The Science of Golf

Test Lab Toolkit
The Swing: Putting

Grades 6-8

USGA

Science | Technology | Engineering | Mathematics

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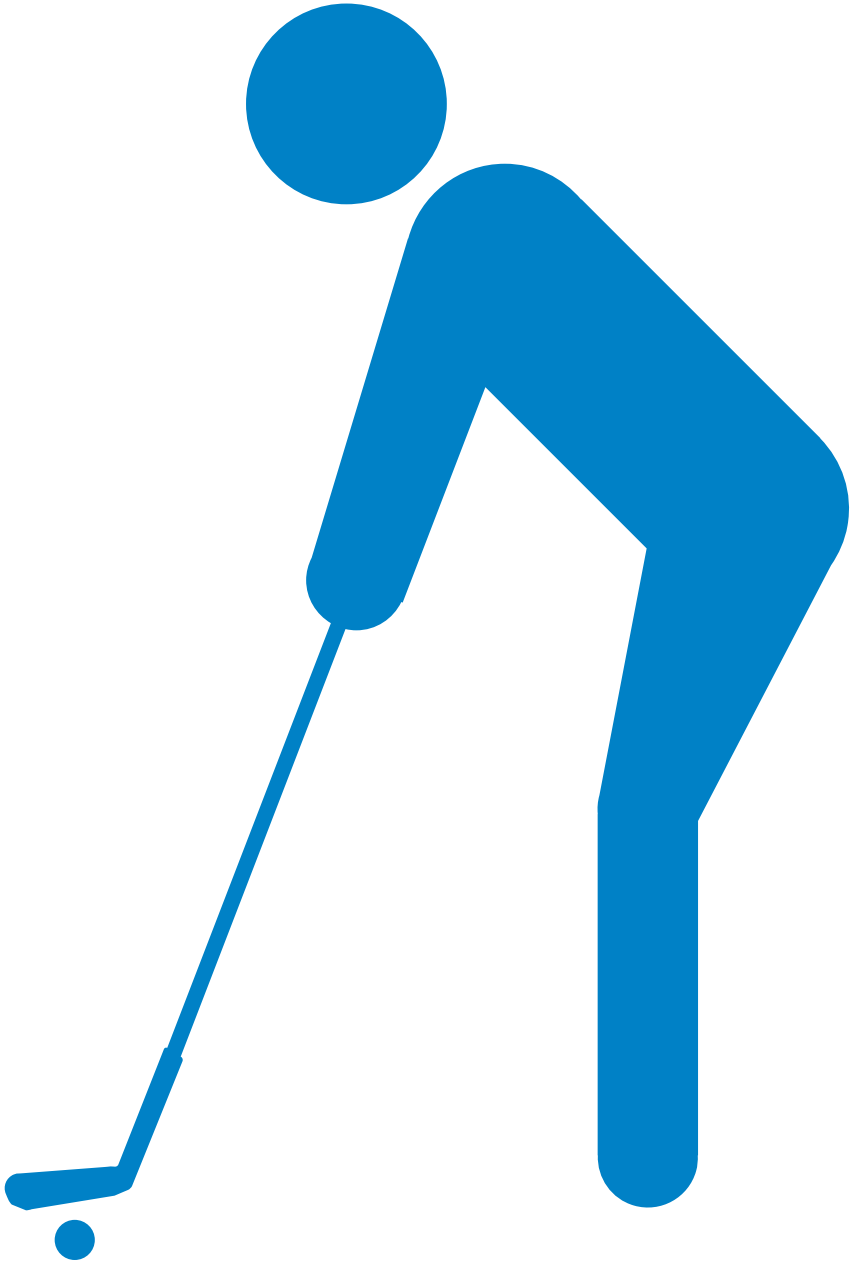
Test Lab Toolkits bring math and science to life by showing how STEM studies play a big role in the game of golf. They are funded by the United States Golf Association (USGA).



USGA

Welcome to the Test Lab Toolkit!

Sometimes the study of science and math can seem a little disconnected from the “real” world, a little irrelevant, a little boring. Yet a closer look reveals that science and math are everywhere in the world around you, in familiar and surprising ways.

Take something fun, like the game of golf. Sure, there’s math, because you have to keep score. But there’s also lots of science, technology, and engineering hidden in the game — from the physics of how you swing, to the mechanics of a golf club, to the remote sensors that tell you when to water the golf course.

At the United States Golf Association Test Center, scientists and engineers play around with golf balls, clubs, and other equipment every day so that they can learn how they work. Since people keep thinking of new ways to improve the game, the Test Center needs to test new equipment to make sure it works with the game’s traditions and doesn't make game play unfair.

How does the USGA Test Center study this stuff? With golf ball cannons, robot clubs, and other cool experiments. And now you can do some of the very same experiments with the **TEST LAB TOOLKITS**, which let you set up your own test center in your club, class, or at home.

In this Toolkit, you’ll explore the science of **PUTTING** through experiments that let you:

1. **Do daring feats of balance (and see how your center of gravity affects how you putt)**
2. **Build a Stimpmeter (and learn what that thing is even used for)**
3. **Design your own putting green (and find out what makes it more or less challenging)**
4. **Measure the speed of your local golf course (and discover why the ball rolls faster on some putting greens than others)**

For every experiment you try, record your results with photos, diagrams, or any way you like, and then put it all together into your own Test Lab Log. The more Toolkits you do, the more of a golf (and science) expert you’ll become!

Ready to explore the science behind the world's greatest game?

Investigate: Center of Gravity

Putting

Grades 6-8

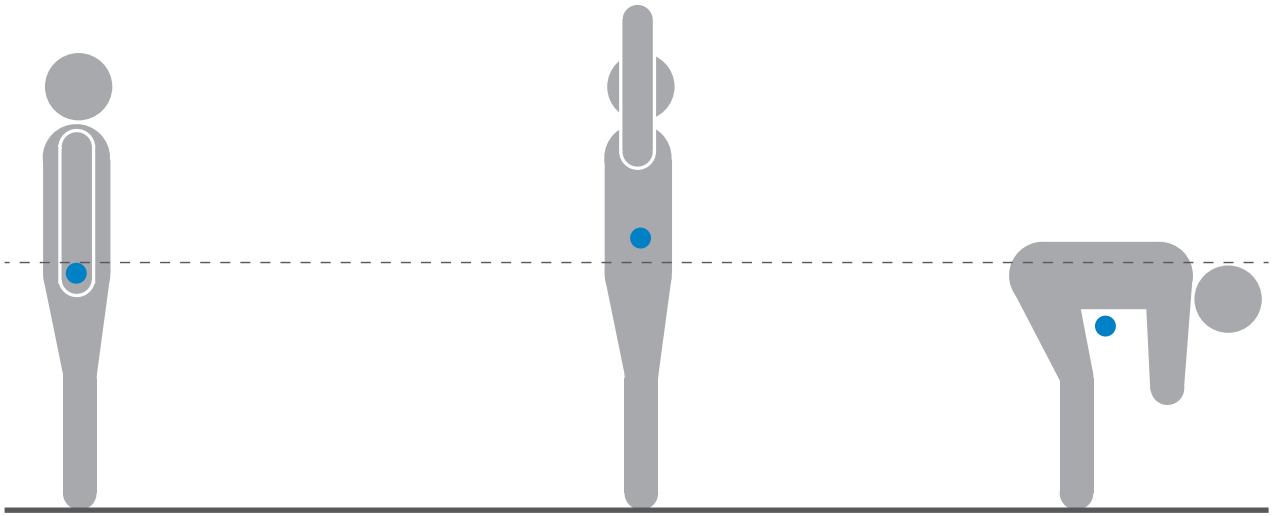
S T E M

How does your center of gravity affect how you putt?

The USGA Test Center tests golf clubs to make sure they are balanced and don't have unfair features. But just as important as the club's balance is the balance of the player during a swing. In this activity, you'll explore how changing your own **center of gravity** changes the way you play.

What Do You Need?

- Stopwatch
- Wall
- Putter (or stick of similar length)
- Golf ball (or similar small ball)
- Large plastic cup
- Masking tape



= Center of Gravity

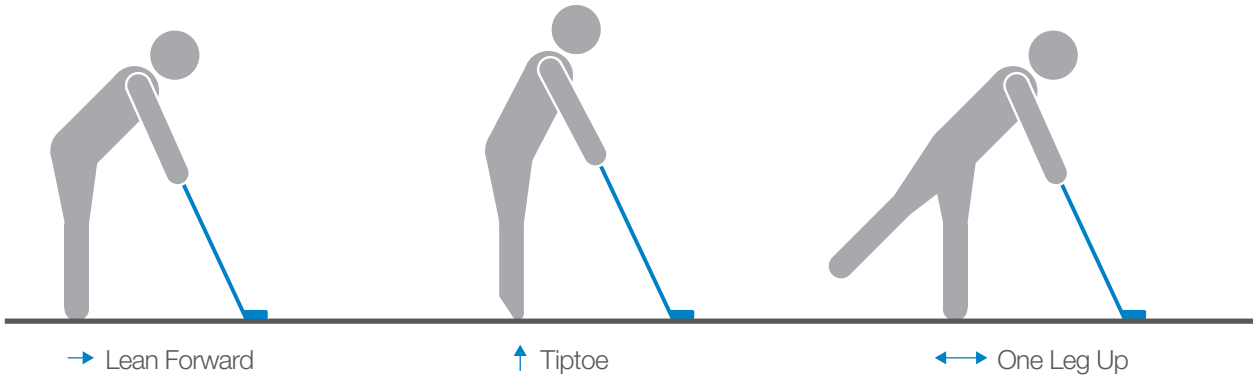
What Do You Do?

Leg Lift

1. With hands at your side, lift one leg. Time how long you can balance.
2. Try again, this time with arms stretched out.
3. Place the cup on the floor in front of you. Lift your right leg. Without bending your left leg, try to lean over and pick up the cup. What happens?
4. Stretch your right leg out behind you. Is it easier or harder to pick up the cup?
5. Now stand with the entire right side of your body pressed against a wall. Try to lift your left leg. What happens?
6. Face a partner and lift one leg. Look at how each other's posture changes. Why?

Putting Stance

1. Set up a target by lying the cup on its side and taping it to the floor, so that it creates a "hole."
2. Standing at least 6 feet away from the cup, putt the ball toward the cup. Record accuracy.
3. Experiment with different ways of standing. Change your posture (stand straight, lean backward), weight distribution (more weight on one foot, on tiptoe), balance (stand on both feet, stand on one foot), or make up your own variations.
4. For each variation, predict what will happen before you hit, and then record what did happen.



What Happens?

- Use the chart to record your data, and make more charts as needed.
- Note the results and/or make a diagram of your most successful stance.

What Does it Mean?

- What did you learn about your center of gravity?
- Which combination of posture, balance, weight distribution, etc., works best for putting?

Challenge!

Try the "Putting Stance" activity with other sports, such as hitting a baseball, throwing a football, kicking a soccer ball, etc. Do different sports need different stances, and if so, why?

Find Out More

- Read *Key Concepts.*

Putting Stance

Posture Straight or bent?	**Weight Distribution** Forward or backward?	**Balance** One foot or two?	**Other Variations** How else can you change your stance?	**What will happen to the ball?**	**What did happen to the ball?**	**How stable was your body?**
Straight	*Backward*	*Left foot only*		*Will go far*	*Went short distance only*	*Not very*

Add this chart to your Test Lab Log!

Investigate: Speed and Friction

Putting

Grades 6-8

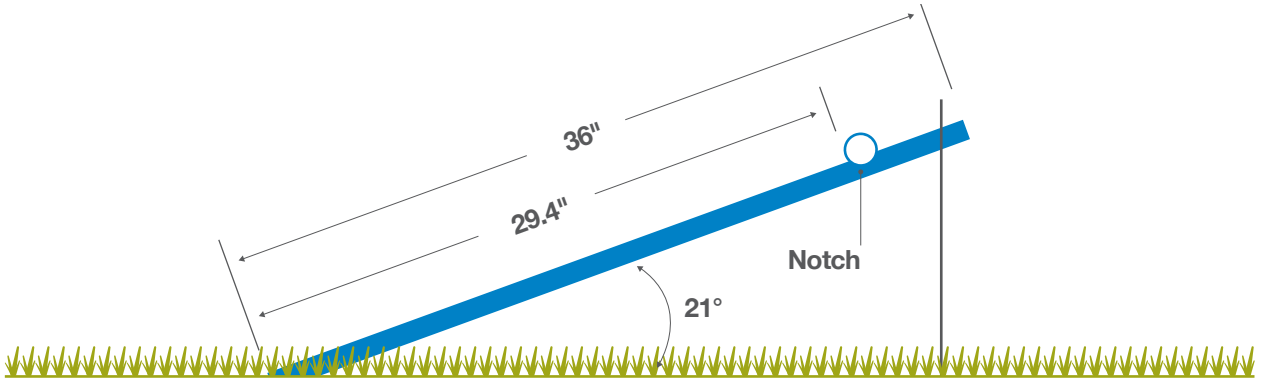
S T E M

Why does your putt roll fast or slow?

On a putting green, it isn't just how hard you swing that matters. It's also the **speed of the green** — how far and fast the ball rolls before friction slows it down. The USGA Test Center uses a **Stimpmeter** to measure green speeds. In this activity, you'll build your own Stimpmeter and try it out.

What Do You Need?

- 2 narrow pieces of firm material at least 36 inches long, such yardsticks or cardboard
- Tape or glue
- Scissors or marker
- Protractor
- Tape measure
- Golf ball, plus at least two other types of small balls (ping pong ball, hard rubber ball, etc.)
- At least three different surfaces to test on (grass, astroturf, carpeting, cement, wood, etc.)
- Stopwatch



Stimpmeter

This activity is adapted from NBC Learn, *Science of Golf: Kinematics* (http://www.nbclearn.com/science-of-golf)

What Do You Do?

1 Build a Stimpmeter. Hold two pieces of firm material together length-wise, so they form a v-shaped channel. Tape or glue them. Cut a notch (or mark a spot) at 29.4 inches from the end.

2 Stand on a level surface, at least 15 feet long. Face the center.

3 Using the protractor, raise the notched end of the Stimpmeter to 21 degrees. Release the ball from the notch. Record how far and long it rolls from the END of the Stimpmeter until it stops.

4 For each experiment, follow these steps:

- Roll the ball 3 times in one direction. Average the results.
- Walk to where the ball stopped rolling and turn around to face your starting position.
- Now roll the ball 3 times in the **opposite direction.** Average the results.
- Calculate the combined average.

5 Experiment with these variations:

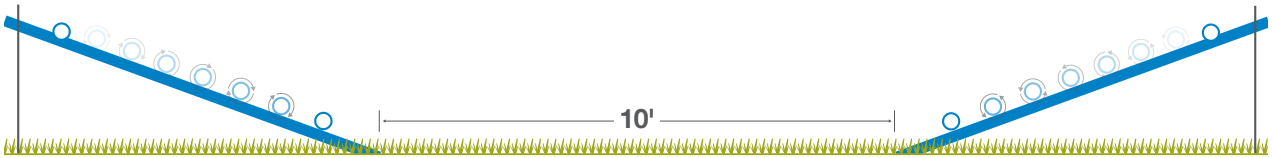
- Test how a golf ball rolls across at least 3 **different surfaces.**
- Test how at least 3 **different balls** roll across the same surface.
- Roll one ball across one surface with the Stimpmeter at 3 **different angles.**
- Roll one ball across one surface from 3 **different positions** on the Stimpmeter.

How to Calculate Averages

1 Add distance measurements from the first 3 rolls and divide by 3.

2 Add distance measurements from the second 3 rolls and divide by 3.

3 Add the averages from steps 1 and 2, and divide by 2 to get the speed of the green.



What Happens?

Use the chart to record your data and make more charts as needed. Use the data to make a graph comparing distance and time.

What Does it Mean?

- Which experiment had the fastest green? The slowest?
- What did you learn about friction and speed?

Challenge!

Try different combinations of variables (surface type, ball type, angle, position).

- Which combination makes the ball roll the furthest and longest?
- Which combination makes the ball roll the shortest distance?

Find Out More

- Read *Key Concepts.*
- Watch the NBC Learn video “Kinematics” at www.nbclearn.com/science-of-golf.

Golf Ball on Different Surfaces

Surface	Distance: Starting Direction feet				Distance: Opposite Direction feet				Overall Distance Average Speed of the Green feet
	Roll 1	Roll 2	Roll 3	Average	Roll 4	Roll 5	Roll 6	Average	
Grass	*6*	*5*	*7*	*6*	*5*	*7*	*5*	*5.6*	*5.8*

Surface	Time: Starting Direction seconds				Time: Opposite Direction seconds				Overall Time Average seconds
	Roll 1	Roll 2	Roll 3	Average	Roll 4	Roll 5	Roll 6	Average	

Add this chart to your Test Lab Log!

Create: Putting Green

Putting

Grades 6-8

S T E M

What makes a putting green challenging, but not impossible?

The USGA Test Center helps golf courses make sure that putting greens challenge the skill level of the players, but aren't unfair. In this activity, you'll use what you've learned about **friction, speed,** and **balance** to create your own putting green — and then compete with your friends in a tournament!

What Do You Need?

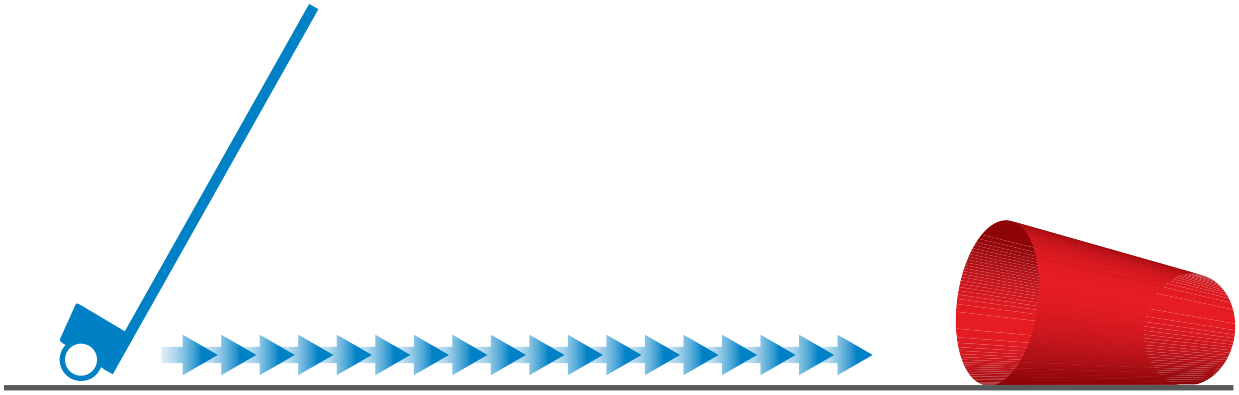
- Paper
- Pens
- Materials for the green surface (astroturf, cardboard, fabric, etc.)
- Materials to create hazards (water, sand, etc.)
- Scissors
- Large plastic cup (one per hole)
- Masking tape
- Putter (or stick of similar length)
- Golf ball (or similar small ball)

What Do You Do?

1. Find a large space where you can create one or more putting greens.
2. Design them first on paper, including shape, hole size and placement, and standard golf course hazards (sand pit, water, etc.). Think about what would make a green harder or easier — faster isn't necessarily better.
3. Decide whether to restrict how a player can stand, e.g., must stand on tiptoe, must bend over 90 degrees, etc.
4. Build the putting green(s) out of available materials, taping down one cup per hole for the target.
5. Have everyone play each putting green once. Record the scores. For each hole, calculate the average of the top half of the scores (the "better half" average). You can use this average as par.
6. Have a tournament. Invite friends to play also!

How to Calculate Averages

1. Add up the best half of scores for the same hole.
2. Divide that number by the number of scores. The result is the "better half" average.



What Happens?

- Record your scores.
- Note the results, including diagrams and/or photos of the putting greens.

What Does it Mean?

- How did what you know about friction, speed, and balance influence your design?
- What is the best strategy for playing each hole, and why?

Find Out More

- Read *Key Concepts.*
- Watch the NBC Learn video "Kinematics" at www.nbclearn.com/science-of-golf.

HOLE	1	2	3	4	5	6	7	8	9
PAR									
[NAME]									

Add this chart to your Test Lab Log!

Connect: Your Local Golf Course

Putting

Grades 6-8

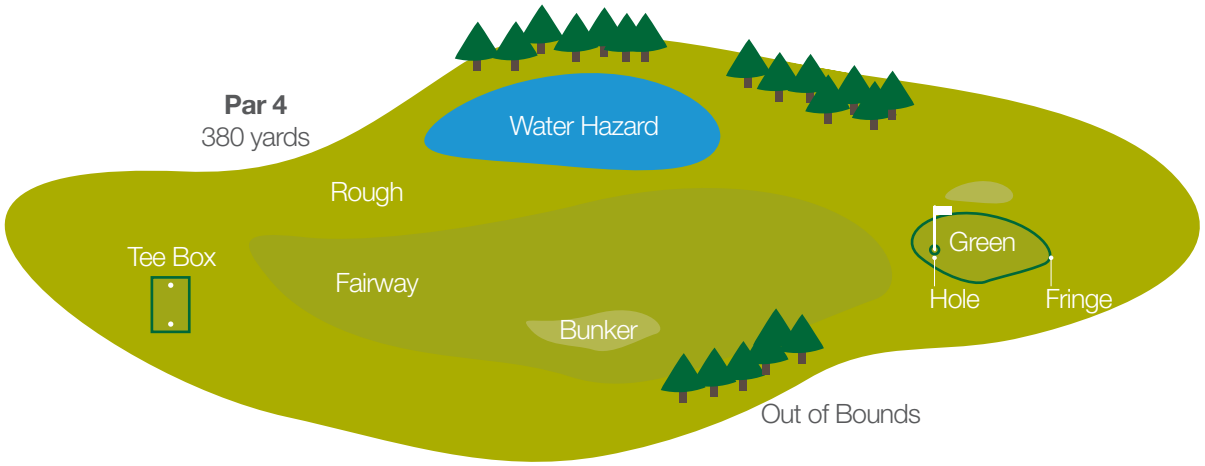
S T E M

How fast is your local golf course?

The putting green speed of American golf courses ranges from 7 to 12 feet. How does your own local golf course compare? In this activity, you'll use a Stimpmeter to find out!

What Do You Need?

- 2 narrow pieces of firm material at least 36 inches long, such yardsticks or cardboard
- Tape or glue
- Scissors or marker
- Protractor
- Tape measure
- Putter
- Golf ball



What Do You Do?

1 Build a Stimpmeter. Hold two pieces of firm material together length-wise, so they form a v-shaped channel. Tape or glue them. Cut a notch (or mark a spot) at 29.4 inches from the end. You can skip this step if you have already built one.

2 Find a nearby golf course. Ask them if it's ok to do your experiment.

3 For each putting green on the course, follow these steps:

- Find a level area on the green.
- Using the protractor, raise the notched end of the Stimpmeter to 21 degrees. Release the ball from the notch. Record how far and long it rolls from the END of the Stimpmeter until it stops.
- Roll the ball 3 times in one direction. Average the results.
- Walk to where the ball stopped rolling and turn around to face your starting position.
- Now roll the ball 3 times in the **opposite direction.** Average the results.
- Calculate the combined average.

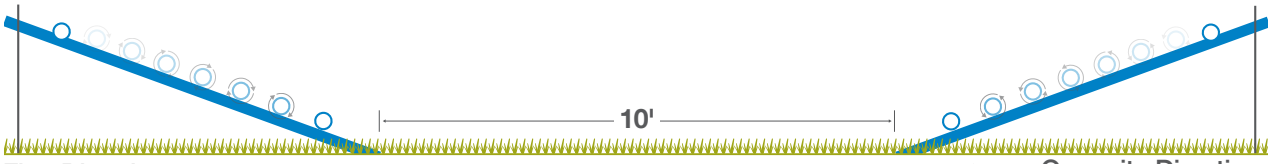
4 Once you know the speed of the greens, play a full round, and figure out the best strategy for each hole based on how fast or slow it is.

How to Calculate Averages

1 Add distance measurements from the first 3 rolls and divide by 3.

2 Add distance measurements from the second 3 rolls and divide by 3.

3 Add averages from steps 1 and 2, and divide by 2.



What Happens?

- Use the chart to record your data.
- Note the results, including diagrams and/or photos, and share them with the golf course, friends, and family.

What Does it Mean?

- What did you learn about the putting greens on your local golf course?
- What is the best strategy for playing each hole, and why?

Find Out More

- Read *Key Concepts.*
- Watch the NBC Learn video "Kinematics" at www.nbclearn.com/science-of-golf.

Hole	Distance: Starting Direction feet				Distance: Opposite Direction feet				Overall Distance Average Speed of the Green
	Roll 1	Roll 2	Roll 3	Average	Roll 4	Roll 5	Roll 6	Average	feet
	6	*5*	*7*	*6*	*5*	*7*	*5*	*5.6*	*5.8*

Add this chart to your Test Lab Log!

Key Concepts

Acceleration
The increase of an object's velocity over time.

Balance
An even distribution of weight enabling an object to remain stable.

Center of Gravity
The point in an object around which all weight is evenly distributed and balanced.

Deceleration (Negative Acceleration)
The decrease of an object's velocity over time.

Friction
A force between objects moving in different directions, when their surfaces touch each other and oppose each other's motion.

Gravity
A force of attraction that pulls objects toward each other. The more mass an object has, the stronger its gravitational pull.

Kinematics
A branch of classical mechanics in the science of physics that describes motion through position, velocity, and acceleration.

Position
The place where an object is located.

Read the Green
To look carefully at the shape, slope, grass, etc., of a putting green to figure out the best way to putt the ball into the hole.

Speed
The measure of how fast an object travels a specific distance over a specific time.
S = D / T

Speed of the Green
How fast or slow the ball moves across a putting green.

Stimpmeter
A simple device that rolls a golf ball onto a putting green at a fixed speed, so that you can measure how fast or slow the green is.

Velocity
The measure of speed in a specific direction.