damage, particularly a low white blood cell count.

White blood cells are capable of rapidly dividing which prompted the attention that this chemical agent could be useful in killing rapidly dividing cancer cells as well. As a consequence, the event at Bari enhanced the suspicion that the effect of *Dichlorodiethyl Sulfide* on blood cells could have medical use.

In 1946, all the results and findings were published and more research was conducted on chemical agents like nitrogen mustard giving rise to the first alkylating agents such as *mechlorethamine*. This also motivated other cancer research such as the study on folic acid that gave rise to methotrexate. These events changed the perception of cancer therapy. In the late 1960s, with the introduction of combination of chemotherapy agents like *nitrogen mustard, vincristine, methotrexate and prednisone,* an increasing number of patients had longer remission from cancer, allowing it to be conceived as a curable disease, particularly for diseases like *lymphomas* and *leukemia*.



Artist Comments

This image represents the world's requirement for ammonia based fertilisers to help feed the global populations. The molecules in the soil are ammonia and the crop is wheat.
Natalie Dollar

Ammonia NH3

The Good and The Ugly

80% of the world's ammonia is used in the production of fertiliser and without we would not be able to feed ourselves. It is essential in the production of food crops and it is essential to our survival.

However, it is not a compound without controversy. It's discoverer, Fritz Haber played a key role in bringing chemical warefare to WWI. The production of ammonia produces massive amounts of greenhouse gases, thus contributing to the acceleration of climate change.

Properties of Ammonia

- Compound formula NH3; one nitrogen atom and three hydrogen atoms per molecule

- Boiling Point: -33.5C

- It is a weak base and reacts with acids to neutralise them. It can also be used in cleaning products, for example cloudy ammonia.

- Density: 0.76kg/L

- Highly soluble in water

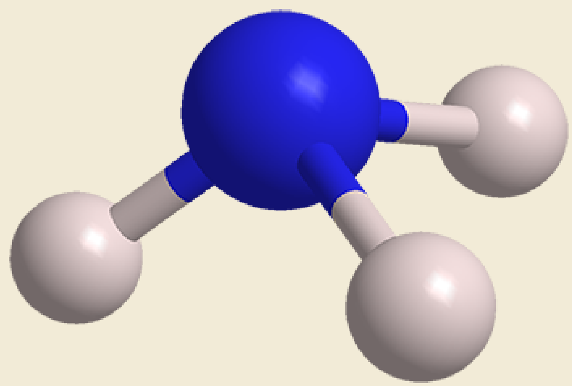
Discovery of Ammonia

Ammonia has been known by its distinctive, pungent odour since ancient times. It was isolated in the 18th century by notable chemists Joseph Black (Scotland), Peter Woulfe (Ireland), Carl Wilhelm Scheele (Sweden/Germany), and Joseph Priestley (England). In 1785, French chemist Claude Louis Berthollet determined its elemental composition.

Ammonia is produced by a series of chemical reactions known the Haber Bosch process. This reaction uses nitrogen from the air and reacts it with pure hydrogen gas. The method was first developed by German chemist Fritz Haber, for which he received a Nobel Prize in 1918. Carl Bosch took Haber's work to the next level by using a metallic catalyst and high pressures. For making the synthesis of ammonia a large scale process Bosch won a Nobel Prize in 1931.

Structure of Ammonia

Ammonia is a molecular compound, made up of 1 nitrogen atom and 3 hydrogen atoms. It forms a three dimensional shape, called a pyramid.
Ammonia exists as a gas a room temperature, thus its molecules have little attraction with each other. It is easily compressed and is thus transported in tankers as a pressurised liquified gas.

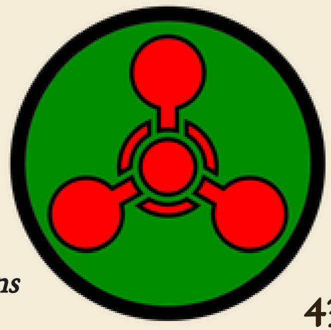


History of Ammonia and Fritz Haber

Although known to chemists for a long time, it took the great mind of Fritz Haber to find a way to produce it on a large scale. Haber, in partnership with another chemist Carl Bosch combined hydrogen and nitrogen under high pressures and temperatures. They found these reaction conditions, when used in conjunction with a metal catalyst were very favourable in producing ammonia. Previous to the large scale production of ammonia developed by Haber and Bosch, the world relied on much of its fertiliser supply from South America.

Despite his positive contribution to industrial chemistry, Fritz Haber was not without controversy. He played a key role in the development of chemical warfare in World War One, a conflict often referred to as the 'Chemist's War' due to the widespread use of chemical weapons. Haber worked alongside a number of other chemists to develop and implement the use of poisonous chemicals in the war, in particular chlorine gas. On the 22 of April 1915, after weeks of planning, members of the German Army released more than 6000 cylinders of chlorine gas into the trenches of Allied troops along the defensive perimeter at Ypres, Belgium. It was the first time chemical weapons had been used on the battlefield and the history of military combat was changed forever. It was Fritz Haber who suggested the use of the heavier than air chlorine gas. His understanding of the chemistry of chlorine gas proved vital to the German Army in Second Battle of Ypres. Minutes after its release the plume of chlorine gas killed 1000 French and Algerian soldiers and wounded many more.

A British soldier described the pandemonium that followed;
"Figures running wildly in confusion over the fields. Greenish-gray clouds swept down upon them, turning yellow as they traveled over the country blasting everything they touched and shriveling up the vegetation. . . . Then there staggered into our midst French soldiers, blinded, coughing, chests heaving, faces an ugly purple color, lips speechless with agony, and behind them in the gas soaked trenches, we learned that they had left hundreds of dead and dying comrades."



International Symbol for Chemical Weapons

Ammonia and Contemporary Society

Up to 90% of the world's ammonia is currently used in the fertiliser industry with the remaining being used in pharmaceuticals, plastics and resins. 50% of the world's food production reliant on the application of fertilisers, ammonia quite literally helps feed the world's population. With the global population rising and the reliance on food production at an all time high, the use of ammonia has never been more important than it is today.

The hydrogen gas required to react with nitrogen in the formation of ammonia must be pure. This pure hydrogen is often produced by reacting methane with steam, shown in the following reaction. $CH_4 + H_2O \rightarrow CO + 3H_2$.

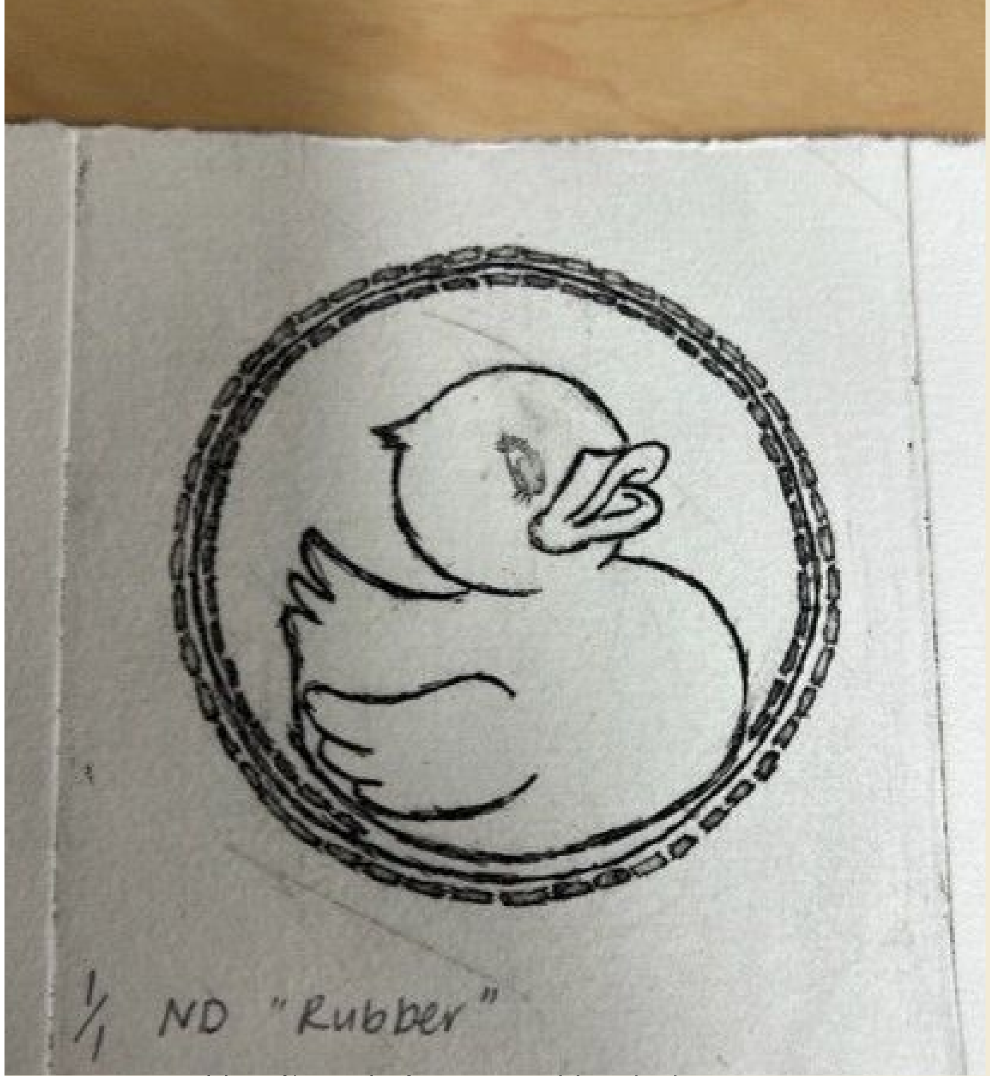
The reaction conditions of hydrogen gas formation and the Haber-Bosch process both require high pressures and temperatures and thus are very reliant on consuming energy. Most of this energy comes from the burning of fossil fuels and thus contributes to accelerated global warming. It is estimated that 2% of the world's greenhouse emissions come from the processes involved in synthesising ammonia. Despite our current requirement for food production, the reliance on energy for the formation of ammonia certainly presents concerns for the environment.

Green Ammonia; the way of the future?

One way of producing pure hydrogen is by the electrolysis of water. Water, H_2O is a compound composed of two hydrogen atoms and one oxygen atom. If a current is run through it, it separates into its atoms and thus yields pure hydrogen gas. Many of the plants worldwide that produce ammonia are using renewable resources to breakdown water and form the hydrogen gas needed for the Haber-Bosch process. Whilst the Haber-Bosch process remains reliant on fossil fuels, the use of renewables to form our hydrogen gas is a step in the right direction. One plant using this technology is Yara Pilbara, an ammonia production facility on the Burrup Peninsula, Western Australia.

Rubber- Ugly, in more ways than one

Mrs Dollar and Miss Fairhead



use rubber. From the innocent rubber ducky toy we are all familiar with, to the car tyres that surround the duck, rubber is ubiquitous. One of the most important compounds in industry today, it's Congolese history was very ugly and its disposal presents great environmental concern for the future.
Natalie Dollar

Introduction

Rubber's chemistry is a about as complex as its role in history. Whilst natural rubber is now produced mainly in South East Asia, it was first used by the Indigenous cultures of Central America. It was until the arrival of Europeans to the area that the applications of rubber gnarned international attention. In the late 19th century the Congo became a focal point for the production of rubber, and that is where its history gets very ugly.

Rubber's Chemistry

Natural rubber is taken in the form of latex from the rubber tree. By the 19th century natual rubber supplies were surpassed by demand. This meant it was necessary for scientisits to find a way to manufacture synthetic rubber. In 1910, the German laboratory Bayer made the first sythetic rubber from the polymerisation of isoprene. Chemists classify rubber as a specific type of polmer called an elastomer, meaning it has high viscosity and elasticity. These properties, among its many others means it plays a pivitol role in many industries; from automotive to healthcare.

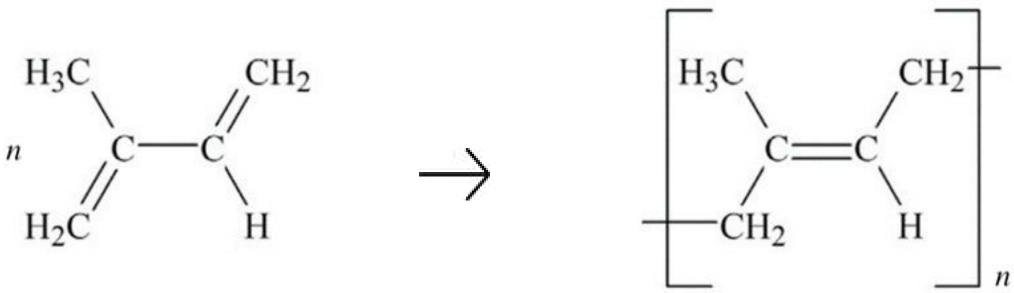
The chemistry of rubber

Rubber is a polymer, a large molecule made up of repeating smaller units called monomers. Polymers are among the most important compounds in chemistry. The most common type of rubber is natural rubber, primarily composed of the polymer polyisoprene, which occurs naturally in the latex sap of certain plants, such as the rubber tree *(Hevea brasiliensis)*.
The chemistry of rubber involves the process of vulcanisation, which was discovered by Charles Goodyear. Vulcanisation is a chemical process that strengthens and stabilises rubber by cross-linking the polymer chains with sulfur or other additives. This process helps to improve the rubber's elasticity, durability, and resistance to abrasion, heat, and chemicals.

The environmental concerns associated with rubber

There are a number of environmental issues with both natural and synthetic rubber. Whilst natural rubber, collected in the form of latex seems somewhat less problematic, it leads to deforestation, declining biodiversity and pollution. It does however degrade naturally, though the process takes years.
Synthetic rubber production starts with the refining of petroleum products such as oil and then sulfur is added at high temperatures. This process is very energy intensive and releases toxins into the air. The rubber produced is non-biodegradable and is often left to accumulate in landfill.

The polymerisation reaction to form rubber



History of rubber

In 1735, Charles de la Condamine, a French scientist, sent rubber samples to Europe from Central America, piquing scientific curiosity. Despite attempts to utilise it, rubber's tendency to become brittle in cold temperatures and sticky in heat hindered its widespread use.
In the early 19th century, Charles Goodyear made a pivotal breakthrough by discovering the process of vulcanisation in 1839. This discovery revolutionised the practical applications of rubber, enabling its use in manufacturing tires, waterproof clothing, industrial machinery, and more.
Advancements in the understanding of rubber chemistry led to the development of synthetic rubber during the early 20th century. This innovation, particularly during World War II when natural rubber supplies were limited, spurred the creation of synthetic alternatives with properties similar to natural rubber.

Rubber's ugly backstory; King Leopold and the Congo.

During the late 19th and early 20th centuries, rubber became a highly sought-after commodity, with demand skyrocketing due to the burgeoning automotive and industrial sectors. The Congo, under the brutal colonial rule of King Leopold II of Belgium, became the epicenter of the rubber trade.
The rubber extraction process in the Congo was marked by forced labor, coercion, and unimaginable cruelty. Villagers were subjected to horrific conditions, facing torture and mutilation if quotas were not met. The infamous system of forced labor, known as "rubber terror," was enforced by Leopold's agents, who ravaged the land, exploiting its people for profit.
The extraction of rubber led to the exploitation and suffering of countless Congolese, resulting in a devastating loss of life and cultural upheaval. Villages were decimated, families torn apart, and indigenous communities shattered by the insatiable demand for rubber.
This exploitative era has left a lasting scar on the Congo, affecting its socio-political landscape to this day. The memory of this dark period remains a poignant reminder of the atrocities committed in the pursuit of wealth and power. Despite the harrowing past, the Congo's relationship with rubber continues. Efforts have been made to reclaim the industry, focusing on sustainable and ethical practices. Indigenous communities have been at the forefront of initiatives, aiming to balance economic growth with environmental preservation and social justice. Rubber in the Congo stands as a testament to the intersection of commerce, colonialism, and human suffering. It serves as a stark reminder of the devastating consequences of unchecked exploitation and the ongoing struggle for justice and restoration in the region.

The END

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Natalie Dollar who worked with the students for the duration of the project and who contributed two amazing pieces of artwork.

Year 8W students who took on this project with enthusiasm and work collaboratively to ensure it was finished on time to a high standard.