In The Swing

ACTIVITY 1

There's a lot of science behind making a good shot in golf. As we see in the video, the distance you get depends in part on the arc of the swing you create with the club you choose. It's much like a pendulum. In this activity we will use a pendulum to demonstrate the difference between the carry distance of a long and a short club. When pulled back and released, the pendulum defines an arc much like that of the club.

The length of a club's shaft greatly affects the distance a golf ball can be hit. In the video we saw a demonstration using a driver and a 9-iron. The driver is the longest club a golfer has; it allows the player to obtain the greatest clubhead speed to hit the ball the farthest, and that's why it is used off the tee. The shorter 9-iron can't get the same clubhead speed, so it won't drive the ball as far, and thus you would choose it for reaching shorter distances from the fairway.

Both of these clubs form an arc when they are raised and swung to hit the ball. The greater the arc, the greater the clubhead speed and the greater the momentum at impact with the golf ball. In the video, we see how the student simulates a driver by leaving his left arm free to be pulled back as far as possible, thus forming a large arc to hit the beach ball. However, when his arm is put in a sling to simulate the arc of the shorter 9-iron, the swing distance is very limited and the beach ball does not go nearly as far.

Now use the directions and materials provided by your teacher to set up a pendulum:

1. Position the front end of a ruler directly under the middle of the hanging pendulum bob. Place the object that will represent the golf ball right next to the bob so that it can be struck straight on when the bob is pulled back and released.

2. Hold the bob and pull it straight back over the ruler until it is directly over the 10-cm (4-inch) marking. Release the bob and observe the results. Measure how far the ball rolled as accurately as you can. Record your measurements below. Repeat this three times and record your average reading:

1 = _____ cm 2 = _____ cm 3 = _____ cm Average = _____ cm

3. What do you think will happen to the distance the ball will travel as you pull the pendulum back farther and farther before you release it?

____

Why? ______________________________

____

4. Pull the pendulum back 16 cm and make three trials and record the results:

1 = _____ cm 2 = _____ cm 3 = _____ cm Average = _____ cm

5. Pull the pendulum back until it is stretched straight from its taped position. What cm mark is it directly over?

____

Now release the bob and record the results:

1 = _____ cm 2 = _____ cm 3 = _____ cm Average = _____ cm

6. How did the results of the greater pull-back compare to those of the shorter?

____

____

How does this pattern follow what happens with golf clubs?

____

7. What type of energy does the ball have when it is at rest?

____

8. What type of energy does the pendulum have when it is pulled back and held, but not released?

(a) ______________________________

What type of energy does the pendulum have as soon as it is released?

(b) ______________________________

What kind of energy does the ball have as soon as it is struck?

(c)______________________________

9. What does this tell you about the energy in both a pendulum and a golf club?

____

10. Newton's First Law of Motion says that the ball at rest has inertia and will stay at rest unless acted on by an outside force. What is the force that acts on the ball to change its state of rest?

____

11. Newton's Second Law of Motion says that the change in a body's motion is directly proportional to the force exerted on it. In other words, the bigger the force, the farther the object will be moved. From this, what can you infer about which pull-back distance created the greatest force?

____

12. What would you predict would happen if the pull-back distances were kept the same but the ball was much heavier?

____

(If there is time and you have a heavier object available, try it and see.)

Moving It

Mass, Momentum and Motion

ACTIVITY 2

It takes a force to put anything into motion—and you can take advantage of the science behind the principles of momentum to get the maximum "thwack" from hitting the ball. The golf club's momentum (mass in motion) depends on two factors—how *much* mass is moving and how *fast* it is moving. Scientists express this as an equation—***mass x velocity (speed) = momentum.*** It's momentum that helps make the golf ball move when it is struck by the golf club.

1 **To learn how momentum is dependent on mass,** feel the small rolling objects (marbles or ball bearings) your teacher gives you.

Which one seems to be the heaviest?

____

The lightest?

____

2 Place a ruler that has a groove down the middle on a very small book to elevate it slightly as a track for these rolling objects. Which object do you think will roll the farthest when you release it down the track?

____

Why? ______________________________

3 Release them one at a time and note where each mass object stops. Do this at least three times to discover a pattern in their distances. After all three trials, which mass object traveled the farthest?

(a) ______________________________

Which one traveled the shortest distance?

(b) ______________________________

4 Because these objects are all moving, they all have momentum. We can determine momentum by multiplying mass times speed or velocity. If all the objects have approximately the same speed or velocity as they travel down the ruler, which one has the most momentum to carry it the farthest?

(a) ______________________________

(b) Why? ______________________________

5 How could you make the same mass golf club have more momentum from one swing to the next?

____

6 **To learn how friction reduces momentum,** use the same setup you used at left, but select only one object to roll down the ruler.

7 First roll the object down the track onto the bare floor. Note how far it rolls. This will be your control or standard of comparison.

8 Your teacher has given you some samples of materials with different surfaces. Write the names of each material below and describe its surface:

Material Name	Description of Surface	Distance Predicted	Distance Traveled	
			Trial 1	Trial 2
bare floor	smooth			

9 What effect do you think each of these surfaces will have on the speed of the object and why? Which do you think will have the most dramatic effect? Record your predictions above.

10 Now roll the same object down the groove onto each different type of surface at least twice. Note the results above. Were your predictions correct?

____

11 What caused this loss in momentum?

____

12 If you could take the temperature of each surface as the ball moves over it, what do you think you would find?

(a) ______________________________

Why? (b) ______________________________

(*Hint*—Think about what you saw in the video when the student rubbed his hands together.)

13 Can you infer from these findings why the grass on a green is kept very short?

____

____

14 **To learn about what happens to energy from the clubhead when it strikes the golf ball,** tape two meter sticks parallel to each other on the top of a table or on a clean floor. They should be about 15 cm (1/2 in) apart. These will form a track for the marbles.

15 Place one marble in the middle of the track. Flick an equal-weight marble from the beginning of the track so that it hits the one that is not moving. What happens?

____

16 Now place two marbles touching each other in the center of the track. Flick a third marble into them. What happens?

____

17 Try other combinations, for example, two marbles into two marbles, or two marbles into three marbles. Record what you observe:

____

____

18 What has to happen to the momentum of the moving marble to cause the still one to move?

____

19 From this, what can you infer about the energy from the clubhead when it strikes the golf ball?

____

ACTIVITY 3

Energized

The Conservation of Energy

When you watch Tiger Woods smack a drive off the tee, the ball is moving so fast that it's hard to follow its flight with your eyes. A golf club accelerating at about 100 mph causes a golf ball to fly off the tee at speeds of between 125 and 140 mph. This seems to indicate that the collision created extra energy. According to the Law of Conservation of Energy, however, energy can neither be created nor destroyed. So, what happens here?

Watch as your teacher performs a demonstration similar to the one you have just seen in the video.

Write your answers below.

1. What type of energy does each ball have as it is held up high before being released?

____

2. What type of energy will it have when it is falling?

____

3. The balls will bounce when they hit the floor. Estimate how high each will bounce.

____

4. What will happen to the bouncing motion of each ball after awhile? Why?

____

____

____

5. What will happen to the bounce height if the balls are dropped together?

____

6. Now watch as your teacher drops them together. What happens to the bounce height?

____

7. Where does this extra "bounce " come from?

____

8. How does this apply to the collision of the clubhead with a golf ball?

____

9. Volunteer to try the demonstration for yourself or repeat it at home using your own equipment.

Soaring To Heights
Aerodynamics and Air Pressure

ACTIVITY 4

How is a golf ball like an airplane?

When a golf ball is hit off of the head of a golf club, it is lifted into the air by the same forces that lift an airplane at takeoff—the spinning golf ball is just like the wing of an airplane. The club can control spin and the spin helps create lift, but it's the dimples on the ball's surface that send it soaring straight towards the pin—if you've aimed it properly!

In the video we saw the principles of aerodynamics being demonstrated when a student blew a stream of air across the top of a strip of paper. Try that now for yourself.

1 Get a strip of paper from your teacher. Curl one end over the end of a pencil and hold the strip up to your lips. Blow a strong steady stream of air across the top of the strip.

What happens?

(a) ____________________

For this to happen, where must the air be stronger—on the top or the bottom of the strip?

(b) ____________________

Where is the air moving faster—on the top of the strip or on the bottom of the strip?

(c) ____________________

Which air speed is stronger—faster air or slower air?

(d) ____________________

2 Another example of the power of air can be found using two empty soda cans. Place them on their sides (so they can roll) about two inches apart with their bottoms near the edge of a table or counter.

When you blow a steady stream of air between them, where will the air be moving faster—between the cans or outside of them?

(a) ____________________

Which way do you think they will roll—together or apart—when the air is blown between them?

(b) ____________________

(c) Why?____________________

____

Now try it and see. What results did you get?

(d) ____________________

Were you correct? ____________________

For the cans to roll like this, where must the air be more powerful—inside of them or outside of them?

(e) ____________________

What does this tell you about the pressure or power of slow air compared to that of fast air?

(f) ____________________

3 Now build a bridge by placing a sheet of computer or writing paper over a stack of books about four inches high. From what you have learned already, predict what will happen when you blow a strong stream of air under your bridge.

(a) ____________________

Tell why you think this will happen.

(b) ____________________

____

____

Try it now and see. Was your prediction correct? ____________________

You have just seen ***Bernoulli's Principle*** at work. When air moves more slowly, it exerts greater pressure than when it moves faster (slow air = higher pressure, faster air = lower pressure).

Now think about that golf ball you're about to drive. For the ball to rise, what speed of air must be created on top of it?

(c) ____________________

On the bottom of it?

(d) ____________________

The earliest golf balls, called gutta percha, were smooth and had great difficulty getting and staying airborne because of their drag in the air. However, golfers found that when the gutta percha became dented and dinged from use, the ball could fly farther. Today's golf balls are made with dimples on the surface.

Some examples of drag are the flaps coming down on an airplane wing as the plane lands, parachutes opening as a skydiver falls—or when you stick your hand out the window of a moving car. What do all of these motions do to the flow and speed of the air?

(e) ____________________

What would this do to the lifting power of the air?

(f) ____________________

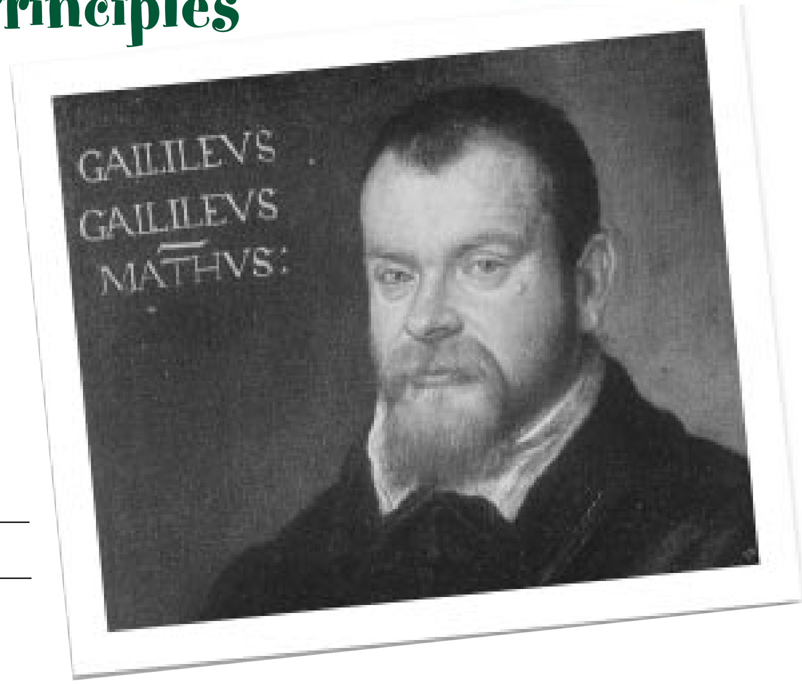
What do you think dimples do to the drag of the ball?

(g) ____________________

Links in Motion

The Scientists of Golf Principles

ACTIVITY 5



If you think it's just your power off the tee that sets your golf ball in motion, you're not alone—actually, the ball has lots of company, namely, gravity and the laws of motion. We know this thanks to the work of two famous scientists, Galilei Galileo and Sir Isaac Newton (who pops in in the video)—two of the most influential and important people in the history of science and especially in our understanding of the physics of motion.

1 First research the lives of these two scientists to answer the questions below, using both reference books and the Internet.

a. When and where were they born?

b. What were the major contributions of each?

c. What were their specific contributions about motion?

2 Now answer these questions:

a. What did their work have in common?

b. How did their work differ?

c. How was the work of each scientist viewed or accepted by the public?

d. Describe how the work of one scientist was the foundation for the work of the other.

3 The golf links: How do the findings of Newton and Galileo apply to the game of golf?

It's All in the Ball

ACTIVITY 6

Imagine if the early golfer who used wooden clubs and wooden balls or feather balls covered with leather were to tee it up at a tournament today. While much about the game might seem familiar, he or she would be shocked to see how the equipment has changed over the years, and is still changing with today's latest technologies. Advances in manufacturing as well as materials like plastics, silicon and space-age alloys have all been utilized to produce today's golf equipment.

Let's take a closer look at golf balls. We already know that all golf balls have dimples, but the size, shape, depth, and arrangement of them may vary depending on the desired flight and carry distance. Looking at the golf balls you have been given, fill in below what you observe as you measure them:

Equipped for the Challenge

Ball #	Weight (g)	Diameter (cm)	Circumference (cm)	Dimple Observations	Bounce (cm)

1. Weigh each golf ball in grams.
2. Place each ball on the metric side of a ruler and determine the diameter (the distance through the middle).
3. Wrap a piece of thread or string around the ball. Cut the string where it just meets and measure its length in centimeters. This gives you its circumference.
4. Look closely at the dimples. Try to see if they make any patterns on the ball surface and if they are all the same depth.
5. Partner with another student for this measurement: Stand a meter stick by the leg of a table or along a wall. Drop each ball from about six feet onto the floor and have your partner try to determine how high it bounces, using the meter stick. Repeat this procedure at least three times for each ball to get an average.
6. If possible, place the same golf balls into a refrigerator overnight and measure their bounce the next day.

Now answer these questions:

1. How did the measurements for each golf ball compare?

____

____

2. In 1930, the United States Golf Association standardized golf ball weight and size. Why do you think this was important?

____

____

3. Was the dimple pattern the same on all the balls you observed?

____

4. Did all the dimples have the same depth?

____

5. How do you think the depth of the dimples affects the flight of the ball?

____

____

____

6. Did all the golf balls bounce the same height?

____

7. What do you think might make the balls bounce differently?

____

____

____

8. How do you think that temperature will affect the bounce of a golf ball?

____

____

Why? ______________________________

____

9. Put a rubber band in the refrigerator overnight. Compare how it behaves to the same size and type of rubber band at room temperature and at a warmer temperature. What do you find?

____

____

10. If time permits, research the different constructions of golf balls and how each type of construction affects distance and spin.