STEM NEWS

The Science, Technology, Engineering and Math of Golf

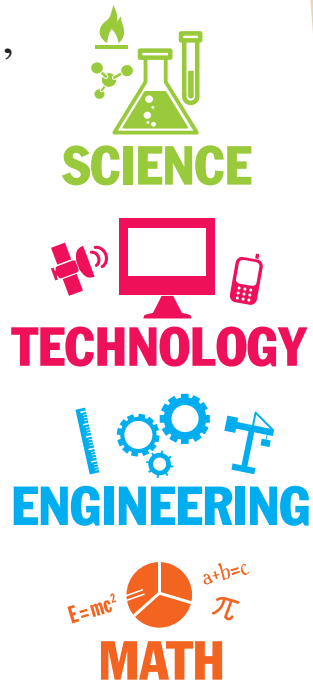
Kid Scoop®

USGA®

EDUCATIONAL SPECIAL FEATURE

WHAT'S STEM?

STEM stands for **S**cience, **T**echnology, **E**ngineering and **M**ath.



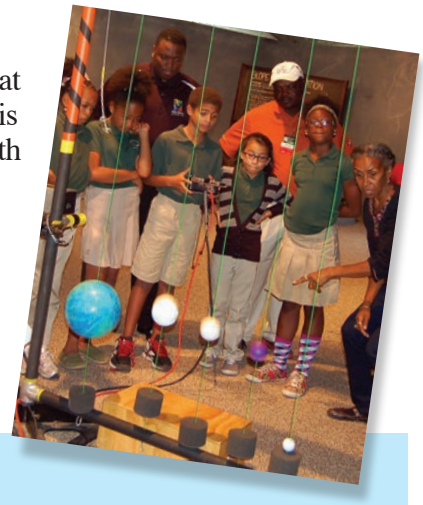
The amazing thing about STEM is that it's part of life all around us—the weather, cars and even the sports you watch and play—including golf!

And it turns out science and math have a lot to do with golf.

What is the STEM ZONE?

A few years ago, the United States Golf Association (USGA) created an engaging experience to help show the cool science behind the game of golf. The STEM ZONE is a tent that has tons of fun experiments and travels to USGA Championships.

The STEM ZONE was such a hit, that the USGA now is bringing the math and science of golf to young people nationwide through digital and interactive experiences.



CONTENTS

STEM Resources

STEM NEWS

STEM NEWS, created by the internationally syndicated ***Kid Scoop***, gets the scoop on the many ways sports and science collide with hands-on activities and learning experiences—in fact, you are reading it right now! STEM NEWS is distributed through newspapers around the country, at USGA golf championships and is available online. A teacher guide is available.

STEM TOOLKITS

These printable toolkits provide STEM lessons and activities for golf pros, teachers and youth organizations to teach young people golf and STEM at the same time. Coming in July.

INTERACTIVE MODULES

These interactive modules explore STEM concepts and allow kids to learn STEM principles in a fun and interactive way. Coming in July.

STEM VIDEOS

NBC Learn has partnered with the USGA and Chevron to create 20 informative videos that explore STEM subjects at work in the game golf! Lesson plans go with each video.

Find these resources and more at www.usga.org/chevron.

Careers That Are Part of the Game!

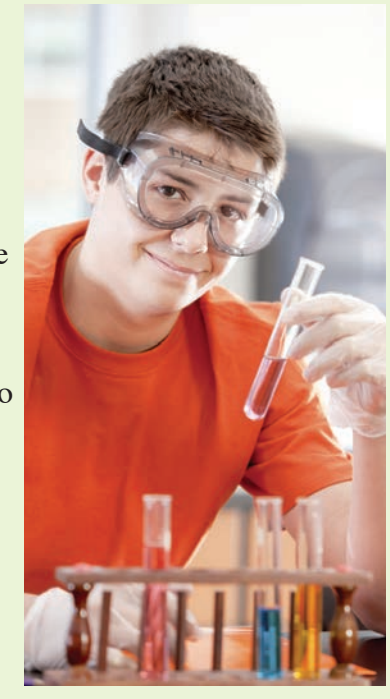
Science and math have a role in playing the game of golf. STEM concepts are also key to keeping the game challenging and fair. The USGA has a laboratory and a staff of scientists at their USGA Test Center.

The USGA Test Center tests golf balls, clubs, and other equipment to determine whether or not they conform to the Rules of Golf.

Clubs and balls are tested to determine they don't have properties or features that would make their use unfair, or eliminate the challenge and skill required to play the game.

STEM NEWS puts the spotlight on the USGA Test Center and the scientists and engineers who get to play with golf balls, clubs, robots and other cool stuff everyday!

Just turn the pages and discover how you can conduct the same kinds of experiments done at the USGA Test Center while gaining first-hand knowledge of careers more like a game than work.



FUEL FOR THOUGHT

WHICH IS FASTER?

Do the math to find out.

RUNNING CHEETAH
(30 x 2) + 10 = _____ MPH

PRO BASEBALL PITCH
(31 x 3) + 3 = _____ MPH

PRO HOCKEY SHOT
(33 x 3) + 1 = _____ MPH

PRO TENNIS SERVE
(54 x 2) + 47 = _____ MPH

PRO GOLFER DRIVE
(58 x 3) + 1 = _____ MPH

Some people think golf is a slow game. But it clocks some of the **highest speeds** in the world of sports! Hitting a ball hundreds of yards into a tiny hole with the least strokes possible requires some serious speed.

Sir Isaac Newton

No relation to Sir Isaac.

Speed in the STEM Zone™

Speed is about ***motion***. An English scientist named Isaac Newton came up with ideas about motion that have been tested and proven again and again. His ideas are called **Newton's Laws of Motion**.

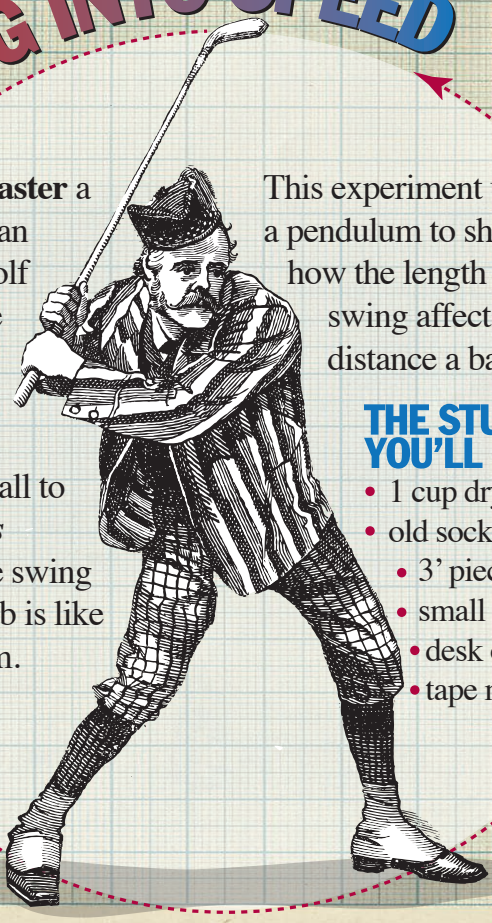
NEWTON'S FIRST LAW OF MOTION

Any object at rest will stay at rest, until a force causes it to move. An object in motion will stay in motion, until a force causes it to stop.

(WHICH MEANS THIS BALL WILL SIT HERE FOREVER UNLESS SOMETHING HITS IT.)

SWING INTO SPEED

The **faster** a golfer can make a golf ball go, the **farther** it will travel. How does a golfer get a ball to go faster? ***It's science!*** The swing of a golf club is like a pendulum.



This experiment uses a pendulum to show how the length of the swing affects the distance a ball travels.

THE STUFF YOU'LL NEED:

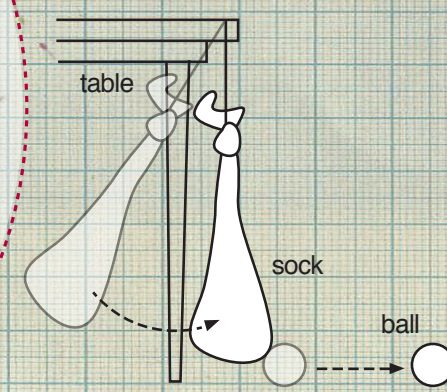
- 1 cup dry rice
- old sock
- 3' piece of string
- small ball
- desk or table
- tape measure

Scientist's Notebook

Question: Does the length of swing change the speed of the ball?

Hypothesis: (Your guess here) _____

PENDULUM OF DOOM! *



Experiment:

1. Pour the rice into the sock and knot the open end.
2. Tie one end of the string around the knot in the sock. Securely tape the other end to the top edge of table so that the sock hangs just above the floor.
3. Set the ball on the floor so that its side touches the sock. Pull the sock about 3 inches (5 cm) away from the ball. Release the sock and let it hit the ball.
4. Allow the ball to roll to a stop. Use the tape measure to measure how far it traveled.
5. Repeat steps 3-4, pulling the sock back about 10 inches (25 cm).

Conclusion: Was your hypothesis correct? ☐ **YES** ☐ **NO**

What did you learn from this experiment? _____

*This experiment contains no actual doom (unless you use a stinky sock).

STEM Connection: The swing of the golf club is like the hanging sock pendulum. The weight and mass of the sock stayed the same – but the distance the sock traveled changed. Golfers use their longest clubs when hitting off the tee. A shorter club can't get the same speed.

ENGINEERING THE GAME OF GOLF

Engineering is man's application of scientific and mathematical knowledge to build nearly everything we see around us. Computers, buildings, bridges, ships, planes and – YES – even the equipment used in the game of golf.

"Scientists study the world as it is. Engineers create the world that has never been."
– Theodore von Karman

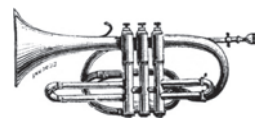
EASIEST QUIZ EVER

CHECK "YES" FOR EACH THING BELOW THAT REQUIRES ENGINEERING:


☐YES ☐YES

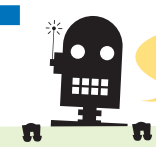

☐YES ☐YES


☐YES ☐YES


☐YES ☐YES

WHAT IS A VARIABLE?

In experiments, a **variable** is something that can be changed, or can affect the outcome of an experiment in different ways.

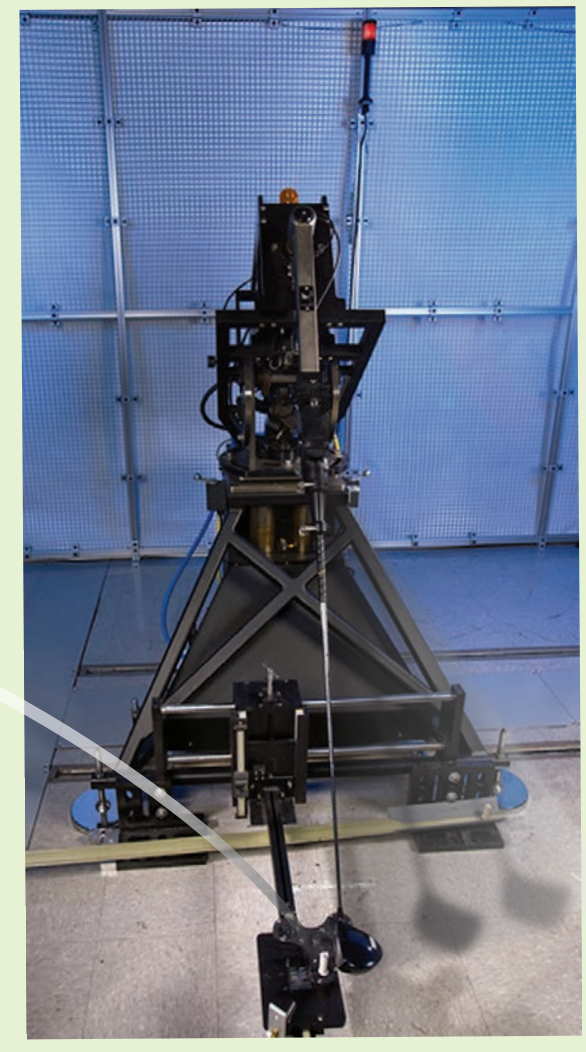


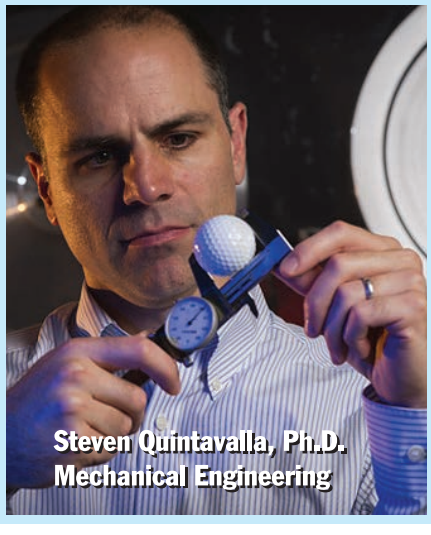
ROBOT GOLFER

The USGA Test Center uses a Robot Golfer to test more than 30,000 golf balls per year.

"It is important to use the robot," says Dr. Steven Quintavalla, senior research engineer at the USGA Test Center. "With the robot we can keep the speed of the swing the same each time. That way the only thing that changes is the ball."

Q: Why do you think it is important for only the ball to change when testing balls with the Robot Golfer?




Steven Quintavalla, Ph.D.
Mechanical Engineering

FAST-PACED RESEARCH

At the USGA Test Center, Dr. Quintavalla studies golf balls and other golf equipment. He also helps the USGA write rules that make sure the game is played fairly.

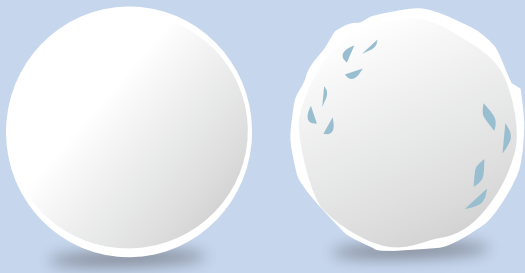
Dr. Quintavalla likes the fact that when he goes to work each day, there are always new and different challenges. Because advances in technology lead to new equipment, he and the USGA team are there to review and test them.

"Even though technology can improve and change, it's important to make sure the game of golf is first and foremost a game of skill," says Quintavalla. "When new golf equipment comes out, we check to make sure that it conforms to the Rules of Golf."

And, Dr. Quintavalla likes things that go fast – like golf balls and the race cars he works on in his spare time!

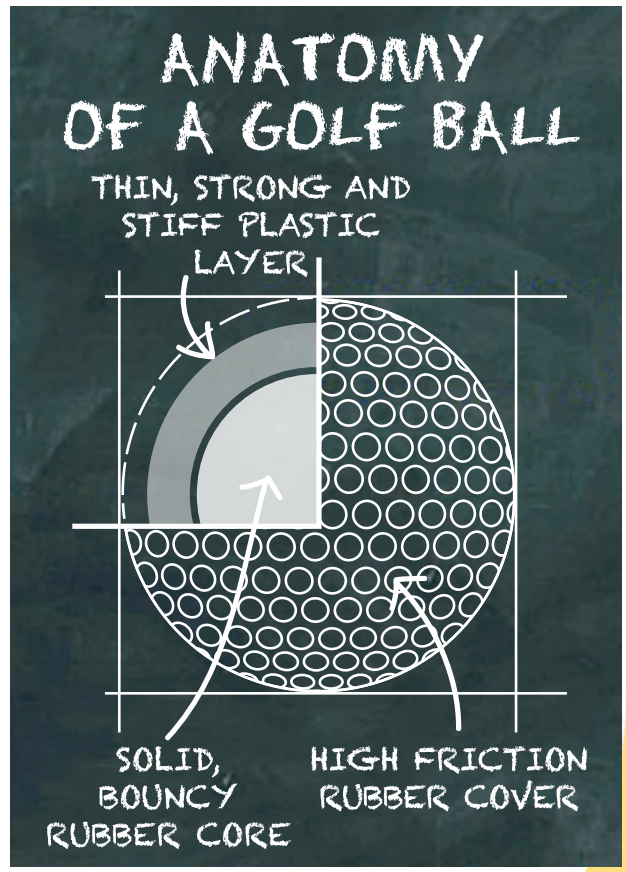
FUEL FOR THOUGHT

WHICH IS THE BETTER GOLF BALL?



a. Shiny, smooth ball *or* b. Used, dinged-up ball

Through the years, players discovered that golf balls with dings and dents flew farther. Those bumps and dents reduce wind resistance causing balls to travel farther.



RULES OF THE BALL

A golf ball can weigh no more than 1.62 oz (45.93 grams), and have a diameter no less than 1.680 in (42.67 mm).

Golf balls can't go any farther than 317 yards (289.9m) when hit at 120 mph by the USGA's test robot, and they have to go the same distance no matter how you line them up.

STEM in the News

Look through the sports section for photos of equipment - helmets, cleats, clubs, etc. Cut out one example and write a brief summary about the object's purpose and importance to the game. Complete the sentence: **Engineering may have been used to** _____.

Scientist's Notebook

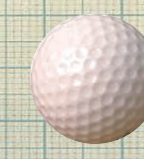
In the quest for speed and distance, the materials used to make golf balls have changed over the centuries. The first golf balls were hard wooden balls. These were used until the early 17th century.

1618: A new type of ball was created by stuffing a wet leather pouch with goose feathers. As the leather and feathers dried, the leather shrunk and the feathers expanded to create a hard, compact ball.

1848: The Rev. Dr. Robert Adams discovered he could make a hard ball from the sap of the Gutta-percha tree. The rubber-like ball became known as a "gutty."

Players discovered that older, nicked and dented gutties flew farther than smoorther, new ones. The "Hand Hammered Gutta" ball was invented. A consistent pattern of dents was hammered over the entire ball surface.

1898: Coburn Haskell worked with the BF Goodrich Company to create a ball with a solid rubber core, wrapped with a high-tension rubber thread (like a long rubber band) and coated in a Gutta-percha cover.



TODAY: Modern golf balls have a three-layer design: a solid, bouncy rubber core, a plastic-like layer that is strong and stiff and a thin, dimpled outer layer.

Use the information above to determine which of the following statements are TRUE or FALSE.

1. A smooth golf ball travels further than one with nicks and dents. ☐ TRUE ☐ FALSE
2. A "gutty" is a nickname for a golf ball made of tree sap. ☐ TRUE ☐ FALSE
3. Golf balls used in pro tournaments today have multiple layers. ☐ TRUE ☐ FALSE
4. Early golfers hand-carved their own golf balls. ☐ TRUE ☐ FALSE
5. Feather-stuffed golf balls travel farther than rubber ones. ☐ TRUE ☐ FALSE

STEM Connection: Imagine if you could buy a rocket-propelled golf ball. This would allow a player to get a better score even with poor golf skills. Technology would eliminate the need for a player to develop skill, which would take the fun out of golf.

HISTORY OF THE GOLF CLUB

People have been hitting balls with sticks for a long time. In the 1400s, the Scots invented a game played by hitting a little ball with a stick over a course with 18 holes. This was the beginning of the game of golf.

"The important thing is not to stop questioning. Curiosity has its own reason for existing."
– Albert Einstein

WOOD

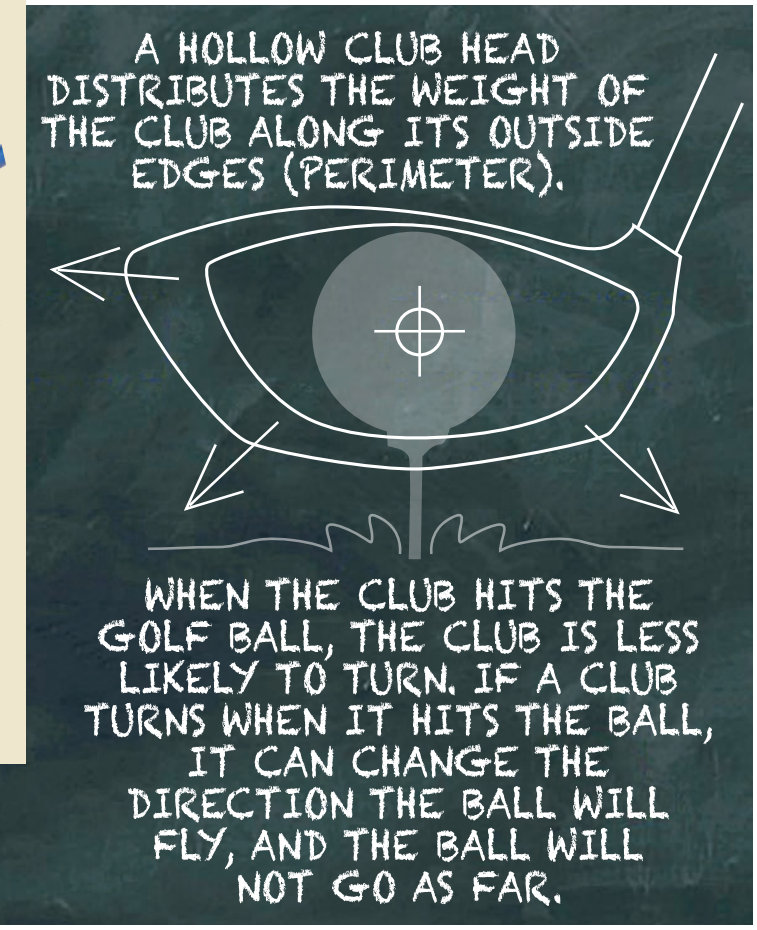
The earliest golf clubs were carved from a single block of wood. They were handmade – often made by the golfers themselves – and there was no standard design. Golfers called their clubs "woods."

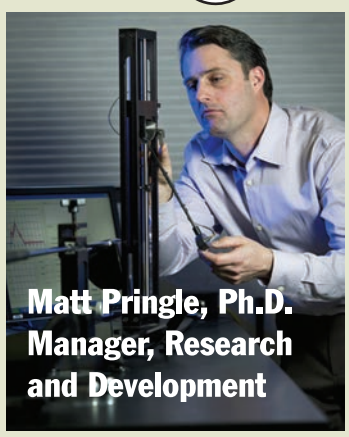
STEEL

When clubs were made out of metal, they were still called "woods." Golfers discovered that when they hit a golf ball with a hollow steel club, they had more control over the ball.

TITANIUM

Today clubs are made with titanium because it is very strong and much lighter than steel. This makes it possible for the club head to be larger, which distributes the weight even farther away from the center, making it possible for a golfer to hit the ball more accurately.





Matt Pringle, Ph.D.
Manager, Research and Development

GOLF FROM THE GROUND UP

Dr. Matt Pringle's knowledge of science got him the job of studying how golf clubs and golf balls work. He uses what he learns in these studies to help write the rules for equipment used in the game of golf.

"I get paid to study sports for a living! And, I get to travel all over the world," Dr. Pringle says. "I'm pretty lucky!"

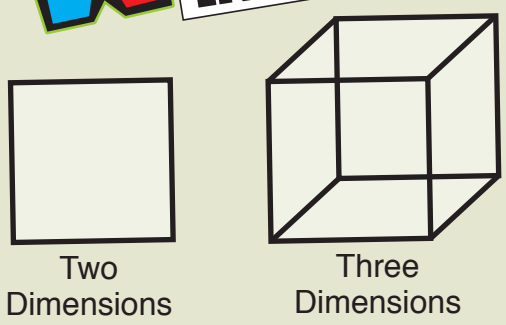
Dr. Pringle invented "TruFirm," a tool that measures the firmness of golf turf and bunker sands. Why do you think it is important to know the firmness of golf course grounds?

Math in the STEM ZONE

Sports Math: Identify ten different ways math is used in the sports section of the newspaper.

FUEL FOR THOUGHT

AMAZING MEASURING! IN 3-D!



When we use a ruler to measure the length of a line, that is measuring in one dimension. Measuring the area of a flat surface is measuring in two dimensions. Measuring in 3-D is called measuring something's **volume**.

GOLF CLUB RULES

In professional and amateur golf, the head of the club can be no more than 2.8 in (7.1 cm) high and 5 in (12.7 cm) wide. The volume can be no larger than 28.07 cubic inches (460 cubic centimeters).

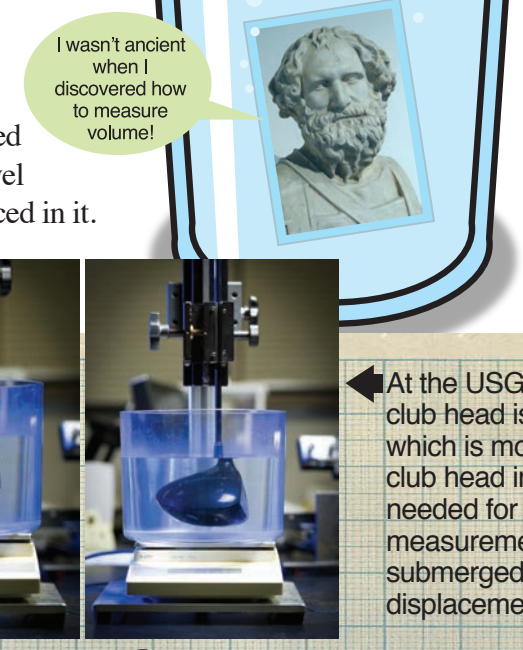
Measuring the height and width of a club is straightforward. But how do you measure the volume? To find out read the **Scientist's Notebook**.

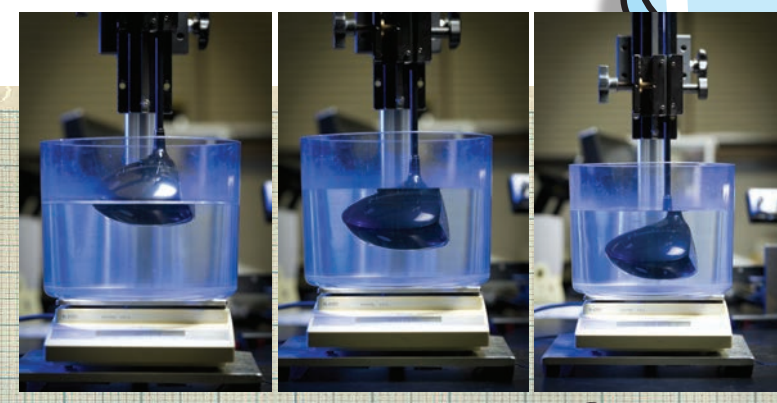
STEM workers typically use metric measurement because it is internationally accepted and understood.

Interestingly, the USGA uses the British Imperial System of measurement – which includes inches, feet and yards – in their measurements, because of golf's history and tradition. After all, the game did get its start in the British Isles.

ARCHIMEDES DISPLACEMENT EXPERIMENT

The Ancient Greek mathematician, Archimedes, discovered that the volume of an object can be determined by measuring the change in water level (displacement) when an object is placed in it.

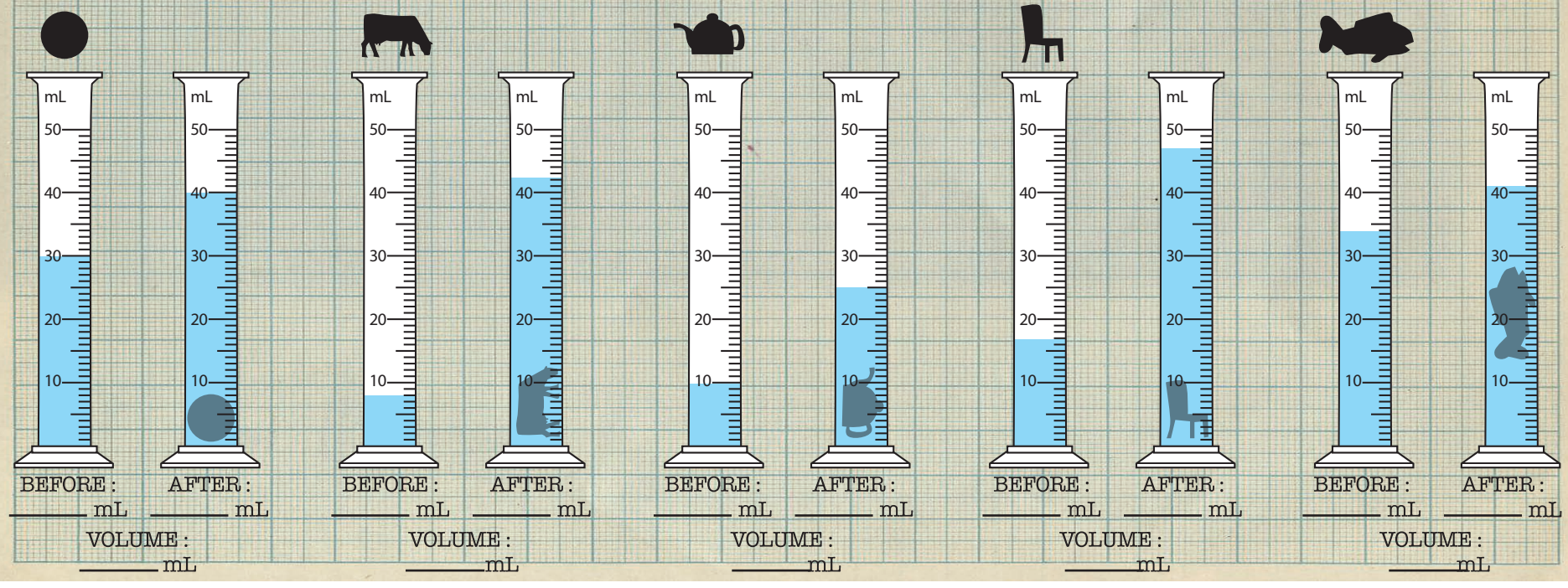




At the USGA Test Center, the club head is attached to a shaft which is mounted to hold the club head in the exact location needed for an accurate measurement. The club is then submerged and the level of displacement is measured.

Scientist's Notebook

Record the measurement before an object is dropped into each graduated cylinder. Then record the level after it is in the water. The difference between these two levels is the VOLUME.



STEM Connection: If a golf club had a targeting laser that lined up a golfer's shot, a player could get a better score even with poor aiming skills. As technology improves golf equipment, it is important to have rules which keep the game a challenge of skill.

AERODYNAMICS: IT'S ALL AROUND YOU

You may see a funny, bumpy ball sitting on a tee. But when you take it into the the STEM ZONE, a golf ball looks ***aerodynamic!***

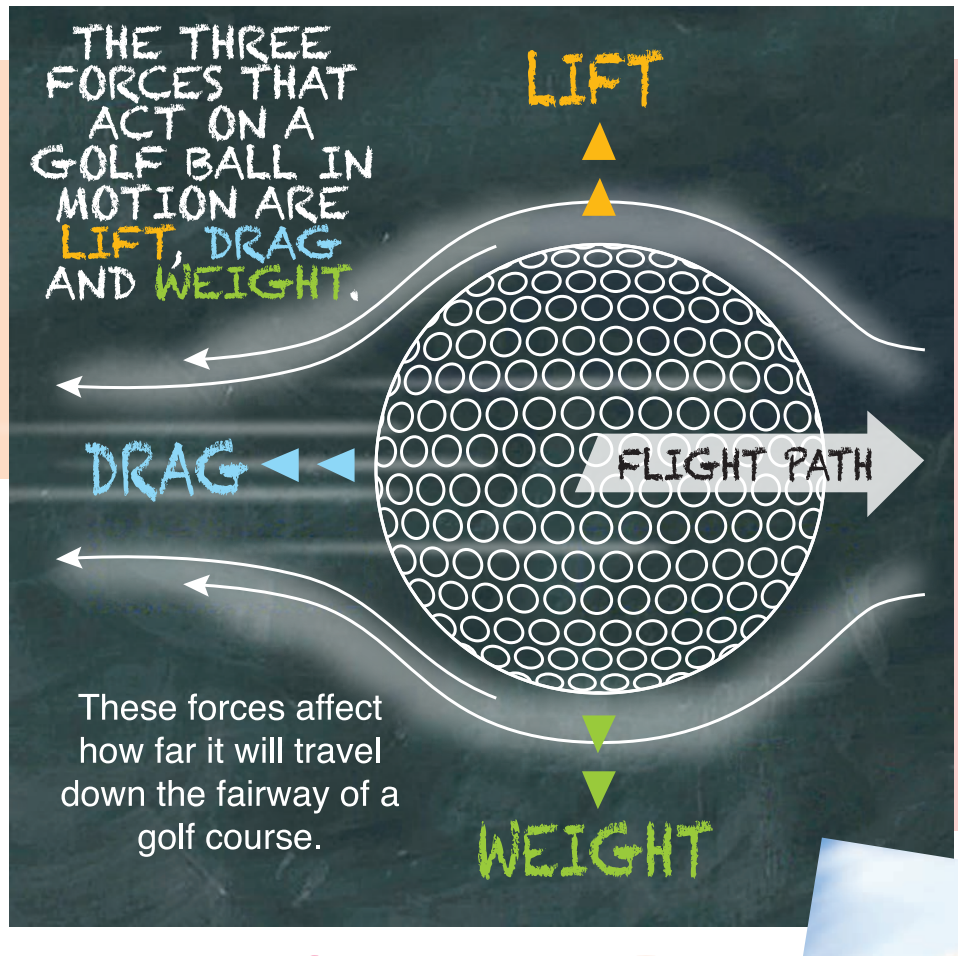
"What other people may find in poetry or art museums I find in the flight of a good drive."
– Arnold Palmer

The word **aerodynamic** comes from two Greek words:

AEROES → **OF THE AIR**

DYNAMIS → **POWER, STRENGTH, FORCE**

Scientists and engineers use the rules of aerodynamics to make things go fast and far – like race cars, jet planes and golf balls!



ROUND AND ROUND WE GO!

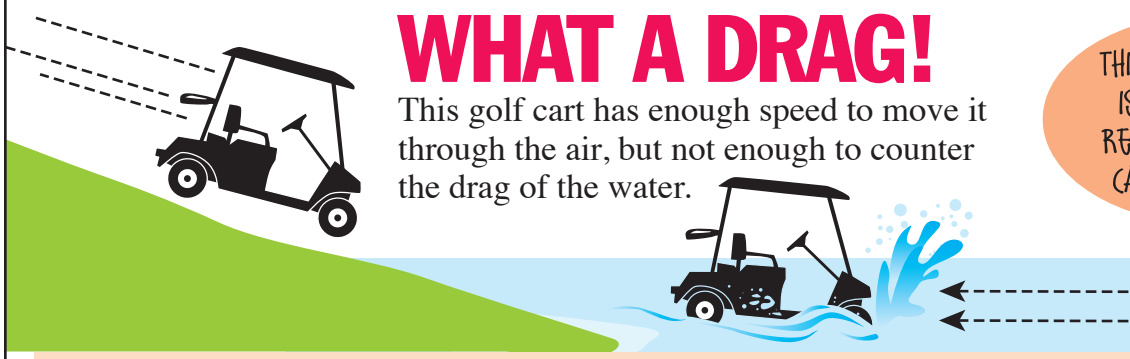
The impact, or hit, of a golf club on a ball gives it speed to move. **Drag** is an opposite force that slows a moving object.

Most round objects (like a golf ball) have less drag than flat objects (like a cube).

Wave your hand through the air. You can feel the drag of the air. You can feel it against your face when riding your bike.

WHAT A DRAG!

This golf cart has enough speed to move it through the air, but not enough to counter the drag of the water.



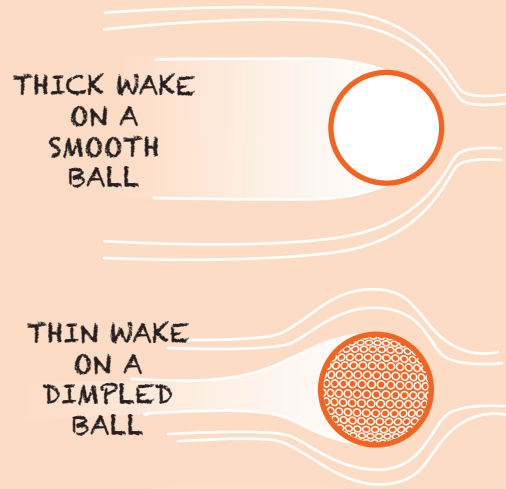
GOLF ON THE MOON

Air slows down moving objects. So what would happen if you hit a golf ball on the moon where the air is much thinner than on earth?

Astronaut Alan Shepard found out when he walked on the moon on Feb. 6, 1971. Even wearing a bulky space suit, he hit a ball that traveled 400 yards (366 meters). On earth the average golfer can hit a ball about 200 yards (183 meters).

FUEL FOR THOUGHT

DIMPLES = DISTANCE



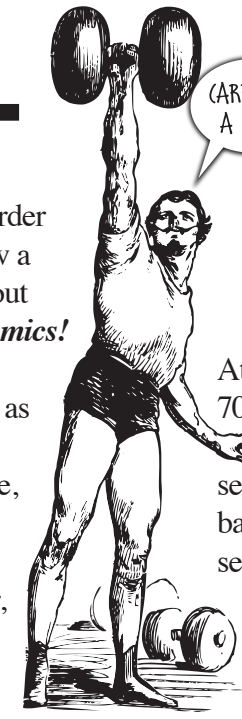
Dimples on a golf ball reduce drag and increase lift. Here's how: The air boundary around a golf ball with no dimples is wider. This creates a thick wake behind the ball and more drag.

WEIGHT AND LIFT

The weight of an object makes it harder to lift. Have you ever wondered how a full passenger jet, which weighs about 300,000 pounds, can fly? ***Aerodynamics!***

Golf balls do not create as much lift as a passenger jet, but they do create enough to greatly increase hang time, and therefore, distance.

As a golf ball travels through the air, wind resistance creates drag, which slows the ball down. The dimples on a golf ball reduce the drag of the air making it possible for the ball to go faster and farther.

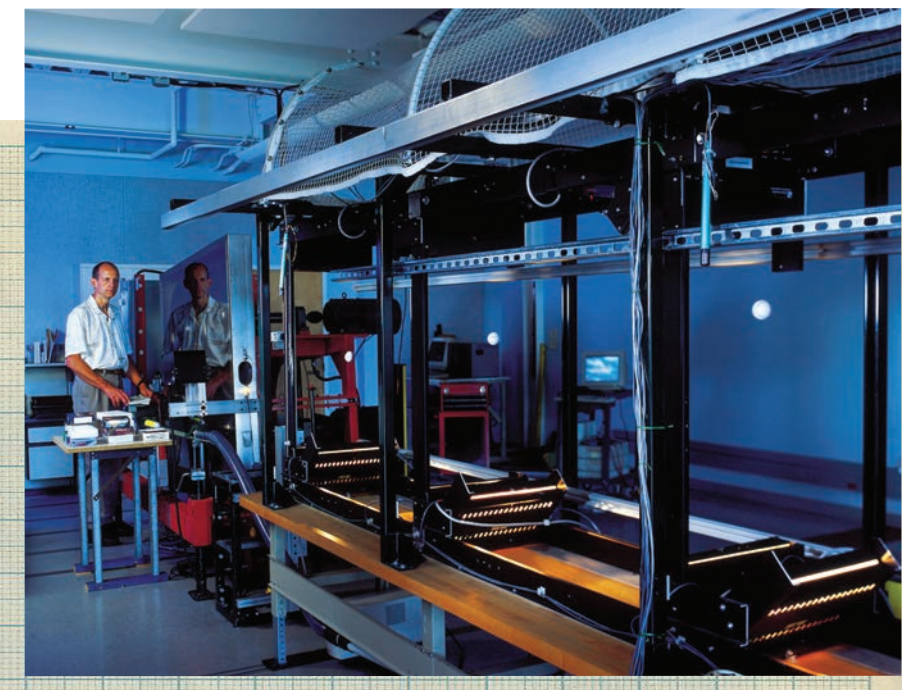


STEM in the Newspaper

STEM workers are problem solvers. Locate a problem in the sports section of the newspaper that an athlete or team faced. Write about and illustrate an invention to solve it!

At the USGA Test Center, scientists created a 70-foot-long tunnel to test golf balls. A machine shoots out golf balls at 190 mph. Infra-red sensors along the tunnel record the flight of the ball as it flies through the tunnel. The sensors send this data to a computer for analysis.

The indoor test tunnel is used by golf ball companies around the world as they develop new golf balls for the sport.



Scientist's Notebook

Question: What will happen to a strip of paper if you blow over the top of it?

Hypothesis: (Your guess here) _____

PAPER PUZZLER

Stuff You'll Need:

- Strip of paper 2 inches (5cm) wide and 6 inches (15cm) long
- You (and your lungs!)

Experiment:

1. Fold one end of the strip of paper about 1 inch (or 2 cm) from the end and hold it beneath your bottom lip.

FOLD

2. Blow a long, steady stream of air down and over the top of the strip of paper.
3. Repeat a few times.

Conclusion: Was your hypothesis correct? ☐ **YES** ☐ **NO**

What did you learn from this experiment? _____

Blowing air over the strip of paper causes the air on top of the paper to move faster than the air below the paper. Based on what you observed in this experiment, complete this sentence using these words:

BELOW LOWER AIR LIFTED

Faster-moving _____ has a _____ pressure, so the paper is _____ by the higher air pressure _____. This is called Bernoulli's Principle.

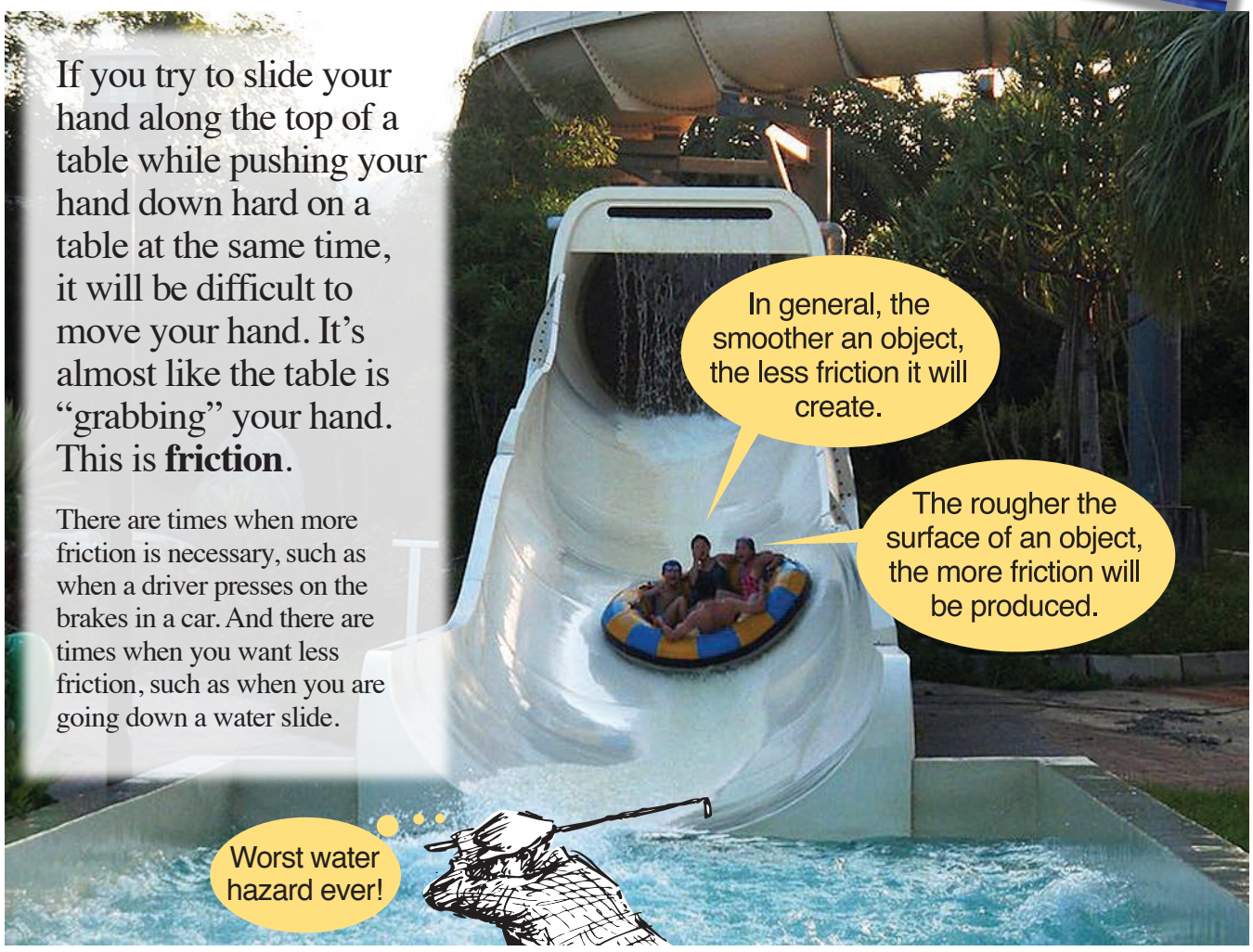
STEM Connection: Bernoulli's Principle explains how objects generate aerodynamic lift. Lift is partly responsible for getting golf balls to travel as far as they do.

FRICTION:
A FORCE THAT OPPOSES MOTION

"A gem cannot be polished without friction nor a man perfected without trials."
– Lucius Annaeus Seneca

If you try to slide your hand along the top of a table while pushing your hand down hard on a table at the same time, it will be difficult to move your hand. It's almost like the table is "grabbing" your hand. This is **friction**.

There are times when more friction is necessary, such as when a driver presses on the brakes in a car. And there are times when you want less friction, such as when you are going down a water slide.

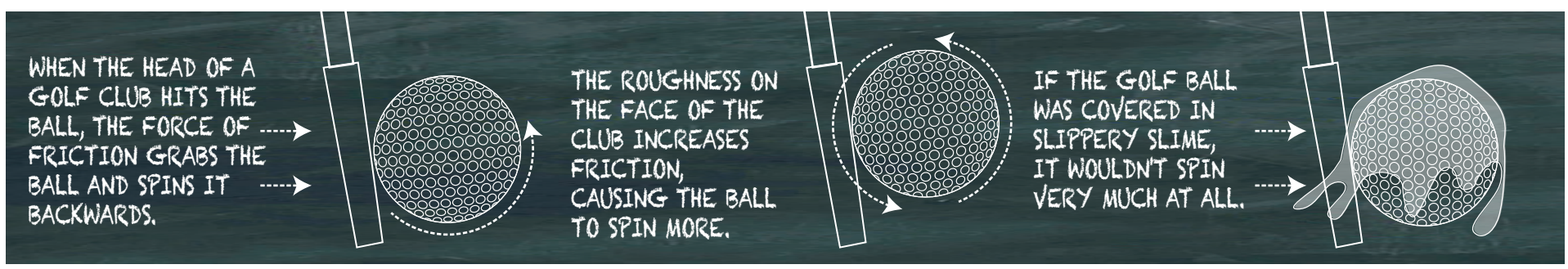


STOP RIGHT THERE!

Friction slows or stops moving things. A rolling ball eventually stops because friction between the ball and the ground brings it to a stop.

When a golf ball is struck accurately by a slanted, or lofted club, the ball will tend to roll up the club-face before it launches. This causes the ball to have ***backspin***.

But if the ball is hit with the bottom of the club-face, the ball will get ***topspin*** causing the ball to go downward toward the ground.



SNEAK PEEK AT THE NEW EQUIPMENT

When scientists at the USGA Test Center test golf clubs and balls, it is important to make sure that tests don't contain mistakes. That is John Spitzer's job – to be sure the tests are done correctly and the data collected is accurate.

"We have to be positive that none of the balls or clubs people use when they play golf give them an unfair advantage," says Spitzer.

"I love my job because I get to see all of the new golf balls and clubs before anyone else!"

FUEL FOR THOUGHT

WHAT'S YOUR ANGLE?

A golf bag contains a variety of clubs. The face of each club has a different angle or slope to it. For long drives, it is best to use a club with a face that is only slightly angled, or nearly vertical. For higher, shorter shots a club with a more angled face is better.

HOW MUCH TO SPIN?

Fill in the blanks using these words.

lift farther distance longer backwards friction enough stop slows control aerodynamics resistance hole right ball

For a long drive, a golfer needs to understand _____ to get just the right amount of backspin. Spin creates _____, so the ball stays in the air _____. That's thanks to _____!

With more hang time, the ball travels _____. Too little spin, and the _____ doesn't lift enough to travel down the fairway.

However too much spin increases the wind _____, which makes the ball slow in the air. When the ball _____ down too much, it falls down. Getting just the _____ amount of spin is important to make sure the ball will reach the maximum _____.

For short hits on to the green, more spin can _____ the ball. If the ball doesn't spin _____, it can bounce and roll too far. With a lot of spin, the ball can actually roll _____.

Controlling spin lets players control where the ball will _____, so that they can get the ball close to or in the _____.

Time Capsule

Gather STEM related articles from today's newspaper to place in a time capsule. What do the articles tell us about our current technology?

Scientist's Notebook

A special machine at the USGA Test Center shoots a golf ball out of a gun through a tunnel toward an angled target. A camera uses video and slow motion photography to observe and measure the spin. Golf ball manufacturers want to know how a ball's construction affects its spins.

Q: Does hitting a more steeply angled surface cause a ball to spin more?

The data below illustrates actual USGA Test Center results for a test that measures a golf ball's spin speed when it hits different angled surfaces at 55 miles per hour.

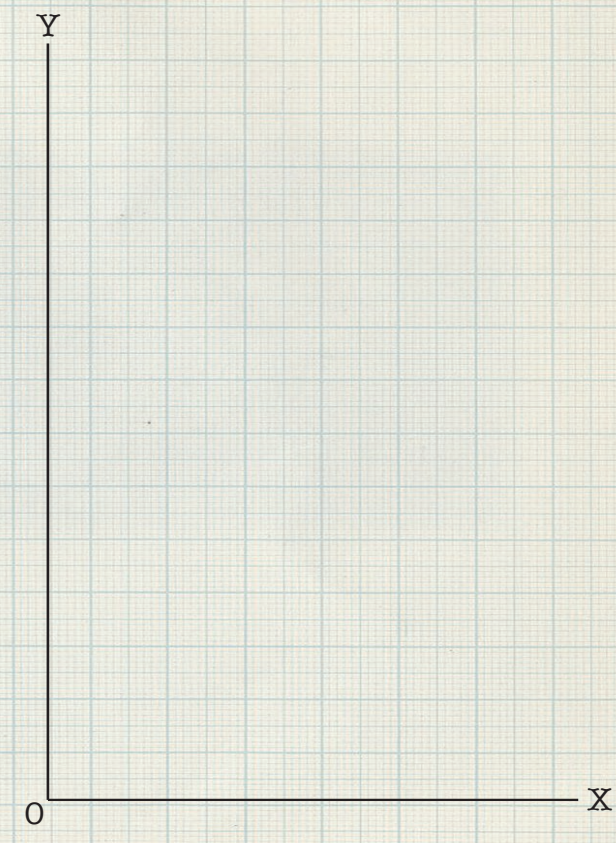
ANGLE (degree)	Spin (RPM)
10	1100
20	2300
30	4000
40	6000
50	7200
60	7500

RPM is Revolutions Per Minute. This is the term used to describe spin speed.

Graph It!

It's your turn to be an engineer and record the results on a bar chart. Follow these steps:

1. From the "0" point, create six evenly spaced intervals along the **X** axis. Label the intervals from 10 to 60. Name the **X** axis "ANGLE."
2. From the "0" point, create eight evenly spaced intervals along the Y axis. Label the intervals from 1000 to 8000. Name the **Y** axis "SPIN."
3. Begin with the 10 degree angle and draw a bar to approximately the 1100 point.
4. Continue to fill in the angle/spin data.



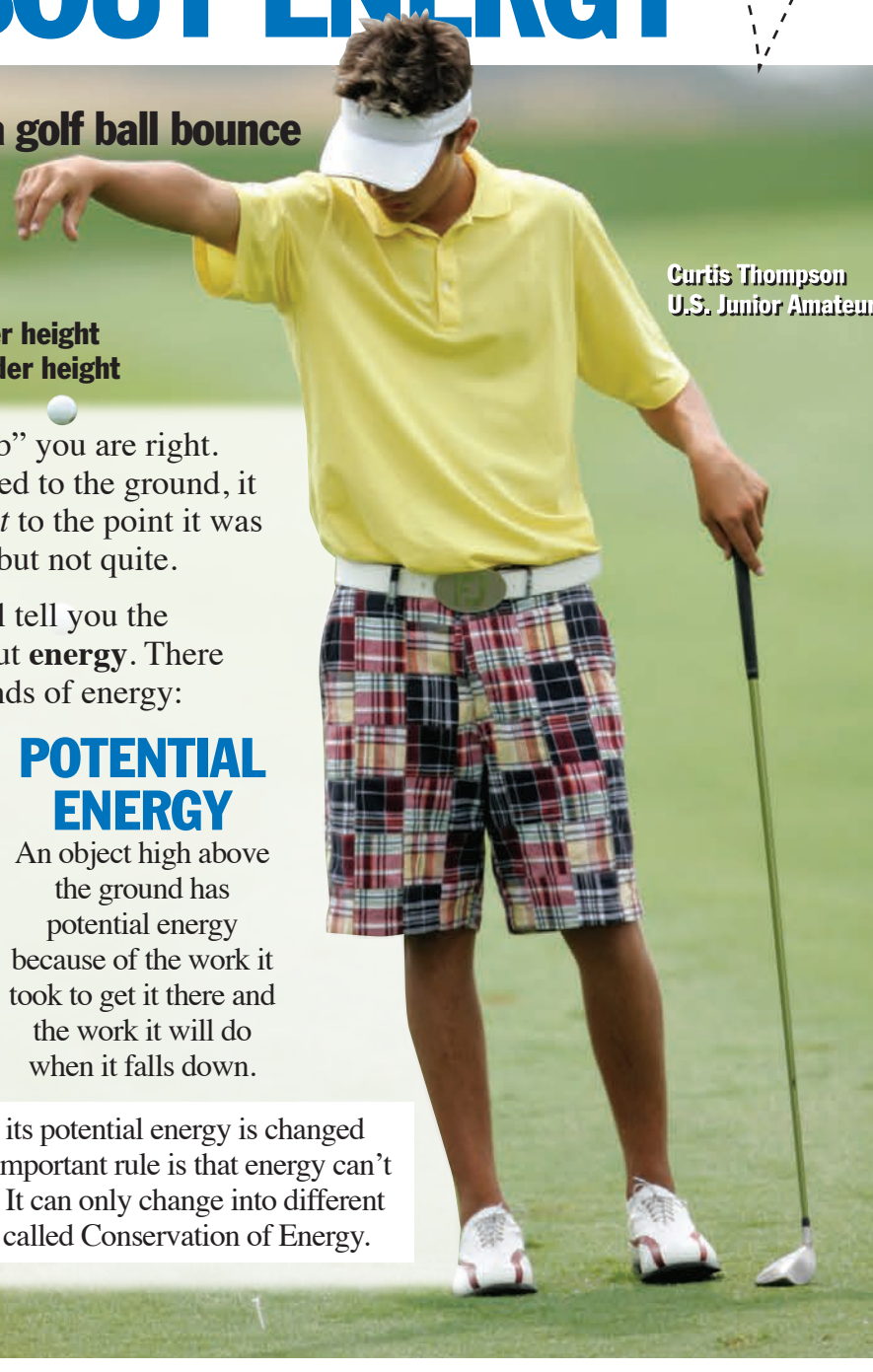
STEM Connection: To do well in a game of golf, a golfer wants to control the speed and direction of the golf ball. The spin of a golf ball affects its speed and direction. Different angled clubs will produce different results.

BOUNCE: IT'S ABOUT ENERGY

"Math and science are the engines of innovation. With these engines we can rule the world."
– Dr. Michael Brown

Q: How high will a golf ball bounce when dropped from shoulder height?

a. back to shoulder height
b. less than shoulder height



Curtis Thompson
U.S. Junior Amateur

If you answered "b" you are right. When a ball is dropped to the ground, it comes back up *almost* to the point it was dropped from, but not quite.

A scientist will tell you the explanation is about **energy**. There are different kinds of energy:

KINETIC ENERGY

Anything that is moving has kinetic energy, and the faster it is moving, the more kinetic energy it has.

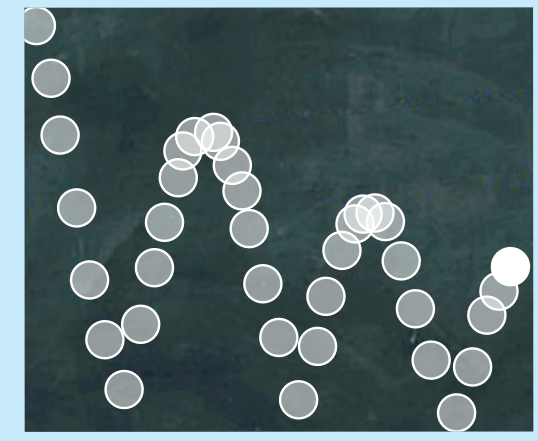
POTENTIAL ENERGY

An object high above the ground has potential energy because of the work it took to get it there and the work it will do when it falls down.

When a ball is dropped, its potential energy is changed into kinetic energy. An important rule is that energy can't be created or destroyed. It can only change into different forms of energy. This is called Conservation of Energy.

OKAY, LET'S DROP IT!

When a ball is held above the ground, it has a lot of **potential energy** and no **kinetic energy**. As it falls, it starts losing its potential energy and gets kinetic energy.



When the ball hits the ground, it has lots of kinetic energy. The friction against the ground slows the ball down, but it also slightly heats the ball. This is **thermal energy**.

The ball bounces back up but to a lower height than where it started. The original potential energy was transformed into thermal energy.

Mary Jane Rogers
Research Assistant

MAKING EQUIPMENT FAIR

Mary Jane Rogers is a Research Assistant at the USGA Test Center. Her job is to collect and analyze data to help determine if equipment meets all of the Rules of Golf.

"I like being involved with the different studies and experiments that go on at the USGA," says Rogers. "I love studying about how the body functions and about body movement. I even got to stay awake to watch my own knee surgery!"

Her job requires a lot of attention to detail. She must be very observant.

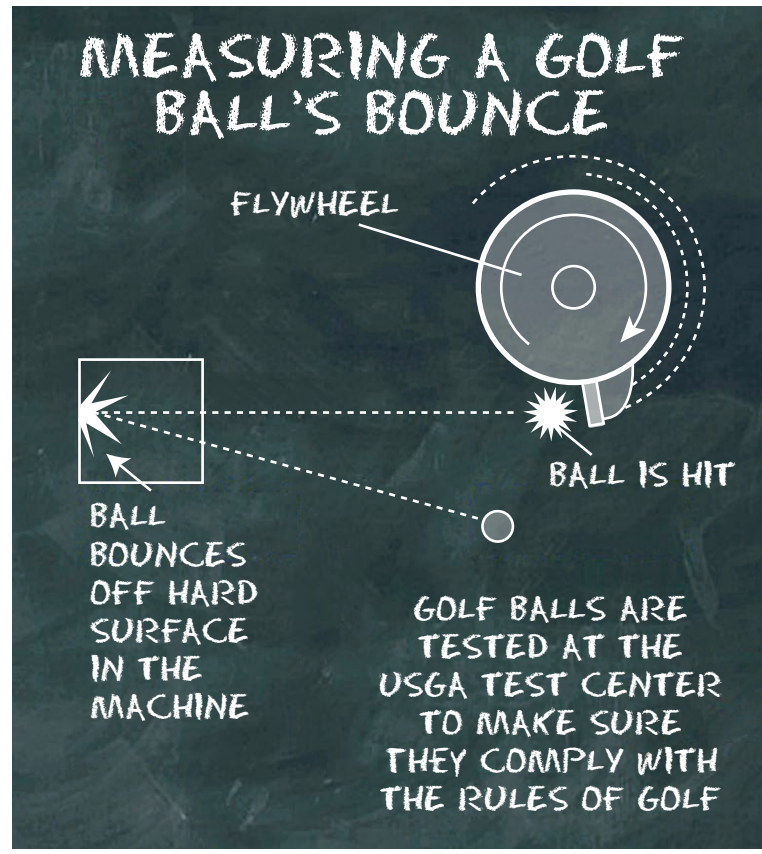
How observant are you? Look at the golfer on this page. List 10 details about the picture. Then have a friend try it. Compare.

FUEL FOR THOUGHT

WHICH BOUNCES HIGHER?

Easy question, right? But why does a golf ball bounce higher than a bowling ball? Because it is made of different materials. A golf ball is made with a rubber core that has a high bounce factor. Bowling balls are made out of materials that don't bounce.

Why is bounce good for a golf ball and not so good for a bowling ball?



RULES OF GOLF

At the USGA Test Center, a special machine with a big flywheel is used to test a golf ball's bounce energy when the ball is hit by a club. A ball is hit by the special flywheel through a machine that measures its speed.

The rule in golf is that a ball cannot travel faster than the speed of 173.9 MPH when bounced off this flywheel. (That's 255 feet per second!)

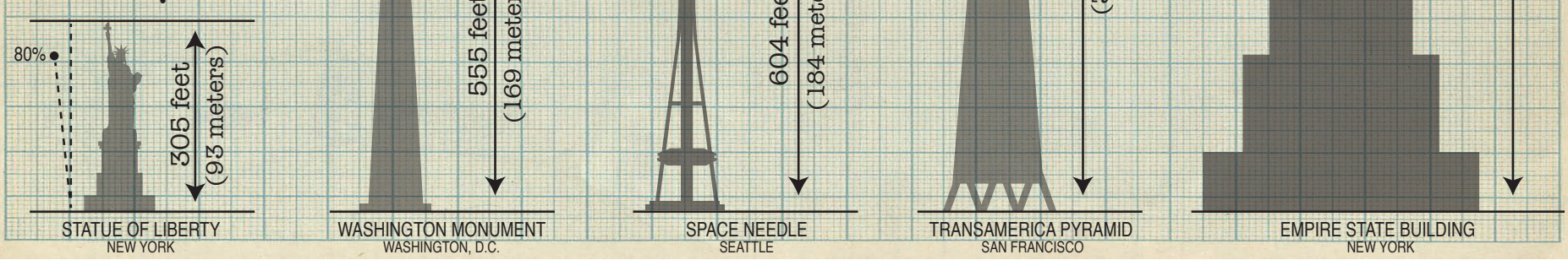
Font Math

Measure the height of a headline in today's newspaper or an online article. Next measure the height of the text in the article. Calculate the ratio.

Scientist's Notebook

Imagine dropping a golf ball from the top of these famous structures. If the ball bounces 80% of the way back up toward the top, how many feet/meters high would the ball travel for each? (We did the first one for you. Are we cool or what?)

305
x .8
244 FEET



STEM Connection: The "bounce" energy of a golf ball plays a big role in the distance it will travel once it is hit with a golf club. To keep competitions and games fair, players need to use golf balls that don't go faster than the allowed maximum speed.

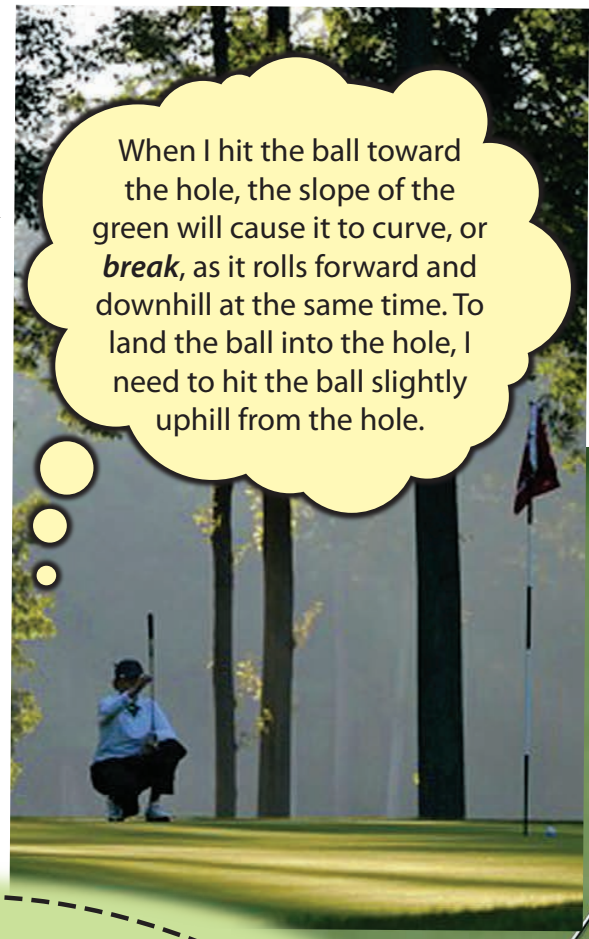
BREAKING ON THE GREEN

"Golf is a game that is played on a five-inch course—the distance between your ears."
– Bob Jones

Bob Jones is considered the greatest amateur in the history of golf. He was the first and only golfer to win the Grand Slam – four back-to-back prestigious tournaments that included the British Amateur, the British Open, the U.S. Open and the U.S. Amateur in the same year.

Jones knew that being a champion is about more than just the right equipment. Golfers need skill and knowledge.

Once a golfer has the ball on the green, hitting for speed and distance is no longer the objective. Now the goal is to hit the ball in such a way that it will go into the hole. *And that takes a knowledge of science.*

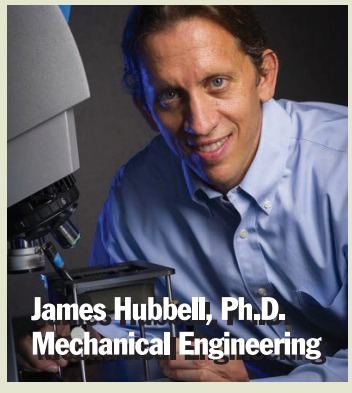


THE UPS AND DOWNS OF PUTTING

Although golf course greens may appear flat, most have undulations and dips that prevent a ball from traveling in a straight line. Golfers must take these surface slopes into consideration. **Gravity will always pull the ball downward.**

The putter must make the ball curve, or break, toward the hole.

THIS OVERHEAD VIEW SHOWS A BALL "BREAKING" TO THE LEFT TOWARD THE HOLE.



Q: WHAT DO YOU DO AT THE USGA TEST CENTER?

A: I develop and monitor tests that measure how well new golf balls and golf clubs work. I work with professional golfers to see how new models of golf balls and clubs work for them.

Q: WHAT DO YOU LIKE BEST ABOUT YOUR JOB?

A: I like using a variety of skills and the chance to be creative. I get to use robots, computers and radar in our test labs and outside on golf courses. And, I get to travel. It's a great job!

Q: BESIDES SCIENCE, WHAT ELSE DO YOU ENJOY?

A: As a scientist, some might find it surprising that I enjoy art and carpentry. Engineers and scientists are often creative and like to work spatially.

FUEL FOR THOUGHT

GRAVITY: A WEIGHTY PROBLEM

Weight is actually the result of gravity pulling on the mass of an object. (Everything–including you– is made of stuff, **mass** is the stuff.)

If you travel to another planet, your mass would stay the same, but your weight would change depending upon the planet's gravitational pull on you.

For example, if you weigh 100 pounds and visit a planet with twice the gravitational pull, you would weigh 200 pounds on that planet.

BREAK FOR LUNCH?

There are no machines at the USGA Test Center that measure "Breaking on the Green." It takes practice and skill to determine the slope of the green and to decide how hard to hit a ball.

At their lunch hour, Test Center scientists head out to the USGA greens to experiment putting golf balls with different amounts of force and direction.

STEM in Your Future?

STEM in Your Future? Look through the newspaper want ads to identify careers in science, technology, engineering or math. Count different careers. Graph results.

Scientist's Notebook

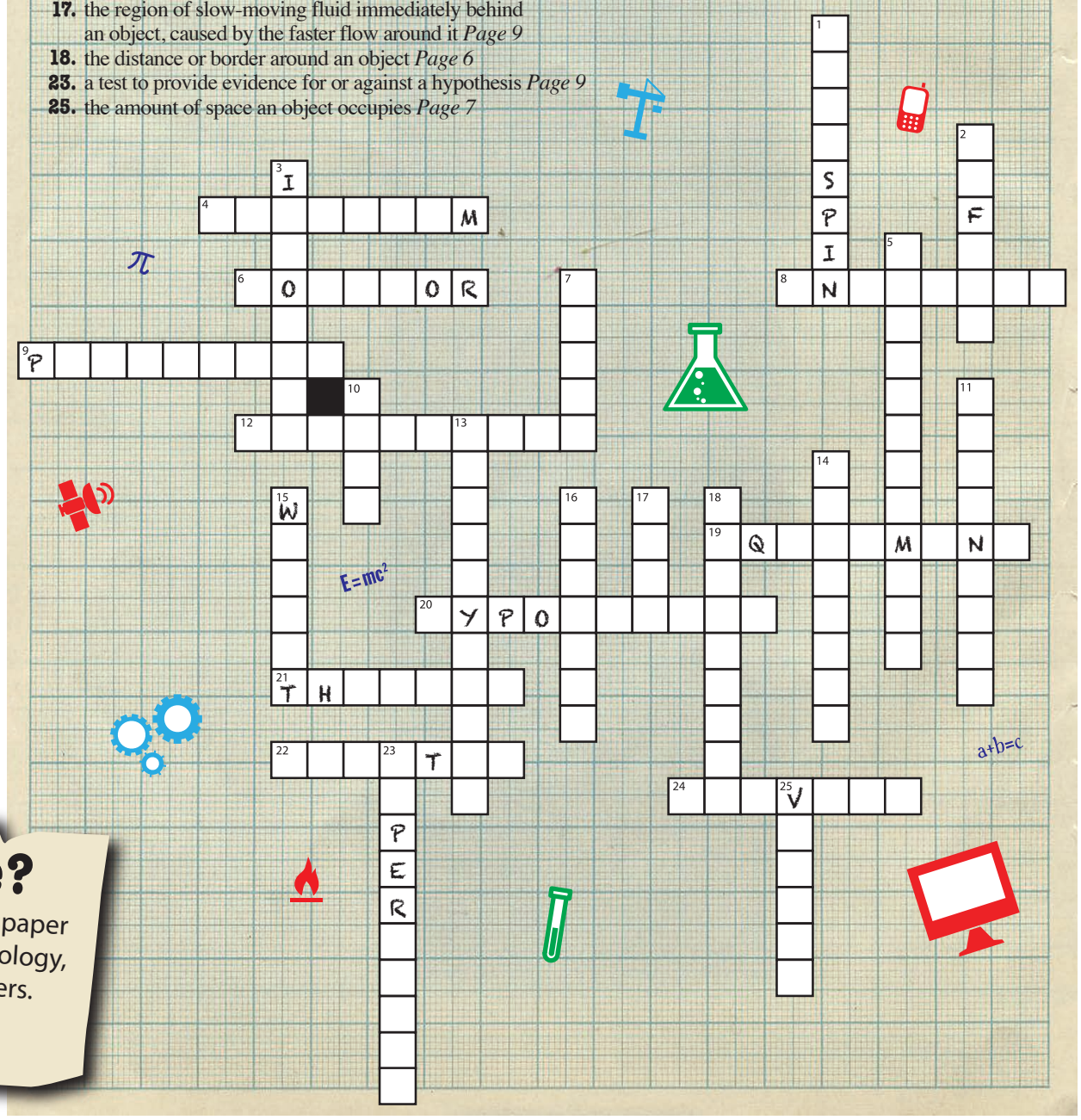
Complete the crossword puzzle below to review the STEM Zone™ terms and concepts you've read about in this special supplement.

Down

1. a slanted club, when hitting a ball accurately, will generate this *Page 10*
2. a slanted club will lift the ball upward *Page 10*
3. to introduce something new *Page 12*
5. the volume of liquid pushed out of the way by an object that takes its place *Page 7*
7. slant or curve *Page 11*
10. a force that raises *Page 13*
11. measurement in length, width and/or thickness *Page 7*
13. the way air moves around objects *Page 8*
14. surface resistance when one object moves against another *Page 10*
15. the result of gravity pulling on an object *Page 15*
16. relating to, or having the character of space *Page 14*
17. the region of slow-moving fluid immediately behind an object, caused by the faster flow around it *Page 9*
18. the distance or border around an object *Page 6*
23. a test to provide evidence for or against a hypothesis *Page 9*
25. the amount of space an object occupies *Page 7*

Across

4. a weight hung from a point so it can swing freely *Page 3*
6. oversee or regulate *Page 4*
8. a person who designs, constructs and uses engines *Page 4*
9. capable of being, energy stored *Page 12*
12. any force that slows motion or drags *Page 8*
19. a set of tools, devices or materials *Page 4*
20. a theory or idea to guide an investigation *Page 3*
21. relating to generating heat caused by raising temperature *Page 12*
22. related to motion or movement *Page 12*
24. the force by which objects fall toward the center of the earth *Page 15*



STEM Connection: Advances in technology and expert engineering have improved the equipment used by golfers. The USGA Equipment Standards Department uses math and science to evaluate new equipment to ensure that skill, not technology, determines success in golf.