
Overview

Next time you're playing catch with your kids or watching a game on TV, ask them to think about the different balls used to play different sports. What do they look like? Why don't baseballs, soccer balls, footballs, and tennis balls have indentations like a golf ball?

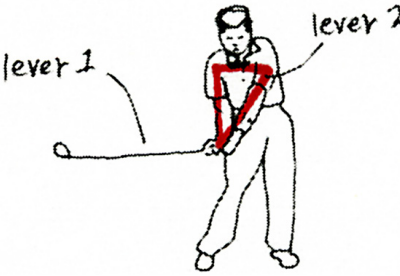
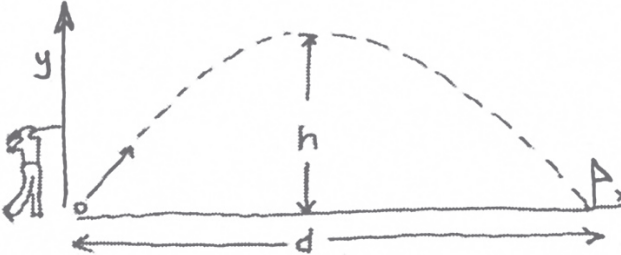
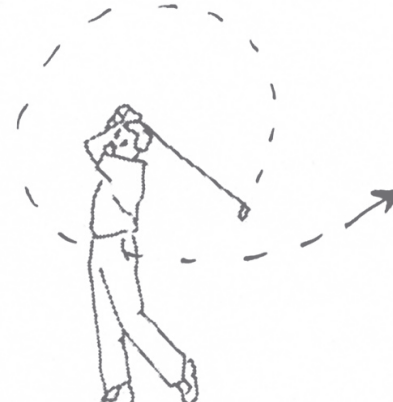
While you may not realize it, the 300-450 dimples that dot the surface of a golf ball actually help it travel farther than a ball with a smooth surface. Love this science of golf fun fact? We've got plenty more to share. Here you'll find games and factoids to help your middle-school student connect the dots between science and golf. To get started, print out a copy of the **Golf Science Facts** for each person who wants to play. The Golf Science Facts highlight key information about different science principles, as well as how they might help a golfer improve their game. Refer to the Golf Science Facts as you play each game.

Ready to challenge your child to a game of **Caddie's Choice**, **Guess My Principle** or **Nine Hole Mix-Up**? Take a swing and get ready to learn about the science and math that make golfers successful on the greens.



GOLF SCIENCE FACTS

Refer to the diagrams and principles here to play the games included in this guide.

Diagram	Action	Scientific Principle
	<p>full swing</p>	<p>LEVER ARM</p> <p>A lever arm is a simple machine. A stiff bar that pivots or turns on a fixed point. It is used to transmit force.</p> <p>How many lever arms work together in a golf swing?</p> <p>A golf swing can be thought of as two levers. One lever is made up of the combined work of a golfer's shoulder, arms and hands. The second lever consists of the club rotating on an axis through the golfer's hands.</p>
	<p>motion of a golf ball</p>	<p>PROJECTILE MOTION</p> <p>Projectile motion is the motion of a moving object that has been given an initial velocity. The object then moves through the air following a path, or parabolic trajectory. The path is caused by the effect of gravity on the object as it travels vertically to its peak and then descends to the ground.</p> <p>Why does a golfer need to understand how projectile motion works?</p> <p>When a golf ball (the projectile) is hit by a golf club, the club gives the ball an initial velocity. The initial velocity can be thought of as having both horizontal and vertical components (an x, y axis). The ball will move along that x, y axis in an arc, in a parabolic trajectory that is caused by the effect of gravity on the ball.</p>
	<p>full swing</p>	<p>MOMENTUM TRANSFER</p> <p>Momentum transfer is the amount of momentum one particle gives to another.</p> <p>How can momentum transfer impact a golfer's tee shot?</p> <p>A golfer's downswing creates momentum. The momentum achieved in that swing provides an energy momentum transfer to the the head of the golf club, creating club-head velocity. The energy from the swing is given to the club head. A well-timed transfer of energy or momentum will create maximum club-head velocity when the ball is hit. This can result in long drives or tee shots.</p>

CADDIE'S CHOICE QUESTIONS

FIRST HOLE

In order to reach the green, I need to hit my ball in an arc over a tree and a pond. Which scientific principle will help me achieve this?

SECOND HOLE

I have my ball on the tee. It is a long way to the green. I want to hit a shot with a faster downswing so I'll hit a longer drive. I know my golf swing is a rotating motion, but which scientific principle will help me reach the green?

THIRD HOLE

I think that my golf ball has more lift and less drag, allowing it to spin and roll farther. What scientific principle makes that happen?

FOURTH HOLE

I'm on the green and need to make a precise shot over a short distance. Which scientific principle will help me find a stroke that is more accurate on the green?

FIFTH HOLE

I need a simple machine that will allow me to transmit force on a golf ball. What scientific principle will help me achieve this?

SIXTH HOLE

When I swing the club, my legs push down onto the ground. Then, the ground pushes me back in an equal and opposite reaction. The ground and I are connected in a kinetic chain of energy transfer. Which scientific principle explains this?

SEVENTH HOLE

There are grooves cut into the face of my club, which are designed to transfer momentum to the ball and create backspin. Do you know which scientific principle makes that happen?

EIGHTH HOLE

When I swing a golf club I realize how hard it is to hold some parts of my body still while other parts are moving. I try to keep my center of gravity near the middle of my body, but it's tough to do. Which scientific principle should I study to help keep my lower body locked, while my upper body moves?

NINTH HOLE

I want to try to hit the longest drive I've ever hit. I think that I need to create a lot of club-head velocity. I have to find a way to move the energy from the swing to the club head. Which scientific principle would help me do that?



CADDIE'S CHOICE PRINCIPLE CARDS

Friction
(club head)

Kinematics
(putting)

Moment of inertia

Ground reaction
forces

Projectile motion

Stability

Momentum
transfer

Aerodynamics

Lever arm



CADDIE'S CHOICE ANSWERS

FIRST HOLE

Projectile motion

SECOND HOLE

Moment of Inertia

THIRD HOLE

Aerodynamics

FOURTH HOLE

Kinematics (putting)

FIFTH HOLE

Lever arm

SIXTH HOLE

Ground reaction forces

SEVENTH HOLE

Friction (club head)

EIGHTH HOLE

Stability

NINTH HOLE

Momentum transfer



GAME #2: GUESS MY PRINCIPLE

Lever Arm

Projectile Motion

Momentum Transfer

Friction

Kinematics

Moment of Inertia

Aerodynamics

Ground Reaction Forces

Stability



GAME #3: NINE HOLE MIX-UP PRINCIPLE SUMMARIES

A golf swing can be thought of as two levers, one being made of the golfer's shoulders, arms and hands and the other being the club rotating on an axis.

The motion of a ball moving along a parabolic trajectory after being hit-moving towards a peak and then falling back down due to the effect of gravity.

A well-timed transfer of energy or momentum from a golf club to the ball's head, creating maximum velocity.

The result of two surfaces rubbing against one another, helping to transfer momentum and create backspin, and lift, allowing a ball to stay in the air longer. This can add yards to a drive.

All of the characteristics of motion that a golfer considers in play – his aim, the club-head velocity when he hits the ball, the position of the club in relation to his body and the point of contact between the ball and the club.

Golfers who want to have a faster downswing and longer drives will need to study the property in physics that shows how easy it can be to set an object in motion around an axis of rotation.

Design properties of a ball, like having dimples, which create lift and minimize drag.

By exerting the force of a golfer's body on the ground, during a downswing, the ground will then generate a force back into the golfer's body, passing energy through a kinetic chain, or ultimately, into the swing.

It will help a golfer maintain control of their body mass while they are moving if they keep their center of gravity near the middle of their body.



NINE HOLE MIX-UP ANSWERS

LEVER ARM

A golf swing can be thought of as two levers: one is the golfer's shoulders, arms and hands and the other is the club rotating on an axis.

PROJECTILE MOTION

The motion of a ball moving along a parabolic trajectory after being hit - moving upwards towards a peak and then falling back down due to the effect of gravity.

MOMENTUM TRANSFER

A well-timed transfer of energy or momentum from a golf club to the ball, creating maximum velocity.

FRICTION

The result of two surfaces rubbing against one another, helping to transfer momentum and create backspin, and lift, allowing a ball to stay in the air longer. This can add yards to a drive.

KINEMATICS

All of the characteristics of motion that a golfer considers in play -- her aim, the club-head velocity when she hits the ball, the position of the club in relation to her body and the point of contact between the ball and the club.

MOMENT OF INERTIA

Golfers who want to have a faster downswing and longer drives will need to study the property in physics that shows how easy it can be to set an object in motion around an axis of rotation.

AERODYNAMICS

Design properties of a ball, like having dimples, which create lift and minimize drag.

GROUND REACTION FORCES

By exerting the force of a golfer's body on the ground, during a downswing, the ground will then generate a force back into the golfer's body, passing energy through a kinetic chain, or ultimately, into the swing.

STABILITY

It will help a golfer maintain control of their body mass while they are moving if they keep their center of gravity near the middle of their body.

