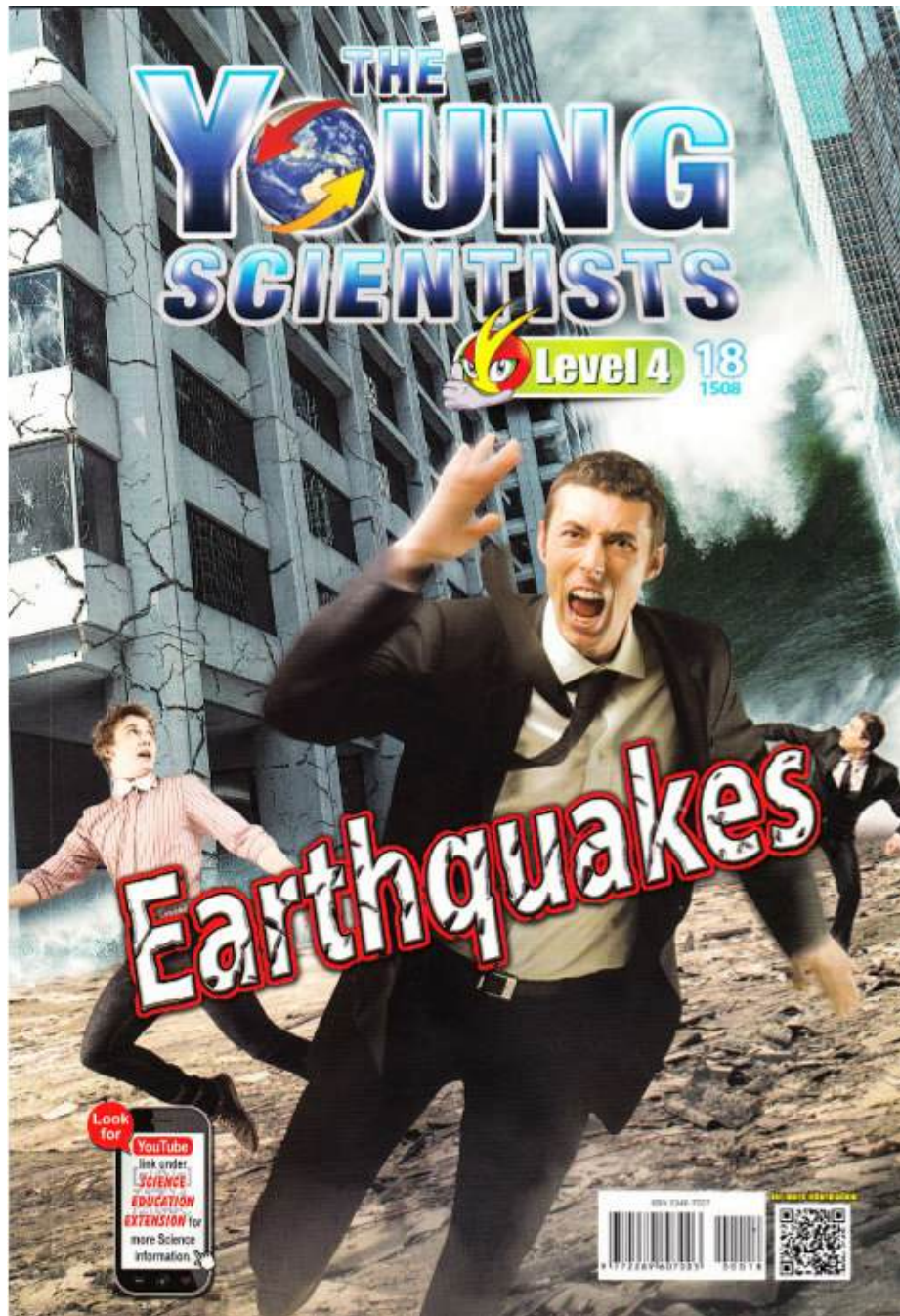
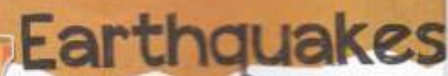




The Young Scientists Level 4		Contents	
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58 How The Davy's Lamp Was Invented





SCIENCE FACT

An avalanche is also called a snow slide. It occurs when a large mass of ice and snow breaks away from the side of a mountain and plunges down with tremendous speed and force. An earthquake can trigger off an avalanche just as easily as noise from heavy machines.



SCIENCE FACT

Some animals will behave abnormally prior to an occurrence of an earthquake. The earliest such reference recorded was in Greece in 373 BC. Rats, weasels, snakes, and centipedes were reported to have left their homes and headed for safety several days before the devastating earthquake.





SCIENCE FACT

Earthquakes are mostly caused by geological faults, but they can also be caused by landslides, nuclear bomb testing, mine tests and volcanic activities.



SCIENCE FACT

An aftershock is a smaller earthquake that occurs after an earlier major earthquake, in the same place. Aftershocks are dangerous because they are usually unpredictable and can be of a magnitude great enough to collapse buildings that were damaged by the earlier quake.



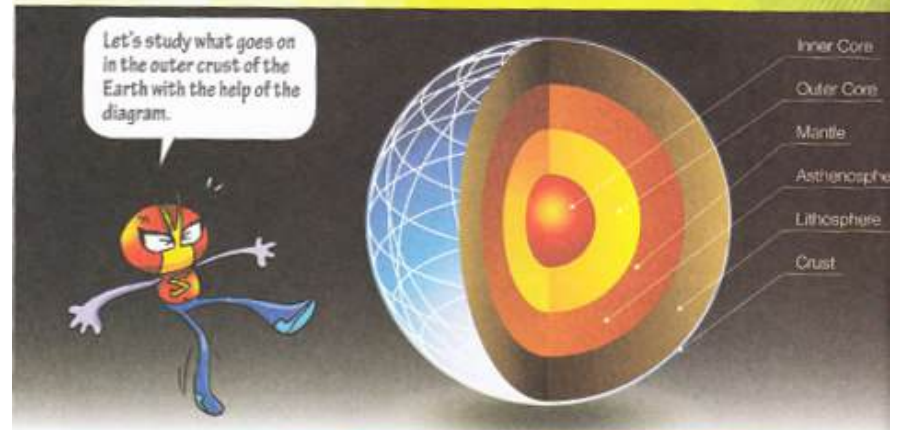


SCIENCE FACT

Seismometers are instruments for monitoring earth movements, including those of seismic waves generated by earthquakes, volcanic eruptions, and other sources of seismic activities. The first seismometer was invented in China in 132 AD by an inventor called Zhang Heng.



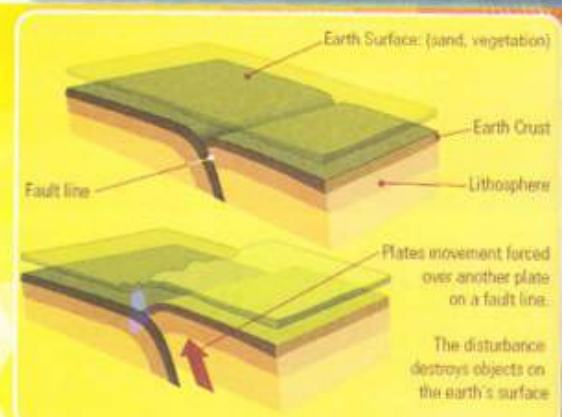
How Do Earthquakes Form?



The crust and the upper mantle form a layer known as the 'lithosphere'. The lithosphere is fragmented into many huge, irregularly shaped pieces, called tectonic plates, which are in constant motion as they slide over, under and past each other on top of the partly molten inner layer.



After a period of time, the built up energy and movements cause huge tension in the plates, and there will be massive pressure exerted on the fault lines. This intense pressure from accumulated energy, causes the fault lines to give way, and plates start to move over, against or apart from each other.

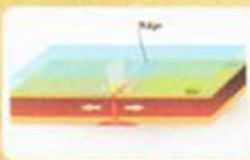


An earthquake may occur at this point. The escaping energy radiates outwards from the fault in all directions in the form of seismic waves that shake the earth as they move through it. When the waves reach the earth's surface, they shake the ground and anything on it, tearing down houses and structures.



Types Of Earthquakes

Earthquakes can occur in three main forms, depending on the plate movements that occur beneath the earth's surface.



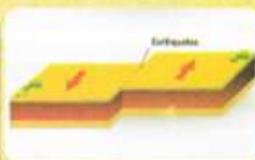
Divergent boundary

Plates are forced apart from each other, forming a Rift Zone. Such quakes are common in ocean floors where new floors are created. An example is the Mid-Atlantic Ridge.



Convergent boundary

One plate is forced over another plate during movements, creating a thrust fault.



Transform fault

Unlike divergent and convergent plate movements, the plates just slip by each other. This is also called the Strike-Slip boundary.



Science Education Extension

Enter **YouTube** and key in
"How do earthquakes happen?" World
Vulcan emergencies" input: Pothol



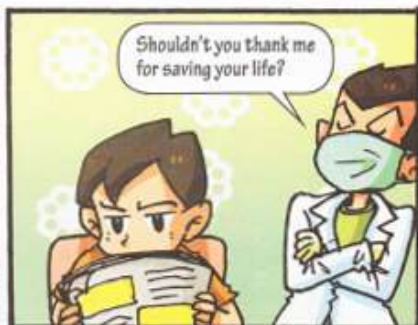
The Silent Killer



SCIENCE FACT

Carbon monoxide is a colourless, tasteless, odourless gas consisting of one carbon atom and one oxygen atom. It is very toxic to human beings.





SCIENCE FACT

The common fuel used in the kitchen is natural gas and liquefied petroleum gas (LPG). In some developing countries, wood, charcoal and crop residues are used in rudimentary stoves or open fires to cook food.



SCIENCE FACT

The deadly effect of carbon monoxide poisoning was known long ago by the Greeks and Romans who used the deadly gas to execute criminals.



You're totally misinformed! Cooking gas itself doesn't contain carbon monoxide. Carbon monoxide is a byproduct of incomplete combustion of various fuels.



Hey, you should stop boasting about always getting an A in your Science assessment!



Professor George, was Daney correct in what she just said?

Yes. When there is complete combustion, only carbon dioxide is produced. When there is incomplete combustion, both carbon dioxide and carbon monoxide are produced. In most cases, the combustion will be incomplete as it is very difficult to obtain complete combustion.



SCIENCE FACT

Gas contains hydrocarbons. When there is complete combustion carbon dioxide is formed. During incomplete combustion, in addition to carbon dioxide, carbon monoxide and carbon (soot) are produced as well.

complete combustion:

hydrocarbon + oxygen $\rightarrow$ carbon dioxide + water

incomplete combustion:

hydrocarbon + oxygen $\rightarrow$ carbon dioxide + carbon monoxide + carbon + water



As a safety precaution, shouldn't we leave a place immediately when we smell carbon monoxide in the air?



But how can we tell carbon monoxide is present when it's an odourless gas?



The cooking gas we use does have a pungent smell, doesn't it?



The cooking gas we use is actually odourless like carbon monoxide. However, ethanethiol is added to give cooking gas a pungent smell to help housewives and cooks detect dangerous gas leaks, which might otherwise go undetected.



That's the reason gas stoves should be placed in well-ventilated areas to prevent the accumulation of carbon monoxide gas.



SCIENCE FACT

Carbon monoxide poisoning in pregnant women may cause severe adverse fetal damage such as fetal tissue hypoxia due to decreased maternal oxygen to the fetus.

Vocabulary **hypoxia** - a condition in which not enough oxygen reaches the body's tissues



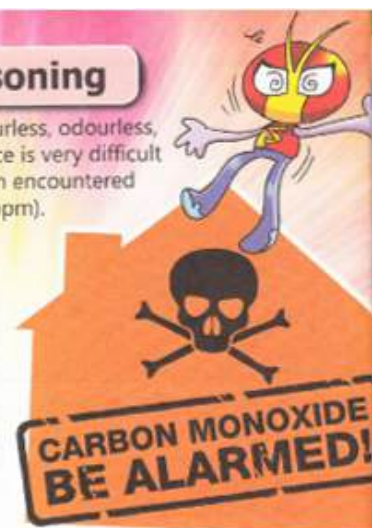


SCIENCE FACT
Constant exposure to low levels of carbon monoxide can lead to persistent headaches, lightheadedness, depression, confusion, memory loss, nausea and vomiting.



Carbon Monoxide Poisoning

Carbon monoxide is a toxic gas although colourless, odourless, tasteless, and initially non-irritating. Its presence is very difficult for people to detect. It is toxic to humans when encountered in concentrations above 35 parts per million (ppm).



Carbon monoxide is often produced in the domestic or industrial environment by motor vehicles that run on gasoline, diesel, methane, or other carbon-based fuels and tools, heaters, and cooking equipment that are powered by carbon-based fuels such as LPG.



The initial symptoms of low to moderate carbon monoxide poisoning are similar to that of flu. They include:

- headaches
- fatigue
- shortness of breath
- nausea
- dizziness.

High level carbon monoxide poisoning can result in progressively more severe symptoms, such as:

- mental confusion
- vomiting
- loss of muscular coordination
- loss of consciousness
- death.

Signs of Carbon Monoxide Poisoning



Do not use gas-powered equipment and tools inside the home. Use them only in a well-ventilated area, and install the engine unit and its exhaust outside in an open space!

Do not burn charcoal in an enclosed area or have indoor barbecues.

How To Prevent Carbon Monoxide Poisoning

Never leave a car running in the garage or other enclosed compartment. Carbon monoxide can also accumulate even when a garage door is open.

Install a carbon monoxide alarm, especially near sleeping areas and keep it at least 4 metres away from fuel-burning appliances.

Science Education Extensions
Enter **YouTube** and key in:
"Carbon Monoxide Poisoning / Educational Video" anysearch.com

19

Y5, Level 4, h. 18

A Touch-free Smartphone

SCIENCE FACT

Paralysis is the loss of muscle function in parts of your body. It happens when something goes wrong with the way messages pass between your brain and muscles. Paralysis can be complete or partial. It can occur on one or both sides of your body. It can also occur in just one area, or it can be widespread.

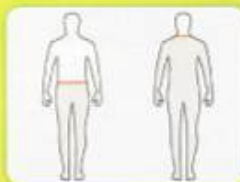
Y5, Level 4, h. 18

20



SCIENCE FACT

Paralysis of the lower half of your body will include both legs and is called paraplegia. Paralysis of the arms and legs is called quadriplegia.



SCIENCE FACT

Most paralysis is due to strokes or injury to the spinal cord or a broken neck. Other causes of paralysis may include:

- Nerve diseases such as amyotrophic lateral sclerosis
- Autoimmune diseases such as Guillain-Barre syndrome
- Bell's palsy, which affects the facial muscles





SCIENCE FACT

The sesame touch-free smartphone is an invention by Giora Livne, a quadriplegic veteran and former electrical engineer together with Oded Ben Dov, an app developer and computer vision expert. They teamed up in 2012 to develop this special smartphone for people who are handicapped and can't use their hands.



Y.S. Level 4, Is. 18



SCIENCE FACT

The sesame touch-free smartphone is specially designed for disabled people. The phone is ideal for people with spinal chord injuries, smytrophic lateral sclerosis (ALS), cerebral palsy, severe Parkinson's, multiple sclerosis, severe arthritis, carpal tunnel syndrome, and other disabilities that impair the use of the hands and arms.



Y.S. Level 4, Is. 18

What's the matter, Peter?

The house opposite ours is on fire!

Hello, I'm speaking from No 17 Abbey Road. There is a house on fire opposite mine.

Sheezn

You saved our lives when you alerted your parents about the fire. Thank you, my dear boy.

You're welcome, Mr and Mrs Wilson.

Dad, Mum, I'm sorry for being such a depressive mope. I'll not indulge in self-pity anymore from now on. I'm going to be courageous and positive about life.

SCIENCE FACT

The Sesame Phone is a Google Nexus 5 Android smartphone equipped with Sesame's proprietary head-tracking technology and voice control.

Sesame Touch-free SMARTPHONE

25

Y.S. Level 4, Is. 18

Touch-free Smartphone - Sesame

Uses the front-facing camera

Your head movements control the cursor

Your voice turns the phone ON/OFF

Sesame is a system designed specifically for people who can't use their hands or have limited use for them.

The device pairs head tracking software with some familiar hardware in order to bring smartphone functionality to those who would otherwise be unable to make use of it.

The device comes pre-loaded with a software that allows for touch-free functionality right out of the box. It uses a mixture of voice and gesture recognition for control, designed with accessibility in mind, and even simple enough for children to use.

26

The phone is switched on when the phrase 'Open Sesame' is said and immediately it begins tracking the user's head movements, which will control an on-screen cursor that navigates the phone. It can even be used by people who are able only to move their head slightly.



OPEN SESAME



The phone has a front-facing camera that searches for a face in the frame. Once it finds the user's face, the cursor is controlled by moving the head up, down or sideways. When the user rests in one position for a couple of seconds, a navigation icon pops up and he can choose whether he wants to click, swipe, or exit the menu on the phone.

With the Sesame smartphone, those with limbs impairment can call, text, surf the Web, access in social media sites and play games, as normal users do without procuring any special equipment.



Science Education Extensions

Enter YouTube and key in
"Heads up for Touch-Free Smartphone"
Copyright: Prof. Dr. S. Level 4, 10, 18



Self-recovery of Human Wounds



SCIENCE FACT

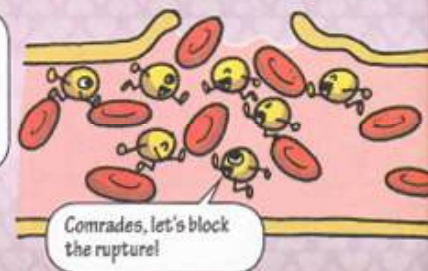
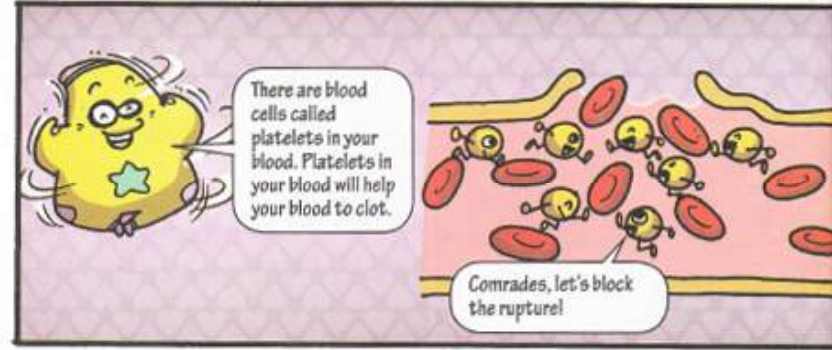
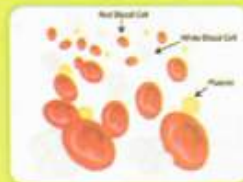
Platelets are irregularly-shaped, colourless cells that are present in blood. They are essential for preventing continuous bleeding and clotting of blood. They are produced in the bone marrow by very large bone marrow cells called megakaryocytes.





SCIENCE FACT

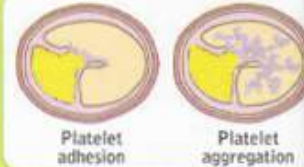
A normal platelet count ranges from 150,000 to 450,000 platelets per microlitre of blood. Having a count more than 450,000 is indicative of a condition called thrombocytosis while having a count less than 150,000 is indicative of a condition called thrombocytopenia. A platelet count is conducted as part of a complete blood count (CBC).

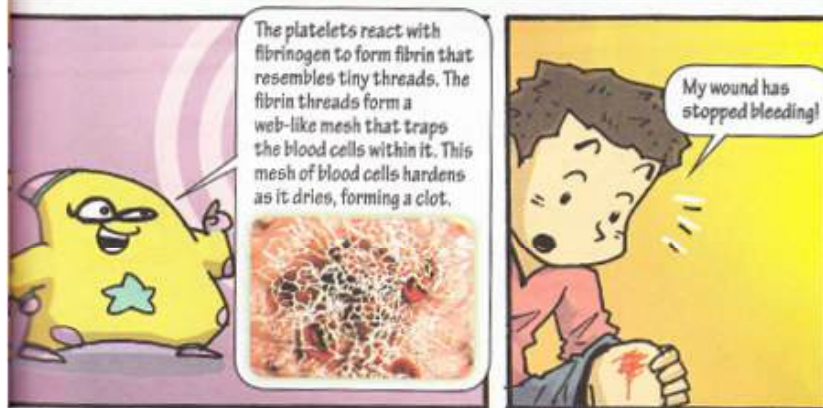
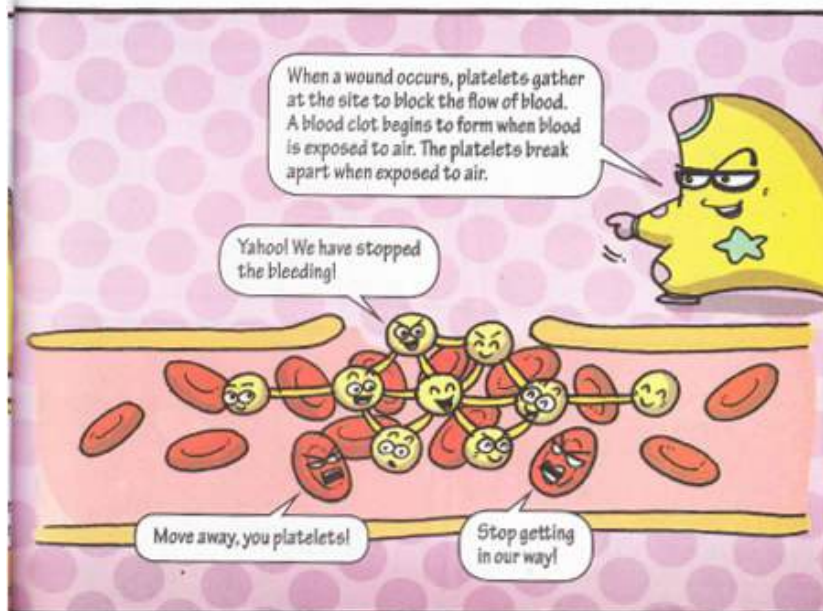


SCIENCE FACT

The process of spreading platelets across the surface of a damaged blood vessel to stop bleeding is called adhesion. When platelets get to the site of the injury, they produce sticky tentacles that help them adhere. They also send out chemical signals for more platelets to pile onto the clot in a process called aggregation.

Vocabulary
rupture - a surface that has been broken





SCIENCE FACT
A scab is an external blood clot that is easily seen although there are also internal blood clots. A bruise is the result of an internal blood clot. Both scabs and bruises are clots that lead to healing.



Scab



Bruise



SCIENCE FACT

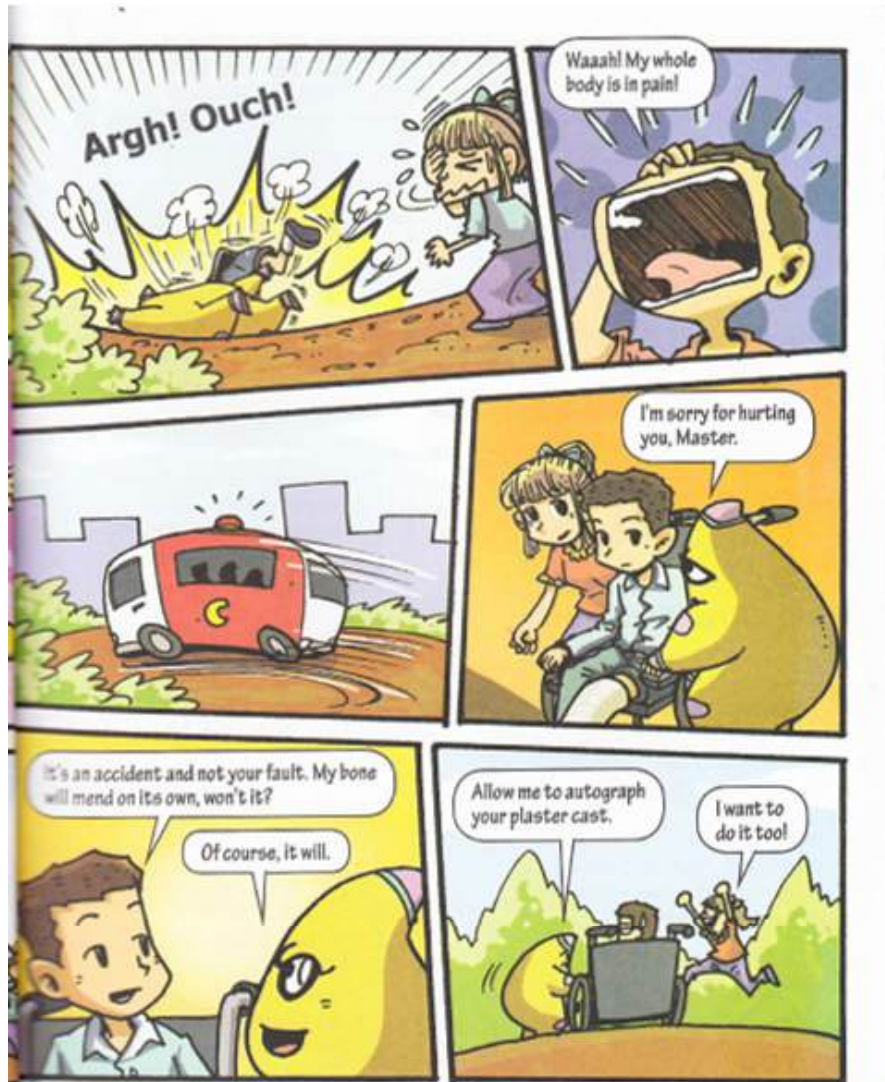
Calcium and vitamin K must be present in blood to support the formation of blood clots. If such nutrients are lacking in blood, it will take longer than normal for it to clot.



Calcium



K



SCIENCE FACT

Platelet transfusions help to support patients undergoing treatment for certain blood diseases, cancers and also help control bleeding after severe trauma and major surgery. While plasma can be frozen and stored for up to two years, platelets only have a shelf-life of five days so they pose more of a challenge to maintain a steady supply.

33

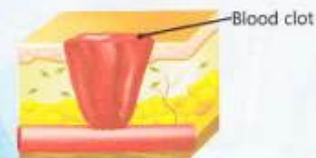


Y.S. Level 4, Is. 18

Phases Of Wound Healing



Clotting



Red blood cells form blood clots to help stop bleeding and create a temporary barrier to prevent pathogens from getting into an open wound.

1

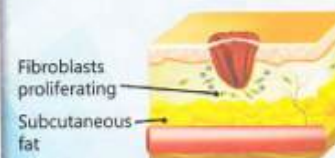
Inflammatory



A few hours after a wound is inflicted, the skin will turn red and appear swollen. This is the inflammation phase, when the body sends white blood cells to fight and destroy any rogue bacteria that happened to get through.

2

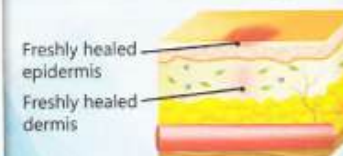
Proliferation



As fibroblast cells enter the wound, they supply collagen, which will form connective skin tissues to replace what was lost.

3

Remodelling



The dermis and epidermis, then connect and contract to close the wound. After this, the skin is likely to be much stronger than it was before the wound.

4

Do You Know?

Platelets (also called thrombocytes) in mammals are cells without a nucleus. They are actually fragments from the megakaryocytes. But thrombocytes in other animals such as birds and amphibians are intact mononuclear cells.



Y.S. Level 4, Is. 18

How To Clean A Skin Wound



Skin wounds need thorough cleaning to reduce the risk of infection and scarring and to promote healing.



For mild bleeding, clean the wound first and then stop the bleeding. Before cleaning the wound, wash your hands well with soap and water.



After cleaning, stop the bleeding by applying direct pressure on the wound and elevating it.



Large, deep, or very dirty wounds may need to be treated by a doctor who can provide thorough cleaning, evaluation for stitches, and antibiotic treatment.



Use a large amount of water under moderate pressure. Cool water may be better than warm water on a wound. Washing the wound will remove as much dirt, debris, and bacteria as possible which will reduce the risk of infection.



Science Education Extension

Enter **You Tube** and key in
"How a wound heals itself - Sarthak
Sinha" (www.youtube.com)



The Smell of Books



Why do you keep flipping every book? What are you looking for?



Do you realise that new books and old books smell different?



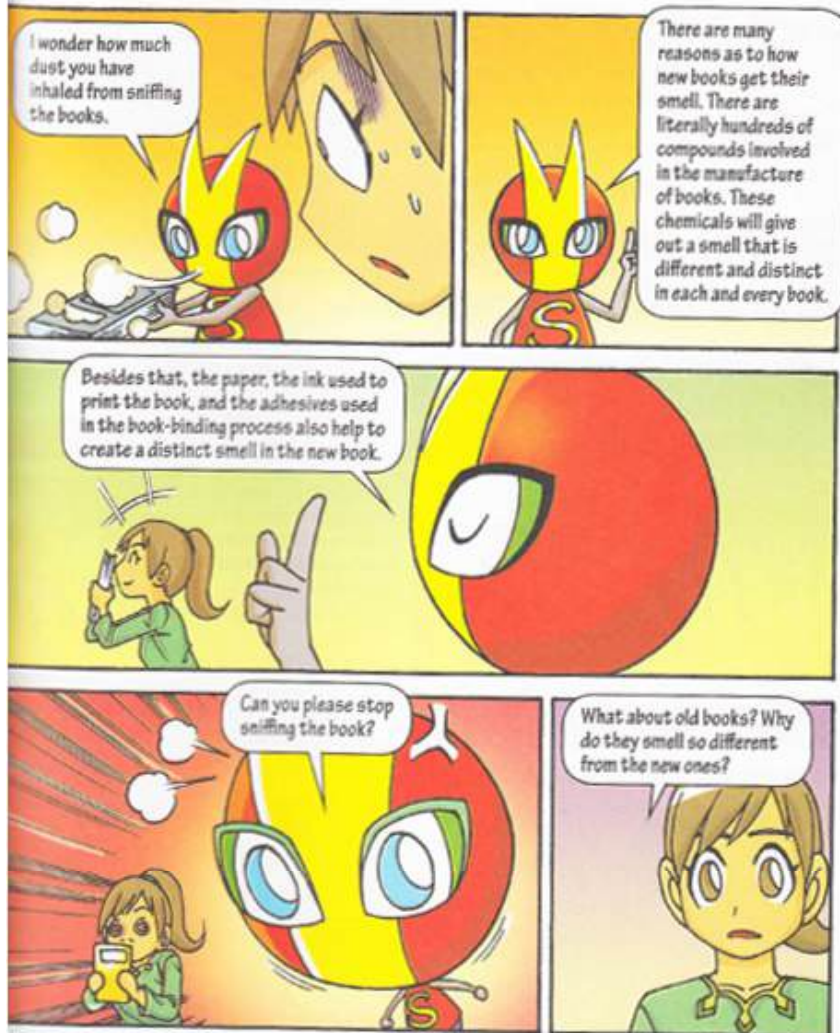
Different books have different smells. What's so unusual about that?



SCIENCE FACT

No single chemical gives a prevalent odour to books. The odour from books is due to a complex mix of volatile chemicals produced and used in their manufacture, as well as the gradual degradation of the chemicals within the paper. Some of the compounds produced, such as furfural, can even be used to gauge the age and condition of the book in question.





SCIENCE FACT

Knowing why paper produces different smells could be used to help librarians 'sniff out' the books and papers that are in danger of degradation. Identifying such aging manuscripts will allow them to be preserved and protected.



SCIENCE FACT

Lignin, which is present in all wood-based paper, is closely related to vanillin. As it breaks down, the lignin gives old books a faint vanilla scent.



Perfume That Smells Like A Book

Paper Passion is a perfume designed by boutique perfumer Geza Schoen in consultation with Gerhard Steidl and in collaboration with Wallpaper magazine.



Gerhard Steidl



Geza Schoen



Schoen spent days sniffing through books, paper samples and inks, to find inspiration for a perfume that is true to books and wearable. It took Schoen 17 trials to create this unique fragrance.



Though most perfumes consist of more than 100 ingredients, Paper Passion features only five woody ingredients.

It is a perfume formulated to smell like books and meant to appeal to booklovers. It captures the unique olfactory pleasures of the freshly printed book.



Science Education Extensions

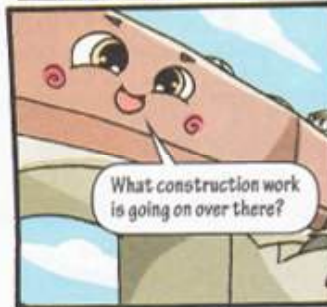
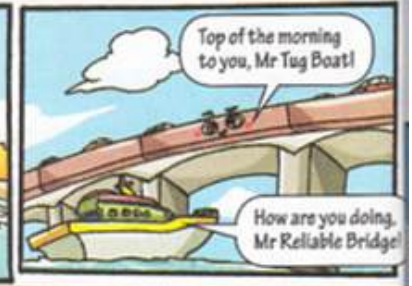
Enter YouTube and key in

"Why Do Old Books Smell?"

Copyrighted



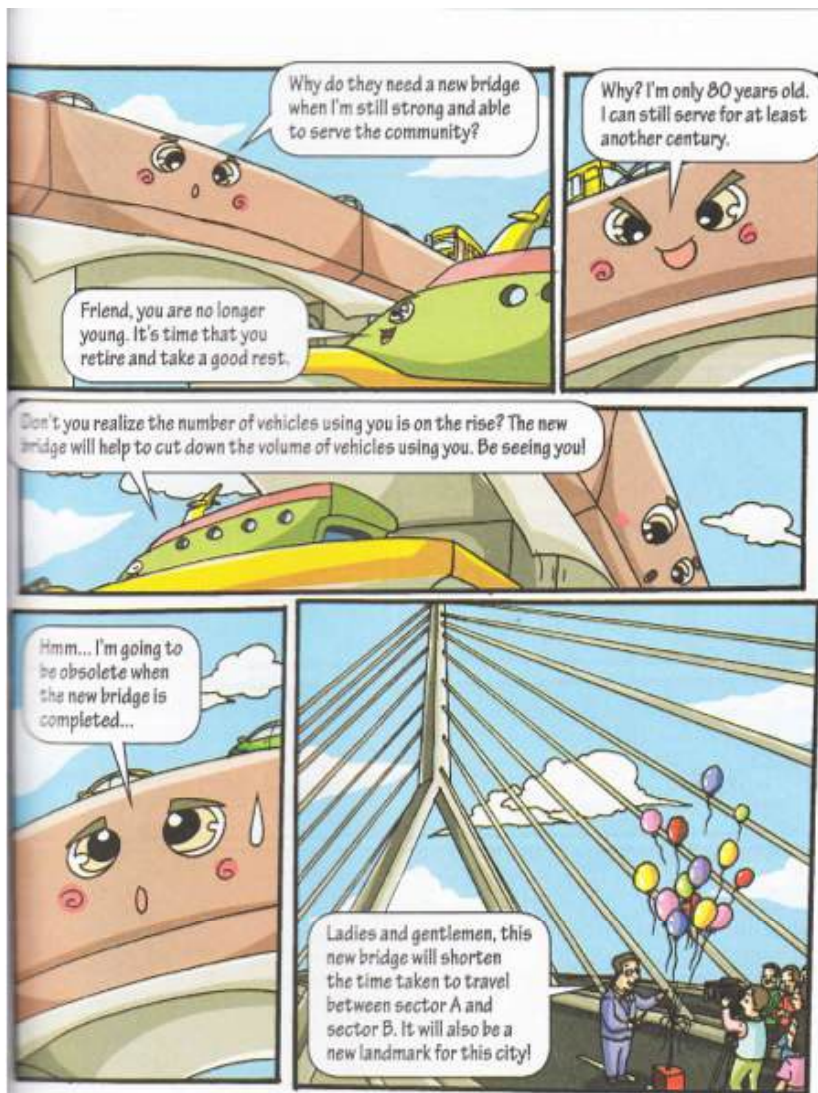
An Old Bridge And A New Bridge



SCIENCE FACT

The key structural components of constructing a bridge are Beams, Arches, Trusses and Suspensions (BATS). Various combinations of these four innovative technologies allow for numerous bridge designs, including beam bridges, arch bridges, truss bridges, cable-stayed bridges, cantilever bridges and suspension bridges.

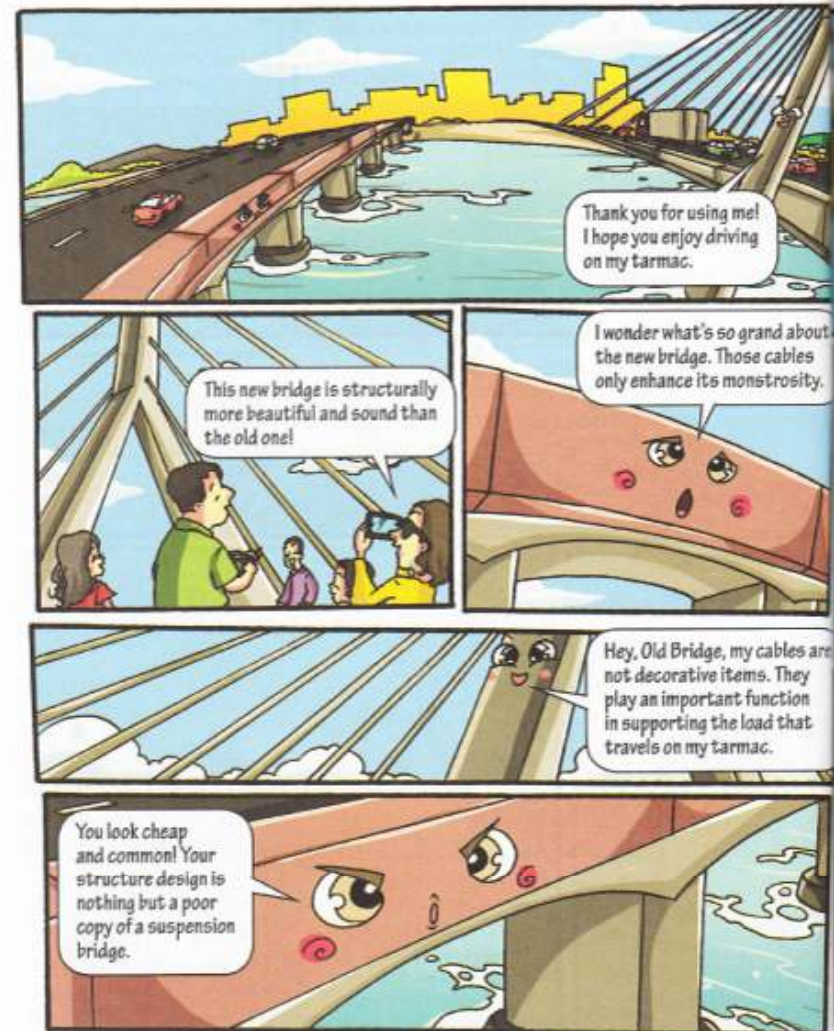
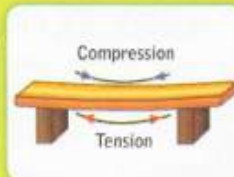




SCIENCE FACT

Bridges are subject to compression and tension as varying loads act on them. These forces can damage parts of the bridge. Bridges are designed to handle such forces to prevent buckling or snapping of the structures.

Vocabulary
obsolete - no longer in use because something new has been invented

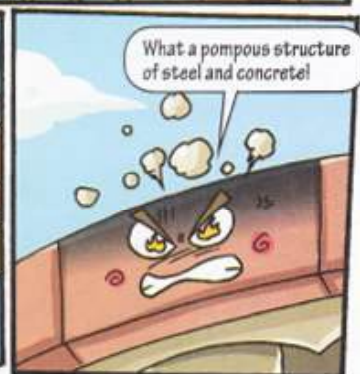
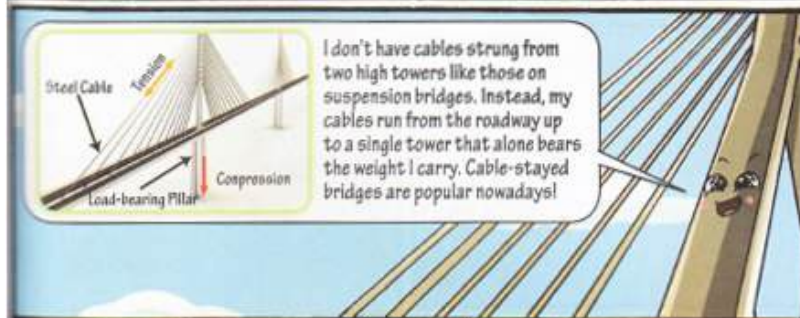
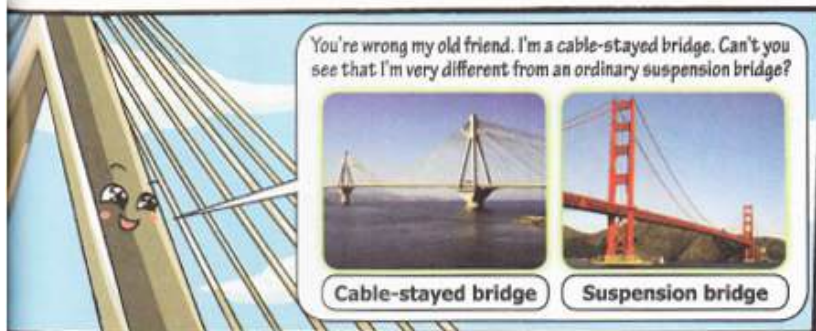


SCIENCE FACT

During the Industrial Revolution of the 19th century wrought iron was introduced into the design and building of large bridges. Wrought iron was later replaced with steel because steel has a higher tensile strength.

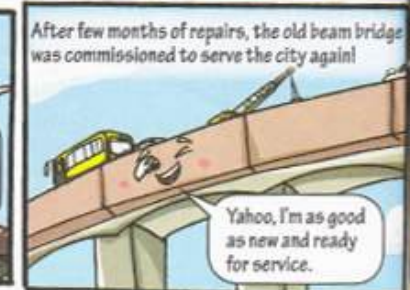
Vocabulary
monstrosity - something that is very large and very ugly, especially a building





SCIENCE FACT

Compared to suspension bridges, cable-stayed bridges require less cables, can be constructed out of identical pre-cast concrete sections, and are faster to build. The result is a cost-effective bridge that is undeniably beautiful.



SCIENCE FACT

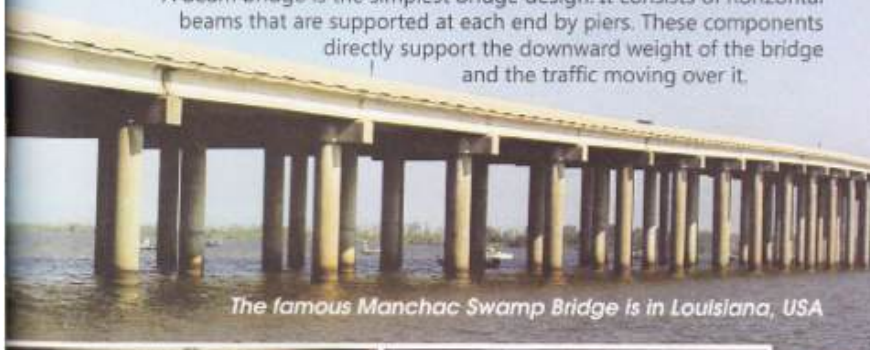
The Zhaozhou Bridge is the oldest standing bridge in China and the world's oldest stone segmental arch bridge. It was built in 605 AD and is still standing strong today, after more than 1,400 years.

Vocabulary
resentful - feeling bitter or angry about something that you think is unfair



The Beam Bridge

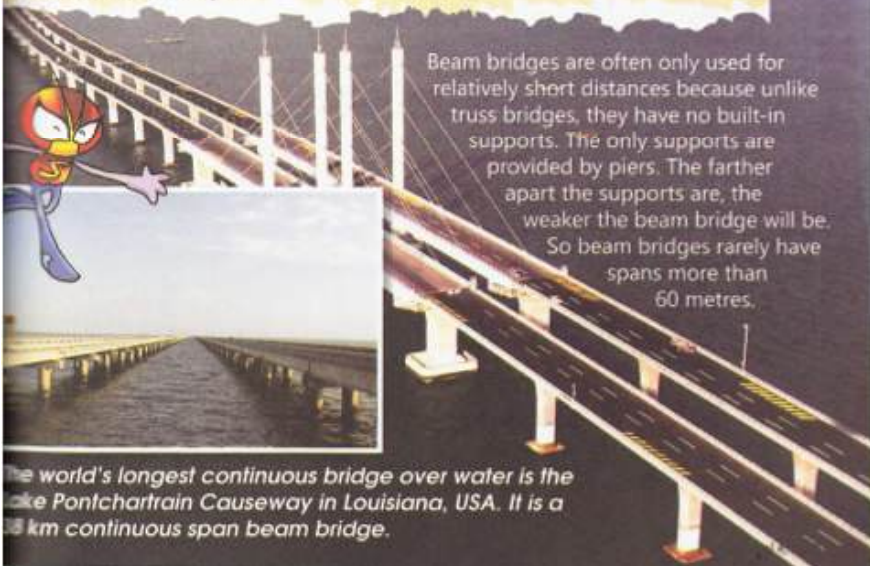
A beam bridge is the simplest bridge design. It consists of horizontal beams that are supported at each end by piers. These components directly support the downward weight of the bridge and the traffic moving over it.



The famous Manchac Swamp Bridge is in Louisiana, USA



Many beam bridges use concrete or steel beams to support the load. The size of the beams, and in particular, the height of the beams control the distance that the beams can span.

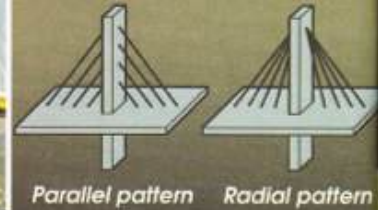
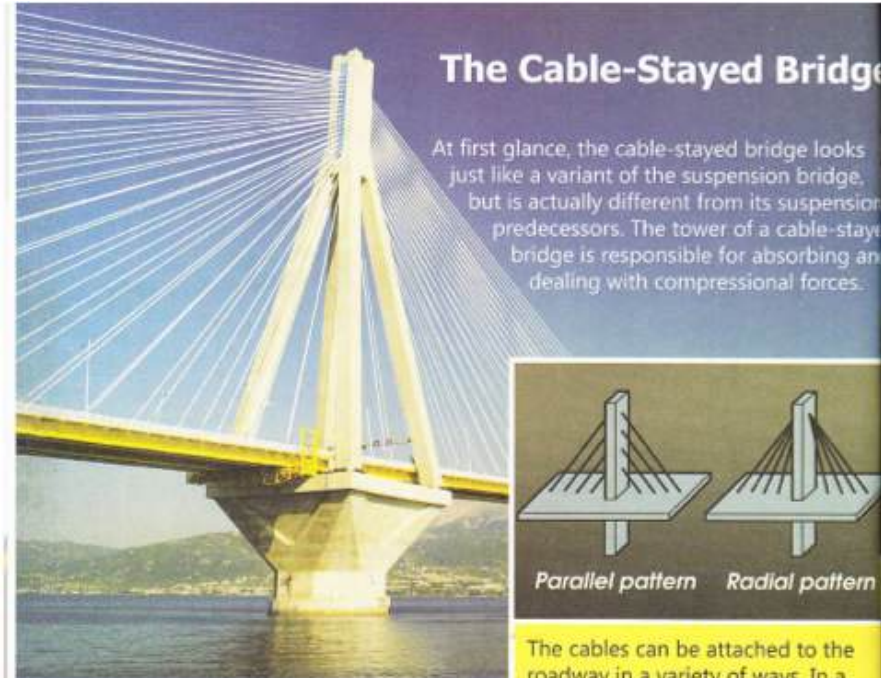


Beam bridges are often only used for relatively short distances because unlike truss bridges, they have no built-in supports. The only supports are provided by piers. The farther apart the supports are, the weaker the beam bridge will be. So beam bridges rarely have spans more than 60 metres.

The world's longest continuous bridge over water is the Lake Pontchartrain Causeway in Louisiana, USA. It is a 23 km continuous span beam bridge.

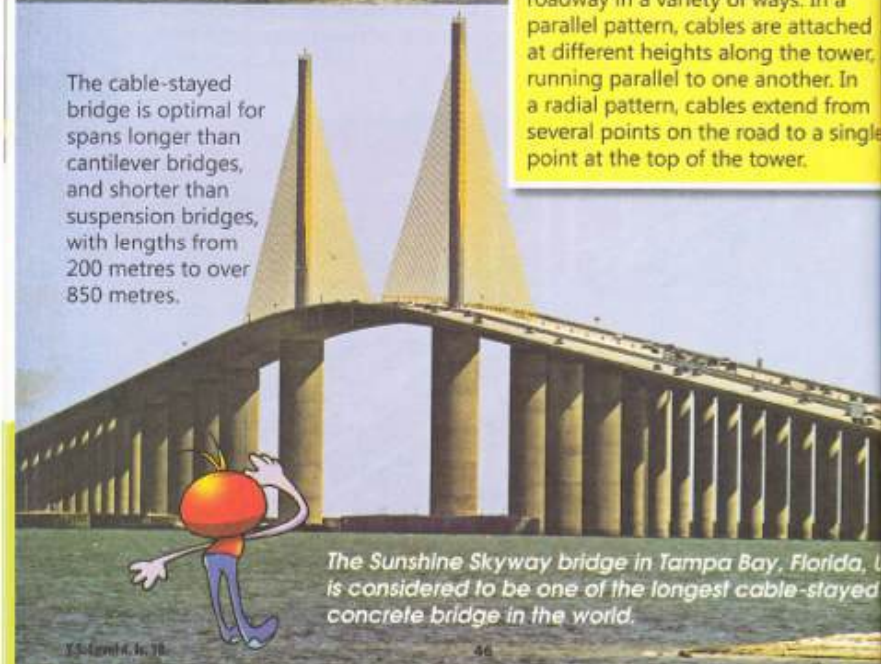
The Cable-Stayed Bridge

At first glance, the cable-stayed bridge looks just like a variant of the suspension bridge, but is actually different from its suspension predecessors. The tower of a cable-stayed bridge is responsible for absorbing and dealing with compressional forces.



The cables can be attached to the roadway in a variety of ways. In a parallel pattern, cables are attached at different heights along the tower, running parallel to one another. In a radial pattern, cables extend from several points on the road to a single point at the top of the tower.

The cable-stayed bridge is optimal for spans longer than cantilever bridges, and shorter than suspension bridges, with lengths from 200 metres to over 850 metres.



The Sunshine Skyway bridge in Tampa Bay, Florida, USA is considered to be one of the longest cable-stayed concrete bridges in the world.



Types Of Suspension Bridges



Suspension bridge



Underspanned suspension bridge



Stressed ribbon bridge



Suspension bridge

Suspension bridges are capable of extending from 610 metres to 2,134 metres. However, their construction costs are high and therefore are economical only for spans in excess of 300 metres.



Science Education Extensions

Enter YouTube and key in

"Understanding Bridges" (page 18)



Fireflies Light Up The Night



Shh... Lower your voice before you scare them all away.

Boy, be quiet and enjoy the spectacle. Make sure you don't fall into the water.



SCIENCE FACT

There are about 2,000 species of fireflies in temperate and tropical countries. Fireflies are also called lightning bugs but they are neither flies nor bugs. Fireflies are actually beetles. Like all beetles, they have hardened forewings called elytra, which meet in a straight line down the back when at rest.



Coltron, how do the fireflies emit light?

I'm scanning for an answer from my data bank processor.

Beep! Beep!

The fireflies have a chemical in their abdomen called luciferin.

Hey, don't go away!

When that chemical combines with oxygen and an enzyme called luciferase, the ensuing chemical reaction will cause their abdomen to light up.

This type of light is called bioluminescence.

Luciferin + Oxygen $\xrightarrow{\text{Luciferase}}$ Oxyluciferin + Light

SCIENCE FACT

Fireflies produce a 'cold light', with no infrared or ultraviolet frequencies. The light produced may be yellow, green, or pale red, with wavelengths from 510 to 670 nanometres.

Vocabulary **ensue** - something that happens after or as a result of another event



Gee, this is too technical and scientific for me to understand...

Since many fireflies can all emit light at the same time, I suppose they can survive high temperatures.

No, they can't withstand an environment with a high temperature. The light they emit isn't hot at all.

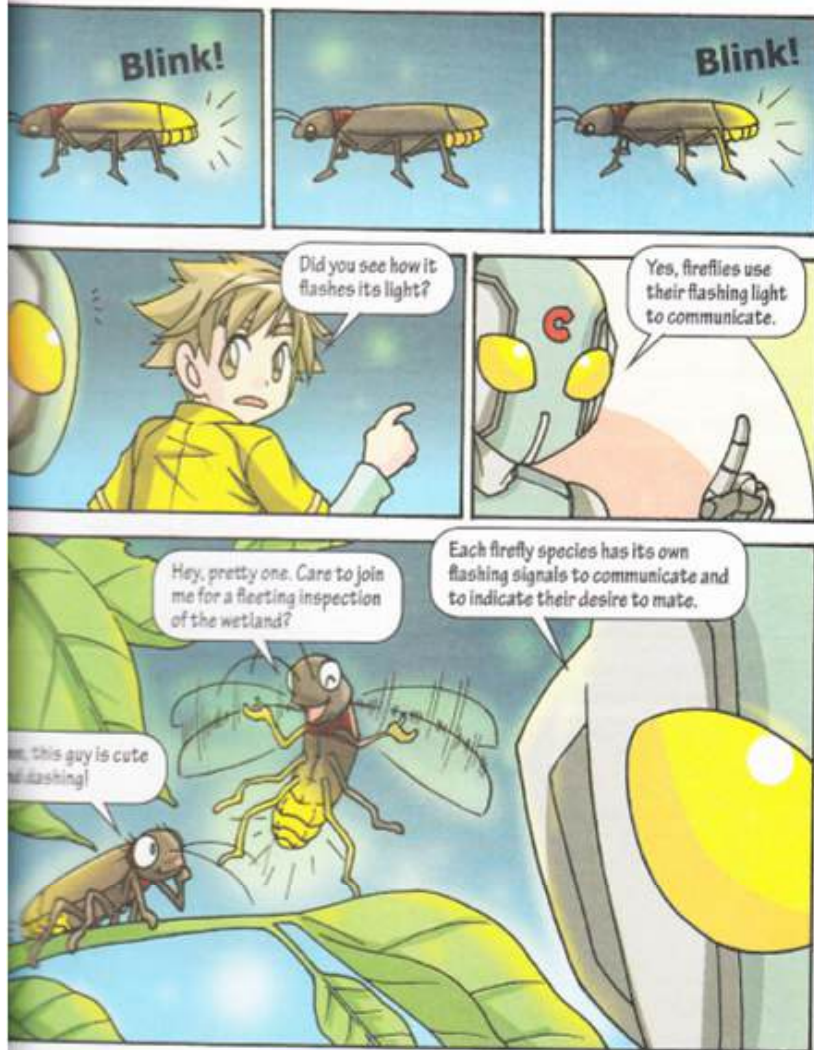
Really? I thought the light they emit is similar to the light of an incandescent light bulb.

An incandescent light bulb gives out heat as well as light. The light from a firefly is cold light without heat energy.

SCIENCE FACT

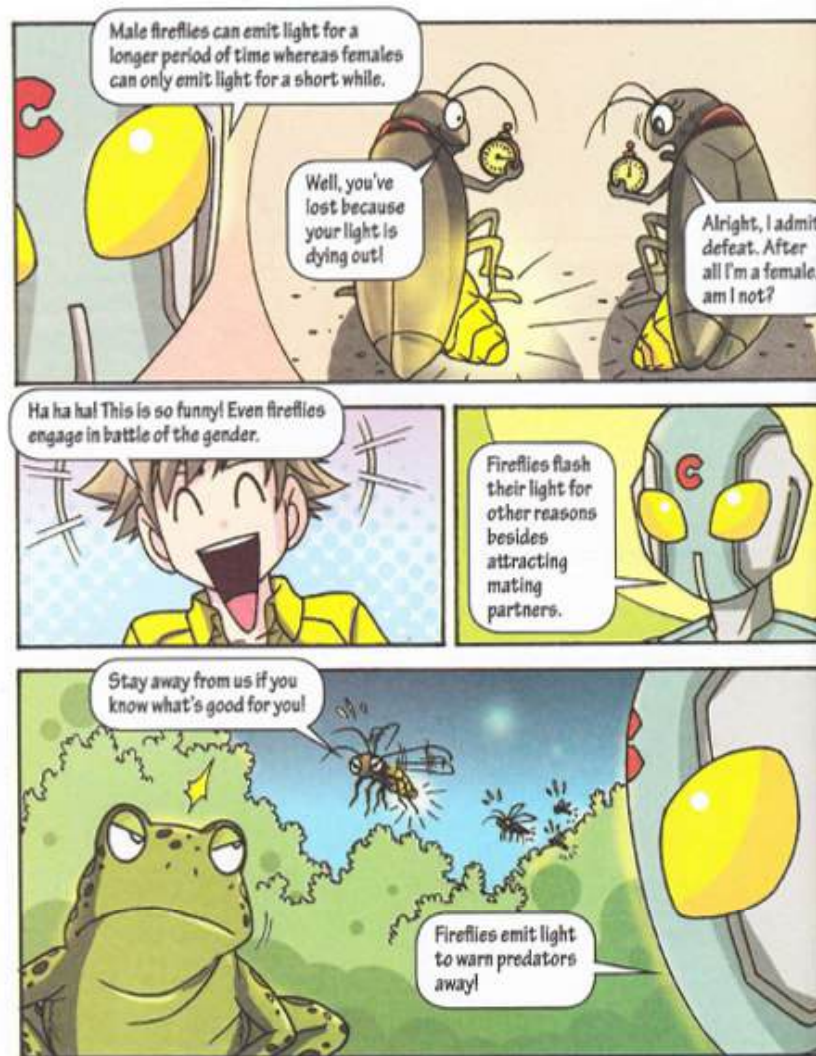
Fireflies produce light through an efficient chemical reaction that allows them to glow without wasting heat energy. Nearly 100% of the energy goes into making light. By contrast, an average electric light bulb gives off 90% of its energy as heat, and only 10% as light.





SCIENCE FACT

Fireflies will emit light to indicate their desire for mating partners and a willing female will respond with her own light. However, some females also mimic the light signals of other firefly species to attract, kill and eat the males.



SCIENCE FACT

Fireflies are filled with a chemical called lucibufagins, which has an unpleasant taste. When a predator eats a firefly, it will learn to associate the glow with the unpleasant taste. So the firefly's glow actually warns would-be predators to stay away.





SCIENCE FACT

Fireflies are known for their blinking light signals, but not all fireflies flash. Some adult fireflies, most notably those that inhabit western regions of North America, don't use light signals to communicate. These fireflies use pheromones to signal mates.

Pheromones - a chemical secreted by an animal that can alter the behaviour of another animal of the same species, such as the mating behaviour



Glowing Animals

Some living things can light up dark places without help from the Sun. This is called bioluminescence. While fireflies are the best-known bioluminescent creatures, some insects, fungi, bacteria, jellyfish and bony fish can also glow. They create a chemical reaction to glow at night in dark caves or in the black depths of the ocean.



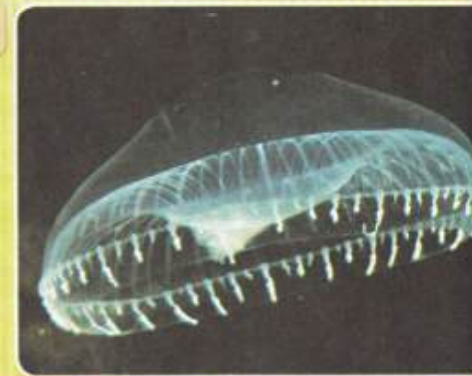
Vampire Squid

Vampire squids don't have ink sacs. When one is frightened, it shoots out a cloud of bioluminescent mucus that will surprise its attacker and give it a chance to escape. Vampire squids also use photophores on the underside of their bodies to conceal their body outlines against the sky.



Aequorea Victoria

Many jellyfish have the ability to produce light in their bodies notably the Aequorea Victoria. This jellyfish is almost entirely colourless and transparent. They will produce a bluish light in the sea.



Abraliopsis Squid

The abraliopsis squid has small light organs on the underside of its belly for the purpose of camouflage. It uses this luminescence to blend in with the sea, hiding its silhouette from predators watching from below.

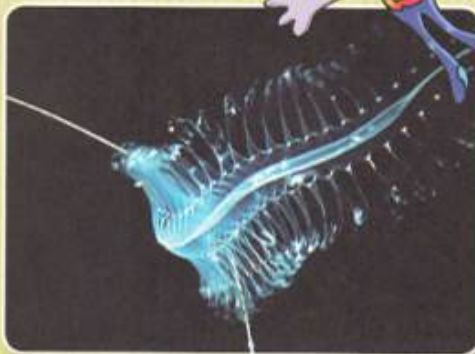
Vocabulary

Silhouette - the dark outline or shape of a person or an object that you see against a light background



Tomopteris

The polychaete Tomopteris is one of the only marine creatures that produces yellow luminescence. If disturbed, it will emit glowing sparks from foot-like appendages called parapodia.



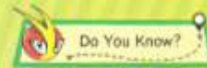
Red Tide

The most common bioluminescent creatures are speck-sized, plant-like dinoflagellates whose blooms are the cause of the so-called red tides. They flash brilliant blue to scare off predators when they are disturbed or caught in a wave.



Science Education Extension

Enter **You Tube** and key in
"The brilliance of bioluminescence"
Leslie Kenna™ (www.lesliekenna.com)



Incredible Facts About Plants



Avocados have the highest **fibre** and **calories** content of any fruit.

A **watermelon** contains about **7% flesh** and the rest of the **93% is water**.



The **sea coconut**, also known as **Coco de mer**, is the **largest** and **heaviest** seed in the plant kingdom (weighing up to 18 kg).



Peanuts are **beans**.



The world's **smallest** flowering plant is the **Wolffia**, whose **one full bouquet** of flowers can fit on the head of a **push-pin**.

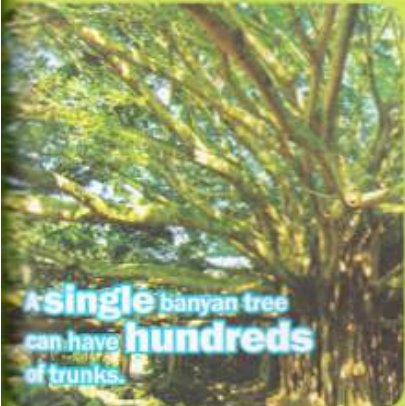
A fully grown tree produces enough oxygen in one year to keep a family of four breathing.



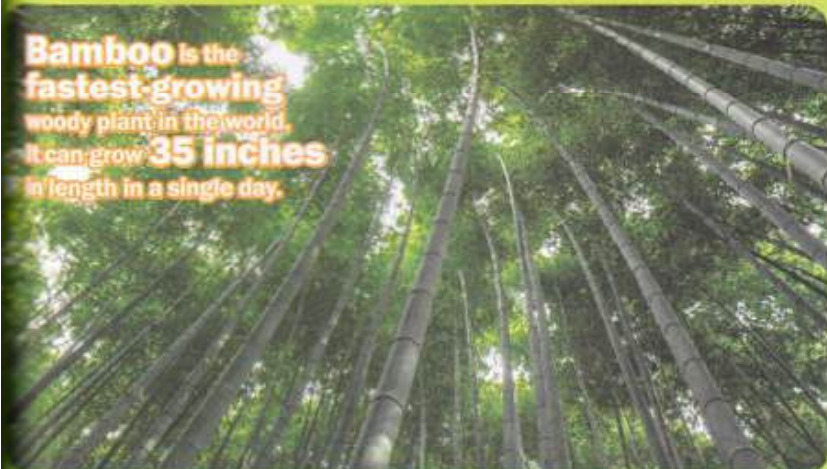
As much as 70% of the oxygen in our atmosphere is produced by marine plants and algae.



A single banyan tree can have hundreds of trunks.



Bamboo is the fastest-growing woody plant in the world. It can grow 35 inches in length in a single day.



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World Of Physics

How the Davy's Lamp Was Invented





What a tragedy! How sad for the family members of the dead miners.

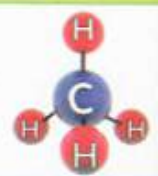


Some form of scientific investigation should be commissioned to prevent such a tragedy from recurring in the future!



SCIENCE FACT

Firedamp is a highly explosive gas found in coal mines. It is a mixture of methane (CH_4) gas and air. Methane is odourless, tasteless, colourless, and lighter than air which means it is found near the roof of working mines. Firedamp is explosive at concentrations between 5% and 15% with most explosions occurring at around 10%.



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Davy, I hope you can come up with something to protect the miners in the coal mines.

The parish priest and Davy discussed the plight of the miners as a result of the tragic mine explosion.

Alright, I'll pay a visit to one of the coal mines to find out the cause of the explosion.

Thank you, Davy!



SCIENCE FACT

The Davy lamp is a safety lamp for use in flammable atmospheres, consisting of a wick lamp with the flame enclosed inside a metal mesh screen. It was invented in 1815 by Sir Humphry Davy. It used a heavy vegetable oil as a source of fuel.



It's so dark inside. Why don't you use oil lamps or candles to light up the place?

No, we can't! There is a lot of methane gas inside the mine. It takes only a spark to trigger off an explosion.

The miners are in dire need of some form of safety light to help them see inside the dark mines.



In his laboratory.

The firedamp explosions in the mines are mainly caused by the presence of a gas called methane.

That's right.



What we need is a lamp that will provide light in the mine and yet not trigger off an explosion.

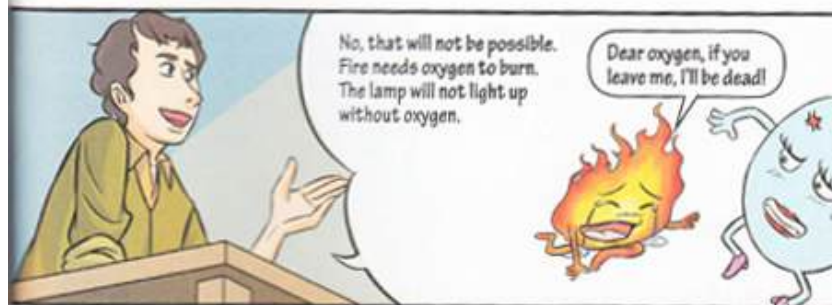


What if we quarantine the flame in the lamp from contact with the surrounding air?

SCIENCE FACT

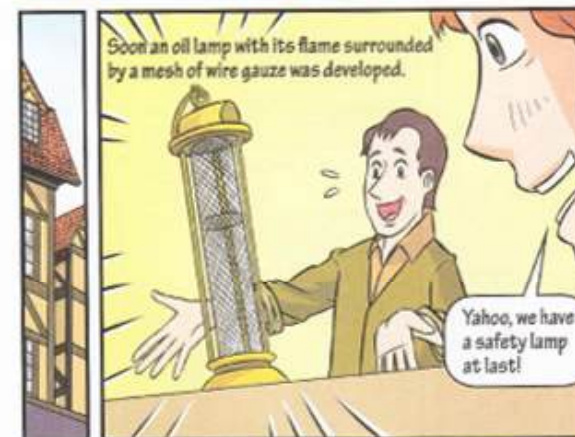
Before the invention of the safety lamp, miners used candles with open flames. This gave rise to frequent explosions. For example, at one colliery in the north east of England, 10 miners were killed in 1806 and 12 in 1809. In 1812, 90 men and boys were suffocated or burnt to death in the Felling Pit near Gateshead.





SCIENCE FACT

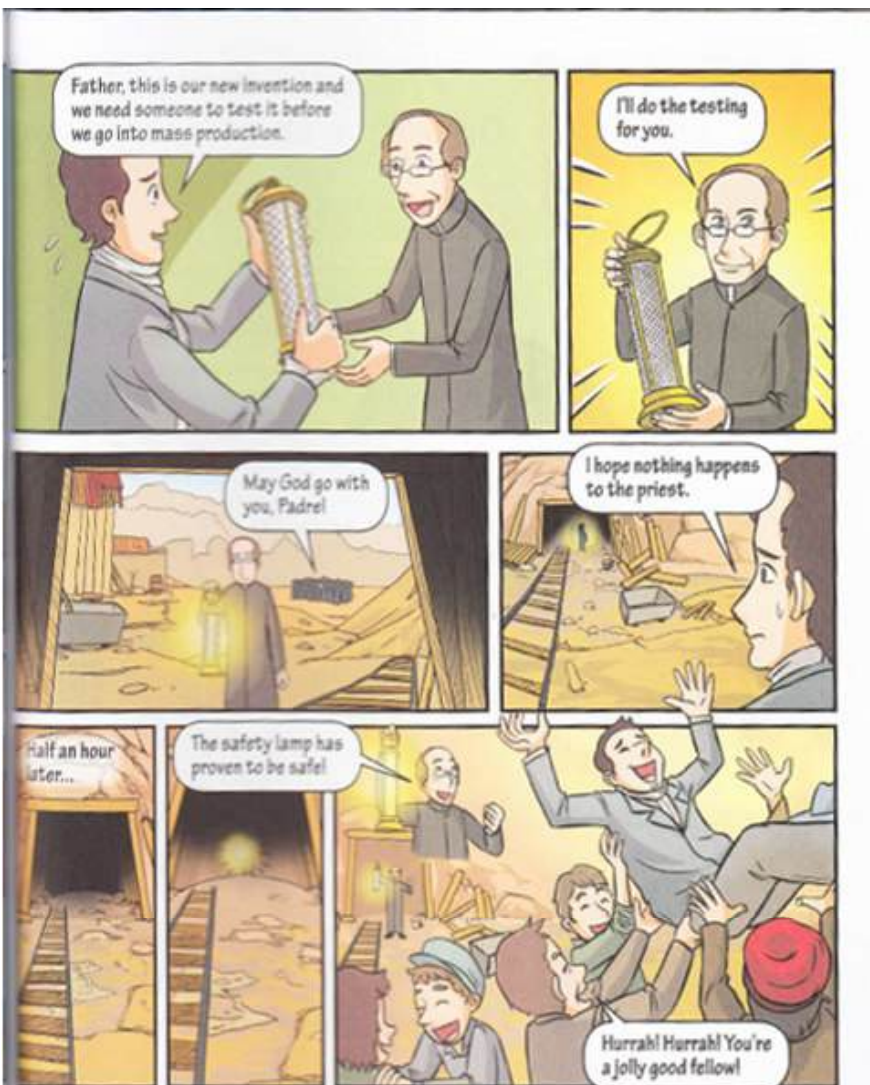
Being an underground fireman was one of the most dangerous jobs in the coal mines during the early days of the Industrial Revolution. Such a job required the checking of the pits for firedamp and other dangerous gases such as carbon monoxide and carbon dioxide. Firemen risked their lives every time they had to enter a gaseous area of the mine.



SCIENCE FACT

Miners once used canaries to test the air quality in the mines. Canaries are very sensitive to carbon monoxide. If the carbon monoxide level was too high, the canaries would have trouble breathing, and could even die. When the canaries were no longer singing, the miners left the mine quickly to avoid being caught in an explosion.





SCIENCE FACT

A modern day equivalent of Davy's Lamp is the Protector Garforth GR6S flame safety lamp which is used for firedamp testing in all UK coal mines. A modified version of this lamp was used in the Olympic Flame torch relays. It was also used in the relays for the Sydney, Athens, Turin, Beijing, Vancouver and Singapore Youth Olympic Games.



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Y5, Level 4, 10, 18

Principles Behind The Operation Of A Safety Lamp



Safety lamps need to address the following issues:

- They must provide adequate light.
- They do not trigger explosions.
- They give warning when an atmosphere becomes dangerous.

Fire requires three elements to burn: fuel, oxygen and heat. If any one element from this trio is removed, burning will stop. A safety lamp has to ensure that the three elements of fire are maintained inside the lamp, and do not leak outside.




Fuel

This is the easiest element of the three to consider. Fuel is in the form of an oil inside the lamp and fuel is in the form of a firedamp or coal dust on the outside.

Oxygen

Oxygen is in the form of air that is present outside the lamp. The design of the lamp must allow oxygen to pass into the lamp or else the flame in the lamp will die out.

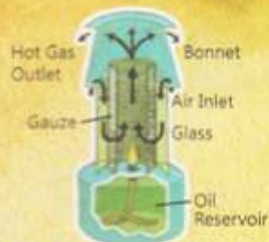
Heat

Heat is carried by the exhaust gases, through conduction and through burning of the firedamp drawn into the lamp passing back down the inlet.




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In a Davy's safety lamp, the cylindrical metal gauze of high thermal conductivity surrounds the flame. When this lamp is taken inside a mine, even if explosive gases are present, they do not ignite because the wire gauze conducts the heat away from the flame. The temperature outside the wire gauze remains lower than the ignition temperature of the gases.

The lamp burns brighter with a blue halo when the atmosphere is at a dangerous level thus acting as a warning to miners of the rising level of firedamp. As soon as a miner notices the presence of explosive gases from the colour of the flames, work will be stopped and the mine will be thoroughly ventilated.

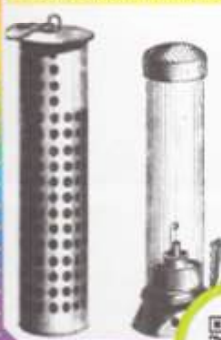


Examples Of Safety Lamps

Davy lamp



Stephenson lamp



Clanny lamp



Science Education Extension
Enter **YouTube** and key in
"Wrexham - How safety lamps were made
ready for underground" (approx. 10:00)



Is The X-Ray Dangerous?



SCIENCE FACT

The X-ray was accidentally discovered by the German scientist, Wilhelm Conrad Röntgen while experimenting with vacuum tubes in 1895. He was awarded the very first Nobel Prize in Physics in 1901.





SCIENCE FACT

An X-ray delivers about 10 million times more energy than a radio wave, which explains why radio waves don't hurt us but X-rays can.



SCIENCE FACT

Some materials are radioactive because the nucleus in the atom of such materials is unstable and can split up by emitting nuclear radiation in the form of alpha particles, beta particles or gamma rays. The nuclear radiation given off can be detected using a Geiger counter.





SCIENCE FACT

Lead is particularly well-suited to lessen the effect of gamma rays and X-ray radiation due to its high atomic number. This number refers to the relatively high number of protons along with a corresponding number of electrons within its atom. These electrons block many of the gamma and X-ray particles that try to pass through the lead barrier.



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SCIENCE FACT

Lead is used as a shield in X-ray machines, nuclear power plants, labs, military equipment, and other places where radiation may be encountered. Personal shields include lead vests, thyroid shields and lead gloves.



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SCIENCE FACT

Lead is not effective against all types of radiation. High energy electrons (including beta radiation) incident on lead may create bremsstrahlung radiation, which is potentially more dangerous to body tissues than the original radiation. Furthermore, lead is not a particularly effective absorber of neutron radiation.

CAUTION

RADIOACTIVE

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Naked To The Bone — X-Rays

X-radiation is a form of electromagnetic radiation. Most X-rays have a wavelength ranging from 0.01 to 10 nanometres, corresponding to frequencies in the range 3×10^{15} Hz to 3×10^{18} Hz.

The Electromagnetic Spectrum

Radio waves Micro-waves Infrared radiation Visible light Ultraviolet X-rays Gamma-rays

10³ 1 10⁻³ 10⁻⁵ 10⁻⁷ 10⁻⁹ 10⁻¹¹ 10⁻¹³

Many objects in space emit X-rays, including black holes, neutron stars, the Sun, some comets, supernova remnants, and binary star systems.

An X-ray is a non-invasive medical test that helps physicians diagnose and treat medical conditions. Imaging with X-rays involves exposing a part of the body to a small dose of ionizing radiation to produce pictures of the inside of the body. X-rays are the oldest and most frequently used form of medical imaging.

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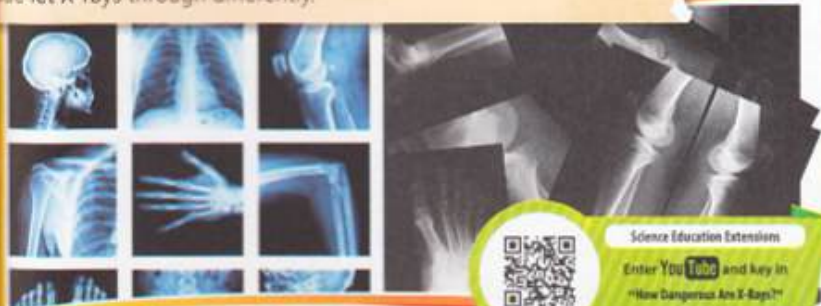
The chest X-ray is the most commonly performed diagnostic X-ray examination. A chest X-ray produces images of the heart, lungs, airways, blood vessels and the bones of the spine and chest. It can be used to diagnose pneumonia, lung cancer, or pulmonary edema.



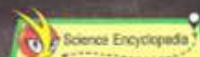
Special types of X-rays include mammograms, dental X-rays, contrast X-rays, fluoroscopy, and computerized tomography (CT) scans. Other imaging techniques such as magnetic resonance imaging (MRI) and ultrasound do not use X-ray.



When X-rays are passed through the body, some waves pass through the tissue and turn the film black. Other waves are blocked (e.g. by bones), which leave white shadows on the film. Different types of tissue let X-rays through differently.



Science Education Extensions
Enter **YouTube** and key in
"How Dangerous Are X-Rays?"
Imagined by the author



A Dirty Thunderstorm



A dirty thunderstorm (also known as volcanic lightning) is a rare and breath-taking phenomenon. It is a weather phenomenon that is related to the production of lightning in a volcanic plume.



Storms might spark off when rock fragments, ash and ice particles in the plume collide to produce static charges—just as ice particles collide to create charge in regular thunderstorms.



A famous image of this phenomenon was photographed by Carlos Gutierrez when it occurred in Chile above the Chaiten Volcano.



A volcanic lightning struck during an eruption of Japan's Sakurajima volcano in February, 2013.

Science Trivia

Who determines the gender of a baby?

The male parent does. Gender is determined by two chromosomes, X and Y. Since women do not have the Y chromosome but only contribute the X chromosome to the baby, a man determines the gender of a baby depending on whether his sperm carries an X or Y chromosome. An X chromosome combining with the mother's X chromosome will result in the birth of a baby girl (XX) whereas a Y chromosome combining with the mother's X chromosome will result in the birth of a baby boy (XY).

WOMEN (XX)
MEN (XY)

Why do bubbles burst?

Anything that fractures the tenuous layer of water molecules can cause a bubble to burst. For example, a gust of wind or your finger will easily cause a bubble to burst. Also a bubble will burst if enough water molecules evaporate. However, the force must be enough to break the surface tension. A nail will usually pop a bubble. But, if the nail is wet, and the bubble is thick enough, you can pierce a bubble many times without popping it. The water on the nail gives the water molecules in the bubble something to hold onto so the bubble will remain intact.

Readability **Tenacious** - that, tender

ES, level 4, 5, 10

The Minesweeping Robot

A team from the Institute of Systems and Robotics at Portugal's University of Coimbra developed a minesweeping robot to assist in the monumental task of clearing the millions of active land mines around the globe. Its designs were based on the Husky Unmanned Ground Vehicle module.

This robot has navigational and localization sensors attached with a ground penetration radar and metal detector.

It is able to perceive terrain characteristics, navigate across the terrain and detect localized land mines.

Robots do not get tired and are extremely thorough in performing their jobs. Their cost is also infinitely lower than that of a human life. For such reasons, robots are a perfect solution for the minesweeping problem.

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