International Journal of Electrical and Electronics Research ISSN 2348-6988 (online)
Vol. 5, Issue 2, pp: (77-87), Month: April - June 2017, Available at: www.researchpublish.com

Trap the Thunder and Lightning

Dronadula Borraiah

Abstract: **During the past decade there has been a considerable amount of information written about lightning and lightning safety. There has, however, been a void of K-12 educational textbooks and supplemental teaching materials on the acoustics (sound) produced by lightning, called thunder. Everyone has heard thunder and understands a little about it, but few know any specifics beyond the basics. This paper is primarily written for science students, teachers, and other interested individuals to provide a resource to enhance their knowledge about the origin of thunder.**

Keywords: **Trap the Thunder and Lightning.**

1. INTRODUCTION

Thunder is the audible pressure (compression) wave produced by lightning. Nearly all lightning is generated by thunderstorms. However, lighting has also been observed during snowstorms, in columns of billowing smoke from forest fires, in erupting volcanic debris clouds, near fireballs created by nuclear explosions, and on some planets and moons in our solar system. Lightning is a giant static electrical spark. Where there's lightning, there's thunder, and vice versa.

It was not until the turn of the 20th century that consensus was reached in the scientific community about the origin of thunder. Thunder is the sound generated by lightning produced by a sudden and violent expansion of super-heated air in and along the electrical discharge channel path. Thunder can be a sharp or rumbling sound. The intensity and type of sound depends upon atmospheric conditions and distance between lightning and the listener. The closer the lightning, the louder the thunder.

2. CONCEPT

100 % of (thunder and lightning) tapping is not impossible, So we use this project 25 % of (thunder and lightning) trapping is possible. And elements are available in periodic table.

Cu is lighting Absorber.

W is lighting capture.

1A group (alkali-metals) is lighting storage. (Max. battery conditions).

MY PROJECT IN ONE LINE: The lighting energy is converted into current, that current is used for peoples, so this is a people’s project.

This project successful condition, very useful for current, this generation and next generation.

My project Question: See the Indian map,30 % of water is available in earth,next generation 15% and next generation 0% of water is available in earth. So that type of situation how to produce current, i am asking? That type of situation (thunder and lightning) project is very helpful.

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3. DISCRIPTON

Thunder is highly power, but trapping the thunder with help of anti-lighting instrument (ALI), Thunder energy is converted into current, that current is used to peoples, So this is the peoples project, this project is very useful for this generation and next generation peoples, Coming to point, thunder is highly power we can't touch and we can't see the thunder, so thunder is highly power then compared with sun also.

NOTE: THUNDER IS 100% POWER

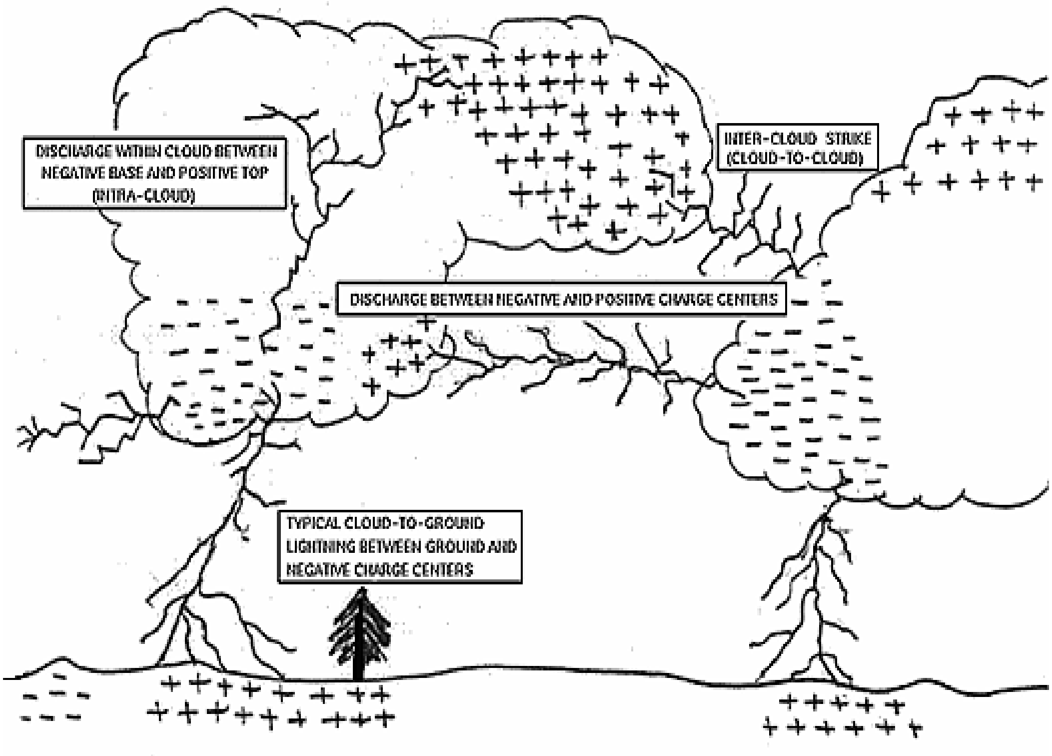
100% thunder we can't trap, because no instruments are available in earth, but minimum 25%(or) 30% power is trapping in thunder it is available for periodic elements, Thunder power is maximum 70,000 F (39,000 C) in few milliseconds, Above value divided ¼ 17500 F(9750 C), This is the value of ¼ thunder:17500 F(9750 C) So we will trapping 25% thunder instrument, that is anti-lighting instrument (ALI) ALI instrument Create only for periodic elements.

EX: tungsten, because this element high power capture solid element and strong element, Tungsten 100% power is 6192 F(3422 C).

Then finally we will create the (ALI); and check the (ALI) It`s works or not It is OK for trapping the lighting (thunder).

DESCRIPTION OF LIGHTNING DISCHARGE PROCESSES:

With the initial breakdown of the air in a region of strong electric fields, a streamer may begin to propagate downward toward the Earth. It moves in discrete steps of about 50 meters each and is called a stepped leader. As it grows, it creates an ionized path depositing charge along the channel, and as the stepped leader nears the Earth, a large potential difference is generated between the end of the leader and the Earth. Typically, a streamer is launched from the Earth and intercepts the descending stepped leader just before it reaches the ground. Once a connecting path is achieved, a return stroke flies up the already ionized path at close to the speed of light. This return stroke releases tremendous energy, bright light and thunder. Occasionally, where a thunderstorm grows over a tall Earth grounded object, such as a radio antenna, an upward leader may propagate from the object toward the cloud. This "ground-to-cloud" flash generally transfers a net positive charge to Earth and is characterized by upward pointing branches.



The lower part of a thundercloud is usually negatively charged. The upward area is usually positively charged. Lightning from the negatively charged area of the cloud generally carries a negative charge to Earth and is called a negative flash. A discharge from a positively-charged area to Earth produces a positive flash.

The initial breakdown and propagation are similar for intra-cloud lightning, but the discharge generally occurs between regions of opposite charge. Without the benefit of air conducting Earth, intra-cloud lightning does not produce a return-stroke-like feature. Rather, it is characterized by slower propagating "recoil streamers" and "K" changes. Nevertheless, tremendous energy, bright light, and thunder are still produced by intra-cloud lightning.

LIGHTNING:

As the ice particles within a cloud (called hydrometeors) grow and interact, they collide, fracture and break apart. It is thought that the smaller particles tend to acquire positive charge, while the larger particles acquire more negative charge. These particles tend to separate under the influences of updrafts and gravity until the upper portion of the cloud acquires a net positive charge and the lower portion of the cloud becomes negatively charged. This separation of charge produces enormous electrical potential both within the cloud and between the cloud and ground. This can amount to millions of volts, and eventually the electrical resistance in the air breaks down and a flash begins. Lightning, then, is an electrical discharge between positive and negative regions of a thunderstorm.

A lightning flash is composed of a series of strokes with an average of about four. The length and duration of each lightning stroke vary, but typically average about 30 microseconds. (The average peak power per stroke is about 10^{12} watts.)

THUNDER:

Sound is generated along the length of the lightning channel as the atmosphere is heated by the electrical discharge to the order of 20,000 degrees C (3 times the temperature of the surface of the sun). This compresses the surrounding clear air producing a shock wave, which then decays to an acoustic wave as it propagates away from the lightning channel.

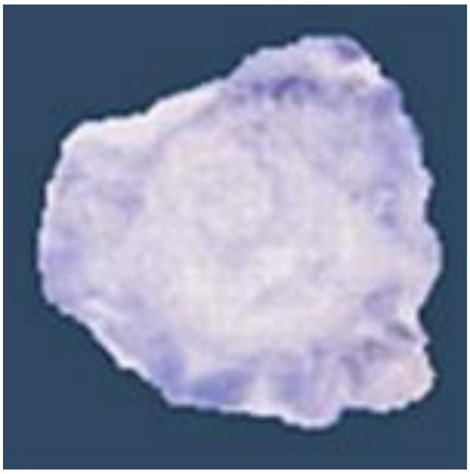
Although the flash and resulting thunder occur at essentially the same time, light travels at 186,000 miles in a second, almost a million times the speed of sound. Sound travels at the relatively snail pace of one-fifth of a mile in the same time. Thus the flash, if not obscured by clouds, is seen before the thunder is heard. By counting the seconds between the flash and the thunder and dividing by 5, an estimate of the distance to the strike (in miles) can be made.

CLOUDS AND RAIN:

When moisture-laden warm air is heated, it begins to rise. As these currents or bubbles of warm moist air rise higher in the atmosphere, both the surrounding air pressure and temperature decrease. The air bubbles expand, causing cooling of the moisture which eventually condenses to form clouds. As the cloud cools further, more moisture condenses and the water droplets making up the cloud grow and merge until some become so large and heavy that the air currents within the cloud can no longer support them. These water droplets begin to fall as rain.

HAIL:

Air currents in cumulonimbus clouds can be very violent. Even when lightning is not produced, pellets of ice may grow by the accumulation of liquid droplets. When the updrafts are very strong, the growing ice pellets can be suspended for long periods, allowing them to grow larger. Eventually some may become too large for a given updraft and begin to fall as hail. Diameters are typically 5 to 10 mm, although a l40 mm hailstone has been recorded.



4. TYPES

Lighting originates when wind updrafts and downdrafts take place in the atmosphere, creating a charging mechanism that separates electric charges in clouds – leaving negative charges at the bottom and positive charges at the top. As the charge at the bottom of the cloud keeps growing, the potential difference between cloud and ground, which is positively charged, grows as well.

When a breakdown at the bottom of the cloud creates a pocket of positive charge, an electrostatic discharge channel forms and begins traveling downwards in steps tens of meters in length. In the case of IC or CC lightning, this channel is then drawn to other pockets of positive charges regions. In the case of CG strikes, the stepped leader is attracted to the positively charged ground.

Many factors affect the frequency, distribution, strength and physical properties of a "typical" lightning flash in a particular region of the world. These include ground elevation, latitude, prevailing wind currents, relative humidity, proximity to warm and cold bodies of water, etc. To a certain degree, the ratio between IC, CC and CG lightning may also vary by season in middle latitudes. Types of Lightning Discharges

THE MOST COMMON TYPES OF LIGHTNING

Cloud-to-ground lightning is the most damaging and dangerous form of lightning. Although not the most common type, it is the one which is best understood. Most flashes originate near the lower-negative charge center and deliver negative charge to Earth. However, an appreciable minority of flashes carry positive charge to Earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually the process takes place within the cloud and looks from the outside of the cloud like a diffuse brightening which flickers. However, the flash may exit the boundary of the cloud and a bright channel, similar to a cloud-to-ground flash, can be visible for many miles.

The ratio of cloud-to-ground and intra-cloud lightning can vary significantly from storm to storm. Storms with the greatest vertical development may produce intra-cloud lightning almost exclusively. Some suggest that the variations are latitude-dependent, with a greater percentage of cloud-to-ground strikes occurring at higher latitudes. Others suggest that cloud-top height is a more important variable than latitude.

Details of why a discharge stays within a cloud or comes to ground are not understood. Perhaps a flash propagates toward the Earth when the electric field gradient in the lower regions of the cloud is stronger in the downward direction.

Depending upon cloud height above ground and changes in electric field strength between cloud and Earth, the discharge stays within the cloud or makes direct contact with the Earth. If the field strength is highest in the lower regions of the cloud a downward flash may occur from cloud to Earth.

Inter-cloud lightning, as the name implies, occurs between charge centers in two different clouds with the discharge bridging a gap of clear air between them.

5. PROCEDURE

Early Theories:

Early man probably considered lightning to be the ultimate weapon or a weapon of their gods. The Navajo Native Americans believed the Thunderbird, a mythical bird, flapped its wings and created the sound of thunder and the source of lightning was reflected sunlight from its eyes. It was the Norse god Thor, the Greek god Zeus, and the Roman god Jupiter who wielded the mighty bolt of lightning to keep man in his place. There continues today a phrase about lightning coming from a supernatural or divine power. The phrase goes something like: "Let lightning strike me if I'm

______." The word 'bolt', often used to describe lightning, has no meaning in meteorology and is an inappropriately used term.

Some of the earliest theories about thunder originated during the Greek and Roman Empires and from the Viking (Scandinavian) people. Beliefs about thunder included that it occurred before lightning, it was a burning wind, it was caused by the collision of clouds, the sound was produced by resonance between high and low clouds, and by high clouds descending and colliding onto low clouds. By the mid-19th century, the accepted theory was the vacuum theory, whereby lightning produced a vacuum along its path (channel), and thunder was due to the subsequent motion of air rushing into the vacuum. The second half of the 19th century saw the steam explosion theory, created when water along the lightning channel was heated and exploded by lightning's heat. Another theory was the chemical explosion theory that suggested gaseous materials were created by lightning and then exploded.

Lightning Physics:

For simplicity, there are two types of lightning produced by thunderstorms: lightning that strikes the earth and lightning that does not. Flashes of lightning between a thunderstorm and earth are called cloud-to-ground (CG). Flashes of lightning within a thunderstorm are called intra-cloud (IC). There is roughly five to 10 times more IC than CG flashes.

Research during the last decade confirms the existence of sprites, elves, and blue jets that are unusual momentary flashes that take place far above thunderstorms discharging into the stratosphere. These events and terms were not included in the meteorological vocabulary until recently. Such flashes are not as bright or the same in appearance as discharges observed from thunderstorms. They are faint, extremely fleeting, display different colors, and produce no thunder because they occur in the upper regions of the atmosphere where there is little or no air. For additional information about sprites, jets, and elves go to the following sites

All thunderstorms go through stages of growth, maturity, and dissipation. The life span of a thunderstorm can be as short as 45 minutes or as long as 12 hours. Lightning is initiated by the attraction of positive and negative charges, but air (gases) in our atmosphere acts as an insulator to inhibit the flow of electricity between electrical polarities. When the electrical potential builds up to overcome resistance of the air, lightning will occur.

Nearly 70% of all lightning occurs in the tropical latitude band between 35° north and south latitude. Globally, 85% to 90% of lightning occurs over land because solar radiation heats land faster, causing convection (thunderstorms) to be taller and stronger. Some intense thunderstorms over land have been known to tower over 70,000 feet (21,000 m). There are 50-75 flashes to ground occurring every second on earth. In the U.S., there are over 125 million flashes of lightning annually; an estimated 25 million strike ground. The lightning capital in the U.S. is in Florida, centered between the cities of Tampa and Orlando.

The vertical extent of a CG lightning channel averages 3-4 miles (5-6.5 km) with a maximum height of about 6 miles (9.6 km). Most CG flashes originate in thunderstorms between 15,000-25,000 feet (4,500-7,600 m) above ground level in the mixed water and ice region. The record horizontal distance of a cloud flash is 118 miles (190 km) that occurred in the Dallas-Ft. Worth area.

Most lightning in the continental U.S. occurs in the eastern three quarters of the country. The Pacific Coast states in the U.S. have the least amount of lightning. Lightning is typically associated with the warm season, but has occurred in winter during heavy snowfalls. A man was struck by lightning during a blizzard in Minneapolis, Minnesota in March and another man in Vail, Colorado in April 1996. In February 2002, a 15-year-old boy was struck by lightning while sledding. Two men, one from Maine and the other from Chicago, were struck by lightning during a snowstorm in the winter of 2004-2005.

During a cloud-to-ground flash, the first stroke of lightning is downward from the cloud along the channel. A flash consists of one or more return strokes. A CG flash may have only one return stroke, but usually has more (two to three). They are called returned strokes because the flash originates in the cloud, not at the ground. The flash and strokes lower charge to ground. Then objects on the ground send up streamers to meet the leader coming down. The electrical discharge travels upward at one-third the speed of light (62,000 miles per second or 94,000 km/second). It is routinely followed by two to three downward return strokes to ground. This is why you see lightning flicker during a CG flash.

A record number of return strokes occurred at Cape Canaveral, Florida when 26 return flashes were recorded. Research has revealed that during a CG lightning flash, the initial stroke does not produce as loud or as long a thunder as subsequent return strokes.

Thunder Definitions:

The sounds produced by thunder have been categorized into recognizable terms. Claps are sudden loud sounds lasting 0.2 to 2 seconds. Peals are sounds changing frequency or amplitude. Rolls are irregular sound variances. Rumbles are of long duration but relatively low in frequency. Close-in lightning has been described first as a clicking or cloth-tearing sound, then a cannon shot sound or loud crack/snap, followed by continuous rumbling.

Malan (1963) described these in more technical terms: the click is the upward streamer(s) and the crack is the rumble originating from the upper regions of the channel. A typical thunder episode consists of a rumble and a roll, on which three to four peals or claps are superimposed.

The step leader comes from the cloud toward the ground. Then the return stroke is later. Of course, on the ground, we hear the closet part first, which are the upward streamers, then the step leader, which is farther away but occurred first. People who fear the sound of thunder suffer from a phobia called brontophobia and the fear of lightning is called keraunophobia.

Science of Thunder:

Lightning has a diameter of 1-2 inches (2-5 cm) and can heat air to 70,000° F (39,000° C) in a few milliseconds. Ninety percent of the electrical energy of lightning is released in the form of heat, which is quickly dissipated into the atmosphere. Less than 1% of lightning's energy is converted into sound and the rest released in the form of light. A sudden increase in pressure and temperature causes surrounding air to expand violently at a rate faster than the speed of sound, similar to a sonic boom. The shock wave extends outward for the first 30 feet (10 m), after which it becomes an ordinary sound wave called thunder. The speed of sound through air at sea level is 758 mph (1,130 feet/second; 344 m/second) at 68° F (20° C). Thunder is exploding air occurring along the entire length of the lightning channel. An average thunderstorm produces thousands of mi/km of lightning channel during its lifetime.

Sound velocity is proportional to the square root of temperature. Temperature typically decreases with height, unless there is an inversion (warm air over cooler air). Thus, the sound of thunder will be deflected upward. Humidity, wind velocity, wind shear, temperature inversions, terrain features, and clouds, also influence thunder's audibility. The loudness of thunder can be expressed in decibels (dB). A clap of thunder typically registers at about 120 dB in close proximity to the ground stroke. This is 10 times louder than a garbage truck or pneumatic jackhammer drill. By comparison, sitting in front of speakers at a rock concert can expose you to a continuous 120+ dB level. Thunder in close proximity is capable of producing temporary deafness and may cause rupturing of the ear's tympanic membrane that can lead to hearing damage or deafness.

At very close range, thunder is capable of causing property damage. The shock wave, pressure, and propagation of thunder may cause exterior and interior damage to structures. Popping of nail-supported drywall away from horizontal and vertical wooden studs inside houses has been documented. Glass windows have been broken by the concussion of thunder.

Thunder contains a somewhat cylindrical initial pressure shock wave along the lightning channel in excess of 10 times the normal atmospheric pressure. This shock wave decays rapidly into a sound wave within feet or meters. When thunder is heard from about 328 feet (100 m) distance, it consists of one large bang, yet hissing and clicking may be heard just prior to the bang (upward streamers). When heard at .6 mile (1 km) from lightning, thunder will rumble with several loud claps.

Thunder is seldom heard beyond 10 miles (16 km) under ideal conditions. The sound of distant thunder has a characteristic low-pitched rumbling sound. Pitch, the degree of highness or lowness of a sound, is due to strong absorption and scattering of high-frequency components of the original sound waves, while the rumbling results from the fact that sound waves are emitted from different locations along the lightning channel, which lie at varying distances from a person. The longer the lightning channels, the longer the sound of thunder. Humans hear frequencies of thunder between 20-120 Hertz (Hz). However, there is a small amount, less than 10%, that is inaudible to humans produced from lightning, called infrasonic. Special listening devices are required to record these inaudible sounds.

Thunder and Lightning Facts:

Lightning is the number two thunderstorm-related killer in the U.S. On average, it kills more people each year than do tornadoes and hurricanes. A hundred years ago, lightning probably was the leading thunderstorm-related killer. At that time, the U.S. economy was predominantly agricultural and labor intensive. The majority of people worked outside, exposing them frequently to the threat of lightning compared to today. In addition, housing was much less substantial, lacking the plumbing and wiring that we have today that acts more or less like a Faraday cage to channel lightning around and away from the inhabitants. It was not unusual for a structure to literally blow apart when hit by lightning, often crushing the inhabitants.

Lightning and its subsequent thunder can be used in lightning safety to protect yourself and others. The flash-to-bang method of protection considers the time between seeing lightning to hearing its thunder. Light from lightning travels at the speed of 186,000 miles per second (300,000 km/second), arriving at the observer in about 10 microseconds when the strike point is 1.85 miles (3 km) away. The sound wave, at an air temperature of 68° F (20° C) and atmospheric pressure of 29.92 in of mercury or 1,013.25 millibars, arrives more slowly in about 10 seconds. Figure 1 shows how a time interval from flash-to-bang of 5 seconds = 1 mile (1.6 km) can be approximated.

The Lightning Safety Group (LSG), an interdisciplinary group of the nation's lightning experts, met at the 1998 American Meteorological Society Annual Meeting. New lightning data showed that most CG flashes in a storm were within 5-6 miles (8-9.6 km) of the previous flash. The LSG recommended what has become known as the 30/30 Rule. Using the flash-to-bang method, lightning that has a 30-second count between the flash and the thunder is 6 miles (9.6 km) away. This translates into 5 seconds per mile (1.6 km). It is possible that the next flash of CG lightning may occur at your location.The LSG also suggests waiting 30 minutes after hearing the last sound of thunder or seeing the last lightning in daytime before returning to any outside activity. This allows the thunderstorm to move out of the area, greatly reducing the lightning threat level. The average lightning flash distance between two flashes averages about 2-3 mikes (3-5 km), but 6 miles (9.6 km) accounts for about 80% of subsequent CGs. The LSG strongly recommends proactive action rather than a reactive approach to lightning safety.

This means knowing the weather prediction and pre-planning for a scene evacuation that includes knowing a safer place to go and the time needed to reach it. Statistics have shown the majority of people who are struck by lightning are struck before or after a thunderstorm, not during the heaviest rain.

A few short rhymes or slogans to remember for lightning safety are as follows: "If you see it, flee it."

"If you hear it, clear it."

"When lightning roars, go indoors." "Lightning kills; play it safe."

A lightning flash has brightness, infrared and ultraviolet radiation that can temporarily blind a person or seriously damage vision. Lightning injury and death predominantly occurs outside, often during recreational activities. Lightning injuries often last a lifetime.

In 2000, the National Weather Service, in association with corporate and private sponsors, established Lightning Safety Awareness Week (LSAW). This annual event takes place during the last full week in June. The goal of the LSAW is to reduce injury and death from lightning by promoting awareness and education. Medical information, lightning safety, and support groups for strike victims can be obtained from the following web sites, in addition to this one.

Unusual Events:

During the later half of the 19th century, H.F. Kretzer collected thunderstorm newspaper articles. Terminology used to describe lightning and thunder was different than that used today. Instead of using the word thunder, it was described as an unusual acoustical or deadening report, or an acoustical bombardment. Lightning was described as an electrical bombardment or accompaniment, or an electrical pyrotechnic or peculiar pyrotechnic display.

During an 11-hour period on July 17-18, 2003, in a 15-mile (24-km) radius centered in Merrillville, Indiana, there were 10,428 CG flashes. Since the majority (between 50%-90%) of all lightning flashes are IC flashes that do not strike the ground, taking a rate of 10 cloud flashes per CG flashes, this storm had an estimated 104,280 flashes, which corresponds to 158 flashes per min or 2.6 flashes per sec.

For centuries there have been documented records from reliable individuals reporting unusual behavior (anxiety, restlessness, and irritability) associated with some pets and livestock prior to thunderstorm activity. This behavior has been observed in animals for as much as an hour or more before the first sound of thunder is heard in the distance. It is speculated that some animals are reacting to hearing long-wave sound energy below the 20-Hz level from an approaching thunderstorm.

Tungsten 100% power is 6192 F(3422 C):

Tungsten , also known as **wolfram**, is a chemical element with symbol **W** and atomic number 74. The word *tungsten* comes from the Swedish language *tung sten*, which directly translates

to *heavy stone* Its name in Swedish is *volfram*, however, in order to distinguish it from scheelite, which is alternatively named *tungsten* in Swedish.

Tungsten W

6. ADVANTAGES AND DISADVANTAGES

The seeds and the pollen , and they help remove the old and weak vegetation and so they make way for new growth , The lightning strikes liberate nitrates that fertilize the soil , The lightning produces about 20 percent You should know that the thunderstorms are small , intense weather systems that make strong winds , heavy rain , lightning , and thunder , They serve to cool the earth , They create rainfall and remove the pollution from the air , They are a direct result of the atmospheric heating and the increased air convection .

It is very important to know that the thunderstorms provide the water to the vegetation and also to the lakes and the reservoirs , They can happen anywhere with two conditions which are the air near the Earth's surface must be warm and moist (with lots of liquid) , and the atmosphere must be unstable . You have to know that the storm winds distribute of the nitrogen to the soil per year .

You should know that the updrafts and other wind effects remove large amounts of pollution , transporting it aloft , The storm rainfall washes the pollution out of the air , The thunderstorms are very active electrically , And the Lightning is an electrical discharge which happens between two opposite charged surfaces .The thunderstorms

It is very important to know that when the lightning strikes , The energy is let out which moves to the air and makes the air spread quickly and send out the sound waves , The thunder is the sound that comes from the rapid spread of air along the lightning strike , The thunder is slower than the lightning because the light is faster than the sound .

You have to know that although the thunderstorms are dangerous , They are also a great blessing , They can be a great help to man and all living creatures , We get lots of water for many continents during the summer , The rain from the thunderstorms washes away many of these pollutants out of the air .

You have to know that without the thunderstorms , many continents would become dry , The fish would die , The crops would fail , and the animals would die , They helps our earth maintain its electrical balance because the lightning helps transfer the negative charges back to the earth .

It is very important to know that the lightning helps fertilize the soil , The heat and the pressure from the lightning turns nitrogen and other gases in the air into useful compounds that are a natural fertilizer which help the plants make vital proteins , And it produces the ozone that is a vital gas in our atmosphere.

7. CONCLUSION

Theories about the cause of thunder date back thousands of years. It wasn't until the turn of the 20th century that the origin of thunder was properly identified and accepted. Thunder is produced by the explosive expansion of heated air surrounding a lightning channel. Thunder can be heard from a maximum distance of about 10 miles (16 km) under good atmospheric conditions. When lightning strikes close, thunder has a loud clap or snapping sound. The rumbling we hear is the sound of thunder reaching us at different times from the sound produced along its length. People have experienced injury and property damage from the sound of thunder at close range.

If outdoor activity is planned for the day, check your local weather forecast for the possibility of thunderstorms. Become proactive about safety, instead of reactive. The sound of thunder can be a wake up call for lightning safety. Practice the 30/30 Rule and visit the lightning safety web sites for additional information. If you see lightning and hear thunder in 30 seconds or less, the threat is imminent and the next strike may be at your location. Take safety measures immediately. Outdoor activities should not be resumed until 30 minutes after the last thunder is heard or lightning seen.

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