

# The Science of Golf

## Test Lab Toolkit **The Course: Water**

Grades 6-8



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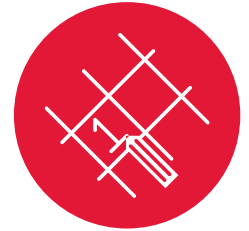
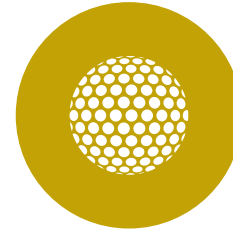
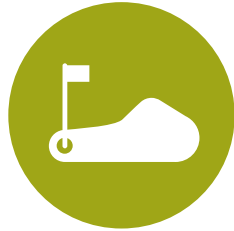
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Test Lab Toolkits bring math and science to life by showing how STEM studies play a big role in the game of golf. They are funded by the United States Golf Association (USGA).



# Welcome to the Test Lab Toolkit!

Water



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 more about how they work. Since people keep thinking of new ways to improve the game, the USGA needs to constantly test new equipment to make sure it doesn't interfere with the game's best traditions or 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 behind the **WATER** through activities that let you:

- 1 Experiment with evaporation and transpiration (and learn how they affect a golf course)
- 2 Investigate different kinds of soil (and discover which captures or loses the most water)

3 Design your own golf course (and figure out how to give it the water it needs)

4 Measure water use in your own home (and come up with easy water conservation strategies)

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 and math behind the world's greatest game?

# Investigate: Evapotranspiration

Water



Grades **6-8**



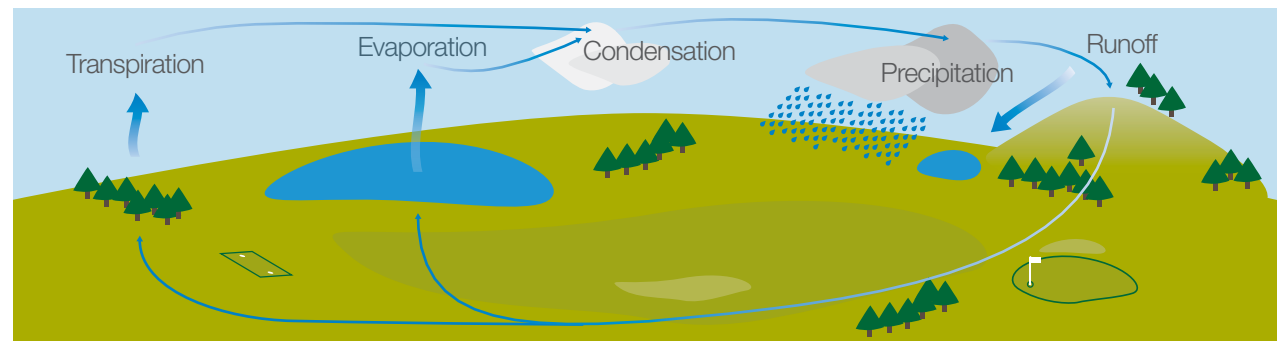
## How does water change from a liquid to a gas?

In addition to testing golf equipment, the USGA also promotes **environmental sustainability** on golf courses by studying how to keep courses beautiful and healthy, while conserving resources. One of the most important resources is water. To be able to conserve it, knowing when you need to irrigate and when you don't, you have to understand the **water cycle**. In this activity, you'll investigate the phase of the water cycle called **evapotranspiration** — the double process of **evaporation** from land and **transpiration** (breathing out water vapor) by plants.

## What Do You Need?

5 clear plastic cups or other clear containers, all the same size, at least 6 inches high  
Masking tape  
Ruler  
Marker

Water  
Aluminum foil  
Scissors  
2 white carnations (or other white flowers)  
Food coloring in 2 colors



Water Cycle





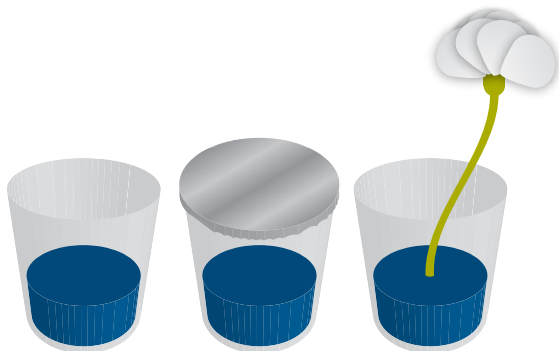
## What Do You Do?

- 1 Put a piece of tape up the side of 3 cups. Mark the tape every  $\frac{1}{4}$  inch, up to 5 inches.
- 2 Pour water into all 5 cups, up to 4 inches.
- 3 For the 3 containers with tape: cover one with aluminum foil, put a carnation in the second, and leave the third alone. Put them all by a sunny window.
- 4 For the other 2 containers, put a few drops of different food coloring in each. Split the stem of the second carnation in half, from the bottom up about 7 inches. Put the carnation in between the 2 cups, so that half its stem is in each.
- 5 Let all containers sit at least 24 hours.
- 6 When you return, measure the level of the water in the 3 cups with tape. What happened?
- 7 Look at the carnation in the food coloring. What happened?

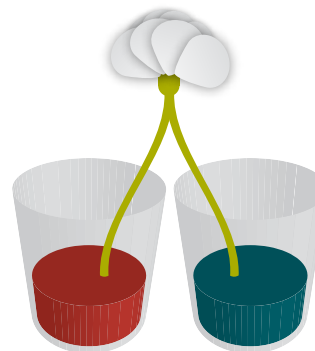
## Challenge!

After it rains, go outside and find a large puddle. Draw its outline in chalk. Check on the puddle every few hours, or even days, depending on its size. Each time, draw a new outline. How long does it take to evaporate?

Evaporation Experiment



Transpiration Experiment



## What Happens?

Use the chart to record your results, and make more as needed.

## What Does it Mean?

- What did you learn about evaporation and transpiration?
- Which container had the least water after 24 hours, and why?
- How do you think evapotranspiration would affect a golf course?

## Find Out More

- Read *Key Concepts* at the back of this Toolkit.
- Read *Water: Background Information*.
- Watch the NBC Learn video “Water Conservation” at [www.nbclearn.com/science-of-golf](http://www.nbclearn.com/science-of-golf).



Cup	Water Level		
	Day/Time	Day/Time	Day/Time
Aluminum Foil	4 inches	3 1/2 inches	3 inches
Carnation			
Just Water			

Add this chart to your Test Lab Log!

# Investigate: Water Retention

Water



Grades **6-8**

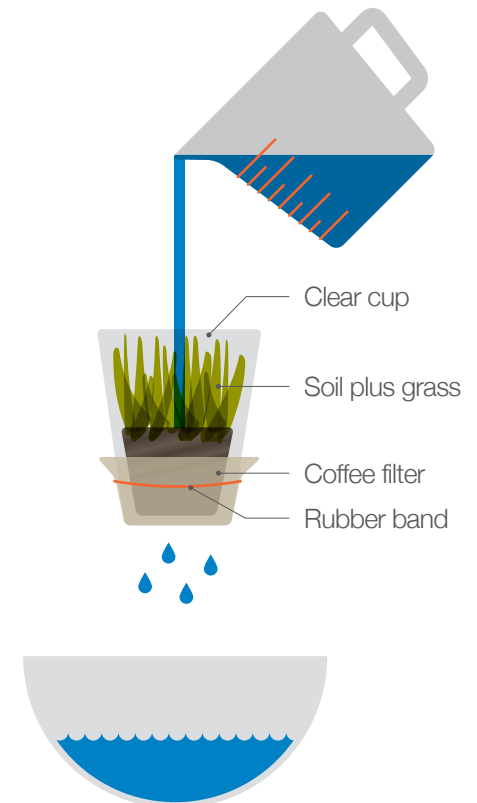


## How can you tell how much water different kinds of soil capture?

On a golf course, turfgrass plays an important role in **water retention**. By looking at how much water the course “captures” through natural sources (such as **rainfall**) and how much it loses (through **runoff**), you can figure out how much is retained and how much needs to be replaced through **irrigation**. The USGA studies the water retention of different turfgrasses to help golf course managers make the best selections. In this activity, you’ll explore how well turfgrass holds onto water compared to other soils.

## What Do You Need?

- 4 plastic cups
- 1 sample of turf (grass plus soil), about 4 inches deep
- 3 different soil samples (sand, gravel, soil without grass, etc.), each about 4 inches deep
- 4 paper coffee filters
- 4 rubber bands
- Bowl
- Scissors
- Measuring cup
- Water
- Scale (optional)



This activity is adapted from NBC Learn: Science of Golf, “Water Conservation”





## What Do You Do?

- 1 Collect the turf and soil samples from your local park, backyard, garden store, etc.
- 2 Cut off the bottom of each cup. Place each cup inside a coffee filter and attach it with a rubber band.
- 3 Put a turf or soil sample in each cup, about 4 inches deep. If you want to be precise, you can weigh each cup with sample. Label the different samples.
- 4 Hold a cup over a bowl and pour in 6 oz of water.
- 5 When water stops dripping out of the cup's bottom, pour the water in the bowl back into a measuring cup. Record the amount.
- 6 If you have a scale, weigh the cup again and record the new amount.
- 7 Repeat steps 4-6 with the other cups.

### Challenge!

Try this experiment with common turfgrasses used on golf courses, such as bent grass, bermudagrass, or Kentucky bluegrass. You can ask your local golf course for samples, or grow them from seed.

## What Happens?

Use the chart to record your results, and make more as needed.

## What Does it Mean?

- What did you learn about water retention?
- Which type of soil retained the most water and why?
- How do you think turfgrass affects a golf course?

## Find Out More

- Read *Key Concepts* at the back of this Toolkit.
- Read *Water: Background Information*.
- Watch the NBC Learn video “Water Conservation” at [www.nbclearn.com/science-of-golf](http://www.nbclearn.com/science-of-golf).



### ◀ Different types and cuts of turf at Harbour Trees Golf Club

Copyright USGA/Kirk H. Owens





	Water Added ounces	Water Lost ounces	Water Retained (added - lost) ounces	Weight before Water pounds	Weight after Water pounds
Turf (soil plus grass)	6	4	2	.2	.3
Soil only					
Sand					
Gravel					

 Add this chart to your Test Lab Log!

# Create: Golf around the World

Water



Grades **6-8**



## How would you design a golf course for a different environment?

How much water a golf course needs depends a lot on **local climate**. For example, a golf course in a desert climate may need more or less water than one in New England, depending on the type of **turfgrass** used.

That's why the USGA Green Section recommends using turfgrass adapted to the natural environment.

In this activity, you'll design your own golf course and think about how much water you would need (and how you would supply it) to keep the course healthy.

## What Do You Need?

Computer

Paper and markers

OR foam board and craft materials

▼ **Pebble Beach Golf Links (coastal golf course)**

Copyright USGA Museum/John Mummert





## What Do You Do?

- 1 Pick a location somewhere in the world for your golf course. Research its biome (climate, rainfall, temperature, vegetation, etc.) at [earthobservatory.nasa.gov/Experiments/Biome](https://earthobservatory.nasa.gov/Experiments/Biome) or elsewhere.
- 2 Decide how your course will compare to its natural environment. Will it use the same kinds of terrain, vegetation, and water features, or will you create a different environment? For example, you could design a grasslands course in a grasslands environment, or a grasslands course in a desert environment.
- 3 Create at least one hole of your golf course on paper or with craft materials, showing vegetation and water sources, as well as the surrounding natural environment.
- 4 Based on your research, estimate whether your course will need a little or a lot of water. How much will be available from rainfall and onsite water sources? How much irrigation will be necessary? A course that uses plants adapted to the natural environment may need less irrigation.
- 5 Compare your course with the ones your friends made. Which ones need the most and least water?



## What Happens?

Compare golf courses and note the results.

## What Does it Mean?

- How does the local environment affect water needs?
- What did you learn about golf course design?

## Find Out More

- Read *Key Concepts* at the back of this Toolkit.
- Read *Water: Background Information*.
- Watch the NBC Learn video “Water Conservation” at [www.nbclearn.com/science-of-golf](http://www.nbclearn.com/science-of-golf).

### ◀ Desert Forest Golf Club (desert golf course)

Copyright USGA Museum/John Mummert

# Connect: Water in Your Home

Water



Grades **6-8**



## How can you conserve water at home?

The USGA Green Section helps golf course managers maintain courses so that they conserve water as much as possible. But **water conservation** isn't just an important issue on a golf course

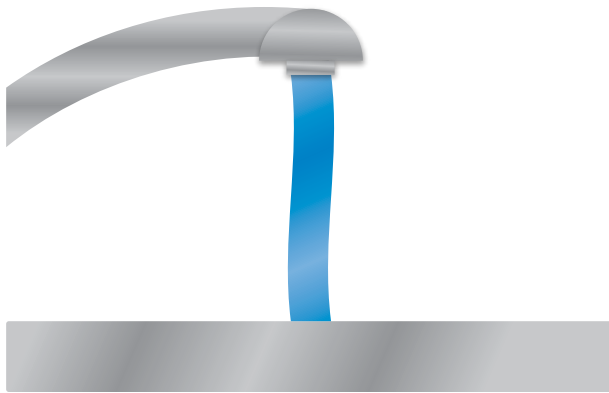
— it's important throughout the world, including in your own home. In this activity, you'll explore how much water you use at home, and think about ways to conserve it.

## What Do You Need?

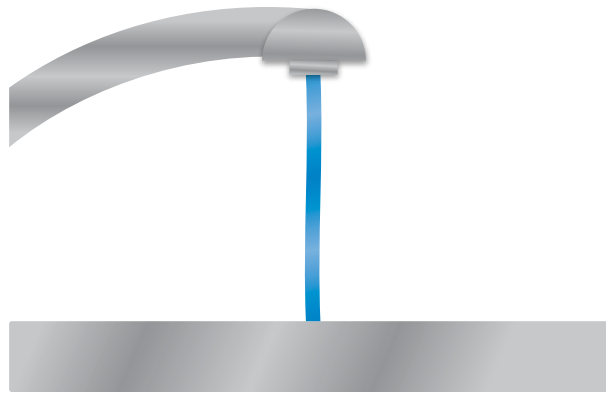
Chart

Pencil

Stopwatch



Full on



Half on



Dripping

This activity is adapted from the Three Actions Project ([www.threeactionsproject.org/Actions/Track-Your-Daily-Water-Use.php](http://www.threeactionsproject.org/Actions/Track-Your-Daily-Water-Use.php))

The Science of Golf





## What Do You Do?

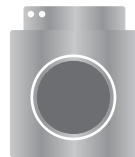
- 1 Use the chart to calculate how much water you (or your entire family) use in a week. Record **how many times** you do each of the activities each day.
- 2 At the end of the week, **add up the total** for each activity and **multiply** by the Average Water Usage.
- 3 Compare your results with friends. Who had the lowest and highest weekly water consumption? Why?
- 4 Brainstorm ways to conserve water at home. Check out [www.threeactionsproject.org/Actions](http://www.threeactionsproject.org/Actions) for ideas.
- 5 You can also work with friends to figure out how much water your golf course or school uses.

If the faucet is run for 4 minutes a day...



4,000 gal/yr

If you do just 2 loads every week...



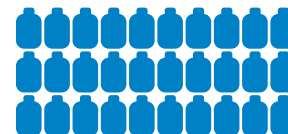
5,000 gal/yr

If every other day you took a 15-minute shower...



19,000 gal/yr

If a toilet is flushed 15 times per day...



33,000 gal/yr

This chart is adapted from eLocal.com (<http://www.elocal.com/content/home-expert-network/water-home-wasting-infographic-431>)

## What Happens?

Use the chart to record your results, and make more as needed.

## What Does it Mean?

- What did you learn about your water consumption?
- What are some ways to conserve water at home?

## Find Out More

- Read *Key Concepts* at the back of this Toolkit.
- Read *Water: Background Information*.
- Watch the NBC Learn video “Water Conservation” at [www.nbclearn.com/science-of-golf](http://www.nbclearn.com/science-of-golf).



	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total for Week	Average Water Usage gallons	Total Water Usage gallons
Toilet flush									x 3.5	
Wash hands (half-on)									x .25	
Wash face (half-on)									x .5	
Brush teeth (half-on)									x .5	
Shower (10 min)									x 20	
Kitchen faucet (1 min)									x .5	
Wash Dishes by hand (fill basin)									x 10	
Dishwasher									x 12	
Washing machine									x 42	
Lawn sprinkler (5 min)									x 10	
<b>Total Weekly Water Usage</b>										

This activity is adapted from the Three Actions Project ([www.threeactionsproject.org/Actions/Track-Your-Daily-Water-Use.php](http://www.threeactionsproject.org/Actions/Track-Your-Daily-Water-Use.php))

 Add this chart to your Test Lab Log!

# Key Concepts

Water



## **Agronomist**

A scientist who specializes in turf and soil management.

## **Condensation**

The conversion of water from a gas or vapor to a liquid due to cooling.

## **Evaporation**

The conversion of water from a liquid to a gas or vapor due to heat. Water can evaporate from both soil and bodies of water (lakes, rivers, oceans).

## **Evapotranspiration (ET)**

The combined processes of evaporation and transpiration. Golf course managers use this term to refer to the total loss of liquid water from a course via both evaporation and transpiration.

## **Humidity**

The amount of moisture in the air. Even in the desert, the air always contains water vapor that has evaporated from land and water sources, or transpired from plants.

## **Irrigation**

To apply water to the land via artificial means (such as a sprinkler) rather than natural means (such as rainfall). Irrigation is used on golf courses and farms when water from natural sources isn't enough for healthy plant growth.

## **Precipitation (Rainfall)**

The process by which water vapor in the air condenses to a liquid and falls to the ground as rain. Precipitation can also take a solid form (hail, sleet, or snow).

## **Runoff**

Water that flows away from the soil surface, often into a nearby body of water (river, pond, etc.), rather than being absorbed by the soil. To figure out the water deficit of a golf course and how much to irrigate, managers need to know how much rainfall is lost to runoff.

## **Salinity**

The salt content of a substance. Excessive salinity in the soil slows down the growth of turfgrass.

## **Transpiration**

The movement of water through a plant from the moment it's absorbed by the roots until it's released as a gas through the plant's leaves.



### **Turfgrass**

A variety of grass used to grow turf (outdoor playing surfaces), for sports like golf or baseball. Different types of turfgrass are well-suited to different climates and seasons. Warm-season grasses (such as bermudagrass and buffalograss) require less water than cool-season grasses (such as Kentucky bluegrass and tall fescue).

### **Water Conservation**

The effort to protect the purity of water sources, reduce the need of environments and populations for water, and use water as efficiently as possible with little waste. Water conservation is an important issue in many areas of the world where water quality and quantity are both at risk.

### **Water Cycle (Hydrologic Cycle)**

The natural process by which water constantly changes its state and moves from the surface of the Earth into the atmosphere (via evaporation and transpiration), and then back to the surface again (via precipitation).

### **Water Deficit**

On a golf course, the amount of rainfall that is lost to evapotranspiration and runoff, instead of being retained by the soil.

### **Water Retention**

The ability of an object or surface (like turfgrass) to retain water.

### **Water Requirement**

The amount of water that needs to be applied to a golf course through irrigation, in order to make up for the water deficit.