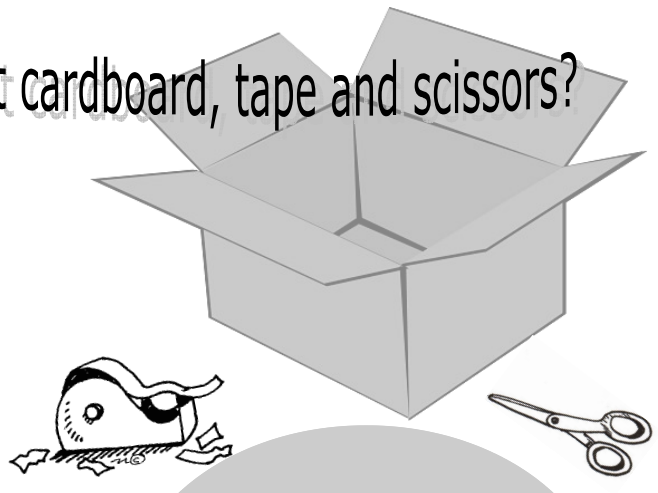
K-2 Science Enrichment Activities for the Weekend Scientist

Provided by the Pathways to Excellence Staff

Just Cardboard!

What do you think you could invent with just cardboard, tape and scissors?

My ideas!



Give it a try!

Bill Allen Cardboard Creations

Most people think that to be an inventor you have to work with complex electronics or expensive materials. Engineer and inventor Bill Allen of Louisville, Kentucky, proved that he could create an invention with little more than cardboard, scissors, and tape! When Allen retired in 1980, he no longer had the sophisticated materials and tools of the engineer, so he used what he had. The challenge of a friend initially prodded Allen into inventing. His friend was tired of recovering spilled items from grocery bags that had shifted in the back of his station wagon. He said to Bill, "If you're so smart, why don't you figure out what to do about those ...plastic bags?"

Allen's solution was the Spillstopper®, a bottomless cardboard container that fits into a backseat, trunk, or back of a station wagon and holds bags in place. Allen, however, didn't stop there. Always carrying a notebook with him to write down new ideas for inventions, Allen pursued patents on about 50 inventions, including a small, foil-lined window box for starting seeds and a cardboard holder to keep floral arrangements secure in a delivery truck. Allen's partner, Dave Maxfield, said he feels confident that the Spillstopper® will be a success: "Sometimes the simplest ideas are the most successful.

OSCILLOSCOPE

Would you like to *see* patterns of sound as well as hear them? You can, with an instrument called an oscilloscope. Sound comes from patterns or waves of vibrations in the air; these waves vibrate in your ear, and you hear. The oscilloscope lets you *see* sound. You can make a simple one using these instructions.

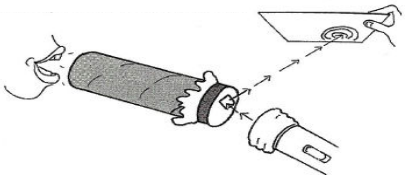
Materials:

- Balloon
- Masking tape
- Glue
- Mylar® (found at art supply stores)
- Flashlight
- Empty toilet paper or paper towel tube
- Plain white card
- An inquiring mind

Step One: Stretch a balloon tightly over one end of the tube. Secure it with masking tape.

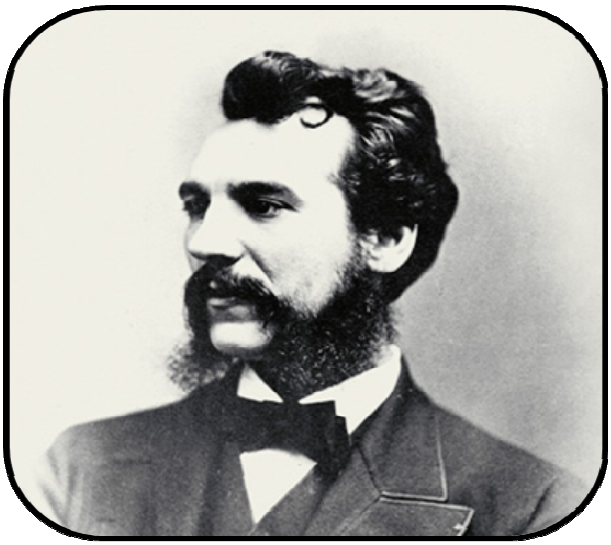
Step Two: Attach the Mylar® to the balloon with a small amount of glue. Put the Mylar® somewhere other than the middle of the balloon.

Step Three: Dim the lights in the room. Shine the flashlight so it reflects off the Mylar®. Hold a plain white card so that the light reflects off the Mylar® and onto the card.



Step Four: Now have someone speak into the tube. The reflection will vibrate as the person talks. You *see* the sound.

Alexander Graham Bell
Not Just the Telephone



It's hard to imagine living without telephones. But it took even more imagination for Alexander Graham Bell to conceive of transmitting speech in the first place. In 1874, Bell devised the basic idea for the telephone. On March 10, 1876, Bell transmitted to his assistant Thomas Watson the famous sentence: "Watson, come here; I want you." Bell displayed his invention at the 1876 Centennial Exposition in Philadelphia, Pennsylvania, and founded Bell Telephone Company in 1877.

Bell's lifelong interest in sound stemmed in part from his interest in people who are hearing-impaired. His father had developed a system on teaching the deaf, which he called "visible speech". Bell founded a school for the deaf in Boston. One of his students, who had been deaf from age 5, became his wife. After his marriage, Bell's desire to help those who could not hear increased. Bell used his knowledge of the anatomy of speech to devise a way to send the human voice by machine. His invention worked in a way similar to the vibrations of the vocal cords.

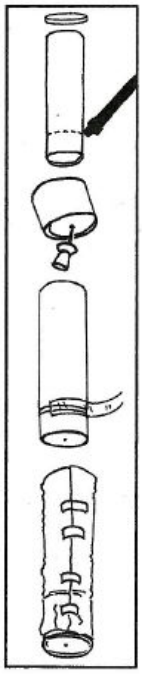
Bell's creative genius extended beyond the telephone. He invented a kite strong enough to carry a person and worked on hydrofoil boats. For a while, his boat was the fastest in the world!

Make a Simple Camera

Many copy machines are like very fast cameras. Maybe you can't make your own copy machine, but you can make a simple camera out of a Pringles ® potato chip can!

Materials:

- Empty Pringles® can
- Marker
- Ruler
- Utility knife (Ask an adult for help.)
- Thumbtack
- Masking tape
- Aluminum foil
- Scissors
- Sunny day



1. Take the lid off the can and wipe the inside clean. Keep the lid!

2. Draw a line with the marker all the way around the can about 2 inches from the bottom. Ask an adult to cut the can into 2 pieces along that line.

3. With the thumbtack or pushpin, make a very small hole in the center of the metal base on the shorter bottom piece.

4. Put the plastic lid over the end of the shorter piece. Put the longer piece back on top, and tape all the pieces together.

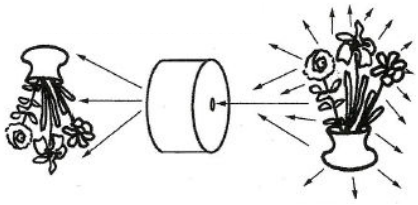
5. Use a piece of aluminum foil about 1 foot long to keep the light out of the tube. Tape one end of the foil to the tube, and wrap the foil all the way around the tube twice. Tape the loose end of the foil closed.

6. Go outside on a sunny day, close one eye, and hold the tube up to the other eye. Cup your hands around the top of the tube to keep it as dark as possible. Look around the yard. The lid makes a screen that shows you upside-down color pictures!

7. Hold your hand in front of the pinhole, and move it up very slowly. Your hand will be moving up, but you will see its shadow moving down the screen!

Make a Simple Camera

How does it work?



Light reflects off colorful objects in all different directions.

Hold a piece of white paper near a bouquet of flowers. The reflected light shins on the paper, but all the colors from the bouquet are mixed in the light, and you see no colored image on the paper.

However, the pinhole camera filters the light reflected from the bouquet. Only those light rays reflected in the direction of the hole pass through the hole and travel in a straight line toward the screen.

There is no mixing, and the image of the bouquet is focused on the screen. Experiment with different sizes of holes to see how the quality of the image changes.

Chester Carlson
The Copy Machine

If you're looking for a study in persistence, look no further than Chester Carlson. He's the inventor of the process that makes the modern copier work. While you might become impatient if making a copy takes more than two seconds, Carlson had to wait 20 years before he could market his invention.

Carlson always had a reputation for working harder than everyone else. The strength of his dream and the sheer force of his will enabled this shy introvert to persist until he finally achieved success. One of Carlson's early jobs was at a print shop. The difficulties he saw in printing processes inspired him to look for better methods. From that point on, he was never seen without a notebook to record his ideas.

Despite a difficult life, Carlson studied technical journals and sought out the best physics education he could find. He lived and breathed inventing and inventions. He even went to law school so that he could understand patents! In 1938, However, his work was far from over. It was not until 1960 that he finally got an investor to produce the first Xerox ® copy machine. Carlson, who had struggled financially his whole life, became fabulously wealthy. He spent most the rest of his life giving his money away to research projects and charities. Chester Carlson is indeed a person whose persistence and generosity we could all copy!

Your Own Chemistry Kitchen!

Research the garden vegetables that Carver suggested for improving the conditions of the soil. Plant your own "Carver" garden in the spring.

In addition to being a scientist, Carver was also an artist and used his drawing skills to make illustrations of the plants he was studying. Draw an illustration of a plant from your garden.

Plant from my garden

My research

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My garden plan

A little extra...

Today, many people use the copyrighted term Xerox ® to refer to any photocopy. Carlson and his associates struggled to find a suitable name for the new process. The word electrophotography was not exactly catchy. The solution came when a Greek scholar recommended the word xerography, taken from the Greek words *xeros* for dry and *graphos* for writing. When the first copier was introduced in 1949, it was called XeroX; only later was the final "x" changed to a lowercase letter.

What catchy name can you come up with for an invention?

Your Own Chemistry Kitchen!

Look around your kitchen to create your home research lab and do some experimenting. Using a basic chocolate cookie recipe, vary the flavoring ingredients to see if you can invent a "new" cookie. Do not vary the flour, baking soda, or other essential ingredients; instead, focus on the flavorings. Try your favorite candy bits instead of chocolate chips, or substitute mint or another flavor for the vanilla. Be creative. *Bon appétit!*

George Washington Carver
300 Uses for Peanuts

Here's a challenge for you: How many uses can you come up with for peanuts? Of course there's peanut butter and ...peanut butter…George Washington Carver had no limits when it came to creative uses for an agricultural product– he devised 300 uses for peanuts. Who was this agricultural wonder?

In 1864, Carver was born in Missouri to parents who were slaves. He worked his way through high school and college. Graduating from what is today called Iowa State University, he joined the faculty and specialized in botany lab work. Soon, he became director of the Department of Agricultural Research at Tuskegee University in Alabama. It was there that he began his extensive experiments with peanuts and other crops. Using what might be called "creative chemistry", Carver devised 300 commercial products that could be made from peanuts, including peanut butter, mayonnaise, coffee, soap, salad, oil, pancake flour, lotion, glues, dyes, grease, and milk.

Carver's goal was to better the lives of poor farmers in the South. Since the Civil War, farmers had struggled. Southern farmers had two major problems: soil depleted of nitrogen from growing too much cotton and the boll weevils that ate cotton plants. Carter came up with a solution– planting peanuts to restore nitrogen to the soil. Finding every possible way to use all the peanuts became Carver's mission. But Carver did much more. He also introduced methods of crop rotation, organic fertilizers and hybridization of plants.

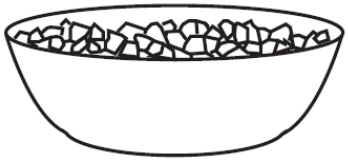
There's no end to the number of fun things you can do with a magnet. Crystal Englert used a magnet to solve her crayon-spill problem. Here's a magic trick that is sure to impress friends at your next sleepover.

Flake(y) Magic

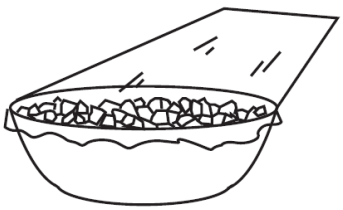
Materials needed:

- One shallow paper bowl
- Cereal flakes
- Plastic wrap
- Transparent tape

Magic trick:



1. Fill the bowl halfway with cereal flakes. Show the bowl of cereal to your friends. Tell them that you bet your cereal is "stronger" than theirs – and you can prove it!

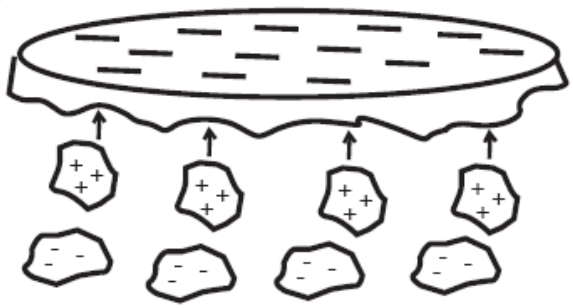


2. Cover the bowl of flakes with a piece of plastic wrap. Secure the plastic wrap with tape, making sure that the plastic on the top of the bowl is pulled taut.

3. Then, rub your knuckles eight to 10 times across the plastic wrap that covers the flakes. The flakes will begin to jump up and cling to the underside of the plastic wrap as if holding on with invisible strong arms.

Flake(y) Magic

Why it works!



- As you rub your knuckles across the plastic wrap, millions of electrons leave your hand and “pile up” on the surface of the wrap. This creates a strong negative charge.

- Because **like** charges repel, the negative wrap pushes away electrons into the bottom of the dry flakes. The cereal top surface becomes positively charged.

- Since **unlike** charges attract, the positively charged flakes move forward and cling to the already negatively charged plastic wrap.

Crystal Englert Magnetic Crayon Box

What drives you crazy? Pickle jars that get knocked over when you reach for the yogurt at the back of the refrigerator? For Crystal Englert of DuBois, Indiana, it was crayons that spill out of the crayon box. However, Crystal didn't just complain about her pet peeve—she actually invented something to stop it.

In 1993, Crystal devised a way to deal with the aggravation of constantly spilling crayons. She put a magnet in the bottom of the crayon box and then inserted a hot nail into the bottom of each crayon. Her crayons would all stay put when the box is tipped over. That's innovation out of aggravation!

Indiana neighbor Nichola Klein of New Albany also solved an annoying problem. In 1991, she used the "lazy Susan" concept to replace the shelves of a refrigerator with revolving food trays. No more spilled pickles!

We spend much of our lives solving problems. What's bugging you? Go solve it!

RUBBERTOWN?

Do you know anyone who works in the Louisville, Kentucky neighborhood known as "Rubbertown?" In this area, there is a concentration of factories that manufacture synthetic rubber, polyvinyl chlorides, epoxies, and similar chemicals. These industries played a major role in the creation of synthetic rubber during World War II. When the war began, the United States lost access to 90 percent of its natural rubber supply.

Synthetic rubber was needed—yesterday! Everyone believed it would take 20 years to begin large-scale manufacturing of a brand-new material like synthetic rubber. However, the U.S. government and manufacturers worked together in a cooperative way never before seen. The competing companies shared ideas and research. It didn't take 20 years—only two!

Need a project? How about doing some research to figure out where chewing gum fits into this picture? Bet you can find out!

My research on chewing gum told me that...

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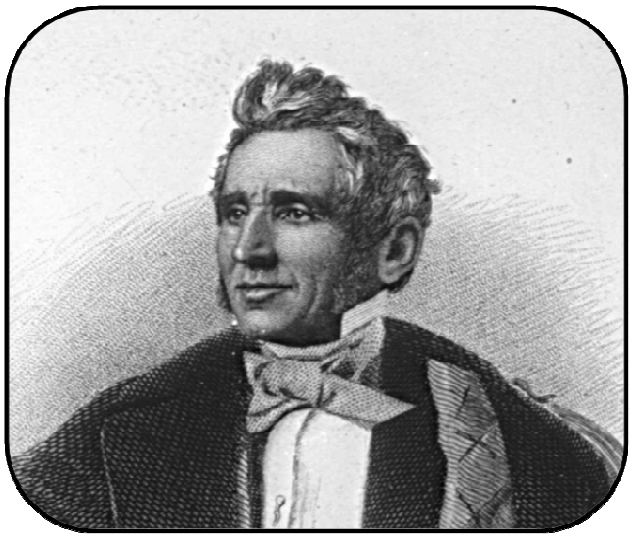
Charles Goodyear Vulcanized Rubber



The 16th century Spaniards apparently were the first people to make use of natural rubber. Their children played games with balls formed by the hardened gum (now called latex) of certain trees. In 1770, English scientist Joseph Priestly discovered that this sticky substance would “rub out” his written mistakes, so he called it rubber.

A Scottish scientist, Charles Macintosh, found a good use for rubber. He coated hardened pieces with the softened latex and found that it was waterproof. People began to use it to make boots and raincoats. Unfortunately, rubber becomes soft and sticky at high temperatures and brittle at low temperatures. After a while, inventors tried to improve the product.

An American with a very familiar name, Charles Goodyear, found the answer. Goodyear was the son of an inventor who was an unsuccessful merchant. Charles became obsessed with creating a form of rubber that would not be so sensitive to temperature changes. Because Goodyear failed to pay his bills, he even spent time in prison. Unfortunately, his luck didn't improve. When he sold the U.S. government a large order of mailbags coated with rubber, they melted from the heat before they even left the factory!

Could Goodyear’s luck change? Turn over to find out!

What connection can you make to solve a problem? Inventor Paul MacCready suggests looking for unconventional ways to solve problems. He invented a flying machine powered by pedaling called the Gossamer Condor.

UNORDINARY THINKING...

Let’s say you would like to invent something to find lost items around the house. MacCready recommends that you think of a noun that has nothing to do with your idea. Using this noun as your starting point, brainstorm more words while you’re thinking about your problem. From each of these words, brainstorm some more. While that may sound silly, MacCready’s whole point is that nothing about your ordinary thought patterns has solved this problem… so maybe some unordinary thinking will work. You’ll find yourself looking at problems from totally different angles, and that’s where many creative solutions come from. Give it a try on the back!

Charles Goodyear
Vulcanized Rubber

Still Goodyear didn't give up. One method he tried was mixing rubber and sulfur. While doing so, Goodyear accidentally let the mixture come in contact with the heat of a stove. The rubber did not melt but reacted more as leather would. Immediately, Goodyear knew what he had accomplished. He nailed a piece of this "gum" outside in the weather, and he found that it was just as flexible in the cold as in heat.

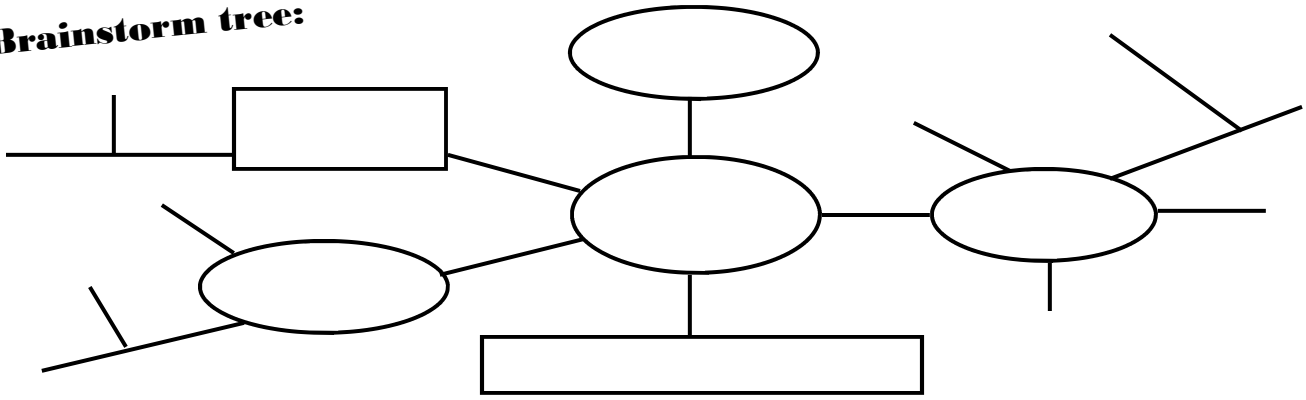
We can now understand the chemistry behind Goodyear's success. The sulfur atoms combined with the long chain of rubber molecules. The result was a more stable material less subject to temperature changes.

In 1844, Goodyear patented his rubber. He called it vulcanized rubber after Vulcan, the Roman god of fire. There was not a happy ending for Goodyear. He had to defend his patent from theft many times, and he never recovered the initial money he had invested. However, as a tribute to him, the Goodyear Tire and Rubber Company was named in his honor.

UNORDINARY THINKING...

The problem:

Brainstorm tree:



Some solutions:

Betty Nesmith Graham
Liquid Paper ®

Have you ever learned from a mistake? Betty Nesmith Graham did—big time! Graham was working as a secretary, but she was not the best typist in the world. She noticed that the sign painters often covered their mistakes with white paint and wondered if she could do the same thing with her typed mistakes. She dabbed some white tempera paint over her mistake, and the error disappeared. While her bosses scoffed at her "invention", other secretaries loved it.

Graham believed her idea could make money. With the help of her son's chemistry teacher, she refined and improved the product, then applied for a patent. She began selling it as "Mistake Out". In 1968, Graham sold her company, now called "Liquid Paper ®", for $47.5 million. Now that's a mistake you can live with!

A little extra

If the name "Nesmith" sounds familiar to you, maybe you've heard of Betty's famous son— Mike Nesmith of the Monkees!

Design Architect

Try your hand at being a design architect. Begin by standing on the shoulders of post-modern architect Michael Graves. Using a shoe box or foam core, make a scale model of the Humana Building. Then, experiment with a building design of your own, and make another scale model.

Spaghetti Fight:

Materials needed:

- A box of spaghetti (uncooked)
- A bag of miniature marshmallows
- One Ping-Pong® ball

The challenge:

- **You and your friends can challenge each other to a "spaghetti fight" without getting into trouble!** Your challenge is to build a spaghetti and marshmallow tower capable of holding up a Ping-Pong® ball. Build it as tall as possible using the least amount of "money".
- **The building materials will cost you money.** The imaginary costs are $100 for every spaghetti stick you use and $50 for every marshmallow.

How to compute:

- Measure the height of your structure from the base to the top of the Ping-Pong® ball.
- Compute your final score using the formula:

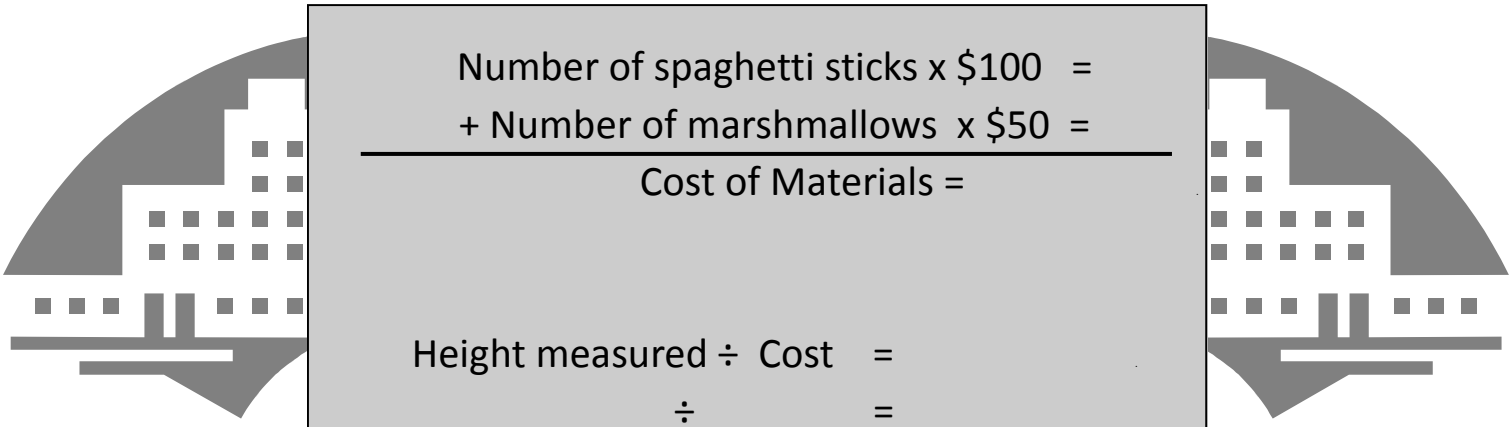
  score = h ÷ $

  h = height of the structure

  $ = money spent on materials

Spaghetti Fight:

My Score:



Number of spaghetti sticks x $100 =

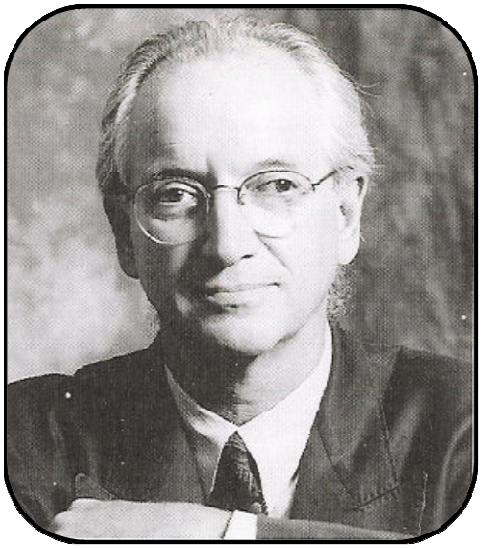
+ Number of marshmallows x $50 =

Cost of Materials =

Height measured ÷ Cost =

_____ ÷ _____ = _____

Michael Graves
Architect



When you were younger and first starting to draw, did you try to draw houses and other buildings? For most of us, drawing and designing structures was a phase. For Michael Graves, however, it became a life's work. Architecture is a design process that combines art and science like nothing else.

Graves is the award-winning architect of the famous Humana Building at Fifth and Main streets in Louisville, Kentucky. He won a worldwide competition in 1980 with his design for this 27-story "post-modern" building. At the time, Graves was not very well known, but after creating the Humana Building, his fame spread.

What many people find fascinating about Graves' building is the interesting way it relates to the other buildings around it and to the nearby Ohio River. It is a tall building like the National City Tower next door. The Humana Building's lower portion is reminiscent of the nearby 19th century cast-iron buildings. The glass balcony on the 25th floor projects out toward the Ohio River like the prow of a boat.

Graves was not afraid to break away from convention in designing the Humana Building. It became a turning point in his career. His sought-after New Jersey firm now designs not only buildings but also furniture, flooring, and artifacts. Graves has won at least 15 "Progressive Architecture" design awards, as well as honors from the American Institute of Architects and more.

What To Do With Silly Putty

Imagine that you are a materials testing specialist. You have been assigned the job of figuring out what to do with Silly Putty®. First, you have to figure out its properties.

Buy a container of Silly Putty® and perform these tests:

Silly Putty® Materials Testing	
When I do this:	**This is what happens:**
1. Stretch putty slowly.	
2. Stretch putty rapidly.	
3. Roll it into a ball; see if it bounces.	
4. Roll it into a ball; smash it with a hammer.	
5. Try to pick up newsprint with it.	
6. Try to pick up magazine print with it.	
7. Stretch it slowly and measure its maximum length.	

What To Do With Silly Putty

Now that you have
explored your Silly Putty®,
can you invent new ways
to have fun with it?

Peter Hodgson
Silly Putty®

The Hula Hoop®, The Pet Rock®, The Yo-Yo®. Among the inventions that leave us shaking our heads is the always-popular Silly Putty®. The story of this gooey toy is quite different than you might expect.

During World War II, there was a tremendous need for rubber, but the war had cut off most of the United States' supply. Among the many companies trying to produce synthetic rubber at that time was the General Electric Company. James Wright, a GE engineer, created a gooey but bouncy substance out of silicon. This raw material was easy to find because of its major component of sand. While the substance was elastic like rubber, it was too soft to be very useful. GE tried hard but couldn't find a use for this substance first known as "Nutty Putty".

In 1949, a toy store owner named Peter Hodgson saw the substance demonstrated. Borrowing $147, he bought as much of the substance as he could and packaged it into plastic eggs. He called it Silly Putty®. People were fascinated by the properties of this strange material; it bounced, but when pounded by a hammer, it shattered. It could pick up newsprint, especially comics, and remove animal hair from furniture. Adults used it for practical purposes, but soon children began to play with it. During the 1950s and 1960s, over $6 million worth of Silly Putty® was sold. It is still quite popular today.

Margaret Ingles and other engineers and inventors of the 20th century have achieved success that makes people marvel at their genius. However, you and today's inventors can look all the way back to the late 1400s and the early 1500s for inspiration from one of the most amazing creative minds in the world has ever known– **Leonardo Da Vinci**.

Become Leonardo's Assistant

Select one of Da Vinci's drawings that you find interesting, and try to make a model of it. Maybe it will be his experimental flying machine, movable bridge, or construction crane. Use such materials as balsa wood, glue, string, toothpicks, marshmallows, and rubber bands to try to become Leonardo's assistant.

Maybe some of his genius will rub off!

Make a Model!

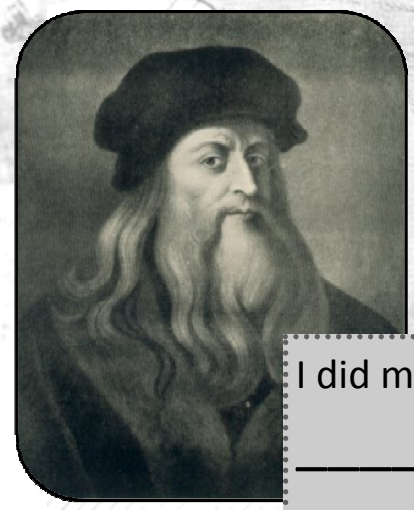
You can research Da Vinci on the Internet, in books, in encyclopedias, or in museums. You will find sketches of Leonardo's ideas for many inventions. You'll even find his designs for airplanes and other inventions that didn't come into existence until the 19th or 20th century! By the way, if you are a little confused about the notes with Leonardo's drawings, use a mirror to decode them. (Da Vinci often wrote backwards!)

can you write backwards?

A little extra...

Silly Putty® actually was invented twice. A Dow Corning scientist, Earl Warrick, had invented the same substance a few years earlier. His invention never became known because it was not marketed like Silly Putty ®.

Become Leonardo's Assistant



I did my research on Da Vinci by:

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Margaret Ingles
World's First Female Mechanical Engineer

In 1916, Margaret Ingles graduated from the mechanical engineering department of the University of Kentucky, becoming the first woman in the world to receive a degree in mechanical engineering. Ingles went immediately into a graduate program, then went to work for the Carrier Corporation, an air conditioning manufacturer in Syracuse, New York.

New York City happened to be the home of the 1939 World's Fair. Ingles spent long days in New York, visiting the World's Fair and the Carrier booth. At the close of an August day, with her feet burning from endless hours of walking on concrete, Ingles wondered if there was a way to let people cool their tired, hot feet. "The idea hit me then: Why not air-condition the hot 'dogs' at the fair next year?" (Feet were sometimes called "dogs" back then.) Margaret returned to Syracuse and put her ideas on paper.

She devised a three-seat stand with a cool air grill in front of each seat for cooling fair visitor's hot "dogs." The "cold dog stand" was a hit!

From an early age, Ingles wanted to build things. Although Ingles described her grades as "just above average," she worked hard to achieve her goals. In 1940, she was recognized by the Women's Centennial Congress of NY as one of the 100 American women who had achieved success in fields previously not open to women.

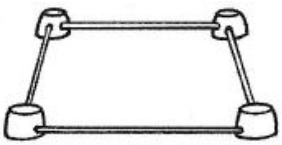
Terrific Triangles

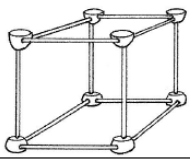
Basic Building Materials:

- One box of toothpicks, spaghetti, or drinking straws for structural beams
- One bag of gumdrops, mini marshmallows or bits of clay for connecting beams

Procedure:

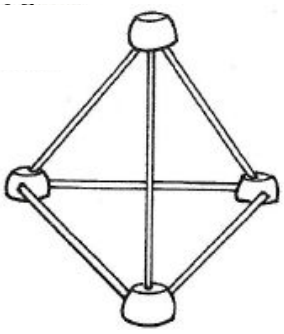
First, using four toothpicks and four gumdrops, make the base of a cube by poking the toothpicks into the gumdrops and shaping a square.





Now, stick a toothpick in each corner of the base to make the sides of the cube. Put a gumdrop on top of each toothpick, and use toothpicks to connect the gumdrops. After you've finished the first cube, keep adding more toothpicks and gumdrops to make a tower. Try wiggling your structure. Does it feel solid or shaky?

Now, start a second figure. This time use only three toothpicks and three gumdrops to make a triangle for a base. Now, add another toothpick to the top of each gumdrop. Pull all three toothpicks toward the center to make a three-sided pyramid. To create a larger figure, use the pyramid as a base, and attach more toothpicks and gumdrops for additional triangle-shaped sides. Does it feel solid or shaky?



Your pyramid figure made of triangles should be stronger than your tower made of cubes.

Think back to your original base for the cube. Given a good squeeze, your cube would collapse into a diamond. It is basically weak. But think again about the triangular base of your pyramid. Try to squish it, and it will push back. You won't really be able to squish it unless you break one of the toothpicks

Jim Jolly
The Revolution® Rim

Jim Jolly's scientific "laboratories" include his big blue easy chair and a tobacco barn workshop. The tobacco farmer and former cabinetmaker became obsessed with designing a "soft" basketball goal. To basketball players, a soft rim is forgiving and actually allows more shots to go in. The challenge was to make a rim soft but not loose.

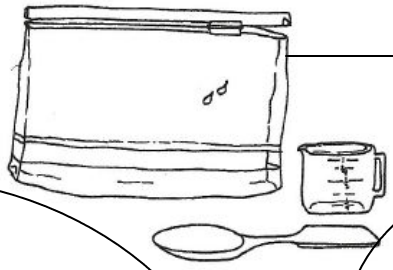
Jim Jolly worked on that challenge for 13 years. He designed, redesigned, invested his own money, and traveled extensively. He tried to get manufacturers interested in his designs. Sometimes he thought he'd never achieve the design of his dreams. Then one day, he unlocked the secret as he doodled in his easy chair. "I jumped out of my chair, and I hollered to my wife, 'There it is.'"

The final design Jolly had drawn became the Revolution®. It is a breakaway rim based on what Jolly calls a "triangle lock." This innovation compensates for the wearing effect that would otherwise eventually loosen the rim. The rim is indeed revolutionary—so much so that it is guaranteed for 10 years, twice as long as that of any other manufacturer. Jim Jolly's rim also has other special features. There is a way of attaching a net without hooks, and there is even a softness adjustment feature.

Jim Jolly hopes he eventually will recoup the money he has invested in his rim, but making money was not his primary goal. He said he just wanted to take a shot at helping all kids who play basketball.

Want to work with a polymer like Stephanie Kwolek did?

You can. Try this recipe for Slime.



A few cautions before you put on your chef's hat:

- Slime is not edible. Don't feed it to your dog...or your little brother.
- Slime stains. Store it in a zippered plastic bag when you're not slimming. Keep it off mom's new couch and your new shirt.
- Wash your hands before and after playing with it. You might start growing yucky things.
- If your slime eventually grows mold, throw it out and start a new batch!

Start sliming with the recipe on the back!

Want to work with a polymer like Stephanie Kwolek did?

You can. Try this recipe for Slime.

Slime

Ingredients: 1 tablespoon borax (Look for it in the laundry detergent aisle)
1 cup water
1/4 cup Elmer's Glue-All® (Not school glue– must contain polyvinylalcohol)
1/4 cup water
2 drops food coloring

- Take a cup of water and add one tablespoon of the borax to it. Stir it completely dissolved, but no tasting please.
- In a zippered plastic bag, mix 1/4 cup glue and 1/4 cup water. Add an equal amount of the borax solution to the glue solution. (OK, math whiz, that's 1/2 cup, right?) You'll be making one cup of slime.
- Add a couple of drops of food coloring to produce your favorite gross-out color. Zip the bag closed, and knead the mixture like bread. (Hold the butter!)

Let the slime out of the bag and start sliming!

Stephanie Kwolek
KEVLAR®

What happens to curious kids– the kind who catch frogs or try to figure out what grows under rocks? Stephanie Kwolek was just that kind of kid. She went to work for DuPont Chemicals Company and invented a material that saved many lives. She invented KEVLAR®, the material used to make bullet-resistant vests.

As a child, Kwolek was already well on her way to being a scientist. "I remember spending an awful lot of time with my father roaming through the woods, collecting wildflowers and making scrapbooks of them."

Kwolek went to college during WWII. Impressed by the scientific advances of that time, she decided to study science. When she joined DuPont, she began working with polymers, and her challenging research eventually led her to invent a polymer that was incredibly strong and stiff. It was lighter than asbestos and stronger than steel, yet showed the same useful properties. It did not rust and could be made into yarn or thread. KEVLAR®, as the polymer is now named, is best known for its use in bullet-resistant vests for law enforcement officers. Today, it is also used to make inflatable boots, parachutes, safety gloves, and building materials.

What is Stephanie Kwolek like? She's just like you and me, but she always satisfied her curiosity about how things work and how she could make them better.

RESEARCH & CREATE GLUE

Epoxy resins are strong and protective, but they also can also be very toxic. Be sure to have adult supervision and plenty of ventilation when using an epoxy or any chemical glue. Better yet, try making a homemade non-toxic glue of your own to use for creative art and science projects. Listed below are the basic ingredients you need to make glue. However, you need to do some experimenting to determine the best "recipe" for your homemade glue.

Basic ingredients:

- Corn syrup
- Cornstarch
- Vinegar
- Water

Using basic measuring spoons from the kitchen, mix three or more different glue recipes. Vary the proportions or amounts of each of the basic ingredients for each glue you create. Test each glue recipe on construction paper and cardboard to determine which glue holds the best. You will need to let the glue dry overnight. Be sure to label your samples so you can keep track of your recipe for the **best homemade glue**.

Test results: **Stickiness Rating**

	Formula	Poor	Good	Excellent
Glue 1				
Glue 2				
Glue 3				

RECORD YOUR FORMULA

Once you've determined the perfect glue formula, record your measurements here.

My glue

Ingredients:

_____ **Corn syrup**

_____ **Cornstarch**

_____ **Vinegar**

_____ **Water**

J.S. Long
Epoxy Resin

OK, here are some questions about your can of green beans. What is that coating on the inside of the can, and why is it there? The coating is an epoxy resin that improves the taste of canned food by keeping it away from the metal. Why should you care? Epoxy resins give us tastier veggies.

The first successful formula for epoxy resins came from the inquiring scientific mind of a chemist, J.S. Long. Working at Devoe & Raynolds Paint Company in 1945, he devised a synthetic "amber." Amber is a material so indestructible that today we find Stone Age bugs encapsulated in it. Long's epoxy resin revolutionized paint production. It was the beginning of a line of liquid plastic coatings that are widely used for tools, reinforced plastic and protective coatings.

Virtually all of today's paint is based on the chemistry of plastics. Polyvinyl acetate and acrylic paints, for example, dry fast, come in a wide range of colors, and can be scrubbed. Most importantly, they are easier to use than they are to pronounce!

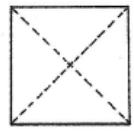
Make a Windmill:

Materials:

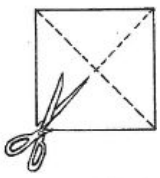
- Large square of construction paper
- Toilet paper or paper towel tube
- Paper clips
- Hole punch
- Scissors
- Plastic straw
- String
- Tape
- Ruler
- Styrofoam® tray

Directions:

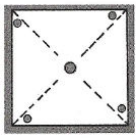
Step One: Fold your paper square diagonally. Open and fold again across the other diagonal. It might help to draw a dotted line along each fold.



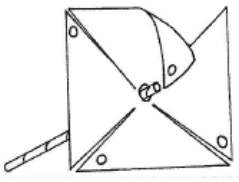
Step Two: Cut along each fold, stopping two centimeters from the center.



Step Three: Punch a hole in the center and a hole in the left corner of each section.



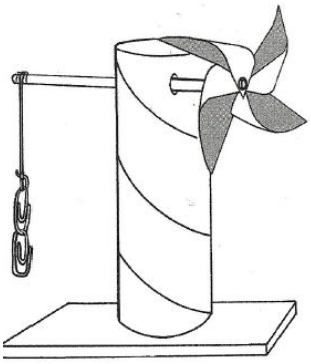
Step Four: Slide the straw through the hole in the center. Fold each hole-punched corner toward the center, and slide the hole over the end of the straw.



Step Five: Punch a hole through the top of the paper towel tube. Slide the straw through this hole. The straw should spin freely.

Step Six: Tape the string to the empty end of the straw. Attach paper clips to the bottom of the string.

Step Seven: Using tape, attach the bottom of the paper towel tube to a Styrofoam® tray.



Step Eight: Blow on the windmill, and see if you can lift the paperclip. Add more paperclips and see how many you can lift.

Elijah McCoy
The Real McCoy

Did you ever wonder where the expression “the real McCoy” originated? Elijah McCoy was an early African-American inventor who became known for the excellence of his designs. People didn’t want imitations of his products. They knew McCoy was dedicated to quality, and they wanted to be sure they got “the real McCoy.”

Elijah McCoy was born in Canada to parents who had escaped from slavery. Education was a high priority in the McCoy family. Very early, Elijah showed strong mechanical skills. He enjoyed taking things apart and putting them back together again. When he was only 16, Elijah traveled to Scotland to study engineering. By the time McCoy finished his degree, the American slaves had been freed. McCoy was able to return to America.

Although McCoy was fully credentialed as an engineer and master mechanic, jobs were difficult to find. Many people thought of blacks as uneducated or even still considered them slaves. Elijah finally found work as a fireman/oilman and discovered that the process of oiling the train was dangerous and inefficient. He worked for two years to design a cup that would automatically drip oil wherever it was needed. In 1872, he applied for a patent on this product. While many engineers were skeptical, railroad engineers realized how good the product was. Soon, people were asking for “the real McCoy” by name.

Build a Bridge

Your challenge is to design and build a toothpick bridge that will support as much weight as possible using the fewest resources.

Here are your design parameters:

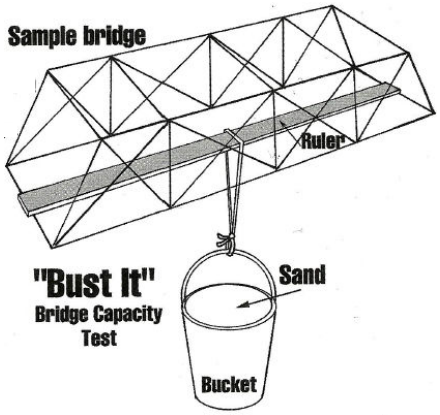
- The bridge must span a gap of 33 centimeters.
- You may use up to 1,000 toothpicks to construct your design.
- Toothpicks may be shortened, blunted, or spliced.
- You may use cement glue to join the toothpicks. The entire bridge cannot be covered with glue.

Bust it:

Test the capacity of your bridge.

CAUTION: This test will destroy your bridge!!!

- Weigh and record the weight of your bridge.
- Lay a ruler along the span of your bridge.
- Tie an empty bucket to the middle of the ruler. The ruler will help distribute the load over the span of the bridge.
- Slowly fill the bucket with sand (or other heavy material) until the bridge collapses.
- Measure the weight of the bucket and its contents.
- Now, calculate the capacity of your bridge. **The higher the capacity, the stronger your bridge.**



$$\text{Capacity} = \frac{\text{Weight of Bucket}}{\text{Weight of Bridge}}$$

Bonnie Money
Bridge Engineer

At her 20-year high school reunion, Bonnie Money was the only class member who had achieved her childhood dream—to work as a bridge engineer! She worked on the engineering team for Taylor-Southgate Bridge, which spans the Ohio River from Newport Kentucky, to Cincinnati, Ohio. This three-span, parallel-chord through-truss bridge (Did you catch all that?) uses a variety of state-of-the-art materials and innovative techniques. From structural design to field inspection, Money had the satisfaction of seeing her dreams become reality.

As a girl growing up in southwestern Michigan, Bonnie became fascinated with the Mackinac Bridge, which connects the upper and lower peninsulas of Michigan. When she studied history in school, she thought the story of the bridge was the highlight of the class. Doing research later, Bonnie realized that she and the bridge had grown up together! Its construction began about the time she was born, and it opened to traffic when she began elementary school. For her, a visit to this bridge today feels like visiting an old friend.

Bonnie Money has advice for anyone interested in a career in engineering: Study lots of the mathematics and science. But she also realizes that the best engineers are those who can communicate well, both verbally and in writing. So, don't shortchange your English classes in your quest to be a successful engineer.

What a Gas!

Garrett Morgan's prototype of the gas mask protected people from harmful gases. Here's your chance to learn about some of the properties of gas.

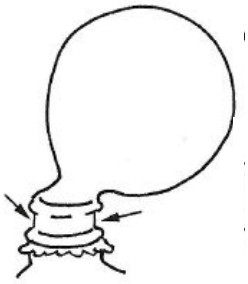
Materials needed:

- A 1-liter plastic soda bottle
- An 8-inch or larger balloon
- 1 teaspoon baking soda
- 3 tablespoons vinegar
- Clear tape

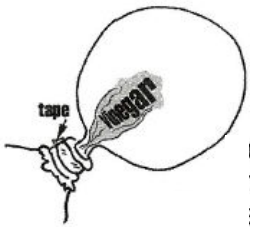
Procedure:

1. Pour the baking soda into the bottle and the vinegar in the balloon.

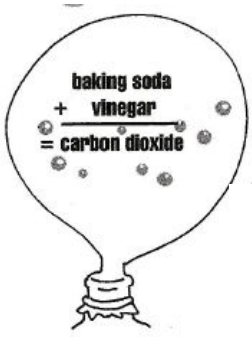
2. Place the open end of the balloon onto the mouth of the bottle.



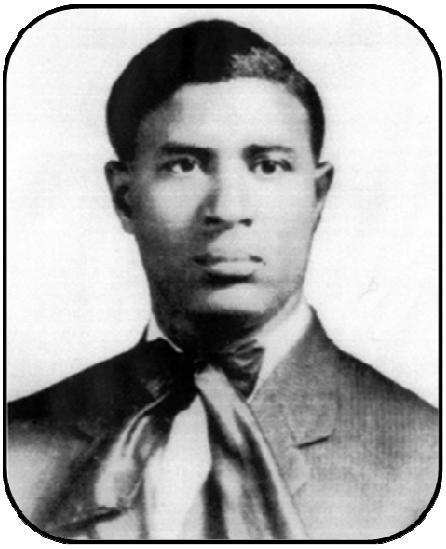
3. Tape the balloon securely, then tilt the balloon to allow the vinegar to run down into the bottle and mix with the baking soda.



4. The balloon will inflate because the mixture of baking soda and vinegar produces a gas called carbon dioxide.



Garrett Augustus Morgan
Don't Run that Red Light!



Garrett Augustus Moran had to overcome many obstacles to success. First, he had to quit school after the sixth grade to help make money for his family. Later, he had to deal with prejudiced people who did not want to buy his inventions because he was African-American. His later years were troubled by an eye disease that threatened his vision. Morgan persisted despite these obstacles, and today we all benefit from his creative mind.

Morgan's first invention was an accidental one. Trying to make a polish to keep sewing machine needles sharp, he got some polish on his neighbor's dog. He was shocked to see the dog's hair straighten. Morgan had invented a hair straightener.

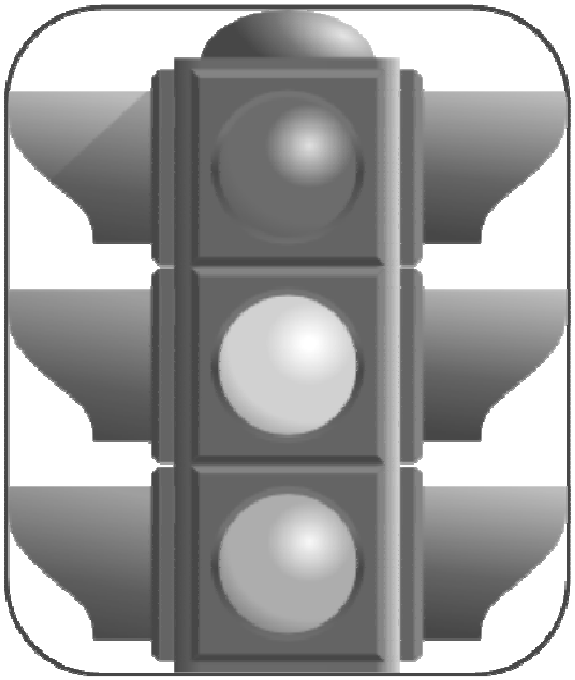
His next invention had a very serious purpose: to save lives. In 1916, an explosion rocked a tunnel in Cleveland, Ohio. The smoke, gas, and dust prevented rescue workers from entering. Someone remembered a gas inhalator that Morgan had been demonstrating to manufacturers. Morgan And his brother used the mask-like device to rescue the unconscious workers caught in the tunnel. The publicity from this rescue brought in many orders. However, when they discovered that Morgan was African-American, some companies actually cancelled their orders. As WWI began, the need for gas masks was so great that people ignored the color of the inventor, and the device was used extensively.

Sketch your own plan for a new vehicle here:

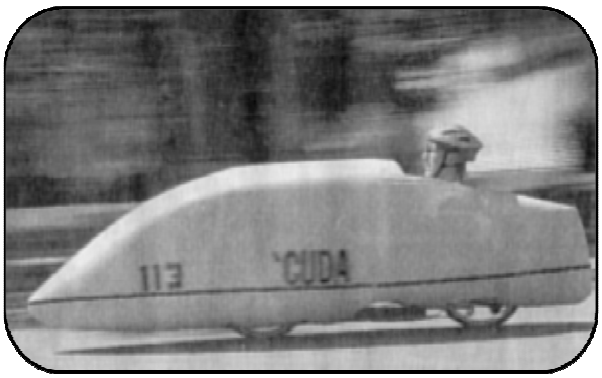
A little extra...

The best known of Morgan's inventions was the three-way automatic traffic light. Prior to his invention, lights were two-way—stop or go. When Morgan added a warning light to the system, the traffic moved more safely. Morgan sold his invention to the General Electric Company.

In his success, Morgan never forgot the prejudice that he had endured. During his later years, he was involved in the National Association for the Advancement of Colored People (NAACP). He even ran for the Cleveland city council to try to improve the lives of others.



David "Doc" Pearson Recumbent Bike



Have you ever thought an invention was pretty good… but wondered if you could make it better? David "Doc" Pearson did! Like a few other forward-thinking people at the time, he set his sights on building a vehicle that would be similar to a bicycle but faster, more comfortable, and more efficient. People dubbed it the Human-Powered Vehicle or HPV.

Most inventions begin the same way—with a fresh idea like the HPV. Pearson loved bicycles and even appeared as an extra in the bicycle movie "Breaking Away." He had seen a picture of a recumbent bike in *Bicycle* magazine and was inspired to try his own design. In 1980, Pearson put together a prototype, or model, of what he had in mind. He used old bike parts that he had stored in his garage. Pearson was impressed enough with its potential that he decided to try to manufacture his design.

Pearson's design began with a freehand drawing. Today, it would be done on a computer with a CAD (computer-aided design) program. An engineering drawing must be precise so that the prototype can be made from it. Everything must be built to scale and size. Pearson tested his prototype, and it worked well.

When the prototype was finished and tested, Pearson was ready to manufacture his product. As the recumbent bike has grown in popularity, he has filled orders from all over the world. The company even makes a version with hand-cranked pedals for use by people with disabilities.

Sunscreen and Light Energy

Bob Schlenk describes the light from his new lightbulb as warm and similar to sunlight. When it comes to sunlight, sometimes we do get too much of a good thing. That's why we use sunscreen—to lower the dose of light energy reaching the skin. Here's an experiment about sunscreen and light energy you can do at home.

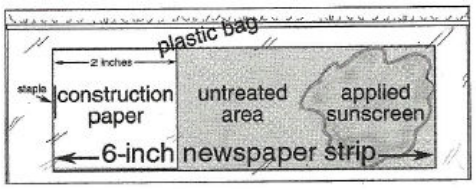
Materials needed:

- A selection of sunscreens of different SPF (sun protection factor) levels– 2, 6, 15, 24, 30, 45…
- Resealable small plastic bags
- 6"x2" strips of newspaper
- 2"x2" pieces of white construction paper
- Stapler

Procedure:

First, staple a piece of white construction paper over one end of each newspaper strip. Place each in a resealable bag, close the bag, and put a staple through the construction paper, newspaper strip and bag to prevent slippage.

Next, on the end of the newspaper strip opposite the construction paper, apply sunscreen to the outside of the plastic bag. Leave the middle section untreated. Allow each bag to remain in the sun for a few hours. Compare the results of the various SPF values.

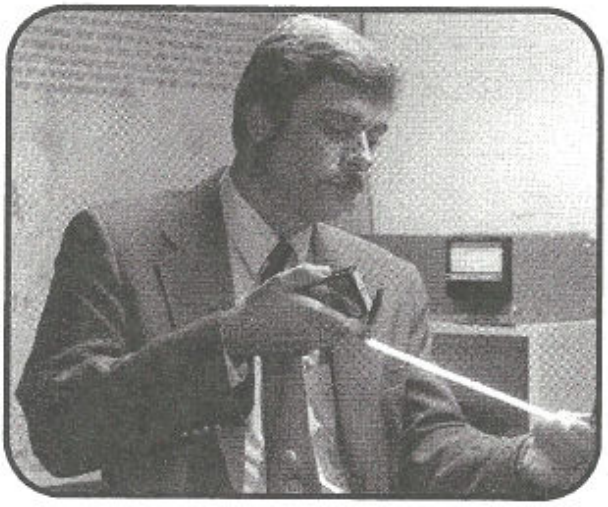


After a few hours in the sun:

- **The section of each newspaper strip not protected by sunscreen will yellow more than the section protected from the sun by the construction paper.**

- **The section of the newspaper protected by sunscreen will yellow according to the SPF value of the sunscreen. Newspaper protected by sunscreen with higher SPF values (24, 45) will take much longer to yellow than those with lower SPF values (2, 6).**

Bob Schlenk
Innovations in Lighting



If you think all light bulbs are the same, just ask those who have seen the innovative new light bulb pioneered by Bob Schlenk. “His device is so exciting….,” said Alexander Marinaccio, founder and president of the Inventor’s Clubs of America. “He’s going to do some great things.” In 1992, the club awarded Schlenk two first prizes – in the “new product” and “new technology” categories.

Even before the 1992 awards, Schlenk was named one of the top 66 inventors of 1991 by the Patent and Trademark Office of the U.S. Department of Commerce. What’s so special about his new kind of light bulb? Schlenk’s light bulb is a “lamp driver circuit.” According to the inventor, its brighter and more efficient than a standard fluorescent bulb. One of his 14-inch tubes will give off as much light as four standard 4-foot bulbs but only uses about 60 percent as much electricity. Amazingly, the bulb will last from 15-20 years! The secret of the technology is a circuit that makes transistors work together more efficiently.

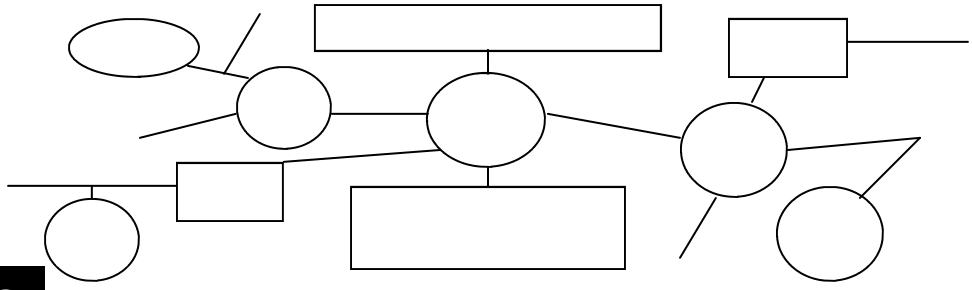
As often happens, the technology behind Schlenk’s lightbulb may have widespread applications, such as welding machines and portable cauterizing devices. His was certainly a bright idea!

What Drives You CRAZY?

1. Think of an everyday problem that drives you **CRAZY**.

It drives me crazy when… _____

2. Then, brainstorm some ideas for solving that problem.



3. Select the idea that intrigues you the most and go for it!

My best idea is… _____

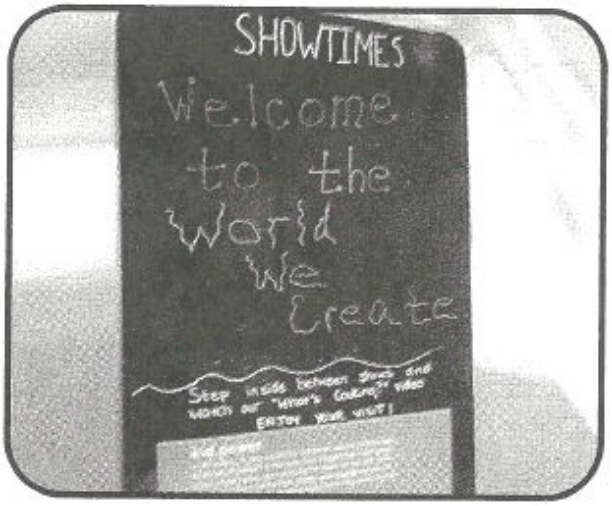
_____

4. Draw a rough design, and then try to make a model of your invention.

Good luck!

My rough drawing/design:

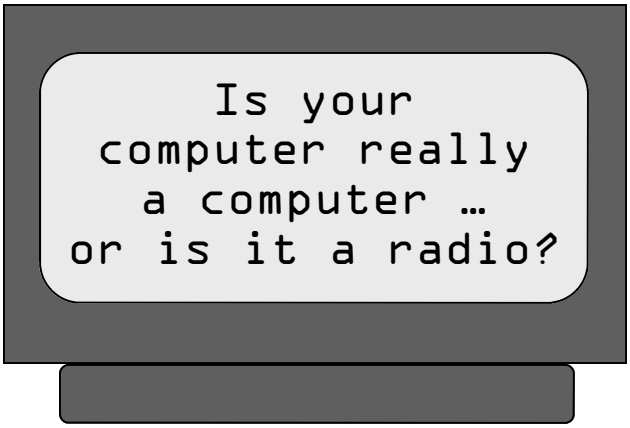
Becky Schroeder
Glo-Board



Out of boredom can come only…more boredom, right? Becky Schroeder knows that answer is absolutely wrong. When she was 10 years old, Becky frequently sat in the car while her mother ran errands. She was bored. She tried to do her homework, but when it got dark, she had to stop. Bored again. But she didn't waste her downtime. She thought about ways she could manage to do her homework in the dark.

When she got home one evening, she put her brainstorming into action. She painted a piece of cardboard with a glow-in-the-dark paint and drew lines on it. When it was dry, she put a piece of paper over it. Now, she could write in the dark. Becky had invented the Glo-Board, which is used extensively for restaurant menu boards and other signs.

You can use your intuition like Becky Schroeder did. She just had a feeling that if she could make her paper "light up", she could see to work on it. Sometimes young people have more creative ideas than older people because their minds aren't so fixed on finding the *right* way to solve a problem.



You may wonder how someone could confuse the two, but did you know that your computer gives off enough radio waves that it is actually checked by the Federal Communications Commission, or the FCC? Want to prove it to yourself?

Try this:

1. Get a portable radio and set it on AM.
2. Tune the radio to a spot on the dial where there is no station. Turn it up and listen.
3. Move the radio close to your computer. Do you hear sounds from your computer on the radio? Move the tuner dial around, and you will pick up

- There are several other experiments you can do to see if you are getting radio waves. Turn your monitor off and see if the sound changes. Open an application or copy a file and see if the sound changes.
- Radio waves are also given off by your processor, If you know the frequency of your processor, tune to that frequency on the FM band. For example, try 133 MHz. FM resists interference better than AM, but you still might be able to pick it up.

Nathan Stubblefield
Marconi Who?

You probably would be amazed how many times in history two people have invented the same thing at about the same time in different parts of the world. That is the case with wireless radio communication. Nathan Stubblefield is the lesser known of a pair of such inventors. While the Italian Guglielmo Marconi gets all the credit for the first radio transmission in 1896, there is reliable evidence that Stubblefield broadcast the human voice as early as 1892!

From boyhood on, Nathan Stubblefield loved science, especially electricity. He educated himself largely through reading *Scientific American* magazine at the local newspaper office. While farming seemed to be the only career option to Stubblefield, he often ignored his farm in favor of his scientific experiments. Stubblefield's family and friends date his first success with broadcasting as early as 1890 or 1892. If that is the case, Stubblefield beat the more famous Marconi to the punch.

Unfortunately, Stubblefield ran into serious business problems. His friends persuaded him to go to New York City and form a company to promote his invention. Stubblefield helped organize the Wireless Telephone Company of America. He then turned the business end of his work over to others. Years later, he discovered that he and his friends, who had also invested money, had been duped by the New York promoters. These promoters had never even obtained a patent on his innovation. Bitter and discouraged, Stubblefield suffered another blow. A trunk containing important parts of his invention and sketches of his idea were lost on a trip.

Could Stubblefield's luck change?
Turn over to find out!

Want to Make a Spectroscope?

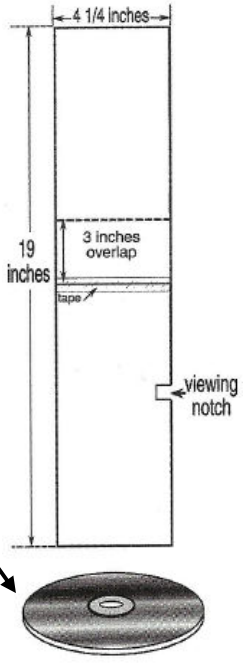
Light can be separated into all of its component colors through an instrument called a spectroscope. Want to make a spectroscope out of a CD?

Materials needed:

- Two (8 1/2 x 11") sheets of cardstock or heavy construction paper
- One compact disc, preferably one you don't like anymore
- Scissors
- Tape
- Several light sources– lamp, flashlight, etc.

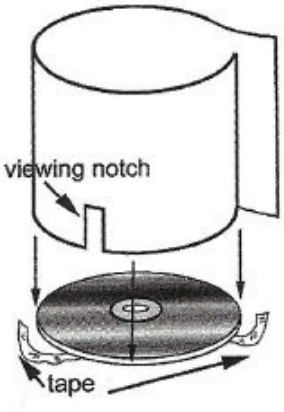
Procedure:

1. Fold one sheet of cardstock in half lengthwise. Cut along its fold line. Tape these two half sheets end-to-end, overlapping 3". Cut a viewing notch 1/4" wide and 1 1/4" high centered on one edge of the cardboard.



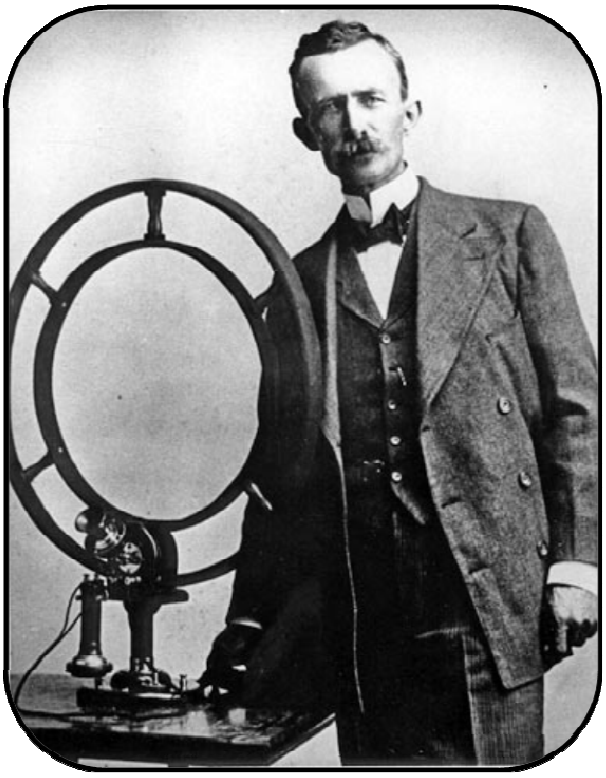
2. Hold the CD in your hand by the edges. Look carefully at the side that doesn't have writing on it. That is where the information is encoded. Tilt the CD back and forth. Do you see rainbows?

3. Your goal is to make a coffee-can-like container with the CD at the bottom and the top open. First, wrap the card around the edge of the CD. The notch you cut needs to be at the bottom of the container. This notch will be your window to view the rainbow side of the CD. Finally, fasten the cardstock container to the CD with pieces of tape. (Be sure that you do not tape the information side of the CD, or you will damage it.



Continued on the back!

Nathan Stubblefield
Marconi Who?



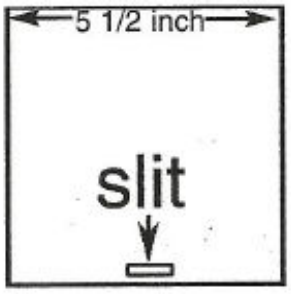
While Stubblefield continued to work on his wireless telephone, he did not actually apply for a patent until 1907. By that time, his method of transmitting sound had become obsolete. Stubblefield's last days were spent in isolation. He withdrew from friends and lived in a run-down tenant shack. He died alone and penniless.

Marconi gets all the glory for inventing the radio, but he never really transmitted the human voice; he just sent the Morse Code. Now we know that the American genius Nathan Stubblefield seems to be, as the Kentucky legislature decreed in 1944, "the true inventor of radio."

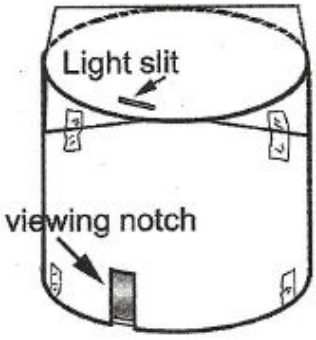
Want to Make a Spectroscope?

Procedure:

4. Now, make the top of your spectroscope. Cut a 5 1/2" square from the other piece of cardstock. Then, cut a slit 1/2 inch from the edge. Make the slit about 1/16" wide and parallel to one side of the square.



5. Finally, place this square on top of your coffee-can-shaped container. Position the slit over the notch in the container, and tape the top to the sides.



6. **Now its time to play with your spectroscope.** Shine a light source through the slit on the top, and look inside through the notch. You should see a rainbow of colors through your viewing notch. Move the light around until you get the best spectrum. Try different lights, and see different depths of color.

Explanation:

Your spectroscope is separating light into its component colors. A spectroscope does this through a "diffraction grating," which bends the light waves and causes the interference of light waves. This separates the light into its component colors. A CD works because it acts as a diffraction grating if light hits it at the right angle.

Kacy White
Light When You Need It!

Most people are fascinated by light. Albert Einstein was reportedly 16 when he wondered what it would be like to ride on a beam of light. Physics students perform complex experiments to determine the properties of light. Kacy White, however, was not exactly Einstein or a physics student. When she was six years old, she just wanted to find a way to make light last a little longer.

It drove Kacy crazy that she had to turn the light off and then try to find her way to bed in the dark. She imagined if she could make the light bulb glow for a while after it was turned off, she could solve her problem. Kacy's father began to ask her questions to encourage her to find a solution. Eventually, they came up with the idea of coating the bulb with fluorescent paint. It worked! Not only was Kacy's problem solved, but she was a winner in the 1990 Invent America contest. Can you picture yourself shining like Kacy's lightbulb? Sure! Start thinking...

Information and activities were gathered from *The World We Create.*