

MORE SCIENCE FOR SENIORS



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Why add *Science for Seniors* to your activity calendar?

- Use it or lose it is not just a saying – it’s a proven scientific fact! Science for Seniors is a fun, easy, safe and inexpensive way to add knowledge and enjoyment to our lives at every age and cognitive level.
- Here’s proof:
- Dr. Clive A. Wilson, author of “No One Is Too Old to Learn: Neuroandragogy: A Theoretical Perspective on Adult Brain Functions and Adult Learning”, found adults can sharpen their minds and learn new concepts throughout life. He believes we may even grow new brain cells through lifelong learning. Wilson argues lifelong learning may delay Alzheimer’s disease.
- The *Journal JAMA Neurology* reported in 2014, “People can gain protection against late-life dementia if they adopt a mentally stimulating lifestyle. Study lead author Prashanthi Vemuri, an assistant professor of radiology at the Mayo Clinic and Foundation in Rochester, Minn., said, "Exposure to a lot of intellectual stimulation during non-leisure activity, intellectual leisure activity later in life can really help."
- Johns Hopkins School of Education study found that research supports the notion of lifelong learning. While no one can stop the aging process, there are some things that have been associated with increased retention of mental processes: education and otherwise stimulating activities to the brain have been shown to help the cognitive process. While older adults are not as quick to learn as are younger people, they can often make up for this through a wealth of experiences that tend to support superior reasoning and judgment abilities if given time to think and reflect on the learning activity.
- *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry* in a 2012 study found participating in education activities helped older adults increase their overall level of activity and improve memory functioning over time. However, both activity level and memory became worse over the same three-year period for the control subjects who did not attend educational activities. There were significant differences between the two groups for social and productive activities and emotional balance. Those attending educational activities also did better on tests of information-seeking and general health awareness. These results stayed consistent even when the researchers controlled for education and age.

CONTENTS

Introduction	7
Dedication	7
Light.....	8
Why is the Sky Blue?	8
Experiment: Why Does a Straw Appear Broken Through a Glass Filled with Water?	8
What is a Rainbow?	9
Experiment: How Can You Create a Rainbow?	10
What is a Shadow?.....	10
Experiment: How Do Shadows Form?	10
What are The Northern Lights?	11
Experiment: How Do Mirrors Reflect light?	11
Why Do Items Glow in the Dark?.....	12
Experiment: How Does a Black Light Demonstrate UV light?.....	12
Experiment: Why Do Some Items Glow in the Dark?	12
Why Do Plants Appear Green?	13
Experiment: How Do Plant Leaves Turn Green?.....	14
Light Trivia.....	14
Experiment Log	15
Sound	16
What is Sound?	16
Experiment: How Can You Feel Sound?.....	17
Experiment: How Can You See Sound?.....	17
Why Do Animals Hear Better Than Humans?	17
Experiment: Can You Hear a Dog Whistle?.....	18
Experiment: How Can You Amplify Sound with a Balloon?	19
What is Music?.....	19
Experiment: How Does a Tuning Fork Work?	20
Experiment: Why Does Water Level Change the Sound of a Struck Glass?	21
Why do People Enjoy Music?.....	21
Experiment: Is Music a Universal Language?.....	23
How Do Drums Make Sound?	23
Experiment: Does the Height from Which a Marble is Dropped on a Drum Head Change the Sound?	24
Experiment: Why Does the Sound of a Drum Change Based on How it is Struck?	24

Sound Trivia	24
Experiment Log	25
Weather	26
What is Weather?	26
Experiment: How Can You Bake Cookies with Solar Energy?	27
Experiment: How Can You Demonstrate Chaos Theory?	27
What is Rain?	27
Experiment: How Can You Demonstrate Rain Clouds?	29
Experiment: Why Does a Rain Drop Splash Upwards on Water?	29
Experiment: How Does a Few Inches of Rain Create a Flood?	29
What is Snow?.....	29
Experiment: How Much Water/Air is in Snow?	30
Experiment: Why is Every Snowflake Different?	31
What is an Icicle?	31
Experiment: How Do Icicles Form?	32
What is Frost?	33
Experiment: How Does Frost Form?	33
Weather Trivia	34
Experiment Log	35
Nature	36
What is a Desert?.....	36
Experiment: How Does the Waxy Skin of a Desert Plant Save Water?	37
Experiment: How Do Desert Plants Store Water?	38
Experiment: How Do Small Pores Help Plants Save Water?.....	38
What is the Difference Between a Marsh, a Swamp, a Bog and a Fen?.....	38
Experiment: How Much Air is in a Marshmallow?.....	39
What is the Difference Between a Forest, a Jungle and a Rainforest?.....	40
Experiment: How Does Quicksand Work?	42
Experiment: How Do Trees Create Oxygen?.....	42
Experiment: How Do Trees Create Fresh Water?	42
How Do Continents Form?.....	43
Experiment: How Do Rocks Become Sand?	44
Experiment: Can a Rock Float?	44
Experiment: How Does Movement of the Planet’s Crust Create an Earthquake?	44

Experiment: Why does Wet Sand Stick Together and Dry Sand Fall Apart?	45
Where Does Fresh Water Come From?	45
Experiment: How Does the Water in Oceans, Rivers and Lakes Recycle?	46
How Did the Grand Canyon Form?	46
Experiment: How Does Erosion Change the Land?.....	47
What is a Geyser?	48
Experiment: How Can You Demonstrate a Geyser?	49
What is the Earth’s Magnetic Field?	49
Experiment: How Can You Make a Compass?	50
Why is North Up?.....	50
Experiment: How Far Can You See at the Horizon?.....	52
Experiment Log	54
Space	55
Is There Life in Space?.....	55
Experiment: How Can You Demonstrate the Ice Volcanoes on Europa?	56
What is the Big Bang Theory?	57
Experiment: How Can You Demonstrate How the Universe Began?	58
Who Created Time?	58
Experiment: How Does a Pendulum Work?.....	59
How Do You Nativigate By the Stars?	60
Experiment: How Can You Find the North Star With a Star Chart?.....	60
What is the Difference Between a Comet, Meteor and An Asteriod?	61
Experiment: How Did Comets Bring Water to the Earth?	62
Experiment: How Did a Meteorite from Mars Land on Earth?.....	62
What Powers Space Ships?	63
Experiment: How Does Energy Drive a Space Ship through Space?	64
Experiment: How Do Satellites Stay in Orbit Around the Earth?.....	65
How Much of Science Fiction is Real Science?.....	65
Experiment: What Would Happen if a large Asteroid hit the Earth’s Oceans?	66
Space Trivia	66
Experiment Log	67
Life On Earth	68
How Does a Heart Beat?	68
Experiment: How Does a Human Heart Pump Blood?	68

What’s in the Air?	68
Experiment: Are Seeds alive?.....	70
How Do Plants Crack the Sidewalk?.....	70
Experiment: How Can You Show the Strength of Soybean Plants?.....	71
Why Do Plants Need Water?	72
Experiment: How Does Water Benefit Plants?	72
Why Do Bees Matter?	73
Experiment: How Do Bees Find Their Hive?	74
Experiment: How Can You Help Save Bees?	75
How Do Butterflies Migrate?	75
Experiment: How Do Butterflies Fly?.....	76
Experiment: How Do Butterflies See Flowers?	77
Experiment: How Do You Make a Butterfly Feeder?.....	77
The Truth About Sharks	77
Experiment: How Do Sharks Stay Afloat?	78
Life on Earth Trivia	79
Experiment Log	80
Holidays.....	81
Why Do We Celebrate the New Year with a Ball Drop?	81
Experiment: How Can You Make a Bouncing Ball?	82
Earth Day Celebration	82
Experiment: How Can You Show How Pollution Enters the Water Source?	83
Why Do the Dates of Passover and Easter Change Each Year?	83
Experiment: How Can You Use Natural Colors to Dye Easter Eggs?.....	84
Why Do We Enjoy Being Scared?.....	84
Experiment: How Can You Recreate “Thing”?	86
Was Frankenstein Real?.....	86
Experiment: How Can You Re-create the Blob from the Movie?	87
Who Discovered Fingerprints?.....	87
Experiment: How Do You Dust for Fingerprints?.....	88
What Was the Christmas Star?	89
Experiment: How Can You Create a Wooden Image of the Bethlehem Star?	90
Holiday Trivia.....	90
Experiment Log	92

Ecology	93
How Can You Cook Up an Environmental Solution to Plastic?	93
Experiment: How Can You Make Plastic from Milk?	93
What is Happening to the Birds?	94
Experiment: How Do You Make a Bird Feeder from a Milk Carton?	95
Experiment: How Do You Make a Bird Feeder with a Pine Cone?.....	96
How Do CFL Blubs Save Energy?	96
Experiment: How Does Static Electricity Light up a CLF bulb?.....	98
What Is in the Air We Breath?	98
Experiment: How Much Pollution is in the Air You Breath?.....	98
Ecology Trivia	99
Experiment Log	101
References	101
Resources.....	106
More Activity Resources by Gloria Hoffner	107

How to Use This Book

- *Science for Seniors* can be used as a monthly program in which residents choose a topic for a one hour program. Record and discuss results.
- *Science for Seniors* can be used in conjunction with current events discussions such as the launch of a new satellite paired with a space program activity and experiment.
- *Science for Seniors* can enhance holiday fun with learning the history and the science in festive events, such as the traditions of New Year’s Eve.
- *Science for Seniors* can be used as a one-on-one activity and/or for short term rehab residents in their room who will enjoy the fun facts, doing a safe, easy experiment in their room and keeping a log of the results.
- *Science for Seniors* can be used as an inter-generational program with visiting students and/or grandchildren taking part in the educational theme and experiment.

INTRODUCTION

In October 2007 I had an idea to create an activity program for the 50th anniversary of Sputnik. I had no way of knowing where the success of that program at Sterling Healthcare and Rehabilitation Center in Media, Pennsylvania approved by Nancy Newman, activity director, would lead.

It lead to *Science for Seniors*, a nationally registered trademarked company providing real evidence based hands on programs for residents in independent, assisted living, personal care, long term care, memory care and adult day care centers. *Science for Seniors* won first place in the National Certification Council of Activity Professionals Best Practice Award. It became a monthly column in Creative Forecasting Magazine; an on-line NCCAP certified course at raronline.org; activity booklets for in-home activity providers through ROS Therapy Systems and lead to my presenting *Science for Seniors* training sessions at local, state, national and international activity, CTRS and health professionals' conventions.

In 2012, my book, *Science for Seniors* published by Idyll Arbor Inc., won a National Mature Media Merit Award. This collection of science topics, trivia and experiments is a supplement to *Science for Seniors* the book. I hope it brings fun and learning to you and your residents.

I **LOVE** to hear from people using *Science for Seniors*. Please contact me at: Guitarwithgloria@yahoo.com. Visit my websites: Guitarwithgloria.com and Scienceforseniors.net.

Dedication

To my amazing family, co-workers and friends

– ***Thank you!***

LIGHT

WHY IS THE SKY BLUE?

Light as a visible spectrum, meaning the part of the electromagnetic spectrum that the human eye can see, is all around us. But why is the sky blue?

That age old question was answered in part by Isaac Newton. He observed that a thin beam of sunlight hitting a glass prism on an angle creates a band of visible colors that includes red, orange, yellow, green, blue, indigo and violet. This happened because different colors travel through the glass at different speeds, causing them to refract at different angles and separate from each other.

Lord John Rayleigh, an English physicist, discovered that when light hits a gas molecule, some of the light may be absorbed. Different colors of light are affected differently. All of the colors can be absorbed, but the higher frequencies, such as blue, are absorbed more often than the lower frequencies, such as red. This process is called Rayleigh scattering.

As sunlight moves through the Earth's atmosphere, most of the longer wavelengths pass straight through. Little of the red, orange and yellow light is affected by the air. However, much of the shorter wavelength blue light is absorbed by the gas molecules. The absorbed blue light is then radiated in different directions making the sky look blue.

Why is the sky red at sunset? This is because at sunset, light must travel farther through the atmosphere before it is seen by your eye so more of it is reflected and scattered and the sun appears dimmer. The color of the sun itself appears to change, first to orange and then to red because even more of the short wavelength blues and greens are now scattered and only the longer wavelengths, the reds and oranges are seen.

Experiment: Why Does a Straw Appear Broken Through a Glass Filled with Water?

Materials: Clear 8 ounce glass, straw and water.

Process: Fill the glass with water. Place the straw in the water. Observe what happens.

Result: Light changes speed due to the density of the object it strikes. Air molecules are spread far apart down but the molecules in glass, a solid, are closely packed, slowing light. Water is less-dense than glass, but more dense than air.

As a beam of light moves from thin air into dense glass, it slows and bends a little. It bends again when it speeds out of glass and into the water until it hits the straw and we observe refraction. Refraction is the term for bending of light.

WHAT IS A RAINBOW?

A rainbow begins as a million tiny rain droplets. When white light from the sun enters the rain drop at a specific angle rain drop separates the white light into many different colors. This angle is a fixed measurement between your eye and the Sun.

Which color is refracted and seen by your eye depends on the angle at which the sunlight hits the back of the raindrop. Red light bends at a 42 degree angle and violet light at a 40 degree angle, with the rest of the colors coming in between. The colors change as the angle changes as the rain drops fall but the order of the rainbow colors is always red, orange, yellow, green, blue, indigo and violet.

Rainbows appear as an arch in the sky, but in truth they are a circle. The Earth's horizon prevents us from seeing the full circle, so we only see about half, thus the arch. Sometimes you can form a full circle rainbow by using a garden hose and causing a spray of water drops in the air.

The best way to see a rainbow is bright sunlight to your back and rain clouds in the direction of your shadow. You can also see rainbows as a result of water mists from waterfalls, the ocean and even a lawn sprinkler.

Have you ever wondered what causes a rainbow to appear on an oil slick in a parking lot? Here's why. If the ground is wet, the oil spreads on top so very thin that the oil's thickness reaches the wavelength of visible light. When this happens, the oil/water mix allows you to see color.

This only works when you view the oil slick from an angle because the angle affects the distance the color has to travel from the puddle to be reflected towards your eyes. If you see it from different distances, the colors will change.

You can also see a rainbow of colors in a soap bubble. When light hits the surface of the bubble part of the light is reflected back from the outer surface and part from the inner surface. As the two waves of light travel towards your eye they interfere with each other and the result is a mix of color.

If the light waves get too close together you see almost no color and when waves reinforce each other the color is more intense. When the bubble wall gets

thinner as gravity pulls the chemical content to the bottom the two wavelengths cancel each other and the bubble becomes nearly invisible.

Many Americans are familiar with the Irish tradition that a pot of gold awaits at the end of the rainbow, but this is not the only country where rainbows and superstition mix.

In the United Kingdom children were taught to drive away rainbows by making a cross on the ground with two sticks. This may stem from a Norse legend that believed rainbows carried the souls of the dead. In Austrian legends, the souls of children walk a rainbow bridge to heaven.

Experiment: How Can You Create a Rainbow?

Materials: Flashlight, clear plastic cup, water.

Process: Darken a room, turn on the flashlight, place the cup on top of the light and add water to the cup.

Result: A rainbow will be reflected on the ceiling. This happens because the water creates a prism which splits the light into different colors.

WHAT IS A SHADOW?

A shadow is formed when an opaque object, such as a person walking outside on a sunny day, blocks the travel of light on a second object, such as the sidewalk. Light travels in straight lines and any barrier along its path averts the rays striking the barrier. This forms a region of darkness, shaped like the surface of the object obstructing the light, in this example, the shape of a person.

A shadow takes up all the space behind the object with light before it. Its cross-section is a two-dimensional outline of the obstructing object.

When there are multiple sources of light, multiple shadows can occur. They can have darker overlapping sections or mixed colors. Shadows converge at the site of touch, such as an individual touching a surface, the floor, or pole on the surface.

Experiment: How Do Shadows Form?

Materials: Darkened room, flashlight and two volunteers who can stand and walk independently

Process: In a darkened room, have one volunteer stand near a blank wall and the other stand about five feet away from the wall, in front but to the side of the first volunteer. Now shine the flashlight on both volunteer. Ask the experiment

participants which in the larger shadow? Have the volunteers change positions and move closer and further from the wall.

Result: A shadow larger if the object blocking the light is closer. The shadow is smaller if the object is further away. When the light source is wide, the shadow will appear blurred.

WHAT ARE THE NORTHERN LIGHTS?

The Northern Lights also called Polar Lights are bright colored lights that dance across the night sky almost like curtains fluttering in a breeze. In truth, they can be seen in both the northern and southern hemispheres, but in the U.S, mostly in the far northern skies. The scientific name for the northern lights is aurora borealis and the southern lights aurora australis.

The lights are the result of solar activity interacting with the Earth's magnetic field. It begins when the sun ejects a cloud of gas. Between two and three days later, the gas hits the magnetic field and generates charged particles that flow along the lines of the magnetic field in the polar areas of Earth. When these particles collide with oxygen and nitrogen atoms in the upper atmosphere the result is auroral light.

The lights can be seen anywhere, but they are most frequent at higher latitudes near the poles. The color is determined by the altitude. Blue violet/reds occur below 60 miles, bright green between 60-150 miles and above 150 miles (240 km) ruby reds appear.

Residents of Alaska may see the lights most nights. The lights are flashing during the day, but invisible to our eyes until the sky is dark. In addition to the common ripple appearance, the lights may also appear as pulsating globs or steady glows.

You can't recreate the northern lights, but you can explain another way humans view light images with this simple experiment.

Experiment: How Do Mirrors Reflect light?

Materials: Aluminum foil.

Process: Place a 12 inch piece of foil; make sure it stays flat without wrinkles, shiny side up on a table directly in front of a resident. Have the resident see their reflection. Now crinkle the foil and spread it out again in front of the same resident.

Result: The resident's reflection will disappear. This happens because light reflects from a surface in straight lines. When the surface of the foil is wrinkled the reflected light bounces in all directions making the image of the resident seem to disappear.

WHY DO ITEMS GLOW IN THE DARK?

We see light all around us every day from the time we open our eyes in the morning until we close them again to sleep. It comes from the sun, from the lamp in our homes and even from the lighting bugs. But what is light? It is the name for a range of electromagnetic radiation that can be detected by the human eye.

This electromagnetic radiation is both a particle and a wave. The particle is called a photon. The wave has amplitude, which is the brightness of the light, and a wavelength, which is the color of the light.

There is light that is undetectable by human eyes under normal conditions, such as ultraviolet, a form of electromagnetic radiation that has a shorter wavelength than the light humans can see. It carries more energy than visible light and can also cause some substances to emit visible light, a phenomenon known as fluorescence.

All glow-in-the-dark products, such as fabric, toys and posters, contain phosphor, a substance that radiates visible light after being energized. People who lived through the 1960s likely remember their bedroom glow in the dark posters.

Chemists have created thousands of chemical substances that behave like a phosphor. Phosphors have three characteristics: The type of energy they require to be energized; the color of the visible light that they produce and the length of time that they glow after being energized. Tonic water contains phosphors.

Experiment: How Does a Black Light Demonstrate UV light?

Materials: Tonic Water and a black light flashlight.

Process: Sit in a dark room; a windowless room is best. Shine the black light flashlight on the bottle of tonic water.

Result: Tonic water contains phosphorus which when struck by radiation emits light. The phosphorus receives the radiation from the black light thus, causing the water to glow.

Experiment: Why Do Some Items Glow in the Dark?

Materials: Glow in the dark fabric or stickers.

Process: Place the items under a light source for a few hours. Now bring the items into a darkened room.

Result: The items will ‘glow’ because they were energized by the light effect on the phosphors in the material.

WHY DO PLANTS APPEAR GREEN?

Green plants are green because they contain a pigment called chlorophyll which absorbs red and blue visible light and reflects green light, thus making the plant appear green.

A pigment absorbs some wavelengths of light and reflects others so for example a yellow pigment absorbs all the colors except yellow. The yellow that is not absorbed is reflected in your eyes and you see ‘yellow’. When you see something that is white, it is because all the light is reflected.

Humans have the best color vision of any mammals but we are less able to see color when compared to many species of birds, reptiles, insects and even some fish. Our vision is described by scientists as humans being trichromats, which means our brains interpret three wavelengths of color based on the ratio of red, green and blue light.

The white light from the sun is actually many different colors called a spectrum and are always in this order: red, orange, yellow, green, blue, indigo and violet. There are also colors we don’t see at the ends of this spectrum. These are infrared off the edge of what we see as red and ultraviolet off the edge of what we see as violet.

Birds are tetrachromatic which means they can see four wavelengths of color and sometimes ultraviolet wavelengths of light. This means they can see a far greater range in the various hues of green plants than humans. The tiny shrimp can see 12 wavelengths of light!

The color of chlorophyll is second to its real purpose for plants. Chlorophyll is a molecule that traps light. It converts the energy of sunlight to chemical energy that can be used to sustain the plant through a process called photosynthesis. This is a reaction between carbon dioxide and water which is then catalyzed by sunlight which produces glucose, a sugar used to feed the plant, and a waste product oxygen, which is expelled into the atmosphere and used by humans to breathe. There are different kinds of chlorophylls which is why we see different shades of green in

plants. Plants contain chlorophyll a, which is teal-green, chlorophyll b, which is yellow-green and beta-carotene which is yellow.

There are different combinations in nature that give plants their coloring. For example, red algae have chlorophylls a and lipid-based pigments called phycobilins which create a deep red or even deep blue color.

You might be thinking blue as in Kentucky blue grass, but is the grass actually blue? Truth is the grass is not named for its leaves, which are always green, but rather for the seed heads. When the seed heads grow to three or four feet in length and wave in the summer sun, the field has a blue appearance.

Experiment: How Do Plant Leaves Turn Green?

Materials: Scissors, black construction paper, large Geranium plant and tape.

Process: Cut two squares of construction paper big enough to cover one large leaf of the Geranium. Next cut a heart shape out of the center of one of the pieces of construction paper. Tape the two pieces over the leaf, with the heart cutout on top, so the sunlight reaches the cutout section.

Result: In a week remove the construction paper. You will see a dark heart appear on the lighter colored leaf surround because photosynthesis turns light into food for the plant and in the process turns the leaf green. Without light, the leaf does not turn green.

LIGHT TRIVIA

- 1) What is light? Answer – Light is electromagnetic radiation.
- 2) What is the visible spectrum? Answer – The part of light that can be seen by humans.
- 3) Can animals see light humans cannot see? Answer – Yes. For example, insects can see ultraviolet light.
- 4) Why can't humans see infrared light? Answer – The wavelength is too long to be visible to the human eye.
- 5) What is the science that studies light? Answer – Optics.
- 6) How fast does light travel? Answer – 186,000 miles per second in a vacuum.
- 7) Does light travel slower through glass? Answer – Yes. Glass slows the movement of air to about 124,000 miles per second.
- 8) How long does it take light to travel from the Earth to the Moon? Answer – 1.255 seconds.
- 9) How deep does light travel into the ocean? Answer – 262 feet.

- 10) What color is the sun if you were viewing it from space? Answer – White because there is no atmosphere to scatter the light.
- 11) Do humans glow with color? Answer – Yes, humans are bioluminescent, but glow at 1,000 times less than visible by the human eye.
- 12) How long has the longest light bulb continued to glow? Answer – The Centennial Light in California has been glowing since 1901 with just a few power outages.
- 13) What is photic sneeze? Answer – A condition that causes about 18 to 35 percent of humans to sneeze in bright sunlight.
- 14) How much candles would it take to light up Niagara Falls? Answer – 250 million.
- 15) How can light fry an ant? Answer – When light passes through a magnifying glass it is refracted, slows down and bends, and can focus the resulting heat on a single item such as an ant. (*Science for Seniors* reminds readers no ants were killed in the publishing of this book.)
- 16) True or false. You can travel through space on light? Answer – True. Astronomers and scientists are working on plans to power spacecraft with the solar wind by use of solar sails.
- 17) How do fireflies make light? Answer – The insects create cold light through a chemical reaction which scientists are studying in hopes to use this process for generating light for human use.
- 18) How long does it take for light to travel from the sun to the Earth? Answer – Eight minutes and 17 seconds.
- 19) Is a black hole black? Answer – Black holes are actually the brightest objects because they generate the most energy in the universe.
- 20) True or false. Isaac Newton stuck needles in his eye to see if color was coming from within or outside his eye. Answer – True. He found both were true. Rods in the eye react to certain electromagnetic frequencies.

EXPERIMENT LOG

How many times did Thomas Edison unsuccessfully attempt to make a light bulb?
 Answer – 1,000. Record your results below and remember Edison said, “I didn’t fail 1,000 times. I learned through a 1,000 step process.”

Results: _____

Results: _____

Results _____

SOUND

WHAT IS SOUND?

Sound is all around us even before the moment of our birth, but what is sound? Scientists have proven sound is a pressure wave caused by vibration. When an object vibrates it causes a disturbance. When the vibration takes place in air, the vibration is carried on the air as a wave.

Humans enjoy sounds such as birds chirping outside the window and a favorite song on the radio, but humans can also be annoyed by sounds from an irritating commercial on the TV to leaf blowers that disturb sleep on Saturday mornings. Have you ever wondered why some sounds bother humans?

Researcher Sukhbinder Kumar of the Institute of Neuroscience at Newcastle University in Newcastle, United Kingdom has studied the problem and believes it is linked to primitive humans.

The amygdala, the part of the brain that regulates emotion, seems to take over the hearing interpretation part of the brain when a human listener is really annoyed at the sound. This emotion response may trigger a link to danger. The study also found the most annoying sounds were in the range of 2,000 to 5,000 hertz, which is also the range for screams.

Surveying 13 people listening to 74 different sounds they found the most irritating sounds were: knife on a bottle, fork on a glass, chalk on a chalkboard, ruler on a bottle, nails on a blackboard, a female scream, disc grinder, squealing bike brakes, baby crying and an electric drill.

While the least annoying were: applause, baby laughing, thunder and water flowing.

Using the same sound with animals, researchers found the animals had the same reaction to human annoying sounds, such as nails on a chalkboard, as to just white noise. So it was not the sound itself, but some distance relationship that bothers humans. Or it could be certain ranges of sound trigger physical pain in humans.

If the sounds of people nearby chewing loudly or tapping their fingers, really annoys you, you might just be a genius.

Scientists have discovered that people who have a hard time filtering out background noise are usually very creative and talented. This happens because a

mind that is irritated by sounds all around from the person eating potato chips to a car alarm is actually able to focus on multiple tasks at once. Thus they feel overwhelmed and annoyed.

Charles Darwin, for example, could not work in a location with multiple sounds. Novelist Marcel Proust worked in a cork lined room with ear plugs to avoid distractions.

Experiment: How Can You Feel Sound?

Materials: Cardboard tube, wax paper, rubber bands, and scissors

Process: Cut a small square of wax paper about one inch larger than the opening of the cardboard tube. Wrap the wax paper over one end of the tube and secure it with a rubber band. Put the open end of the kazoo up to your mouth and hum a tune into it.

Result: You will feel the vibration in your hand as the sound passes through the tube. Your voice contains a lot of different sounds that when all put together sound like one sound. When your voice travels down the cardboard tube and reaches the wax paper, the wax paper vibrates.

Experiment: How Can You See Sound?

Materials: Plastic wrap, bowl, rice and spoon.

Process: Cover the top of the bowl with plastic wrap. Put some rice in the center of the plastic wrap. Tap the side of bowl with the spoon. Observe what happens.

Result: Sound is energy. The sound waves moving through the bowl move the rice sitting on the plastic.

WHY DO ANIMALS HEAR BETTER THAN HUMANS?

Everyone knows their dog can hear sounds better than human ears, but why? Hearing is a mechanical process. The senses of taste, smell, touch, and sight involve chemical reactions in the brain, but hearing is based entirely on physical movement.

Most of the sounds humans hear travel through the air around us. The vibrations move air particles in the atmosphere, setting off a chain reaction in which air particles disturb other air particles.

The pinna, the outer part of the human ear that's pointed and has many folds, catches the sound waves and signals to our brains where the sound is coming from

by recognizing the direction of the sound wave and altering its pattern by bouncing the wave off the pinna's folds.

The human pinnae face forward so that we can hear sounds in front of us better than those behind us. Most mammals, on the other hand, have large, moveable pinnae that help them focus on sounds from all directions, in order for them to detect predators and prey more easily. For example, dogs have 88 muscles they can use to focus on sound.

Our pinnae are not as adept at focusing on sound, because they lie flat against our heads and don't move independently. Cupping our hands behind our ears can help us catch more sound waves, but nowhere near as many as, say, a dog's ears can.

Animals also hear a broader range of frequencies than we can, which is why humans can't hear dog whistles. Louisiana State University researchers have charted these frequencies to show that while humans can detect frequencies from 64 hertz to 23,000, dogs can hear from 67 Hz to 45,000 Hz; cats from 45 Hz to 64,000 Hz; and horses from 55 Hz to 33,500 Hz. The most acute hearing in the animal kingdom, however, belongs to mice, bats, beluga whales, and porpoises.

There is some good news for human listeners. We may not be able to hear sounds from as many directions or at frequencies as high as our mammalian fellows do, but some Israeli researchers have shown that we may be able to detect more precise frequencies than other animals.

Professors Israel Nelken, of the Department of Neurobiology at the Alexander Silberman Institute of Life Sciences at the Hebrew University of Jerusalem; Itzhak Fried, from UCLA and Tel Aviv Medical Center; and Rafi Malach, of the Weizmann Institute of Science, along with their students Roy Mukamel and Yael Bitterman, published a study in the journal *Nature* in 2008 revealing that neurons in the human auditory cortex respond to frequency differences as small as a quarter of a tone. This kind of resolution exceeds that typically found in the auditory cortexes of other mammals. Human hearing range may be limited, but we are better able to distinguish among the sounds we can hear, and therefore to appreciate nuances in musical and linguistic tones.

Experiment: Can You Hear a Dog Whistle?

Materials: Dog whistle, human volunteer, a human who can whistle

Process: With the person's back to you, blow the human whistle. Can they hear the whistle? Next blow the dog whistle. Did they hear the dog whistle?

Result: No, we can't hear a dog whistle. Dogs can hear a whistle that makes sounds beyond the 20,000Hz band, the limit for humans.

Experiment: How Can You Amplify Sound with a Balloon?

Materials: Balloon and human volunteer.

Process: Blow up the balloon. Hold the balloon next to your ear. Now tap lightly on the balloon.

Result: Even though you tap lightly on the balloon, it sounds loud. This is because the air molecules inside the balloon are forced closer together and thus become better sound conductors than the air outside the balloon.

WHAT IS MUSIC?

In answer to this question you may say, I don't know, but I know it when I hear it. It's true that when a neighbor is playing music loud enough for you to hear in your own backyard you may be tempted to yell, "Turn down that noise", but what is the difference between music and noise?

Science has been perplexed at defining music by itself, so the definitions are culturally based. Some of the best explanations are:

- Music is human organized sound.
- Music is a form of communication.
- Music cannot be described in non-musical terms.
- Music offers a history of human endeavors.

Music is a powerful force on humans. A lullaby can sooth a crying baby and a national anthem can fill an audience with pride. How does different music affect out moods?

Scientists break music's influence on our emotions into four categories:

- Tempo and rhythm
- Pitch, melody and harmony
- Pattern recognition
- Cultural

Most music is the range of 50 to 200 beats per minute which mimics the range of the human heart beat. Music in the range of 60 to 80 beats creates a calm laid back feel in the listener. Music at 80 to 100 beats is a moderate feel and music over 100 beats per minute is lively toe tapping music.

The most common tempo for music is between 80 to 120 beats per minute. This pattern also suggests that music mimics movement so the speed of the tempo is likened to talking, walking, running and dancing.

The 2/4 time of march music follows the left-right pattern of the march itself while the 3/4 time of a song follows a circular pattern.

The impact of rhythm in our enjoyment of music can be heard in the expressions, “This music is upbeat” or “This music has a strong downbeat”.

Pitch has a strong impact on listeners. High pitch sounds generally make listeners feel happy while low pitch sounds are sad and serious. Composers know this well. Consider the opening music of the famous movie, *Jaws* with its low scary sounds and then think of *Snow White and the Seven Dwarfs* light and bouncing tune, “Whistle While You Work.”

Melody is a linear sequence of tones and it has been said the best melodies leave the audience humming the tune as they leave the theater. Melody’s design mimics human sentences in that they are phrased to be not too long or too short.

The combination of tones of different pitches is called harmony. Human brains cannot only recognize harmony but also musical patterns. Composers also use patterns for audience response. Think for a moment of the familiar music that introduces the *Star Wars* movie bad guy Darth Vader. Now think of *The William Tell Overture* and your brain will create memories of the TV show hero, The Lone Ranger.

Cultural aspects of music link it to different parts of the world and even periods of time. You hear the sound, “I Will Survive” and you think 1980s disco. If you hear blue and jazz you might be reminded of New Orleans.

Music is Whatever it means to you is the correct answer.

Experiment: How Does a Tuning Fork Work?

Materials: Tuning fork, a hard surface and a human ear.

Process: Strike the tuning fork on a hard surface. Place the struck fork next to the person’s ear. What do they hear?

Result: When a tuning fork is struck the energy of the impact makes the two sides of the fork wiggle quickly inward and outward. When the fork's tines move outward, the force air molecules quickly congregate and move away, and when they move

inward, they create a gap where molecules are less densely packed. This high movement creates a sound wave.

Experiment: Why Does Water Level Change the Sound of a Struck Glass?

Materials: Two equal sized glasses, water and a metal spoon.

Process: Fill one glass $\frac{3}{4}$ full of water. Fill the second glass $\frac{1}{4}$ full of water. Strike each glass with the spoon separately. Listen and compare the sounds.

Result: When a bottle is partly filled with water, the water takes away some of the space in which the sound waves can vibrate. As a result the more water in the glass the lower the sound and the less water the higher the sound.

WHY DO PEOPLE ENJOY MUSIC?

Scientific studies have shown what most of us already knew but never thought about: music connects us as a generation and as a culture.

Maybe you grew up in New York City and someone your same age grew up on a farm in Montana, but when the TV plays, “Here’s the story of a man named Brady...” You can each finish the song with, “who was busy raising three boys on his own...” This happens because music has cultural memory.

If you were dating in the 1960s anywhere in the U.S. you remember a number one hit, “These Boots Were Made for Walking”. Most likely you also remember who sang the song, the tune, lyrics and how it made you feel. This happens because music has emotional memory.

It’s a fact. You may enjoy many different kinds of music throughout your life, but your favorite tunes will be those of your teens and twenties, and the second group of favorite will be songs your parents enjoyed.

Levine School of Music in Washington DC studied 300 seniors. Over a two year period those who attended the arts program had better health while those who did not attend saw their health deteriorate.

The arts group used fewer medications, felt less depressed, were less lonely, and were more socially active. The National Institute of Nursing Research who found that listening to music reduced patient pain levels.

The National Institute of Education and Health Sciences found music tempo can improve mood and heart rate. Dr. Gottfried Schlaug, a neuroscientist at Harvard

Medical School, found stroke victims regained their speaking ability through singing. The melody helped the stroke victims' brains rewire and bypass the damaged regions of the brain and thus restore communication skills.

German doctors studied a 68 year old musician, who suffered total amnesia *except* he can remember and even learn new music. They reported music is stored in a different part of the brain from other memories. This is the reason a resident with dementia who can no longer remember their ABCs, can sing their favorite songs.

American doctors found that musicians ages 60 to 80 have improved their cognitive skills by playing music.

In the book, *This Is Your Brain on Music: The Science of a Human Obsession* by Daniel J. Levitin, the author says, "Music listening, performance and composition engage nearly every area of the brain that we have so far identified and involve nearly every neural subsystem. Music's effects on neurons are so distributed that in some cases stroke victims who can no longer decipher letters can still read music, and some impaired individuals who cannot button a sweater can nevertheless play the piano."

Why do people like different kinds of music? That question was studied by psychologists at The University of Cambridge and published in the online journal PLOS One in 2015. The study recorded the choices of 4,000 people who were asked to rate 50 songs of different styles.

Looking at the link between music preference and personality they found people who tested high in empathy preferred mellow music such as soft rock, adult contemporary and rhythm and blues. While those with analytical minds preferred intense music such as punk, heavy metal and hard rock.

David Greenberg, a PhD candidate and lead author of the study, believes people with strong empathy for others are driven to understand the thoughts and feelings of the people around them. Thus, he said, they prefer music with emotional depth.

People who prefer to analyze and look for patterns of behavior in the world's population enjoy high energy songs. He believes both results show that humans tends to seek out music which reinforces their own mental states and mirrors their own personality. If these findings are repeated in further tests and proven to be true, Greenberg said, music could be used in clinical settings to help people improve their empathy for others.

Experiment: Is Music a Universal Language?

Materials: CD player and CDs of jazz, country, Hindu, Japanese, rap and Native American music.

Process: Seat participants with their backs to the CD player and play three minutes of each type of music. Have participants raise a hand when they hear music they like. Track the number of hands raised for each selection.

Result: Scientists have found that 99.8 percent of people enjoy music. There is a very tiny minority to whom music, any and all music, is extremely irritating. However, that does not mean everyone enjoys jazz, rap, country and classical. The collection of sounds pleasing to one person may be very annoying to another.

HOW DO DRUMS MAKE SOUND?

No one knows when the first cave man or cave woman beat a rock with a stick and discovered a pleasing sound, but archeologists have discovered evidence of early drums in Ancient Sumeria in 3000 B.C.

Throughout history drums have been used in ceremonial dances. They have also been tools for communication between tribes and a way to signal troop movement during battles.

There are three basic kinds of drums: frame drums, rattle drums and tubular drums.

A frame drum is a skin stretched and attached tightly over a frame or an urn. This is also true of a tambourine. These instruments are played by striking a hand or a stick against the drum skin. Sometimes chords were attached to the side of a frame drum. Thus when shaken the chords hitting the drum produced sound.

Rattle drums can be as simple as dried gourds whose seeds rattle. They can also be a tanned animal skin filled with dried grain then shook to produce sound.

A hollowed out log and even hollowed out bones were sometimes covered with an animal skin and beaten by hand or stick to create the instrument known as a tubular drum.

The science behind the sound of a drum is the displacement of air. When the drum head is struck it vibrates creating areas of high and low pressure within the drum and sound. Drum sound depends on the object striking the drum head. When the drum head is hit softly the air compression is limited and the sound will be low volume. A hard hit against the drum head will create a larger displacement of air and

thus a larger sound. Drum heads must be adjusted for proper sound. Too loose limits air compression; too tight will limit the head vibration. Both conditions cause a shortened resonance.

Experiment: Does the Height from Which a Marble is Dropped on a Drum Head Change the Sound?

Supplies: Marbles, drum and/or a tambourine.

Process: Drop the marble from several heights and allow the participants to hear and consider each sound.

Result: The greater the distance between the marble and the striking drum head the louder the sound. This is caused by decay time, the time from the beginning of the sound to when the sound is no longer heard.

Experiment: Why Does the Sound of a Drum Change Based on How it is Struck?

Materials: Any drum or any box that can be used as a drum and a drum stick.

Process: Hit the drum surface with your open hand. Then hit the drum in the same spot and with the same intensity with the drum stick. Compare sounds.

Result: The way the drum is played affects the tone because if you hit a drum with your open hand or a wooden stick, you will get a sharp attack, like the sound you get clapping your hands. This attack will be followed by the sound of the drum vibrating. If, on the other hand, you hit the drum with a padded mallet, you will start the drum vibrating without the attack.

SOUND TRIVIA

- 1) What generates sound? Answer – Sound comes from vibrations in a medium such as air and water.
- 2) Is there sound in space? Answer – No. Sound cannot travel in a vacuum.
- 3) How fast is sound? Answer – About 767 miles per hour.
- 4) Why does cracking a whip make sound? Answer – The tip of the whip moves so quickly through the air that it breaks the sound barrier.
- 5) What is the study of sound called? Answer – Acoustics.
- 6) What causes thunder? Answer – The rapidly heated air surrounding lightning is expanding faster than the speed of sound and thus creates the boom you hear.
- 7) Can sound travel through solid matter? Answer – Yes. This is why you can hear loud sounds coming through the wall of the room next door.

- 8) How do humans hear? Answer – Human hear sound energy as air particles collide with the ear drum which causes vibrations that are interpreted by the brain.
- 9) What is an echo? Answer – Hard materials reflect sound so the sound travels back in the opposite direction.
- 10) What makes loud sounds? Answer – Large vibrations.
- 11) What makes quieter? Answer – Small vibrations.
- 12) What makes a high sound? Answer – Fast vibrations.
- 13) What makes a low sound? Answer – Slow vibrations.
- 14) How does the human ear drum work? Answer – Vibrations pass through the bones in the middle ear to the inner ear and in the process bend tiny hairs in the inner ear that cause nerves to send a message to the brain.
- 15) Does sound travel faster in air or through the ground? Answer – Through the ground. Fun fact, elephants can hear ground vibrations two miles away.
- 16) Where do sea lions hear well? Answer – Under water because sound travels faster through water than through air.
- 17) Why do you see lighting before you hear thunder? Answer – Because sound travels slower than light.
- 18) What is a sonic boom? Answer – When a jet travels faster than the speed of sound, sound waves pass in front of the plane and as the plane crashes through the sound waves you hear a boom.
- 19) Why does a cloud of vapor sometimes form around a plane? Answer – As a jet approaches the speed of sound the lower air pressure from the plane’s lift and disturbed air around it condenses moisture in the air and forms a vapor cloud.
- 20) Who hears better, a human or a bat? Answer – A human hears sounds that vibrate between 20 and 20,000 times per second but a bat hears sounds that vibrate up to 200,000 times per second.

EXPERIMENT LOG

How long did Charles Goodyear struggle to make a rubber for tires that would not melt? Answer: 4 years. Record your experiment results here:

Results: _____

Results: _____

Results: _____

WEATHER

WHAT IS WEATHER?

When someone says, “What’s the weather today?” what do they mean? Weather is the condition of the atmosphere and how it affects humans.

This can mean a description of: temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure. It also includes: sunshine, rain, cloud cover, winds, hail, snow, and sleet, freezing rain, flooding, blizzards, ice storms, and thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and/or a combination of one or more of these conditions.

Weather is different from climate. Weather can be predicted and change from hour to hour while climate is the conditions in the atmosphere over a long period of time such as years, decades and/or centuries.

Weather is caused by the Sun heating the Earth including the atmosphere and the water. The atmosphere is 50 miles thick. It is warmest closest to the Earth and coolest near space.

Why can’t we predict the weather? The truth is humans have tried to predict the weather for centuries. Ancient people watched the movement of birds and plants to predict a coming rainstorm. Modern forecasters such as the National Weather Service use the power of over 1 million computers, weather balloons and satellites daily to measure and track wind, temperature, water round the planet in an attempt to predict what will happen next in the weather. And yet, the best estimates are only about two weeks ahead of a weather event.

Scientist Edward Lorenz described this problem as the butterfly effect. He said a butterfly flapping its wings in Asia could drastically alter the weather in New York City because in the Earth’s highly complex weather systems small changes in initial conditions can radically change the final results.

Temperatures on our planet range from the hottest temperature ever recorded as 159°F in the Lut Desert in Iran and the coldest temperature was the Russian Vostok Station at -129°F.

Our sun is 24 million degrees F at the core and 7,800 degrees F on the surface. The sun produces over 35,000 times the amount of electricity now used on the Earth.

It's equal to giving our planet's 7 billion residents each their own light bulb that will shine for their entire lifetime.

Everyone enjoys a sunny day. However, too much sun exposure, such as sunburn and skin cancer, is bad for humans. You can see the power of the sun and the potential danger of solar heat and radiation in this experiment.

Experiment: How Can You Bake Cookies with Solar Energy?

Materials: Cookie sheet, refrigerator cookies dough, hot parked, car, and 90 degree day for 4 hours steady.

Process: Place cookie dough on metal pan, place the pan on the dashboard of a car, park the car in the sun with the windows rolled up for about 2 hours on a 90 degree day.

Result: Solar energy is radiant light and heat from the sun. The Earth receives more energy from the sun in one hour than the entire world uses in one year. In this experiment, the temperature in the car will exceed 120 degrees and you will have fresh cookies – and a lesson on the dangers of leaving anyone in a hot car.

Experiment: How Can You Demonstrate Chaos Theory?

Materials: Running water and a large metal spoon.

Process: Hold a spoon under running water and you will see different patterns emerge.

Result: If you held the spoon in place and took thousands of photos, no two would be alike. This is due to the chaotic flow in the stream of water. As a result, chaos in the atmosphere makes long term weather prediction impossible. It is summed up in The Butterfly Effect. “The flap of a butterfly's wings over a Pacific Island might cause a hurricane on the other side of the world,” Ed Lorenz, meteorologist.

WHAT IS RAIN?

If you wanted to move to a rain free place, would you be able to stay on Earth? Well, technically yes, if you exchange the wet of rain for the frozen alternative of snow at the North and South Poles. You can also go a long time between rain storms if you moved to a desert, such as The Atacama Desert of Chile which had very little rain fall between 1570 and 1971.

Perhaps you have visited Mount Washington, in New Hampshire, the highest peak in the Northeastern United States at 6,288 feet. It is the most prominent

mountain east of the Mississippi River. Visitors can hike, drive or ride a cog rail car to the summit where during summer months you may be able to walk even in sunshine among the clouds that form on the mountain peak.

So what causes rain? The air around us contains water vapor. Most of the time the vapor is invisible, but you can see it and feel it when you are in a hot steamy shower. The fog in the shower contains millions and millions of tiny water droplets floating in the air.

This fog is the same process that creates clouds. Look outside at the sky and observe what happens at the edges of a cloud. Over time the cloud will get larger or smaller. The cloud grows as more water droplets are condensing out of the air. When the cloud shrinks, water droplets are evaporating, which mean they are changing from visible liquid water into invisible water vapor.

If the water droplets remained small, then like fog they would not be heavy enough to fall to the Earth. To become rain, droplets need to grow by acquiring more water. For some this happens as they collide with other droplets and when merged become larger. Other droplets grow as water condenses out the air directly into the droplet. Still others will grow by the combination of both methods. The process within the cloud happens to millions of tiny droplets all growing at the same time.

Warm air holds more water vapor than cool air. When warm air starts to cool, it can no longer hold as much water vapor. Clouds cool for three possible reasons:

Conventional rain – The warm air rises from the ground while the atmosphere gets cooler in higher elevations. Thus, as the warm air rises it is cooled by the colder air around it.

Frontal rain – This is when an area of relatively warm meets an area of cooler air. The warmer air rises over an area of relatively cool air and the warm air cools.

Relief rain – This requires a physical obstruction, such as a mountain range, large hill or cliff, which forces warm moist air to rise. As the warm air rises over the obstruction it cools and clouds form. Rain falls from the clouds. When the droplets don't grow large enough for rain, fog may form over the hill tops.

Rain happens when the water condensing in the clouds becomes so heavy the water drops fall to Earth.

Experiment: How Can You Demonstrate Rain Clouds?

Materials: Clear glass jar about 32 ounces, water, shaving cream, blue liquid water color paint and a medicine dropper.

Process: Fill the jar $\frac{3}{4}$ full of water and then top off the jar with shaving cream. Fill the dropper with the blue paint. Now squeeze a few drops of the blue paint on the top of the shaving cream and observe.

Result: The shaving cream represents the cloud and the paint represents the water moisture in the cloud. The weight of the paint will slowly push through the shaving cream and fall into the water of the jar, just as rain drops fall from the clouds to the Earth.

Experiment: Why Does a Rain Drop Splash Upwards on Water?

Materials: Clear pie pan, eye dropper and water.

Process: Fill the box with water, drop the water from the dropper.

Result: When the drop of water hits the surface it causes depression, a circular dent in the water and a rim of water forced out by the depression. The rim collapses and pushes the water outward and inward. The water moving inward collides at the bottom of the depression and throws the drop of water up into the air.

Experiment: How Does a Few Inches of Rain Create a Flood?

Materials: Water, three containers small, medium and large.

Process: Fill each with three inches of water.

Result: The three inches over a larger area is more water than three inches in a small area. Ex. Texas received an average of 8 inches over the month of May 2015. However, considering the size of Texas, the 8 inches over the entire state equaled 35 trillion gallons from May 1 – 29, 2015 and resulted in major flooding, according to the National Weather Service in Fort Worth.

WHAT IS SNOW?

The Merriam-Webster Dictionary defines snow as “precipitation in the form of small white ice crystals formed directly from the water vapor of the air at a temperature of less than 32°F and also as “a mass of fallen snow crystals.”

Each snow flake begins as a speck of dust, volcanic ash or a particle from outer space. Moisture in the form of water vapor forms around the dust ash or particle

which becomes the center of a snow flake. Temperature, humidity and wind determine the shape of each individual snow flake.

How much water is in snow? That depends on the snow. You may have noticed that some snow is light and fluffy while other snow is dense and heavy. This is due to a variety of factors including temperature, snow flake structure and wind. The average snowflake is made of about 180 billion molecules of water.

On average one inch of rain would equal one foot of snow, thus a 12 to 1 ratio. However, during a snowstorm the ratio can be 20 to 1. The National Weather Service website, <http://www.weather.gov/>, usually posts the ratio when it reports on a snowstorm moving through a geographic area.

What is a snow storm? Scientifically, a snow storm occurs whenever there is an excessive amount of snow in a short period of time. It can be two inches or 22 inches of snow and be called a snow storm. It is a snow storm when it causes hazards for humans. In most parts of the United States where snow is common, forecasters consider six inches or more a snow storm. However, in an area where snow is very unusual and causes major safety issues, as little as two inches may be called a snowstorm.

The United States weather service reports the United States has an average of 105 snowstorms per year with each lasting between two and five days. The biggest snowstorm in U.S. history happened in February 1953 at Thompson Pass, Alaska when snow fell at the rate of 5.5 feet per second and accumulated to 187 inches.

Red, orange, brown and green snow occurs when cold tolerant pigmented algae that grow on fallen snow. Sometimes called ‘watermelon snow’, this snow can smell like fruit, but don’t eat it. Ingesting red snow will cause a person intense physical internal stress. Falling snow in the colors of grey, pink, brown, orange or red is due to the pollution. Russia experienced falling colored snow: orange snow fell in Siberia in 2007 and pink snow that fell on Krasnodar in 2010.

If you love snow, you will want to visit Valdez, Alaska which holds the record for the highest average snow fall in the United States. It has an average snow fall of 326 inches or 27 feet per year.

Experiment: How Much Water/Air is in Snow?

Materials: Coffee mug, snow and warm room

Process: Fill the cup to the very top with fresh snow. Bring the cup indoors and observe. After the snow melts, measure the amount of water in the container.

Result: Most snow is 90 to 95 percent air and five to ten percent water. When the snow in the cup melts in a room above 32 degrees, it returns to water, minus the air that gave the snow its volume.

Experiment: Why is Every Snowflake Different?

Materials: Empty plastic jar, pipe cleaners, Borax, hot water and string

Process: Make a six-sided star from the pipe cleaner, tie a string in the center, place in jar of hot water and three large tablespoons of Borax. Let sit overnight.

Result: The Borax will form crystals on the pipe cleaners just as snow crystals form in the atmosphere. No two will be the same because no two snowflakes fall through the exact same atmosphere as no two pipe cleaners float in the exact same area of water.

WHAT IS AN ICICLE?

Have you ever eaten an icicle? It's a good way to start a fun discussion group and even in warm climate areas it is a way to learn something new.

What is an icicle? According to the Merriam-Webster dictionary an icicle is: "a hanging piece of ice formed when water freezes as it drips down from something (such as a roof)". It's a definition scientists can agree upon, but what was more challenging was understanding how icicles form.

In a 2006 report in the journal *Physics of Fluids*, Ray Goldstein, a mathematician and physicist from the University of Cambridge in the United Kingdom, said he began tackling the problem of how icicles form by considering how much their shape resembled stalactites.

Icicles form when the outdoor temperature is below freezing while the sun is warming and melting snow on the roof. The melting snow as liquid water drips off the roof but as it does it cools again in the air temperature and the water droplet freezes and begins to form the icicle.

As water continues to melt on the roof, it drips down over the forming icicle. Each time it adds a layer to the icicle as the water freezes and gives the icicle its shape. Meanwhile, the thin fluid layer on the surface of an icicle gives off heat that warms the air around it through a process called conduction. As warm air rises, it removes heat from the liquid layer and causes it to freeze. Thus, the buffer of heated air is widest at the top of the icicle, where conduction is slowest and thinner at the pointy bottom where more heat is escaping. Is it ok to eat an icicle? The website StateFoodSafety.com advises against it. Why? Snowflakes can contain pollution

from the atmosphere. When the snow lands on a roof and then melts as it begins the process of forming an icicle, the melting water may then contain the pollutants in the original snowflake as well as carry lead and other metals from the roof of the building into the icicle.

Experiment: How Do Icicles Form?

Materials: 5 ounce paper cup, 7 ounce paper cup, 7 ounce clear plastic cup, 12 inch ruler, 5 by 7 inch index card, masking tape, ½ foot square of corrugated cardboard, paper towel, scissors, pin, pencil, transparent tape, freezer, marker and a timer.

Process: 1) Write #1 on the 7 ounce paper cup then turn the cup over, make a pin hole in the bottom of the cup, cover the hole with masking tape and fill the cup 2/3rds full of water. Put it in the freezer and set the timer for 30 minutes.

2) Write #2 on the five ounce cup, then place a paper towel on the table and put the cup on top of the paper towel. Now draw a circle around the base of the cup and cut it out of the paper towel. Put this circle in the bottom of the #2 cup. Push the pencil into the bottom of #2 cup making three evenly spaced holes in the cup.

3) Place cup #2 on the index card and draw a circle at the base of the cup. Cut out this circle making your cut about 1/8 larger than the pencil drawing. Next, slide the cup through the hole in the index card. When finished, two inches of the cup should be below the index card and the remainder of cup #2 should be above the index card. Place the clear plastic cup at the bottom of the index card and attach the plastic cup to the index card with the transparent tape.

4) At this point you should have a stack of cups. The plastic cup is on the bottom, the index card in the middle and cup #2 sticks through the index card and into the plastic cup. 5) When the timer goes off, remove cup #1 from the freezer, remove the masking tape and put cup #1 into cup #2.

6) Use the cardboard to make a stand for the cups in the freezer and place the stack of cups in the freezer. Set the timer for one hour. Then remove from the freezer and observe.

Results: During the hour icicles will begin to form through the bottom of cup #2.

WHAT IS FROST?

Did you know there are several forms of frost? These are: hoarfrost, advection frost, window frost, and rime. They all begin as water vapor, which is water in gas form and then become solid, which is frost.

Frost forms when an outside surface cools past the dew point. The dew point is the point where the air gets so cold, the water vapor in the atmosphere turns into liquid. This liquid freezes. If it gets cold enough, little bits of ice, or frost, form. The ice is arranged in the form of ice crystals.

Frost usually forms at night, when the air temperature is cooler. Once the sun rises and warms the air around the frosted object, frost melts quickly.

Hoarfrost, also called radiation frost, is tiny ice crystals and the type most people commonly refer to as frost when it covers sidewalks and lawns. It is also the name of the frost many people will remember that formed inside the freezer before the invention of frost-free refrigerators.

Advection frost is a collection of small ice spikes. Advection frost forms when a cold wind blows over the branches of trees, poles, and other surfaces.

Window frost forms when a glass window is exposed to cold air outside and moist air inside. Window frost is familiar to winter residents of cold climates. Indoor heat and cold outdoor temperatures form this type of frost. Window frost was much more common before people began using double-paned windows.

Rime is frost that forms quickly, usually in very cold, wet climates. Rime also forms in windy weather. Rime sometimes looks like solid ice. Ships traveling through cold places like the Arctic Ocean often end up with rime covering at least part of the exposed part of the ship.

Experiment: How Does Frost Form?

Materials: Empty tin can, ice, salt and spoon

Process: Fill the can with ice, add salt and stir. Then let the can sit untouched for 30 minutes and observe.

Result: Frost forms when the surface of the moisture on the container is cooler than nearby air. Salt melts ice by lowering the freezing point of ice.

WEATHER TRIVIA

- 1) What is a snowflake? Answer - A snowflake is made of over 1 million frozen ice crystals, that's about 180 billion water molecules.
- 2) What is the largest snowflake? Answer - Most snowflakes are less than a ½ inch across, but according to the Guinness Book of World Records the largest snowflake was reported at Fort Keogh, Montana on January 28, 1887. It measured 15 inches wide and 8 inches thick.
- 3) What place hold the record for the most snow in the U.S.? Answer - Mount Baker, in the North Cascades of Washington State, a reported 1,140 inches accumulated during the 1998-99 snowfall season.
- 4) Why are no two snowflakes alike? Answer - All snowflakes are unique because as they form in the upper atmosphere and drift towards the ground, no two will fall in the exact location and experience the exact same temperature changes.
- 5) What is hail? Answer - Hail is a form of precipitation that falls from the sky as pellets of ice. The pellets can range in size from small pea-sized pellets, to hailstones as large as grapefruits. Hailstones are built like an onion with each layer one time the hail stone was pulled up to the top of the storm before landing on the ground.
- 6) What is the biggest hailstone? Answer -The biggest hailstone reported was the size of a softball, weighed about 2 pounds and fell in South Dakota on July 23, 2010.
- 7) What is freezing rain? Answer - Freezing rain is liquid that falls as rain and then freezes upon landing on a below freezing surface.
- 8) What is sleet? Answer - Sleet is precipitation that falls as frozen pellets.
- 9) What is the coldest place on Earth? Answer - Antarctica. It has reached -129 degrees.
- 10) What is the coldest place in the U.S.? Answer - Alaska has an average of 161 days below zero. The coldest temperature ever recorded in Alaska is - 80 degrees on January 23, 1971 in Prospect Creek.
- 11) How does salt melt ice? Answer - Water freezes at 32 degrees. Salt lowers the temperature at which water freezes. For example, a 10 percent salt solution will lower the freezing temperature of water to 20 degrees and a 20 percent salt solution will lower the point at which the water will freeze to 2 degrees.
- 12) What else is used to keep melt ice and snow on roadways? Answer - Sugar beet juice. The New York State Thruway Authority uses sugar beet juice from the sugar refining process to pre-treat roads prior to snowstorms.

The carbohydrates in the beet juice help prevent ice from bonding to the road. New Jersey has used pickle brine and Wisconsin has used cheese brine.

- 13) What is the wind chill factor? Answer - Wind chill is the combination of the cold and the wind to predict how cold a human will feel based on the loss of heat from exposed skin.
- 14) What is a blizzard? Answer -: A blizzard exists when winds 35 mph or higher is combined with falling snow or blowing snow to reduce visibility to $\frac{1}{4}$ miles for a minimum of 3 hours.
- 15) What is an ice storm? Answer - An ice storm is the falling and surface coating of freezing rain.
- 16) What is a snowstorm? Answer - Any snow precipitation falling from the sky is a snowstorm.
- 17) What is thundersnow? Answer - This happens when warmer temperatures on the ground mix with cooler temperatures up in the atmosphere and create lightning and thunder during a snowstorm, thus thundersnow. It is a rare event because warm ground temperatures usually don't occur during snowstorms.
- 18) How much air and water is in snow? Answer -The amount of water in snow depends on the kind of snow. Some is light and fluffy with more air and other snowfalls are dense and contain more water. An average snow is about 92 percent air.
- 19) What is the world's largest snowman? Answer - The town of Bethal, Maine claims this honor having create a 113 feet and 7 inch tall snowman in 1999.
- 20) How do igloos provide winter weather protection? Answer - Igloos are built of tightly packed snow blocks which prevents the freezing winds from reaching the people living inside. When the inhabitants build a fire, the heat from the fire rises, melts the ice on the inside ceiling a little, then that liquid refreezes and forms an airtight seal keeping the heat in and cold winds out of the igloo.

EXPERIMENT LOG

Was Einstein a good student? No. In 1895, at the age of 17, Albert Einstein failed the entrance exam at the Swiss Federal Polytechnical School. He reapplied and was admitted the following year. Record your results here:

Results: _____

Results: _____

NATURE

WHAT IS A DESERT?

Approximately one fifth of Earth's land area is desert which means an arid land with little rainfall to support plants, animals or people. A desert can be hot or cold and can have sand, plants or rocks but in every case they are dry.

Deserts are located on every continent and home to about 1 billion people. They are divided into five types: subtropical, coastal, rain shadow, interior and polar.

A subtropical desert, such as the Earth's largest, the Sahara in Northern Africa, was created by the circulation of patterns of air masses. The hot, moist air rises from near the Equator and cools and drops as rain. The cooler dryer air moves away from the Equator and as it descends it warms up again. This process hinders the formation of clouds and results in very little rain.

The Sahara is about the size of the U.S. Other subtropical deserts include Kalahari Desert in southern Africa and Tanami Desert in northern Australia.

Coastal deserts, such as the Atacama Desert in Chile, are created when air blowing towards the shore is chilled by cold water and produces fog. This results in high humidity but almost no rain. There are weather stations in Atacama that have never reported a single drop of rain.

A rain shadow desert occurs near leeward slopes, those facing away from prevailing winds, of mountain some ranges. Americans are familiar with such a desert in Death Valley.

Early American settlers who headed west through the desert experienced extremely high losses of life. The death toll was so high, that survivors who exited the area said, "We survived Death Valley" and thus the desert received its name. Death Valley is located in parts of California and Nevada and is the lowest and driest place in the country.

These forms of deserts are formed when moisture laden air hits a mountain range and the air rises. The air then cools and forms clouds which drop moisture on the wind facing slopes but the remaining air moving over the mountain has very little moisture left. Thus no clouds form to produce rain.

An interior desert, such as the Gobi Desert in China and Mongolia, occurs because no moisture laden winds ever reach the area. Air masses traveling from the

coast to these regions lose all moisture before reaching the interior land and thus creates a desert region.

Polar deserts are located in the Arctic and Antarctic where there are vast amounts of water, however all the moisture is frozen in glaciers and ice sheets. Thus Antarctica is actually the largest desert in the world.

The deserts of today were not always dry landscapes. Scientists believe between 8,000 and 3,000 B.C. the Sahara was a green lush area. They know this by the study of fossils, rock paintings and tools found in graves. They also believe the area was a lush green space about 25,000 years earlier.

Deserts have some extreme weather patterns. The Chihuahuan Desert, located in the U.S. and Mexico, can have a day time temperature of 100 degrees F and night time can fall to 32 degrees F.

Wind speeds in a desert can be up to 60 miles per hour. Sand from the Sahara can be swept across the Atlantic Ocean and cause a yellow tinted sunset in Florida. Winds can create sand dunes as high as 590 feet and a violent wind can move 65 feet of sand in a single day. Flash floods in deserts can suddenly sweep away plants, animals and people.

Plants survive in deserts through various methods. Some grow far apart to gather as much water around themselves as possible while other plants have waxy leaves to store water. Desert plants have small surface pores in order to lose as little water as possible to the atmosphere.

Cactuses have no leaves and instead produce food in their green stems. They also have shallow root systems so they can soak up water quickly and store it in their cells. A large saguaro cactus can hold hundreds of liters of water and has thorns to prevent animals from eating the plant.

Experiment: How Does the Waxy Skin of a Desert Plant Save Water?

Materials: Wax paper and water.

Process: Place a few drops of water on a sheet of waxed paper. Observe what happens to the water.

Result: The water does not soak through due to the wax surface of the paper. This shows how the wax coating on a desert plant keeps water from escaping from the inside of the plant.

Experiment: How Do Desert Plants Store Water?

Materials: Two plastic bowls, a sponge and water.

Process: Fill one bowl with water. Place the sponge in the bowl of water and squeeze. The sponge will absorb the water. Next put the sponge in the empty bowl and squeeze out the water.

Result: The sponge represents the desert plant which soaks up water and hold it until it is needed by the plant.

Experiment: How Do Small Pores Help Plants Save Water?

Materials: Two empty water bottles, water, a small and a large nail, hammer, and large basin.

Process: Hammer six large nail holes in the bottom of one bottle and six small nail holes in the bottom of the second bottle. Fill both bottles with water. Hold them over the basin and observe what happens.

Result: The bottle with the small holes will leak slower than the bottle with the large holes just as plants with small pore lose less moisture to the air than those with large pores.

WHAT IS THE DIFFERENCE BETWEEN A MARSH, A SWAMP, A BOG AND A FEN?

Marshes are wetlands filled with reeds and grasses while swamps can sustain trees and woody plants. Bogs contain a high peat content and fens have less peat and more plants.

To be a marsh, the land must be constantly flood with water either fresh water provided by streams, lakes, ponds or groundwater from heavy rains. Most are freshwater, but marshes can also be found along oceans and are flooded with seawater due to tides. A temporary marsh forms when a depression in the Earth is filled with water from melting snow.

Most of the vegetation in a marsh are reeds and cattails. While in a swamp the plants are cypress and some varieties of maple and oak trees as well as woody plants such as buttonbush and swamp rose.

Marshes and swamps are rich in nutrients for plants. Bogs and fens are identified by their lack of nutrients.

Bogs are formed over hundreds or thousands of years as a result of plant matter decaying and filling a formed lake. The result are layers of peat which is

drained and burned as fuel. A second benefit of bogs is they store carbon and thus remove greenhouse gases from the atmosphere.

Fens also contain decaying plant matter, but they have a slightly higher nutrient level than a bog and they form when a water table close to the surface keeps the ground saturated. The water level may rise and fall during the year, but it must always have flowing water to be a fen. If and when the decaying material reaches too high a level the fen will turn into a bog.

What about that summer treat, marshmallows? They come from the marsh mallow plant that grows in wetlands such as marshes. The plant is native to Europe and was originally used to relieve coughs and sore throats.

Marshmallows, the treat, began in 2000 B. C. and were considered a delicacy deemed worthy only for gods and royalty. During those times, Egyptians made individual marshmallows by hand by extracting sap from a marsh mallow plant and mixing it with nuts and honey.

In the 1800s, candy makers in France took the sap from marsh mallow plants and combined it with egg whites and sugar. The mixture was whipped by hand and became the form known today.

Later, candy makers replaced the sap taken from the marsh mallow plant with gelatin, which enabled the marshmallow mixture to maintain its form and reduced the labor intensive process. The gelatin was combined with corn syrup, starch, sugar, gelatin, and water to create the fluffy texture of the marshmallow.

In 1948, Alex Doumak created an extrusion process to make marshmallows. The marshmallow substance was pressed through tubes, cut into equal pieces, cooled, and then packaged and become an everyday treat to the general public.

The marshmallow came to the United States in the 1900. Americans are now the number one consumers of the fluffy candy, buying more than 90 million pounds per year, which is more or less equivalent to the weight of almost 1,300 adult gray whales.

Experiment: How Much Air is in a Marshmallow?

Materials: Marshmallows and a coffee vacuum.

Process: Place the marshmallows in the vacuum. Use the vacuum to remove the air from the container.

Result: Marshmallows have small bubbles of air trapped inside them. These bubbles are at atmospheric pressure. When the air inside the container is sucked out, the volume of the container remains the same although there is much less air inside – so the pressure is reduced. The air bubbles inside the marshmallows are therefore at a much higher pressure than the air surrounding the marshmallows, so those bubbles push outwards, causing the marshmallows to expand. When air is let back into the container, the surrounding pressure increases again, and the marshmallows deflate back to their normal size.

WHAT IS THE DIFFERENCE BETWEEN A FOREST, A JUNGLE AND A RAINFOREST?

You may have heard the expressions, “It’s a jungle out there” and/or “You can’t see the forest for the trees”. Each contain lots of plants, but here’s how each are different.

Forests cover one third of our planet and found in every corner of the globe. They are divided into three different layers: the forest floor, the understory and the canopy. The forest floor is comprised of soil, dead plants and animals and small plants such as grasses and wildflowers. The understory contains small trees or bushes and is also called the shrub layer. The canopy is made up of the leaves and branches of the trees that dominate the forest.

Among plants, trees are by far the most effective evapo-transpirers. Complementing oceans, trees form the other half of the planet-wide system known as the rain or water cycle. A typical tree breathes out 250 to 400 or more gallons of water per day through the amazingly large surface area of its leaves. An acre of forest can contain well over 1,000 acres of leaf surface area.

If trees are clear cut over large areas, therefore, rains slow or stop downwind, describing the situation existing now over most of the U.S. Southwest. This has not always been the case here, even relatively recently. Our present Southwest is drier than that of just a couple hundred years ago—our popular view of the Old Southwest comes from cowboy movies, all filmed in modern degraded landscapes.

A rainforest is a type of forest that until the 20th century was lumped into the category of jungle. Jungle, coming from the Sanskrit word jangala meaning uncultivated land, was used by European explorers when they first visited the interiors of the South American Amazon. Used to describe tangled and impenetrable vegetation, jungle is now used as the term for the dried portions of the land area, while rainforest means a forest with several layers of vegetation and high rainfall.

Jungles cover about 20 percent of the Earth’s surface and are located in both

equatorial and tropical climates. They are usually located at the edges of rainforests and contain young trees, vines and herbaceous plants.

Tropical rainforests are located between 23.5 degrees north latitude and 23.5 degrees southern latitude and have a year round temperature of between 68 to 77 degrees Fahrenheit and most receive over 100 inches of rain per year.

Plants in a rainforest grow 82 to 115 feet tall and provide homes for a variety of wildlife including birds, bats, monkeys and snakes.

Temperate deciduous forests are located in the Eastern U.S., Canada Western Europe and parts of Russia, China and Japan. These forests experience spring, summer, fall and winter and receive about 30 to 60 inches of rain each year.

Plants here include maple, oak, some evergreens and birch trees which provide shelter for a range of animals who can survive cold weather such as land animals like the fox and birds including woodpeckers and hawks.

Temperate coniferous forests are found along coastal areas where there are mild winters and rainfall ranges from 50 to 200 inches per year. They can be found in America's Pacific Northwest and Southwest as well as in Canada, South America, Japan, New Zealand and parts of Europe.

The most common tree is the evergreen including pine, spruce, and cedar as well as many fern plants. This forest is home to deer, elk, black bears and the spotted owl.

The boreal forest is found between 50 and 60 degrees north latitude in Canada, Asia, Siberia and Scandinavia. Receiving between 15 and 40 inches of rain per year, these forests exist with short summers and long winters.

Trees that grow here are evergreens such as fir and pine and they provide a home for animals who can survive a long cold winter including moose, caribou and the snowshoe hare.

In popular movies, the jungles and rainforests are places of the mysterious quicksand which always traps the bad guy (and sometime the beautiful woman waiting to be rescued by the handsome leading man). What is quicksand? Quicksand is a thick, liquid mixture of sand and water that can't support any weight. Can you drown in quicksand? Contrary to Hollywood movies – no. You would only sink half way, but without traction in the goo you will be stuck and need someone to help pull you out.

Quicksand can form in the areas between jungle and rainforest but can also be found in the U.S. in New Jersey, South Carolina and Florida. Quicksand may occur anywhere where there is sand and rising water.

When hydraulic pressure forces water up into sandy deposits but there is not enough pressure to force a water runoff, quicksand forms. It can also form during an earthquake when vibrations in the Earth shake up wet sand and even soil and cause this land become liquid.

Experiment: How Does Quicksand Work?

Materials: Two cups of corn starch, six tablespoons of water, small soup bowl and a spoon.

Process: Place the corn starch in the bowl. Slowly add water and stir – you want the mixture to be semi-hard with a thin layer of water on the top

Tap your fingers on top of the mixture and feel how it seems solid under the thin layer of water

Now push one finger into the center of the mix in the center of the bowl. Once at the bottom of the bowl, slowly pull your finger out and you will feel a tug as you pull out of the mix.

Result: Quicksand is sand which has become so saturated with water that the friction between sand particles is reduced. Once in quicksand you will sink about waist deep, however the lack of traction will keep you from pushing yourself out.

Experiment: How Do Trees Create Oxygen?

Materials: Green leaf, glass bowl, water, sunlight and magnifying glass

Process: Cut a green leaf off a tree. Fill the bowl with water. Place the leaf on top of the water. Leave the bowl in the sunlight for an hour.

Result: Use your magnifying glass to observe tiny bubbles on the sides of the bowl. These bubbles are oxygen. The leaf takes in carbon dioxide and put out oxygen.

Experiment: How Do Trees Create Fresh Water?

Materials: Plastic bag, twisty tie, and healthy tree.

Process: During spring and/or summer place the plastic bag over a health large group of leaves and tie the bag around the stem, tightly so it will not fall off but not so tight it damages the steam. Leave in place for one week and then observe what has happened.

Result: A clear plastic bag sealed around a branch allows photosynthesis to continue, but traps the evaporating water causing the vapor pressure of water to rise to a point where it begins to condense on the surface of the plastic bag. Gravity then causes the water to run to the lowest part of the bag.

HOW DO CONTINENTS FORM?

Geologists say the Earth is 4.54 billion years old, but how do they determine the age of the planet? All rocks and minerals contain long-lived radioactive elements that were incorporated into Earth when the Solar System formed. As these radioactive elements break down over time the changes that occur allow geologists to determine the age of the rocks.

The oldest rocks found on the Earth are tiny zircon crystals found in sedimentary rocks in Western Australia. Scientists believe these rocks are about 4.2 billion years old. Meteorites, fragments of asteroids that have struck the planet, have been found to be between 4.4 and 4.6 billion years old.

A study of these rocks gives scientists an age for the Earth based on the time required for the lead isotopes in four very old lead ores to have evolved from the composition of lead at the time the Solar System formed, as recorded in the Canyon Diablo iron meteorite. Thus the age of 4.54 billion years.

The Earth is constantly moving under our feet because the continents are constantly changing, moving and rearranging themselves over millions of years. The change is so slow we don't notice it on a daily basis but this movement affects the Earth's climate and biology. How does this happen?

Our planet has five interior levels: the inner core, outer core, mantle, upper mantle, and the crust. The crust and the part of the upper mantle form the lithosphere, a portion of our planet that is basically rigid, solid rock. This is where we live.

The lithosphere is divided into roughly two dozen major and minor plates, and these plates move very slowly over the almost fluid-like asthenosphere. There are two types of crust: oceanic crust and continental crust. Predictably enough, oceanic crust makes up the ocean beds and are much thinner than their continental counterparts.

Plates can be made up of either oceanic or continental crust, or just as often some combination of the two. There are a variety of forces pushing and pulling the plates in various directions, and indeed that's what keeps Earth's crust from being one solid landmass and keeps the landmasses moving over millions of years.

There are convergent boundaries, in which two plates smash into each other. Two possible things can happen here - either one plate slips underneath the other and is subsumed and destroyed in the furnace of Earth's mantle, or the two plates collide and force up huge mountain ranges. These collisions are also often responsible for volcanism and earthquakes.

What is the difference between rocks and minerals that form the Earth? A mineral is a naturally occurring, inorganic compound with a unique chemical structure and physical properties. A rock is a solid, stony mass composed of a combination of minerals or other organic compounds. For example, quartz and feldspars are minerals, but when formed together, they make a rock, granite.

An easy way to remember the difference is to imagine our planet is a cookie. Let's say a plain sugar cookie represent a mineral. Thus chocolate chip cookies would represent the rocks because they are plain cookie plus chocolate.

Experiment: How Do Rocks Become Sand?

Materials: Sandstone, water, bowl and a freezer.

Process: Place the sandstone in a bowl of water. Let sit for a few days until saturated. Remove the rock and place in a freezer. Let freeze for several days. Remove and observe the cracks in the rock. Repeat over this process over a month.

Result: The water will sweep into small cracks in the rock, freeze, expand and the force of the expansion will crack the rock. As this happens again and again the rock would be dissolved into small grains of sand.

Experiment: Can a Rock Float?

Supplies: Small sedimentary rock, pumice stone, two bowls of water.

Process: Fill the two bowls with water. Ask participants will these rocks float? Drop the sedimentary rock – it sinks; the pumice stone floats.

Result: Pumice is an extrusive igneous rock that has a lower density than an equal volume of water. Pumice forms from an airborne, rapidly cooled frothy magma, full of tiny gas pockets, making it extremely light in weight.

Experiment: How Does Movement of the Planet's Crust Create an Earthquake?

Materials: One inch thick of 12 inch square foam board, rocks, and scissors

Process: Cut the foam board in half to represent a fault, the place where rocks in the Earth's crust break apart. Place the two pieces together and place a handful of small rocks on top of the board (you can use dirt but rocks are less messy.)

Move the two pieces back and forth against each other to represent a strike-slip fault. Next move one piece up and one down next to each other to represent a normal fault. Finally move one piece over the over to represent a thrust fault.

Result: When rocks move laterally relative to each other, they create a strike-slip fault. An example of this is the San Andreas Fault in California. When one piece of crust falls relative to another, this is a normal fault. Normal faults exist along the boundaries of rift valleys, such as Death Valley in California and the Rhine Valley in Germany. When one piece of crust moves over or under another, it creates a thrust fault. Thrust faults bound the entire Pacific Ocean Basin.

Experiment: Why does Wet Sand Stick Together and Dry Sand Fall Apart?

Materials: Sand, water and paper cup

Process: Fill one cup with loose dry sand. Ask a person to take a handful of sand and make a ball. Now add a little bit of water to the sand and make the same request.

Result: There are small particles of air between the grains of sand forcing the grains apart so you cannot make a ball or any structure with the sand. The small amount of water replaces the air and forms a bond with the sand and thus you can make a structure.

WHERE DOES FRESH WATER COME FROM?

Seventy percent of the Earth's surface is covered by ocean water, salt water, yet humans and land creatures need fresh water to exist. How does the planet turn ocean water into the fresh water found in rivers and streams every day?

The process begins with the ocean where scientists say life began and which is still home to most of the life on the planet.

The number of fish species on the Earth is a mystery. Scientists know there are at least 20,000 but there may be as many as 20,000 more still undiscovered.

More than 50 feet in length and weighing several tons, the whale shark is the largest fish. The smallest fish is the goby, a resident of the Philippines, this fresh water fish seldom grows to more than ½ an inch as an adult.

It is believed the hagfish, also known as a slime eel, represents the most primitive fish. They live in warm water oceans and range in size from about 8 inches to 50 inches in length. In answer to a popular question - fish do not sleep. Fish do rest in a form of what we humans would call day dreaming. They usually enter this state while floating in place, hiding in coral or in mud and yet remain alert to danger.

Along with sea and land creatures that eat fish, humans consume over 100 million tons of fish worldwide each year. In coastal countries, over 50 percent of the population's food source is fish, according to a 2005 Italian study.

The majority of fish live in the oceans where 97 percent of the world's water is found. Of the three percent fresh water on our planet, 69 percent is stored in glaciers and icecaps. Almost all the remaining fresh water is ground water. Less than 0.3 percent of fresh water is in rivers, lakes, ponds and streams according to the U.S. Geological Society. The water on our planet today is the same water that existed millions of years ago. Our planet's water is recycled every day.

Experiment: How Does the Water in Oceans, Rivers and Lakes Recycle?

Materials: Water, Ziploc bag, sunny window on a hot day, masking tape

Process: Half fill a Ziploc bag with water. Seal the bag shut. Tape the bag to a sunny window in the morning of a hot day. Return in the afternoon and observe the bag.

Result: The heat from the sun turns the water into moisture that rises in the bag and then condenses and rolls back into the water at the bottom of the bag. On the Earth, the water rises into clouds and returns as rain, snow, sleet etc.

HOW DID THE GRAND CANYON FORM?

When visitors arrive at the Grand Canyon they all have the same first impression, big is too small a word to describe this land formation.

The Paiute Indian tribe gave the landform the name Kaibab, which means "mountain lying down" or "mountain turned upside down."

It's believed that Spanish explorers and soldiers, traveling with Hopi guides, reached the canyon in 1540. The next contact with the site from Europeans didn't come until 1776, and then not until the 1820s.

Civil War veteran John Wesley Powell, who charted the Colorado River's course in 1891 and 1892 in a wooden boat, was the first to consistently use the name "Grand Canyon." Its average depth is about 1 mile, though the canyon the depth ranges from 2,400 feet deep below Yavapai Point on the South Rim to 7,800 feet deep at the North Rim. The canyon is 277 miles long.

At its narrowest, at Marble Canyon in the Grand Canyon is only 600 yards across. At its widest, the canyon spans 18 miles. On average, the canyon is only 10 miles wide from rim to rim. Up for a trip? Crossing by foot takes 21 miles and driving by car is a 251-mile, five-hour odyssey.

Impressive but not the largest on the Earth. That title belongs to Yarlung Tsangpo Grand Canyon in the Himalayas which is the world's longest and deepest canyon. Its depth reaches 17,567 feet and its length 308 miles. Australia wins the prize for the world's widest canyon, with its Capertee Valley edging out the Grand Canyon at a little more than 18 miles wide.

The Grand Canyon was formed by the Colorado River that cuts through schist, a type of metamorphic rock that is 1.75 billion years old. Because they are metamorphic rocks, which form from the alteration of other rocks under high temperatures and pressures, these schists represent even more ancient marine and volcanic rocks.

Weather at the Grand Canyon includes all four seasons from deep snow falls to serious hot days. The South Rim, where Grand Canyon Village is located is 7,000 feet above sea level. This means a chance of snow in winter and cool nights in summer. High temperatures range from the 70's to 80's in the summer months during the day to 30's and 40's during the winter.

Below the rim the summer temperatures along the Colorado River at the canyon bottom can reach as high as 120 °F. In the winter the temperature ranges from a low of 20 °F to a high of 43 °F.

During July and August, the canyon has some rain almost every afternoon. Snow in the canyon can range from a few inches to snowstorms of over five inches a day which normally occur two or three times a year. Blizzards that dump ten inches or more in one day are rare events in the canyon.

Experiment: How Does Erosion Change the Land?

Materials: Five cups of sand, clear container to hold the sand, cookie sheet and seven cups of water.

Process: On top of the cookie sheet, pile the sand into the shape of a hill. Slowly pour a little water, about a ½ cup, over the top of the hill and observe the water make channels in the sand as it moves some sand down towards the cookie sheet. Now quickly pour all the water over the sand hill and observe.

Result: The channels in the sand are is erosion in action, the carrying away of soil by water. This is what formed the Grand Canyon. However, the heavy pour of water over the sand hill demonstrates a landslide in action. When there is just too much water between sand grains and the soil slope collapses.

WHAT IS A GEYSER?

A geyser is a vent in Earth's surface that periodically ejects a column of hot water and steam. A geyser erupts when superheated ground water, confined at depth, becomes hot enough to blast its way to the surface.

Geysers are hot springs with constrictions in their plumbing, usually near the surface, that prevent water from circulating freely to the surface where heat would escape. The constriction is caused by sinter, a dissolved volcanic rock that forms the geyser cone and is found on the walls and sides of the geyser vent.

The process begins when cool ground water near the surface percolates down into the earth. As it approaches a heat source below it is steadily heated towards its boiling point. When water converts into steam at surface conditions it undergoes an enormous expansion because steam occupies 1600 times as much space as the original volume of original water.

In a geyser, deep below the ground, the weight of cooler water above produces a high confining pressure. This is a condition called, superheated. The superheated water is unable to expand because of the high confining pressure.

As the water temperature continues to rise, eventually the deep water becomes hot enough, or the confining pressure is reduced, and the frustrated water explodes into steam in an enormous expansion of volume. Bubbling upward, the steam expands as it nears the top of the water column. At a critical point, the confined bubbles actually lift the water above, causing the geyser to splash or overflow.

Tremendous amounts of steam force water out of the vent, and an eruption begins. Water is expelled faster than it can enter the geyser's plumbing system, and the heat and pressure gradually decrease. The eruption stops when the water reservoir is depleted or when the system cools. The tallest active geyser in the world is Steamboat Geyser in Yellowstone National Park. Some of its eruptions blast water as high as 400 feet into the air. However, it has erupted fewer than ten times in the last twenty years.

The United States has the most geysers in the world and the most famous, Old Faithful. It was named by the Washburn – Langford- Doane Expedition of 1870

Located in Yellowstone National Park, Old Faithful erupts every 35 to 120 minutes and blasts a few thousand gallons of boiling hot water between 90 and 184 feet into the air. The eruption lasts between 1.5 to 5 minutes in duration and expels from 3,700 to 8,400 gallons of water each time.

The longer the eruption the longer the time between eruptions. For example, a 2 minute eruption equals about 55 minutes before the next eruption.

There are also geysers in Alaska, California, Nevada and Oregon. Other countries with geysers include Russia, Chile, New Zealand and Iceland.

The source of heat for both volcanoes and geysers is geothermal reactions. Both erupt, under increased temperature and pressure through vents, holes, cracks etc. into the earth surface. Volcano lava can reach between 2,200 degrees and geyser steam can reach 212 degrees.

Experiment: How Can You Demonstrate a Geyser?

Materials: Two liter bottle of soda and a roll of Mentos candy unwrapped

Process: Do this outside in an area easy to wash off, as this will make a large mess, sometimes as high as a 15 foot soda geyser. Open the soda bottle. Quickly drop all the candies into the soda.

Result: The physical texture and the sugary ingredients in Mentos accelerates the release of bubbles caused by molecules of dissolved carbon dioxide in the soda.

WHAT IS THE EARTH'S MAGNETIC FIELD?

Have you ever watched a flock of birds migrating south for the winter and wondered, how do the birds know what path to follow to reach their destination?

It's an answer scientists still seek. They know it has to do with the magnetic field of the Earth. Dr. David Keays and coworkers from the Research Institute of Molecular Pathology in Vienna believe birds use the Fe balls inside their cells and their beaks as sensors of earth's magnetic field that leads the birds in their long flights. This research continues.

Humans have no such built in sensors and over time have sought many ways to find their path across the Earth such as hikers knowing moss grows on the north side of trees. This is because moss prefers dark, damp areas to grow. Thus, because the sun shines from the south in the Northern Hemisphere, the north side of the tree will tend to be the shadiest and also the dampest and most moss will grow on the north side. This does not work in a dense forest where moss grows equally on both sides of the tree and of course is reversed to the south side of the trees in the Southern Hemisphere. The most common and practical travel tool for humans is the compass created in China around 206 BC. The earliest compasses were lodestones. This mineral is made of iron oxide which orients itself to a north and south axis.

In the 8th century AD in China, magnetic needles replaced the loadstones as navigational devices. From the 8th century to the 1050s the compass was reportedly being used by ships.

The earliest record of magnetic needles being used in was a reference in Paris in 1190. The modern history of what we today refer to as a compass began with William Sturgeon's invention of the electromagnet in 1825.

Since that time, a number of different compasses have been created including the bearing compass in the early 18th century. In 1885, the hand compass was patented. Sir Edmund Halley, famous astronomer from England, demonstrated a prototype of the liquid compass in 1690.

How does a compass work? Scientists believe the Earth's core consists mostly of molten iron. At the very core of the planet, the pressure is so great that this superhot iron crystallizes into a solid. Convection caused by heat radiating from the core, along with the rotation of the Earth, causes the liquid iron to move in a rotational pattern. It is believed that these rotational forces in the liquid iron layer lead to weak magnetic forces around the axis of spin.

It turns out that because the Earth's magnetic field is so weak, a compass is nothing but a detector for very slight magnetic fields. To understand why the compass needle always points north, imagine the Earth with a gigantic bar magnet buried inside. In order for the north end of the compass to point toward the North Pole, the imaginary buried bar magnet must have its south end at the North Pole. Because magnets opposites attract, the compass always points north.

Experiment: How Can You Make a Compass?

Materials: One inch sewing needle, cork from a wine bottle, magnet, water, clean empty clear jar.

Process: Rub the needle against the magnet making sure to rub in the same direction 50 times. Put the needle through the cork. Fill the jar with water. Place the needle in the cork in the jar and make sure it can float.

Result: The magnetized needle in the jar will face north.

WHY IS NORTH UP?

Did you ever wonder why the United States is in North America and Brazil is in South America? Who decided that the North Pole is at the top of the world and the South Pole is at the bottom of the world?

That, as they say, is ancient history. In primitive times, as now, people learned a great deal of information from observing the world around them. They noticed that the sun which provided warmth and helped them grow plants, was above them, in other words, up.

They saw bugs, rats, mice in dirt and mistakenly believed these creatures sprung from the dirt that was below their feet, in other words, down. Thus, they determined heaven and all good was up and hell, what was bad, was down.

Early map makers drew the planet as the European and Asian continents surrounded by one giant ocean. They didn't know any other land masses existed until the time of the ocean explorers.

Ocean sailors, especially Columbus, did not believe the Earth was flat. They did fear sea creatures and finding their way home in unfamiliar waters, however the early Greeks knew the planet was round due to the movement of the stars.

In 340 BC Aristotle wrote the book, *On the Heavens*, in which he noted that the stars are different depending on your location on the planet. For example, the North Star is close to the horizon in Egypt and higher in the sky in Greece. Why does that happen?

He concluded the stars position would only change in relation to the view if the Earth were round. If you stand at the North Pole the North Star is directly overhead, but at the equator the North Star is down on the horizon because you traveled along a curve.

Traveling further south, the North Star will be hidden by the curve of the earth, yet go further north and as you walk the North Star will rise higher in the sky.

After the Americas are discovered, European map makers begin work on the maps we know today. Since they were making the maps, they oriented the planet to themselves.

The truth is a space craft coming from another planet would see north and south from the perspective inside the craft. An alien visitor may draw Antarctica as the top of the world!

Back on Earth, flying in a plane gives the pilot and passengers a great view of the planet. The curve of the planet allows Greg Hillard, pilot for U.S. Air, to sometimes surprise his passengers with the following question: How can a jet pilot make the sun 'appear' to rise in the evening?

“If the sun is setting at take off at 8 p.m. and the plane climbs to 2000 feet per minute, the plane will actually exit the Earth’s shadow out pacing the rate the sun is setting. Thus the sun will appear to rise at 8 p.m.,” he said. “Also, when the sun sets the higher clouds are still illuminated, so sunset is actually later at a high altitude.”

Experiment: How Far Can You See at the Horizon?

Materials: Stand in an area with a clear view all the way to the horizon.

Process: Look out towards the horizon. The distance you can see is based on your height. Thus, for example, a five foot tall person can see about three miles.

Result: The math to calculate the exact distance to the horizon is: Distance to horizon = Sq root of, (radius of earth + height above ground)² - radius of earth²)

Nature Trivia

- 1) How did the solar system begin? Answer - Our solar system, one sun and eight planets, formed as a result of a shock wave from an exploding star, supernova, which triggered the collapse of a dense, dusty gas cloud, which then contracted to form the Sun and the planets.
- 2) How old is the Earth? Answer - Our planet Earth was formed some 4.5 billion years ago. In the beginning, the Earth had no atmosphere, no water and was hot rock and gases formed out of a solar nebula.
- 3) How did the Moon form? Answer – Scientists believe the Moon formed 4.533 billion years ago, about 70 million years after the formation of the Earth, when a Mars-sized body collided catastrophically with the Earth, throwing many trillions of tons of magma and rock into Earth's orbit. This material coalesced and cooled to become the Moon.
- 4) What is a volcano? Answer - A volcano is an opening in the Earth's crust where magma from the mantle reaches the surface. If it is in dribbling fashion it is called an effusive eruption. When violent it is called an explosive eruption. Volcanoes usually occur in divergent boundaries between tectonic plates, places where the Earth’s crust is weak.
- 5) What is the difference between magma and lava? Answer – When magma exits the volcano and lands on the Earth’s surface it is call lava.
- 6) How many volcanoes are there on the Earth? Answer – There are thousands, some perhaps still unknown, as one was discovered in 2013 under the Pacific Ocean. They are located on every continent and scattered across the ocean floor.

- 7) What are some famous volcanos? Answer - Mount Etna in Sicily, Mount Vesuvius in Italy, Mount Merapi in Indonesia, Sakurajima in Japan, Mauna Loa in Hawaii, Mount Rainier in Washington, USA, and Mount Erebus in Antarctica.
- 8) What American state was formed by a volcano? Answer - Volcanic activity is how the Hawaiian Islands formed. Measured from its' beginning on the ocean floor to its height in the clouds, Mauna Loa in Hawaii is actually a taller mountain than Mt. Everest in Nepal.
- 9) What is an earthquake? Answer – An earthquake is a shaking of the ground caused by the sudden movement of tectonic plates in the Earth's of the earth's rocky outermost crust. The edges of the tectonic plates are marked by faults.
- 10) Why do earthquakes occur? Answer - Most earthquakes occur along the fault lines when the plates slide past each other or collide against each other.
- 11) What is the epicenter of an earthquake? Answer – The hypocenter is the below surface location where the earthquake begins and the epicenter is the surface location directly above the hypocenter.
- 12) Are there different kinds of earthquakes? Answer – There are three types:

Thrust fault – The most violent when ocean crust move beneath continental crust, creating great friction and can release energy equal to a thousand hydrogen bombs.

Normal fault happens when Earth's brittle crust becomes fractured along fault lines and two sides the two sides move apart. The rock slabs sitting above the fault slide down in the direction the plates are moving.

A strike- slip fault happens when in the crust two plates are slide horizontally past each other.

- 13) Where are the most earthquakes occurring? Answer - Earthquakes mostly occur in places where there is a Fault Line such as: North and South America, Japan, Australia, Africa, Philippines, India, Caribbean and Haiti.
- 14) Where are the most earthquakes in the US? Answer - Alaska is the most earthquake-prone state. It experiences a magnitude 7 earthquake almost every year, and a magnitude 8 or greater earthquake about every 14 years.
- 15) What is a landslide? Answer - A landslide is a down slope movement of mass soil and/or rock that happens when gravity exceeds the strength of the earth materials.
- 16) How old are Moon rocks? Answer – Rocks collected during the Apollo missions date the moon to about 4.4 billion years old.
- 17) What is a glacier? Answer - Glaciers are made up of fallen snow that, over many years, compresses into large, thickened ice masses. Glaciers form when

snow remains in one location long enough to transform into ice. What makes glaciers unique is their ability to move. Due to sheer mass, glaciers flow like very slow rivers. Some glaciers are as small as football fields, while others grow to be dozens or even hundreds of miles long.

18) How much of the planet is covered in glaciers? Answer - Glaciers occupy about 10 percent of the world's total land area, with most located in polar regions like Antarctica, Greenland, and the Canadian Arctic. Glaciers can be thought of as remnants from the last Ice Age, when ice covered nearly 32 percent of the land, and 30 percent of the oceans

19) How much oxygen does a tree generate? Answer – A 50 year old tree will have contributed 120 pounds per year or 6,000 pounds of oxygen per its lifetime.

20) What is an example of quicksoil forming? Answer – In Port Royal, Jamaica in 1692 the vibrations from an earthquake liquefied the land and thus buildings and people were sucked into the land.

EXPERIMENT LOG

Walt Disney was fired in 1921 and told he had “No imagination”. He invented the multiplane camera brought better looking, richer animation and in 1937, Snow White and the Seven Dwarfs was the first full-length animated film to use the camera. Record your experiment results here:

Results: _____

Results: _____
Results _____
Results _____

SPACE

IS THERE LIFE IN SPACE?

One of the greatest questions faced by humans is: Are we alone in the universe? It's a big questions because it's a huge universe. It is estimated there could be 40 billion Earth sized planets according to preliminary studies from scientists using NASA's Kepler Space Telescope.

The Search for Extraterrestrial Intelligence (known in popular culture as SETI) began in 1960 using a 26-meter radio telescope. The first SETI conference was held in 1961 and the former Soviet Union began searching with omnidirectional antennas during the 1960s.

In 1979 the University of California, Berkley began a SETI project. Congress funded the project until 1981, then restored funding in 1982, until finally canceling all funding in 1994. Private donations have continued SETI since that date using satellite dishes 10 foot by 16 foot and research grade radio telescopes. While so far no life has been detected off the planet Earth. However, researchers have explained that humans have searched such a small part of the universe compared to its actual size that saying there is no life at this point in the search would be like filling an 8 ounce container with sea water at the shore and announcing the search for ocean life produced no results.

Looking for life in our own solar system, in 1969, the U.S. sent the first humans to the moon. We did not find any signs of past or present life on the moon.

Scientists have studied Mercury, the planet closest to the Sun, and found it is too small and too weak to hold an atmosphere.

Probes of Venus, second planet from the Sun, have found temperatures of 870 degrees, carbon dioxide and sulfuric acid clouds and a surface pressure 90 times greater than the Earth.

Mars has been studied by roving robots from Earth beginning in 1976. Scientists have and found a planet with no magnetic field, less atmosphere than Earth, lots of dangerous space radiation, but no life.

Space probes, Voyager 1 and Voyager 2 launched in 1977, have photographed Jupiter, Saturn, Uranus, Neptune and Pluto and as of this date have left the solar system. Each contains information on Earth, hello in every language and a map on where to find humans, but so far no one has returned the greeting.

However, on the way through the solar system, scientists learned more about Europa. This is an icy moon of Jupiter that might be a location for life beyond Earth. In 1997 NASA's Galileo spacecraft took photos of ice flows thought to be the result of ice volcanoes and geysers on Europa.

The moon is covered in ice, but volcanoes and/or geysers indicate heat, which along with water is essential for life. Researchers believe under the ice could be a large salty ocean. Since life on Earth began in the ocean and since most of the life on the Earth today lives in the ocean, the hope is there may be some life found on Europa.

NASA has budgeted \$30 million in the 2016 budget to build a spacecraft to explore Europa that would launch in 2020. It will take several years to reach the moon and once there the investigating probe would use cameras and equipment to study the icy world.

Experiment: How Can You Demonstrate the Ice Volcanoes on Europa?

Materials: Bowl, water, 9 ounce clear plastic cup, plastic sandwich box, Kool Aid, baking soda, and a baking tray.

Process: Fill the bowl $\frac{3}{4}$ full of water. Place the cup upside down at the bottom of the bowl and hold in place by placing a sandwich container full of water on the bottom of the cup. Freeze overnight.

The next day, remove the sandwich box and bowl from the freezer. Remove the ice from the bowl and place on the tray with the cup facing up. Remove ice from the cup. Mix Kool Aid and baking soda and place in the cup. Add vinegar to the cup.

Result: This mixture will erupt due to the formation of carbon dioxide. In this demonstration, the erupting mixture will slide across the surface and not freeze. However, on Europa, where the off surface temperature in space is minus 455 degrees Fahrenheit, the erupting water from the volcano freezes instantly due to the extreme low temperature.

WHAT IS THE BIG BANG THEORY?

The universe is about 13.8 billion years old. Have you ever wondered how scientists came to that conclusion? There are actually two methods for dating the universe. Our universe cannot be younger than the objects inside itself. By learning the age of the oldest stars, scientists can determine the age of the universe. The life of a star, such as our Sun, is determined by its mass. The more mass the faster the star burns. There are also dense collections of stars known as globular clusters. Studying the oldest globular clusters researchers estimate the universe must be a minimum of 11 billion years old.

The second method is tied to the reality that the universe is constantly expanding. This was discovered by Edwin Hubble, so the equation to calculate the expansion of the universe is called the Hubble constant.

The constant is determined by the type of matter that dominates the universe and the density of the universe. This information came from space probes including NASA's Wilkinson Microwave Anisotropy Probe and The European Space Agency's Planck spacecraft. They studied the thermal radiation left over from the Big Bang, the origin of the universe.

The Big Bang states an area smaller than a marble grew in a trillionth of a second to become larger than the visible universe. Most scientists now believe the Universe sprang into existence from a singularity a term physicists use to describe regions of space that defy the laws of physics

Once the singularity was created it began to expand through a process called inflation. The Universe went from very small, very dense, and very hot to the cool expanse that we see today.

The big bang theory is based on research in 1964, when radio astronomers Arno Penzias and Robert Wilson inadvertently discovered the Cosmic Microwave Background which was evidence that the Universe had a beginning. By studying the rate of universe expansion, scientists can run the clock backwards in time to find the age of the universe.

Prior to the Hubble discovery of the universe expansion and the work of Penzias and Wilson, the origin of the cosmos was explained by the Steady State Theory. This stated that the universe while expanding does not change its appearance over time. Thus is argued the universe had no beginning and no predicted end. It required that matter be continually created in order to keep the universe density from decreasing.

The Steady State Theory was popular in the mid-20th century until disproven by Albert Einstein's Theory of General Relativity. A Quasi-Steady State Theory was proposed in 1993 which argued that pockets of new creation occurred over time, called mini-bangs or mini-creations, but flaws in this model helped to confirm the Big Bang Theory. What caused the singularity that started the Big Bang? That has scientists baffled. By definition, nothing existed prior to the beginning. A fact that creates more questions.

Astrophysicist Robert Spitzer, Ph.D., a priest with the Society of Jesuits, has pointed out that science theories must be proven through math. In math 0 plus 0 equals 0. It takes 1 plus 0 to equal 1. Therefore, if nothing existed before the universe, there must be a creator to bring the universe into being.

Experiment: How Can You Demonstrate How the Universe Began?

Materials: Air and water tight Ziploc sandwich bag, baking soda, paper tissue and water and vinegar.

Process: Place a cup of baking soda in a tissue and fold the edges of the towel. Add ½ cup of water and vinegar to the plastic bag. Drop the towel into the bag and seal *quickly*. **This will not work if the bag leaks air or water.

Result: The bag will explode from the carbon dioxide gas resulting from mixing baking soda and vinegar to illustrate how hot compact gases exploded outward during The Big Bang.

WHO CREATED TIME?

In 2014 we can access the precise moment in time by googling the atomic clock at: <http://time.is/> , but have you ever wondered how humans began tracking time?

The earliest humans awoke with the sun and worked until dark when they slept. About 2000 BC the Egyptians divided the day into the two 12 hour periods. They marked time by tracking the movement of the sun across large obelisks and sun dials. These uses the sun's shadow onto a surface marked with lines to indicate the hours of the day. All sundials must be aligned with their styles parallel to the axis of the Earth's rotation to tell the correct time throughout the year. Sun dials do not work on rainy days or cloudy days, so there were other methods.

It's believed the Egyptians as well as the Greeks and the Chinese of this period also developed water clocks and hourglasses. Sandglass hourglasses were also used by people in Tibet and Europe.

Both devices work on the same principal. Water or sand moves in a trickle between two connected vertical bulbs to measure the passage of time. A modern day example would be the egg timer. The flaw in this method is the limited size of the timer. A full day model would be too large and heavy to be practical.

Other methods used to divide the day included the candle clock in China, Japan, England and Iraq. This was a thin candle with spaced markings, that when burned, indicate the passage of periods of time. A candle clock could be easily transformed into a timer by sticking a heavy nail into the candle at the mark indicating the desired interval. When the wax surrounding the nail melts, the nail clatters onto a plate below.

Grandfather clocks began with Galileo Galilei who in the early 1600s discovered the pendulum could be used as a timekeeper. He realized a pendulum is kept in motion by two forces. Inertia gives the pendulum its tendency to remain in motion. Gravitational pull regulates this motion by compelling the pendulum to return to its resting. The distance that the pendulum can swing is always equal on both sides of the equilibrium position.

This led to the invention of the pendulum clock in 1656 by Christian Huygens, a Dutch scientist. This clock was the world's most precise timekeeper until the 1930s. Pendulum clocks must be stationary to work properly. Thus, came the pocket watch, invented in the mid-1600s, which uses a balance spring attached to a balance wheel with a regulator lever on the spring to set the speed for accurate time.

Atomic clocks, built after WWII, are the most accurate and measure time by the energy electrons in atoms emit when they change energy levels.

Experiment: How Does a Pendulum Work?

Materials: Weight from a hardware store, string, a table and a watch with a second hand.

Process: Tie the string to the weight and suspend the pendulum over the edge of the table so that the length of the pendulum is about 2 feet. Pull the weight back about a foot and let your pendulum start swinging. Time it for 30 or 60 seconds and count how many times it swings back and forth. Record the number.

Stop and restart the pendulum but pull back 6 inches. Count the number of swings in the same time period as the foot long swing.

Result: The number of swings will be the same in both experiments. The angle of the arc through which the pendulum swings does not affect the pendulum's speed.

HOW DO YOU NAVIGATE BY THE STARS?

The earliest sailors navigated the water without maps, compass or GPS systems. Historians believe the first sailors stayed on inland waters and rivers where they could visually plot their course.

Even as human sailors moved out into the oceans, they continued to pilot their ships near the shore using towns and coastline to guide their journey. The next step in navigation was as sailors began using the sun and even following the paths of migrating birds as a way to choose a direction on the water.

Eventually, sailors looked to the stars for a more reliable means of navigation. Using the North Star as a landmark, sailors sighted the star with a quadrant, an instrument that is used to measure angles up to 90 degrees, measured the angle from the horizon and identified the latitude. Once the ship reached the correct latitude, it sailed east or west to reach its destination. Sailors could tell how far they were going in either direction by locating the lines of longitude. Nautical direction was determined by the magnetic needle of a compass. In the days of sail, courses and bearings were given in points around a compass.

Thus the famous poem *Sea Fever* by John Masefield's which states, "All I ask is a tall ship and a star to steer her by..."

Unfortunately, due to light pollution many Americans and millions around the world have never seen the Milky Way Galaxy. Light pollution is excess artificial nighttime lighting which causes glare and skyglow, which is artificial light over inhabited areas. This light blocks a clear view of the sky.

If you want to find out how bad light pollution is where you live use the NASA Blue Marble Navigator for a bird's eye view of the lights in your town or check out the Globe at Night interactive light pollution map data.

Experiment: How Can You Find the North Star With a Star Chart?

Materials: Find directions on to print out and fold a star chart at the NASA site: <http://spaceplace.nasa.gov/starfinder/>

Process: The best star viewing is a clear moonless night. To find the North Star begin by locating the Big Dipper and Cassiopeia (shaped like a W). The position of the stars in the sky depends on the time, date and your geographical position. This is because of the Earth's rotation around its axis.

Starting from the Big Dipper, follow away from the Big Dipper about five times the length of the cup and you will see a medium bright star, this is the North Star. To

make sure you are looking at the North Star, look for Cassiopeia. The North Star will be located between Cassiopeia and the Big Dipper.

Result: Once you have learned to find the North Star and mastered a sky chart you can find all the 88 constellations in the Northern and Southern hemispheres.

WHAT IS THE DIFFERENCE BETWEEN A COMET, METEOR AND AN ASTEROID?

Sitting outside on a clear evening you may have seen what is called in common reference, a shooting star, and wondered, what makes that bright flash in the sky?

Shooting stars begin as meteoroids. A meteoroid is a piece of interplanetary matter that is smaller than a mile in size. Most meteoroids that enter the Earth's atmosphere are so small that they vaporize completely and never reach the planet's surface. When they do enter Earth's atmosphere, they are called a meteor or a shooting star.

A meteor is the flash of light that we see in the night sky when a small chunk of interplanetary debris burns up as it passes through our atmosphere. Meteor refers to the flash of light caused by the debris, not the debris itself.

If any part of a meteoroid survives the fall through the atmosphere and lands on Earth, it is called a meteorite. Although the vast majority of meteorites are very small, their size can range from the size of a pebble to 220 pounds or more.

The largest are asteroids which originate in the asteroid belt located between the orbits of Mars and Jupiter. Sometimes their orbits get perturbed or altered and some asteroids end up coming closer to the Sun, and therefore closer to Earth.

Comets are a rock with ice, methane, ammonia, and other compounds that develop a fuzzy, cloud-like shell called a coma, sometimes called a tail, as it gets closer to the Sun. Comets are thought to originate from two different sources. Long-period comets, such as those which take more than 200 years to complete an orbit around the Sun, originate from the Oort Cloud.

The Oort Cloud is located between 465 million and 9,300 million miles from the sun at the outer edge of our solar system. It contains about 2 trillion icy rocks. It was discovered in 1950 by Jan Oort, a Dutch astronomer. It is believed that giant molecular clouds, stars passing nearby or interaction with the Milky Way Galaxy causes some of these icy bodies to leave the Oort Cloud and pass near Earth.

Short-period comets, those which take less than 200 years to complete an orbit around the Sun, originate from the Kuiper Belt. This is a disc-shaped region beyond the planet Neptune with thousands of rocky materials, some up to 62 miles in diameter, leftover from the formation of the solar system 4.6 billion years ago. It is located between 2,790 million and 5,115 million miles from Earth and named for the astronomer Gerald Kuiper.

In 2011, astronomers using the Herschel Space Observatory studied Comet Hartley 2 and confirmed it contained Earth ocean type water. In 2015, after a European space craft successfully landed on an asteroid and found ice there is also speculation that the water you used to brush your teeth came from a mix of comets and asteroids during the early days of our planet.

Experiment: How Did Comets Bring Water to the Earth?

Materials: Clear ice tea sized glass, water and an Efferdent tablet.

Process: Fill the glass with water. Drop the Efferdent tablet into the water. Observe the bubbles streaming up the water in the glass from the dissolving tablet.

Result: Comets are like dirty snowballs leftover from the beginning of the solar system. As they pass by the hot sun some water evaporates causing the appearance of a tale. When some comets slammed into the hot forming early Earth, their melting brought water to our planet.

Experiment: How Did a Meteorite from Mars Land on Earth?

Materials: Four sheets of black construction paper, flour – enough to fill the pan, metal baking pan 9 x 11 inch, and large rock

Process: Place the black paper under the pan so the black extends beyond the edges of the pan. Fill the pan with flour. Throw the rock into the pan. Flour dust should scatter on the paper.

Result: The flour in the pan represents the surface of a planet, such as Mars. The rock represents an asteroid or meteorite slamming into the surface of the planet. When these objects hit the planet surface the force is so great that material from the planet is thrown into space, represented by the black construction paper.

The ejected material then floats in space and some material is pulled into another planet's surface by gravity. This is how a Martian meteorite, an object once found on Mars, comes to Earth.

WHAT POWERS SPACE SHIPS?

Watching NASA send a rocket into space or viewing a science fiction television show, you may have wondered, what powers the spacecraft. If you are planning on building your own for a trip into outer space there are several options.

Batteries use energy made and stored on Earth and release the energy as electricity in the spacecraft. Sound impossible? The radio transmitter on Sputnik, the world's first artificial satellite built by the Soviet Union and launched on October 4, 1957, was powered by silver-zinc batteries for 22 days before giving out.

The first spacecraft to use solar panels was the Vanguard 1 satellite, launched by the US in 1958. Solar panels are devices that convert light from the Sun into electricity. A solar panel is a collection of solar cells. The more light that hits a cell, the more electricity it produces, so spacecraft are usually designed with solar panels that can always be pointed at the Sun even as the rest of the body of the spacecraft moves around.

Radioisotope thermoelectric generators, or RTGs, which uses radioactive materials encased in a sealed shell will generate heat as they decay into non-radioactive materials and thus power a spacecraft. Electrical power is supplied by three MHW-RTG radioisotope thermoelectric generators which are powered by plutonium-238. This was method was used to launch Voyager 1 and Voyager 2 in 1977.

Voyager 1 left the solar system, entered interstellar space and became the most distant human made object in 2012. It was still running on its original power source and along with Voyager 2, the power sources are expected to last until 2025, according to NASA.

Solar power, other than propulsion, has been used by the Juno, Magellan, Mars Global Surveyor, and Mars Observer spacecraft as well as the Earth-orbiting, Hubble Space Telescope. The Rosetta space probe, launched March 2, 2004, will use solar panels as far as the orbit of Jupiter previously the furthest use was the Stardust spacecraft. Solar power for propulsion was also used on the European lunar mission SMART-1. Solar power does not work beyond Jupiter due to the decreased sunlight at the far end of the solar system.

Most of the satellites orbiting Earth are powered by solar energy. Each is equipped with solar cells that convert sunlight into electricity. The first solar cells developed in 1954 converted about 6 percent of the sunlight received into electricity. Today's solar cells can convert about 29 percent of sunlight to energy.

The Juno mission, which launched in 2011, is the first mission to Jupiter to use solar panels instead of the traditional RTGs that are used by previous outer solar system missions. It has 60 square miles of panels. Another spacecraft of interest is Dawn which went into orbit around 4 Vesta in 2011. It is using ion thrusters to get to Ceres in the asteroid belt.

Other power sources are fuel cells which work somewhat like batteries, storing power in the form of separated oxygen and hydrogen. A thin membrane between the two elements harnesses the energy separated when the oxygen and hydrogen combine to form water. Alkaline fuel cells have been the primary source of electrical power on human spaceflight systems for over four decades, according to NASA. The space agency is working on improved fuel cells which can be used in spacecraft that operate at extreme altitudes and low temperatures for extended durations.

Ion propulsion uses ions, which are atoms and molecules electrically charged and extracted from plasma, an electrically neutral gas. This method could be used to send a spacecraft to Mars in 39 days rather than the conventional fuel method of six to nine months of travel.

An idea straight from the pages of science fiction is the use of solar sails that allow a spacecraft to harness the miniscule but continuous push imparted by photons streaming from the sun. This propellant-free propulsion strategy holds great promise, potentially allowing spacecraft to cruise around the solar system cheaply and efficiently, according to the non-profit Planetary Society which launched a test sail in 2015.

Experiment: How Does Energy Drive a Space Ship through Space?

Materials: Balloon, straw, string, tape and two chairs of equal size and shape about six feet apart.

Process: Cut a seven foot length of string. Thread the string through the straw. Tape the string to the chairs so it is tight between the chairs. Pull the straw along the string so it is nearest to one chair. Blow up the balloon and pinch shut. Tape the balloon parallel to the straw. Let the air out of the straw.

Result: The air escaping from the balloon will push the balloon forward along the various power sources create energy for the space ship. This is due to Isaac Newton's third law of motion, "to every action there is an equal opposite reaction."

Experiment: How Do Satellites Stay in Orbit Around the Earth?

Materials: Yoyo

Process: Unroll the string from the yoyo. Hold one end of the string and spin the yoyo quickly in a circle above your head.

Result: The satellite is represented by the yoyo. Satellites stay in orbit due to the balance of two factors: the speed at which the satellite would travel in a straight line and the gravitational pull between the Earth and the satellite.

HOW MUCH OF SCIENCE FICTION IS REAL SCIENCE?

Jules Verne, the father of science fiction, believed all good science fiction was based on science fact. Is that true in cinema? The answer lies in the movie. For example:

Star Wars, *Star Trek*, and any other movie where space ships fire on each other and the audience hears the space battle – the sound is false. Space is a vacuum so you would never hear a space ship’s engine or weapons.

Terminator and all other gun fights – where the bad guy falls backward from the impact of the super bullet but the good guy is still upright – that scenario is false. The fact is when the bullet moves forward the force also pushes back on the person firing the gun. The person being shot would feel the impact but the shooter would also be knocked down by the recoil force.

Deep Impact, *Armageddon* and other movies - where an asteroid, comet or meteor is going to wipe out a huge section of the Earth. This is true. A seven mile wide comet, as in *Deep Impact*, would hit the Earth with a force of millions of Hiroshima sized atomic bombs a cause giant tidal waves that would swamp huge sections of our planet. As for saving the Earth by flying to the oncoming space rock and then blowing it up using an atomic bomb, that is false. You would need the simultaneous detonation of 10,000 atomic bombs.

Jurassic Park and other dinosaur movies – where the T. Rex dinosaur out races a speeding car is false. T. Rex’s top speed was 20 miles per hour. As for dinosaurs stalking humans and opening doors, also false, scientists believe cows are smarter than T. Rex.

Independence Day and destruction by large alien spaceships – where the hovering ‘Mother Ship’ orbits the Earth while sending out thousands of smaller crafts against the Earthlings. If, as reported in movie, the ‘Mother Ship’ is larger than the moon

there is no need for smaller attack ships. The gravity force from the Mother Ship so close to our planet would create a tug on the Earth's oceans and cause worldwide flooding.

Experiment: What Would Happen if a large Asteroid hit the Earth's Oceans?

Materials: Plastic baking pan, step ladder, water and large rock.

Process: Fill the pan with water to represent the ocean. Stand on the top of the step ladder, you represent space, and drop the rock, representing the asteroid, into the pan.

Result: The splashing water represents how the ocean water would swamp the land during impact.

SPACE TRIVIA

- 1) What is a solar system? Answer - A solar system consists of a star and all the objects orbiting it as well as all the material, such as planets and moons, in that system.
- 2) How many planets in our solar system? Answer – Eight. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune
- 3) What happened to Pluto? Answer - On August 24, 2006, the International Astronomical Union (IAU) defined what it means to be a planet and excluded Pluto as a planet because of its small size, 15 times smaller than the Earth, and irregular orbit around the sun. It was categorized as a dwarf planet.
- 4) Why is Earth the only planet in our solar system where life has been proven to exist? Answer – It is the only planet in our solar system with everything life needs to survive: air, water, and land. It is also called the “Goldilocks” planet because it is not too hot or too cold for life, as we know it, to exist.
- 5) What are the terrestrial planets? Answer: Mercury, Venus, Earth, and Mars because of their rocky composition.
- 6) What is the largest planet? Answer – Jupiter. It is 1300 times the volume of Earth.
- 7) What is the smallest planet? Answer - Mercury is the smallest planet. It has a diameter is about 3032 miles; just slightly larger than the moon.
- 8) How big is the sun? Answer – 1.3 million Earths can fit inside the sun.
- 9) How old is the universe? Answer – 13.79 billion years old.
- 10) How old is our solar system? Answer – 4.5 billion years old.

- 11) What cosmic body is bigger and contains our solar system? Answer - The Milky Way Galaxy is a spiral galaxy consisting of over 400 billion stars including our sun.
- 12) Who was the first human in space? Answer - Russian cosmonaut Yuri Gagarin on April 12, 1961 became the first human in space, making a 108-minute orbital flight in his Vostok 1 spacecraft.
- 13) Who was the first human to walk on the moon? Answer - Neil Armstrong on July 20, 1969, became the first human to step on the moon.
- 14) When was the last human trip to the moon? Answer – December 1972, Apollo 17 astronauts Eugene Cernan and Harrison Schmitt.
- 15) What was the first mission to Mars? Answer - Mariner 4 sailed past Mars while taking 21 photos on July 14, 1965. These were the first photos beamed back from another planet.
- 16) When was the first space shuttle launched? Answer - The Space Shuttle *Columbia*, launched on April 12, 1981 and returned to Earth on April 14, having orbited the Earth 37 times during its 54.5-hour mission.
- 17) When did space craft Voyager leave the solar system? Answer – Voyager 1 launched in 1977 left the solar system around August 25, 2012, according to NASA.
- 18) Who is the oldest astronaut? Answer - John Glenn at age 77 in 1998. He is also the first American to orbit the Earth in 1962.
- 19) When was the International Space Station built? Answer - The International Space Station first component was launched in 1998. It has been occupied since November 2000.
- 20) What are exoplanets? Answer – Exoplanets, also called extrasolar are planets, are located outside of the solar system. The first was discovered in 1992 and since then over 600 have been found.

EXPERIMENT LOG

Robert Goddard, the father of space rockets, was told in a *New York Times* editorial that he lacked, “the basic physics ladled out daily in our high schools”. Goddard achieved the first successful flight with a liquid-propellant rocket on March 16, 1926. Fueled by liquid oxygen and gasoline, the rocket flew for only two and a half seconds and became the forerunner of a whole new era in rocket flight. Record your experiment results here:

Results: _____

Results: _____

LIFE ON EARTH

HOW DOES A HEART BEAT?

The human heart is an amazing organ. In children it is about the size of a child's closed fist. In an adult, it is the size of about two closed fists. It beats about 100,000 times per day for an average of about 35 million times a year.

How it works. Oxygen poor blood flows from the body into the right atrium and then into the right ventricle. Next, the right ventricle pumps the blood to the lungs where waste gases are released and oxygen picked up by the blood. This oxygen rich blood returns to the heart through the left atrium into the left ventricle and oxygen rich blood is pumped throughout the body.

Adult humans have about 6 quarts of blood which circulates through the body three times per minute. Every 24 hours, each person's blood travels the equivalent of 12,000 miles which would be like traveling four times coast to coast across the U.S. The one million barrels of blood pumped in the average person's lifetime would fill more than three super tankers.

Doctors and nurses listen to human hearts with a stethoscope. This device was invented in 1816 by French physician Rene Theophile Hyacinthe Laennec after he observed children listening to sound through a hollow piece of wood.

Experiment: How Does a Human Heart Pump Blood?

Materials: Sixteen inch length of garden hose, tennis ball, drill, bucket, water and volunteer.

Process: 1) Place one end of the 16 inch length of garden hose on the volunteer's heart and the other end at the volunteer's ear. Result: Hear a heartbeat.

2) Drill a small hole in a tennis ball and fill the ball with water. Squeeze the ball until the water empties. Result: This action demonstrates how ventricles pump blood.

3) Pump the tennis ball up and down in the bucket of water.

Result: This demonstrates how the heart pumps blood in and out.

WHAT'S IN THE AIR?

How often have you heard someone say they want to, "go outside and breathe in the fresh air"? And how many speak of feeling better when sitting in the garden. Is it just a feeling or is it something more? Researchers at the University of

Edinburgh decided to try to learn the answer. The study, “The urban brain: analyzing outdoor physical activity with mobile EEG” published in the British Journal of Sports Medicine in 2013, found that when surrounded by nature their subjects were less frustrated, more relaxed and had improved concentration.

What caused the change? Was it the quiet of the natural setting or the beauty of the plants? It may be a difference in the air we breathe.

Unseen, but present, the air we breathe is filled with electrically charged positive and negative particles called ions. These particles come from many sources including cosmic rays, waterfalls, electronic devices and blowing sand and dust.

With every breath, we breathe in negative and positive ions. Ions are atoms that gain or lose electrons to acquire an electric charge. When an atom gains one more electron it will become negatively charged. When the atom loses electrons, it becomes positively charged.

A study of indoor and outdoor air found clean mountain air contains 2,000 negative ions while a typical office has 150 negative ions. Research studies since the 1950s have shown humans feel better when exposed to negative ions.

The outdoor benefit for humans may also be in the soil. Scientists have discovered that *Mycobacterium vaccae*, a soil dwelling bacteria, affects the brains in a similar way to antidepressants. It activates brain cells to produce serotonin, a hormone that helps regulate mood and sleep. Low levels of serotonin are often correlated with moodiness, feeling down and depression.

How does it work? Scientists at the University of Bristol believe the bacteria works by activating immune cells. Experiments on mice revealed the bacteria simulated the production of cytokines, indicating an increase in immune system activity, as well as an increase of serotonin in the brain. Experiments at the Sage Colleges in Troy, New York, have also suggested *Mycobacterium vaccae* can increase learning abilities, according to a report in Austrian Science published in 2013.

Gardeners benefit from *Mycobacterium vaccae* by working in the soil where the bacteria can be inhaled. It is also ingested by eating home grown plants.

Experiment: Are Seeds alive?

Materials: Part 1 - Dry lima beans, butter knife, water, cup and magnifying glass. Part 2 – Potting soil, flower pots or plant bedding area, plastic bags, paper towels, water, and masking tape.

Process: Part 1 - Soak $\frac{1}{2}$ the lima beans in water for 12 to 15 hours. Remove the beans from the water. Slice the beans to remove the protective coating and see inside the bean using the magnifying glass. Observe how the seed contains the shoot and leaves of an embryonic plant.

Part 2 – Place a folded wet paper towel in the Ziploc bag, add a few dry lima bean seeds inside the towel and seal the bag. Tape to a full sun window. In 5 days check for germination; lima beans take between 4 and 7 days. When the seeds produce a shoot, transfer to potting soil.

Result: Part 2 - Water activates the enzymes that stimulate the release of food energy stored inside the seed. Next, the water splits the tough seed coat open to allow oxygen to enter the seed. The energy stored in the seed powers the seedling's cells as they begin to divide and grow. During its early stages of growth, the seedling relies upon the food supplies stored with it in the *seed* until it is large enough for its own leaves to begin making food through photosynthesis. The seedling's roots push down into the soil to anchor the new plant and to absorb water and minerals from the soil.

HOW DO PLANTS CRACK THE SIDEWALK?

Every homeowner has seen it and fought it; weeds sprouting in your driveway and sidewalk. How can that small plant break through such a solid surface?

There are several answers. It may seem concrete and asphalt are solid, but there are actually small cracks and openings in concrete sidewalks or asphalt driveways. This allows winter water from snow and ice to sweep in, expand as it solidifies and create larger cracks.

In the same way, weeds grow in tiny concrete cracks because the concrete warms up faster than the soil and easily retains heat from the sun. As the weeds grow they can cause extensive damage to parking lots and sidewalks.

All weeds are misplaced flowers or plants. So what is a weed to one person, such as milk weed, is a food vital to others, such as monarch caterpillars. When it comes to strength, a few plants, such as soybeans, dandelion, and Japanese knotweed, have the ability to actually grow up through the concrete. Japanese

knotweed, a native of eastern Asia, is found in the United States and Canada. The dandelion has a taproot that can extend 3 feet into the ground. The flower head actually consists of 150 to 200 tiny flowers and grows at the top of a stalk approximately 2.5 to 16 inches tall. After the dandelion blooms, each flower produces a seed that's attached to the stem with fluffy white threads that form a downy parachute easily blown away by the wind.

Do you remember blowing dandelion seeds as a child? This childhood favorite pastime is the reason gardeners find dandelions growing everywhere. Picked up and carried on the wind, dandelion seeds can literally travel miles before landing and planting themselves into the ground.

Soybeans originated in China over 5,000 years ago and were brought to North America in 1765. They were used to create hot drinks for soldiers during the Civil War and today more than 10,000 varieties are used in everything from making plastic car parts to feeding livestock. Soybeans are used to make crayons and since 2002 the USDA's Agricultural Research Service has heated its buildings in Beltsville, Maryland with fuel from soybeans.

A soybean is a small round seed that takes between four and seven days before a bud sprouts. In six to eight weeks it will produce purple or white flowers. A mature plant will grow two to four feet tall and produce between 60 and 80 pods with 3 beans in each pod over a period of between 90 and 150 days depending on the variety.

Experiment: How Can You Show the Strength of Soybean Plants?

Materials: Clear plastic cup, 5 tablespoons of Plaster of Paris, 5 tablespoons of water, spoon, eye dropper and 3 soybeans.

Process: Place the Plaster of Paris in the cup, add water and stir until the mixture is about as thick as a milkshake. Push the soybean seeds into the mixture making sure they are covered by the Plaster of Paris. Sit in a sunny spot near a window. Day two, add a tablespoon of water to the cup. Place in an area where the plant can observe over the next week.

Result: All seeds require moisture and warmth to germinate. In this experiment, the soybean seed absorbs moisture from the plaster and as the seed grows in size and thus applies pressure to the hardened plaster. The strength of the germinating sprout cracks the plaster and allows the plant to grow up through the plaster just as some weeds grow up through concrete sidewalks or asphalt driveways.

WHY DO PLANTS NEED WATER?

Water is about 80 to 95 percent of the mass of most growing plants. The water is needed because of transpiration which is the loss of water from plants in the form of vapor, the process of evaporation. Plants use about 95 percent of the water absorbed from the soil for transpiration and about 5 percent of the water absorbed by the plant is used during photosynthesis for producing the carbohydrates necessary for plant growth. Sunny, hot weather increases the rate of transpiration and thus the risk for wilting and dying plants without sufficient water.

How should you water your plants? Gardeners advise you want a regular steady watering system because dramatic shifts between wet and dry soil, such as forgetting to water a garden for a week and then drenching the plants with a garden hose, can slow the plant's growth and with continued neglect even kill the plant.

The best way to water a plant is to place the water directly on the roots. Morning is the best time of day for watering plants so the plant can drink up water during the heat of the day. If you forget to water in the morning, avoid the afternoon. Plants watered during the afternoon lose much of the moisture to solar evaporation. If watering in the evening, remember to water at the roots and never on the foliage. Foliage that stays wet overnight can be subject to diseases and fungi.

On average, plants need about 1 inch of water per week. Watering well once a week is better than daily sprinklings, because shallow watering encourages the roots to stay in the top 4 inches of soil. Shallow roots make plants more susceptible to water stress and weed competition. For an outdoor garden, wet the soil to at least 1 foot down from the soil surface.

It's easy to spot plants in need of water. The signs include: leaves with brown edges, smaller than average leaf size and a plant that appears droopy in the morning or late evening. It's harder to see what is actually happening under the soil. This experiment will allow you to see the watering process at work.

Experiment: How Does Water Benefit Plants?

Materials: Clean, empty two liter soda bottle, permanent marker, ruler, scissors, potting soil, old cotton tube sock, and small house plant.

Process: Measure and mark four inches down from the top of the bottle. Next measure and mark six inches up from the bottom of the bottle. Cut the two sections apart at the markings. Cut a strip of sock about three inches wide and eight inches long. Turn the top bottle neck portion of the bottle upside down and push the sock

material through the bottle neck until three or the eight inches of cloth remain in the top portion of the bottle.

Place the top of the bottle with the bottle top side down inside the bottom portion of the bottle. Fill the top portion of the bottle half way with top soil. Add the plant to the top portion of the bottle and fill in with top soil until the top soil completely covers the plant roots.

Now lift out the top portion with the plant, half fill the bottom portion with water and place the top portion back into the bottom portion.

Result: Water will be drawn up the cotton material and into the plant's roots. The water moves up the cotton sock material because water molecules, the building blocks of water, stick together and thus appear to 'climb' up through the cotton sock to the plant roots. Reminder – keep the water level at the base the same at all times and you will continue to see the roots draw water into the plant.

WHY DO BEES MATTER?

Where have all the bees gone? It's a serious question that has baffled scientists since the turn of the century. In 2007, researchers discovered that 30 billion honey bees, one quarter of the northern hemisphere's population had disappeared.

In the past few years scientist searching for a cause have studied blood sucking mites, pesticides, viral infections, overused antibiotics, loss of habitat and climate change searching for a cause. In 2013 hoping to save bee lives, Europe banned neonicotinoids, is an insecticide.

However in 2015, they discovered that eliminating neonicotinoids did not save bee colonies and only lead to a rise in other insects. Why the concern for bees?

Bees have existed on Earth for about 125 million years. In the U.S. alone 80 percent of the food sold in supermarkets is pollinated by bees. These crops include apples, asparagus, avocados, blueberries, broccoli, celery, cherries, citrus crops, cranberries, cucumber, kiwis and melons.

How many bees do you need per crop? Take California almonds as one example. To pollinate 2.5 trillion almond flowers requires over 80 billion honeybees making several visits to produce one nut. The state harvests between 50 and 80 percent of all the almonds in the world. In addition to crops, humans have benefited from the honey produced by bees since 6000 BC in Spain when it was discovered as a food source, used as medicine, letter sealant and in candles.

New research published in the Journal *Science* finds that bees are dying due to climate change. Also called global warming, climate change is the term that refers to the rise in the average surface temperature of the planet due to excess carbon dioxide in the air creating a greenhouse trapping excess heat is on the Earth.

The 2015 bee study looked at 110 years of data from 67 bumblebee species and followed their movements over time. This found compared 1901 to 1974 to recent decades and found over this period bees have reduce their area of range in the U.S. and Europe by almost 200 miles.

Ruling out land use changes, pesticides and weather, scientists found changes in temperature, climate change, attributed to the loss of bees.

This is why. Some insects, such as butterflies, have adapted to the warming planet by migrating further towards the north and south poles. However not every bee species is capable of finding a new migration path. The bees are dying in their traditional southern home areas due to heat and are unable to adapt and find new home areas in the cooler north.

Solutions? Researchers have suggested humans assist bees by physically moving them from areas under migration threat to safe areas created as bee havens. Already, due to a lack of bees in their traditional northern habitats areas each year farmers require truckloads of bees raised in the south to be brought north to pollinate crops. This safe zones suggestions would go further in attempting to establish new natural homes for bee colonies.

Experiment: How Do Bees Find Their Hive?

Materials: Five index cards, five small dishes, five Ziploc bags, black marker, $\frac{1}{4}$ cup of sugar and $\frac{3}{4}$ cup of boiling water.

Process: On each card draw a design – bell, star, circle, square, triangle and rectangle, the fills the surface of the card. Put the cards in Ziploc bags and seal. Now mix up a bowl of sugar water. Place the bowls of plain water next to four cards outside in an area where you can observe. Place the sugar water next to the fifth card in the same area.

Record when bees come to the sugar water. Then move the sugar bowl to a different card design and watch the bees.

Result: The bees will go first to the card with the marker than was the home of the sugar water, then realize the water was moved and move to the next design card.

Bees can recognize human designs and bee keepers mark the hives to show the bees the location of home.

Experiment: How Can You Help Save Bees?

Materials: Pie pan, marbles and water.

Process: Fill the pie pan with marbles and add water. Place the pan in a flower bed. Make sure to empty excess water after a strong rain.

Result: Imagine how hard just one bee works in a single day. Bees tend to at least 2,000 flowers daily, with tiny wings beating 10,000 times per minute, carrying pollen, and dramatically assisting our food supply. Bees get thirsty, and they need safe water sources.

Shallow water evaporates quickly. Birdbaths are not the best option as bees tend to drown if the water is not be shallow enough. As for river and lakes, bees risk their lives trying to get water in the presence of fishes, frogs, and other wildlife, not to mention the risk of being swept away in water currents. The marbles give the bees a spot to land so that they don't drown when they come to drink.

HOW DO BUTTERFLIES MIGRATE?

The beauty and the mystery of a Monarch butterfly in flight. We love to see them in our gardens all summer and as the days start to chill, the butterflies take flight for warmer weather.

To a Monarch, it's time to move on when three things change in their environment: the length of daylight, change in temperature and the quality of local milkweed plants.

University of Minnesota researchers discovered that constant but shortened daylight would not trigger migration. The butterflies only responded to daylight hour varied over time. The scientists also discovered a Monarchs raised only where the climate changes recognize the period for migration.

If you want more butterflies in your garden next year, grow milkweed! Monarch butterfly larvae eat milkweed because the chemicals from the milkweed plant that they eat when they are in the larvae stage builds up inside of them and gives them a poisonous defense against predators like frogs, birds, mice and lizards.

Monarch the caterpillars need the milkweed plant to live. Once through metamorphosis they become a butterfly, they can sip nectar from any flower. In late August or September as milkweed plants begin to yellow and dehydrate and lack

nutrition, adult monarchs will delay reproduction and begin migration south. The orange and black butterflies are the only insect that migrates over 2,500 miles to avoid the cold. They travel from Canada to Mexico and then a new generation makes the journey north again in the spring.

Fall Monarch butterflies differ from those born in the spring and summer. The reproductive organs of fall Monarchs will not fully develop until spring. This allows them to put all their energy into making the flight to Mexico.

Known as the Methuselah generation, they will roost in trees together overnight and float, rather than fly, to conserve energy for the journey and the long winter. They live six to nine months.

In contrast, the return trip to Canada will be concluded by four generations since the Monarchs born in Mexico. This is because the spring and Summer Monarchs have functional reproductive organs so they can mate soon after emerging from their cocoons. They live alone, except for mating, and have a life span of only about six weeks. During this brief time, a female Monarch will lay several hundred eggs.

You can tell a male from a female Monarch butterfly because male Monarchs have a black spot on each of the hind wings over a vein. The female monarch butterfly does not have this spot.

Lincoln Brower, a biology professor at Sweet Briar College, spoke on the decline of the Monarch butterfly the National Public Radio show Science Friday, April 10, 2013. According to Brower, the monarch population is in serious decline for several reasons, including habitat loss in the butterflies' Mexican overwintering grounds and a decline in milkweed plant populations in the U.S.

That same month, University of Kansas insect ecologist Orley R. "Chip" Taylor reported the population had declined 59 percent over 2012 and was at the lowest level ever measured. You can help track Monarchs at the website: [Spring Monarch Migration Map](#).

Experiment: How Do Butterflies Fly?

Materials: One sheet of thin plastic foam, two pennies, one toothpick, scissors and glue.

Process: Cut the plastic foam into the shape of a butterfly. Place and glue a toothpick as the body of the butterfly. Glue a penny to the middle of each wing. Balance the toothpick on your finger.

Result: This shows how the butterfly balances in flight.

Experiment: How Do Butterflies See Flowers?

Materials: Black Eye Susan flower (can be plastic) and assorted plastic flower in assorted colors, yellow, blue, white etc.; black light and a dark room.

Process: Shine the black light on each flower one at a time. Observe what color the black light turns the flower.

Result: Butterflies vary widely in their sensitivity to light, and are considered to have the widest visual range of any form of wildlife. One flower that shows a bulls-eye effect in the ultraviolet range is the black-eyed Susan. The petals of the black-eyed Susan, a large daisy-like flower, appear plain yellow to humans, but butterflies see a very dark center.

Experiment: How Do You Make a Butterfly Feeder?

Materials: Plastic coffee container lid, string, over ripened fruit, plant hanger and scissors.

Process: Cut three pin holes on lip of the upside down lid and tie equal lengths of string in each. Next tie these strings together to form a center knot to place on the plant hanger 6 to 10 inches above the highest flower.

Instead of fruit Master Gardener Bobbie Truell of Texas suggests:

"An alternative food source for butterflies is a homemade feeder filled with a solution of 4 parts water to 1 part granulated sugar. Boil the solution for several minutes until sugar is dissolved, and then let cool."

THE TRUTH ABOUT SHARKS

There are more than 350 types of sharks in the world. They range from a whale shark, up to 46 feet long, to a spined pygmy shark between seven to eight inches long.

Based on the fossil record, scientists believe sharks have lived on the Earth for more than 420 million years.

Megalodon was the largest shark that ever lived and the largest predatory creature on the planet. Based on fossilized teeth, which were 7 inches long and serrated, researchers believe this shark grew to be at least 60 feet and weighed 100 tons or more. Its jaw closed on a victim with a force of between 10.8 and 18.2 tons. In comparison, today's great white shark has a jaw crushing strength of 1.8 tons and

a lion produces about 600 pounds of jaw closing pressure. Some scientists estimate that Megalodon consumed about 2,500 pounds of food a day.

Megalodon became extinct over 2 million years ago. There are several theories on extinction including, change in ocean temperatures, land mass and among the creatures in megalodon's food supply.

What megalodon and today's sharks have in common: all sharks are fish, all sharks' teeth are replaced throughout its lifetime and shark skeletons are made of cartilage, not bone like most fish. Sharks breathe under water through gills, like fish and unlike whales which as mammals must surface to breath air.

A shark can grow more than 30,000 teeth in a lifetime with the most powerful bite of any creature in the world. This does not mean they kill the most people in the world. Unlike in the movies, sharks are not a huge threat to human life. There are less than 10 reported human deaths by sharks annually worldwide.

Sharks can live in both fresh and salt water and reproduce in three different ways depending on the species. Some sharks are born alive from the mother, some develop from an egg inside the mother and then are born and some hatch from an egg laid outside by the mother. A liter of shark 'pups' as they are called can range from one to 100 depending on the species.

A baby shark is on its own from the moment of birth. Most sharks live about 20 years, but a Spiny Dogfish Shark can live to be 100 years old. A shark can smell one drop of blood in three miles of water. Shark skin has the texture of sandpaper.

Experiment: How Do Sharks Stay Afloat?

Materials: Empty toilet paper tube, three pennies, packing tape, 12 inch balloon, $\frac{3}{4}$ cup of cooking oil and punch bowl filled with water.

Process: Tape three pennies to one side of the toilet paper roll, spaced evenly apart, and wrap the roll in the tape leaving the sides open. Fill the balloon with $\frac{3}{4}$ cup of cooking oil and tie off the end of the balloon. Place the toilet paper roll in the water and observe. Removed the toilet paper roll, insert the balloon and observe.

Result: The toilet roll with the pennies represents the density of the shark. The cooking oil in the balloon represents the oil in a shark's liver. The shark floats because the liver oil is less dense than the water.

LIFE ON EARTH TRIVIA

- 1) How many creatures live on the Earth? Answer – The estimated number of animals on our planet in 1988 was between 3 to 30 million species.
- 2) How are they categorized? Answer – They are divided into two groups: invertebrates and vertebrates.
- 3) What are invertebrates? Answer: Invertebrates are 97 percent of all species and include animals that lack backbones such as sponges, cnidarians, molluscs, platyhelminths, annelids, arthropods, and insects.
- 4) Which of these are the most common? Answer: Insects are the most numerous and in fact there are so many species of insects that scientists have yet to discover them all. Estimates of the total number of insects fall in the range of 1 to 30 million.
- 5) What are vertebrates? Answer: Creatures with a backbone. They represent the remaining 3% of all species and include: amphibians, reptiles, birds, fishes, mammals.
- 6) What are domesticated animals? Answer: A domesticated animal is any animal that depends on a human for food, water, and shelter. This includes farm animals such as cattle, horses, sheep, chickens, goats, dogs, silk worms, and cats.
- 7) What animals serve people but are not domesticated? Answer: To be a domesticated animal the creature must be able to breed in captivity conditions. For example, the Indian Elephant, although tamed, is not domestic as new stock are usually captured from wild bred animals.
- 8) How many dogs on the planet? Answer: The estimate over 1 billion.
- 9) How many kinds of dog species are there? Answer: Over 400 species, not including mutts.
- 10) How many cats in the world? Answer: Estimates are a minimum of 2 billion.
- 11) How many types of house cats on the planet? Answer: 67 breeds in the world?
- 12) What creature is the biggest in the world? Answer: The blue whale is 98 ft. long and weighs 200 tons. It is the largest known animal to have ever existed.
- 13) What is the largest land animal? Answer: The African Bush Elephant is 24.6 ft. long, 10.8 ft. tall and weighs 13,000 lbs.

14) What is the smallest creature on Earth? Answer: A bacterium called Mycoplasma genitalium, with a diameter of about 250 nanometers or 0.00025 mm, which is about one-tenth the size of most bacteria.

15) What is the longest living creature? Answer: The Ocean Quahog at 400 years.

16) How did dogs become domesticated? Answer: Wolves drawn to early humans for the warmth of fire and scraps of food evolved into domesticated dogs about 10,000 years ago. The first dog as house pet was in Rome about 2,000 years ago.

17) How do cats become domesticated? Answer: Egyptians domesticated cats about 4,000 years ago as a way to keep down the population of rodents eating stored grain.

18) What are the most popular pets in the U.S.? Answer: 1. dog 2. cat 3.hamster 4.bunny 5.gerbil 6. goldfish 7.mice 8.rats 9.snake 10.scorpionian.

19) Which creatures have been in outer space? Answer: Monkeys, Chimps, Dogs, Mice, Rats, Rabbits Insects, and Jellyfish.

20) Has every president had an animal at the White House? Answer: Yes, since the time of Thomas Jefferson. Some of the most unusual: Abraham Lincoln had a turkey named Jack and Andrew Johnson feed the wild mice in the White House. Theodore Roosevelt's pets included a zebra, a parrot, bears, a lion, a hyena, a coyote, rats, and a one-legged rooster and Herbert Hoover had two pet alligators.

EXPERIMENT LOG

Dr. Edward Jenner was scorned and ridiculed for his smallpox vaccine. In newspapers his vaccine results were cartooned as people growing cow's heads on their bodies. Vaccination was forbidden by Act of Parliament in 1840. Just 13 years later vaccination was made compulsory. Record your experiments here:

Results_____

Results_____

Results_____

Results_____

Results_____

Results_____

Results_____

HOLIDAYS

WHY DO WE CELEBRATE THE NEW YEAR WITH A BALL DROP?

The idea of dropping a ball to mark time comes begins in 1833 when a ball would drop from the top of England's Royal Observatory at Greenwich to mark one o'clock in the afternoon. The purpose was for captains of nearby ships to see the ball fall and set their chronometers to the timing of the ball.

Historians believe about 150 balls were installed around the world to repeat the success of the Greenwich ball. The U.S. Naval Observatory in Washington DC still drops a ball every day at noon.

The New York New Year's Ball Drop legend begins in the 20th century when in 1903 the New York Times newspaper was opening their new headquarters in what was then the second tallest building in the city. Adolph Ochs, newspaper owner, celebrated with fireworks on the roof on New Year's Eve.

Ochs convinced then New York Mayor George B. McClellan to re-name the location Times Square. Four years later, Ochs decided he wanted something grander than fireworks for the holiday. He commissioned a five foot in diameter, iron ball covered in 25 lights and weighing 700 pounds to be lowered from the flag pole to the roof on one second after midnight 1907.

The newspaper moved its headquarters away from Times Square in 1913. A ball has been lowered every year since 1907 with the exceptions of 1942 and 1943 when lights were the ceremony was suspended due to World War II.

In 1920, the original ball was replaced with a five foot, 400 pound lighted ball. This remained in use until 1995 when a new ball incorporated rhinestones, strobe lights and a computerized light system. In 2000 there was a new ball weighing 1,070 pounds, measuring six feet in diameter and covered in 504 Waterford Crystals triangle and illuminated by 168 halogen bulbs and spinning mirrors. This was retired in 2006 and replaced for one year in 2008 with a Waterford Crystal ball that weighed 1,212 pounds, was six feet in diameter and with LED bulbs could produce 16.7 million computerized colors of light.

In 2009, the current ball weighing 11,875 pounds and 12 feet in diameter ha the 2008 design but at twice the size. It sits on a new flagpole 475 feet above the ground and is viable all year round as a symbol of the one magical holiday night when the ball drop seen by about one billion people around the world.

Experiment: How Can You Make a Bouncing Ball?

Materials: This is the mix to make one ball. Two tablespoons of warm water, 1 tablespoon of corn starch, 1 teaspoon of Borax, five drops of your choice of food coloring, spoon, two bowls, one tablespoon of clear or white liquid glue, and glitter, just for holiday spirit.

Process: To a bowl add ½ teaspoon of Borax and mix with two tablespoons of warm water. Add five drops of the food coloring of your choice. Stir. In the second bowl, place one tablespoon of white or clear liquid glue and glitter. From the first bowl, take a ½ teaspoon of the Borax and water mix and add to the bowl with the glue and glitter. To this add, 1 tablespoon of cornstarch and stir.

Result: Once the mixture starts to harden, pick it up and form into a ball. When formed, let sit for 10 minutes to dry. The ball will then be ready to drop.

EARTH DAY CELEBRATION

What is Earth Day and when did it start? April 22 is the world celebration of Earth Day, a day set aside to consider the condition of our environment and the future of the planet. The holiday was created by Gaylord Nelson, then a U.S. Senator from Wisconsin, in 1970 after witnessing the ravages of the 1969 massive oil spill in Santa Barbara, California. Nelson announced the idea for a “national teach-in on the environment” to the national media; persuaded Pete McCloskey, a conservation-minded Republican Congressman, to serve as his co-chair; and recruited Denis Hayes as national coordinator. Hayes built a national staff of 85 to promote events across the land.

On April 22, 1970, 20 million Americans took to the streets, parks, and auditoriums to demonstrate for a healthy, sustainable environment in massive coast-to-coast rallies. Thousands of colleges and universities organized protests against the deterioration of the environment. Groups that had been fighting against oil spills, polluting factories and power plants, raw sewage, toxic dumps, pesticides, freeways, the loss of wilderness, and the extinction of wildlife suddenly realized they shared common values.

The first Earth Day led to the creation of the United States Environmental Protection Agency and the passage of the Clean Air, Clean Water, and Endangered Species Acts. In 1990, Earth Day became a global event engaging 200 million people in 141 countries. Its influence helped create the 1992 United Nations Earth Summit in Rio de Janeiro. In 1995 Senator Nelson received the Presidential Medal

of Freedom, the highest honor given to civilians in the United States, for his role as Earth Day founder.

By 2000, Earth Day was celebrated in 184 countries by hundreds of millions of people. On the 45th anniversary of Earth Day in 2015, one billion people around the world took part in planting one billion seeds, plants and/or trees to help replenish and restore the Earth.

Every Earth Day volunteers around the globe clean up trash from waterways and litter from nearby parks that can in the future will also enter waterways. In the U.S., 40 percent of the lakes and rivers are too polluted for swimming, according to the U.S. EPA. In 2000 alone, 8 million tons of plastic was dumped into the world's oceans, according to a study published in 2015 by National Geographic.

Experiment: How Can You Show How Pollution Enters the Water Source?

Materials: Materials needed: Plastic toy fish, Punch bowl $\frac{3}{4}$ full of water, dish soap, syrup, salt, paper holes made by a hole punch, dirt and green food coloring.

Process: Start with clean water, represents mountain stream, add fish soap from washing cars in driveways, syrup – fluids leaking from cars, salt – ice melting, paper holes - blowing trash and green food coloring – sewers leaking.

Result: This is how our water supply is polluted. Discuss how to clean up the environment. Ex. Eliminate plastic shopping bags and use canvas bags.

WHY DO THE DATES OF PASSOVER AND EASTER CHANGE EACH YEAR?

For the answer you need to look to the sky. Jesus' celebration of the Jewish Passover is known to Christians as The Last Supper. The date of Passover is determined by the Jewish calendar, a lunar calendar. A lunar calendar is based in the phases of the moon. Passover is always celebrated the on the first full moon after the Spring equinox, the point at which the sun passes over the vernal equinox point in the sky. Early Christian leaders wanted Easter to always follow Passover so this means Western Easter celebrations are always the first Sunday, after the first full moon, after the Spring equinox.

Why dye the eggs colors? According to legend, during medieval times eggs were valued and given as gifts on Easter. The Lord and Lady of the manor would give eggs wrapped in pressed gold. The peasants, the workers of the castles and grounds, would wrap their eggs in spring flower petals. Did you ever wonder how and why dye changes the color of the egg? Egg shells are made of calcium carbonate. Dye has two chemical parts, one molecule is the color and the second is

a bonding molecule. When you place an egg in dye, the color bonds to the egg shell. Adding vinegar, which is an acid, makes the color bonding stronger because the negative charge of the vinegar is attracted to the positive charge of the egg shell.

You can also increase the strength of the color on the egg shell by increasing the amount of time the egg is in the dye solution or by increasing the strength of the dye coloring.

Increasing the intensity of the color increases the concentration of color molecules for bonding to the egg. Allowing the egg to remain in the dye longer gives more time for the bonding process to happen.

Experiment: How Can You Use Natural Colors to Dye Easter Eggs?

Materials: Purple grape juice, carrots, raspberries, spinach leaves, beets, and lemon peels, fresh eggs, water, six pans, vinegar and a stove.

Process: In six single pans for each item pour with water and boil the grape juice, carrots, raspberries, spinach leaves, beets and lemon peels for 20 minutes. This will create a dye. Remove the large items and leave the dye in the pans.

Add to each pan one teaspoon of vinegar, one egg and enough water so the egg is covered. Bring the water to a boil, then reduce the heat and allow each pan to simmer for 15 minutes.

Result: When you remove the eggs they will have taken on the color of the dye.

WHY DO WE ENJOY BEING SCARED?

Halloween is the time of year when little kids look forward to dressing up as their favorite cartoon hero or movie character and when big kids and adults pay big bucks to be scared at interactive haunted houses, haunted hayrides and scary movies.

How you ever wondered, why do we pay money to enjoy being scared? It's a topic medical science has considered and studied.

David H. Zald, a professor of psychology and psychiatry at Vanderbilt University studied the chemical reaction within human brains while engaged in a scary (yet safe as in planned activity) situation. He found that one of the main hormones released during such experiences is dopamine.

However, everyone does not react the same to the rush of dopamine. Some individuals enjoy the chemical reaction and others do not. This rush of chemicals can have a powerful effect on memory. A child who is too young to know the

monsters at the horror show are fake may experience a scare trauma that remains with them the rest of their lives. Studies have shown that individuals who enjoy being scared are those who first understand they are in a safe environment. They realize the scary sounds, the air blasts and the costumed vampires and ghosts that jump out from behind hidden walls are fake. Thus while startled, their brains are lighting fast at determining these are not real dangers.

Some monsters are cultural based such as the Loch Ness Monster of Scotland and America's own Jersey Devil or Bigfoot. The Jersey Devil is a legendary creature who lives in the state's Pine Barrens area who has the head of a goat, the wings of a bat, hooves of a horse and a forked tail. Bigfoot, also known as a Yeti in Europe and Sasquatch in Canada, is a large hairy humanoid said to live in the Pacific Northwest and as a Yeti, in the Alps.

Each monster is different but they share some common traits such as being non-human or semi-human and they manage to defy the laws of nature.

Television has proved lots of scary characters over the years including aliens on *Twilight Zone* and *Outer Limits* and also safely scary characters such as the friendly weirdly strange neighbors *The Monsters* and *The Addams Family* which both debuted September 1964.

The Munsters, a CBS show, were the family at 1313 Mockingbird Lane. It included Herman, the dad, who looked like the Frankenstein monster; Lily, the mom, and her dad, Grandpa, were both vampires; and their son Eddie was a werewolf. Niece Marilyn, lives with them and they pity her because she is an attractive normal looking human.

The Addams Family, on the ABC network, was about a family that included Gomez, the dad, Morticia, the mom, Uncle Fester, Lurch, the butler, Grandmamma, Thing and the children Wednesday, and Pugsley.

Thing was a disembodied hand/arm limb member of the family, was usually played by Ted Cassidy who also played the show character Lurch. When Lurch had to be on camera at the same time as Thing, however, associate producer Jack Voglin lent his hand. Thing lived in a box in the Addam's family home, but he seemed to have more than one residential box as he would pop out as needed in the script. Thing was usually a right hand. Lurch occasionally used his left hand just to see if anybody would notice. Thing also had an arm, which was seen when it reached outside for something while in its box.

There was a sign in the Addams front yard that read "Beware of the Thing". The Addams Family was created by cartoonist Charles Addams.

Experiment: How Can You Recreate "Thing"?

Materials: 9 ounces clear plastic cup, baking soda, vinegar and plastic glove.

Process: Shake baking soda into the fingers of the glove. Fill the cup ½ full with vinegar. Put the glove on the cup so the ends of the cup fit tightly on the cup. Now lift the fingers of the glove and shake the baking soda into the vinegar.

Result: The baking soda and vinegar mix will form carbon dioxide gas which will rise and cause the glove to inflate.

WAS FRANKENSTEIN REAL?

No, but the book written by Mary Godwin Shelley has some ties to 17th century science. In the early days of medicine, before x-rays, doctors had few opportunities to study the interior of human beings. In England dissection of a human by medical schools was only permitted on the bodies of a few executed prisoners.

In the late 1700s, Luigi Galvani, an Italian doctor, had discovered that when he applied an electric arc to a dead frog, the frog's legs twitched. He believed this meant there was a liquid fluid running through all living creatures and that life could be restored by electrifying the liquid.

Galvani never brought a frog back to life, but the idea encouraged his nephew Giovanni Aldini to continue these studies and expand them to include dead sheep, pigs and cows. The creatures didn't come back to life, but Aldini believed this was because animals were too dumb to know electricity would bring them back to life.

In 1803 he traveled to England to try his experiment on the body of a murderer hung for his crime. Before the members of the Royal College of Surgeons, Aldini attached electric probes to the man's limbs, chest and forehead. The body jerked, the left eye opened, but the man remained dead. This story circulated London and became the spark of interest that Shelly used to create Frankenstein. The readers of the time were not afraid of a monster in the dark, but rather Frankenstein's immortality. Believing that the soul leaves the body immediately upon death, Shelly's readers feared a man brought back to life could never die again because as a soul less creature he would wonder the Earth forever.

Other science misunderstandings that became horror stories include vampires. Vampire bats are real creatures who feed on the blood of cattle and live in Mexico,

Brazil Chile and Argentina. Bram Stoker's book, Dracula expands on the public fears of illness.

During the 1800s, Londoners faced repeated outbreaks of cholera. About the same time, Louis Pasteur develops a vaccine for rabies, and his the germ theory of disease begin the modern medical understanding of infection. It is also during this time when medical doctors and the general public are very concerned about how disease spreads. These ideas in a creative mind, gave us the story of Dracula, whose bite brings the worse disease, the wandering of an immoral soul.

In 1958, Hollywood drew on public fears and science to create the movie, The Blob, a creature from outer space that lands near Valley Forge, Pennsylvania.

The fear of creatures from outer space was heightened by the launch of Sputnik in October 1957, the first artificial satellite. Originally entitled The Molten Meteor, in the movie, The Blob keeps growing in size until it morphs into a giant pile of goo which begins swallowing the town and its population.

Experiment: How Can You Re-create the Blob from the Movie?

Materials: Empty 20 ounce bottle, liquid dish soap, bowl, warm water, hydrogen peroxide, red food coloring and 1 tablespoon of yeast.

Process: Pour hydrogen peroxide into the empty bottle. Add 10 drops of red food coloring, one tablespoon of soap and gently shake together to stir to mix. In a second bowl mix warm water and the yeast together until smooth. Pour the yeast material into the soda bottle! It will erupt suddenly and slowly smooth into the Blob texture.

Result: The yeast separates the hydrogen peroxide into hydrogen and peroxide and dish soap attracts the oxygen resulting in foam. The experiment can be safely flushed down any drain.

WHO DISCOVERED FINGERPRINTS?

You might think the use of fingerprints begins with Sherlock Holmes, but you would be wrong. Chinese records from 221-206 BC detail how handprints were used as evidence to investigate burglaries. There are similar reports from Persia in 1400s and Europe in the 1600s. In July of 1858, Sir William James Herschel, of England, begins collecting fingerprints and has a theory that each person's fingerprint is unique.

In 1880, Dr. Henry Faulds of England published an article in the Scientific Journal, "Nature" where he discussed fingerprints as a means of personal

identification. This is followed in 1882, when Gilbert Thompson of the U.S. Geological Survey in New Mexico, used his own thumb print on a document to help prevent forgery. It is the first known use of fingerprints in the United States. The idea comes to the printed page in Mark Twain's book, "Life on the Mississippi", in which a murderer was identified by the use of fingerprint identification.

Fingerprints officially enter modern police work in 1892 when Juan Vucetich, an Argentine police officer, began the first fingerprint file system using right thumb impressions. Using this method, he successfully identified a woman who murdered her sons and attempted to blame someone else. Her bloody fingerprint on a doorway confirmed her guilt.

Sir Francis Galton, an English anthropologist, began studying fingerprints in the 1880s and published the book, "Fingerprints". Based on earlier research he concluded fingerprints do not change over the course of a person's lifetime and that the odds of having the same fingerprint as someone else were 1 in 64 billion.

Earlier methods to mark and track criminals included branding the criminal. Ancient Romans tattooed soldiers to prevent and when needed track deserters.

Since the 1800s, no two humans' fingerprints have ever found to be the same. They have been used by forensic scientists worldwide since 1915 and are still one of the most common forms of identification. Skin conditions, such as wrinkles due to aging, can change the appearance of skin. However fingerprints do not change except in the cases of major scarring due to surgery or the disease of leprosy.

Scotland Yard began using a fingerprint system in 1901 and this method was adopted in America in 1904. India has the world's largest collection of fingerprints at over 600 million. The United States Homeland Security Department has over 120 million fingerprints on file.

Experiment: How Do You Dust for Fingerprints?

Materials: Hand lotion, baby powder, adhesive tape, paintbrush, cookie sheet, magnifying glass and black construction paper.

Process: Ask a volunteer to rub hand lotion on her thumb. Now ask her to press her thumb to the cookie sheet. Show the other participants the cookie sheet (be careful not to touch where the volunteer placed his/her thumb). Place the cookie sheet on a flat surface and sprinkle baby powder on the sheet where the thumb print was placed. Next, using the brush gently brush away excess powder until the fingerprint is revealed. Take one piece of tape, cut from the roll and place the tape over the fingerprint. Now lift the tape and place it on the black construction paper.

Result: The fingerprint will become clear on the black paper. Repeat the process with several volunteers and use the magnifying glass so everyone can see how each fingerprint is unique. Criminals do not purposely rub on hand lotion before committing a crime, so how do the police still find fingerprints? The answer is our skin produces natural oils that are left behind when we touch a surface.

WHAT WAS THE CHRISTMAS STAR?

During the celebration of Christmas, Christians recall and celebrate the birth of Jesus Christ. The story of the birth of Christ is recorded in the Bible and in Matthew 2:4-8 it says wise men from the East followed a star:

“Where is he who has been born king of the Jews? For we saw his star when it rose and have come to worship him.”

In ancient times, wise men were astrologers, who we today call astronomers, because they spent their lives studying the movements of the sun, moon and stars. This information was vital to the people at the time of Christ’s birth because their lives depending on knowing when to plant, the changing of the seasons, etc.

This is also a time when there was a common belief in what we today call astrology. This is a belief that stars and other objects in the sky have a direct influence on the lives of people. Science has proven astrology is not real. Movements of the stars and planets do not predict or explain human behavior. In addition, the Earth’s precession, meaning its wobble on its axis, changes over time. Thus, even if astrology were real, the Zodiac signs created about 2,000 years ago would not be in alignment with the birth of people in the 20th and 21st centuries.

What do modern astronomers believe the wise men saw? There are a few explanations.

In 1980 there was an astronomy symposium at Griffith Observatory in Los Angeles. Astronomer John Mosley of Griffith programmed the Zeiss instrument in the observatory theater to project how the heavens appeared from 3 to 1 B.C. Turning the clock back, this program enabled them to see the twilight period of June 17, 2 B.C. and witness planets Jupiter and Venus in conjunction, meaning the planets appeared merged as a single bright star in the sky in Babylon and Jerusalem. Many believe this conjunction is the Star of Bethlehem. However, there is another possible explanation. Frank Jennings Tipler, a mathematical physicist and cosmologist, argues that the Star of Bethlehem was a Type Ic hypernova located in the Andromeda Galaxy or perhaps a Type Ia supernova in a globular cluster in our own galaxy.

In a paper on the topic dated March 20, 2005, Tipler states, "It is not a planet, or a comet, or a conjunction between two or more planets or an occultation of Jupiter by the Moon." He argues that the Bible says the star "stood over" and thus this could only be a supernova or hypernova at the latitude of Bethlehem of 31 43' N. Astronomer Hubert J. Bernhard, former lecturer at San Francisco's Morrison Planetarium offered another answer. "If you accept the story told in the Bible as the literal truth, then the Christmas Star could not have been a natural apparition. Its movement in the sky and its ability to stand above and mark a single building; these would indicate that it was not a normal phenomenon, but a supernatural sign. One given from on high and one that science will never be able to explain," Bernhard said.

Experiment: How Can You Create a Wooden Image of the Bethlehem Star?

Materials: Five wooden toothpicks, a plate and water.

Process: Bend the five toothpicks in half without breaking and place the bent portions together touching in a star shape on a plate. Now place a drop or two of water in the center of the star. Wait about 15 minutes for a new star to form.

Result: The water causes the wood to expand and as it does the folded parts of the toothpicks push outward and form the shape of a star.

HOLIDAY TRIVIA

- 1) What are the federal holidays in the U.S.? Answer – New Year's Day; Martin Luther King Day; Memorial Day; July 4th, Labor Day; Columbus Day, Veterans Day, Thanksgiving and Christmas.
- 2) On what holiday do American spend the most money? Answer – Christmas is number one followed by: Halloween, Easter, Mother's Day, Father's Day and Valentine's Day.
- 3) How much do Americans spend at Christmas? Answer - In 2012 the average family budget allotted for Christmas was \$749.
- 4) Where does Ground Hog Day come from? Answer –Thousands of years ago in Europe people believed the appearance of a badger would predict spring. German immigrants brought the tradition to the U.S. in the 1800s and substituted a groundhog for the badger. Tradition says if the groundhog sees his shadow on February 2 he will be frightened, return to his burrow and there will be six more weeks of winter.
- 5) Was there a real St. Valentine? Answer - Valentinus was a Roman priest martyred during the reign of Claudius the Goth for marrying couples in

opposition to the emperor who prohibited marriage prior to an upcoming battles believing single men made better soldiers.

- 6) How many flowers Americans buy on St. Valentine's Day? Answer – About 200 million flowers annually.
- 7) How much candy do Americans buy at Halloween? Answer – About 600 million tons.
- 8) What is April Fools' Day? Answer – It is not completely proven, but the most popular theory according to The National Geographic Society, is the in the 1500s when the popular calendar switched the beginning of the new year from spring to January 1 anyone who still celebrated the new year on April 1st was an April Fool.
- 9) When was the first Memorial Day in the U.S.? Answer - In 1868, Commander in Chief John A. Logan of the grand Army of the Republic issued what was called General Order Number 11, designating May 30 as a memorial day. He declared it to be "for the purpose of strewing with flowers or otherwise decorating the graves of comrades who died in defense of their country during the late rebellion, and whose bodies now lie in almost every city, village, and hamlet churchyard in the land."
- 10) When did Congress create the federal holiday of Memorial Day? Answer – Memorial Day became official under U.S. Federal law in 1967. On June 28th in 1968 the traditional celebration became the last Monday of May instead of May 30th and became a federal holiday in 1971.
- 11) When was the first Thanksgiving? Answer – The Pilgrims from England and the Native Americans celebrated with a harvest feast in the fall of 1621 at Cape Cod, Mass.
- 12) Why do we celebrate Mother's Day? Answer – About 150 years ago Appalachian homemaker Anna Jarvis organized a day called 'Mother's Work Day,' in order to advocate mothers working against poor health conditions within her community. When she passed away, her daughter Anna began campaigning to U.S. Presidents Roosevelt and Taft along with other businessmen to create a specific day honoring mothers. In 1914, Woodrow Wilson signed a bill recognizing the day.
- 13) Why do we celebrate Father's Day? Answer – In 1909 Mrs. John B. Dodds, from Spokane, Washington, campaigned for a Father's Day celebration. Mrs. Dodds was raised in a family of six children by a single father after the death of her mother.
- 14) The first father's day was June 19, 1910. In 1972 Richard M. Nixon signed a congressional resolution creating Father's Day in the United States.

15) Why do we use fireworks to celebrate the 4th of July? Answer - When the Second Continental Congress in Philadelphia adopted the Declaration of Independence on July 4, 1776, John Adams future president, wrote to his wife Abigail on July 3, 1776; "The day will be most memorable in the history of America. I am apt to believe that it will be celebrated by succeeding generations as the great anniversary festival...It ought to be solemnized with pomp and parade...bonfires and illuminations (fireworks) from one end of this continent to the other, from this time forward forevermore."

16) Why do we celebrate Labor Day? Answer – President Cleveland signed it into law in 1881 as an official holiday the first Monday in September. Motivation opinions vary it was a political response to a riot by workers or to honor workers killed in an accident.

17) How many hot dogs do Americans eat on the 4th of July? Answer - Americans eat some 20 billion hot dog per year, and 155 million of them are consumed on July 4th alone, according to the National Hot Dog and Sausage Council. That’s enough average-sized franks to stretch from L.A. to D.C. five times, with some left over.

18) How many turkeys consumed at Thanksgiving? Answer -45 million turkeys are cooked and eaten on Thanksgiving Day! That's 535 million pounds of meat.

19) How many ice cream is eaten on Labor Day? Answer – Unknown BUT - Each American consumes a yearly average of 23.2 quarts of ice cream, ice milk, sherbet, ices and other commercially produced frozen dairy products.

20) What is Patriot Day? Answer - Patriot Day is an annual observance on September 11 to remember those who were injured or died during the terrorist attacks in the United States on September 11, 2001.

EXPERIMENT LOG

Wilson Greatbatch was working on building a heart rhythm recording device when he reached into a box, pulled out the wrong size resistor and plugged it into the circuit. The resulting sound he recognized as the rhythmic *lub-dub* sound of the human heart and wondered if an electrical stimulation could make up for a breakdown in the heart's natural beats. His initial error resulted in his creating the implantable pacemaker. Record your experiments here:

Results: _____

Results: _____

ECOLOGY

HOW CAN YOU COOK UP AN ENVIRONMENTAL SOLUTION TO PLASTIC?

The average American throws away approximately 185 pounds of plastic per year. As a country we throw away 35 billion plastic water bottles every year. It takes each bottle 500 to 1,000 years for plastic to degrade.

Plastic in the ocean breaks down into such small segments that pieces of plastic from a one liter bottle could end up on every mile of beach throughout the world, according to the website Ecowatch. In addition, approximately 500 billion plastic bags are used worldwide each year. That equals more than one million bags used every minute.

Plastic is the term for a material that can be molded into different shapes. All plastic is made from molecules which can be repeated again and again in a chain. These molecules used as chains are called polymers. A single repeat in a pattern of molecules in a polymer is a monomer.

The milk used to make your pumpkin pie can be used to make ecologically friendly plastic. This was first demonstrated at the Paris Universal Exhibition of 1900. The items made were jewelry, buttons and buckles. These early items tended to break splinter and break easily. Milk plastic was also used to make fountain pens, hand held mirrors and comb and brush sets in the 1930s and 1940s.

Today most of our everyday plastic products are made from petroleum which requires drilling for oil and creates a finished product that can last over 230 years in a landfill. The United States uses over 2 million gallons of oil per day for the manufacture of plastic. Plastics made from natural products, such as milk, have the advantages of being a renewable resource. In addition, the manufacturing process releases fewer toxins and greenhouse gases than oil based plastic. Disposable natural plastics can break down in a few months and release no toxic fumes when burned.

In 2011 oil based plastics constituted over 12% of municipal solid waste, while in the 1960s, these plastics constituted less than 1% of municipal solid waste, according to the E.P.A. In 2012 the E.P.A. reported plastic bags and food containers are the majority of 165 million tons of plastic pollution in the world's oceans.

Experiment: How Can You Make Plastic from Milk?

Materials: One cup of milk, four teaspoons of white vinegar, microwave oven, ceramic bowl, spoon, strainer, and wax paper.

Process: Pour the milk into the bowl and place in the microwave oven. Heat for 2 minutes. Remove the bowl from the oven, place on a table, and add four teaspoons of vinegar. Stir. As you do you will see the formation of white curds in the liquid. Strain the curds from the liquid and place the curds on the wax paper. After it cools, mold the plastic into a shape. You can do this with your hands or use a cookie cutter. Let this dry for 24 hours.

Result: You will have a shape made of milk plastic. **Explanation:** Milk is made of water, fats, protein, minerals and carbohydrates. When you heat the milk above 212 degrees Fahrenheit, boiling point, the fat within the milk will glob together. The two main milk proteins are: casein and whey. Casein contains coagulates when added with vinegar. The whey does not coagulate. Thus the two materials separate and can be strained.

A casein molecule is a monomer. The polymer made of casein monomers can be scooped and molded and thus it is called a plastic. The plastic you make in this experiment will not be as strong as the plastic made from milk and sold commercially. Commercial milk plastic is washed in formaldehyde. This chemical will help harden the plastic but is too dangerous to be used at home. Formaldehyde is a colorless, strong smelling gas that can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing for some people exposed to levels above 0.1 parts per million. Exposure can cause irritation of the eyes, nose, throat, and skin.

WHAT IS HAPPENING TO THE BIRDS?

A National Audubon Society report in 2013 found of the more than 900 bird species in North America generally thought to be secure they have actually have decreased in number as much as 80 percent since 1967. This is due to a variety of factors including change climate, chemicals in plants and loss of habitat. Birds are important because they keep planetary systems in balance. They pollinate plants, disperse seeds, scavenge carcasses and recycle nutrients back into the Earth.

The greatest concern is habitat destruction and degradation pressures on the world's birds, according to the website Bird Life International. Habitat destruction due to construction, agriculture, flooding for dams etc. renders areas entirely or almost entirely unsuitable for their original fauna and flora.

The intensification of agriculture and fisheries, slash-and-burn crop cultivation, logging of hardwoods in tropical forests, nutrient enrichment of fresh- and saltwater and the spread of invasive species are just some of the factors that can

alter habitats and drastically affect their ability to support populations of particular bird species.

Fire can have some of the most far-reaching consequences. Fire is a natural phenomenon in many habitats but since pre-history humans have drastically altered the fire regime wherever they have spread, often with major impacts on local biodiversity. Humans often burn large areas of landscape in order to clear land for other uses.

Fragmentation, which is the division of formerly contiguous areas of natural or semi-natural habitat into smaller, more or less isolated patches affects the ability of habitats to support populations of constituent species.

For example, when a formerly wildland is used for housing and the developer sets aside open areas. These smaller open areas are different from those of larger areas, principally owing to so-called 'edge effects' and to the inability of small areas to support viable populations of species that have large territories or home ranges. For these reasons, small fragments of a habitat almost invariably support fewer species than large areas.

How can humans help birds? Birds seek reliable food sources. Bird feeders should be filled with Suet, Nyjer thistle seed, and black sunflower seed. Birds seek out reliable backyard feeders in late summer to early fall. If they don't find a feeder by August they will not return for winter feed. Once you start a winter feeding program, the birds will count on food being available all winter long.

Birds also need fresh unfrozen water all winter. They can eat snow for hydration, but this requires extra energy to eat snow and warm it to their body temperature. Fresh unfrozen water in a birdbath is best.

Water is not only important for hydration, but it also helps birds preen their feathers. Without proper preening, birds' feathers won't stay positioned and aligned. Feathers out of alignment in winter create gaps in insulation, which makes birds lose body heat faster.

Experiment: How Do You Make a Bird Feeder from a Milk Carton?

Materials: half gallon milk or juice carton, craft knife or scissors, two bamboo skewers, bird seed, hole punch, used egg shells, and twine to make a hanger.

Process: Part 1 - Cut an opening in the carton half way down the front of the carton about three inches square. Punch a hole in the top ridge of the carton.

Thread twine through the hole and tie off as a hanger for the bird feeder. Push the through the front of the carton below the opening to serve as perches for the birds.

Result: Do bird feeders really help birds? Yes according to the Cornell Lab of Ornithology, which found bird feeders help birds all year ‘round especially during migration. The lab reported, “In the spring, a bird feeder might be a very welcome source of food for a bird that has already come a long way from its wintering grounds and still has a long way to go before reaching its breeding grounds. In the summer, even though there is a lot of food available for birds, their energy requirements are high because they must feed their young.”

Experiment: How Do You Make a Bird Feeder with a Pine Cone?

Materials: Pine cone, peanut butter, string, butter knife, plate and bird seed.

Process: Tie the string to each pine cone, spread peanut butter on each cone, and then roll the cone in the seeds. *Please note – if the pine cone is closed up place indoors until it opens naturally or place in an oven at 300 degrees for 10 minutes to force the opening before spreading the peanut butter in the nooks of the cone.

Result: Hang the feeder outdoors six feet off the ground and ten feet from the nearest tree branch to avoid squirrels eating the seed. In addition to the bird seed, peanut butter is good for bird because it contains protein and fat which birds need all year, especially in winter.

HOW DO CFL BLUBS SAVE ENERGY?

In the United States electricity is usually taken for granted much as the air we breathe. April 22 is Earth Day and a good time to learn about electricity. The typical American household uses about 903 kilowatt hours of electricity per month which costs about \$107, according to Inside Energy website facts published in May 2014.

To generate the electricity, used for everything from the alarm clock and hot shower that wakes you up to the coffee maker microwave, refrigerator and stove that makes your breakfast and even the traffic lights you pass as you start your day, the United States uses mostly steam turbines.

The steam turbine is powered by fossil fuels, such as coal, petroleum, and natural gas. This fuel is burned in a furnace to heat water in a boiler to produce steam. The turbine works by forcing steam against a series of blades mounted on a shaft. The steam rotates the shaft connected to the generator. The generator, in turn,

converts its mechanical energy to electrical energy based on the relationship between magnetism and electricity.

In 2014, coal was the fuel that generated about 39 percent, natural gas about 27 percent, nuclear power about 19 percent, hydropower about 6 percent, wind power about 4 percent, biomass which is waste such as food scraps and leaves, about 2 percent, petroleum about 1 percent and geothermal and solar less than 1 percent each of the electricity generated in America, according to the U.S. Energy Information Administration.

An American household in 2010 used about twenty times more electricity than the typical Nigerian household, and two to three times more than a typical European home, according to the website Shrink That Footprint. The reasons include the size of the home, number of appliances, etc.

Almost half, 47% of the electricity in a typical American home is for heating and cooling, according to a 2009 study by Lawrence Berkeley National Laboratory. Lighting is about 12 percent, washer and dryer about 6 percent, refrigerator about 4 percent, TV, DVD etc. about 3 percent, dishwasher 2 percent and computer 1 percent.

The U.S has taken steps to reduce its energy usage by banning incandescent light fixtures, traditional light bulbs, brought into or manufactured in the U.S. Homeowners are not banned from having incandescent bulbs and stores may sell remaining stock. There are many exceptions to the rule including 3-way bulbs, appliance lamps, colored lamps, and rough service bulbs. While the traditional lightbulb loses 90 percent of its energy to heat, the newer bulbs such as compact fluorescent lamps (CFL) save energy through efficiency, according to the U.S. Department of Energy.

Compact fluorescent lamps use one fourth the energy and lasts ten times longer than a comparable traditional incandescent bulb that puts out the same amount of light. CFL bulbs are available for about \$2, can last 10,000 hours, and consume 13 watts for the equivalent of a 60-watt incandescent bulb. These bulbs contain a small amount of mercury and should always be recycled at the end of their lifespan.

As the country switches bulbs, the impact and electricity savings increase. If every home in America replaces one incandescent bulb with a CFL in one year the energy savings would light over 3 million homes. The saved electricity means less burning of fossil fuel to run electric turbines to generate electricity. In fact, the

electric generating savings by using CFLs would eliminate the gas emissions equal to about 800,000 cars.

Experiment: How Does Static Electricity Light up a CLF bulb?

Materials: a dark room, a balloon, a 15 to 20 watt CLF bulb, and a volunteer with lots of thick hair.

Process: Blow up the balloon and tie off. Rub the balloon against the volunteer's head for 20 seconds. Next, take the balloon away from the hair and touch the end of the CLF to the balloon.

Result: The balloon will glow. Rubbing the balloon against the volunteer's hair generates static electricity. When the CLF is placed against the electric charged balloon the low pressure fluorescent gas inside the bulb becomes excited and thus lights the phosphorous coating inside the bulb.

WHAT IS IN THE AIR WE BREATHE?

All humans need air to breath. The natural composition of our air is a mix of nitrogen, oxygen, water vapor and inert gases. Pollution is the addition of unnatural substances in the air such as black carbon due to the release of particles into the air from burning fuel from cars to factories and even fireplaces and barbeques.

The World Health Organization has found air pollution is a global health risk causing respiratory infections, heart disease and lung cancer worldwide. It is estimated to cause 1.3 million deaths worldwide per year. The U.S. Environmental Agency has established about 4,000 monitoring stations to track air pollution.

Air pollution is not limited to the area where the particles are generated. Rather, the pollution can rise high above the clouds and from there spread out across the planet.

Scientists have found pollutants including black carbon, sulfur dioxide and nitrogen oxide more than 20 miles above the surface of the Earth. Some of these pollutants then fall back onto the planet through rain and other atmosphere conditions.

Experiment: How Much Pollution is in the Air You Breath?

Materials: Four white index cards, four 8 inch lengths of string, pen, petroleum jelly, cotton swap, re-closeable plastic bag and magnifying glass.

Process: Label the cards: inside my house, in my yard, in my neighborhood and control. Next attach one string to each card. Now using the cotton swap, cover each card on one side with petroleum jelly. Hang the cards as labeled (try to seek an upcoming period of several days of dry weather forecasts before hanging the cards) and place the control card inside the sealed plastic bag in your home.

After four days, gather the cards together and examine the cards with a magnifying glass. Later place the cards where you can see all the results at a glance.

Result: This is a clear way to “see” air pollution because black carbon particles in the air will attach to the petroleum jelly. If possible try repeating this experiment in different seasons and compare findings.

ECOLOGY TRIVIA

- 1) What is Earth Day? Answer – It is a day set aside to consider the beauty and wonder of our planet and seek ways to preserve and protect the Earth and its species.
- 2) When was the first Earth Day? Answer – April 22, 1970.
- 3) How many countries celebrate Earth Day? Answer – Over 1 billion people in over 170 countries celebrate Earth Day on April 22 each year.
- 4) What are some ways to celebrate Earth Day and help the planet? Answer – Plant a tree. Trees take in carbon dioxide that people exhale and give off oxygen that people breathe.
- 5) What Earth Day project helps birds? Answer – Build a bird house.
- 6) What are the three Rs of Earth Day? Answer – Refuse, reuse and recycle.
- 7) What is an example of refuse? Answer – Refuse plastic bags from stores. A city the size of Philadelphia disposes of over 2,000 plastic bags and hour into landfills and these bags take over 230 years to decay and when decaying put chemical into the water supply.
- 8) What is an example of reuse? Answer – When you shop place your purchases in a reusable cloth bag. Use reusable coffee cups, drink mugs and bottles rather than disposable plastic. The amount of plastic dumped in the Pacific Ocean is the size of the continental U.S.
- 9) What is an example of recycle? Answer – Plastic containers with a triangle symbol can be recycled and turned into new plastic and even fabric. Use your town’s recycle bins to household items and make a backyard compost for yard wastes.

- 10) What can I do with stuff I no longer need? Answer – Don't trash, donate useful items from clothing to linens to furniture to charities, rummage sales, etc.
- 11) What can I do in my community? Answer – Join a neighborhood group cleaning up litter. Lady Bird Johnson made litter clean-up her mission as first lady and as a result stopped the public habit of tossing trash from a car etc. This action helped clean up streams and other waterways.
- 12) What can I do to support the Earth when I buy food? Answer – Buy locally grown produce to reduce the energy needed to bring food to your table.
- 13) What can I do to reduce toxins in my house? Answer – Use natural based products for cleaning your house. For example – vinegar and newspaper can be excellent for cleaning windows and baking soda and vinegar are perfect for cleaning a sink.
- 14) What can I do to reduce my energy usage? Answer – Unplug unused appliances! After the morning coffee maker has made your brew, unplug it! Appliances left plugged in, even when not in use, continue to draw power. Put your computer, TV and CD player on surge protectors for an easy way to turn off when not in use. Reducing wasted energy reduces the amount of coal burnt to generate electricity.
- 15) What can I do to encourage energy alternatives such as wind and solar power? Answer – Contact your utility company. In many places you may choose your source of energy.
- 16) What can I do to conserve water? Answer – Americans use about 8.5 bathtubs of water per person per day for cooking, cleaning etc. Reduce this amount with low flow toilets, showers and faucets and use barrels to collect rainwater for use in gardening.
- 17) How can I help keep pollution out of streams, lakes and rivers?
Answer – Don't wash your car and let the soapy water run into the storm drain and directly into the streams. Instead, use a commercial car wash that recycles the water. Don't pour any oil, gas, cleaning materials or chemicals into a storm drain.
- 18) What can I do with a non-working TV, computer, and refrigerator?
Answer – Call your local government for the location of their appliance collection center. These and other tech products have chemicals and batteries that must be disposed of properly to avoid harmful chemicals entering the environment.

- 19) Should I flush unused drugs down the toilet? Answer – No. These medications end up in the water table. Instead, ask your pharmacy about unwanted drug collection sites.
- 20) What small steps can I take every day to help the Earth? Answer – Take a walk. Enjoy and appreciate nature as well as reduce car exhaust by strolling to your destination.

EXPERIMENT LOG

French physicist Antoine – Cesar Becquerel in 1839 was experimenting with a solid electrode that was dipped in the electrolyte solution he was able to see a photovoltaic effect. He even saw a voltage develop when the sunlight fell on the electrode and created a solar energy panel.

Results: _____

Results: _____

Results: _____

Results: _____

Results: _____

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Resources

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U.S. Geological Society – USGS – www.usgs.gov

National Oceanic and Atmosphere Association – NOAA – www.noaa.gov

National Park Service – NPS – www.nps.gov

National Institutes of Health – NIH – www.nih.gov

National Weather Service – NWS – www.weather.gov

National Aeronautics and Space Administration – NASA – www.nasa.gov

Holidays – National Archives and Records Administration – www.archives.gov

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“Gloria Hoffner is a well respected Activity Professional. Her presentations and professional writings are filled with relevant and practical strategies that can be used in any health care community. As a retired elementary school teacher and administrator, I am impressed with Gloria's knowledge and application of science-based experiments and studies that our residents can experience and enjoy each day. Improving each resident's daily Quality of Life is what we do as Activity Professionals. Gloria helps make this journey more enjoyable!” Anthony Vicari EdS, AC-BC, ADC/EDU, CADDCT, CDCM, CDP; NAAP Vice President, Certified Alzheimer's Disease and Dementia Care Trainer and Eden Alternative Educator and Associate.

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Science for Seniors. 277- Page book. 2012 Idyll Arbor Inc.: Enumclaw, Washington.
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